DNR College (A) Bhimavaram

Subject –Zoology 6A Sustainable Aquaculture management

Unit-I

Essay questions

1. 1, **Status of Aquaculture at global level**

Rearing and propagation of selection of economically important species culture under controlled or semi controlled conditions is called Aquaculture.

The word ‘aquaculture’, though used rather widely for the last two decades to denote all forms of culture of aquatic animals and plants in fresh, brackish and marine environments, is still used by many in a more restrictive sense. For some, it means aquatic culture other than fish farming or fish husbandry, whereas others understand it as aquatic farming other than mariculture. It is also sometimes used as a synonym for mariculture. However, the term aquaculture is sufficiently expressive and all-inclusive. It only needs a clarification that it does not include the culture of essentially terrestrial plants (as, for example, in hydroponics) or of basically terrestrial animals. However, when it needs to be used to denote

- The type of culture techniques or systems (e.g. pond culture, raceway culture, cage culture, pen culture, raft culture),
- The type of organism cultured (e.g. fish culture or fish husbandry, oyster, mussel, shrimp or seaweed culture),
- The environment in which the culture is done (e.g. fresh water, brackish water, salt water or marine aquaculture or mariculture) or
- a specific character of the environment used for culture (e.g. cold-water or warm-water aquaculture; upland, low land, inland, coastal, estuarine), the use of restrictive terms would probably be more appropriate.
- While aquaculture is generally considered a part of fisheries science, there is now a tendency to denote the distinction between the two by using the term ‘fisheries and aquaculture’, because of some of the basic differences in development and management.

Significance of aquaculture

Alternative food source

Fish and other seafood are good sources of protein. They also have more nutritional value like the addition of natural oils into the diet such as omega 3 fatty acids. Also since it offers white meat, it is better for the blood in reducing cholesterol levels as opposed to beef's red meat. Fish is also easier to keep compared to other meat producing animals as they are able to convert more feed into protein.

Alternative fuel source

Algae are slowly being developed into alternative fuel sources by having them produce fuels that can replace the contemporary fossil fuels. Algae produce lipids that if harvested can be burn as an alternative fuel source whose only by products would be water when burnt.

Increase Jobs in the market

Aquaculture increases the number of possible jobs in the market as it provides both new products for a market and create job opportunities because of the labor required to maintain the pools and harvest the organisms grown. The increase in jobs is mostly realized in third world countries as aquaculture provides both a food source and an extra source of income to supplement those who live in these regions.

2. Identifictaion and Biology of Two Indian Major Carps

Carps are major source of animal protein for millions of people in Asia.. They are the most cultured species in the world with 40% production by volume. The major countries producing carps through Aquaculture Are China And India.
Carps belong to the family Cyprinidae which is typically a freshwater group with very wide distribution.

a.Catla catla

Phylum :chordate

Class : Actinopterygii

Order :cypriniformes

Distribution: Tropical freshwater in India, Pakistan, Burma. Physical appearace and special features Body is deep. Head is large and very curspicuous. Mouth is large and upturned. Lips are nonfringed and no barbles Body is greenish dorsally and silvery on sides and ventrally. Structure with a big head, strong fins with more body depth and big scales.

Habitation in pond- Pelagic habitat

Feeding behavior- surface feeder. It filters the plankton available esp. zooplankton. Gill rakers are specially adapted for filtering specific food organism from the water. stage of maturity catla attains maturity by the end of its 2nd year.

Fecundity -fecundity is very high; 2 lakh to 4.2 lakh. g.Catla grows to a length upto 45 cm, weighing more than a kilogram in one year and attains 2.2 kg and 6.5 kg at the end of 2nd and 3rd year respectively.

Breeding-catla breeds naturally in the open waters like the rivers, in particularly during monsoon season. The technique of induced breeding called hypophysation is successful in this species.

b. *Labeo rohita*

Distribution-Tropical freshwaters of India, Pakistan and Burma. It is also cultured in India and in countries like Srilanka, Malaysia, Japan and Thailand.

Physical appearance and special features -Head is small and pointed. Mouth is terminal. The intra orbital space is flat. Lower lip of the mouth is fringed. Scales are light red in colour.

Habitation in Pond -This forms one of the component species of composite culture where it occupies middle column layer.

Feeding behavior -It is column feeder. It feeds on both phytoplankton and zooplankton. It is considered as the tastiest fish of all the carps.

Stage of Maturity- It attains the maturity by the end of 2nd year. Fecundity Fecundity ranged from 2 to 5 lakhs.

Growth- It is one of the fastest growing carp, it attains a length of 35 to 45 cm with a weight of 0.7kg to 1kg in the 1st year depending upon the conditions. At the end of 2nd year it reaches around 2 kg.

Breeding- It is capable of breeding in ponds after inducement by pituitary gland extract. In natural conditions it spawns once in a year. But by induced breeding, it can breed twice in a year.

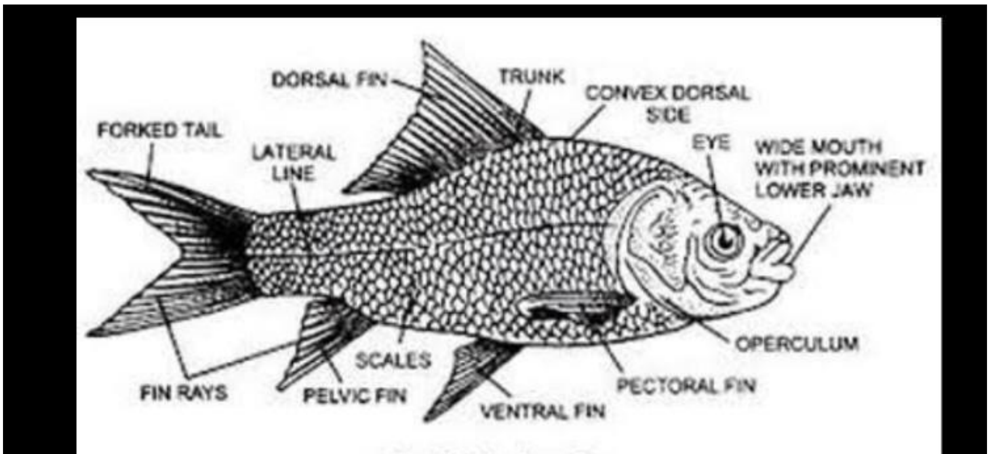

Fig. 9.3. Catla catla.

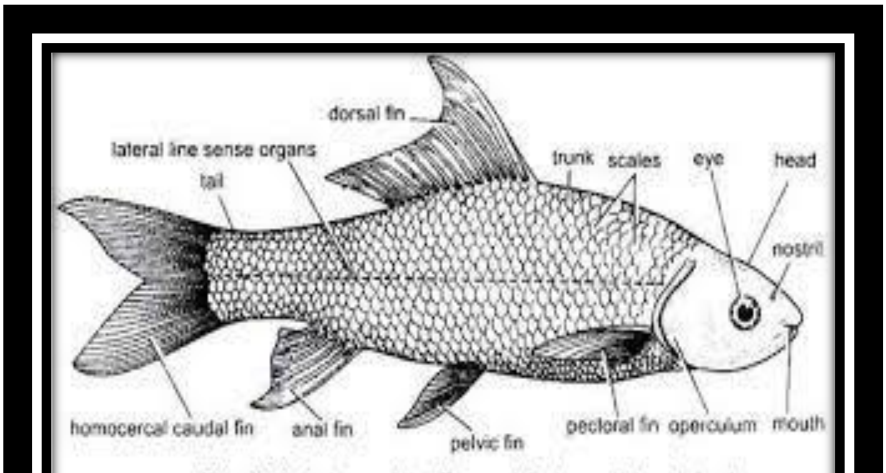

Fig. 15.1. *Labeo rohita*. External features (lateral view).

3. **Identification And Biology of Two Brackish Water Fishes**

India has around 1.2 million ha brackishwater resources comprising of estuaries (deltaic river mouths), coastal lagoons, lakes, backwaters, tidal creeks, canals, mudflats, mangrove plants, etc.

These water bodies lying between the freshwater and marine regimes have certain characteristics: (i) fluctuating water level synchronizing with the tides, (ii) wide salinity range of 0-35 ppt, (iii) higher nutrient content and productivity, (iv) serve as nursery grounds for numerous marine organisms, (v) harbour a rich diversity of flora and fauna, and (vi) support artisanal capture fisheries and provide livelihood to the coastal fishers.

A.Chanos chanos

Distribution: advance fry and finger lings occur in good quantities in estuaries in southindia. In india it is collected from natural soaurces on the east and west coasts during april to June.

Physical appearance: It is elongated and compressed. Mouth is relatively small, anterior and transuerse in position. Upper jaw situated over hanging lower jaw. Pectoral fin pointed with elongated scaly appendages at base.

Special features: Tolerate wide ranges of salinity. It can also be acclimatized to fresh water and grown. One of the additional species in composite fish culture and its performance has been similar to common carp and mrigal.

Feeding behaviour: Generally they feed on lab-lab. The algal mat, consists of a complex animalplant combination material. The young larvae feed on algae belonging to bacillariophyceal, 31 myxophyceal and chlorphyceae. Fry and fingerlings feed upon diatoms, algae, lamellilranchs, fisheggs etc. It is primarily a phytoplankton feeder.

Stage of maturity: The smallest matured female so far recorded was 95 cm length. Fecundity: Fecundity has been observed to vary from 1,93,550 to 57,00,000 eggs from fishes ranging in size from 110 to 157 cm. Eggs are pelagic about 1.2mm in diameter.

Growth: Growth is very rapid on an average, it grows to 350mm in length and 250 gm weight in the first year.

Breeding: The fish does not breed in confined waters. It spawns in the inshore waters of the sea. The seeds of chanos chanos occur generally along shallow coasts, tidal creeks and estuaries during march to august and October to December

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B.Mugil cephalus

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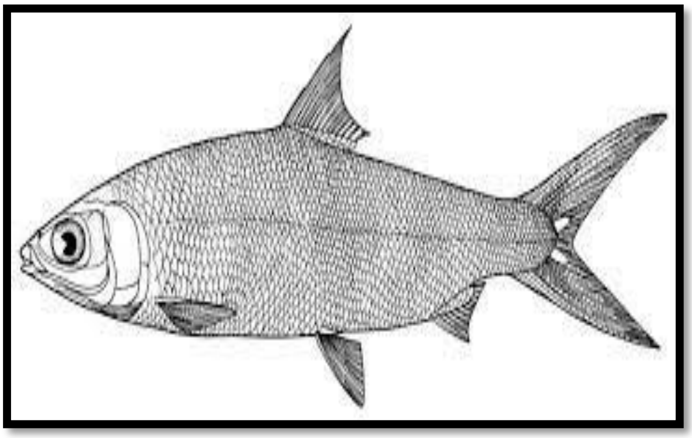
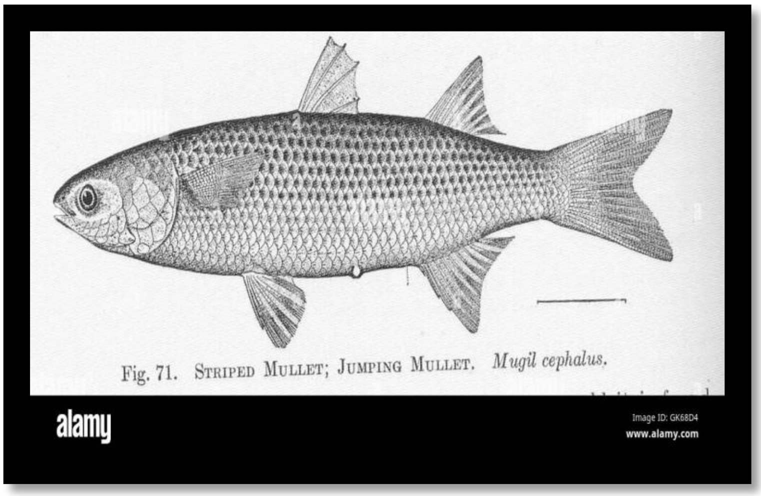


Mugil Cephalus



4.**Traditional,Extensive And Intensive Culture Systems /Types of Prawn culture systems**

The process of growing the baby shrimp a marketable Size in an water body (or) Specially created aquatic environment can be termed as Shrimp farming. Allied activities such as Seed production through hatchery, feed production, harvesting and marketing can also be included under Shrimp farming. According to the nature of scientific management and inputs, shrimp farming systems can be broadly classified as traditional, Extensive, Semi- extensive and Intensive. However there is no universally accepted classification for shrimp farming

Extensive culture

The extensive system of Shrimp farming is an improved method than traditional farming involving construction of new ponds ranging from 1 to 5 ha. In suitable selected areas, selective stocking with fast growing shrimp seeds at a comparitively lower density ranging from a few thousands to 100,000 seeds per hac with supplementary feeding. The water quality is maintained through natural fall and rise (or) exchange through pumping on a low scale. The average production under this system ranges from 1 to 3 tonnes/ha/crop.

Semi-intensive culture

The semi intensive system of Shrimp farming involves construction of ponds ranging from 0.2 to 0.5 hac in size. Selective Stocking hatchery seeds at a high density ranging from 1 to 3 lakh per hac, maintainance of water quality by exchanging daily30%. aerating of the pond with aerators, and feeding the Shrimps with nutritious feed.The average production in this system ranges from3-10 tonnes/hac/crop. In 4-5 months.

Intensive Culture

The intensive sytem of shrimp farming involves construction of concerete ponds in sizes 0.03-0.1 ha ,selective stocking with quality shrimp seeds exclusively procured from hatcheries at a density ranging from 5 to 10 Lakhs per ha maintaining water quality. exchanging over 70% ,using aerators in the ponds feeding the shrimps with nutritionally well balanced high energy feed. The production from this system ranges from 8-12 tonnes/ ha/crop.

5. Lay out And Construction of Fish Pond

The success of any aquaculture system depends on the design and Construction of pond. The major designing features can be deliberated on the and basis of the site, physiography, source and nature of water supply, organisms to be cultured and techniques of management including feeding and harvesting.

1. **Site selection**
   One of the most important aspects of the planning of aquafarms is the selection of site. Proper site selection is the key to Successful aqua

farming. while considering a site for an aquafarm, several aspects have to be Considered like the type and number of ponds to be constructed, the topography of the area, the water supply, the type of fishes to be reared and the metereorological data relating to the temperature, rainfall, evaporation, humidity, sunshine and the wind speed and its direction.

2. **Size of the farm**

Generally the size of the farm varies from 2-200 hactares. The Size of a farm has to be determined number the basis of number of factors. They include the extant of land available,quantity of water, technology to be followed, production and income required to make the enterprise economically viable, and access to markets, manpower and equipment.

3. **Dike Design -**

Dikes are essential and protecting structures of ponds. Since the life span of a farm depends mostly on dike system, the dikes should be the carefully designed.

Types-Dikes are of three types depending on position and width in the farm.

1. Main or peripheral dikes
2. secondary dikes
3. Teritary or partition dikes.

Berm:-

If the production pond is more than 5ha, a platform like space between dike and water area known as berm or Bench line.The width of berm may vary 0.5 and 1.0m, depending on the size of the pond and the height of the dike.The berm provides walkable space for fishermen. It also protect the dike from direct contact with water.

Drainage system: The water supply and drainage systems have to be designed to convey the required quantities of water in the ponds. For operational safety and efficiency, it is considered essential to have separate feeder and drainage canals,as well as inlets and outlets for each pond

Inlets and outlets:

There are many types of water control structures for use in freshwater and coastal pond farms. The Inlets may be anything from a simple pipe to a concrete Sluice. The outlet control structure used is the monk simple or open sluice or turn-down pipe.The type of. inlet or outlet depends mostly on size of the pond.

Pipes -For Small ponds, simple pipes are used for waterControl. The inlet/outlet pipes 15-25cm diameter are to be provided with suitable screens to prevent the entry of unwanted fish from outside and the escape of cultivated fish from the pond.

Sluice :-Another commonly used water control structure is the open sluice.. Sluice gates are commonly used in coastal fish farms Asia. The sluice is a screened gate used both for inlets and outlets. It is especially useful where the discharges are higher in large ponds.Sluice is constructed in the center of the dike wall...It is made of wood Or Concrete and bricks.

Monk

This is the main exit point for water. It is constructed over a strong foundation either with concrete (or) bricks, at the deepest point of the of the lake towards innerside. The monk has two compartments namely vertical tower with three pairs of grooves for housing a screen and control boards, and a horizontal conduit or culvert,behind he tower and passes through the dike. It is made of concrete or brick or the combination of these two.this helps to empty the pond.

6. **Integrated Culture**

The culturing of fish in association with agriculture, ducks, chicks, pigs, prawns is called integrated fish culture. Fish wastes fertilizes the crops while waste from poultry, chicks are used as feed by fish. By integrated fish culture ther is no need to add manure or supplementary feed.

Rice- fish culture:

Fish and rice are one cultured in one.field simultaneously or one after the other.

Advantages-

- 5-15% of increase in Rice production is achieved in this type of culture.

- Tilapia, Common Carp Control aquatic weeds.
- Fish feed on insects and protect plants from infection.
- Fish feed on mosquits, infectious pathogen and control water borne diseases.
- Fishes cultured in this method must face some Situation like high temperature,.low depth, high turbidity,less acidity in water.
- Rice. fish culture taken up in two ways. 1. Simultaneous culture2. Rotational method

Simultaneous culture –

The field *sele*cted for culture is dug up and in ditches 0.75m width h and 0.5m depth. Dikes of 0.3M height, 0.3m width strengthed by embeding grass ,straw are constructed around the plots. Main drain canal will have connections. Fishes of 1 cm size are introduced based upon the calculated site area. Plankton production increasesd requirement. Fish is harvasted before the harvest of rice.

Limitations

- Use lead of chemicals for rice cultue will lead to mass mortaliy of fish.
- Maintaining water depth for fishes is not possible.
- Fishes like Grass carp feed rice plants and cause damage.

Rotational

First rice is cultured and harvested later in the same field fishes are cultured. This is beneficial than simultaneous method. Here chemicals can be utilized for rice as there are no fishes. Water level depth can also be maintained for fishes without any restrictions. Common Coop is selected for rotational Culture.

Pokkali Culture –

This practice is followed in kerala.. Here fish, prawns and rice are cultured in Rotational method. Pokalli field are controlled and influenced by the tides of Vembanad back waters.. Rice is cultured from July- september , after the harvest of rice, from October when marine water enters through tides fish or prawn are cultured. Culture continues from Oct – April. 500-1200 kg per hectare yield is achieved in this method.

