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PRACTICAL MANUAL OF

AQUACULTURE AND FISHERIES

Zoology – B.Sc. III, Semester V

AS PER NEP-2020 (2.0)
SYLLABUS OF SHIVAJI UNIVERSITY, KOLHAPUR
(IMPLEMENTED FROM JUNE 2026)

AUTHORS

Dr. S. A. Vhanalakar | Mr. K. J. Adate | Dr. V. A. Jagtap | Dr. R. J. Lad

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PREFACE

The Practical Manual of Aquaculture and Fisheries has been prepared for the students of B.Sc. III, Semester V, Zoology, in accordance with the NEP-2020 (2.0) syllabus of Shivaji University, Kolhapur, implemented from June 2026. The manual is designed to provide systematic practical exposure to the identification, culture, management, harvesting, preservation, processing, and marketing of fishery resources.

The practical syllabus emphasizes both laboratory-based identification and field-oriented learning. Students are introduced to the identification of major fish species belonging to Chondrichthyes and Osteichthyes using taxonomic keys, as well as the recognition of different fish seed stages such as spawn, fry, and fingerlings. Practical exercises further cover various types of fish hatcheries, induced breeding techniques, freshwater aquaculture systems, and extensive, semi-intensive, and intensive fish culture practices.

The manual also provides practical knowledge of traditional fishing gears and crafts, mechanized and non-mechanized fishing boats, fish storage and transportation, traditional and modern preservation techniques, fish products and by-products, and value-added fish products. Special attention is given to the identification of common bacterial, viral, and parasitic fish diseases and their basic preventive measures. The inclusion of a fish-market survey enables students to understand fish species diversity, marketing practices, and the practical dimensions of fisheries.

Each practical has been presented in a clear and student-friendly format, incorporating essential components such as aim, requirements, principle, procedure, observations, identification, and conclusion, wherever applicable. The manual is intended to strengthen observation, identification, analytical, field-survey, and practical skills while connecting classroom knowledge with real-world aquaculture and fisheries practices.

It is hoped that this manual will serve as a useful academic resource for students and teachers and promote scientific understanding of sustainable aquaculture, responsible fisheries, and efficient utilization of aquatic resources.

- Authors

PRACTICAL MANUAL OF AQUACULTURE AND FISHERIES

B. SC. III ZOOLOGY (NEP-2.0)

SEMESTER V

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1. Identification of 10 major fish species with the help of key (05 Chondrichthyes and 05 Ostechthyes).
2. Study on different types of fish hatcheries in aquaculture.
3. Identification and comparative study of fish seed stages—spawn, fry and fingerlings with reference to size, morphology and survival.
4. Demonstration of Induced breeding techniques in freshwater fishes.
5. Study of freshwater aquaculture system (River or Pond culture).
6. Comparative study on fish culture system: Extensive fish culture, Semi-intensive and intensive fish culture.
7. Identification and demonstration of traditional fishing gears and crafts used in inland fisheries.
8. Observation and study of mechanized and non-mechanized fishing boats.
9. Study of fish storage practices, including icing, cold storage and transportation.
10. Study or demonstration of traditional fish preservation methods such as drying, salting and smoking.
11. Study of modern fish preservation methods including freezing, canning and irradiation.
12. Study and identification of fish products and by-products, including value-added products.
13. Study and identification of common fish diseases—bacterial, viral and parasitic—with basic preventive measures.
14. Survey or visit to a fish market to study species diversity.

PRACTICAL 1
IDENTIFICATION OF 10 MAJOR FISH SPECIES WITH THE HELP OF IDENTIFICATION KEY (5 CHONDRICHTHYES AND 5 OSTEICHTHYES)

General Charachristics of Class Chondrichthyes

1. Exclusively marine fishes, with a few exceptions inhabiting brackish water.
2. Endoskeleton is made up of cartilage.
3. Body is generally streamlined and spindle-shaped.
4. Skin is covered with placoid scales (dermal denticles).
5. Mouth is usually ventral in position.
6. Five to seven pairs of gill slits are present and operculum is absent.
7. Tail is generally heterocercal.
8. Swim bladder is absent.
9. Fertilization is generally internal; males possess claspers.
10. They are mostly carnivorous/predatory and include sharks, rays and skates.

General Charachristics of Class Osteichthyes

1. They are mainly freshwater and marine fishes.
2. Endoskeleton is predominantly made up of bone.
3. Body is generally streamlined, with head, trunk and tail regions.
4. Skin is usually covered with cycloid or ctenoid scales.
5. Mouth is generally terminal in position.
6. Four pairs of gills are present and covered by an operculum.
7. Tail is generally homocercal.
8. Swim bladder is usually present and helps in buoyancy.
9. Fertilization is generally external, particularly in freshwater forms.
10. They show great diversity in feeding habits, habitats and body forms.

Aim

To identify ten major fish species (05 Chondrichthyes and 05 Osteichthyes) using a standard identification key and study their distinguishing characters.

Requirements

Fresh or preserved fish specimens or models or photographs, identification key, hand lens, measuring scale, forceps, observation sheet and notebook.

Procedure:

1. Observe the external morphology of the given fish specimen.

2. Examine the body shape, mouth position, fins, scales, gill openings and tail.
3. Use the identification key to identify the fish up to species level.
4. Record the common name, scientific name and important identifying characters.
5. Repeat the procedure for all ten specimens.

Dichotomous Identification Key for 10 Major Fish Species

Step 1: General Skeleton & Gills

- **1a.** Cartilaginous skeleton; 5–7 exposed gill slits (no gill cover) →**Class Chondrichthyes** (Go to **2**)
- **1b.** Bony skeleton; gills covered by an operculum (gill cover) →**Class Osteichthyes** (Go to **6**)

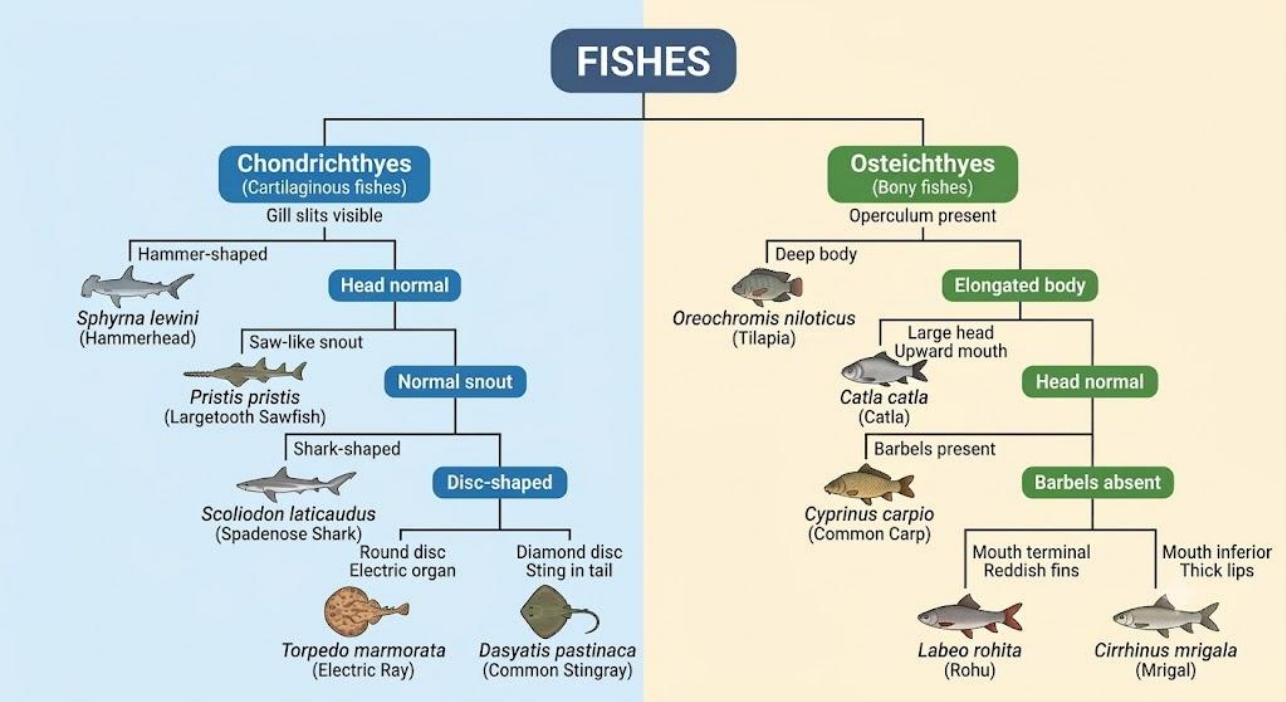
Class Chondrichthyes (Cartilaginous Fishes)

- **2a.** Head extended sideways into a hammer shape →***Sphyrna lewini*** **(Scalloped Hammerhead)**
- **2b.** Head normal, not hammer-shaped →**Go to 3**
- **3a.** Snout long, flat, and saw-like with teeth on the sides →***Pristis pristis*** **(Largetooth Sawfish)**
- **3b.** Snout normal, not saw-like →**Go to 4**
- **4a.** Body flattened into a wide disc →**Go to 5**
- **4b.** Body cylindrical and shark-like →***Scoliodon laticaudus*** **(Spadenose Shark / Dogfish)**
- **5a.** Disc circular; produces electric shocks →***Torpedo marmorata*** **(Marbled Electric Ray)**
- **5b.** Disc diamond-shaped; whip-like tail with a stinging spine →***Dasyatis pastinaca*** **(Common Stingray)**

Class Osteichthyes (Bony Fishes)

- **6a.** Body deep/compressed with a long, continuous dorsal fin →***Oreochromis niloticus*** **(Tilapia)**
- **6b.** Body streamlined with a short dorsal fin →**Go to 7**
- **7a.** Very large head with an upturned (superior) mouth →***Catla catla*** **(Catla)**
- **7b.** Normal head with a forward or downward-facing mouth →**Go to 8**
- **8a.** Mouth has 2 pairs of barbels (whiskers/feelers) →***Cyprinus carpio*** **(Common Carp)**
- **8b.** No barbels around the mouth →**Go to 9**
- **9a.** Mouth opens forward (terminal); body bluish with reddish fins →***Labeo rohita*** **(Rohu)**

- **9b.** Mouth opens downward (inferior) with thick lips; slender body →***Cirrhinus mrigala*** **(Mrigal)**



IDENTIFICATION CHART OF 10 MAJOR FISH SPECIES

(05 Chondrichthyes & 05 Osteichthyes)

I. CLASS CHONDRICHTHYES (CARTILAGINOUS FISHES)

Sr. No.	1	2	3	4	5
Common Name	**Spadenose Shark**	**Hammerhead Shark**	**Sawfish**	**Cowtail Stingray**	**Electric Ray**
Scientific Name	*Scoliodon laticaudus*	*Sphyrna lewini*	*Pristis pristis*	*Pastinachus sephen* (Syn. *Dasyatis sephen*)	*Torpedo marmorata*
Order	Carcharhiniformes	Carcharhiniformes	Rhinopristiformes	Myllobatiformes	Torpediniformes
Family	Carcharhinidae	Sphyrnidae	Pristidae	Dasyatidae	Torpedinidas
Picture					
Key Identification Characters	• Body long and spindle shaped • Snout pointed • 5 gill slits on each side • Mouth ventral • Placoid scales	• Head laterally expanded into hammer shape • Eyes at the ands of cephalofoil • 5 gill slits • Heterocercal tail	• Rostrum long, flat and saw-like with lateral teath • Body shark-like • 5 gill slits • Mouth ventral	• Body disc-shaped • Pectoral fins fused with head • Tail long with a venomous spine • Spiracles present • Mouth ventral	• Disc-shaped body • Electric organs present on both sides of head • Tail short and thick • Mouth ventral

II. CLASS OSTEICHTHYES (BONY FISHES)

Sr. No.	1	2	3	4	5
Common Name	**Catia**	**Rohu**	**Mrigal**	**Common Carp**	**Tilapia**
Scientific Name	*Catia catla*	*Labeo rohita*	*Cirrhinus mrigala*	*Cyprinus carpio*	*Oreochromis niloticus*
Order	Cypriniformes	Cypriniformes	Cypriniformes	Cypriniformes	Cichliformes
Family	Cyprinidae	Cyprinidae	Cyprinidae	Cyprinidae	Cichlidae
Picture					
Key Identification Characters	• Body deep and laterally compressed • Head large • Mouth upturned • No barbals	• Body elongated • Mouth terminal • Lips thick • Fins slightly reddish • No barbels	• Body long and slender • Mouth inferior • Lips thin • No barbels	• Body stout • Two pairs of barbels • Large cycloid scales • Mouth inferior	• Body laterally compressed • Long dorsal fin • Mouth terminal • Vertical dark hands on body

CLASSIFICATION SUMMARY

Kingdom : Animalia
Phylum : Chordata
Subphylum : Vertebrata
Infrophylum : Gnathostomata
Superclass : Pisces

Class Chondrichthyes (Cartilaginous Fishes) | Class Osteichthyes (Bony Fishes)

GENERAL CHARACTERS OF CLASS CHONDRICHTHYES

- Endoskeleton cartilaginous
- Placoid scales
- 5–7 pairs of gill slits exposed
- Operculum absent
- Mouth usually ventral
- Caudal fin heterocercal
- Swim bladder absent
- Fertilization internal

GENERAL CHARACTERS OF CLASS OSTEICHTHYES

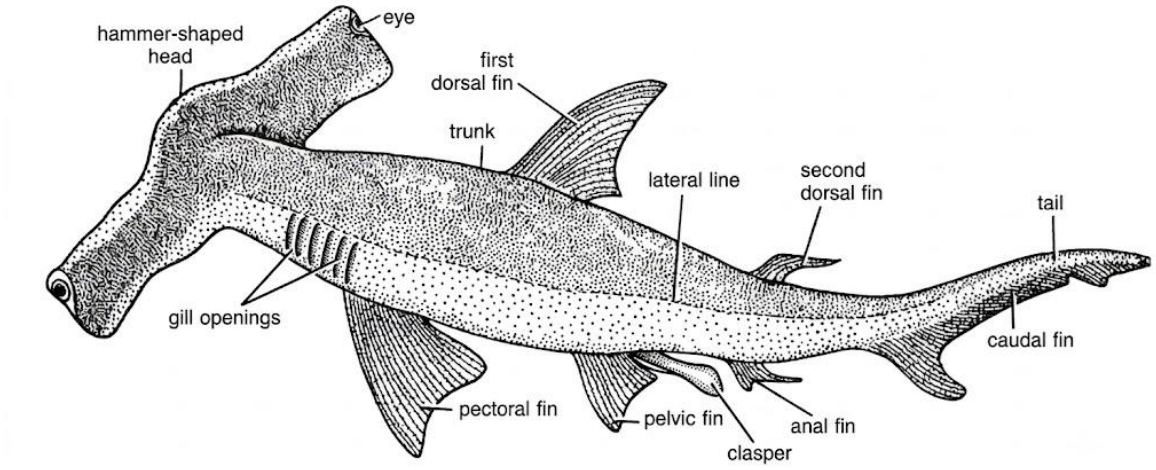
- Endoskeleton bony
- Cycloid / stenoid / ganoid scales
- Gills covered by operculum
- Mouth terminal or inferior
- Caudal fin usually homocercal
- Swim bladder present
- Fertilization external

Note: Classification follows Nelson, Gemde & Wilson – Fishes of the World, 5th Edition (2010) and Eschmeyer's Catalog of Fishes (2024).

