

# Economic Zoology (B.Sc.- Zoology Sem. - V)

**Contact us:** 

Q



8404884433

# AISECT University, Hazaribag

Matwari Chowk, in front of Gandhi Maidan, Hazaribag (JHARKHAND)-825301

www.aisectuniversityjharkhand.ac.in  $\overline{\ }$  info@aisectuniversityjharkhand.ac.in



## **AQUACULTURE - INTRODUCTION**

Aquaculture, also known as aquafarming, is the farming of fish, crustaceans, molluscs, aquatic plants, algae, and other aquatic organisms. Aquaculture involves cultivating freshwater and saltwater populations under controlled conditions, and can be contrasted with commercial fishing, which is the harvesting of wild fish.

#### **1. CAPTURE FISHERY**

Initially, man tried to capture fishes by using different types of gear in different water bodies. In this method, he is able to collect only the existing fish in waters. This method of capturing the naturally existing fish is termed as capture fishery Capture fishery is still the only method used in catching fist, in huge water masses (marine water and riverine water systems). In the year 1987 the capture fishery from marine water constitutes 1.65 million tonnes.

#### 2. Culture Fishery

Man developed the idea of growing selected fish. For this purpose, the fishes such as carps breeding in flowing waters are collected. They are artificially induced to breed in confined water bodies. The pituitary gland extract is injected to the breeders. The breeders under the influence of pituitary hormones, breed in these waters. This method is called induced breeding. The fish hatchlings thus obtained are called fish seed.

While growing the fish seed, man is also able to control the environmental conditions. He is able to supply additional food for their growth. The diseases





common for fishes are controlled. Due to this, better growth of fishes is achieved. Ultimately, he is also able to grow large number of fish and achieve better production of fish. This method of growing selected fish under controlled environmental conditions in confined water bodies so as to achieve maximum productivity is termed as culture fishery.

The culture fishery is also of two types viz.,

- a. Fin fish fishery
- b. Shell-fish fishery.

The fishery concerned with fishes having fins is called fin fish fishery. The fishery concerned with fishes having shell is called shell-fish fishery.

Molluscans, Crustaceans such as crabs, lobsters and prawns constitute shell-fish fishery.

The culture of fin fishes is also termed as pisciculture. The culture of any aquatic food organisms can be referred to as aquaculture.

The fish not only yields flesh but also vitamins like A and D. Due to less cholesterol content the fish flesh is used as food for heart.

## Prawn Culture

# A. Important cultural prawns and their importance in fishery:

A good number of prawn species are of commercial value.

# The following are important:

a. Penaeus indicus:





Maximum size 230 mm. One of the most important commercial species. Young ones are fished in estuary.

## b. Penaeus monodon:

Maximum size 320 mm. An important commercial species. Good fishery in West Bengal and Orissa.

## c. Metapenaeus monoceros:

Maximum size 180 mm. Very important commercially.

## d. Metapenaeus brevicornis:

Maximum size 125 mm. Good fishery in northern region of south and east coasts.

Juveniles are also fished in estuary.

## e. Palaemon styliferus:

Maximum size 90 mm. One of the most important fisheries in Gangetic delta.

## f. Macro brachium rude:

Maximum size 130 mm. Good seasonal fishery in West Bengal and Orissa.

## g. Macro brachium Rosenberger:

Maximum size 320 mm. Very good fishery in monsoon and post-monsoon months in Kerala.

# h. Macro brachium malacolmsonii:

Maximum size 230 mm. Fairly good fishery in Northeast coast in monsoon months.







## **B.** Prawn seed collection: sites and time:

The creeks, canals and shallow waters, preferably with sloping sides, are suitable places for seed collection. The lunar phases are the best time period for collection.

## Different types of gears are used for collection:

- a. A battery of nets are operated in longitudinal rows in shallow water.
- b. The shooting net is suitable for the pelagic forms.
- c. Scoop nets and drag nets are used in intertidal pools and shallow inundations.

Different species of prawn do not breed in confined water. Induced breeding with

hypophysation has been a success.

#### C. Prawn culture in brackish water:

Four types of prawn culture are prevalent in West Bengal:





a. Only stocking and harvesting without any care to prawn population and food supply.

b. Stocking of known quantity and cultured with natural food.

c. Stocking at higher concentration and extra nutrient added. In this method, production can be increased by 500 per cent.

d. Stocking selected prawns at higher concentration with fertilisation, supplemental feeding and stock manipulation.

## **1. Pond preparation:**

a. Prior to stocking, the culture pond is dewatered, and its bed is exposed to sun to dry. It helps in high soil fertility.

b. Mohua oil cake, an organic toxicant, is spread over the bed at a rate of 100 to 150 kg/ha and water is drawn to a depth of 4 to 5 cm.

c. The toxin dissolves in water and the unwanted organisms are killed.

d. The water is again drained out after 2-3 days and the pond is flushed with fresh tide water to wash away rest of the toxicants.

## 2. Fertilisation:

a. For a better growth of prawn food organisms, manuring of ponds is essential.

b. This is repeated monthly with oil cake @ 50 to 100 kg, urea and superphosphate each 50 kg/ha.

#### 3. Water management:

a. Water is periodically drawn through inlets guarded with close mesh screen.





b. This prevents entry of undesirable organisms and also escape of prawn.

c. The optimum ranges are-temperature 25-30'C; dissolved oxygen 4-8 PPM; pH

8.0.

## 4. Stocking:

# Fry and fingerlings are directly stocked in ponds:

a. Stocking density is high in brackish water than in fresh water as the growth rate is slow in the first.

b. Supplementary feeding is done depending on the stocking density and productivity of the pond.

# c. Stocking density largely depends on the culture practiced:

i. Single stocking and single harvest.

ii. Single stocking and multiple harvest.

iii. Multiple stocking and multiple harvest.

# **5.** Supplementary feeding:

Shortage of natural food needs supplementary feeding. It leads to a better growth in

a pond where prawns are stocked at a high concentration.

# 6. Harvest:

a. Partial harvesting is done by setting bag nets at the outlet during low tide.

b. Total harvest is possible only with complete dewatering.