Fish – poultry Culture

Poultry farm is constructed over a platform ,built of bamboo sticks,above water level of pond or on the shore of ponds. The dropping from chick fertilise the pond, dead fishes aregiven as meal to fishes. In one hectare land when we rare 5000 prawns,1500 silver carps, 250 chick an yield of 600 kg prawns,600kg fish,in 4 months can be achieved. This Culture followed in AP, TN, Karnataka, west bengal.

Fish Cum Duck farming

Ducks are natural in manure factories. The waste coming from ducks is highly proteineous. Ducks release waste directly in water. These can be reared in pond day time need Shelter only at night times. so, sheds are constructed on

Shore con big coater in cohich ducks cat barrels ducks ave are made to float on.. live at night times. reared 90 one hacters away insects, snails, fishes. land. Duck S Infectious (asual forms and protect. They should Stage fry fertilise be the water by Dabbing. Fishes introduced into pond at fingerling otherwise etc. ducks eat away larval l stage, stages and cause heavy damage. Ducks lay eggs at an age of 2 yrs and, that to at night times. So there damage and carefully early collect eggs from their is no way hours. we can habitat in an hacre tand 2000 kg yield, as obtained this Culture. 3 months

Fish - piggery

China, malasia, Hungry like countries following this Culture. sheds for pigs are near to the pond, waste from pigs highly nutriceous. In one hactare land. Grass Carp, silver coup 6 months pig grow average weight. each pig yield per year. The are Constructed is also 60-100 pigs can be along with pigs for around around feed the 50-60 kg 500-600 kg manure we give to fish their age decide percentage of waste released. pigs are Omnivorous when they take up plantmaterials they fail to digest all70%, Come out as waste toaste along with taken up by common the pond

Short answer questions

1. **Lates Calcarifer**

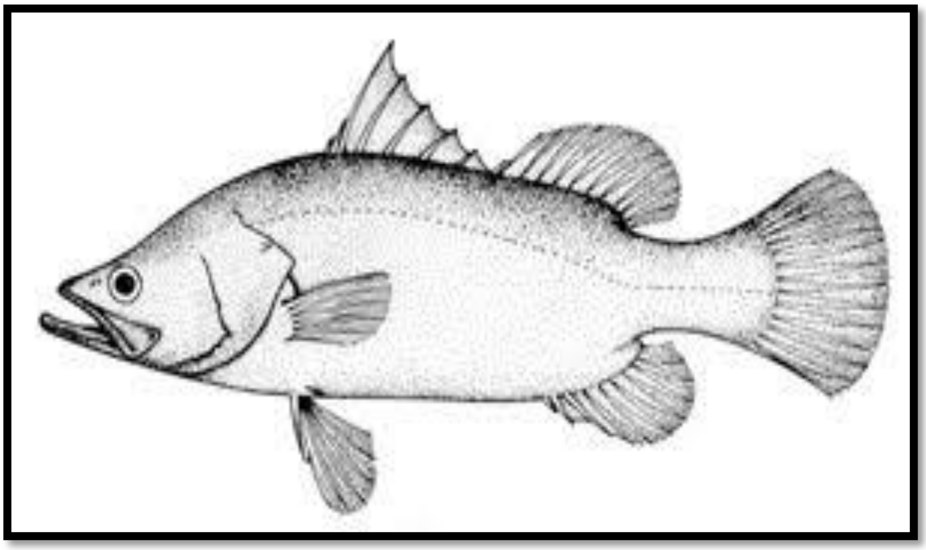
   Identification features

- Body is elongated, compressed, with a deep caudal peduncle. Head pointed, with concave dorsal profile becoming convex in front of dorsal fin. Mouth large, slightly oblique, upper jaw reaching to behind eye; teethvilliform, no canines present.Scales large, ctenoid.
- Dorsal fin with 7 to 9 spines and 10 to 11 soft rays; a very deep notch almost dividing spiny from soft part of fin; pectoral fin short and rounded, several short, strong serrations above its base; dorsal and anal fins both have scaly sheaths.
- Anal fin rounded, with 3 spines and 7 to 8 short rays. Caudal fin rounded. Colour in two phases, either olive brown above with silver sides and belly (usually juveniles) or green/blue above and silver below. No spots or bars present on fins or body.

Habitat and biology

- Lates inhabit freshwater, brackish and marine habitats including streams, lakes, estuaries and coastal waters. Theses are opportunistic predators; crustaceans and fish predominate in the diet of adults. Spawning seasonality varies within the range of this species.
- Spawning occurs near river mouths, in the lower reaches of estuaries, or around coastal headlands. Lates spawn after the full and new moons during the spawning season, and spawning activity is usually associated with incoming tides that apparently assist transport of eggs and larvae into the estuary.
- Lates are highly fecund; a single female (120 cm TL) may produce 30–40 million eggs. Consequently, only small numbers of broodstock are necessary to provide adequate numbers of larvae for large-scale hatchery production.
- Larvae recruit into estuarine nursery swamps where they remain for several months before they move out into the freshwater reaches of

coastal rivers and creeks. Juvenile lates remain in freshwater habitats until they are three–four years of age (60–70 cm TL) when they reach sexual maturity, and then move downstream during the breeding season to participate in spawning.



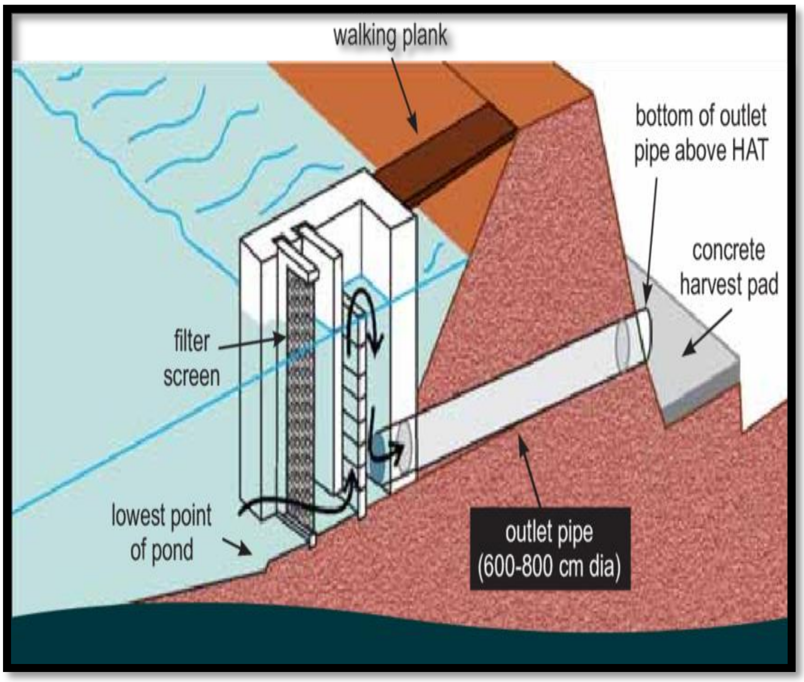
Lates Calcarifer

2. Monk

The monk 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. The water is discharged through a pipeline buried under the dike. A screen keeps the farmed fish from leaving the pond.A monk has advantages similar to those of the sluice gate. The pond water level is easily controlled and adjusted. It can function as an overflow. It simplifies the fish harvest. In addition, a monk is more easily protected than a sluice gate,and it is more economical to build if the pond dike is large. However, it has the disadvantage of not being very simple to construct, particularly if it is built with bricks or concrete.

The complete monk outlet consists of: a vertical three-sided tower (called the monk), usually as high as the outlet dike , a pipeline running through the dike, which is sealed to the back of the tower at its base; a foundation for the tower and the pipeline; and grooves to fix the wooden boards and screens which form the fourth side of the monk. Earth will be filled between the boards.

Internal width 30 – 50 cm , Internal length 40 – 65 cm , Diameter of pipe 10 – 30 cm



3. Monoculture -This refer to fish farming where only one type of fish species and breed is raised on a farm.

Advantages of monoculture fish farming: easy to monitor individual fish breed performance, their is no undue competition for space and feed.

Disadvantages of monoculture fish farming: these includes regression in water quality, cannabalism among fish themselves, overstocking of pond with fish which may leads to diseases outbreak.

Qualities of cultivable fish species in monoculture

- should have fast growth rate.
- should have ability to feed on natural and cheap artificial food.
- should be hardy and resistance to disease. hould be able to tolerate adverse and physico-chemical conditions of pond water.
- should be high nutritive value

Objectives of monoculture in fish culture:

- To get maximum amount of production, and to prevent species extinction by over-exploitation.
- High nutrient rich fish cultivation
- Fish oil used in medicines and in soap making industries for research purposes.
- should be gentle and non poisonous.
- should be easily harvested.
- should be proliferate breeder.
- can reproduce under confined conditions.

should support high population density in pond

DNR College (A) Bhimavaram

Subject –Zoology 6A Sustainable Aquaculture management

Unit-II

Essay questions

1. Construction and maintenance of Fish hatchery

Hatcheries are usually designed with a particular species in mind.

• There are elements common to most hatcheries.

• Bio-security is also very important.

• Maintenance of phytosanitary systems using foot baths at the entrance of hatcheries.

Basic requirements in fish Hatchery

Ponds or tanks for holding and rearing brood stocks

• Spawning pond, tanks or hapas

• Nursery pond, tanks or hapas

• Conditioning pond/tank

• Water supply system and storage tank

• Aeration system

Pumps (for recirculatory egg incubation system)

• Electricity supply and/or generator

• Basins, buckets, containers

• Seine nets, scoop nets, grading basket

• Sensitive scale for weighing fry and fingerlings

• Accessories for packing of fry and fingerlings

Site selection

Selection of site is firat successful step for perfect operation of hatchery.area should be free frompouching, seed availability is to e easy from the site, water source quality and quantity should beadequate.site should be free from floods, easy availability of labour,site should be accessible torail or roadway for transport.

Water Quality

Water quality determines to a great extent the success or failure of a fish cultural operation. Physicaland chemical characteristics such as suspendedsolids, temperature, dissolved gases, pH, mineralcontent, and the potentialdanger of toxic metals must be considered in the selection of a suitable watersource. Plankton & Pollution free water: As running water from rivers or canals or reservoirs is utilizedgenerally for hatchery, it is necessary that the water should be made free of silt and plankton. The watermay be allowed to stand for 24 hrs to allow the setting of silt & debris and then can be passed throughfitters before use in the incubator and hatchery unit.see that watertake is free from pathogens.

Temperature

Optimum temperature: for carps, optimum temperature is 25°C and incubation period is 14-24 hrs.Constant flow of water: The metabolic wastes from the developing embryo such as ammonia andcarbon dioxide are liberate into the water and the accumulation of same is highly toxic to developinembryo. Hence in a carp hatchery provision for maintaining constanflow of water is ensured so thatdeveloping eggs are not exposed to lethal dose of metabolic toxicants.

Disturbance free environment:

The fishes exhibit better courtship behavior in the absence of human interference and hence a stressfree environment is essential for better spawning efficiency.

Dissolved Oxygen

Dissolved oxygen concentrations in hatchery waters are depleted in several ways, but chiefly byrespiration of fish and other organisms and by chemical reactions with organic matter (feces, wastefeed, decaying plant and animal remains, et cetera). As temperature increases the metabolic rate of thefish, respiration depletes the oxygen concentration of the water more rapidly, and stress or even deathcan follow. Fluctuating water temperatures and the resulting change in available oxygen must beconsidered in good hatchery management.

AERATION

Water from springs and wells may carry noxious gases and be deficient inoxygen; lake and river sourcesalso may have low dissolved oxygen contents. Toxic gases can be voided and oxygen regained if thewater is mechanically agitated or run over a series of baffles.

STERILIZATION

Any water that has contained wild fish should be sterilized before it reaches hatchery stocks. Pathogensmay be killed by chemical oxidants orby a combination of sand filtration (Figure 5) and ultraviolet radiation.

Feed management

selection of feed for breeders, different stages which come out of fertilized eggs after incubation variesa lot. We should be very careful while selecting the feed, and should also keep it free from pathpgens and feed should be given in time .

2. Construction and maintenance of Nursery pond

The ponds which are used for growing hatchlings, spawn, fry to advanced fry and fingerling stageis called Nursery pond. Nursery pond management is crucial for quality seed production.

a. Pond size

3 days old hatchlings (Hatched from the egg) are called Spawn and are good for stocking . The spawn grown up to nearly 20 days are called fry; size of the fry is generally 25 to 30 mm . Small perennial water bodies or even seasonal in nature can be used for growing Spawn to Fry .Fry attains fingerlings size of 100 mm in about 2 to 3 months in nursery ponds . The recommended size of the nursery pond is 10 to 25 decimal . The recommended water depth is 1 meter to 1.5 meter (3.5 ft to 4.5 ft) .

b. Stocking

The spawns are ready to transfer in to nurseries after 3 days of hatching .Stocking has to be done preferably during morning hours by acclimatizing them to the new environment. The normal socking density of spawn is 16-20 lakh per acre in pond .

c. Soil Correction (pH)

Liming is done to maintain the PH of the water, increases oxygen in the pond and kills germ in pond . The recommended dose of lime application is 200 kg/acre per pond (50kg/ 25 decimal pond)

d. Manuring

Plankton are the natural fish food organisms produced by fertilizing the Nursery ponds with manure. Manure like – Cow dung, Poultry dropping, and inorganic fertilizer can be used . The recommended dose of cow dung is nearly 2000 kg/acre (@ 500kg/ 25 decimal pond).

e. Feeding

Feed thoroughly mixed by putting all ingredients and broadcast on the surface of water preferably in fixed area of pond and at fixed time to avoid wastage of feed. Feeding has to be given 2 times per day, once after sunrise in the morning and second time in evening before sunset

f.Water Management

Regular watch on water parameters like dissolved Oxygen, Ph, total alkalinity and quantity of natural feed called plankton is important for successful nursery operations. (3) Growth Monitoring . Regular netting has to be done to monitor growth and mortality rate.

g.Harvesting

After 4 weeks of stoking approximately it attains a size of 1”-1.5”. After 8-12 weeks (2 -3 months) of stoking approximately it attains a fingerling size of 3”-5”. No feeding is to be given for complete one day before harvesting. Acclimatization for 4 - 6 hours is needed before packing for transportation. Fry / fingerling can be stocked in Happa for at least 4-6 hours before transport. Fingerlings can be marketed & transported by Oxygen packing in poly bags for distant places.

3. Classification of Ponds based upon their functional Role

Based uopn the role played ponds are the following types in fish culture

A. Nursery Ponds

The nursery ponds are prepared much before breeding takes place. The nursery ponds are cleared of predatory fishes and weed fishes. The ponds are ready with sufficient growth of zooplankton and phytoplankton by using fertilizers such as cow dung with chemicals like ammonium sulphate, sodium nitrate and superphosphate. The growth of the planktons takes about 10 to 20 days. The pH of the water should be around neutral or slightly alkaline.

Feeding is not necessary during the first week of nursing since the early fry does not accept artificial feed stuffs. Feeding on live zooplankton from nearby fresh water fish ponds is recommended in case of scarcity of food. Large quantities of zooplankton must be collected daily using 100–150 micron mesh plankton net. The nursery ponds should be supplied with good water that is made to circulate. To establish a good standing crop of zooplankton, the nursery ponds are filled with non-polluted, slightly alkaline water (pH 6.5 to 8.0) and well exposed to sunlight. Once the early fry have completed their metamorphosis they become advanced fry.

b. Rearing pond

These are used for rearing fry to fingerling stage (4 to 10 cm). These are deeper ponds in which fish fries from the nursery ponds are transferred and maintained here for about three months. Size: Each rearing pond has size of 80’ x 20’ x 4’. These measures about 0.1 hectares. The ponds are deeper than the former types (generally 1.2 to 1.5 m) and have narrower sides to facilitate netting. In these ponds the advanced fry are raised for about 2 to 3 months. The preparation of rearing pond is done in the same manner to that of nursery i.e. removal of weeds, elimination of predators, manuaring the pond etc. In rearing pond the fish reaches from fry to fingerling stage in about 2-3 months. By this time they attain a length of 75-125 mm. and are ready to be transferred to the stocking pond.

c. Stocking ponds

These are used to store fingerlings. Fingerlings grow to a table size fish in these ponds in the shortest possible time. These are larger ponds and the fingerlings are fed with artificial feed. Organic and inorganic fertilizers are used in increase growth. The dimension of each stocking pond is 294’ x 100’x 8’. However, the size of stocking pond depends mainly on the geoecological condition of the area and the type of fish culture.

Stocking ponds are large perennial ponds covering an area varying form 2-20 ha and average depth of about six feet. Before releasing the fingerlings, the stocking pond is prepared to stock them. The process of preparing the pond is same as that of nursery and rearing ponds.

As for the proper organic manuaring is concerned cow dung is the best and should be used at the rate 20 to 25 thousands kg./hectare/year. The inorganic chemical fertilizers are also used viz.; super-phosphate, ammonium nitrate and ammonium sulphate at the rate of 1,000 to1, 500 kg. / hectare /year. The powdered rice, paddy, oil cakes, coconut, mustard, groundnut etc. are commonly used as artificial food for the fishes. The artificial food used for the fishes should be easily digestible in natural form and economically suitable. The best time for feeding the fishes is in the morning hours. The quality of food should not be changed suddenly. The amount of fertilizers used is totally dependent on the fertility of the soil, number of fishes and types of fishes being kept in the stocking ponds. Antibiotics are used to prevent infectious diseases. When the fishes attain the required size and weight they are harvested.

4. Fish Pond Fertilisation Significance

Indian major carps and exotic carps at their early stages are planktivorous with zooplankton as preferred natural food. Sustained zooplankton population in a pond depends on a good phytoplankton population base, which is ensured through adequate availability of major nutrients like nitrogen, phosphorus and carbon besides certain micronutrients in the water. Such nutrients are supplied to pond water through organic and inorganic fertilizers.

Efficiency of these manures and fertilizers for stimulating pond productivity largely depends on N, P, and C availability, N: P ratio and C: N ratio in pond sediment. The N:P ratio of 2:1 to 4:1 and C:N ratio of 10:1 to 20:1 in pond sediment are desirable for sustaining productivity of pond water.

Types of fertilizers: There are two major classes of fertilizers for aquaculture. Fertilizers can be divided into organic and inorganic fertilizers.

Fertilizers can as well be grouped either as liquid fertilizer or solid.