Key Morphological Diagnostic Characters

Part I: Class Chondrichthyes (Cartilaginous Fishes)

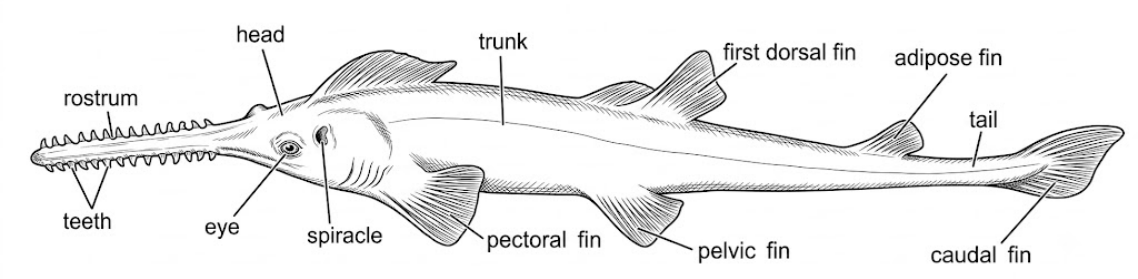
1. *Sphyrna lewini* (Scalloped Hammerhead Shark)



***Sphyrna lewini* (Scalloped Hammerhead Shark)**

i. **Body Shape and Compression:** Streamlined, laterally compressed trunk.
ii. **Snout and Head Region:** Head laterally expanded into a hammer-shaped **cephalofoil**.
iii. **Mouth Position and Jaws:** Ventral mouth with triangular, serrated teeth.
iv. **Barbels and Cephalic Appendages:** Barbels absent; lateral head expansions hold eyes and nostrils at tips.
v. **Exoskeleton (Scale Type):** Densely covered in small, tough **placoid scales**.
vi. **Gill Openings and Operculum:** 5 pairs of lateral gill slits anterior to pectoral origin; **operculum absent**.
vii. **Paired Fins:** Broad, triangular pectoral fins; pelvic fins with claspers in males.
viii. **Dorsal and Anal Fins:** High, strongly falcate first dorsal fin; small second dorsal and anal fins.
ix. **Caudal Fin Type:** Asymmetrical **heterocercal** tail with a deep subterminal notch.
x. **Lateral Line System:** Well-developed along the mid-dorsal and lateral trunk.
xi. **Coloration and Markings:** Olive-gray to dark brown dorsally, shading to white below.
xii. **Special Diagnostic Adaptation:** Ampullae of Lorenzini densely concentrated across the underside of the cephalofoil.

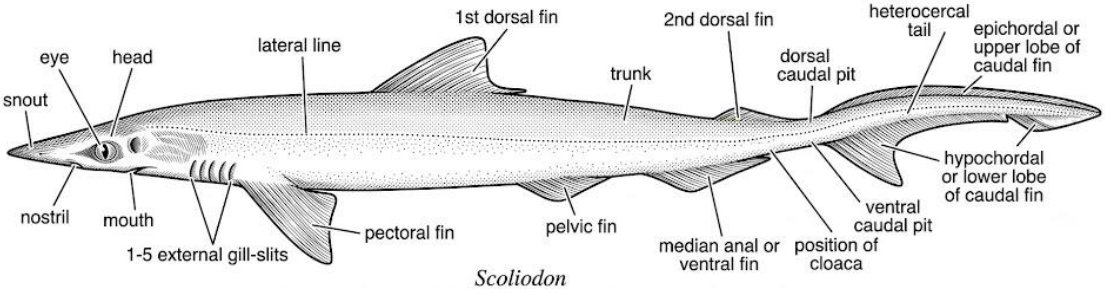
2. *Pristis pristis* (Largetooth Sawfish)



***Pristis pristis* (Largetooth Sawfish)**

i. **Body Shape and Compression:** Shark-like body, dorsoventrally flattened anteriorly.
ii. **Snout and Head Region:** Snout prolonged into a long, flat, rigid **rostral saw**.
iii. **Mouth Position and Jaws:** Ventral mouth located on the flattened head underside.
iv. **Barbels and Cephalic Appendages:** Barbels absent on the rostrum.
v. **Exoskeleton (Scale Type):** Covered in fine dermal denticles (**placoid scales**).
vi. **Gill Openings and Operculum:** 5 pairs of **ventral** gill slits; **operculum absent**.
vii. **Paired Fins:** Broad pectoral fins attached behind the head region.
viii. **Dorsal and Anal Fins:** Two large erect triangular dorsal fins; anal fin absent or weak.
ix. **Caudal Fin Type:** Well-developed **heterocercal** tail with a distinct lower lobe.
x. **Lateral Line System:** Extends along the lateral sides onto the caudal fin.
xi. **Coloration and Markings:** Yellowish-brown to dark gray dorsally, pale whitish ventrally.
xii. **Special Diagnostic Adaptation:** Rostrum armed with 14–24 pairs of lateral socketed teeth used to stun prey.

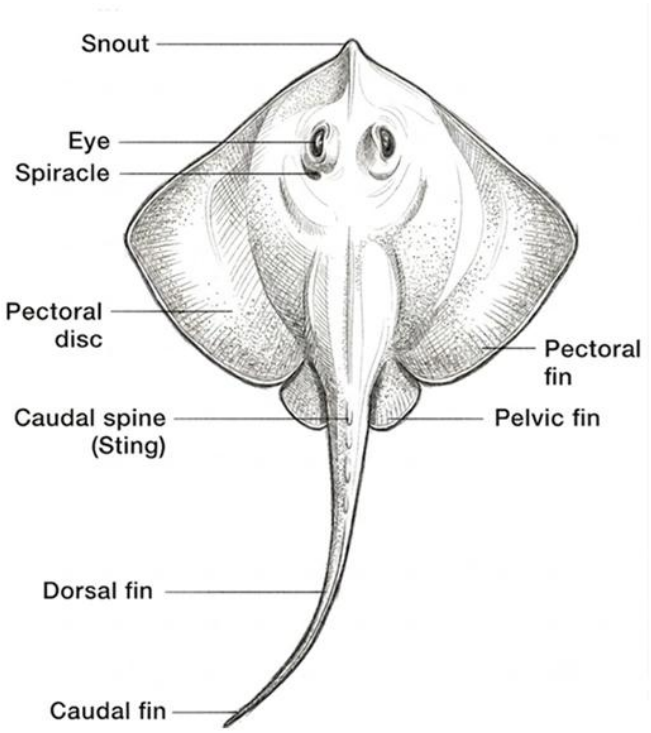
3. *Scoliodon laticaudus* (Spadenose Shark)



***Scoliodon laticaudus* (Spadenose Shark)**

i. **Body Shape and Compression:** Spindle-shaped, fusiform, and laterally compressed.
ii. **Snout and Head Region:** Snout dorsoventrally flattened and spade-like.
iii. **Mouth Position and Jaws:** Ventral crescentic mouth with sharp, backwardly pointed teeth.
iv. **Barbels and Cephalic Appendages:** Barbels absent.
v. **Exoskeleton (Scale Type):** Covered in minute, backwardly directed **placoid scales**.
vi. **Gill Openings and Operculum:** 5 pairs of lateral, exposed gill slits; **operculum absent**.
vii. **Paired Fins:** Well-developed pectoral fins; pelvic fins bear **claspers** in males.
viii. **Dorsal and Anal Fins:** Two dorsal fins (first large, second small); single anal fin present.
ix. **Caudal Fin Type:** Strongly **heterocercal** with an elongated upper lobe.
x. **Lateral Line System:** Continuous longitudinal lateral line along flanks.
xi. **Coloration and Markings:** Bronze-gray or brownish dorsally, creamy white ventrally.
xii. **Special Diagnostic Adaptation:** Hydrostatic lift provided by an oil-rich liver (swim bladder absent).

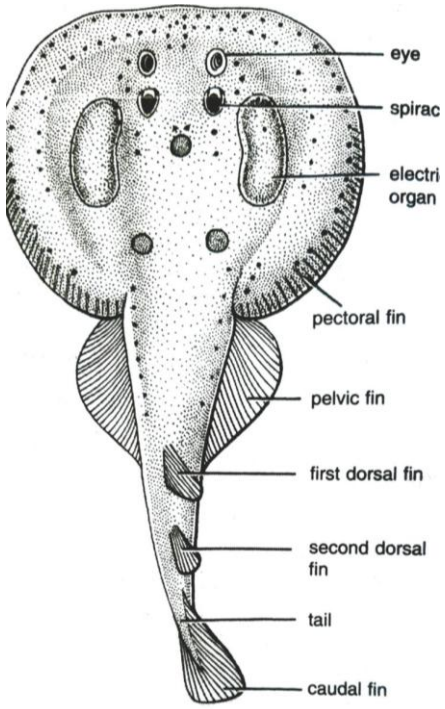
4. *Pastinachus sephen* (Cowtail Stingray)



***Pastinachus sephen* (Cowtail Stingray)**

i. **Body Shape and Compression:** Strongly dorsoventrally flattened into a rhomboidal body disc.
ii. **Snout and Head Region:** Head completely incorporated into the body disc.
iii. **Mouth Position and Jaws:** Ventral mouth with pavement-like crushing teeth.
iv. **Barbels and Cephalic Appendages:** Barbels absent.
v. **Exoskeleton (Scale Type):** Skin with small **placoid scales** and enlarged dorsal midline tubercles.
vi. **Gill Openings and Operculum:** 5 pairs of **ventral** gill slits; **operculum absent**.
vii. **Paired Fins:** Large pectoral fins fused along head margins; small pelvic fins.
viii. **Dorsal and Anal Fins:** True dorsal and anal fins absent.
ix. **Caudal Fin Type:** Tail modified into a long, whip-like filament (caudal fin reduced/absent).
x. **Lateral Line System:** Branching canal network present on both dorsal and ventral surfaces.
xi. **Coloration and Markings:** Uniform dark brown to grayish-black dorsally, white ventrally.
xii. **Special Diagnostic Adaptation:** Tail equipped with a sharp, serrated venomous spine and a broad ventral skin flap.

5. *Torpedo marmorata* (Marbled Electric Ray)

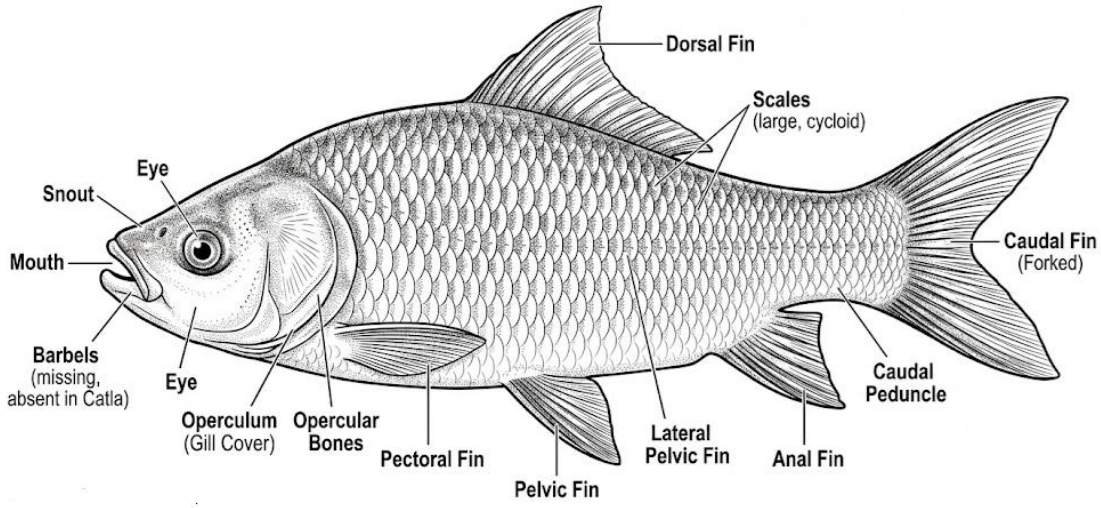


***Torpedo marmorata* (Marbled Electric Ray)**

i. **Body Shape and Compression:** Circular, dorsoventrally flattened disc with a stout tail.
ii. **Snout and Head Region:** Broad, rounded anterior margin fused with pectoral fins.
iii. **Mouth Position and Jaws:** Ventral mouth with small, pointed teeth.
iv. **Barbels and Cephalic Appendages:** Barbels absent; small tentacles fringe the spiracles.
v. **Exoskeleton (Scale Type):** Skin entirely **smooth and naked** (placoid scales absent).
vi. **Gill Openings and Operculum:** 5 pairs of small **ventral** gill slits; **operculum absent**.
vii. **Paired Fins:** Pectoral fins form the rounded body disc; small pelvic fins at disc base.
viii. **Dorsal and Anal Fins:** Two rounded dorsal fins on the tail; anal fin absent.
ix. **Caudal Fin Type:** Well-developed, broad triangular **diphycercal/modified heterocercal** tail.
x. **Lateral Line System:** Canals present primarily around the head disc and spiracles.
xi. **Coloration and Markings:** Dark brown mottled/marbled pattern dorsally, whitish ventrally.
xii. **Special Diagnostic Adaptation:** Pair of large kidney-shaped **electric organs** derived from branchial muscles located on either side of the head.

Part II: Class Osteichthyes (Bony Fishes)

6. *Catla catla* (Catla)



***Catla catla* (Catla)**

i. **Body Shape and Compression:** Deep, robust, laterally compressed body with an elevated dorsal profile.

ii. **Snout and Head Region:** Head very large, broad, accounting for >25% of body length.

iii. **Mouth Position and Jaws:** Upturned (superior) wide mouth with a protruding lower jaw.

iv. **Barbels and Cephalic Appendages: Barbels absent**.

v. **Exoskeleton (Scale Type):** Covered in large, broad **cycloid scales**.

vi. **Gill Openings and Operculum:** Single gill opening per side covered by a **bony operculum**.

vii. **Paired Fins:** Pectoral fins positioned low on flanks; pelvic fins abdominal.

viii. **Dorsal and Anal Fins:** Single long dorsal fin (14–16 branched rays); short anal fin.