# Prawn culture in Kerala:





Prawns are cultured in backwaters along with paddy crops. This is known as paddy cum prawn culture. Juveniles of all commercially important species are trapped in paddy field.

a. The variety of paddy 'Pokali' is harvested in September.

b. From now onwards the salinity of paddy fields gradually increases and prawn juveniles are allowed to enter with water through controlled sluice gates.

c. In and outflow of water are allowed daily during high and low tide, but prawns are prevented to escape with bamboo mats placed inside the gates.

d. In April, the culture comes to an end. Prawns are completely harvested by repeated netting and dewatering of the field.

## **Problems of prawn culture:**

# The hazards of brackish water prawn culture are:

## a. Mechanical:

- i. Structural failure of water gates.
- ii. Landslide from dykes.
- iii. Erosion and silting up of farm ponds.
- iv. Overflowing of ponds.

# **b.** Physical:

- i. Temperature
- ii. Turbidity of water.

# c. Chemical:





i. Salinity.

ii. Organic pollution of farm ponds.

iii. Oxygen deficiency.

#### d. Biological:

i. Parasites and diseases.

ii. Pests.

These, however, can be controlled with proper care.

#### Pearl culture and pearl industry

## **Meaning of Pearl:**

The word 'pearl' is derived from the Latin word 'pirula' which means pear, that is in accordance with the pear shape of the pearls. The beauty of pearl is an object of adoration and a barometer of wealth. Pearl is counted among the nine gems and needs no cutting or polishing to bring out its lustre. All over the world, pearl has been a subject of folklore and is also a subject of one of the most modern sciences — genetic engineering.

The credit for the production and development of modern pearl culture goes to Japan. The initial success was achieved in 1893 by Kokichi Mikimoto, who is considered as the 'Pearl King' and the Father of Pearl Culture industry. From the initial success the technique of pearl culture was developed and perfected.

In India the technological breakthrough in pearl culture was achieved in 1973 by the Central Marine Fisheries Research Institute (CMFRI) at Tuticorin. A second, equally





significant, breakthrough was achieved in 1981, through the development of controlled production of pearl oysters in hatchery.

Pearl oysters are gregarious, and they remain attached to rocks, live or dead corals, other mollu-scan shells or to other hard substrate. They remain at a depth of 10-12 fathoms about 20 km off the shore. The pearl banks in the Gulf of Mannar are known as 'paars' and the intertidal beds in the Gulf of Kutch as 'khaddas'.

## **Types of Pearls:**

#### (a) Natural pearls:

Natural pearls may be formed within the oyster or mussels by either accidental entrance of a solid or accidental wound within the shell muscles or tissues. Pearls so produced are called natural pearls and are very rare because of their accidental origin.

#### (b) Cultured pearls:

Cultured pearls are produced by human interference, when the pearls are produced through the process of culture of pearl producing oysters or mussels.

## (c) Artificial pearls:

Such pearls are cheap imitations made of plastics, glass, fish scales, etc. with an artificial lustre.

## **Pearl Producing Molluscs:**





Any mollusc, which has the mother-of-pearl layer on the inner surface of its shell, is generally capable of producing a pearl. However, pearl as a jewel is only produced by a few species, which are listed below.

## A. Marine pearls:

## (a) Pearl oysters:

*Pinctada fucta, Pinctada margaritifera* and *Pinctada maxima* are the three prime species of pearl oysters and produce superior quality pearls.

## (i) Pinctada fucata (Gould):

It is commonly known as the Indian pearl oyster. It was formerly known as P. vulgaris in India and P. martensii in Japan. Both these species are now known as *P. fucata*. Its distributions are in the Indian subcontinent, Japan and the Persian Gulf. In India it occurs in the Gulf of Kutch (coast of Gujarat) and in the Gulf of Mannar (off the coast of Tamil Nadu). In the Gulf of Mannar the natural pearls produced by this oyster were the famous 'Lingah' pearls or Oriental pearls.

*Pinctada fucata* occurs in the intertidal area to a depth of 12 fathoms. It grows up to a size of 9 cm.

Its maximum lifespan is about 7 years.

# (ii) Pinctada margaritifera (Linnaeus):

This oyster is commonly known as the black-lip pearl oyster (Fig. 7.2). It has a very wide distribution. In India it occurs at the intertidal region of Andaman- Nicobar Islands. The black-lip pearl oyster grows to about 17 cm in shell height.





#### (iii) Pinctada maxima (Jameson):

This oyster is generally known as the gold-lip or silver-lip pearl oyster (Fig. 7.3). It is the largest and best, of all the pearl oysters in the world. Its distribution is restricted and is seen in Australia, Papua New Guinea, China, Philippines, Thailand, Myanmar and Indonesia. It also occurs in the Andaman and Nicobar Islands.

*Pinctada mxima* occurs from low tide level to about 40 fathoms depth. The species grows to about 28.2 cm in diameter and the pair of shells weigh up to 5.5 kg.

## (iv) Minor pinctada species:

The following minor *Pinctada* species are not considered very important as far as pearl production is concerned.

#### Pearls are occasionally produced by these oysters, which are listed below:

*Pinctada albina carcharium* is present in Shark Bay (Australia). The pearls produced have strong iridescence with colours such as light yellow, light brown, light green or light pink.

*Pinctada albino sugillata* occurs in India (Gulf of Mannar) and Australia. It grows up to 11 cm.

Pinctada maculata is observed in Australia.

Pinctada chemnitzii is observed in India and Australia.

*Pinctada imbricata* is known from Venezuela and Bermudas. The pearls are translucent with colours varying among white, light pink or yellow.





In the Indian waters two other species of Pinctada are also recorded — *Pinctada atropurpurea* and *Pinctada anomioides*.

## (b) Winged oysters:

Winged oyster (Pteria penguin) rarely produces pearls.

## (c) Windowpane oysters:

*Placenta placenta*, commonly known as windowpane oyster, produces seed pearls of minute size. They are not considered as gems but are used for medicinal purposes.

## (d) Sea mussel:

Sea mussels such as *Mytilus edulis*. *Pern a viridis* and *P.indica* occasionally produce seed pearls which are not considered as gem.