Organic: Organic fertilizers are derived from animal byproducts or garden, compost, kitchen, slaughter house or food processing plant refuse. Major organic fertilizers in use are chicken droppings, cow dropping and pigsties washout and droppings. Organic fertilizers are well suited for organic aquaculture practices.

Inorganic: In organic fertilizers are chemical fertilizers that provide nutrients' needed in aquatic by the primary producers. Inorganic fertilizers provide different elemental supplements for the ecosystem. Fertilizers like NPK provides similar amount of sodium, phosphorous and potassium, while other like triple supper phosphate provided much needed phosphorous to the aquatic ecosystem. Generally inorganic fertilizers are identified by their chemical constituents subsequently delivered to the environment. There are many commonly used fertilizers produced for a variety of applications.

Fertilizer manufacturers are required to list the grade on each fertilizer container by the percent of nitrogen (N), phosphorus (P) as phosphoric acid (P_2O_5) and potassium (K) as potassium monoxide (K_2O). Therefore, a 20-20-5 grade fertilizer contains 20 percent nitrogen, 20 percent phosphorus as P_2O_5

and 5 percent potassium as K_2O. "Complete" fertilizers contain N, P_2O_5, and K_2O while "incomplete" fertilizers contain only one or two of these elements. Common incomplete fertilizer sources are normal superphosphate (0-20-0), triple superphosphate (0-46-0), diammonium phosphate (18-46-0) and liquid ammonium polyphosphate (10-34-0). Examples of common complete fertilizersare20-20-5, 4-12-12.Additions of phosphorus in ponds usually provide a much greater increase in fish production than from either nitrogen or potassium.

Action of organic manureand inorganic fertilizer

Decomposition of organic manure in pond bottom leads to slow release of nutrients to overlying water column and helps in long term maintenance of rich plankton population.Inorganic fertilizer dissociate into elemental form, which are readily available for utilization by phytoplankton.

Conditions for fertilization

- Test for pH of pond
- Acid ponds needs to be limed before pond fertilization. News inundated pond need pH test before fertilization.
- It is must to test the alkalinity before fertilizing the pond.
- Bit liming and fertilization should not be done at a time.
- Fertilizers should be applied after appling lime gap istwo weeks
- In shallow pods fertilization ahould be done moderately

5. Physical conditions of Water in ponds

Productivity of the fish culture pond depends upon several physic-chemical and biological actors which regulate the quality of water. Physico-chemical and biological factors play a significant role in the productivity of the pond.

Influence of physical factors –

a. Temperature

Water temperature generally depends upon climate, sunlight anddepth. That too, the intensity and seasonal variations intemperature of a water body have a great bearing upon itproductivity. The temperature in fish ponds is generally lessduring the early hours of morning and reaches the maximumvalue in the afternoon showing diurnal fluctuations. Compared tothe yields of fish in ponds in temperate zones, the natural waterin tropical areas generally show a higher production due to moreheat budget in the ponds system.

A part from these, temperature plays very important role inphysiological processes for breeding in fish both under naturaland artificial conditions. The chemical changes in both soil andwater are greatly influenced by temperature. Decrease in DO2 isdirectly related to increase in temperature. Fish display greatvariability in their tolerance to temperature. Indian major carpsusually tolerate wide range of temperature and are calledeurythermal.

b. Depth of the pond

Variations in physico-chemical factors is generally observed depending upon the depth of he pond. When the depth is less sunlight can penetrate till the bottom and hence homogenous distribution of the producers occurs. They naturally increase the productivity. Sometimes due o more temperature water gets warmed up sometimes fish even die.When the pond is deep sunlight cannot reach the bottom of the pond. So producers are limited to the euphotic zone. Organisms living in the bottom may die because of

- Low temperature
- Degradation of waste
- High concentration of toxic substances.

A water depth of 1.5 to 2 meter is considered congenial(agreeable) from the point of biological productivity of a pond.

c.Transparency of water/Turbidty

Turbidity is a condition of water resulting from the presence of suspended matter. It may be due to suspended clay, silt and finely divided organic matter and plankton. It may be temporary due to rains, floods and drainage inflow or permanent an account of nature of soil and constant wind and wave action. Turbidity is measured by secchi disc visibility optimum secchi disc visibility in fish ponds is considered to be 40 to 60 cms. Turbidity is an important binding factor in the productivity of a pond. Light can penetrate deeper into cleaner water and induce the growth of plants. Photosynthesis will be very much reduced in turbid waters. Turbid water gets heated up quickly and trap nutrients and cause siltation leading to ageing of pond. Turbidity suppresses or destroys planktonic organisms by suffocation. Waters containing > 400 mg/l of suspended solids (matter) are not productive.

d.Light

Light is another physical factor of importance. Availability of light energy to a fish pond greatly influences its productivity. Penetration of light is determined by turbidity which is measured optically and represents the resultant effect of several factors such as suspended clay and silt and dispersion of planktonic masses. Required amount of light helps to increase the natural food to fishes and less light penetration is unproductive to culture ponds,

6A.Dissolved Oxygen

- Dissolved oxygen is probably the single most important water quality factor that pond managers need to understand. Oxygen dissolves in water at very low concentrations. Our atmosphere is 20% oxygen or 200,000 ppm but seldom will a pond have more than 10 ppm oxygen dissolved in its' water.

- Dissolved oxygen concentrations below 3 ppm stress most warm water species of fish and concentrations below 2 ppm will kill some species. Often fish that have been stressed by dissolved oxygen concentrations in the range of 2 or 3 ppm will become susceptible to disease.
- Oxygen dissolves into water from two sources: the atmosphere and from plants in the water. The primary source of oxygen for a pond is from microscopic algae (phytoplankton) or submerged plants.
- In the presence of sunlight, these produce oxygen through photosynthesis and release this oxygen into the pond water. At night and on very cloudy days, algae and submerged plants remove oxygen from the water for respiration. During daylight hours plants normally produce more oxygen than they consume, thus providing oxygen for the fish and other organisms in the pond.
- Oxygen depletions are the most common cause of fish kills in ponds. Most oxygen deletions occur in the summer months because 1) warm water holds less dissolved oxygen than cool or cold water, and 2) because the pond's oxygen demand is greater in warm water than in cold water. Fish kills from oxygen depletions can range from "partial" to "total".
- In a partial kill the dissolved oxygen level gets low enough to suffocate sensitive species and large fish, but many small fish and hardy species survive. Most oxygen depletions cause partial fish kills; total fish kills are relatively rare in recreational ponds except for those with extremely high fish populations (>1,000 pounds/acre).

The following are descriptions of the most common types of oxygen depletions.

Excessive Phytoplankton

The abundance of planktonic algae (very green water) in a pond is generally related to the amount of nutrients present in the water. Nutrients can wash into the pond from woods, pastures, fields, human activities in the watershed, or come from pond fertilization.

Generally, the more nutrients, the more planktonic algae (or other aquatic plants) will grow or bloom. Although phytoplankton is good from an abundance of natural food and oxygen producing standpoint, it can become too abundant or excessive. When phytoplankton become so abundant that water visibility is limited to less than 12 inches there is a danger of an oxygen depletion. These heavy or dense blooms use large amounts of dissolved oxygen at night and on very cloudy/overcast, windless days causing an oxygen depletion and fish kill. This problem is often a consequence of overfertilizing, overfeeding, or excessive nutrients from livestock, fields, or septic lines.

Phytoplankton Die-off

Phytoplankton populations, or blooms, can grow rapidly, particularly on sunny days when the water is warm and nutrients are available. Alternatively, they can die-off quickly, especially in the spring and fall as water temperatures change rapidly with weather fronts. However, a bloom die-off can occur at any time of the year with little or no warning.

Typically during a bloom die-off, the color of the water will start to change. Leading up to a bloom die-off the pond water may have a “streaky” appearance. Streaks of brown or gray-black through the otherwise green water of the pond is an indication that the algae are starting to die. As the die-off progresses, the whole pond will turn from green to gray, brown, or clear. The pond water will typically clear after a die-off as the dead algae settle to the bottom.

Turn overs

Probably the least understood but most commonly reputed cause of an oxygen depletion is a pond turnover. As ponds warm in the spring they become stratified or layered, with warm water on the surface and cooler water below. This temperature stratification also leads to an oxygen stratification, with the warm surface water containing dissolved oxygen (and fish) while the deeper, cool water becomes depleted of oxygen because of decomposition and lack of sunlight for photosynthesis. This is particularly true in deep ponds (greater than 8 feet). In fact, the deeper the pond the more likely a turnover can occur.

The problem arises when this stratification is broken down quickly, causing the two layers to mix or "turnover." The turnover mixes the oxygen rich surface water with the deep oxygen depleted water. The dissolved oxygen concentration in the mix can be too low to support life in the pond. Both fish and plankton can die from low dissolved oxygen following a turnover.

Aeration

The risk of a fish kill caused by an oxygen depletion can be minimized by following the guidelines and recommendations discussed previously. However, even a lightly stocked pond can have an oxygen depletion. Some ponds have a history of fish kills caused by oxygen depletions. Mechanical aeration usually can save fish during an oxygen depletion. Many types of aerators are available commercially.

6B. Rearing Pond

Like nursery, the rearing pond is also a seasonal pond, where the fry are grown to fingerlings in about 3 months.

A. Pre-Stocking Management: Preparation of the pond including dewatering and drying, control of unwanted fishes and aquatic weeds is similar to that of the nursery pond.

Fertilization: As in the case of nursery pond, the rearing pond is also first limed and fertilized with organic manure (cow dung) at the rate of 10-15 t/ha. The plankton developed by this organic manure may diminish within 2 or 3 days after stocking the fry, due to their feeding activity. Hence, chemical fertilizers such as urea and superphosphate should be applied at the rate of 40-80 kg/ha once in 15 to 20 days to boost plankton production.

B. Stocking: The stocking density of fry may be between 2-3 lakhs/ha. The fry of different species can be stocked together usually in the following combinations catla, rohu and mrigal, catla, rohu, mrigal and common carp1:2:2, 3:4:1:2

C. Feeding: After few days of stocking in the rearing pond, when the plankton goes down, addition of supplementary feed is essential to enhance the growth of young fish. Usually a mixture of groundnut oil cake powder and rice bran (1:1) is broadcasted in the pond or soaked in water for some time and made into small balls, which are placed in bamboo baskets or earthen bowls and kept in shallow regions of the pond at 3 or 4 places for the purpose of feeding.

To minimize the period of rearing and to enhance the growth rate, protein-rich items such as silkworm pupae, soyabeen, trashfish and prawn wastes may also be added to the feed. An artificial feed containing 40% protein is found more suitable for the growth of carps.

D) Harvesting of fingerlings: The method of harvesting is similar to that of nursery pond. Unlike the nursery pond, the rearing pond is used for growing fry only once in a season. Hence, during the rest of the year the rearing pond can be used as production pond for growing fish of marketable size.

Short Answer Questions

1.Rearing ponds

These are used for rearing fry to fingerling stage (4 to 10 cm). These are deeper ponds in which fish fries from the nursery ponds are transferred and maintained here for about three months. Size: Each rearing pond has size of 80’ x 20’ x 4’. These measures about 0.1 hectares. The ponds are deeper than the former types (generally 1.2 to 1.5 m) and have narrower sides to facilitate netting. In these ponds the advanced fry are raised for about 2 to 3 months. The preparation of rearing pond is done in the same manner to that of nursery i.e. removal of weeds, elimination of predators, manuaring the pond etc. In rearing pond the fish reaches from fry to fingerling stage in about 2-3 months. By this time they attain a length of 75- 125 mm. and are ready to be transferred to the stocking pond.

2. Quarantine Ponds

- Quarantine is one of the most important animal management and biosecurity measures. Quarantine is the procedure by which an individual or population is isolated, acclimated, observed and, if necessary, treated for specific diseases before its release onto the farm or for live market sale (e.g., to grow out or for aquarium fish stores).
- The principles of quarantine apply for new fish coming into a facility, fish moving from one area or system to another within the facility, and resident fish that become diseased.
- Well-designed quarantine systems physically separate incoming fish from the rest of the farm. Water in quarantine systems also should be separate from that on the main farm, and discharges should be handled appropriately.
- Proper quarantine not only protects established populations from potential exposure to pathogens but also gives the new animals time to acclimate to water, feeds and management and to recover from handling and transport. Handling and transport have been shown to reduce disease resistance and recovery may take weeks.
- Fish in the general population that become sick may have to be isolated in tanks in the same system or room as their healthy counterparts; signs or other methods should be used to alert employees that the population is diseased.
- Major components of quarantine include all-in-allout stocking, isolation or separation, observation and diet adjustment, and sampling and treatment. All-in-all-out stocking.
- This involves bringing animals in as a group from only one original source population and maintaining them as a group throughout the quarantine period.
- It prevents exposure to other pathogens not currently in that population. Ideally, no new animals should be added to a group currently in quarantine. All-in-all-out quarantine may involve an entire facility, room or system.

3. Characteristics of soil

Soil is one of the important ecological factor and feature of aquatic environment. Soil is considered as the main source of nutrients as it enhances the productivityof ponds. Soil is also considered as the seat of detritus food chain. Nutrients are released from detritus through decomposition and mineralization process by help of soil microbes such as algae, bacteria, fungi, protozoa etc. In addition, pond mud is also the means of support for bottom – dwelling animals such as bottom fish, shellfish, and bottom organisms (earthworm , molluscs , algae, insects etc.) which are used by as food by fishes and prawns.

Soil parameters-

- Colour
- Bulk Density
- Texture
- Carbon/Nitrogen (C/N) ratio
- Organic Carbon/Matter
- Phosphorus
- Nitrogen
- Water Holding Capacity
- pH (Potentia Hydrogenii)

a.pH -

pH of a soil is the most important property indicating the chemical characteristics of soil The pH of soil depends on relative amount of observed hydrogen and metallic cations ; and it determines the acidic , neutral and alkaline condition of soil. Presence and absence of Ca, Mg, Al, Mn, P2O5, and certain microbes influence the pH of soil. Highly acidic soil is unsuitable for fish culture. Under acidic water, loss of appetite takesplace among the fishes.. Highly alkaline condition of soil creates destruction of soil structure and also retard microbial growth.

b.Organic matter -

Organic Matter prevents soil erosion by reducing soil runoff. In sandy and loamy soil the WHC is increased by the presence of soil organic matter.Accumulation of organic matter on soil surface helps to keep soil temperature low in summer andmoderate in winter. Organic matter is very important in enhancing the fertility of pond ecosystem for high fish production. It supplies nutrients and also regarded as a source of food for microorganisms.Pond bottom soil with very low content of organic carbon is not suitable for fish culture due to itslow productivity in nature. Soil over 1% organic carbon is ideal for fish production.Very high organic content is undesirable because it will result in high C:N ratio. Under high C:N ratio i.e., over 10:1 will adversely affect the microbial activity and most of soil nitrogen will be utilized by microorganisms and soil will lose its nitogen supplying capacity.

c. **Phosphorous**

It is present is various form in the soil. Important forms areA.Organic (phytin and phytin derivatives; nucleic acid; phospholipids). B.Inorganic (calcium phosphate, aluminium phosphate, Iron phosphate and Pyrophosphates). Availability and release of soil phosphorus is mainly pH dependent.Under alkaline condition, the available forms of soil phosphorus are converted into octacalcium form and hydroxy apatite is formed . And under highly acidic condition, insoluble form of Iron and Aluminiumphosphate is formed and phosphorus become unavailable to the organisms. Available phosphorus above 10 mg P/100g soil is favourable for fish culture.

d..**Nitrogen**

Soil may be having rich source of protein. But depending on the other limiting factors, if release of available nitrogen is restricted, the soil is rendered unsuitable for establishing fish pond on such soil base. Soils with available nitrogen above 50 mg N/100 g soil is considered to be suitable for fish production. Availability of soil nitrogen is mainly affected by microbial population of soil in association with other environmental factors.

e.Carbon /nitrogen ratio

C/N ratio is known that there exists a close relationship between nitogen and organicmatter content of soils. Because carbon is present in organic matter in large and definite proportion, the C/N ratio of soils is fairly constant. This is important for controlling the total organic matter , available nitrogen and also for the development of fish pond management strategies. In general, C/N ratio< 5 indicates poor fish production. Although high production is achieved in the ratio between 5-10. The range 10-15 indicates ideal condition. However, the C/N ratio >15 considered as less favourable for fish production.

4. Temperature

After oxygen, water temperature may be the single most important factor affecting the welfare of fish. Fish are cold-blooded organisms and assume approximately the same temperature as their surroundings.

The temperature of the water affects the activity, behavior, feeding, growth, and reproduction of all fishes. Fish are generally categorized into warm water, cool water, and coldwater species based on optimal growth temperatures

Temperature also determines the amount of dissolved gases (oxygen, carbon dioxide, nitrogen, etc.) in the water. The cooler the water the more soluble the gas. Temperature plays a major role in the physical process called thermal stratification (Figure 4). As mentioned earlier, water has a high-heat capacity and unique density qualities. Water has its maximum density at 39.2ºF.

In spring, water temperatures are nearly equal at all pond depths. As a result, nutrients, dissolved gases, and fish wastes are evenly mixed throughout the pond. As the days become warmer, the surface water becomes warmer and lighter while the cooler-denser water forms a layer underneath.

Circulation of the colder bottom water is prevented because of the different densities between the two layers of water. Dissolved oxygen levels decrease in the bottom layer since photosynthesis and contact with the air is reduced.

The already low oxygen levels are further reduced through decomposition of waste products, which settle to the pond bottom. Localized dissolved oxygen depletion poses a very real problem to the fish farmer.

5.pH

The pH of the water reflects the concentration of hydrogen (H+) or hydroxyl (OH-) ions in the water: H20 = H+ + OH-. It can then be said that in neutral water (pH = 7.0) the concentrations of H+ and OH- are equivalent. If a water contains more H+ ions than OH- ions, it will be acidic (pH < 7.0). Otherwise, it will be alkaline (pH > 7.0).