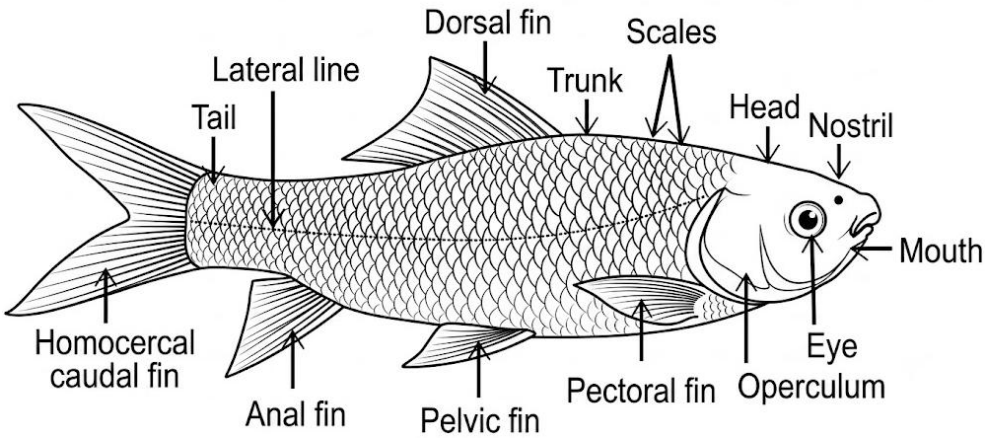
ix. **Caudal Fin Type:** Deeply forked, symmetrical **homocercal** caudal fin.

x. **Lateral Line System:** Complete, continuous lateral line with 40–43 scales.

xi. **Coloration and Markings:** Dark grayish dorsally, silvery-white on flanks and belly.

xii. **Special Diagnostic Adaptation:** Broad gill rakers adapted specifically for surface plankton feeding.

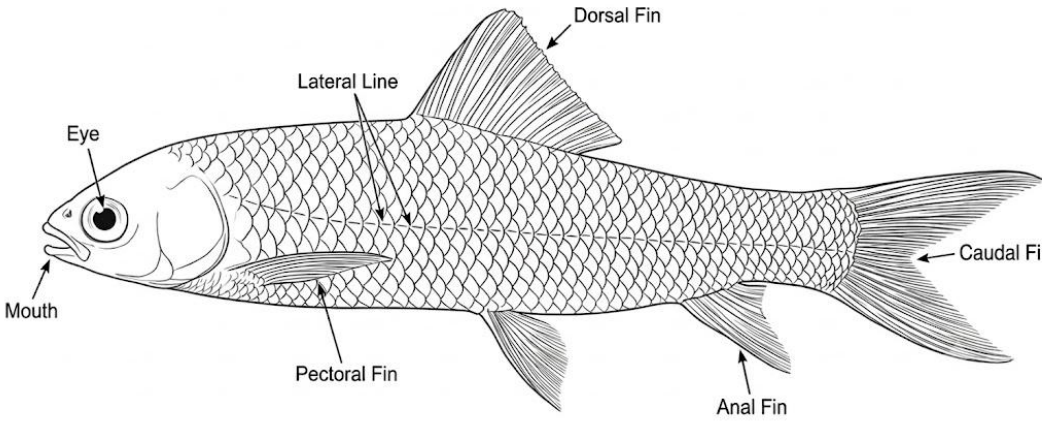
7. *Labeo rohita* (Rohu)



***Labeo rohita* (Rohu)**

i. **Body Shape and Compression:** Streamlined, moderately elongated, laterally compressed body.
ii. **Snout and Head Region:** Blunt snout with small, inconspicuous pores.
iii. **Mouth Position and Jaws:** Sub-terminal, inferior mouth with thick, fleshy, **fringed lips**.
iv. **Barbels and Cephalic Appendages:** Single pair of short maxillary barbels hidden in labial folds.
v. **Exoskeleton (Scale Type):** Covered in moderate-sized **cycloid scales** with reddish centers.
vi. **Gill Openings and Operculum:** Single gill opening per side protected by a **bony operculum**.
vii. **Paired Fins:** Well-developed pectoral and pelvic fins positioned ventrally.
viii. **Dorsal and Anal Fins:** Single dorsal fin placed midway along the back (12–13 branched rays); short anal fin.
ix. **Caudal Fin Type:** Deeply notched, symmetrical **homocercal** tail.
x. **Lateral Line System:** Complete, continuous lateral line running along mid-flank (38–42 scales).
xi. **Coloration and Markings:** Bluish/brownish dorsally, silvery flanks with reddish/pink fin margins.
xii. **Special Diagnostic Adaptation:** Columnar pharyngeal teeth in three rows for grinding plant matter.

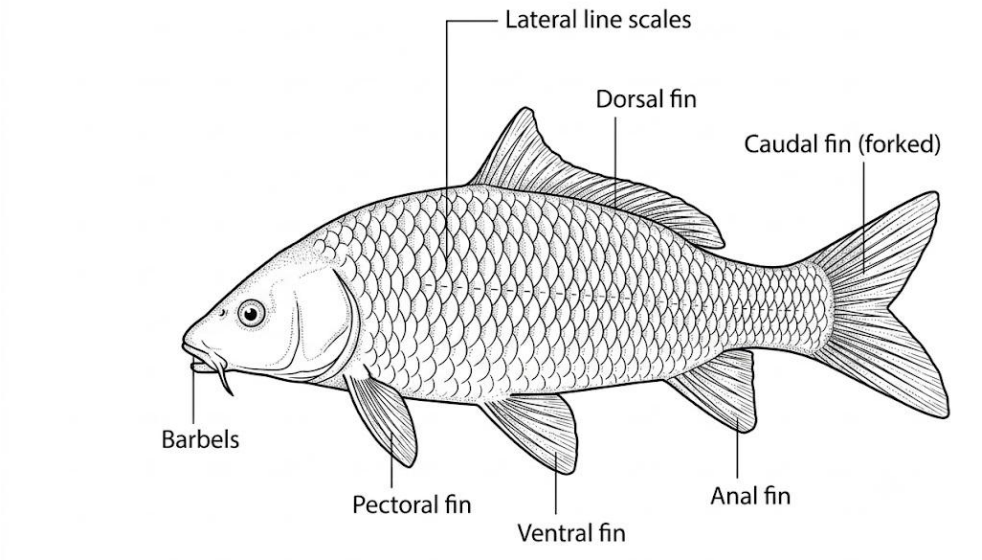
8. *Cirrhinus mrigala* (Mrigal)



***Cirrhinus mrigala* (Mrigal)**

i. **Body Shape and Compression:** Linear, slender, highly streamlined body.
ii. **Snout and Head Region:** Blunt snout projecting slightly beyond the upper jaw.
iii. **Mouth Position and Jaws:** Sub-terminal mouth with thin, non-fringed lips.
iv. **Barbels and Cephalic Appendages:** Single pair of short **rostral barbels** present.
v. **Exoskeleton (Scale Type):** Covered in bright, golden-silvery **cycloid scales**.
vi. **Gill Openings and Operculum:** Single gill opening per side enclosed by a **bony operculum**.
vii. **Paired Fins:** Pectoral fins shorter than head length; abdominal pelvic fins.
viii. **Dorsal and Anal Fins:** Single dorsal fin with 12–13 branched rays; short anal fin.
ix. **Caudal Fin Type:** Symmetrical, deeply forked **homocercal** caudal fin.
x. **Lateral Line System:** Complete, continuous lateral line with 40–45 scales.
xi. **Coloration and Markings:** Dark pinkish-gray dorsally, bright silvery flanks with yellowish fin bases.
xii. **Special Diagnostic Adaptation:** Bottom-feeding adaptation featuring a sharp, horny layer on the inner surface of the lower jaw.

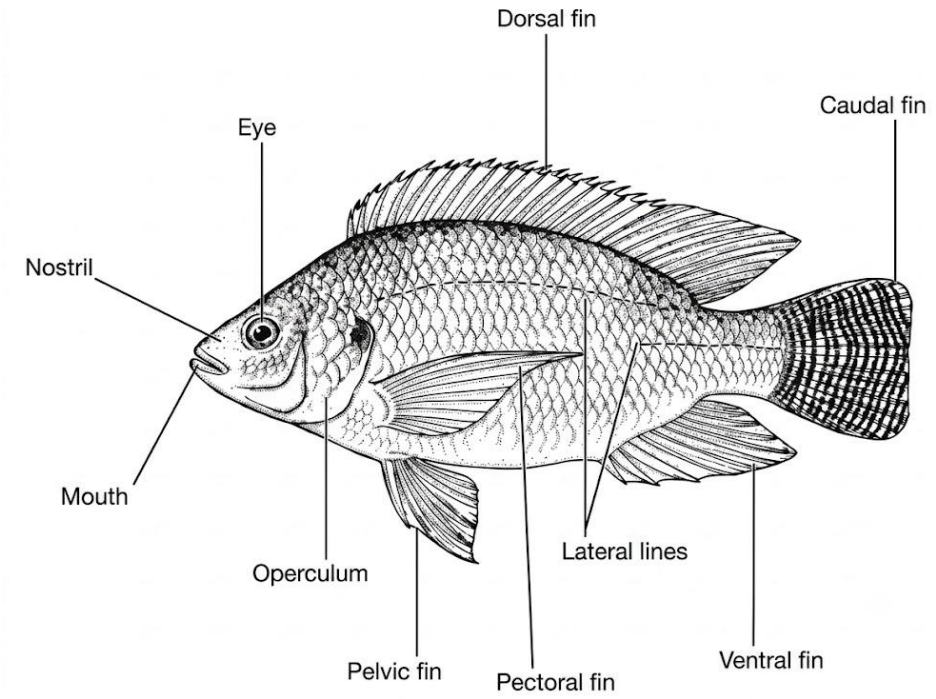
9. *Cyprinus carpio* (Common Carp)



***Cyprinus carpio* (Common Carp)**

i. **Body Shape and Compression:** Robust, deep, strongly laterally compressed body.
ii. **Snout and Head Region:** Blunt, tapering head with a small snout.
iii. **Mouth Position and Jaws:** Sub-terminal, protractile (extensible) mouth.
iv. **Barbels and Cephalic Appendages: Two pairs of barbels** (1 short rostral pair, 1 long maxillary pair).
v. **Exoskeleton (Scale Type):** Covered in large, thick, tough **cycloid scales**.
vi. **Gill Openings and Operculum:** Single gill opening per side protected by a **bony operculum**.
vii. **Paired Fins:** Broad pectoral fins; pelvic fins positioned abdominally.
viii. **Dorsal and Anal Fins:** Single long dorsal fin base; **serrated hard spine** present on dorsal and anal fins.
ix. **Caudal Fin Type:** Symmetrical, deeply notched **homocercal** tail.
x. **Lateral Line System:** Complete, continuous lateral line with 33–39 scales.
xi. **Coloration and Markings:** Brassy-golden to olive-brown dorsally, yellowish-white ventrally.
xii. **Special Diagnostic Adaptation:** Extensible mouth and molar-like pharyngeal teeth adapted for benthic foraging.

10. *Oreochromis niloticus* (Nile Tilapia)



***Oreochromis niloticus* (Nile Tilapia)**

i. **Body Shape and Compression:** Deep, oval-shaped, strongly laterally compressed body.
ii. **Snout and Head Region:** Short snout with a moderately small head profile.
iii. **Mouth Position and Jaws:** Terminal mouth with small bicuspid and tricuspid teeth.
iv. **Barbels and Cephalic Appendages: Barbels absent**.
v. **Exoskeleton (Scale Type):** Covered in rough, firm **ctenoid scales**.
vi. **Gill Openings and Operculum:** Single gill opening per side protected by a **bony operculum** with a dark spot.
vii. **Paired Fins:** High-set pectoral fins; thoracic pelvic fins positioned directly below pectorals.
viii. **Dorsal and Anal Fins:** Single continuous dorsal fin (16–18 hard anterior spines); anal fin with 3 anterior spines.
ix. **Caudal Fin Type:** Truncated/rounded **homocercal** tail.
x. **Lateral Line System: Interrupted lateral line** (split into an upper anterior and lower posterior line).
xi. **Coloration and Markings:** Grayish-bronze with 7–9 dark vertical body bars and striped tail fin.
xii. **Special Diagnostic Adaptation:** Maternal mouthbrooding behavior and highly adaptable respiratory system.

PRACTICAL 2

STUDY ON DIFFERENT TYPES OF FISH HATCHERIES IN AQUACULTURE

Aim To study the different types of fish hatcheries used in aquaculture for induced breeding, incubation, and seed production.

Requirements

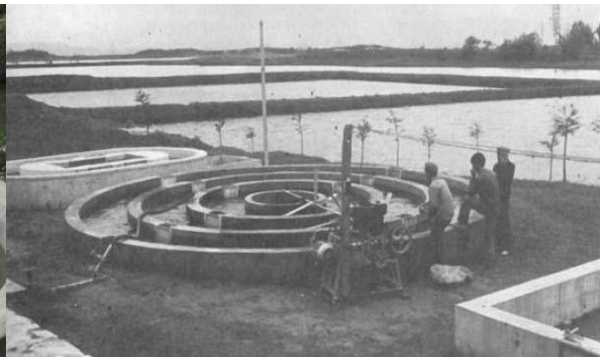
- Charts or photographs of different fish hatcheries
- Models (if available)
- Practical record book

Theory:

A fish hatchery is a facility where fish are bred artificially to produce fertilized eggs, hatchlings, and fry under controlled conditions. Hatcheries play an important role in ensuring a continuous supply of healthy fish seed for aquaculture and fisheries development.

Types of Fish Hatcheries

1. Chinese Circular Hatchery



Principle

A Chinese circular hatchery uses **circular breeding and hatching tanks with continuous water circulation**. The circular water movement keeps fertilized eggs suspended and well oxygenated.

Main Components

- Circular breeding/spawning tank
- Circular incubation/hatching tank
- Water inlet and outlet
- Water supply system
- Egg collection arrangement
- Larval collection tank

Working

i. Mature brood fish are selected and induced to breed when required.
ii. Eggs and milt are released and fertilization takes place.
iii. Fertilized eggs are transferred to the circular incubation tank.

iv. Continuous water circulation keeps eggs moving gently.
v. Eggs hatch into larvae.
vi. Larvae are collected and transferred to nursery facilities.

Advantages

- Good oxygenation of eggs
- Continuous water circulation
- High hatching efficiency
- Suitable for large-scale carp seed production
- Requires comparatively less space than pond-based breeding

Important Species

Catla, Rohu and Mrigal and other carps.

Key feature: Circular tank + continuous water flow + egg incubation.