## (e) Giant clam:

*Tridacna*, the giant clam, produces occasionally large sized pearls, as big as a golf ball.

## (f) Gastropods:

The gastropod, *Haliotis* species, produces multi-coloured irregular pearls, especially red and green in colour.

## **B.** Freshwater pearls:

Freshwater pearls are produced by freshwater mussels belonging to Unionaceae. Some of the notable species used are *Hyriopsis schlegelii* of Japan, *Cristaria plicata* of China and species of *Lamellidens*. In India and South Asia *Lamellidens marginalis* is used.





## **Pearl Fisheries of India:**

## (A) Gulf of Mannar:

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

In 1922, Hornell listed a total number of 72 pearl banks known as 'paars'. 'Paar' means a patch of hard ground of very low profile. These paars are located in line, parallel to and at a distance of 10-16 nautical miles from land. This is stretched from Pamban Karai Paar in the north (head of Gulf of Mannar) to Manapad Periya Paar in the south.

Among these 72 beds, quite a large number of them have not yielded any fisheries at any time. In general, the pearl fisheries at Tholayuram paar, Kodamuthu group and Karuwal group have been relatively consistent in the production of pearl than the others.

Another pearl fishery is situated in the Palk Bay off Toudi, which economically is not a successful fishery as the oysters are of inferior quality than those of Gulf of Mannar.

#### (B) Gulf of Kutch:

In the Gulf of Kutch there are about 42 pearl oyster reefs, known as 'Khaddas'. The intertidal area of the Gulf of Kutch; borders the coastline of Jamnagar District and covers a total area of about 24,000 ha, from Sachana in the east to Ajad in the west





(Fig. 7.6). 'Khadda' means a hard bottom of coral and rocky area with an admixture

of mud and sand. Pearl oysters of the species Pinctada fucata is found here.

## **Chemical Composition of Pearl:**

According to Bolman (1941), the nacreous pearl of Pinctada has the following composition:

Water	 3.97%	
Organic matter	 3.83%	
Calcite and aragonite	 91.53%	
Loss	 0.67%	

Superior and inferior quality pearl is determined by the following way:

Quality of pearl matter	Inorganic matter	Crude
Superior quality pearl (blue)	92.60%	4.50%
Inferior quality pearl (blue)	91.30%	8.31%

The mineral calcium carbonate is secreted by the pearl-sac epithelium in two forms — aragonite crystals and calcite crystals. The third form of vaterite crystals has not been reported in the pearl oyster. The real 'nacre' substance is aragonite while calcite is the prismatic substance.

Although four types of cultured pearl products are known (organic, prismatic, nacreous and compound), it is only the nacreous product that is accepted as pearl.

## **Properties of Pearl:**

## **Classification of pearls:**

Pearls are classified according to the size as given below:





Size (diameter in mm)	Type name
Below 2.6	Minute granular
2,6-4,9	Fine pearl
5.0-6.8	Small pearl
6.9-8.2	Medium pearl
Above 8.2	Large pearl

## Factors responsible for the production of coloured pearls:

(1) The depth of oyster culture and light penetration is related with the lustre and colour of the pearl.

(2) Lustre increases with the increase of rearing period of pearl oyster.

(3) A relation exists between the colour of the cut pieces of the pallium of the 'donor' and the colour and lustre of the pearl.

(4) Availability and quality of food phytoplankton content has distinct effect on the colour and lustre of the pearls via its role of energy supply.

(5) Amount of trace element present influences the colour of pearl.

#### **Texture and colour of pearl:**

Good quality pearls are determined by their lustre and colour. The colour of the pearl is related to the metallic elements present in the oysters environment. This has been analysed through spectral analysis of different coloured pearls.

It has been observed that cream-coloured and golden-coloured pearls contain good quality of copper and silver while much sodium and zinc were reported to be present in meat-coloured and pink-coloured pearls.





Studies revealed that the colour of the pearls is determined mainly by the colour of the cut pieces of the pallium and the part from where they are cut. Further, the colours of the shell of the mussel also have marked influence on the colour and lustre of pearls.

#### **Formation of Pearl:**

#### (a) Natural pearl:

Pearl is formed due to secretion of the mantle tissue. The nacreous layer of the pearl is secreted by the outer epithelial layer of the mantle. This layer has the capability to rearrange and regenerate itself and remain viable when disturbed and also when transplanted in other tissues of the animal. The inner epithelium and the connective tissue, on the other hand, would disintegrate when transplanted.

#### A natural pearl is formed by the following way:

(1) The outer epithelial layer of the mantle accidentally falls into the body of the pearl oyster.

(2) It regenerates a sac consisting of a single layer of cells, thus forming the pearl sac.

(3) Sometimes a foreign body accidently enters into the body of the oyster, when the shells remain open, and gets trapped between the shell and the mantle. The outer epithelium of the mantle invaginates and form the pearl sac.

(4) Inside the pearl sac, as a result of secretion of nacre, a natural pearl grows.





(5) The secretion of nacre continues till the end of life of the pearl oyster, thereby forming/producing a beautiful, natural pearl.

It depicts the formation of a blister pearl or a free pearl inside the mantle. From the figure it is to be noted that every pearl has a nucleus (however tiny it may be) at its core. However, 'pearl without nucleus' may rarely be formed and would obviously be a contradiction.

Such possibility occurs when a few decayed blood cells or epithelial cells might provide the basis for pearl formation, which subsequently disintegrates totally. When such a pearl is cut, it reveals no nucleus and appears to be formed entirely of motherof-pearl layers.

#### (b) Cultured pearl:

The technique of the formation of natural pearl is manipulated in the cultured pearl formation process.

## Here for the formation of pearl, the two pre-requisites are:

- (1) The outer epithelium of the mantle lobe and
- (2) A core substance or nucleus.

#### (i) Formation of pearl sac:

Here, a small piece of mantle from a donor oyster is grafted skill fully into the gonad of the recipient oyster along with a nucleus. The outer epithelium of the grafted mantle piece regenerates itself around the implanted nucleus and forms a pearl sac.