Like oxygen concentration, the pH of fish and shrimp pond water also varies throughout the day. The pH of the water increases from dawn to mid-afternoon (16:00 h), as microalgae (phytoplankton) remove carbon dioxide from the water during photosynthesis. The decrease in carbon dioxide concentration throughout the day reduces the concentration of H+ ions and increases that of OH- ions, making the water more alkaline. The more phytoplankton there is in the nurseries, the more the pH varies throughout the day.

pH values above 9.0 (often between 9.5 and 10) are common in growing waters containing large quantities of phytoplankton (low transparency green water). Water has a buffer mechanism formed by carbonate, bicarbonate and hydroxyl ions (total alkalinity of water) and calcium and magnesium ions (total hardness of water). The high pH and oxygen over-saturation of these tanks allow fish to avoid prolonged exposure to surface water. This may explain the reduction in dietary activity and food consumption of fish during peak hours of photosynthesis (usually between 11 am and 4 pm) in very green ponds. Extreme pH values mean that fish and shrimp have a reduced food consumption, with a loss for growth and food conversion. In addition, aquatic animals exposed periodically to extreme pH values may have compromised immunity and become more susceptible to disease.

pH Range	Impact on Aquatic organism
4	Acidic death point
4to6.5	Slow growth ,no Reproduction
6.5 to 9	Desirable range for growth
9 to11	Slow growth
More than 11	Alkaline death point

6.Nutrients

It is important to understand the sources and basic pathways of nutrients because there is a direct correlation between available nutrients and populations of algae and aquatic weeds. The most important nutrients in aquatic systems are phosphorus (P) and nitrogen (N) in the forms of phosphates (PO_3) and nitrates (NO_3). These nutrients are critical to the growth of plants and animals in aquatic systems. Phosphorus has been identified as the limiting factor for algal growth in most lakes and, as such, is the largest contributor to aquatic plant growth. One gram of phosphorus will produce 100 grams of algal biomass. Excessive amounts of nutrients will lead to over-fertilization, or eutrophic conditions, which can result in an over-abundance of aquatic plants and algal blooms. When the excess plants and/or algae die, they decompose, which leads to a depletion of oxygen that can affect water clarity and smell and can lead to fish kills.

Sources of nutrients

The main sources of nutrients in ponds are bottom silt, dead vegetation, landscape debris, runoff from the surrounding area, poorly functioning septic systems, and wastes from livestock and waterfowl. As aquatic plants and algae grow and die, they sink to the bottom of the pond and provide a source of nutrients for future aquatic growth, a phenomenon known as nutrient cycling. This, along with landscape debris such as grass clippings, leaves, and pine needles, contributes nutrients to ponds, and these nutrients must be managed to prevent eutrophic conditions from developing. Runoff from fertilized fields and lawns in immediate surrounding areas as well as roads, farms, and outlying areas can also be major sources of nutrient enrichment.

DNR College (A) Bhimavaram

Subject –Zoology 6A Sustainable Aquaculture management

Esay Questions

Unit-III

Essay questions

1. **Bundh Breeding**

Bundh is a type of perennial and seasonal tank or impoundment where riverine conditions are simulated and where major carps are known to breed. After a heavy shower, the bundhs receive large quantity of rain water with washings from their catchment areas and provide large shallow areas that serve as spawning grounds for the fishes. The first bundh (dry bundh) was set up in Madhya Pradesh at Sonar Talliya in 1958. After this, persistent expansion of bundhs had taken place due to its simplicity of operation and high rate of success.
Types of Bundh: Bundhs are generally of three types:
(A) Wet Bundhs and
(B) Dry Bundhs.

Wet Bundhs

1. Wet bundhs are perennial ponds situated in the slope of an undulating terrain. It provides a vast catchment area and facilitates quick filling even with a short spell of rain.

2. It has proper embankments with an inlet towards the high catchment area and an outlet at the opposite lower end

3. The deeper portion of the bundh during summer, retain water containing major carp breeders.

4. During monsoon, after a heavy shower, water from the catchment area rushes into the bundh.

5. The major portion of the bundh gets submerged and the excess water passes out through the outlet. The shallow areas of the bundh is called moans where the breeders actually spawn.

6. The outlet is protected by a bamboo fencing called chheva.

7. The outflow of the water through the chheva can be controlled by blocking the spaces in it with straw and mud.

8. Fine meshed nylon cloth is placed in the outlet to stop the hatchlings from escaping. Similar nylon cloth is placed i n the inlet to stop the entry of unwanted fishes.

Dry Bundhs

1. Dry bundh is a seasonal one, which remains more or less dry during greater part of the year.

2. It is a shallow depression enclosed on three sides by an earthen embankment.

3. During the monsoon season it imports fresh rain-water from the catchment area.

4. In modern constructions, the embankment is a pucca stone masonry with a small sluice gate in the deepest portion of the bundh for complete drainage and one or two waste weirs for overflow of excess water.

5. A dry bundh unit (apart from the bundh) also consists of storage ponds for stocking breeders, an observation post with arrangement for storing necessary equipment and a set of cemented hatcheries (2.4 m x 1.2 m x 0.3 m) along with overhead tank and regular supply of water for handling large number of eggs at a time.

6. In dry bundhs, selected numbers of female and male (in the ratio 1:2) breeders of major carps are introduced

Prerequisites of Bundh Breeding

For successful bundh breeding the prerequisites are:

(1) Heavy showers during the monsoon season.

(2) Flow of water from up-land to bundhs and then through outlet, makes some sort of water current

. (3) Inlet and outlet of the bundhs are to be kept closed after the water level reaches brim point.

(4) Sudden fall of temperature.

(5) No definite depth for breeding, as breeding can take place even in paddy fields having a depth of 31-35 cm

(6) Smaller fishes first get inducement to breed and the bigger ones are attracted later.

Drawbacks of Bundh Breeding

(1) Indiscriminate killing of brood fishes particularly milters during dry months, result in improper sex ratio.

(2) It is not possible to hygienically maintain mud hatching pits.

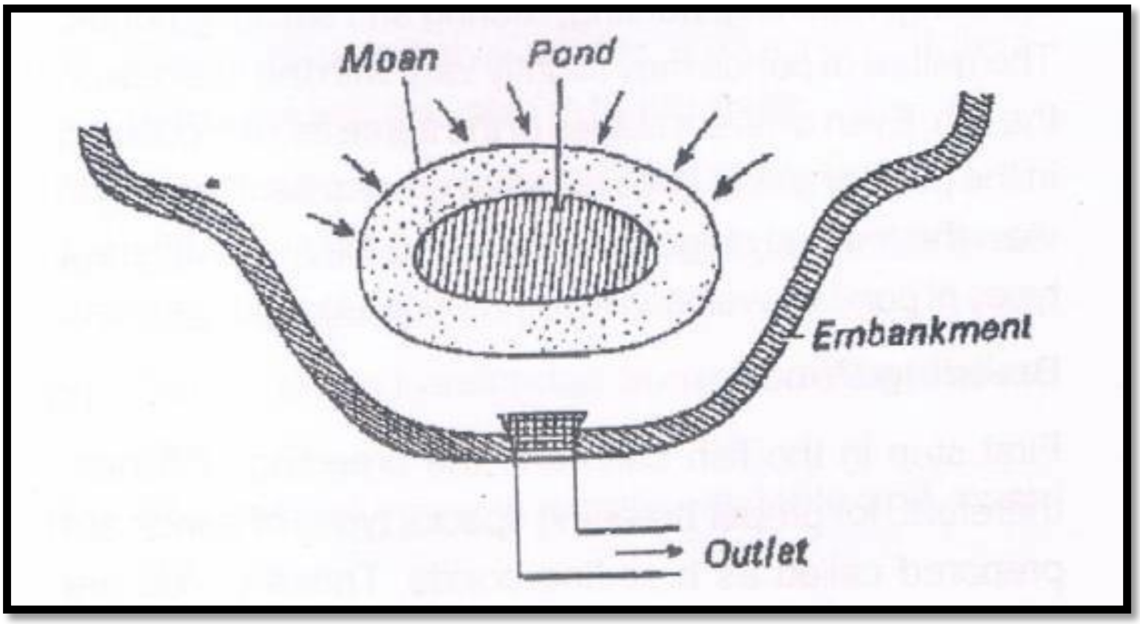
(3) Large scale mortality of spawn takes place as they are not transported before the 3rd day.

(4) Other limiting factors for successful spawning are:

(a) Presence of excessive numbers of copepods (Cyclops, Diaptomus, etc.) that accumulate in the water of the bundh.

(b) Large scale deposition of alluvium in the breeding grounds

Wet Bundh



2. Hypophysation and its applications in fish induced breeding

- Many cultural species of fin fishes (particularly the major corps) under farm culture conditions do not get the required environmental impetus for spontaneous maturation.
- This has led to the development and standardization of a technique, called induced breeding or hypophysation.
- Here, through the injection of pituitary homogenates or extracts, the natural gonadotropin surge is stimulated, disregarding the environmental impetus.
- Thus, it has not only made the major carps and other fin fishes to breed in confined water under farm conditions but it also has the added advantage of regulating the time of spawning.

Advantages of Induced Breeding

- Induced breeding has manifold advantages as under
- Pure and disease-free spawn of a desired variety of fish under cultivation can be obtained through induced breeding.
- Induced breeding ensures availability of seeds for fish culture at any time (except during the winter months) and do not have to depend upon the monsoon season only for its collection, like that of natural sources.

- The demand for any specified quality of pure fish seed of a particular species can be met through induced breeding.
- The technique of induced breeding is very simple and can be easily handled by a layman without much training.

Hypophysation process-

Collection of Pituitary Extract:

- From the matured fishes of both sexes either belonging the same species (Homo plastic) or a closely related (Hetero Plastic) the pituitary glands are collected.
- It is preferred to collect the pituitary gland from freshly killed fishes. But it has been observed that the pituitary glands taken from five to eight days old ice-preserved fishes have also given successful results. The pituitary glands can be taken out from the posterior end of the cranium through the foramen magnum after cleaning the brain tissue.
- After the collection of the pituitary glands are kept in absolute alcohol for dehydration. After 24 hours, the alcohol is changed for further dehydration and defattening.
- The glands are then weighed and preserve in fresh alcohol in dark colored phials. It may be stored at room temperature or in a refrigerator.
- At the time of injection to carps for the induced breeding, the required quantity of pituitary glands are taken out of the phials and the alcohol is allowed to evaporate.
- The glands are then macerated with a tissue homogenizer either in distilled water or 0.3 percent of saline water. The gland suspension is then centrifuged and the supernatant fluid is drawn into a hypodermic syringe for the injection.

Selection of Breeders: Medium sized fully ripe and healthy fish of around 2 to 4 years of age is preferred for induced breeding. The weight should be 1 to 5 kg. Healthy male and female breeders should be identified and netted out before the breeding season and should be kept in spawning pools.

Method of Injection: During the rainy season or cloudy, the extract of the pituitary gland of the same species which is prepared on the above said scientific process is injected in the muscle of the matured carps.

Just before evening, per one female with two males of the approximate same body weight are to be injected the pituitary extract by hypodermic syringe. In case of male carps the pituitary extracts are introduced once and in case of female carps it is introduced twice.

At first, at the rate of 2 to 3 mg of pituitary extract per kg of body weight is introduced in the muscle of the caudal peduncle or near the dorsal fin of the female carp. The needle of the syringe is to be introduced between the scales but with an angle of 45° with the body.

After six hours of first injection, the second injection is given to the same female at the rate of 5 to 8 mg of pituitary extract per kg of body weight. There is no need of injecting dose to the male breeder if it in a state of milt oozing.

Synthetic Hormones: HCG (human chorionic gonadotropin hormone), Synahorin, Ovatide, Ovaprim. It is the new inducing hormone for fish and absolute substitute of pituitary extract though it's costly. Ovaprim is far superior to carp pituitary in inducing spawning in several species of carps. These synthetic drugs are better than the pituitary extract and easier to administrate. Only single dose injection is enough to induced craps.

Spawning- Then the carps, one female and two male are placed in a breeding hapa for spawning. Inside of the breeding hapa both the female and male carps are exited. After the excitation the female carps lays eggs. The eggs are externally fertilized by the spermatozoa (milt) that are discharged by the males.

Spawning Hapa -Hapa for larger fishes its size is 8′ x 3′ x 3′, but for the smaller fishes it is 5'x 3'x 3′. It is held on four bamboo poles, one at each corner of the rectangular case. After that all the fishes are removed from the breeding hapa and then the eggs are collected by a net and are transferred to the inner part of the hatching hapa. After 14 to 18 hours, the spawns enter into the outer hapa and the induced breeding process completed. Then the spawns are collected from the outer hapa and transferred to the pond for nursery.

Precautions for Induce Breeding

- To avoid diseases and parasitic infections,
- breeders should be properly washed with KMnO4 solution for a few minutes.
- Breeder should be protected from mechanical injuries during handling.

- Water condition should be favourable having temperature about 24 to 31°C and turbidity about 100 to 1000 ppm.
- Flowing water with higher O2 content is of great use.
- The intensity and duration of light also affect the induced breeding and spawning. Pituitary glands taken from the same or related species as the recipient species are said to be more effective.

3.Pre-Stocking management practices in Fish Pond

In fish culturethe management practices to be followed through out the yield play vital role on production of yield. The mangement practices are two types-A. Pre –Stocking B. Post-stocking.

Pre- stocking management: Site selection, watering. Liming, manuring,

Control of Aquatic weeds, predators Algal blooms, insects etc.

Site Selection: one of the most imp factors for successful pond management is selection of good site.The site should. have water supply, soil fertility, free from over population, free from pollution.

Liming: Liming is most essential to maintain pH of water .water should be slightly alkaline to eradicate micro-organisms, to maintain hygiene in pond. Limeas is applied at a rate of250 kg

Watering: while watering the pond, care should be taken to see that no predatory fishes enter at egg, young or adult stage. so, water should let through a fine Sieve.

Manuring: Manuring has to be done after filling pond with water. The main aim is to produce adequate quantities of plankton, which act as natural food for carps. organic and inorganic manures are used to fertilise the pond.

Control of aquatic weeds

Aquatic weeds affect fish culture by limiting the space for movement, competing with phytoplankton by absorbing nutrients, causing imbalance in dissolved oxygen, causing siltation, hampering netting operation and harbouring unwanted fishes ,insects and molluscs which act as vectors for many diseases

Aquatic weeds are following types in a pond

Algal weeds (spirogyra, chara). floating weeds (lemna, pistia) Emergent weeds (Nymphaea, ty pha)Emergent marginal weeds (marsilia, ipomea) submerged weeds (vallisneria, Hydrilla)

Aquatic weeds may be controlled by mechanical, chemical or biological methods.

- Mechanical method include Collection, disposal. of weeds by cutting, dropping,ploughing.
- chemical method involves spraying chemicals such as etc simazine, 2-4 D, Diquat, Dichloropheny etc.,
- Biological method. includes introduction of grass. Carp and Common carp that feed on weed plants.

Control of predatory and weed fishes

Common predatory fishes are Channa, Wallago ,Clarius and Anabas etc., They cause heavy mortality to spawn. The common Weed fishes are Puntius, Rasobra, Salmostome ,Chala and Esomus etc., These fishes compete for food, space with the cultured fishs pecies. Derris roast powder Mahuva oil cake, Aldrin , Nuvan, Endrin can be used to eradicate these fishes.

Control of Algal blooms

Sometimes due to more fertilization of pond Algal blooms arise. Algal blooms are invaribly caused by uniceelular and filamentous algae which impart green ,bluish green colouration to water. They can be controlled by application 1ppm Copper sulphate, 0.5 ppm. simazine, or by growing lemna in pond.

Control of aquatic insects

Predatory insects belong to order Hemiptera, coleoptera. Some of the insects in pond are Hydrometra. Notometra, Laccotɣephes, Ranatra, Hydaticus, etc, Repeated drag netting in the pond or sparying oil emulsion on the surface of water a day before stocking controls the insects in a pond.

4.Aquatic weeds and their significance

Aquatic plants are plants that have adapted to living in aquatic environments (saltwater or freshwater).
They are also referred to as **hydrophytes** or **macrophytes** to distinguish them from algae and other microphytes. A macrophyte is a plant that grows in or near water and is either emergent, submergent, or floating. In lakes and rivers macrophytes provide cover for fish, substrate for aquatic invertebrates, produce oxygen, and act as food for some fish and wildlife.

Advantages of Aquatic Weeds

a) They form natural food of many species of fish.
b) Fertilize the pond when decayed.
C)They provide shade and shelter to many fish.

d) Oxygenate the water.

e) They reduce turbidity.
f) Provide spawning beds for fishes.

Disadvantages of Aquatic Weeds

a) Aquatic weeds occupy more space and they restrict space for fish life.
b) They retard the free movement of fish.
c) Plankton production is reduced.
d) They prevent the penetration of light.
e) They provide shelter for predators and parasites.
f) Aquatic weeds produce Hydrogen Sulphide (H_2S) and Methane (CH_4) which are harmful to fishes.
g) They consume more nutrients.
h) They obstruct fishing operations.

Types of Aquatic weeds

Submerged weeds

These weeds are mostly vascular plants that produce all or most of their vegetative growth beneath the water surface, having true roots, stems and leaves. Eg. Utricularia stellaris, Ceratophyllum demersum.

Emerged weeds

These plants are rooted in the bottom mud, with aerial stems and leaves at or above the water surface. The leaves are broad in many plants and sometimes like grasses. These leaves do not rise and fall with water level as in the case of floating weeds. Eg. Nelumbium speciosum, Jussieua repens.

Marginal weeds

Most of these plants are Emersed weeds that can grow in moist shoreline areas with a depth of 60 to 90 cm water. These weeds vary in size, shape and habitat. Eg.Typha, Polygonum, Cephalanthus, Scirpus.

Floating weeds

These weeds have leaves that float on the water surface either singly or in cluster. Some weeds are free floating and some rooted at the mud bottom and the leaves rise and fall as the water level increases or decreases. Eg. Eichhornia crassipes, Salvinia, Nymphaea pubescens.

Weeds are controlled by the following methods:

Manual control:

Weeds can be removed by employing man power with simple devices. They can be removed by hand picking. The floating weeds can be removed by bamboo poles, ropes or nets

C)They provide shade and shelter to many fish.

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Management control

a) Floating weeds can be controlled by constructing barriers.
b) Periodic draining and drying of the ponds.
c) Drying and burning.
d) Submerged weeds can be controlled by increasing turbidity.

Mechanical control

Aquatic weeds can be removed by machines. Water hyacinth can be removed by JCB.

Chemical control

Weeds can be control by chemicals called weedicides. The weedicides should have the following qualities:
a) They should be cheap and easily available.
b) They should kill the weeds at low concentration.
c) They should be non-toxic to human and fish.
d) They should not pollute the aquatic ecosystem.