2. Indian Major Carp Hatchery

Principle

The Indian Major Carp hatchery is designed for induced breeding and mass production of carp seed. The major species are: Catla, Rohu, Mrigal

Main Components

- Brood fish pond
- Breeding pool
- Circular spawning/hatching tank
- Incubation facilities
- Water supply system
- Egg collection system
- Nursery ponds

Working

i. Healthy and sexually mature brooders are selected.
ii. Brood fish are given induced breeding treatment.

iii. Male and female fish are introduced into the breeding facility.
iv. Spawning occurs after hormonal induction.
v. Fertilized eggs are collected and transferred to hatching facilities.
vi. Eggs hatch into hatchlings.
vii. Hatchlings are transferred to nursery ponds for further development.

Advantages

- Enables breeding outside the natural breeding season.
- Produces large quantities of seed.
- Useful for commercial carp culture.
- Provides better control over breeding and seed production.

Key Feature: Broodstock → induced breeding → spawning → egg incubation → hatchlings → nursery.

3. Hapa Hatchery


Principle

A hapa hatchery uses a fine-mesh net enclosure (hapa) installed inside a pond or water body for controlled breeding, egg collection and early larval rearing.

Structure

A hapa is generally a rectangular bag-like enclosure made of fine nylon or synthetic mesh.
It is supported by:

- Bamboo/wooden poles or frames
- Ropes
- Floats/supports

Working

i. A hapa is fixed in a pond with adequate water flow.
ii. Selected male and female brood fish are introduced.
iii. Breeding takes place inside the hapa.
iv. Eggs are retained within the enclosure.

v. After hatching, larvae remain protected inside the hapa for early development.
vi. Fry are subsequently transferred to nursery ponds.

Advantages

- Simple construction
- Low cost
- Easy to operate
- Suitable for small-scale fish farmers
- Easy observation of brood fish and larvae

Limitations

- Limited capacity
- Requires good-quality pond water
- Mesh can become clogged with algae or debris
- Less suitable for very large-scale commercial hatcheries

Key Feature: Fine-mesh rectangular enclosure installed in a pond.

4. Traditional/Extensive Fish Hatchery


Principle

Traditional hatcheries depend largely on natural environmental conditions such as rainfall, temperature, water flow and natural food availability to stimulate fish breeding.

Main Components

- Broodstock pond
- Breeding/spawning pond
- Nursery pond
- Water supply and drainage system
- Screens/nets for controlling fish movement

Working

i. Mature brood fish are maintained in broodstock ponds.
ii. During the natural breeding season, suitable environmental conditions stimulate spawning.

iii. Brood fish are released into breeding ponds.
iv. Natural spawning occurs.
v. Eggs hatch into larvae.
vi. Larvae are maintained in nursery ponds until they reach fry stage.

Advantages

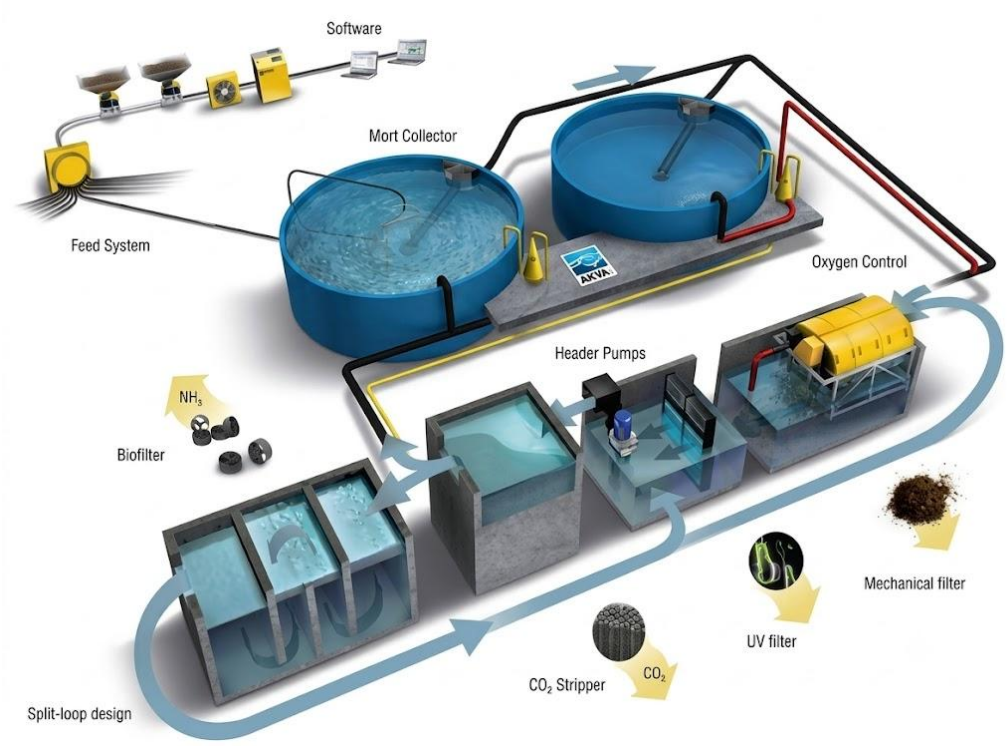
- Low initial investment
- Simple technology
- Easy to manage
- Suitable for small-scale farmers
- Uses naturally available food and environmental conditions

Limitations

- Seed production depends strongly on season and environmental conditions.
- Less control over breeding.
- Production is generally lower than intensive hatchery systems.
- Difficult to maintain uniform seed production throughout the year.

Key Feature: Dependence on natural breeding conditions and pond-based seed production.

5. Recirculating Aquaculture System (RAS) Hatchery



Principle

RAS hatcheries reuse and treat water continuously. Water from culture tanks passes through mechanical and biological filters before being returned to the culture tanks.

Main Components

- Fish/broodstock tanks
- Egg incubation tanks
- Mechanical filter
- Biological filter
- Pump
- Aeration/oxygenation system
- Water-quality monitoring system
- UV/ozone treatment where applicable

Working

Culture tank → Mechanical filtration → Biological filtration → Aeration/Oxygenation → Water-quality treatment → Pump → Culture tank

i. Eggs, larvae or brood fish are maintained in controlled tanks.
ii. Used water leaves the culture tank.
iii. Solid wastes are removed by mechanical filtration.
iv. Ammonia is converted into less toxic compounds through biological filtration.
v. Water is oxygenated.
vi. Treated water is returned to the culture tank.
vii. Temperature and other water-quality parameters can be carefully controlled.

Advantages

- Very efficient use of water
- Better control of temperature, dissolved oxygen and water quality
- Suitable for intensive seed production
- Can operate throughout the year
- Requires relatively little land
- Biosecurity can be better controlled

Limitations

- High initial investment
- Requires electricity and pumps
- Requires skilled management
- System failure can rapidly affect fish if aeration or circulation stops

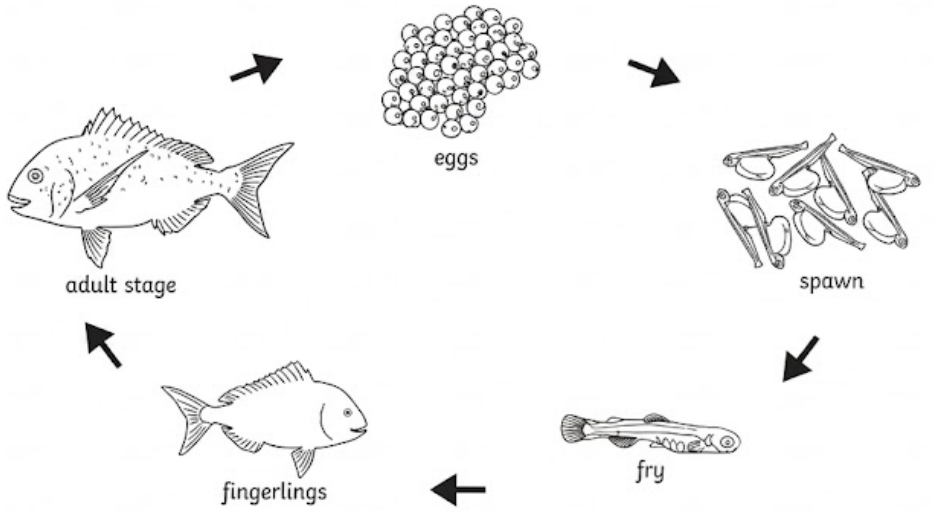
Key Feature: Tanks + pump + mechanical filter + biofilter + continuous water recirculation.

PRACTICAL 3

IDENTIFICATION AND COMPARATIVE STUDY OF FISH SEED STAGES: SPAWN, FRY AND FINGERLINGS

Aim

To identify different fish seed stages based on their size, morphology and survival.



Life Cycle of Fish

Fish seed passes through several developmental stages from hatching to juvenile development. The major stages include egg, hatchling, spawn, fry and fingerling. Each stage differs in size, body shape, pigmentation, fin development and feeding habits. Identification of these stages is important for proper nursery management and stocking practices.

Survival of fish seed depends on water quality, nutrition, stocking density and environmental conditions. This practical helps students identify different fish seed stages based on their size, morphology and survival.

A. Spawn

Size

Spawn is the newly hatched larval stage of fish. It measures about 5–8 mm in length, depending on the fish species.

Morphology

The body is transparent, slender and delicate. A yolk sac is present, which provides nourishment during the early stage. The fins and scales are absent or poorly developed, and the eyes are small. Swimming movement is weak and irregular.

Survival

Spawn has the **lowest survival rate** among all seed stages because of its delicate body, dependence on the yolk sac, and high sensitivity to changes in water quality, temperature and predators. Careful handling is essential during transportation.

B. Fry

Size

Fry is the young fish stage after the yolk sac is completely absorbed. It usually measures about 20–30 mm (2–3 cm) in length.

Morphology

The body becomes elongated and pigmented. The yolk sac is absent, and the fry begins feeding independently. Fins are developed but still soft, while scales begin to appear. Swimming becomes active and well coordinated.

Survival

Fry has a moderate survival rate. It is stronger than spawn but still vulnerable to poor water quality, disease and predators. Proper feeding and nursery management improve survival.

C. Fingerling

Size

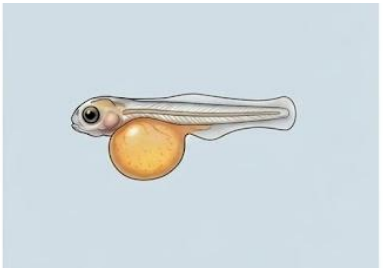
Fingerlings are juvenile fish measuring about 80–150 mm (8–15 cm) in length, although size varies with species.

Morphology

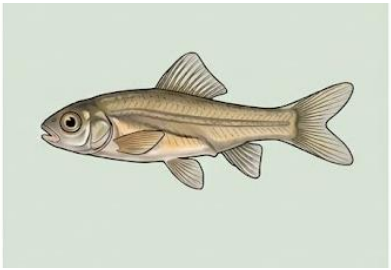
The body resembles that of an adult fish. All fins and scales are fully developed, body colour is well defined, and swimming ability is strong. Fingerlings actively feed on natural and artificial food.

Survival

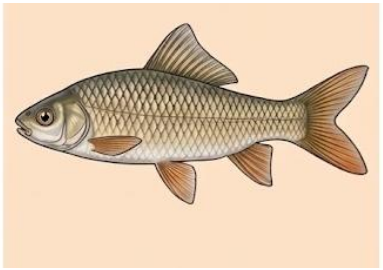
Fingerlings have the highest survival rate among all fish seed stages. They are more resistant to environmental stress, disease and handling, making them the preferred stage for stocking in culture ponds.



Spawn



Fry



Fingerling

PRACTICAL 4
DEMONSTRATION OF INDUCED BREEDING TECHNIQUES IN FRESHWATER FISHES

Aim

To study the induced breeding technique used for artificial spawning and seed production in freshwater fishes.

Requirements

Healthy brood fishes (male and female), breeding tank, inducing hormone (Ovaprim/WOVA-FH/Pituitary gland extract), syringe and needle, weighing balance, breeding hapa or breeding pool, clean water supply, hand net, plastic tub and fish seed collection tray.

Principle

Induced breeding is the artificial stimulation of mature brood fishes by injecting suitable hormones to induce spawning under controlled conditions. This technique ensures the timely production of healthy fish seed and is widely used for breeding Indian major carps and other freshwater fishes.

Procedure

Healthy and sexually mature brood fishes are selected and weighed. The required dose of inducing hormone is calculated according to the body weight of the fish. The hormone is injected intramuscularly below the dorsal fin or at the base of the pectoral fin using a sterile syringe. The injected male and female fishes are then released into a breeding hapa or breeding tank containing clean, well-aerated water. After a latency period of about 6–10 hours (depending on species and water temperature), the fishes spawn naturally. Fertilized eggs are collected carefully and transferred to a hatchery for incubation. The newly hatched larvae are maintained until they are ready for stocking in nursery ponds.

Observations

During the demonstration, students should observe:

- Selection of healthy male and female brood fishes.
- Method of weighing brood fishes.
- Preparation and administration of hormone injection.
- Site of hormone injection.
- Breeding tank or hapa arrangement.
- Spawning behaviour of fishes.
- Collection of fertilized eggs.
- Transfer of eggs to the hatchery.
- Hatching of eggs and appearance of larvae.

Applications

Induced breeding is widely used for the large-scale production of fish seed of Indian major carps, Chinese carps and catfishes. It is an essential technique in commercial hatcheries, fisheries research centres and aquaculture farms for ensuring a continuous supply of quality seed.

Selection of Healthy Brood Fish

↓

Identification of Male and Female

↓

Weighing of Brood Fish

↓

Calculation of Hormone Dose (Ovaprim/PGE)

↓

Hormone Injection to Male and Female Fish

↓

Transfer to Breeding Tank/Breeding Hapa

↓

Spawning and Fertilization of Eggs

↓

Collection of Fertilized Eggs

↓

Transfer of Eggs to Hatchery Unit

↓

Egg Incubation and Hatching

↓

Collection of Spawn (Larvae)

↓

Transfer to Nursery Pond for Rearing

PRACTICAL 5 (A)
STUDY OF FRESHWATER AQUACULTURE SYSTEM – POND CULTURE

Aim

To study the freshwater pond culture system used for fish farming.

Requirements

Fish pond/model/chart, measuring tape, water quality testing kit (optional), notebook and pencil.

Principle

Pond culture is the most common freshwater aquaculture system in which fish are reared in earthen ponds under controlled conditions. Proper pond management, water quality, feeding and stocking help in obtaining higher fish production.

Procedure

Visit the fish pond and observe its construction. Identify the inlet and outlet channels, pond bunds and drainage system. Observe the stocking of fish seed, feeding method, water level, aquatic vegetation and overall pond management practices. Record the important observations.