This pearl sac secretes and deposits nacre or mother-of-pearl around the nucleus, thus resulting into a pearl. As this pearl is produced through manipulation (surgery) in the oyster and by further cultivation of the seeded oyster, it is thus called the cultured pearl. The half- pearl is produced by inserting the nuclei on the nacreous face of the shell at appropriate sites.

#### (ii) Secretion of pearl forming matters:

Initially, after the formation of pearl sac, its internal part is alkaline, and the secretion contains organic substances such as Keratin. The secretion is due to the prismatic layer containing calcites. The internal part of pearl sac later becomes acidic and subsequently neutral. The secretive matter ultimately becomes pearl forming material.

#### (iii) Calcium absorption and formation of calcium carbonate:

The main ingredient of pearl is calcium carbonate (calcite and aragonite). In pearl oysters the main source of calcium is food. However, the gill, mantle and fool can directly absorb calcium from water.

In case of the gills, the calcium absorption power is strong and its rejection capacity is meagre, while, in the mantle both absorption and rejection of calcium are very strong. Thus, the gills are considered to be the most ideal organ for absorption and storing of calcium in pearl oysters.

Calcium absorbed through food and from water slowly moves into the pallium through blood. The carrying of calcium in the body depends mainly upon the role





played by alkaline phosphatase present in the epithelial cells of the connective tissue and mantle of the pearl sac. Alkaline phosphatase combines with the calcium ion  $(Ca^{+2})$  to form phosphate and other salts.

The calcium ion in the presence of phosphatase gains energy and passes through the mantle to be absorbed by its epidermal cells. This is then carried to the connective tissue of the pearl sac.

In the course of its passage the  $Ca^{+2}$  also unites with the cartilaginous sulphate (a compound protein of acidic nature). It further induces the calcium ion to become active and is transported to the cytoplasm of nacreous layer and ultimately excreted by the epidermal cells.

The excreted calcium then under the activity of carbonic acid releasing hydrase combines with the carbon dioxide (released by the body of the mussel due to metabolic activity) and ultimately forms calcium carbonate.

It has been reported that the concentration of carbon dioxide determines the nature of crystal formation. In the presence of increased  $CO_2$  in the aquatic environment calcium carbonate forms sleek-like crystals, while it takes the shape of calcite when  $CO_2$  decreases in the environment.

#### (iv) Factors influencing secretion of nacre:

## (1) Morphological structure of the epidermal cells of pearl sac:

As the secretion from the epidermal cells results in the formation of pearl, the healthy condition of these cells and the quality of pearls formed by them are closely related.





It has been seen that nacres, producing regular pearls, are constituted of flat epithelial cells and lacking in either granular or mucous cells. Moreover, pearl sacs responsible for the formation of hard pearls are composed of bubble- shaped epithelial tissues, while high-rising collumnar cells produce soft pearls.

Furthermore, it was observed that the morphological structure of the epidermal cells of pearl sac are not stable and undergo seasonal and environmental changes.

## (2) Calcium carbonate crystallization:

Formation of calcium carbonate crystals is wholly determined by the environmental conditions.

## (3) Amount of CO<sub>2</sub>:

The amount of CO<sub>2</sub> determines the nature of crystal formation.

## (4) Temperature and pH:

In alkaline pH and high temperature granpel form of crystal is formed. Therefore, pearl culture should be undertaken in neutral or low alkaline medium. Temperature controls the rate of deposition of nacre and is accelerated between February and August when the temperature is high.

(5) In the presence of common salt or calcium phosphate, calcium carbonate crystallises into calcite.

(6) Crystallisation of calcium carbonate in granpel form is favoured by the presence of urea, and salts of ammonia, magnesium and strontium.

## **Uses of Pearl:**





(1) Used as an ornament and a symbol of grandeur.

(2) Used in ornamental handicraft.

(3) It is a very precious medicine for surgery, pediatrics, ENT, etc. as used by the Chinese.

#### **By-Products of Pearl:**

The by-products of pearl culture is referred to the total mass of the oysters after extraction of the cultured pearl. The by-products of pearl culture are, thus, the seed pearls, shell and the flesh.

(1) The tiny seed pearls (which are unsuitable as a gem) are used in the preparation of medicine.

#### In India pearl powder and pearl liquid are important ingredients as follows:

(1) Pearl powder is a highly stimulant tonic and aphrodisiac. Its other medicinal values are — laxative, sedative, emetic and nutritive.

(ii) Pearl powders act as an antacid. It is also used in heart burn and bilious affections.

(2) In case of class 'C' category of pearls (not used in jewellery), the nacreous layer is removed from the nuclei and ground into a powder. It is then dissolved in phosphoric acid. The final product (pearl calcium tablet) is formed by additional chemical processes. The pearl calcium tablet, thus formed, is marketed in Japan for pregnancies, weak bodies, tooth cavities, stomach acids and allergies.

(3) Large oyster shells, for their mother-of-pearl layer, are used in shell craft.





(4) Small and broken shells are ground and used as ingredients in poultry-feed.

(5) The adductor muscle portion of the flesh of oyster is used for human consumption.

(6) After removal of the pearl, the entrails of the oyster are used for feeding fishes.

## UNIT II

# Pisciculture

## Fish culture and rearing methods

Fish culture is of different types viz.,

- 1. Composite fish culture
- 2. Cage culture
- 3. Integrated fish culture
- 4. Lacustrine fisheries
- 5. Sewage fisheries

## **1.** Composite Fish Culture

Maximum exploitation of the aquatic resources through the introduction of selected varieties of compatible fish to achieve high productivity is called composite fish culture or polyculture.

Composite fish culture has been in practice in India since ancient times. The combined efforts of Central Inland Fisheries Research Institute (CIFRI) and Indian Council of Agricultural Research (ICAR) propose the following ratios of different fishes for high yielding in polyculture.





- a. Grass carp, silver carp, scale carp and mirror carp in the ratio of 5: 3: 8: 2.
- b. Grass carp, silver carp, rohu, scare carp and mirror carp in the ratio of 5: 3 6
  8: 2.
- c. Grass carp, silver carp, catla, rohu, scale fish and mirror carp in the ratio of 5:
  3 3:6 8:2.