Chemical used to control weeds

- 2,4-D @ 4.5-6.5kg/hac. (Water hyacinth).
- 2,4-D @ 5.0kg/hac, 2,2-dichloropropionic sodium @ 10- 12kg/hac, Amitrol @ 8.0kg/hac. (Typha, Colocasia, Grasses).
- Copper sulphate with mud on the bottom soil @ 175kg/ hac. (Nymphae).

Biological control

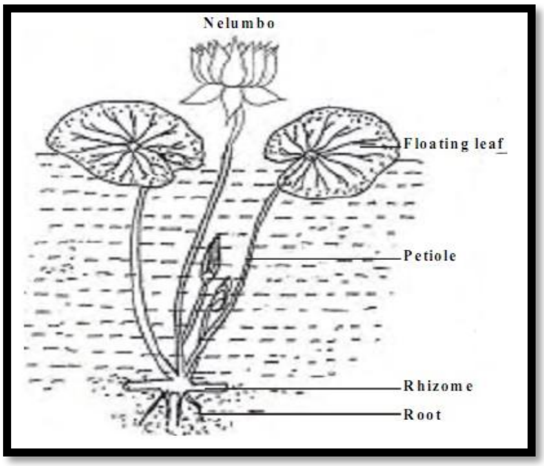
i. Biological control through herbivorous fishes are - Osphronemus gorannmi, Ctenopharyngodon idella (Grass carp), Puntius javonicus (Tawes), Tilapia mossambica, Chanos chanos (Milk fish) have been used.
ii. Some birds have been found in controlling aquatic weeds. For example, Swans, Ducks feed on algae like Wolffia, Lemna, Marginal grasses etc.

Control through utilization

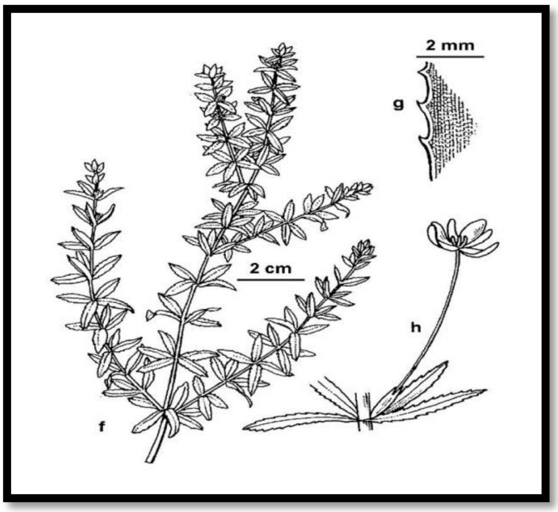
Aquatic weeds have economic value. They are used for various purposes. The removal cost of aquatic weeds by manual, mechanical and chemical methods is high and this cost can be compensated by utilizing the weeds for the following purposes

i. Fertilizer
ii. Feed for animals/fishes/birds.
iii. Leaf protein.
iv. Manufacture of paper.

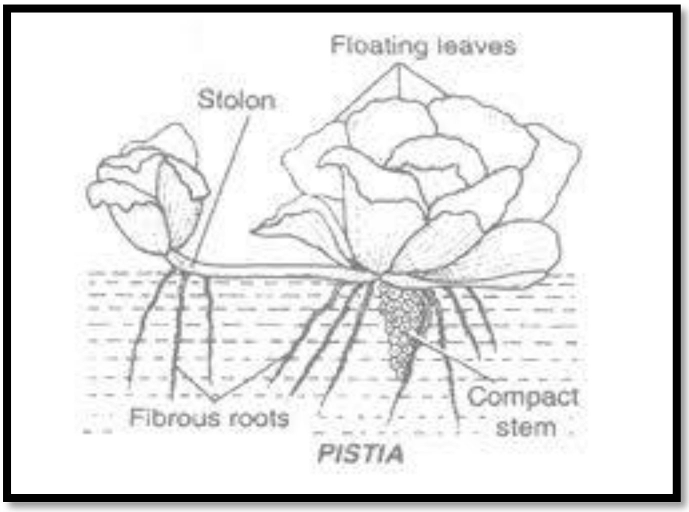
Nelumbo



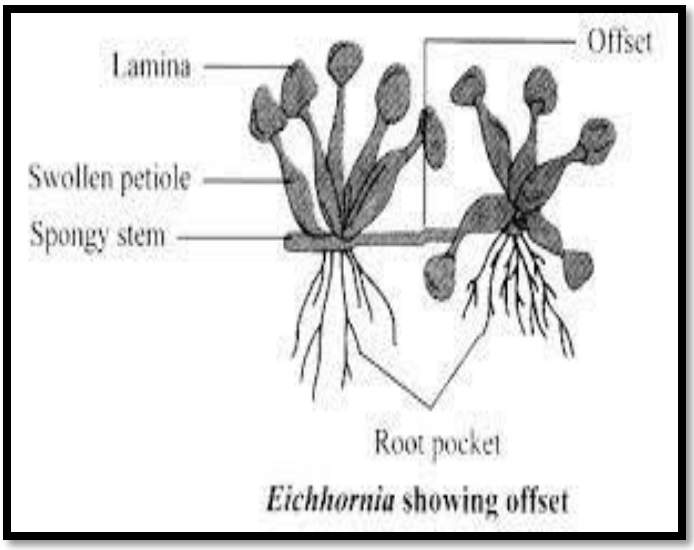
Hydrilla



Pistia



Eichhornia



5. Post stocking management practices followed in fish pond

This phase includes the activities to be undertaken from stocking of fingerlings up to the final harvesting of fish from the pond. The activities are manuring, feeding, growth and health monitoring, water quality monitoring and harvesting.

Manuring / Fertilizing

Besides, application of high dose of basal manuring / fertilizing before stocking, regular addition of manure / fertilizer in small quantities is required in order to ensure in tempted supply of natural fish food. Organisms in the pond manuring / fertilizing should be done monthly or fortnight at regular intervals and the quantities should be in split doses.

Supplementary feeding

The need for supplementary feeding in aquaculture depends on the intensity of fish culture. After certain level of fish biomass increase the available natural food organisms in a pond are not sufficient to support further growth of fish. Oil cakes, rice / wheat beans, grain fodders and other agricultural by-products and available slaughter house by-products (blood, rumen content, Viscera etc) may be utilized as fish feed ingredients. The required can be either farm made or can be produced from feed manufactures. Feeding is the most expensive operation in aquaculture. So cave has to be taken to supply the required quantity and quality of feed to the species culture. Under feeding will result in poor growth of fishes whereas, overfeeding will increase the cost of feeding. Hence, feeding assumes prime importance in improving the yield and the profitability of aquaculture. The required quantity of feed has to be estimated based on the biomass available and feed has to be given in internals based on the species cultured

Storage of feed

The price of feed stuff show seasonal variation. Therefore it is better to by a larger quantity when the prevalent price is low. However, without proper storage, the nutrient values can deteriorate rapidly. A decomposed fungal infected feed must not be given to the fish. Feed ingredients should be stored in places which are dry and well ventilated. Feed should be stored always 10-15 cm above the floor level.

Regular sampling of fish

In a proper fish production management system, periodic sampling at regular internal is very important with a view to Checking the health condition of the fish Monitoring the growth rate of fish Calculating the quantity of supplementary feed to be applied in accordance withthe increasing biomass of fish Estimating survival and mortality of fish in the pond Periodic sampling of fish should be done at least once in a month. In each sampling 10-20 fish of every species should be taken for growth measurement. For sampling, complete netting of pond by seine net is better. However, partial netting of pond also serves the purpose of sampling. During each sampling data relating to fish health and growth rate has to be properly recorded. Any undesirable fish, if some how get into the pond, must be removed if found in the sample netting. In case of some fish exhibit the symptoms of any disease, suitable curative measures should be taken immediately. However, prophylactic treatment measure such as giving the fish dip in potassium permanganate at 250-500ppm / minutes should be strictly followed before releasing the fish back in the pond.

Harvesting of fish

Harvesting of fish means the complete removal of fish from the pond at the end of production. A single stocking and a single harvesting are the common practice in existence. However, the technique of partial harvesting and restocking is now being practiced and has been found to yield better results in terms of fish production per unit area. Bigger size fishes should be harvested and sold in batches and the pond should immediately be restocked with the same number of fishes of such species.

6A. Happa

These are meant for breeding and hatching in earlier days. They are constructed with mosquito net cloth of different sizes for different purposes.

Happas are two types a. Hatching Happa 2, Breeding Happa

Hatching happa

- It is a traditional net enclosure with the inner net being smaller than the outer one (Fig. 6.23).
- The outer net consists of a fine mesh (0.5 mm) seive-cloth tank about 2 x 1 x 1 m in dimension, while the inner chamber, made of the same material, has a mesh size of 2.0 – 2.5 mm.
- The whole device is placed in a protected water body where the water is well oxygenated. The fertilised eggs are evenly spread in the inner hapa.
- The hatched larvae fall or pass through the larger meshes of the inner hapa and are retained by the outer hapa as the small meshes of the outer hapa prevent them from escaping.
- After hatching of the eggs get completed, the inner hapa is removed together with the dead eggs, egg shells and other debris to prevent deterioration of the water quality within the happa.

Breeding Happa

- Breeding hapa is a rectangular cloth container, stitched with close meshed cloth, having an opening on one side (breadth side) through which breeders are introduced and taken out and can be securely tied.
- Breeding hapas are fixed in the marginal waters of ponds, canals, lakes and reservoirs. While fixing the hapas, water bodies having common carp and tilapia are avoided and so also ponds recently-manured and having algal blooms.
- Breeding generally takes place within 3–6 hours after the final injection to females. Stripping method is not followed, since the Indian major carps breed fully after injection with very high percentage of fertilization.

6B.Algal blooms

Algal blooms occur when the ratio of available food to algae, plankton is exceeded. If this ratio is greater than one to one, algae can grow faster than phytoplankton can be absorbed into the surrounding water. If there is a surplus of algae in a particular area, the phytoplankton will begin to accumulate, grow and settle out at the bottom of the water column.

Algal blooms are formed due to various nutrients like nitrogen, phosphorus which enters from various fertilizers into the aquatic system and there they form algal blooms. They cause various effects on ecosystems like blocking of sunlight, depletion of oxygen level in water, secreting toxic material in water, etc. Due to all these harmful effects most of

There are several factors which causes algal bloom in water bodies, they are given below

Run of Nutrients: An algal bloom is mostly caused by the presence of nutrients like nitrogen, phosphorus in water. As these nutrients are washed by water from lands and agriculture areas that are heavily filled with nitrogenous and phosphatic fertilizers. Here rain acts as a washing agent, as they wash all the nutrients from soil and deposit all nutrients to water bodies i.e oceans, rivers, etc. Due to all this deposition of nitrates and ammonia in water bodies it causes algal bloom. Main reason behind this algal bloom is discharge of untreated industrial waste directly into water bodies.

High Temperature: As depletion of ozone layer is happening due to global warming and this reason is a major factor behind tremendous growth in algal bloom. Appropriate temperature is needed for proper growth of algal bloom. As high temperature leads to rapid decompositions of the nutrients like nitrogen, phosphorus and these decomposed nutrients become easy for bacteria to use up and grow rapidly.

Presence of Dead Organic Material: There are so many varieties of bacteria which are present in water bodies as well as in the atmosphere.These bacteria lead to the growth of algae bacteria like all other bacteria. As nutrients in water along with dead organic matter leads to increase in growth of algal bloom.

Large Mass of Water: Large mass of water is needed for growth of algal bloom. As less disturbance in water propagation leads to tremendous growth of algal bloom.

Harmful Effects of Algal Bloom on Aquatic System

Death of Aquatic Animals

As each and every living organism needs proper supply of oxygen whether they live in water or on land. In the same way algal bacteria need oxygen for their survival for which they utilize the amount of oxygen present in the aquatic system, this leads to depletion in oxygen level and causes death of aquatic animals.

b. Leads to Starvation

Algal bloom feeds on important nutrients present in the aquatic system which leads to starvation situations in aquatic organisms as they dont get enough nutrients from the aquatic system and ultimately they lead to death of an affected organism.

Short Answer Questions

1.Bundh breeding

Bundh is a type of perennial and seasonal tank or impoundment where riverine conditions are simulated and where major carps are known to breed. After a heavy shower, the bundhs receive large quantity of rain water with washings from their catchment areas and provide large shallow areas that serve as spawning grounds for the fishes. The first bundh (dry bundh) was set up in Madhya Pradesh at Sonar Talliya in 1958. After this, persistent expansion of bundhs had taken place due to its simplicity of operation and high rate of success.

Types of Bundh: Bundhs are generally of three types:

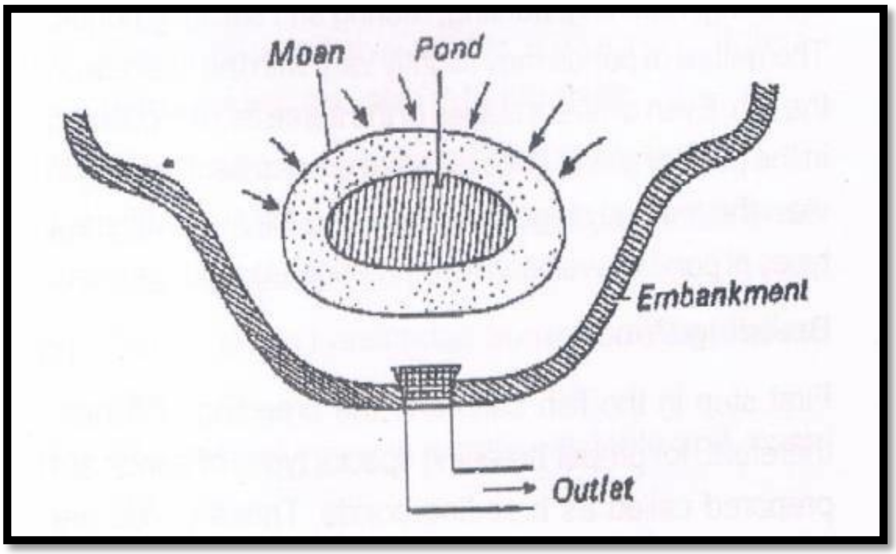
(A)Wet Bundhs and (B) Dry Bundhs.

- **Wet Bundhs**: Wet bundhs are perennial ponds situated in the slope of an undulating terrain. It provides a vast catchment area and facilitates quick filling even with a short spell of rain.
- . It has proper embankments with an inlet towards the high catchment area and an outlet at the opposite lower end .
- The deeper portion of the bundh during summer, retain water containing major carp breeders.
- . During monsoon, after a heavy shower, water from the catchment area rushes into the bundh.
- The major portion of the bundh gets submerged and the excess water passes out through the outlet. The shallow areas of the bundh is called moans where the breeders actually spawn.
- The outlet is protected by a bamboo fencing called chheva.
- 7. The outflow of the water through the chheva can be controlled by blocking the spaces in it with straw and mud.
- Fine meshed nylon cloth is placed in the outlet to stop the hatchlings from escaping. Similar nylon cloth is placed i n the inlet to stop the entry of unwanted fishes.

- **B.Dry Bundhs**
- Dry bundh is a seasonal one, which remains more or less dry during greater part of the year.
- It is a shallow depression enclosed on three sides by an earthen embankment.
- During the monsoon season it imports fresh rain-water from the catchment area.

- In modern constructions, the embankment is a pucca stone masonry with a small sluice gate in the deepest portion of the bundh for complete drainage and one or two waste weirs for overflow of excess water.
- A dry bundh unit (apart from the bundh) also consists of storage ponds for stocking breeders, an observation post with arrangement for storing necessary equipment and a set of cemented hatcheries (2.4 m x 1.2 m x 0.3 m) along with overhead tank and regular supply of water for handling large number of eggs at a time (Fig. 6.14).
- 6. In dry bundhs, selected numbers of female and male (in the ratio 1:2) breeders of major carps are introduced.
- Though major carps breed at any spot in the bundh, it is advantageous to prepare¬ 'spawning grounds' at different levels which could get flooded at different water levels.
- It has been stated that the water depth where sex play/courtship behaviour and spawning¬ take place, varies between 8 cm and 1.2 m.
- In both wet and dry bundhs, spawning usually occurs after a large quantity of rain water¬ fills up the bundh during continuous heavy showers of the monsoon period.

Wet Bundh



2.Synthetic hormones

Induced breeding is necessary to control timing and synchrony of egg production. Various synthetic hormones like **ovatide**, **ovaprim**, wova-FH, ovopel, **HCG** and LHRH are used in induced breeding of fishes.

Ovatide:

Use of Ovatide represents the most modern and advanced technology for spawning of fish at considerably low cost. Fishes injected with Ovatide produce increased number of eggs through complete spawning with high fertilization and hatching percentage with low viscosity of Ovatide makes it easily injectable.

Ovaprim:

Ovaprim is marketed ready to inject in a liquid form. In the ornamental fish industry, Ovaprim is used as a spawning aid to induce ovulation (release of mature oocytes/eggs) and spermiation (release of milt/sperm) in mature, properly conditioned brood-fish.

Ovapel:

Ovapel developed by University of Godollo in Hungary, combined of mammalian GnRH analogue and dopamine receptor antagonist Lactosum. Recommened dose 1-2 pellet/kg of fish in Catla and Rohu.

3.**Predatory and weed fishes**

- Culture fisheries, like every other agriculture practice encounter problems. Pests of fish are unwanted animals or plants that destroy fish or hinder the production of target fish species
- These pests canbegroupedin to plants and animals. Any unwanted living thing that can feel and movewhichretardsfishproductionisanimal pest to fish.
- These may be Predatory fish, Birds, mammals and some other. Fish prey on fish. Predatory fishes prey directly on culture fish and compete for food with the culture fish.
- Despite their nuisance in culture fisheries, fish predators are used in controlling fish over population in ponds.
- However, fish culturist need be careful on the number of predators, the size of prey and predator before stocking.

A. **Predatory Fishes** –

- The fishes which depend on spawn,fry and fingerling of cultured species are known as predatory fishes.
- They get into cultured prawns through water or seed.
- They breed earlier in congfined waters so their size is big than the carps
- They compete for food, DO, space so growth of carps is slow.
- They have of the habit of burrowing in the mud.
- Their complete eradication by physical methods is difficult
- Use of pesticides is inevitable , ex- Channa,clarius,pangus,Heteropneustus Mystus,Glosogobiusetc.,

B.Weed fishes-

- These are uneconomical,small sized.naturally occurring or accidentally introduced into the pond.
- They compete for food,space and oxygen.
- They have high fecundity and breed well before carps
- Many of them breed throughout the year.therefore.fish seed from wild contain more weed fishes seed.
- Ex- Puntius,Rosobra,Esomus,Aplochelius,Ambassis,oxy gaster species.