Observations

A freshwater pond is usually rectangular and supplied with clean water throughout the culture period. Healthy fingerlings of compatible fish species are stocked according to recommended stocking density. Fish are fed regularly with balanced feed, and water quality is maintained by proper fertilization, liming and water exchange. Harvesting is carried out after the fish attain marketable size.

Applications

Pond culture is widely used for the culture of Indian major carps, Chinese carps, tilapia, catfish and freshwater prawns. It is suitable for composite fish culture, integrated farming and commercial aquaculture.

Advantages

- Easy to construct and manage.
- High fish production.
- Better control over feeding and water quality.
- Suitable for composite fish culture.
- Low production cost.
- Easy harvesting.

Disadvantages

- Requires large land area.

- Regular water supply is essential.
- Disease outbreaks may occur.
- Water quality must be monitored regularly.
- Losses may occur due to floods or drought.

Observations Table

Sr. No.	Observation Parameter	Observation
1	Type of aquaculture system	Freshwater pond culture
2	Type of pond	Earthen / Cemented / Other
3	Pond shape	Rectangular / Square / Other
4	Pond size	_____ m² / _____ ha
5	Average water depth	_____ m
6	Water source	_____
7	Inlet channel	Present / Absent
8	Outlet/drainage system	Present / Absent
9	Pond bund condition	Good / Moderate / Poor
10	Fish species stocked	_____
11	Fish seed stage	Fry / Fingerling
12	Stocking density	_____ fish/ha
13	Feed used	_____
14	Feeding frequency	_____ times/day
15	Fertilization	Organic / Inorganic / Both
16	Liming	Applied / Not applied
17	Aquatic vegetation	Present / Absent
18	Water quality	Good / Moderate / Poor
19	Culture practice	Monoculture / Composite culture
20	Harvesting method	Netting / Complete drainage / Other

Result

The freshwater pond culture system was studied successfully, and its structure, components, management practices, advantages and limitations were understood.

PRACTICAL 5 (B)

STUDY OF FRESHWATER AQUACULTURE SYSTEM – RIVER CULTURE

Aim

To study the freshwater river culture system used for fish farming.

Requirements

River culture site/model/chart, cage or pen model (if available), notebook and pencil.

Principle

River culture is a freshwater aquaculture system in which fish are cultured in flowing river water using cages or pens. Continuous water movement supplies oxygen and removes waste materials, providing a healthy environment for fish growth.

Structure

- Flowing freshwater river.
- Cage or pen fixed in the river.
- Strong supporting frame.
- Floating or fixed platform.
- Net enclosure.
- Anchoring system.
- Continuous water flow.

Components

River water, cage or pen, nylon net, floating frame, bamboo/HDPE frame, floats, anchors, ropes, fish seed, and fish feed

Procedure

Visit the river culture site and observe the cage or pen installation. Identify the supporting frame, net enclosure, anchoring system and floating devices. Observe fish stocking, feeding method and water flow. Record all important observations.

Observations

Fish are stocked inside cages or pens installed in flowing river water. Continuous water movement provides natural aeration and removes fish waste. Fish are fed with floating pellets at regular intervals. Growth is monitored periodically, and harvesting is carried out by lifting the cage or using hand nets.

Applications

River culture is suitable for the farming of Indian major carps, tilapia, pangasius, catfish and other freshwater fishes. It is widely practiced in rivers, reservoirs and canals where continuous water flow is available.

Advantages

- Continuous water flow provides natural aeration.

- Waste materials are continuously removed.
- Requires less land than pond culture.
- Suitable for intensive fish production.

Disadvantages

- Floods and strong currents may damage cages.
- Water quality is difficult to control.
- Fish may escape from damaged nets.
- Requires regular feeding and monitoring.

Observations Table

Sr. No.	Observation Parameter	Observation
1	Type of aquaculture system	River culture
2	Water body	River / Canal / Reservoir
3	Water flow	Slow / Moderate / Fast
4	Culture structure	Cage / Pen
5	Cage/pen shape	Rectangular / Circular / Other
6	Cage/pen material	Nylon net / HDPE net / Other
7	Supporting frame	Bamboo / HDPE / Metal
8	Floating arrangement	Floats / Drums / Other
9	Anchoring system	Present / Absent
10	Fish species stocked	_____
11	Fish seed stage	Fry / Fingerling
12	Stocking density	_____ fish/m^3
13	Feed used	_____
14	Feeding method	Manual / Automatic
15	Feeding frequency	_____ times/day
16	Water exchange	Continuous / Natural
17	Aeration	Natural / Artificial
18	Fish health	Healthy / Diseased / Poor
19	Growth monitoring	Regular / Occasional / None
20	Harvesting method	Lifting cage / Netting / Other

Result

The freshwater river culture system was studied successfully, and its structure, components, management practices, advantages and limitations were understood.

PRACTICAL 6
COMPARATIVE STUDY OF FISH CULTURE SYSTEMS: EXTENSIVE, SEMI-INTENSIVE AND INTENSIVE FISH CULTURE

Aim

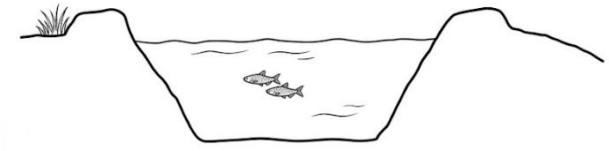
To study and compare different fish culture systems based on management practices, stocking density, feeding, production and cost.

Requirements

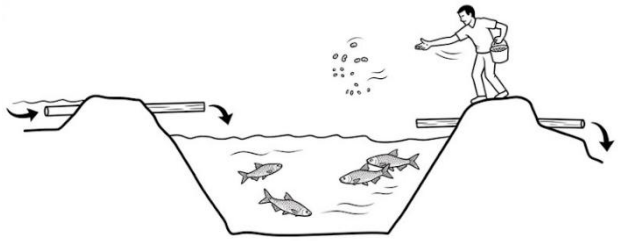
Charts/models/photographs of different fish culture systems, notebook and pencil.

Principle

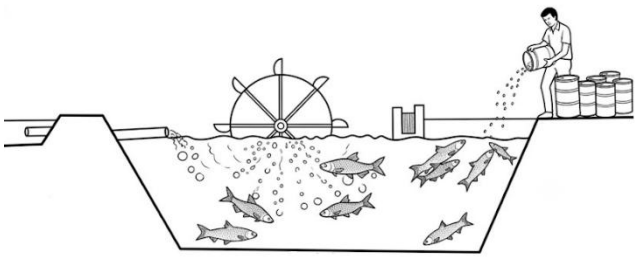
Fish culture systems differ in the level of management, stocking density, feeding practices and production. The choice of culture system depends on available resources, investment and production goals.



Extensive Fish Culture



Semi-intensive Fish Culture



Semi-intensive Fish Culture

A. Extensive Fish Culture

Features

- Fish are cultured in natural ponds, lakes or reservoirs.
- Low stocking density is maintained.
- Fish depend mainly on natural food.
- Very little or no supplementary feed is provided.
- Fertilizers are used occasionally to improve natural productivity.
- Requires minimum management and investment.

Applications

Extensive fish culture is suitable for village ponds, reservoirs and large natural water bodies where low-cost fish production is preferred.

Advantages

- Low production cost.
- Less labour required.
- Uses natural food available in the pond.
- Eco-friendly culture system.

Disadvantages

- Low fish production.
- Growth depends on natural food.
- Difficult to control environmental conditions.

B. Semi-intensive Fish Culture

Features

- Fish are cultured in managed ponds.
- Moderate stocking density is maintained.
- Natural food is supplemented with artificial feed.
- Fertilizers and manures are regularly applied.
- Water quality is monitored periodically.
- Moderate management and investment are required.

Applications

Semi-intensive culture is widely practiced for Indian major carps, tilapia and freshwater prawns in commercial fish farms.

Advantages

- Higher fish production than extensive culture.
- Better growth rate.
- Efficient use of pond resources.
- Moderate investment with good returns.

Disadvantages

- Requires regular feeding and pond management.
- Water quality should be monitored.
- Higher operating cost than extensive culture.

C. Intensive Fish Culture

Features

- Fish are cultured at very high stocking density.
- Complete artificial feeding is provided.
- Continuous aeration and water quality management are essential.
- Regular health monitoring is required.
- High investment and skilled management are necessary.
- Maximum fish production is achieved.

Applications

Intensive culture is suitable for commercial production of carps, tilapia, catfish and pangasius in tanks, raceways and biofloc or RAS systems.

Advantages

- Very high fish production.
- Faster fish growth.
- Better use of available space.
- High economic return.

Disadvantages

- High construction and operating cost.
- Requires electricity and aeration.
- Disease outbreaks may spread rapidly.
- Needs skilled technical management.

Comparative Table

Character	Extensive Culture	Semi-intensive Culture	Intensive Culture
Water body	Natural ponds, lakes	Managed ponds	Tanks, ponds, raceways, RAS
Stocking density	Low	Moderate	High
Fish feed	Natural food	Natural + supplementary feed	Complete artificial feed
Fertilizer use	Occasional	Regular	Limited/As required
Water quality management	Minimum	Moderate	Intensive
Aeration	Usually not required	Sometimes required	Essential
Labour requirement	Low	Moderate	High
Investment	Low	Moderate	High
Fish production	Low	Medium	Very high
Management level	Simple	Moderate	Intensive

PRACTICAL 7
IDENTIFICATION AND DEMONSTRATION OF TRADITIONAL FISHING GEARS AND CRAFTS USED IN INLAND FISHERIES

Aim

To identify and study the traditional fishing gears and crafts used in inland fisheries.

Requirements

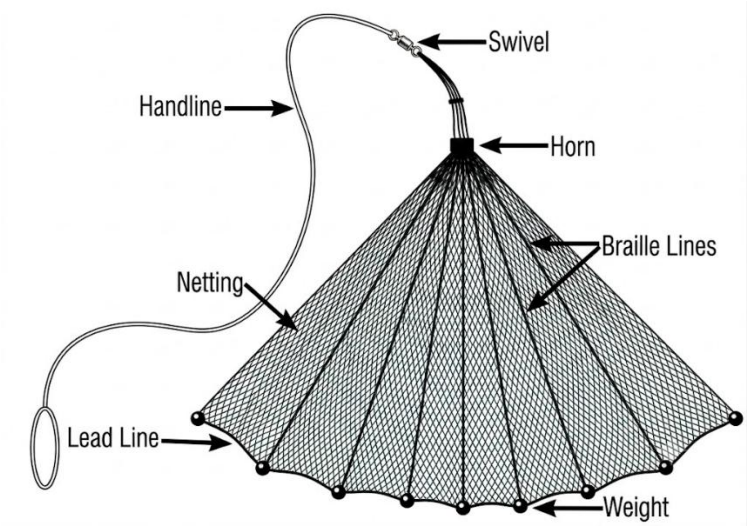
Fishing gear specimens/models/charts, fishing craft model or photographs, measuring tape and notebook.

Principle

Fishing gears and crafts are important tools used for catching fish from freshwater bodies such as rivers, lakes, reservoirs and ponds. Their design and operation depend on the type of water body, fish species and local fishing practices.

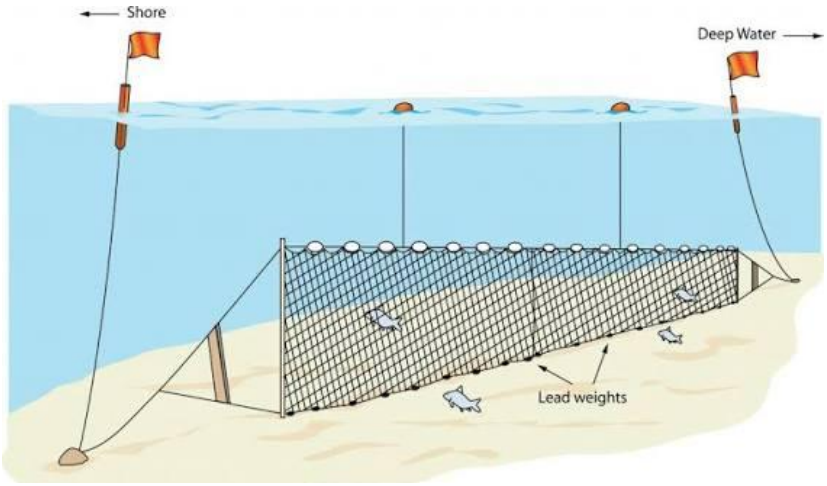
A. Traditional Fishing Gears

1. Cast Net



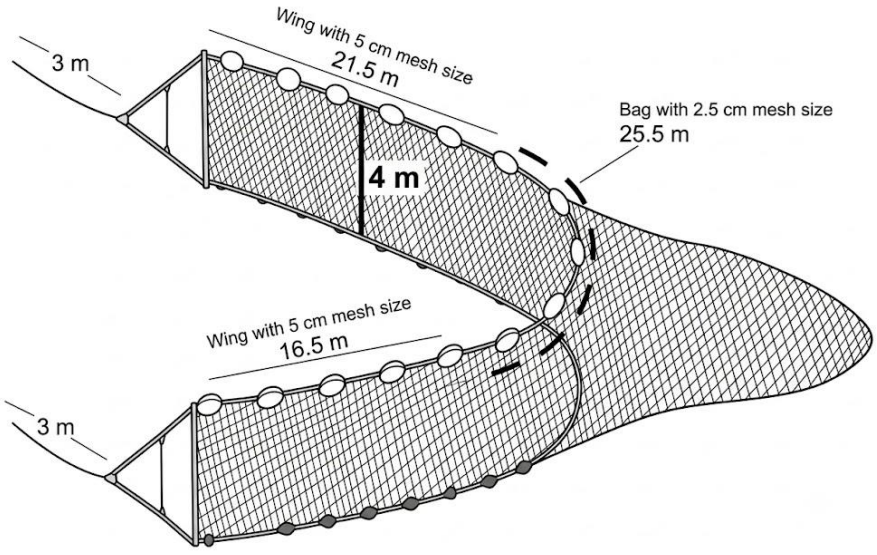
i. A cast net is a circular fishing net with lead weights attached around its edge.
ii. It is thrown by hand over the water and spreads into a circular shape.
iii. The weighted edges sink quickly and trap fish inside the net.
iv. It is easy to carry and can be operated by a single fisherman.
v. It is commonly used in ponds, rivers and shallow lakes.
vi. It is mainly used for catching small and medium-sized freshwater fishes.
vii. It is inexpensive, easy to operate and requires very little maintenance.

2. Gill Net



i. A gill net is a rectangular net fitted with floats on the upper edge and sinkers on the lower edge.
ii. It is fixed vertically in the water.
iii. Fish are caught when their gills become entangled in the mesh.
iv. The mesh size is selected according to the size of the target fish.
v. It is commonly used in rivers, reservoirs and lakes.
vi. It is mainly used for catching medium and large-sized fishes.
vii. It is simple to use, covers a large fishing area and gives a good catch.