#### 2. Cage Culture

In cage culture the fishes are reared in a cage made of Nylon and wooden frame and sometimes in a cage made up of bamboo mesh. These cages are kept in flowing waste-water canals. By this method the fishes can be protected from predators and number of fishes can be culture. Fishes feed upon the food available in waste waters. The waste waters can be re utilised for irrigation. The complications in management and investment are very little in this type of culture.

#### **3. Integrated Fish Culture**

Culturing of fish in association with agriculture or ducks or chicks or pigs or prawns is called Integrated fish culture.

Fish wastes fertilize the crop fields while wastes from crops and poultry chicks are used as feed by fish. individually these farming methods may yield low income. But integrated farming technique yields multiple products of nutritional value and economic importance. Various types of integrated fish culture methods are in practice today. They are





- a. **Fish-Prawn culture:** Prawn are cultured in ponds which are meant for carp culture in this method. The excreta of carp fishes constitute food for prawns.
- b. **Fish-Poultry culture:** In this type poultry farm is constructed over a platform built of bamboo sticks above the water level of the pond. This facilitates direct fertilization of the pond by droppings of chick which are rich in nitrogen and phosphorus.
- c. **Rice Fish culture:** Fish are cultured in rice fields in this method. Fishes which can live in a depth of 15cm are selected for this culture. The rice variety selected for this purpose should also develop strong root system.
- d. **Fish culture in Pokkali fields:** This practice is followed in Kerala. Prawn, fish and rice are cultured on rotational basis in the Pokkali rice fields which are influenced by tides of vembanad backwaters. Rice cultivation is taken up from June to September. Fish and prawn are cultured till May.
- e. **Coconut or Banana Fish Culture:** In banana or coconut fields, the ditches or canals in between the rows of plants can be utilised for fish culture in this method. These canals are always filled with water and rich In insect population.

#### **4.** Lacustrine Fisheries

The culture of fish in takes constitutes lacustrine fisheries. Natural lakes of 0.72 million hectares and manmade lakes of 65 million hectares are available for fish culture in India.





#### 5. Sewage Fisheries

In many countries, fishes are introduced and cultured on commercial basis in sewage canals and ponds. The sewage is used as fertilizer in culture ponds and as feed for fish.

## Types of culturable fresh-water fishes

India occupies second position in prawn <u>culture</u> and seventh position in fish culture and production.

Fresh water fishes cultured in India are (a) Major carps (b) Minor carps (c) Murrels (d) Cat fishes (e) Exotic fishes and (f) Cold water fishes.

# Major carps (Carp Culture)

Indian major carps grow fast and can reproduce even in artificial ponds. They feed upon phytoplankton, zooplankton, decaying organic matter, aquatic plants etc. Stomach is absent in the alimentary canal of major carps. Three types Of Indian major carps are cultured in fresh-water ponds.

#### 1. Catla catla:

This is commonly called catla. It is the largest carp with greyish colour above and silvery on sides. It grows to about one meter. It has broad and stout body, broad head with upturned mouth, prominent lips and elongated fins. The dorsal side of the body is more concave than ventral side. It occurs in surface water. It matures by second year. slender fish. Body is silvery but dark grey along its back.





Pectoral, ventral and anal fins are with orange tinge. It grows to about 65 cm. The fish has a small head with a blunt snout. Mouth is sub-terminal; caudal fin is sharply forked. This carp is also used in culture fishery. It normally occurs in bottom waters of rivers and tanks.

#### 3. Labeo rohita:

This fish is commonly called rohu. It has an elongated body. Head is small but it is with a prominent terminal mouth, thick lips with short barbels. Colour is bluish or brownish grey above. Scales are grey and red or black. It grows to about 90 cm. This carp occurs in column waters of all rivers and canals. The above major carps are extensively cultured in fresh-water ponds and lakes of India.

## **Minor carp fishes**

The minor carp fishes grow to a size of 30- 100cm. with an average weight of 1 to 1.5 kg. Rate of egg production is very low in these fishes.

#### 1. Labeo calbasu:

It is commonly found in fresh-water ponds and tanks of India. The body is bluish green in colour with small head and folded lips. The snout consists of four black coloured long barbs. It is culturable in ponds. It reaches to a size of 1 m and 1.5 to 2 kg. in weight.

#### 2. Labeo bata:

It is grown in composite fish culture along with other Indian major carps. It attains sexual maturity in 9 - 10 months.





#### 3. Labeo fimbriatus:

It has folded lips and lives in deep water zone. It grows to a maximum size of 90 cm and 450 g. in weight. Red spots are present on the scales of middle row.

The other minor carp fishes are *Labeo contius* (pig mouthed fish), *Cirrhinus cirosa* (white carp) and *Puntius karnaticus*.

## **Murrel fishes**

These are air breathing fishes with long cylindrical body, flattened head and protractile mouth. These can grow in fresh-water ponds, irrigation canals, wells and marshy areas. They breed even before the onset of monsoons.

## 1. Channa punctatus or Ophiocephalus: (Snake head)

It is a long fish with snake like body and accessory respiratory <u>organs</u>. As it lives outside the water also, it is commonly called Livefish. It is coloured differently. It grows to an average length of 30 - 35 cm. It is a common food fish of high demand.

## 2. Channa striatus: (stiped snake head)

The body is coloured dark brown with yellow bands on either side. The fish feeds on worms and insects and grows to a length of 0.9 mt. Its flesh is good for health as it does not contain cholesterol.

#### 3. Channa marulius: (large headed snake fish)

It is also used for culture in fresh water ponds and tanks.

#### **Cat fishes**





The cat fishes are predatory fishes. Their skin is devoid of scales. Two pairs of barbels are present on upper and lower jaw. Most of the fish body is utilized as food due to absence of scales and spines.

#### 1. Clarias batracus:

It is commonly found in brackish and fresh-water ponds of India, South and West Asian countries. Head is slightly compressed and enclosed by plates. Body is brown or dark gray in colour. It is not only used as food but also for experiments in laboratories. It is provided with Accessory respiratory organ. It grows to a size of 45 cm.