Fish toxicants:

(i) plant Derivatives (ii) chlorinated hydrocarbons and (iii) organo-phosphates can be used as fish toxicants

- Derris powder with 5% rotenone used mostly as fish poison.
- Tea seed cake can be used as pesticide ans also as a fertiliser.
- The seed powder of Barringtonia acutangula kills a wide variety of fish at 20ppm with its active nature for 48 hrs.

- Aldrin,Dieldrin andEndrin can be used as fish poisons to kill predatory and weed fishes.
- Thiometon,DDVP,Phosphamidon have been found to be effective to kill fish.

4. Liming

Lime is frequently applied in aquaculture practices to improve water quality. After the pond is ploughed, cleared and smoothed, it should be conditioned with lime. Liming increases the productivity of a pond and improves sanitation. It is both prophylactic and theuraptic.

The main uses of lime are:

- Naturalize the acidity of soil and water.
- Increase carbonate and bicarbonate content in water.
- Counteract the poisonous effects of excess Mg, K and Na ions.
- Kills the bacteria, fish parasites and their developmental stages.
- Build up alkaline reserve and effectively stops fluctuations of pH by its buffering action.
- Neutralises Fe compounds, which are undesirable to pond biota.
- Improve pond soil quality by promoting mineralisation.
- Precipitates excess of dissolved organic matter and this reduces chances of oxygen depletion. Acts as a general pond disinfectant for maintenance of pond hygiene.
- Presence of Ca in lime speeds up composition of organic matter and releases CO_2 from bottom sediment.
- Lime makes non-availability of K to algae.

Application mode and time

- New ponds can be limed before they are filled with water. The limestone should be evenly spread over the dry pond bottom. In ponds with water, it is better to spread evenly on surface of water.

- Whether the pond is new or old, a layer of lime should be placed on the bottom of the pond.
- The lime should be added to the pond two weeks before the water is pumped into the pond.
- The best time for lime application is during the period when fertilization has been stopped. Lime should not be applied while the pond is being fertilized.
- The highly acidic soils (pH 4-4.5) need a dose of 1000 kg/ha lime, whereas slightly acidic soils (pH 5.5-6.5) need about 500 kg/ha lime. Nearly neutral soils (6.5 to 7.5 pH) require only 200-250 kg/ha lime. The pH of the pond soil should be brought to nearly neutral for maximum benefits.

5.Role of Manures in fish pond

- Fishes require certain elements to grow and reproduce. These elements are C, H_2, O_2, N_2, K, P, S, Ca and Mg. Some other elements, called trace elements like Cu, Zn, Mn, Mo, B, etc., are needed only in small amounts. If these elements are missing or present in very low quantities, the fish will not grow well.
- Fish get these elements from the pond soil, the pond water and the food they eat. Some fish ponds lack elements that are necessary for fish growth and productivity.
- In these cases, it is necessary to add fertilizers to the water. The fertilizers are simple materials which contain the missing elements.
- The elements most often missing or in short supply in fish ponds are N_2, P and K.
- Fertilizers consisting these missing elements are added to the fish pond to help the growth of the fish and of the plankton, which the fish use as food.

- A pond rich in phytoplankton is often bright green in colour. The colour indicates a bloom of algae.
- Sometimes a pond can become too fertile. Secchi disc is an equipmet used to check the fertility of pond. If the secchi disc disappears at only 15 cm, the bloom is too thick. In this case, there is too much fertilizer in the pond, and hence some of the thick layer of algae formed at the surface of the water should be removed. These ponds do not need any fertilizer.
- If the secchi disc can still be seen at 43 cm depth, the plankton in the pond is not sufficient. It is, therefore, necessary to add fertilizer to the pond water in order to prepare a fertile pond. Another factor which determines the need for fertilizers is the quality of the soil. If the soil is highly productive, the need for fertilizers is less; if the soil is not so productive, the need for fertilizers is greater.
- The choice of fertilizers can be decided on the basis of physical composition of soil. In sandy or sandy loamy soils with low organic matter, fertilization is carried out with organic manures.
- In loamy soils with medium organic matter, a combination of both organic and inorganic fertilizer should be applied.
- In highly clay soil with rich organic matter, fertilization is carried out with only inorganic fertilizers. Amount of fertilizers to be applied to ponds may be worked out on the basis of the productive potentiality of the pond.
- Fertilization should be done 2 weeks prior to stocking the fish, so that, sufficient natural food is available in the pond. 1/5 of the total quantity of organic manure is required as an initial dose, and the rest is applied in 10 equal instalments.
- Organic and inorganic fertilizers may preferably be applied alternating with each other in fortnightly instalments.
- The amount of fertilizers required in general for fish ponds is 10,000 kg/ha/yr of cow dung, 250 kg/ha/yr of urea, 150 kg/ha/yr of single superphosphate and 40 kg/ha/yr of murate potash.

6.Types of fish Feed

Feed is defined as the mixture or compound of various ingredients which accomplish the nutritional requirement of any organism

Moist feed: - These feed contains the level of moisture is 35 – 75 %

Semi moist feed: - This type of feed contains 12 – 35 % moisture level.

Dry feed: - The moisture level in these type of feed 4 – 12 % but not zero.

Aquaculture feeds fall basically into two types – Dry and Non-Dry feed

Dry feeds-

Dry feeds are generally made up of dry ingredients or from mixtures of dry and moist ingredients. Dry feeds are not completely free from moisture .moisture content usually about 7-13% depending on the environment .Dry feed are compacted into a definite shape generally by mechanical means called pellets . Depending on the formulation and compacting technique these diets are floating and non-floating or sinking in water.

Dry feeds may be simple mixtures of dry ingredients, in which case they are called 'mashes' or meals'. Pellets can be made in a range of sizes Depending on the processing technique used, pellets may float or sink when placed in water. The non-floating type are often broken up and then sieved into a range of smaller sizes, called crumbles or granules, for small fish or shrimp.

- **Non-Dry Feed**
  Non-dry feeds- are divided into two major categories - Wet and moist.
- **Wet feeds**- as those which are made entirely or almost entirely from high moisture ingredients, such as 'trash' fish, waste slaughterhouse products, undried forage, etc. Moisture contents of about 45-70%
- **Moist feeds-** are made from mixtures of Wet, or moist and dry raw materials, or from dry ingredients to which moisture has been added .Usually moist fees range from 18-45% moisture. There is no really clear division between 'moist' and'wet' feeds. A third class of products - flaked feed - is designed for aquarium fish, fish fry and early post-larval shrimp.
- Non-dry feeds- 'moist' or 'wet' are either extruded or non-extruded. An extruded feed is one which is made into a product like noodles by forcing it through narrow holes in a special piece of equipment.
- Non-extruded moist or wet feeds may simply be non-formed single ingredients (such as 'trash' fish) or mixtures of them, or they may be formed by machinery (but usually by hand) into cakes, balls and pastes. Natural binding materials in the feed, or added binders. Extruded moist

pellets can be dried, by machinery or by sun-drying, into dry sinking pellets - thus the link between the two products.

- Pellet feed is again two types floating pellets and sinking pellets

DNR College (A) Bhimavaram

Subject –Zoology 6A Sustainable Aquaculture management

Esay Questions

1.Macrobrachium rosenbergii identification features and biology

Phylum :Arthropoda
Sub Phylum :crustacca
Class : Malacostraca
Order :Dacapoda

- **Distribution** -It is distributed in the Indo-west pacific countries, Pakistan, India and Bangladesh. In India, the most common in the river Godavari, Cauvery and their estuaries and lakhs of Chennai and Andhra Pradesh and also in Chilka Lake. 29
- **Physical appearance** -Rostrum is long, slender, slightly upturned. Extend antennal scale. The dorsal margin is armed with 11-14 teeth. Habitation in pond Bottom of the pond Feeding behaviour Accepts artificial feeds. Omnivorous, Cannibalism observed during moulting.
- **Stage of Maturity** -The minimum size of maturity for prawns is 153 mm and 175 mm respectively.
- **Fecundity**- Fecundity 150,000 – 5,00,000
- **Growth** -Growth is in inverse exponential pattern. Made attains a length of 108 mm, 146 mm and 233 mm at the ends of 1st, 2nd and 3rd year respectively. Females attain a length of 82,5 mm, 130 mm, 168.5 mm in the corresponding year.
- **Breeding season-** Mating prawn migrates to the estuarine region for spawning; and the breeding season coincides with the monsoon. Breeding period December to July. It can be cultured in ponds as poly monoculture. Cultured prawns can be harvested after 6 months of growth. Culture period is between 180-240 days. Survival rate about 75% upto 97%.

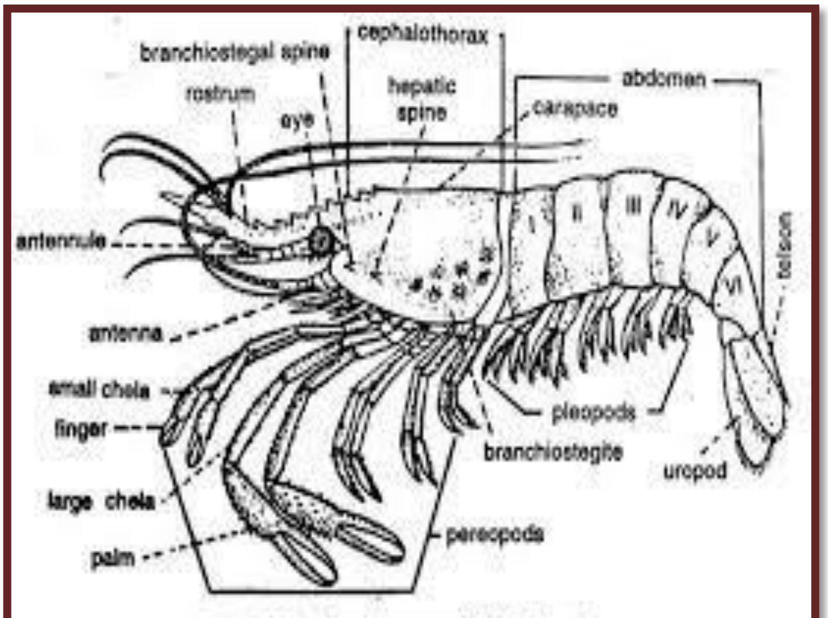


Fig. 23.1. Macrobrachium rosenbergii (Prawn)

2.Production of Macrobrachium rosenbergii seed

The gaint fresh water prawn is the largest and fastest growing fresh water prawn and distributed in Indian rivers confluent of the sea. The Gaint fresh water prawn ,M.rosenbergii has great demand both in national and international markets. It migrates between rivers and estuary.

Reproductive Biology- Female matures 3-4 times a year with a peak during the monsoon season(June to September) .Breeding occurs in fresh water and the female cariies the fertilised eggs in its brood pouch under the abdomen.The number of eggs which are laid depends on he size of the female. A female prawnlays around 80,000-1,00,000 eggs during one spawning when its fully mature. They are incubated for 18-21 days,during which the colour of eggs change from orange to grey.

Obtaining and selecting egg-carrying females- Fresh water prawn eggs are carried under the abdomen that is in the pleaopod regions . such prawn is called Beeried female prawn.such berried prawns can be obtained by cast netting but are frequently selected at times of partial or total harvest.

Berried females can also be obtained from rivers, canals,in areas where they are native. However,collecting ovigerous females from the wild often results in considerable egg loss during ransport,so many hatchereis prefer to use adjacent rearing ponds for their need.

Sex ratio- Brood stock is stocked at about a 4:1 femal –male ratio. Blue and orange clawed males are preferred since these males are able to mate efficiently than smaller males. Berried females which are active, disease resistent, with all the appendages, with pigmnetation and large egg mass should be selected.

Managing the brood stock-

a. **Disinfection of brood stock-** Brood stock should be disinfected upon reaching the hatchery, by placing them in water containing 0.2 to 0.5 ppm of copper sulphate or 15to 29ppm of formlain for 30 minutes with complete aeration .
b. **Salinity-** whether the berried females are obtained from a captive brood stock or from the wild they should be held in slightly brackish water 5ppt at 25-30 ^{0}c and pH 7-7.2 until the eggs hatch.
c. **Temperature –**optimum temperature required for the breeding id 27-31^{o}c. Temperature below 25 promotes fungal growth and above 30 favors protozoan growth.
d. **Light-** generally light does not seem to affect hatching but direct sunlight should be avoided.
e. **Diet-** A nutritionally complete diet should be required for superior quality egg production. Brood stock should be feed daily at the rate of 1-3% of total biomass, adjusted to match consumption.
f. **Hatching and Stocking larvae-** The hatching process is extremely pH sensitive. 7-7.2 is the optimum pH required for

hatching. One can hatch tehlarva ina special broodstock hoiding system and then transfer them to larval rearing tanks in 12 ppt water. As the eggs hatch a process which is normally completed foor the whole brood within one or two nights,the larvae are dispersed by rapid movements of the abdominal appendages of the prawn. Larve reqire brackish water for survival.

g. **Stocking density-**50-100L/ltr ,with DO levels 3ppm,and ammonia 0.1ppm are required for the above stocking density.
h. **Feeding-**A widw variety of feeds can be provided Artemia. Miona,fisg eggs,squid flesh,egg cuatard worms, and commercial feeds. Most fresh water prawn larvae do not feed on the first day.

   There are a number of microscopically distinct stages during the larval life of fresh water prawns ,which last sevesrl weeks. On completion of their larval life,fresh water prawn metamorphose into post larvae(PL)

3.Vannamei Hatchery construction and maintenance

Shrimp is a valuable aquatic food resource high in protein and commands good export markets. It has become the main target commodity for aqua farming in recent years. Traditionally, shrimp fry are trapped and held in ponds and later collected by shrimp gatherers for stocking in grow-out ponds. With increasing demand for shrimp, supply of wild fry for the increasing number of shrimp farms has become insufficient and inconsistent. The excellent growth performance of these hatchery-bred fry in grow-out ponds strongly shows that the shrimp hatchery can answer the industry needs for ample supply of shrimp fry for farming.

Site Selection and Lay-Out

1. **Sea water supply**

   The sea water used in a hatchery should be clean, clear and relatively free from silt. The water quality should be stable with minimal fluctuation in salinity. Suitable sites are usually found in sandy and rocky shore ecosystem where there is clean, clear and good quality sea water all year round. Sites not suitable for hatchery are swamps and muddy shores where the water becomes turbid during heavy rains or due to turbulence. Avoid river mouths where abrupt lowering of salinity often occurs during heavy rainfall. An added advantage of rocky and sandy shores is that good quality sea water is relatively near the shoreline thus reducing the cost of piping installation and pumping cost. The hatchery site should also be free from possible impact from any inland water discharges containing agricultural or industrial waste.

2. Availability of spawners

Presence of spawners at the vicinity of the proposed site is of considerable advantage in ensuring consistent supply of spawners, reducing the cost of transportation which could affect the rate of spawning.

3. Availability of power source

Electricity is essential to provide the necessary power to run equipment and other life support systems in the hatchery. Although some marine pumps and aerators can be driven directly by handy generators, the shrimp hatchery can therefore be operated in areas without electricity supply. However, it is more economical to operate it in areas where there is a reliable source of electricity. Installation of an on-site standby generator is absolutely necessary especially in areas where there are frequent lengthy power failures and fluctuations.

4. Freshwater supply

Freshwater is essential for daily hatchery operation such as salinity adjustment, equipment maintenance and for domestic use.

5. Accessibility

Ideally, a hatchery should be sited in areas where there are active shrimp farming operations so that the shrimp larvae produced can be easily transported and distributed to the grow-out ponds. Hence, the site chosen for hatchery establishment must be easily accessible to facilitate communication and transportation.

6. Climatic conditions

A hatchery can be established in any climatical condition as long as the required rearing conditions can be adequately provided. However, all the commercial hatcheries take full advantage of nature in terms of energy source and supply of good quality water.

Sunlight is the basic requirement for hatchery operations especially in the mass production of natural food used as feeds for the growing shrimp larvae. In the temperate region where adequate sunlight is only available in certain periods of the year, hatchery operations are usually confined to a certain suitable season.

Shrimp Hatchery Design

Hatchery design is aimed at achieving the production target which determines the size of the hatchery. The tank capacity is based on an approximate ratio between algal culture tank and larval rearing and nursery tanks. Desirable algal tank capacity is 10–20% of the larval rearing tank capacity. The capacity of maturation tank depends on the number of spawners needed.

Size of hatchery

Generally, the size of a hatchery should be based on its functional requirements and economic efficiency. Based on the level of operation, production output and financial investment, hatchery practice can be broadly grouped into three categories viz: small-scale, medium-scale and large-scale hatchery.

Facilities

Road access, power supply, communication facilities and emergency generator are all essential components to run the equipment and operating systems in the hatchery.

Water quality

- Water quality and quantity are critical to the success of a prawn hatchery operation. If water quality is good, then good results can be achieved easily. Freshwater from a river, streamor lake, rainwater, or groundwater can be used
- . Use of treated drinking water is not recommended, however, and pure water from a natural source is much preferred. Hardness (as $CaCO_3$) should be in the range 50–100 ppm.

- Seawater is needed to mix with the freshwater to produce brackish water for the larvae. Seawater should be clean and free from pollution, collected from open sea or from a well on the sea shore, and preferably pumped through a bed filter.
- The seawater is disinfected with 10 ppm of calcium hypochlorite and stored with vigorous air bubbling for at least a week before use. The pH of the water should be in the range 7.0–8.5. Ammonia concentration in the water should not exceed 1.5 ppm of ammonia ion (NH_4^+) and 0.1 ppm of un-ionized ammonia (NH_3).

Hatchery components

Every hatchery requires site-specific adaptations for optimum production and cost-effectiveness. Some of the basic hatchery components and equipment are:

- Building to house the larval rearing space
- Hatch tanks 1000 L
- Larval rearing tanks (LRTs)
- mHolding tanks 1000 L for PL, also used for broodstock holding
- Nursery tank 5000 L for PL (optional)
- Brine shrimp hatch tanks
- Water (bio-filters)
- Freshwater storage tank
- Saltwater storage tank
- Air blower (1 HP), air tubes and air stones
- Immersion heaters
- Generator (2 kVA) with auto-changeover switch
- Water pump
  Plastic buckets, basins, containers
- Microscope, refractometer, pH meter, dissolved oxygen meter
- Equipment for packing and transport of PL

- Feed and chemicals like formalin and chlorine, with storage facilities for these

4.Post stocking practices during vannamei culture

Success of any shrimp culture depends on the better management practices involved in pond preparation and pre-stocking management steps. Pond preparation is one of the most important pre stocking management measures essential for optimum growth of shrimp in grow out farming systems. There are various points to be taken care during the pond preparation for shrimp culture.