3. Drag Net (Seine Net)



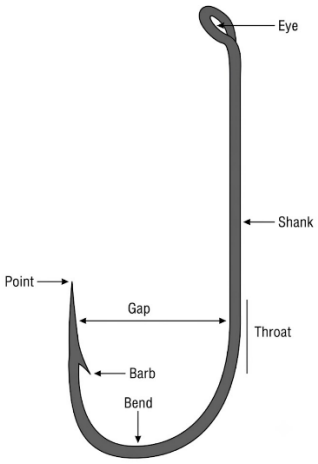
i. A drag net is a long rectangular net with floats at the top and sinkers at the bottom.
ii. It is operated by pulling both ends of the net through the water.
iii. The net surrounds the fish and collects them while being dragged.
iv. It requires two or more people for operation.
v. It is commonly used in ponds, lakes and shallow rivers.

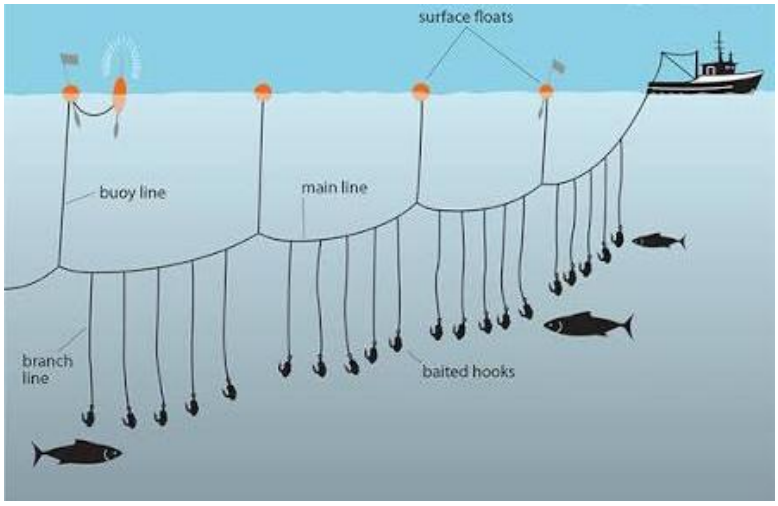
vi. It is mainly used for harvesting cultured fish and catching large numbers of fish.
vii. It provides a high catch and is suitable for harvesting fish from ponds.

4. Scoop Net

i. A scoop net is a small net attached to a circular or triangular frame.
ii. It is fitted with a long bamboo or metal handle.
iii. Fish are collected by scooping them from the water.
iv. It is light in weight and easy to handle.
v. It is commonly used in hatcheries, nursery ponds and fish farms.
vi. It is mainly used for collecting spawn, fry, fingerlings and small fishes.
vii. It is simple to use and causes very little injury to young fish.

5. Hook and Line

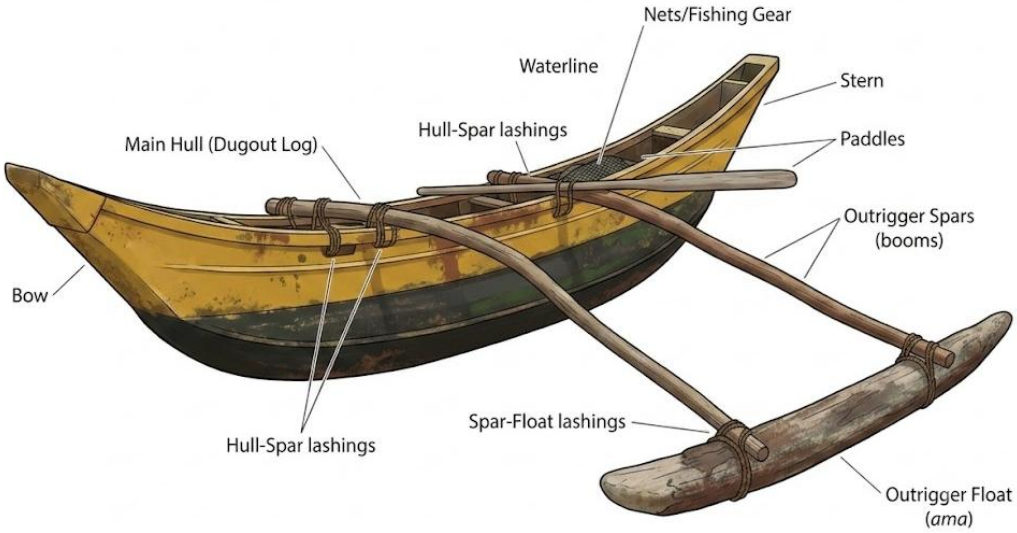




i. A hook and line consist of a fishing hook attached to a nylon line with bait.
ii. Fish are attracted to the bait and caught on the hook.
iii. It is one of the oldest and simplest fishing methods.
iv. It can be operated by a single fisherman.
v. It is commonly used in ponds, rivers and lakes.
vi. It is mainly used for catching individual fishes such as catfish and murrel.
vii. It is inexpensive, selective and does not damage the surrounding habitat.

B. Traditional Fishing Crafts

1. Catamaran

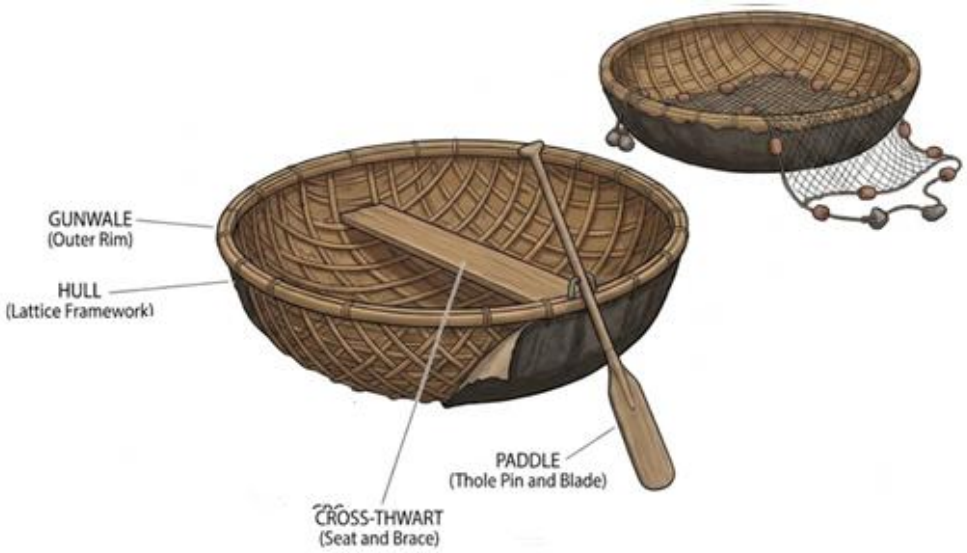


i. A catamaran is a simple traditional fishing craft made by tying several wooden logs together.
ii. It is long, narrow and relatively lightweight in construction.
iii. It is traditionally operated using paddles or oars, while modern versions may use small motors.
iv. It is mainly used for nearshore fishing and coastal operations.
v. It is commonly used along the Tamil Nadu, Andhra Pradesh and Odisha coasts.
vi. It is operated with fishing gears such as gill nets, hooks and lines and small nets.
vii. It is mainly used to catch sardines, anchovies, mackerels and other small coastal fishes.
viii. Its simple construction makes it inexpensive and easy to repair.
ix. Its flexible log structure is suitable for operating through breaking coastal surf.
x. Its main limitations are low carrying capacity, limited storage space and poor protection during rough weather.

2. Coracle

i. A coracle is a small, circular and bowl-shaped traditional fishing craft.
ii. It is traditionally constructed using a framework of bamboo, reeds or flexible branches covered with a waterproof material.
iii. It is lightweight and can be easily carried and launched by fishermen.
iv. It is generally operated using a single paddle.
v. It is commonly used in rivers, lakes and reservoirs of South India.
vi. It is mainly used for small-scale inland fishing and transportation.

vii. It is used with cast nets, small fishing nets, hooks and lines.
viii. It is mainly used to catch small freshwater fishes and prawns.
ix. It is inexpensive, easily manoeuvrable and suitable for shallow waters.
x. Its main limitations are low carrying capacity and poor stability in rough or fast-flowing water.



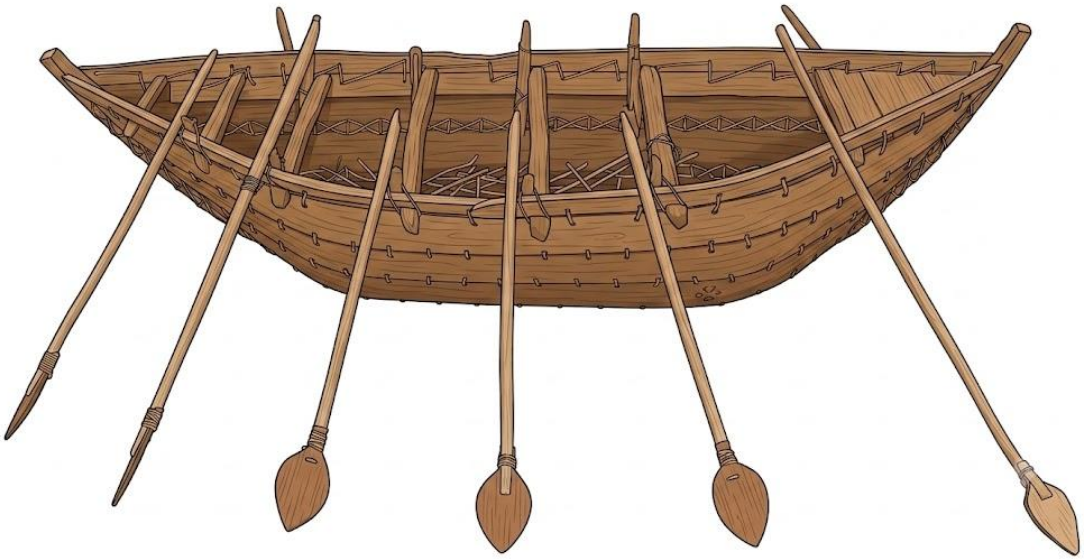
3. Dugout Canoe

i. A dugout canoe is made from a single hollow tree trunk.
ii. It is narrow, relatively lightweight and easy to operate.
iii. It is moved using paddles or oars.
iv. It is suitable for calm inland waters and sheltered coastal areas.
v. It is commonly used in rivers, lakes, ponds and coastal fishing areas.
vi. It is mainly used for fishing and transportation of fishermen and fishing gear.
vii. It is used with gill nets, hooks and lines, traps and small fishing nets.
viii. It is generally used to catch small and medium-sized freshwater or coastal fishes.

ix. It is inexpensive, durable and can be constructed using locally available timber.

x. Its limitations include limited carrying capacity, considerable weight and dependence on suitable timber.

5. Masula Boat



i. A Masula boat is a traditional flexible plank-built coastal fishing craft.

ii. Its wooden planks are traditionally sewn together using strong coir ropes.

iii. Its flexible construction allows it to withstand the impact of coastal waves and surf.

iv. It is generally broad, shallow and suitable for launching through surf.

v. It is traditionally associated with the Andhra Pradesh coast.

vi. It is mainly used for nearshore marine fishing.

vii. It is operated using gill nets, shore seines and other coastal fishing gears.

viii. It is mainly used to catch nearshore pelagic and demersal fishes.

ix. Its major advantage is its flexibility and ability to withstand heavy surf conditions.

x. Its limitations include slow movement, limited storage facilities and regular maintenance requirements.

PRACTICAL 8
OBSERVATION AND STUDY OF MECHANIZED AND NON-MECHANIZED FISHING BOATS

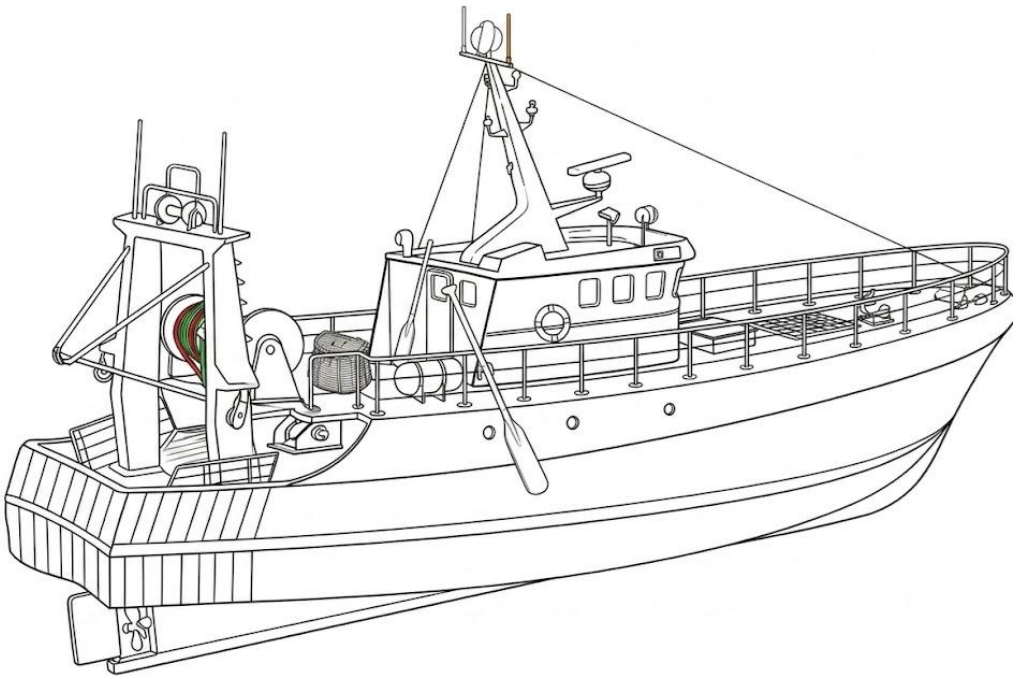
Aim

To observe and study the different types of mechanized and non-mechanized fishing boats used in fisheries.

Requirements

Models/charts/photographs of fishing boats, notebook and pencil.

A. Mechanized Fishing Boat



1. A mechanized fishing boat is fitted with an inboard or outboard engine for movement.
2. It is usually made of wood, fibre-reinforced plastic (FRP) or steel.
3. It is larger in size and can carry more fishermen, fishing gear and catch.
4. It can travel long distances and operate in deep water.
5. It is equipped with navigation and communication devices such as GPS, compass and fish finder.
6. It is mainly used for commercial fishing in rivers, reservoirs, estuaries and coastal waters.
7. It saves time and labour, covers a larger fishing area and gives higher fish production.