## 2. Heteropneustes fossilis:

The head is flat with laterally compressed body. It possesses accessory respiratory organs and lives in lake kolleru of A.P. It feeds on molluscans, algae and grows to a size of 45 cm.

## 3. Clarias macrocephalus:

It grows to a size of 40cm.

# 4. Anabas testudeneus: (Climbing perch)

It grows to a length of 15cm and feeds on aquatic insects. head is triangular with wide mouth and greenish in colour

# 5. Etropius suratensis:

It is commonly called pearl spot due to presence of transparent patches shining like pearls. The body is greenish, light pink and possesses eight black stripes. It is





regarded as a good food fish due to delicious smell. It is not a predator, builds nests during the breeding season and hence regarded as most suitable for culture in ponds and lakes.

#### 6. Wallago attu:

It is a catfish found in all rivers and lakes of India. Head is larger than trunk. The body is laterally compressed. Tail is extraordinarily long and slender. It grows to a size of 2 mt. but captured at 90 cm. length. Two pairs of barbells are present on the head. Mouth is large with large jaws having teeth for feeding on fresh water. Hence it is called fresh-water shark. As it is a predator fish, it is not suitable for artificial culture.

## 7. Mystus seenghala:

Four pairs of barbs elongated upper jaw, long maxillary barbs, deeply divided caudal fin are the main features of the fish.

## **Exotic fishes**

When the indigenous fishnet is not favoured for culture due to economic viability, exotic breeds are selected and cultured. These fishes yield nutritious food and earn foreign exchange.

## 1. Cyprinus carpio: (Common carp)

This fish was imported from China and introduced into Nilagiri lakes. The growth of the fish is higher and grows to a length of 75cm and 6.5 kg weight. It breeds thrice in a year. When cultured under extensive system, the productivity was at 1500 kg/ha.





#### 2. Osphronemus goramy: (Gowramy)

It was imported from Jawa and Maritius and introduced into fresh waters of Madras and Calcutta. The rate of growth is very slow.

#### 3. Ctenopharyngodon idella: (Grass carp)

It grows in fresh water, polluted water and brackish water of low salinity. It feeds on aquatic weeds and used to eliminate them. It is native of Japan and China and was introduced into Cuttack waters in 1959. It can grow to a size of 0.9m in size and 7kg in weight.

## 4. Hypothalamychthys molitrix: (silver fish)

It was imported from Hongkong and introduced into fresh water of Cuttack region. The mouth is located dorsally at the tip of snout, the body is laterally compressed and enclosed by small shiny scales. It feeds on the left-over food particles of carp fish and grows quickly. It reaches to a length of 60 cm and weighs about 1.5 kg.

## 5. Tilapia mossambicus

It was imported from East Africa in 1952. The upper jaw in males is larger. It breeds even at the age of two months.

#### **Cold water fishes**

These fishes are commonly called sport fishes. These fishes include trouts and Mahseers.

## 1. Salmogiardneri: (Rain bow trout)





It is a north American fish introduced into rivers and lakes of Ooty and bill ranges of kerala. The dorsal and caudal fins are pinkish with dark spots. It grows to a length of 1 .8m. and weigh upto 100kg.

## 2. Tortor: (Mahseer)

Head possess short rostral and long maxillary barbs. Dorsal side of the body is greyish green, lateral sides are gold and belly are silvery white. Even though it is adapted to grow well in canals but now it is cultured in reservoirs like Bakranangal. It grows to a size of 1 mt. and considered as good food fish.

## 3. Tor Khudree:

Snout is pointed. Body dark coloured on dorsal and lateral sides while yellow on ventrolateral sides.

## 4. *Tinca tinca* (Doctor fish):

It is the native of Europe and West Siberia and was introduced in Indian waters. It grows to a size of 40cm.

## **BRACKISH WATER FISHES**

The great estuaries on river mouths and backwaters offer important potential for fish culture of particulate species.

The fishes generally reared in brackish water include some iidigenous fish like *Mugil* cephalus, Chanoschanos, Etroplussuratensis, Latescalcarifer and some exotic species like Tilapia mossambica, Osphronemus goramy etc.

# 1. Mugil Cephalus: (Grey mullet)





Although these fishes are available on the coastal region, they enter into brackish waters and rivers. The fish grows to a length of 90cm. It is also reared in ponds in Kerala and Tamil Nadu. 70% of the body is useful as food.

#### 2. Chanos Chanos:

This is commonly known as milk fish. The dorsal side of the body is greenish and shiny. It is mostly obtained in Kerala state. It is highly used in brackish water culture and highly preferred food fish.

#### 3. Iates calcarifer:

It is commonly known as perch. It is found in sea water, brackish waters and also in large rivers. The dorsal side of the body is dark greenish while the ventral side is shiny, it grows to a size of 60cm and may reach to a size of 150cm. It is also highly preferred as food fish.

#### **UNIT III**

#### Sericulture

It is the art and science of silkworm breeding for producing silks. The sericulture is an important cottage industry, but is now the basis of large industries in China, Japan, India and some European countries, where the silkworm, *Bombyx mori* is reared on mulberry leaves on a mass scale to get raw silk from the cocoons of the caterpillars of the moth.





The eggs of the silkworm moth hatch out within 10 days into creamy white rapidly moving caterpillars. The latter feed voraciously on the fresh mulberry leaves and soon undergo a fast growth and are popularly referred to as silkworms.

The silk glands secrete a sticky secretion which is spun around the caterpillars to form a hard covering of silk fibres, known as the cocoon (= pupal case).

Now, each caterpillar gradually metamorphoses in about a fortnight, into a pupal stage called chrysalis. After one or two days of cocoon formation, the pupae are killed either by drying them in the sun or by boiling them. The raw silk fibres forming the cocoon are then reeled out into silk threads. The pupae are killed, because with the emergence of the adult silkworm moth, the long silk fibres will be broken and can only be spun like cotton and cannot be reeled into skeins. Each cocoon of silk moth has about 1000 metres of silk thread.