Drying the pound bottom- After each harvesting cycle, the pond bottom is allowed to dry and crack. It helps to oxidize the decomposed organic components, leftover in the pond after the previous culture. Generally pond bottom is allowed to dry for 7-10 days and, it allows soil crack to a depth of 25-50 mm. It helps to reduce the risk of disease outbreaks and improve shrimp production.

Ploughing or raking -Ploughing or raking the pond bottom help to exposes the nutrient rich sub soil and fast mineralization and oxidation of the organic compounds and harmful gases. Tiling and ploughing is not generally recommended in acidic soils as it increases the soil pH.

Top soil removal: The top black soil and bottom sludge to be removed to prevent development of anaerobic condition during culture period. The sludge must be disposed away from the pond site, so that it does not seep back into ponds. Grow out pond with high stocking density, entire pond top soil is removed whereas modified extensive ponds, areas of the pond where there is a high accumulation of organic matter from previous crops, such as feeding zone should be removed.

Liming

During pond preparation liming is applied to optimize pH and alkalinity conditions of soil and water. The type and amount of lime to be added depends mainly on the soil and water pH, which should be checked before lime application. Generally agricultural lime or dolomite can be applied if soils of pH >5 and Quick lime or hydrated lime can be applied if soil pH below 5. Where disinfectants like bleaching powder (calcium hypochlorite) is used, applies lime only 3-4 days after the application of disinfectant as lime reduce the effectiveness of the disinfectant.

Water intake

Stringent measures to be followed to prevent entry and growth of any unwanted and pathogenic agents in culture ponds. It can be achieved via proper filtration of intake water using appropriate mesh screens, disinfection of intake water. Generally bleaching powder @ 20-60 ppm is recommended for reducing the load of harmful bacteria and virus in the cultured water.

Fertilization of pond water

The purpose of fertilization is to ensure the growth of primary producers in culture ponds. They initiate natural food web in the aquatic ecosystem and directly or indirectly contribute shrimp growth also. It also helps to maintain desirable level of transparency (25- 40 cm) which prevents development of harmful benthic algae. Phytoplankton in culture ponds also help to improve the water quality parameters in grow out ponds. Fertilizers can be applied depending on the fertility status of the soil.

4. **Application of organic based indigenous probiotic-** Yeast based organic preparation are recently being used in zero water exchange shrimp culture ponds as a probiotic. It can be prepared using ingredients like 60 kg paddy flour, 30 kg molasses and 2-4 kg yeast Saccharomyces cerevisiae. Allow these ingredients to

get ferment in 48 h and can be applied in one ha pond. Organic juice can be applied in biweekly interval to improve the fertility status of water @ 1-2 ppm.

5. **Seed Selection and Stocking -**Stocking of shrimp is one of the most important component of a biosecurity program. Use seeds produced from domesticated shrimp stocks that are free of specific diseases (“Specific Pathogen Free” or SPF) and or with stocks resistant to specific disease agents (SPR) SPF broodstock from certified Nucleus Breeding Center (NBC). These are biosecurity facilities where there are two or more years of documented disease testing to support their SPF status. Before purchasing, shrimp post larvae should be checked for their general condition such as activity, color, size, etc. If there is any dead and abnormal colored PL in the stock, t treated with formalin at 100 ppm concentration for 30 minutes in well aerated tanks to remove weak PL. Maintain a balanced or optimum stocking density is also an important component of shrimp culture

6**. Pond bottom and water quality management-** Disease outbreaks in shrimp growout culture are directly related to pond bottom and water quality. Zero water exchange must be followed throughout the culture period to prevent the disease occurrence. Use chemical like KmNo4 dip treatment may be followed to disinfect all equipment– screen net, cast net, trays or accessories while sampling and regular monitoring (surveillance) of shrimp stocks

7. **Better-Feed management-** Cost of feed accounts for about 40% to 60% of the total production cost. Do not use fresh feed, trash fish, bivalves etc. as it can carry vectors. Feed monitoring should be done with check tray evaluation for optimum feed management. Feeding area can be shifted at least once in 7 to 10 days depending on the bottom condition along feeding area. Reduce feeding during periods of low DO, plankton crash, rain

fall, extremes of temperature etc. Slightly under feeding is better than over feeding, which saves money and reduce disease risks and during disease outbreaks. Proper storage of feed is also an important component in the biosecurity plan.

8. **Shrimp Health Monitoring –**Shrimps should be sampled once in a week by cast netting and should be checked for their general health conditions like external appearance For example, a pale whitish gut showed gut infection while a normal gut will have a light or golden brown colour. Probiotics, immunostimulants, bioremediating agents can be employed as prophylactic measures in grow out culture. Yeast based organic preparation(60 kg rice flour, 30 kg yeast and 3 kg yeast) application can be applied to improve the overall pond microbial balance. Since there is a serious concern on the use of antibiotics, their use in shrimp farming should be avoided.he entire batch should be rejected.

Short Answer Questions

1. . Macrobrachium rosenbergii

- *Macrobrachium rosenbergii*, also known as the giant river prawn or giant freshwater prawn .
- Is a commercially important species of palaemonid freshwater prawn. It is found throughout the tropical and subtropical areas of the Indo-Pacific region, from India to Southeast Asia and Northern Australia.
- *M. rosenbergii* can grow to a length over 30 cm (12 in).They are predominantly brownish in colour but can vary. Smaller individuals may be greenish in colour and display faint vertical stripes.
- The rostrum is very prominent and contains 11 to 14 dorsal teeth and 8 to 11 ventral teeth. The first pair of walking legs (pereiopods) are elongated and very thin, ending in delicate claws (chelipeds) which are used as feeding appendages.
- The second pair of walking legs are much larger and powerful, especially in males. The movable claws of the second pair of walking legs are distinctively covered in dense bristles (setae) that give it a

velvety appearance. The color of the claws in males varies according to their social dominance.

- Females can be distinguished from males by their wider abdomens and smaller second pereiopods. The genital openings are found on the body segments containing the fifth pereiopods and the third pereiopods in males and females, respectively

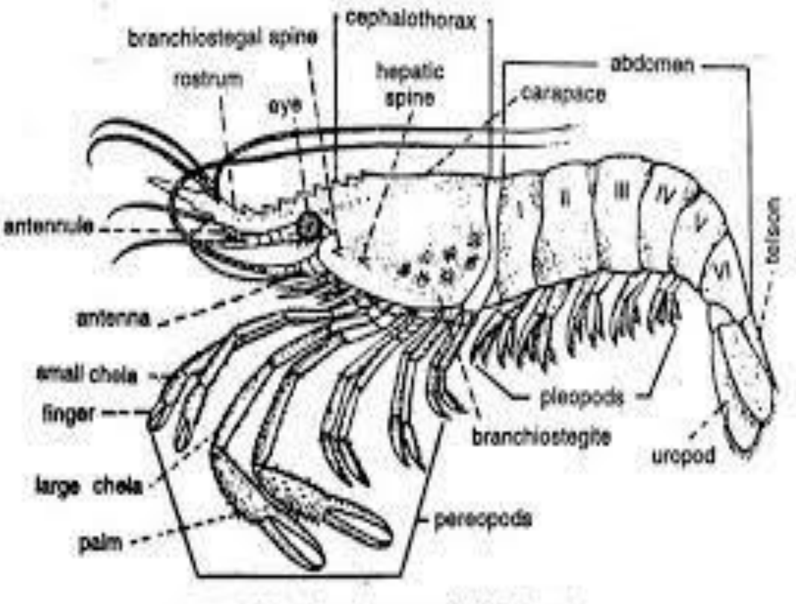


Fig. 23.1. Macrobrachium rosenbergii (Prawn)

2.Male morphotypes in fresh water prawn

Three different morphotypes of males exist. The first stage is called "small male" (SM); this smallest stage has short, nearly translucent claws. If conditions allow, small males grow and metamorphose into "orange claws" (OC), which have large orange claws on their second chelipeds, which may have a length of 0.8 to 1.4 times their body size. OC males later may transform into the third and final stage, the "blue claw" (BC) males. These have blue claws, and their second chelipeds may become twice as long as their bodies.

Males of *M. rosenbergii* have a strict hierarchy; the territorial BC males dominate the OCs, which in turn dominate the SMs. The presence of BC males inhibits the growth of SMs and delays the metamorphosis of OCs into BCs; an OC keeps growing until it is larger than the largest BC male in its neighbourhood before transforming. All three male stages are sexually active, and females that have undergone their premating moult co-operate with any male to reproduce. BC males protect the females until their shells have hardened; OCs and SMs show no such behaviour.

3. Eye stalk ablation in prawns

Shrimp culture has been an age-old practice in India. India is among the largest producers and exporters of farmed shrimp globally. For any effective aquaculture practice, good quality seed is one of the most important inputs. Induced breeding under captivity is necessary for regular and large-scale production of good quality seeds. Though male crustaceans may mature in captivity, females generally fail to attain sexual maturity under captivity. Studies on hormonal control over maturation in decapod crustaceans showed that removal of Gonad Inhibiting Hormone (GIH) through 'eyestalk ablation' leads to maturity in most of them. Later, various researchers succeeded in maturing different penaeid shrimps using eyestalk ablation and it is accepted as a standard technique for the maturation of penaeid shrimps in captivity.

The Technique of Eyestalk Ablation

Eyestalk ablation is a method where half to twothirds of the eyestalk of shrimp is pinched off or removed. It can be either unilateral (removal of one eyestalk) or bilateral (removal of both eyestalks) of which unilateral ablation is widely practiced. Only hard-shelled shrimps in the inter-moult stage should be ablated

Different methods of eyestalk ablation are:

I. **Pinching**
This is a simple technique where half to two third down the eyestalk is removed or pinched off. It leaves an open wound hence, would create stress to the animal

. II**. Slitting**

Here one eye is cut with a razor blade and then crushing the eyestalk, with thumb and index fingernail (enucleation), moving distally, half to two-third down the eyestalk, till the entire content of the eye is removed. The advantage here is that it leaves behind a transparent exoskeleton; hemolymph clotting and closure of the wound occur quickly.

III. **Cauterizing:**

It can be done either using an electro cautery device or instruments like red-hot wire or forceps to remove the eyestalk. Here the woundis closed completely and scar tissue is formed more rapidly when performed correctly.

IV**. Ligation**

The eyestalk is tied tightly around the base, as close as possible to the carapace; with a surgical thread or any other thread. This prevents the flow of hormones. This leads to falling off of eyestalks within a few days.

Eyestalk ablation induces ovarian maturation and spawning by evading the production of the GIH. This is because crustacean eyestalk is the site where the X-Organ sinus gland is located. GIH, a hormone secreted by this gland is found to inhibit the synthesis of yolk protein precursor, ‘vitellogenin’. Also, there is evidence that removal of eyestalk reduces the intensity of perceived light which in turn induces ovarian maturation.

DNR College (A) Bhimavaram

Subject –Zoology 6A Sustainable Aquaculture management

Unit-V -Essay Questions

1. MBV and HPV in Shrimps

Viruses are considered to be the most important pathogens in shrimp. Different life stages of shrimp may be susceptible to certain viral infections causing mortality, slow growth and deformations. More than 20 viruses have been reported as pathogenic to shrimp.

a.MBV /Monodon Baculo virus

- **Causative agent**-MBV is caused by double stranded DNA virus which is popularly known as Monodon baculovirus. MBV has been observed in all life stages of Penaeus monodon and is the most common virus of P. monodon with late larval, post-larval and young juvenile shrimp as the most susceptible stages/ages.
- **Sign and symptoms of diseases**-Infected shrimp shoe generaised sign of diseases as lethargy,anorexia,poor feeding,dark colouration and reduced growth rate. MBV infected shrimps are with fouling gills and appendages by ciliates like Zoothamnium and vorticella sos. Acute infection leads to loss of epithelial cells of tubules of hepatopancreas. Mortality occurs 70-90% of stock.
- **Diseases diagnosis**- virus can be identififed with simple squash preparation of hepatopancres with 0.1%malachite green. We can see oval occlusion bodies ranging from 0.1 to 20 microns. MBV can be diagnoised by PCR technique also.
- **Transmission-**
  Major mode of transmission of this virus is horizontal. The occlusion bodies, which are composed of protein matrix, polyhedrin that contain embedded viral particles, are the source of viral transmission from one animal to another. The OBs are released through faecal matter of infected broodstock as well as larvae, and these are ingested by other larvae

- **Prevention**
  Since the virus gets transmitted from infected individual shrimp through horizontal means, the best method of controlling the infection is by eradicating the infected broodstock and following strict disinfection procedures. Various chemical agents have been reported to be effective in inactivating MBV such as formalin, chlorine and iodophore, and have been recommended for disinfecting shrimp hatcheries.

b.**HPV/ Hepato pancreatic Parvo vorus**

- **Causative agent**- HPV is caused by a small DNA virus(22-24 nm) called Hepatopanceatic parvovirus of penaeid shrimp . HPV is a putative parvovirus

- **Sign and symptoms of diseases**- Affected shrimp show generalised signs of diseases such as reduced feeding,poor growth rate,loss of apetite, gill fouling with ciliates,occasional opacity of abdominal muscle and atrophy of hepatopancreas. Early postlarvae (PL), juveniles and adultsare infected.

- **Diseases diagnosis**- Disease can be diagnosed by histopathological demonstration of single prominent basophilic intra-nuclear basophilic bodies in the hepatop[ancres stained by hematoxylin and oeosin. The host cell chromatin gets compressed,displaced and marginalised.

- **Transmission-** Horizontal, via contaminated water, per (cannibalism). Vertical transmission is unlikely. Eggs may be easily contaminated during spawning when coming into contact with water and faecal material from infected females.

- **Prevention-** HPV can be avoided by quarantins and gross screening for pathogen. No control measures are identified.

2. Fungal Diseases in fishes

a. **Saprolegniasis**

- Saprolegniasis is a fungal disease of fish and fish eggs most commonly caused by the Saprolegnia species called "water molds."
- They are common in fresh or brackish water. Saprolegnia can grow at temperatures ranging from 32° to 95°F but seem to prefer temperatures of 59° to 86°F.
- Poor water quality (for example, water with low circulation, lowdissolved oxygen, or high ammonia) and high organic loads, including
- the presence of dead eggs, are often associated with Sapro legnia infections.
- Saprolegniasis is often first noticed by observing fluffy tufts of cotton-like material coloured white to shades of grey and brown--on skin, fins, gills, or eyes of fish or on fish eggs.
- With progression of infection fish usually becomes lethargic and less responsive to external stimuli. So fish under such conditions is a target to predators
- Saprolegniasis is best prevented by good management practices--such as good water quality and circulation, avoidance of crowding to minimize injury (especially during spawning),and good nutrition.
- Common treatments include potassium permanganate, formalin, and povidone iodine solutions. Bath treatment in NaOH (10-25g/lit for 10-20min), $KmNO_4$ (1g in 100lit of water for 30-90 min), $CuSO_4$ (5-10g in 100 lit water for 10- 30min).

b. **Branchiomyces demigrans/Gill Rot**

- Branchiomyces demigrans or Gill Rot" is caused by the fungi Branchiomyces sanguinis (carps) and Branchiomyces demigrans (Pike and Tench).
- Branchiomyces sanguinis and B. demigrans infect the gill tissue offish. Fish may appear lethargic and may be seen gulping air at thewater surface (or piping). Gills appear striated or marbled with thepale areas representing infected and dying tissue.
- Avoidance is the best control for Branchiomycosis. Good management practices will create environmental conditions unacceptable for fungi growth. If the disease is present, do not transport the infected fish.
- Great care must be taken to prevent movement of the disease to noninfected areas. Formalin and copper sulphate have been used to

help stop mortalities; however, all tanks, raceways, and aquarim must be disinfected and dried. Ponds should be dried and treated with quicklime (calcium oxide).

- A long term bath in Acriflavine Neutral or Forma-Green for seven days helps this condition.

3.Fungal Diseases In prawn

Fungi are important components of the ecosystem typically constituting more of biomass than bacteria and have been considered the largest biotic community after insects. Among the various pathogens, fungi come next only to bacteria. As India is poised for a large scale development of aquaculture especially of prawns with a stress on semi intensive and intensive culture systems, it is natural to expect increasing hazards of diseases in these systems

a. Larval Mycosis

Causative agent: Lagenidium spp., Sirolpidium spp., Haliphthoros

Sign and symptoms of disease: Sudden onset of mortalities in larval stages of shrimps and crabs.
Crab eggs are also susceptible for mycotic infection. The commonly affected larval
stages among shrimp species are the protozoeal and mysis stages.

Effect of host: Progressive systemic mycosis that is accompanied bylittle or no host inflammatory response can be observed. Infection is apparentlylethal, accumulating mortality of 20-100% within 48-72 h after onset of infection

Diagnosis: Microscopic examination of affected larvae will reveal extensive,non-septate, highly branched fungal mycelia throughout the body and appendagesSpecialized hyphae or discharge tubes, with or without terminal vesicles, may bepresent, and could be the basis for identification of the causative agent. Motilezoospores may be observed being released from the discharge tubes in the case ofsome species

Prevention and control: Disinfection of contaminated larval rearingtanks and chlorination and/or filtration of the incoming water can preventoutbreaks. Different antimycotic compounds have been tested in vitro.Recommended chemicals for therapeutic and prophylactic treatments include thefollowing: 0.2 ppm Treflan 1-10 ppm formalin ,egg disinfection with 20 ppmdetergent followed by thorough rinsing before hatching.

b.**Black Gill Diseases/Fusarium (Shrimp**)

Causative agent: Fusarium solani
Species affected: All Penaeus species
Sign and symptoms of disease: Appearance of "black spots" that preceded mortalities in juvenileshrimps grown in ponds
.**Effect on host-**: Infection usually starts on damaged tissues such as wounds, gills damaged from chemical treatments or pollutants, and lesions resulting from other disease processes. Once infection is established, it is usually progressive with 30% remission rate. Lesions may also serve as a route of entry opportunistic pathogens.
Diagnosis: Microscopic examination of wet mounts of infected tissues willreveal the presence of canoe-shaped macroconidia (Fig. 4-8). Fusarium spp. areubiquitous soil fungi. Infection may begin at different loci and spread slowly.
Fusarium solani is an opportunistic pathogen of penaeids and are capable ofestablishing infection in shrimps compromised by other stresses or overcrowding
Prevention and control-: Preventive measures include the eliminationof sources of Fusarium conidiophores and destruction of infected individuals. Several fungicides show promise in vitro but none proved to be effective in actualfield trials.