B. Non-Mechanized Fishing Boat

1. A non-mechanized fishing boat has no engine and is operated by paddles, oars or poles.
2. It is commonly made of wood, bamboo or fibre.
3. It is small and light in weight, making it easy to handle.
4. It is suitable for fishing in ponds, rivers, lakes and shallow water bodies.
5. It carries a small number of fishermen and simple fishing gears.
6. It is mainly used for small-scale inland fishing and transportation.
7. It is inexpensive, easy to maintain and does not require fuel.

PRACTICAL 9
STUDY OF FISH STORAGE PRACTICES, INCLUDING ICING, COLD STORAGE AND TRANSPORTATION

Aim

To study the different methods used for fish storage, including icing, cold storage and transportation.

Requirements

Fresh fish samples, crushed ice, insulated fish box (ice box), cold storage unit/freezer (model or chart), transport container, thermometer and notebook.

Procedure

A. Preservation by Icing

i. Select fresh, healthy fish and wash them thoroughly with clean water.
ii. Drain excess water from the fish.
iii. Clean the insulated fish box before use.
iv. Spread a layer of crushed ice at the bottom of the box.
v. Arrange a single layer of fish over the ice.
vi. Place another layer of crushed ice over the fish.
vii. Continue arranging alternate layers of fish and ice until the box is full.
viii. Keep a thick layer of ice on the top.
ix. Close the lid tightly and allow melted water to drain through the outlet.
x. Observe the condition of the fish after several hours.

Benefits

- Fish remained cool and fresh.
- Ice melted gradually.
- Alternate layers of fish and ice were maintained.
- Fish showed no foul smell.
- Flesh remained firm.

B. Preservation by Cold Storage

i. Wash the fresh fish with clean water.
ii. Pack the fish in clean plastic bags or trays.
iii. Label the packets if required.
iv. Place the packed fish inside a freezer or cold storage unit.
v. Maintain the temperature at −18°C or below.
vi. Observe the fish after freezing.
vii. Record the condition of the stored fish.

Benefits

- Fish became completely frozen.
- No spoilage was observed.
- Colour and shape were maintained.
- Fish remained firm.
- Storage temperature remained constant.

C. Preservation During Transportation

i. Wash the harvested fish thoroughly.
ii. Clean the insulated transport box.
iii. Place crushed ice at the bottom of the box.
iv. Arrange fish in a single layer.
v. Add another layer of crushed ice.
vi. Continue alternate layers until the box is full.
vii. Close the box tightly.
viii. Transport the fish while maintaining sufficient ice.
ix. Observe the condition of the fish after transportation.

Benefits

- Fish remained fresh during transport.
- Ice maintained a low temperature.
- No physical damage to the fish was observed.
- Fish retained their natural appearance.
- Fish reached the destination in good condition.

PRACTICAL 10
STUDY/DEMONSTRATION OF TRADITIONAL FISH PRESERVATION METHODS: DRYING, SALTING AND SMOKING

Aim

To study and demonstrate the traditional methods of fish preservation by drying, salting and smoking.

Requirements

Fresh fish, common salt, clean water, drying trays or bamboo mats, drying rack, smoking kiln/smoke chamber, firewood, knife, plastic container, gloves and weighing balance.

A. Fish Drying

Procedure

1. Select fresh fish and wash them thoroughly with clean water.
2. Remove scales, gills and internal organs if required.
3. Wash the fish again and drain excess water.
4. Spread the fish evenly on clean drying trays or bamboo mats.
5. Keep the trays under direct sunlight or in a solar dryer.
6. Turn the fish at regular intervals for uniform drying.
7. Continue drying until the fish become hard and moisture is greatly reduced.
8. Store the dried fish in clean, airtight containers.

Benefits

- Moisture content decreased gradually.
- Fish became dry, hard and light in weight.
- Characteristic dried fish odour developed.
- No fungal growth was observed.
- Dried fish could be stored for a long period.

B. Fish Salting

Procedure

1. Wash fresh fish thoroughly with clean water.
2. Remove scales and internal organs if necessary.
3. Rub common salt uniformly over the entire fish, including the body cavity.
4. Arrange alternate layers of fish and salt in a clean container.
5. Keep the container covered for 24–48 hours.
6. Drain the brine formed during salting.
7. Remove the fish and allow them to dry partially before storage.
8. Store the salted fish in airtight containers.

Benefits

- Salt removed moisture from the fish.

- Brine was formed during storage.
- Fish became firm and less moist.
- Spoilage was prevented.
- Shelf life increased.

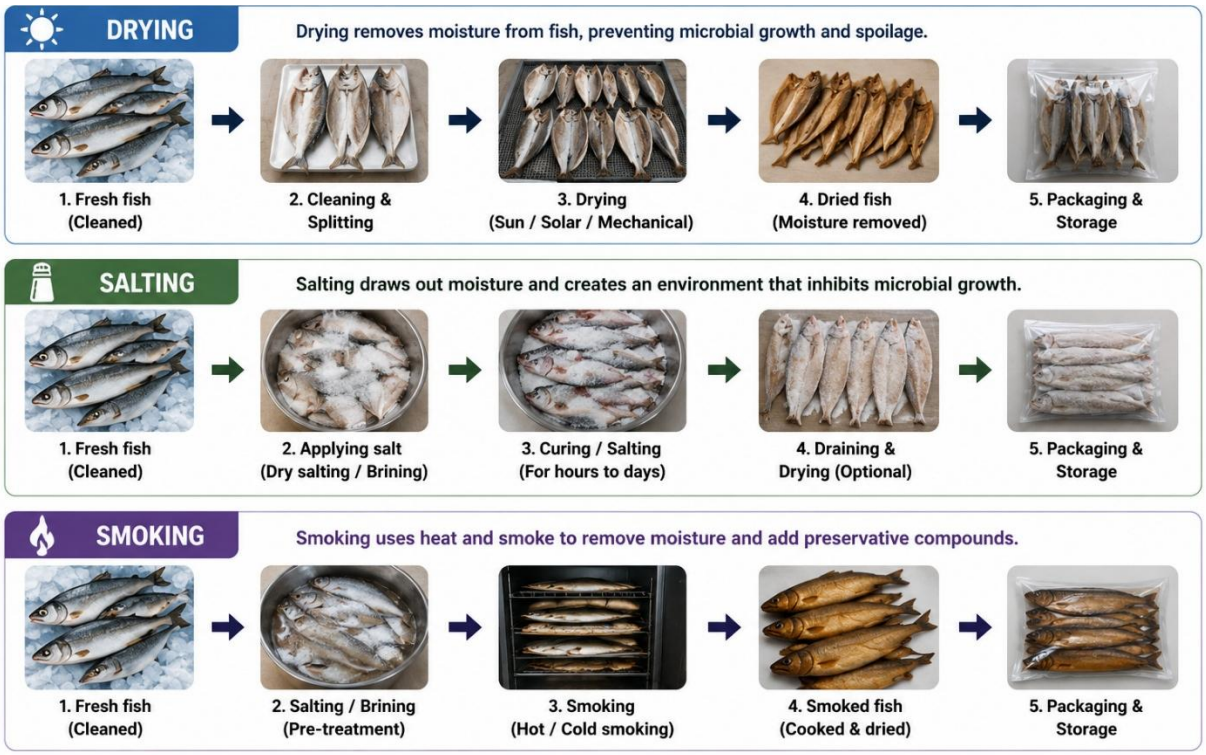
C. Fish Smoking

Procedure

1. Wash and clean the fresh fish thoroughly.
2. Remove scales and internal organs if required.
3. Drain excess water from the fish.
4. Hang or place the fish on racks inside the smoking chamber.
5. Burn hardwood or sawdust to produce smoke.
6. Maintain a moderate smoking temperature (about 60–80°C).
7. Continue smoking until the fish become dry and golden brown.
8. Cool the smoked fish and store them in clean, airtight containers.

Benefits

- Fish developed a golden-brown colour.
- A pleasant smoky flavour and odour were observed.
- Moisture content was reduced.
- Fish became firm and dry.
- Smoked fish showed improved keeping quality.



PRACTICAL 11
STUDY OF MODERN FISH PRESERVATION METHODS INCLUDING FREEZING, CANNING AND IRRADIATION

Aim

To study the modern methods of fish preservation by freezing, canning and irradiation.

Requirements

Fresh fish, freezer/cold storage unit, airtight cans, can sealer, pressure cooker/retort (model or chart), irradiation unit (chart/model), gloves and notebook.

A. Fish Freezing

Procedure

1. Select fresh fish and wash thoroughly with clean water.
2. Remove scales, gills and internal organs if required.
3. Pack the fish in clean plastic bags or trays.
4. Label the packages properly.
5. Place the fish in a freezer or cold storage unit.
6. Maintain the temperature at −18°C or below.
7. Store the fish until required for use.

Benefits

- Fish became completely frozen.
- Colour and texture remained unchanged.
- Fish remained firm after freezing. No spoilage or foul smell was observed.
- Fish could be stored for a long period.

B. Fish Canning

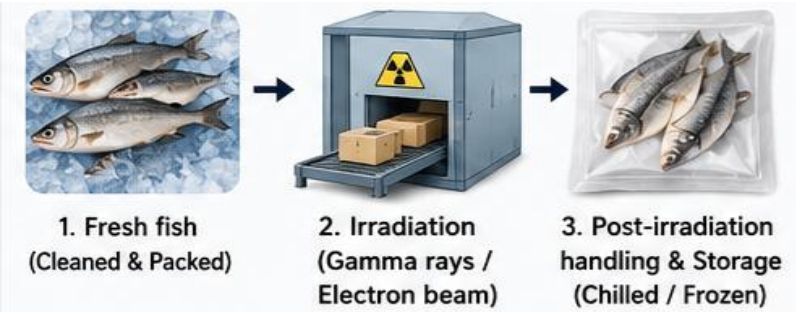
Procedure

1. Wash and clean the fresh fish thoroughly.
2. Cut the fish into suitable pieces.
3. Fill the fish pieces into clean sterilized cans.
4. Add edible oil or brine as required.
5. Seal the cans using a can sealer.
6. Sterilize the sealed cans in a retort or pressure cooker at the recommended temperature and pressure.
7. Cool the cans, label them and store in a clean, dry place.

Benefits

- Cans were tightly sealed.
- Fish remained completely enclosed inside the can.
- No leakage or swelling of cans was observed.
- Fish retained good quality after processing.
- Canned fish had a long shelf life.

C. Fish Irradiation



Procedure

1. Wash and clean the fresh fish.
2. Pack the fish in suitable food-grade packaging material.
3. Seal the packages properly.
4. Place the packaged fish in an approved irradiation chamber.
5. Expose the fish to the recommended dose of gamma rays or electron beam.
6. Remove the treated fish after irradiation.
7. Store the irradiated fish under chilled or frozen conditions.

Benefits

- Fish appearance remained almost unchanged.
- No visible damage to the fish was observed.
- Microbial growth was reduced.
- Shelf life of the fish increased.
- Fish remained safe for consumption after proper treatment.

PRACTICAL 12
STUDY AND IDENTIFICATION OF FISH PRODUCTS AND BY-PRODUCTS, INCLUDING VALUE-ADDED PRODUCTS

Aim

To identify common fish by-products based on their appearance, source and uses.

Requirements

Fish by-product specimens/models/charts, hand lens, notebook and pencil.

Procedure

1. Observe each fish by-product carefully.
2. Note its colour, shape and texture.
3. Identify the source material used for its preparation.
4. Record its major use.
5. Compare the different fish by-products and complete the observation table.

1. Fish Meal

Identification

- Brown or dark brown powder.
- Prepared from fish waste or low-value fish.
- Rich in protein.
- Has a characteristic fishy smell.
- Easy to store and transport.

Uses: Used as a protein-rich ingredient in fish feed, poultry feed and livestock feed.

2. Fish Oil

Identification

- Yellow to light brown oily liquid.
- Extracted from whole fish or fish waste.
- Rich in omega-3 fatty acids.
- Has a characteristic fishy odour.
- High nutritional value.

Uses: Used in pharmaceuticals, health supplements, aquaculture feed and cosmetic products.

3. Fish Liver Oil

Identification

- Clear yellow oil extracted from fish liver.
- Rich in Vitamins A and D.
- Smooth oily liquid.
- High medicinal value.
- Commonly obtained from cod or shark liver.

Uses: Used as a vitamin supplement, medicine and nutritional health product.

4. Fish Manure

Identification

- Brown organic material prepared from fish waste.
- Rich in nitrogen and phosphorus.
- Has a strong fish odour.
- Easily decomposes in soil.
- Environment-friendly.

Uses: Used as an organic fertilizer to improve soil fertility and crop production.

5. Fish Silage

Identification

- Thick brown liquid or semi-solid product.
- Prepared by fermenting fish waste.
- Rich in proteins and nutrients.
- Easily digestible.
- Economical feed ingredient.

Uses: Used as a protein supplement in fish, poultry and livestock feed.

6. Fish Glue (Isinglass)

Identification

- Transparent or light yellow sheets or flakes.
- Prepared mainly from fish swim bladder.
- Strong adhesive property.
- Flexible when soaked in water.
- High commercial value.

Uses: Used as a clarifying agent in beverages, adhesive and pharmaceutical product.

7. Gelatin

Identification

- Colourless or light yellow powder or sheets.
- Prepared from fish skin and bones.
- Forms a gel in warm water.
- Odourless.
- Easily soluble in warm water.

Uses: Used in food products, capsules, confectionery and pharmaceutical industries.

8. Collagen

Identification

- White powder or fibrous material.
- Extracted from fish skin, scales and bones.
- Rich in structural proteins.
- Fine texture.
- High biological value.

Uses: Used in cosmetics, health supplements, wound dressings and biomedical products.

9. Fish Leather

Identification

- Soft, flexible processed fish skin.
- Attractive natural scale pattern.
- Durable after tanning.
- Lightweight material.
- Available in different colours.

Uses: Used for making wallets, belts, handbags, shoes and decorative leather products.

10. Fish Bone Powder

Identification

- White or cream-coloured fine powder.
- Prepared from cleaned and dried fish bones.
- Rich in calcium and phosphorus.
- Fine texture.
- Easily stored.

Uses: Used as a calcium supplement in animal feed and as an organic fertilizer.

11. Fish Scale Products

Identification

- Prepared from cleaned fish scales.
- Rich in collagen.
- White or shiny appearance.
- Processed into different products.
- Valuable industrial raw material.

Uses: Used for producing collagen, gelatin, pearl essence, cosmetics and handicraft items.