About 25,000 cocoons yield one pound of silk. A few cocoons, called the seeds, are kept and are allowed to develop into adults to continue the generation. Now-a-days, the intestine of the silk-moth is being utilized to form a substance, known as 'gut' which is useful in fishing and some surgical work.

#### **Diseases:**

(i) Pebrine. The silkworms are destroyed in large numbers by a severe hereditary disease, known as pebrine, which is caused by a parasite protozoan, Nosema bombycis. Nosema infects the eggs of the silkworm and transmits the disease from





one generation to another. The symptoms of pebrine are that the caterpillars turn brownish or pale, shrivel up and finally die.

(ii) Grasserie. It is caused by a kind of virus which attacks the larva. The larva utimately dies,

(iii) Muscaridine. It is caused by a fungus,

(iv) Flacherie. It is an infectious viral disease marked by digestive disorders.

## Life cycle of Bombyx mori,

Systematic Position

Class: Insecta

Order: Lepidoptera

Family: Bombycidae

Genus: Bombyx,

Species: B. mori

The Silkworm, *Bombyx mori* produces the silk of commercial importance. It is the caterpillar of a moth whose cocoon is used to make silk. This insect is also called the silkworm-moth and the mulberry silkworm. Male and female moths are flightless and lack functional mouth parts. The moths differ in morphological features. The





female has a larger abdomen whereas the male has a much larger pair of antennae.



A. Larvae feeding on mulberry leaves







#### Female moth laying eggs

The life cycle of *Bombyx mori* demonstrates the most advanced form of metamorphosis. The serial progressions of four distinct stages of development complete one generation of the species; egg (ova), larvae, pupa and imago.

Ova:

Egg is the first stage of a silkworm's life cycle. The female moth lays an egg about the size of an ink dot during summer or the early fall. The egg remains in dormant stage until spring arrives. The warmth of the spring stimulates the egg to hatch. The egg of *Bombyx mori* is a very small and hard structure; about the size of a pin head and resembling a poppy seed. The eggshell provides a protective covering for





embryonic development. When first laid, an egg light yellow. A fertile ovum darkens to a blue-grey within a few days.

#### Larva:

The larva is the vegetative stage where growth takes place. The larva of Bombyx mori, commonly called a silkworm, is host specific to mulberry. During growth, the larva moults 4 times. The period between successive moults is called an instar. The silkworm, upon hatching, is about 1/8th of an inch and extremely hairy.

Young silkworms can only feed on tender mulberry leaves. However, during the growth phase they can eat tougher mulberry leaves as well. The larval stage lasts for about 27 days and the silkworm goes through five growth stages called instars, during this time. During the first moulting, the silkworm sheds all its hair and gains a smooth skin.

#### Pupa:

As the silkworm prepares to pupate, it spins a protective cocoon. About the size and colour of a cotton ball, the cocoon is constructed from one continuous strand of silk, perhaps 1.5 km long (nearly a mile). The silk cocoon serves as protection for the pupa. Cocoons are shades of white, cream and yellow depending on silkworm genetics. After a final molt inside the cocoon, the larva develops into the brown, chitin covered structure called the pupa. Metamorphic changes of the pupa result in an emerging moth.







## Lifecycle of silkworm

If the silkworms are allowed to mature and break through the cocoon, the silk would be rendered useless for commercial purposes. So, the encased insect is plunged into boiling water to kill the inhabitant and dissolve the glue holding the cocoon together. The end of the silk is then located, and the cocoon unwound onto a spindle to be made into thread.

#### **Cocoon:**

Cocoon is the stage in which the larva spins silk threads around it, to protect itself from its predators. The larva traps itself inside the cocoon in order to pupate. The colour of the cocoon varies, depending upon what the silkworm eats. It can range from white to golden yellow. The second moulting occurs inside the cocoon, when





the larva turns into a brown pupa. It takes about 2-3 weeks for the pupa to metamorphose into an adult moth.

## Imago:

The adult stage completes the life cycle of Bombyx mori. It is the reproductive stage where adults mate and females lay eggs. Moths are flightless and lack functional mouth parts, so are unable to consume the food/nutrition.

Once the adult moth comes out of its cocoon, its only purpose is to find a member of the opposite sex, and mate. Males are larger than females and more active. They flap their wings rapidly to attract the females. Within 24 hours of mating, the male moth dies, while the female lays abundant eggs, after which it dies as well. There on, a new silkworm life cycle begins.

#### **Peace silk:**

Commercial silk is made by boiling the intact cocoons and unwinding the single silk strand onto reels. Only a few moths are allowed to emerge to continue the population of silkworms. The rest are killed by being boiled in their cocoons. "Peace silk", also known as "vegetarian silk", is raised and processed differently. The moths are allowed to emerge from their cocoons to live out their full life cycle. The silk is degummed and spun like other fibre, instead of being reeled. The resulting yam is soft, fluffy, and light like a cloud. This is the best silk for warmth and therapeutic use.

#### UNIT IV





## Apiculture

# Meaning of Apiculture:

Bees are economically important social insects. They not only provide us with honey and wax, they are also responsible for pollination of flowers of the majority of damaged bee larvae, pollen grains, etc. of commercially important plants. The common Indian honey bees are *Apis (Megapis) dorsata*, *A. (microapis) florea and A. indica*.



A. Queen B. Worker C. Drone

Apiculture or bee-keeping is the technique of rearing honey bees for honey and wax from their comb or beehives. Selection of sites for quality honey and protection of bees and combs from pests and diseases are part of apiculture.

Methods of Bee-Keeping in India:

## **1. Indigenous methods:**

## a. Immovable structures:





It is practiced in villages from time immemorial. Small structures are made in secluded and protected places. During construction of dwelling houses, small permanent chambers are made in the outer wall of the house for bees to build combs. Sometimes mud chambers are constructed.

On the outer-side of the chamber a horizontal slit is made for the entry of bees, while on the inside wall a large opening is left for removal of comb.

#### **b.** Movable structures:

Bee chambers are made up of hollow bags, empty wooden boxes, earthen pots, etc. which can be moved from place to place, and put in a suitable location for the bees. These methods are not much satisfactory, as the comb is lost in the process of extraction of honey. The quality of honey is inferior due to presence of dust, tissues of damaged bee larvae, pollen grains, etc., in it.