4.Bacterial Diseases in fishes

1.Columinaris

- Columnaris disease, caused by the bacterium Flexibacter columnaris may result in acute or chronic infections in both coldwater and warmwater fishes.

- It occurs both as external or systemic infections that result in significant losses of hatchery-reared fish, particularly at warm summer temperatures
- In many species of fish, the first sign of the disease may be the appearance of discolored gray, patchy areas in the area of the dorsalfin.
- These characteristic “saddleback” lesions may progress until skin erosion exposes underlying muscle tissue.
- These lesions may become yellow and cratered and are often prominent in the mouth and head regions
- A presumptive diagnosis of columnaris disease can be made by the detection of long, slender Gram-negative rods in smears of gills or scrapings obtained from cutaneous lesions
- This can be accomplished by the use of disease-free water or by the use of U.V. disinfected water supplies.
- The elimination of wild fish in an open water supply may be helpful when feasible. If water temperature manipulation is available,temperatures above 12.8°C (55°F) should be avoided since they favour development of the disease.

2.**Furunculosis**

- Furunculosis is a serious, septicemic, bacterial disease found principally in
  salmonid fishes. but it may also occur in goldfish and other cyprinids.
- The common name of the disease is derived from the presence of “blisters”
  or furuncules on the surface of chronically infected salmonids

- The disease is caused by a Gram-negative bacterium, Aeromonas salmonicida
- Clinically-infected fingerlings will usually exhibihemorrhages at the baseof fins and erosion of the pectoral fms.
- Bloody or hemorrhagic vents and petecbial hemorrhages on the ventralsurface are frequently observed.
- In chronically infected adults, typical “furuncules” or blisters on the skimcontaining an amorphous yellow substance and blood may be present.
- Terramycin, Sulfamerazine are the recommended drugs for this diseases

b. Tail and Fin rot disease

- Tail and fin rot is associated with polluted water and poor sanitary conditions in hatcheries. Pseudomonas fluorescens is the causative agent.
- This disease was first observed in black mollies. The first symptom of this disease is the appearance of white lines along the margins of the fins.
- The infected fins become opaque and eroded. The fin rays become brittle and break, leading to total destruction. As the disease advances, the size ofthe fins is reduced.
- The fin tissues undergo death or may be eaten away by pathogenic bacteria. Subsequently, the fin rays may be lost. Infected fins become black in colour.
- Early treatment of fish in 0.5 % copper sulphate solution for 1 to 2 minutes is advisable.
- Since the bacterial tail and fin rot disease is caused by unfavourable environmental conditions, the best preventive measures are the maintenance of favourable environment and good sanitation.

5.Bacterial diseases in shrimp

In penaeid shrimp farming bacterial diseases are commonly associated with natural microbial flora of seawater, which possess enriched organic matter that supports the growth and multiplication of bacteria and other microorganisms. The most common shrimp pathogenic bacteria belong to the genus Vibrio. Other Gram- negative bacteria such as Aeromonas spp., Pseudomonas spp., and Flavobacterium spp., are also occasionally implicated in shrimp diseases.

a.Filamentous Bacterial Disease in shrimp

- The bacteria involved in this infection are Leucothrix species. Growthstages affected by these bacteria are larvae, postlarvae, juveniles andadults.
- Signs are the presence of fine, colourless, thread- like growth on thebody surface and gills. It can interfere with locomotary process andmoulting.
- It can cause mortalities of PL in heavy infestations. In largershrimps, it can even result in respiratory distress.
- The infection is treated by $KMnO_4$ at 5-10 pm for 1hr in statictreatment for 5-10 days.

b.Luminescent bacterial Diseases in Shrimps

- Luminescent bacteria such as Vibrio haveryi and V. Splendidus are the causative agent of this diseases.
- Eggs, larvae,post larvae,juvenelis and adults can be infected.
- Affected Shrimp larvae become weak and opaque and exhibit greenish bioluminescence under darkness.
- The diseases can be diagnosed with the microscopic examination of shrimp which revels number of bacteria in the haemocoel .
- Daily exchange of water and good water quality will help in minimising the bacterial load in the pond or hatchery.

c. **Brown spot disease (Shell disease or rust disease)**

- Infected animals showed the brown and black erosions on the surface of the body and whole body appendages, this could be caused through Vibrio spp., Aeromonas spp., and Flavobacterium spp., with chitinolytic activity.

- Diagnosis could be achieved by simple observations such as gross signs and confirmed by isolation of the bacteria from the site of infection on Zobell's Marine Agar and identification of the pathogen.

6.Prophylaxis in aquaculture

World aquaculture has grown tremendously during last few years becoming an economically important industry. However, disease is a primary constraint to the growth of many aquaculture species and is now responsible for severely impeding both economic and socio-economic development in many countries of the world. Prophylaxis refers to all the preventive steps such as vaccination, immustimulation and use of probiotics including group improve routine husbandry practices that are taken during a hatchery and farming operation to minimize the load of pathogen and to prevent the occurrence of disease.

General prophylactic measures followed in aquaculture operations
a) Better management practices (BMPs) for optimum culture environments
b) Practising microbial bioremediation using probiotics
c) Enhancing the general disease resistance by immunostimulants
c) Immunization of the host against specific pathogens using vaccines
d) Nutritional interventions using nutraceuticals
e) Selective breeding for genetic resistance

a. Better management practices (BMPs)-

Intensification in aquaculture leads to the accummulation of metabolites and uneaten feed in the pond bottom causing degradation of the culture environment, putting stress on the environment and the cultured animals. It is essential to maintain the optimum water and soil quality parameters like, pH, transparency, hardness, ammonia, nitrite, nitrate, sulphur, etc. Better Management Practices (BMPs) have been suggested for the hatchery and grow-out cultures to maintain optimal environmental parameters.

b.Probiotics-

The probiotics were defined as live microbial feed supplements that improve health of man and terrestrial livestock. The gastrointestinal microbiota of fish and shellfish are peculiarly dependent on the external environment, due to the water flow passing through the digestive tract. Most bacterial cells are transient in the gut, with continuous form water and food. Some commercial products are referred to as probiotics, though they were designed to treat the rearing medium, not to supplement the diet. Probiotics are administered through water of diet and inhibit the growth of pathogenic microorganisms, contribute digestive enzymes to increase feed utilization, provide other growth-promoting factors, and stimulate the immune response of the organism. Biotics that may influence fish immunity, disease resistance, and other performance indices include those of the genus Bacillus and various lactic acid bacteria (Lactobacillus, Lactococcus, Carnobacterium, Pediococcus, Enterococcus and Streptococcus).

c.Immunostimulants

Enhancing the disease resistance power of the host is one of the important approaches for preventing diseases. Several substances of natural, chemical and microbial origins have been known to possess immune stimulating potential in both humans and animals. Though the administration of immune stimulating agents for general health and wellbeing of humans and animals is well established, its importance has been recognized only recently in aquaculture. Development of immune stimulants for use in aquatic organisms was slow due to the lack of understanding of basic immunology and the efficient parameters to evaluate the immune response in crustaceans and molluscs. Recent surges in the information on the molecular immune system of aquatic invertebrates and tools to evaluate the immune reactive molecules have made it possible to develop new molecules for effective stimulation of the immune system of aquatic organisms and corresponding resistance to invading pathogens.

c. Nutraceutical

According to Stephen De Felice, founder chairman of Foundation for Innovation in Medicine (FIM), who coined the term "nutraceutical", defined it as "a food (or a part of food) that provides medical or health benefits, including the prevention and or treatment of a disease", they include herbal/ natural products, dietary supplements and functional foods. Nutraceuticals gained importance in the last one decade due to the increasing cost and side effects of therapeutic pharmaceutical agents. This concept of food for health and wellbeing was the main basis of the Indian system of medicine for ages which is gaining importance following the drawbacks of modern medical systems. Stress is the common factor affecting the humans (due to modern lifestyle) and plants and animals (due to farm intensification). These groups of products containing dietary fibre, prebiotics, probiotics, polyunsaturated fatty acids, antioxidants and other different types of herbal/ natural foods primarily improve the antioxidant defence mechanism and innate immunity. Though the beneficial effects of nutraceuticals have been well established in human and veterinary medicine, similar reports are limited in aquaculture.

e.Genetic selection

Diseases are becoming a major hurdle in the economic sustainability of agriculture, including livestock and aquaculture. New diseases are emerging due to the increased culture intensity, climate change and crossing over of pathogens between species. Ever increasing cost of disease prevention and control has shifted the focus of health management from prophylactic and therapeutic intervention to genetic selection. Genetic selection for disease resistance has been the milestone in the field of agriculture to meet the global hunger for food. Breeding for disease resistance is a well-established science in the field of crop protection and has shown mixed success in the livestock sector. However such programs for cultured aquatic species are limited.

Short Answer Questions

1. Monodon Baculovirus

Monodon baculovirus (MBV) is the first viral pathogen to be recorded from the cultured prawns of India. MBV infections have been observed in the hepatopancreatic cells of all life stages of the prawn except egg, nauplius and protzoea 1 and 2 stages. Postlarvae and farmed shrimps of all sizes with severe MBV infections appear normal and healthy. The virus, widely distributed in the cultured populations is well tolerated by , the shrimps, as long as rearing conditions are optimal.

Pathogenisis and diagnosis

MBV is a single-enveloped, rod shaped, occluded double stranded DNA virus belonging to the group baculovirus. The virus occurs freely or within proteinaceous polyhedral occlusion bodies in the nucleus, with visions measuring 75-300nm. The presence of MBV in the prawn can be detected by direct microscopic examination of impression smears of infected hepatopancreas (HP) or midgut tissue, stained with 0.05 to 0. % of malachite

Impact on the host

Lethargy, anorexia, dark coloured, and with heavy surface fouling. Acute MBV causes loss of hepatopancreatic tubule and midgut epithelia and consequently, dysfunction of these organs, often followed by secondary bacterial infections.

MBV has been linked with high mortalities (over 90%) in late postlarvae and juvenile shrimp in many culture facilities.Although good culture practices may enhance survival of MBV infected stocks, growth, crop value and performance may be significantly reduced and MBV may predispose infected shrimp to infections by other pathogens, with corresponding higher mortality rates.

Prevention and control

MBV infection may be prevented only through avoidance by quarantine methods, destruction of contaminated stocks, and disinfection of contaminated facilities. There is no treatment for MBV, however good farm management can minimize this disease.

2. Lymphocytosis

- Lymphocystis iscommon viral disease of freshwater and saltwater fish. The virus that causes this disease belongs to the genus *Lymphocystivirus* of the family Iridoviridae.

- The main clinical sign of Lymphocystis in freshwater fish is raised skin nodules. They may present with a few scattered nodules or a cluster of dozens.
- They can appear anywhere on a fish's body, including the fins and oral cavity. Early infections may present as a thin film on the fish's body.

- The virus spreads between direct contact and within the aqueous environment. Once in shed from an infected fish, lymphocystis can survive in the surrounding water for up to 1 week.
- Some fish may be latent carriers, in which they carry the virus, but do not show clinical signs.
- There is no treatment for lymphocystis.
- Often, clinical signs of lymphocystis are exacerbated by other stressors in the tank, such as poor water quality, poor diet or inappropriate temperatures.

3. Branchiomycosis (Gill Rot)

- *Branchiomyces demigrans* or "Gill Rot" is caused by the fungi *Branchiomyces sanguinis* and *Branchiomyces demigrans* .
- Both species of fungi are found in fish suffering from an environmental stress, such as low pH (5.8 to 6.5), low dissolved oxygen, or a high algal bloom.
- *Branchiomyces* sp. grow at temperatures between 57° and 95°F but grow best between 77° and 90°F. The main sources of infection are the fungal spores carried in the water and detritus on pond bottoms.

Disease Signs

- *Branchiomyces sanguinis* and *B. demigrans* infect the gill tissue of fish. Fish may appear lethargic and may be seen gulping air at the water surface (or piping).
- Gills appear striated or marbled with the pale areas representing infected and dying tissue.
- Gills should be examined under a microscope by a trained diagnostician for
- verification of the disease.
- Damaged gill tissue with fungal hyphae and spores will be present.
- As the tissue dies and falls off, the spores are released into the water and transmitted to other fish. High mortalities are often associated with this infection.

Management and Control

- Avoidance is the best control for Branchiomycosis. Good management practices will create environmental conditions unacceptable for fungi growth. If the disease is present, do not transport the infected fish.
- Great care must be taken to prevent movement of the disease to noninfected areas. Formalin and copper sulphate have been used to help stop mortalities; however, all tanks, raceways, and aquaria must be disinfected and dried.
- A long term bath in Acriflavine Neutral or Forma-Green for seven days helps this condition.
- Ponds should be dried and treated with quicklime (calcium oxide) and copper sulphate (2-3kg / ha). Dead fish should be buried.

4. Larval mycosis

- Lagenidium. In 1977, a fungus which caused heavy mortalities among larvae and postlarvae at the SEAFDEC AQD hatchery was isolated, identified as Lagenidium callinectes, and grown in culture media .In vivo and in vitro observations of the sporulation process left no doubt as to its reproductive capacity.
- The hyphal system extends from inside (intramatrical) the body of the prawn to the outside (extramatrical), developing short discharge tubes. A vesicle forms at the end of the discharge tube with sporogenic cytoplasm coming from the hyphal system in 5-10 min.
- Spore formation proceeds for 10-20 min and spores start to move slowly inside the vesicle, after which numerous motile spores become active and are released 10-15 min later to infect other prawns.
- Lagenidium attacks eggs, larvae, and postlarvae of P. monodon and has been the cause of mass mortalities in many hatcheries.
- Infected eggs appear opaque white and do not hatch while larvae become weak, lose equilibrium, respire irregularly, twitch their appendages, and appear either whitish or reddish).
- In all cases, the fungal hyphae fill the eggs, replace the tissues of the larvae/postlarvae, and may cause 100% mortality The signs of the disease, however, are apparent only when it is already widespread. The fungus has wide spread of toleramnce for temperature, pH, and salinity and appears to have the same growth and sporulation conditions as for larval rearing.
- Preventive measures include disinfection of equipment and tanks, filtration of water, chemical treatment of spawners, environmental

sanitation, proper disposal of infected larvae and contaminated tank water, and occasional siphoning of debris and dead larvae .

5. Filamentous Bacterial Diseases

Leucothrix sp., Thiothrix sp., Flexibacter sp., Cytophaga sp., Flavobacterium sp. are the causative agents of filamentous bacterial disease in prawns. Penaeus monodon, P. merguiensis, P. Indicus are generally infected. Presence of fine, colorless, thread-like growth on the body surface and gills as seen under a microscope as disease symptoms.

Effect on host

Infected eggs show a thick mat of filaments on the surface, which may inter-fere with respiration or hatching. In larvae and postlarvae, normal respiration, feeding, locomotion, and molting may be seriously impaired, resulting in slower growth rates, retarded development and eventually death. However, larval shrimps are less prone to infestations due to rapid succession of molts throughout the different larval stages. Frequent molting does not allow ad-equate time for the bacteria to accumulate on the exoskeleton. In larger shrimps, it may result in respiratory distress. Mortality is due to hypoxia. Dis-ease onset is associated with high organic loads in culture water, low dis-solved oxygen levels and added stress from molting. If left untreated in inten-sive culture systems, accumulative mortality may reach 80% or more within a few days to a few weeks of onset of disease signs.

Diagnosis

Direct microscopic examination of wet mounts of larvae or postlarvae, appendages and gill filaments excised from juvenile or adult shrimp, and of filamentous organisms attached to external surfaces of the cuticle.

Prevention and control

- Maintain good water quality with optimum dissolved oxygen and low organic matter levels.
- Apply Cutrine Plus at 0.15 ppm copper in 24 h flow through treatments

6**. Columinaris**

- Columnaris (also referred to as cottonmouth) is a symptom of disease in fish which results from an infection caused by the Gram-negative, aerobic, rod-shaped bacterium *Flavobacterium columnare*.
- It was previously known as *Bacillus columnaris, Chondrococcus columnaris, Cytophaga columnaris* and *Flexibacter columnaris*.
- The bacteria are ubiquitous in fresh water, and cultured fish reared in ponds or raceways are the primary concern – with disease most prevalent in air temperatures above 12–14 °C.
- It is often mistaken for a fungal infection. The disease is highly contagious and the outcome is often fatal.
- The bacteria usually enter fish through gills, mouth, or small wounds, and is prevalent where high bioloads exist, or where conditions may be stressful due to overcrowding or low dissolved oxygen levels in the water column. The bacteria can persist in water for up to 32 days when the hardness is 50 ppm or more.

symptoms

An infection will usually first manifest in fish by causing frayed and ragged fins. This is followed by the appearance of ulcerations on the skin, and subsequent epidermal loss, identifiable as white or cloudy, fungus-like patches – particularly on the gill filaments. Mucus often also accumulates on the gills, head and dorsal regions. Gills will change colour, either becoming light or dark brown, and may also manifest necrosis. Fish will breathe rapidly and laboriously as a sign of gill damage. Anorexia and lethargy are common, as are mortalities, especially in young fish.

Diagnosis

Bacteria can be isolated from gills, skin and the kidneys. For definitive diagnosis, the pathogen should then be cultured on reduced nutrient agar. Inhibiting contaminant growth on the agar by adding antibiotics and keeping the temperature at 37 °C should improve culture results. Colonies are small, 3–4 mm in diameter, and grow within 24 hours. They are characteristically rhizoid in structure and pale yellow in colour.

Treatment

- As *Flavobacterium columnare* is Gram-negative, fish can be treated with a combination of the antibiotics nitrofurazone and kanamycin administered together synergistically.
- A medicated fish bath (ideally using aquarium merbromin, alternately methylene blue, or potassium permanganate and salt), is generally a first step, as well lowering the aquarium temperature to 75 °F (24 °C) is a must, since columnaris is much more virulent at higher temperatures, especially 85–90 °F.
- Medicated food containing oxytetracycline is also an effective treatment for internal infections, but resistance is emerging.
- Potassium permanganate, copper sulfate, and hydrogen peroxide can also be applied externally to adult fish and fry, but can be toxic at high concentrations.
- Vaccines can also be given in the face of an outbreak or to prevent disease occurrence.