12. Fish Roe and Caviar

Identification

- Small spherical, gelatinous orange, yellow, or black granules.
- Obtained during fish evisceration and seafood processing.
- High in marine phospholipids, unsaturated fatty acids, and proteins.
- Distinct savory marine taste.
- Delicate membrane texture with high moisture content.

Uses: Processed into high-value culinary products, delicacy spreads, and marine lipid extracts for cosmetics and dermatology.

PRACTICAL 13

STUDY AND IDENTIFICATION OF COMMON FISH DISEASES: BACTERIAL, VIRAL AND PARASITIC WITH BASIC PREVENTIVE MEASURES

Aim

To study and identify common bacterial, viral and parasitic diseases of fishes on the basis of their causative agents, characteristic signs and symptoms, and to understand the basic preventive measures used in aquaculture.

Requirements

Diseased fish specimens or preserved specimens, charts/photographs/models of common fish diseases, hand lens, dissecting microscope (if available), glass slides, forceps, notebook and pencil.

Principle

Fish diseases may be caused by different infectious agents, including bacteria, viruses and parasites. Disease occurrence is often associated with stress caused by poor water quality, overcrowding, inadequate nutrition and poor management. Identification of external signs and symptoms helps in the preliminary diagnosis of common diseases, while laboratory examination is required for confirmation. Good water quality, biosecurity, proper stocking and regular health monitoring are important preventive measures.

A. BACTERIAL FISH DISEASES

1. Bacterial Haemorrhagic Septicaemia / Aeromoniasis

Causative agent: *Aeromonas hydrophila* and related motile *Aeromonas* species.

Identification characters

i. Red or haemorrhagic patches may be observed on the body and fins.
ii. Skin ulcers or lesions may develop in affected fish.
iii. The fins may show damage or erosion.
iv. The abdomen may become swollen in severe cases.
v. Affected fish may show reduced feeding and abnormal swimming.
vi. Internal infection may result in septicaemia and mortality.
vii. The disease is commonly associated with stress and poor environmental conditions.
viii. It is important in freshwater aquaculture.
ix. Diagnosis should be confirmed by laboratory examination and identification of the pathogen.
x. Good pond hygiene and stress reduction are important for prevention.

Basic Preventive Measures

- Maintain good water quality and adequate dissolved oxygen.

- Avoid overcrowding and unnecessary handling stress.
- Use healthy and disease-free fish seed.
- Remove dead or severely affected fish promptly.
- Maintain proper sanitation of ponds, tanks and equipment.
- Use antibiotics only under qualified veterinary or aquatic-animal-health guidance, because indiscriminate use can contribute to antimicrobial resistance.

2. Columnaris Disease / Fin and Gill Rot

Causative agent: *Flavobacterium columnare*.

Identification characters

i. The disease commonly affects the skin, fins and gills.
ii. Whitish or pale patches may occur on the body surface.
iii. Erosion or fraying of fins may be observed.
iv. Gill damage may result in difficulty in respiration.
v. Affected fish may become weak and lethargic.
vi. Loss of appetite may occur.
vii. Skin lesions may increase in size under favourable conditions for the pathogen.
viii. Stress and poor water quality can increase susceptibility.
ix. Early detection is important to reduce disease spread.
x. Confirmation requires appropriate laboratory diagnosis.

Basic Preventive Measures

- Maintain clean and good-quality water.
- Avoid excessive stocking density.
- Provide nutritionally balanced feed.
- Quarantine newly introduced fish.
- Regularly clean and disinfect equipment where appropriate.
- Monitor fish regularly for abnormal behaviour and lesions.

B. VIRAL FISH DISEASES

1. Koi Herpesvirus Disease (KHV)

Causative agent: Koi herpesvirus, also known as cyprinid herpesvirus 3.

Identification characters

i. The disease mainly affects koi and common carp.
ii. Affected fish may become lethargic and show reduced feeding.
iii. Gill damage may be observed.
iv. Respiratory distress may occur in severely affected fish.

v. Excess mucus production may be present.
vi. Skin abnormalities may occur in some affected fish.
vii. Disease outbreaks may result in high mortality.
viii. The disease can spread through movement and contact with infected fish.
ix. External symptoms alone are not sufficient for definite diagnosis.
x. Laboratory tests are required for confirmation of viral infection.

Basic Preventive Measures

- Obtain fish from reliable and disease-monitored sources.
- Quarantine newly introduced fish before stocking.
- Avoid mixing unknown or potentially infected stocks.
- Maintain proper biosecurity and sanitation.
- Avoid unnecessary movement of fish between culture units.
- Report unusual or severe mortality to an aquatic animal health specialist.

2. Lymphocystis Disease

Causative agent: Lymphocystis virus.

Identification characters

i. The disease produces visible wart-like or cauliflower-like nodules on the skin or fins.
ii. The growths may be white, cream or pale in colour.
iii. Individual lesions may vary in size.
iv. Affected fish may show an altered external appearance.
v. The disease is caused by a virus affecting fish tissues.
vi. Severe lesions may interfere with normal appearance and market value.
vii. Stress may increase susceptibility to disease.
viii. Infected fish may act as a source of infection.
ix. Diagnosis should be confirmed through appropriate laboratory methods.
x. Prevention depends mainly on good biosecurity and healthy stock management.

Basic Preventive Measures

- Use healthy, screened or monitored stock.
- Quarantine newly introduced fish.
- Avoid overcrowding and stress.
- Maintain good water quality and nutrition.
- Prevent mixing of diseased and healthy fish.
- Clean and disinfect culture equipment according to approved farm practices.

C. PARASITIC FISH DISEASES

1. White Spot Disease (Ichthyophthiriasis)

Causative agent: *Ichthyophthirius multifiliis*.

Identification characters

i. Small **white spots** are visible on the skin, fins and sometimes gills.
ii. The spots may resemble grains of salt on the body surface.
iii. Affected fish may rub or scratch against surfaces.
iv. Excess mucus secretion may occur.
v. Fish may show irritation and restlessness.
vi. Severe gill infection may cause respiratory difficulty.
vii. Feeding activity may decrease.
viii. Heavy infection may cause weakness and mortality.
ix. The parasite can spread rapidly under favourable conditions.
x. Microscopic examination helps in confirming the parasite.

Basic Preventive Measures

- Quarantine newly introduced fish.
- Maintain good water quality.
- Avoid overcrowding.
- Clean and disinfect tanks and equipment according to approved practices.
- Regularly observe fish for early signs of infection.
- Seek expert advice for parasite-specific treatment and approved dosage.

2. Argulosis (Fish Louse Infestation)

Causative agent: *Argulus* species.

Identification characters

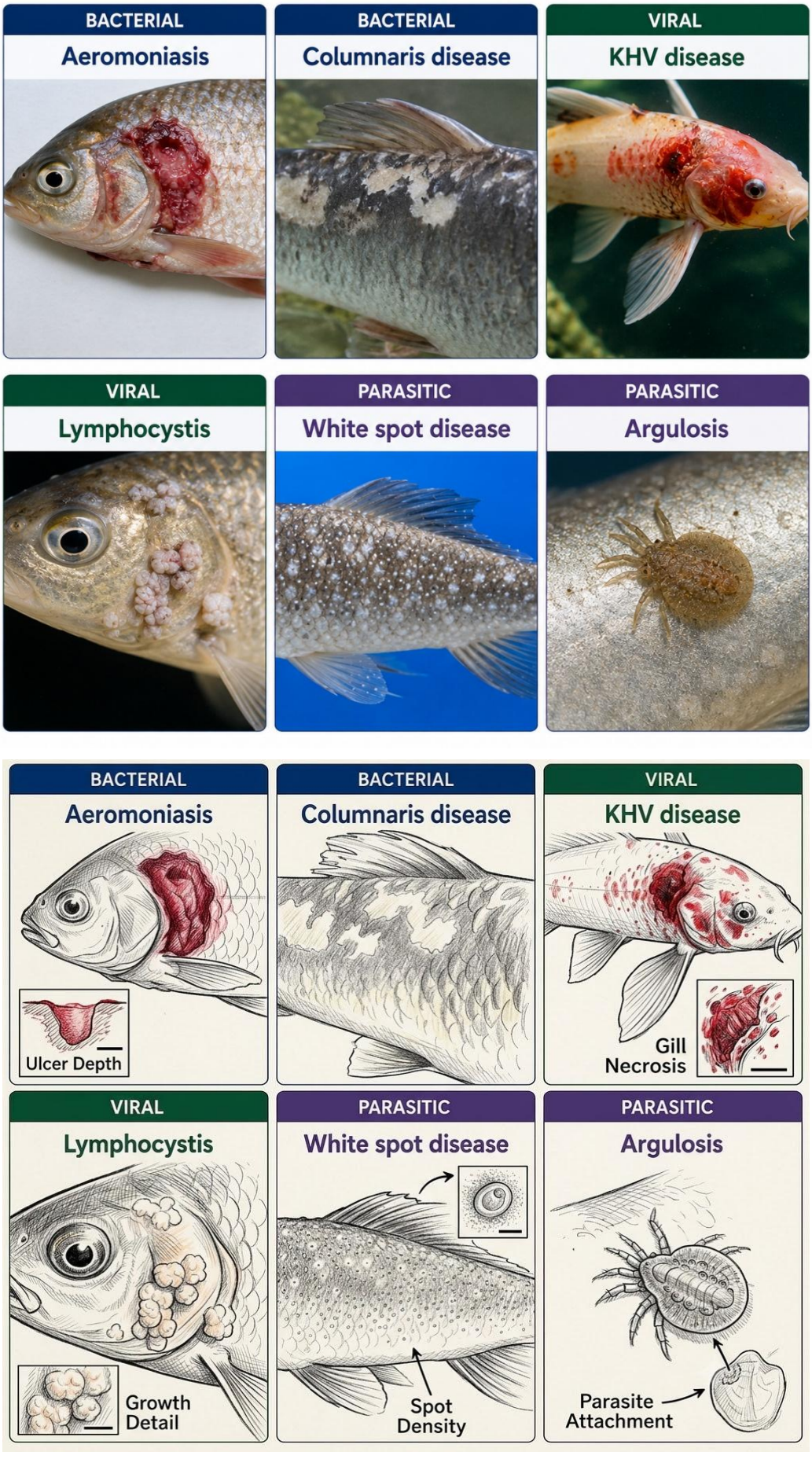
i. *Argulus* is commonly known as the fish louse.
ii. It is an external crustacean parasite.
iii. The parasite attaches to the skin or fins of the fish.
iv. Affected fish may show irritation and abnormal swimming.
v. Fish may rub their body against objects.
vi. Small red or inflamed areas may develop at attachment sites.
vii. Excess mucus may be produced.
viii. Severe infestation may cause weakness and reduced growth.
ix. Secondary infections may develop at damaged sites.
x. The parasite can be identified by careful external examination and microscopic observation.

Basic Preventive Measures

- Use healthy fish seed from reliable sources.
- Quarantine new fish before introduction.
- Avoid transferring infected fish or contaminated equipment.
- Maintain proper pond and tank sanitation.
- Monitor fish regularly for external parasites.
- Follow approved parasite-control methods under expert guidance.

Observation Table

Sr. No.	Type of Disease	Common Disease	Causative Agent	Major Signs/Symptoms	Basic Prevention
1	Bacterial	Aeromoniasis	*Aeromonas* spp.	Haemorrhage, ulcers, weakness	Good water quality and sanitation
2	Bacterial	Columnaris disease	*Flavobacterium columnare*	Skin lesions, fin/gill damage	Reduce stress and maintain hygiene
3	Viral	KHV disease	Koi herpesvirus	Gill damage, lethargy, mortality	Quarantine and biosecurity
4	Viral	Lymphocystis	Lymphocystis virus	Cauliflower-like nodules	Healthy stock and isolation
5	Parasitic	White spot disease	*Ichthyophthirius multifiliis*	White spots, irritation	Quarantine and good management
6	Parasitic	Argulosis	*Argulus* spp.	Visible parasites, irritation	Healthy seed and sanitation


BACTERIAL
Aeromoniasis
BACTERIAL
Columnaris disease
VIRAL
KHV disease
VIRAL
Lymphocystis
PARASITIC
White spot disease
PARASITIC
Argulosis
BACTERIAL
Aeromoniasis
Ulcer Depth
BACTERIAL
Columnaris disease
VIRAL
KHV disease
Gill
Necrosis
VIRAL
Lymphocystis
Growth
Detail
PARASITIC
White spot disease
Spot
Density
PARASITIC
Argulosis
Parasite
Attachment

PRACTICAL 14

SURVEY / VISIT TO A FISH MARKET TO STUDY SPECIES DIVERSITY

Fish Market Survey Report Format

1. Title of Practical:

Survey / Visit to a Fish Market to Study Species Diversity

2. Name and Address of Fish Market:

3. Date of Visit:

4. Time of Visit:

5. Objectives

- To observe the various species of fish, crab, crustacean available in the market.
- To identify freshwater and marine fishes.
- To study the diversity of fish, crab, crustacean species sold in the market.

6. Methodology

The fish market was visited, and different fish species displayed for sale were observed. The fishes, crabs, crustaceans were identified using their common and scientific names. Information regarding their habitat (freshwater/marine), approximate size and market price was collected through observation and interaction with fish vendors.

7. Observation Table

Sr. No.	Common Name	Scientific Name	Freshwater / Marine	Approx. Size (cm)	Price (₹/kg)	Availabilty (Common/ Rare)	Presrvation Type (Live/ Icing/ Salting/ Sun-dried/Other)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

8. General Observations

- Total number of fish species observed: _____
- Total number of crab and crustaceans species observed: _____
- Number of freshwater species: _____
- Number of marine species: _____
- Most abundant species: _____
- Most expensive fish: _____
- Cheapest fish: _____
- Most preferred fish by consumers: _____

9. Market Infrastructure and Observations

Sr. No.	Observation Parameter	Details to Observe	Student Observation
1	**Preservation**	Crushed/block ice, refrigeration and live-storage facilities	_____
2	**Handling**	Fish display, cleaning, weighing and handling practices	_____
3	**Supply**	Source and transportation method of marine and freshwater fishes	_____
4	**Dry Fish**	Availability of salted, dried and other processed fish products	_____
5	**By-products**	Collection and utilization of gills, viscera, scales, bones and swim bladders	_____
6	**Hygiene**	Cleanliness of floor, display surfaces, drainage and waste disposal	_____
7	**Infrastructure**	Water supply, drainage, electricity, storage and weighing facilities	_____

10. Conclusion

The fish market survey was conducted successfully. Different fish, crab, crustacean species were identified, and their diversity, habitat and market availability were studied. The visit provided practical knowledge about fish, crab, crustacean biodiversity and fish marketing.

11. Result

The fish market was surveyed successfully, and the diversity of fish, crab, crustacean species available in the market was studied and recorded.

PRACTICAL MANUAL OF AQUACULTURE AND FISHERIES

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