#### 2. Modern methods:

#### **Beehive:**

In modern apiary, Longs troth's frame hive is most suitable and used commercially for production of honey.

1. It is a two-tier structure. The chambers can be removed from or added to, as required.

2. The hive is made up of wooden box.

a. It has a basal plate or bottom board on which is placed a wooden box called brood chamber.





b. A small opening at the bottom of brood chamber permits passage for bees.

c. Inside the brood chamber several frames hang vertically from the top. These frames can be removed independently. For this arrangement, a modern hive is also called movable frame hive.

d. The distance between the two frames, the bee space is narrow and serves as a passage for the workers but small for building a comb.

e. Above the brood chamber is placed another similar chamber, but of lesser height.

f. It is meant for storage of honey only and known as honey chamber. The queen is never allowed to enter the chamber. In some cases, two honey chambers are used.

3. Above the honey chamber an inner covering is placed over which lies the roof.

## **Tools for Bees Keeping:**

## 1. Comb foundation:

A small piece of comb is necessary to tie with one of the frames from where the bees will start comb-building.

## 2. Bee gloves:

Leather gloves are used to prevent bees from stinging during handling of the comb and bees.

## 3. Bee veil:

A bee veil is required to cover neck, face and head of the keeper during handling. Usually it is made of linen.

## 4. Smoker:





A smoker must be used while capturing bees in a hive. Smoke from paper, wood and coconut cover makes the bees inactive. There is fire box in a smoker in which smoke-producing materials and fire are put. A bellow system is fitted to blow the smoke.

#### 5. Hive tool:

It is a long, narrow and flat piece of steel with a slightly bent head to scrap away dirty materials deposited by bees or some other factors.

#### 6. Honey extractor:

It is used for extraction of honey from the frames without damaging the comb. It consists of a metal drum with several pockets around a rotating wheel. The frames are hanged from the pockets and the pockets are made to rotate round a central axis. The centrifugal force created by rotation separates honey from the comb which is collected in the drum. The honey is taken out from the drum through a hole at the bottom. The combs and frames are again placed in the hive.

## **Typical Location of Apiary:**

A locality for apiary must have different varieties of pollen and nector-producing plants in sufficient number within a distance of 1.5 to 2.5 km. area. Neem, Rita, Tamarind, Cheery, Apple, and Citrus, Lily, Lotus, various wild plants and crops are good sources for both nectar and honey.

#### **Diseases of the Bees:**





Bees suffer from different contagious diseases and are very often subjected to curious organic disorders. The organisms for contagious diseases are Aspergillus, viruses, mites and Protozoa.

a. Aspergillus, a fungus, causes paralysis in worker bees.

b. Virus cause paralysis and high percentage of mortality to all categories of bees.

c. Gut protozoa, particularly Nosima apis, cause death of bees.

## UNIT V

## Lac culture

## **Meaning of Lac Culture:**

Lac culture is the scientific management of lac insects to obtain a high amount of quality lac. This involves selection and maintenance of host plants, inoculation of host plants with healthy lac insects, collection and processing of lac and protection against enemies.

Lac is the resinous secretion of lac insects. Two species of lac insects *Tachardia lacca* and *T. chinensis* are common, of which the former one is predominant in India. India is the highest lac-producing country. Thailand is next in order.

#### **Host plants:**

Kusum, Ranjeeni (Khair) and Ber (Plum) trees. The insects live upon plant juice.

## **Inoculation:**

20 to 30 cm long twigs of host plant with old lac crusts are cut and tied with branches of new plants for propagation. The crust contains eggs laid by female insects.





# **Types of Lac:**

## 1. Kusmi lac:

It grows on Kusum trees. Inoculation is done in January-February and harvested in June-July.

## 2. Ranjeeni lac:

It grows on trees other than Kusum. Inoculated in October-November and harvested in next May-June.

## Life Cycle of Lac Insects:

A resinous exudate comes out of the insect body and forms a crust around it, which gets attached to the host plant. Gradually a thick crust of the resinous substance or lac surrounds the twig.

1. Following inoculation, the larvae hatch out of the eggs present in the old crust.

They are nymphs and come out of the crust. This is swarming.

2. The abandoned old crust is called Phunki.

3. The phunki is removed within three weeks of inoculation.

4. The nymphs are boat-shaped, reddish in colour and possess one pair of antennae, three pairs of thoracic walking legs and a pair of caudal setae.

5. Some of the nymphs are males—both winged and wingless, and others are females.





6. The nymphs move to new branches of the host plant. With the help of maxillae and mandibles modified for sucking, they suck cell sap from the branches of the host plant to thrive. The nymphs settle on the branch and liberate the exudate.

7. Most of the body structures are lost and the nymphs moult several times.

8. The rejected skin and the exudate form a crust around it containing a pair of branchial pores and a large anal tubercular opening.

9. An operculum is present at the tubercular opening. The male comes out removing the operculum after three months.

10. The male copulates with female. The males are devoid of mouth parts and die soon after mating. The female lays eggs in the crust.

#### Harvesting and Extraction of Lac:

1. Twigs with thick crusts around it are cut and removed from sites.

2. The incrustations are scraped out from the twigs. This is granular lac.

3. The granular lac is thoroughly washed with water. A red 'dye is obtained in the

process. Drying and bleaching of washed lac are done by exposure to sunlight.

4. The granules are melted in pot over open charcoal fire.

5. The lac melts and comes out of the crust. Hun sheets are prepared from the molten

lac. The sheets are dried and broken into pieces and marketed as flakes.

#### Uses of Lac:

Lac is used in the manufacture of toys, ornaments, electrical insulating materials, varnishes, polishes, lithographic inks, shoe polishes, sealing wax, etc.





# **Enemies of Lac:**

Some chalcedonic and lepidopteran insects lay eggs inside the mists. The nymphs of

lac insects are eaten up by their larvae.

Proper selection of seed lac, killing of predator eggs in harvested lac, and use of insecticides greatly minimise damage to the crop.

\*\*\*\*\*

