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DEPARTMENT OF AQUACULTURE

UG COURSE

SMESTER -I

PAPER- 1 BASIC PRINCIPLES OF AQUACULTURE

1. Estimation of Carbonates, Bicarbonates in water samples

AIM:

To estimate the concentration of carbonates (CO_3^{2-}) and bicarbonates (HCO_3^-) in water samples, you can perform a titration using a strong acid, typically hydrochloric acid (HCl). This process is usually divided into two stages, where the endpoint pH indicates the completion of each reaction. Here's a step-by-step outline of the procedure:

Materials Needed

- Water sample
- Hydrochloric acid (HCl) solution (standardized, typically 0.1 N)
- Methyl orange indicator
- Phenolphthalein indicator
- Burette
- Pipette
- Erlenmeyer flask

Procedure

1. Preparation

1. **Collect Water Sample:** Collect the water sample to be tested.
2. **Prepare Titrants:** Ensure you have a standardized HCl solution ready.

S.no	Volum of sample	burette reading		x=b-a	Y=c-a
		Initial	Final		
1					
2					
3					

2. Determination of Carbonates

1. **Add Phenolphthalein Indicator:**
   - Take 50 mL of the water sample in an Erlenmeyer flask.
   - Add 2-3 drops of phenolphthalein indicator. If the solution turns pink, carbonates are present.
2. **Titrate with HCl:**
   - Titrate the sample with standardized HCl until the pink color just disappears. This is the phenolphthalein endpoint.
   - Record the volume of HCl used (V_1).

The reaction at the phenolphthalein endpoint is: CO32−+2HCl→H2O+CO2+2Cl−\text{CO}_3^{2-} + 2\text{HCl} \rightarrow \text{H}_2\text{O} + \text{CO}_2 + 2\text{Cl}^-CO32−+2HCl→H2O+CO2+2Cl−

3. Determination of Bicarbonates

1. **Add Methyl Orange Indicator:**
   - Add 2-3 drops of methyl orange indicator to the same sample.
   - The solution will turn yellow if bicarbonates are present.
2. **Continue Titration:**
   - Continue titration with HCl until the solution turns from yellow to orange or light pink. This is the methyl orange endpoint.
   - Record the additional volume of HCl used (V_2).

The reaction at the methyl orange endpoint is: HCO3−+HCl→H2O+CO2+Cl−\text{HCO}_3^- + \text{HCl} \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{Cl}^-HCO3−+HCl→H2O+CO2+Cl−

Calculations

1. **Calculate the Concentration of Carbonates:**

Concentration of CO32−=V1×N×50Volume of Sample\text{Concentration of CO}_3^{2-} = \frac{V_1 \times N \times 50}{\text{Volume of Sample}}Concentration of CO32−=Volume of SampleV1×N×50

2. **Calculate the Concentration of Bicarbonates:**

Concentration of HCO3−=(V2−V1)×N×50Volume of Sample\text{Concentration of HCO}_3^- = \frac{(V_2 - V_1) \times N \times 50}{\text{Volume of Sample}}Concentration of HCO3−=Volume of Sample(V2−V1)×N×50

Where:

- V1V_1V1 = Volume of HCl used to reach the phenolphthalein endpoint.
- V2V_2V2 = Total volume of HCl used to reach the methyl orange endpoint.
- NNN = Normality of HCl solution.
- Volume of Sample = Initial volume of the water sample used (usually 50 mL).

2. Estimation of dissolved oxygen

AIM:

The estimation of dissolved oxygen (DO) in water samples is commonly performed using the Winkler titration method. This method involves a series of chemical reactions that convert the dissolved oxygen into an easily titratable form. Here is a step-by-step procedure for the Winkler method:

Materials Needed

- Water sample
- Manganous sulfate ($MnSO_4$) solution
- Alkaline potassium iodide (KI) solution
- Concentrated sulfuric acid (H_2SO_4)
- Sodium thiosulfate ($Na_2S_2O_3$) solution (standardized, typically 0.025 N)
- Starch indicator solution
- Burette
- Pipette
- Glass-stoppered bottles (BOD bottles)

Procedure

1. Sample Collection

1. **Collect Water Sample:**
   - Collect the water sample in a BOD bottle without introducing air bubbles to avoid contamination with atmospheric oxygen.
   - Fill the bottle completely and ensure no air space remains.

2. Fixation of Dissolved Oxygen

1. **Add Manganous Sulfate:**
   - Add 2 mL of manganous sulfate solution to the water sample using a pipette. Insert the pipette below the surface of the water to prevent introducing air.
2. **Add Alkaline Potassium Iodide:**
   - Add 2 mL of alkaline potassium iodide solution in the same manner. This will form a precipitate of manganese hydroxide.
3. **Mix the Sample:**
   - Stopper the bottle carefully, ensuring no air bubbles are trapped.
   - Mix the contents thoroughly by inverting the bottle several times.
4. **Add Sulfuric Acid:**
   - Add 2 mL of concentrated sulfuric acid to the sample.
   - Restopper the bottle and mix thoroughly until the precipitate dissolves, forming a clear brownish solution.

3. Titration

S.no	Volum of sample	Initial V_1	Final V_2	Hypo used(H=V_2-V_1
1				
2				
3				

1. **Transfer to Titration Flask:**
   - Transfer a portion of the fixed sample to a clean titration flask.
2. **Titrate with Sodium Thiosulfate:**
   - Titrate with standardized sodium thiosulfate solution until the solution turns pale yellow.
3. **Add Starch Indicator:**
   - Add a few drops of starch indicator solution. The solution will turn dark blue.
4. **Continue Titration:**
   - Continue titration with sodium thiosulfate until the blue color just disappears,

Calculation

1. **Calculate the Dissolved Oxygen Concentration:**

Dissolved Oxygen (mg/L)=(V×N×8×1000)Volume of Sample (mL)\text{Dissolved Oxygen (mg/L)} = \frac{(V \times N \times 8 \times 1000)}{\text{Volume of Sample (mL)}}Dissolved Oxygen (mg/L)=Volume of Sample (mL)(V×N×8×1000)

Where:

- VVV = Volume of sodium thiosulfate used (mL)
- NNN = Normality of sodium thiosulfate solution
- 8 = Milliequivalent weight of oxygen (based on the equivalent weight of 1/4 mole O_2)

Notes

- Ensure all reagents are freshly prepared and standardized.
- Perform the titration immediately after fixation to prevent any changes in the oxygen concentration.
- Conduct the procedure in a location free from drafts and direct sunlight to avoid changes in temperature and oxygen concentration.

By following these steps, you can accurately determine the dissolved oxygen content in water samples, which is crucial for assessing water quality and aquatic health.

3. Study of Algal Blooms and Their Control

Introduction

Algal blooms are rapid increases in the population of algae in aquatic systems, often resulting in a colored scum on the surface of water. They can have detrimental effects on water quality, aquatic life, and human health. Understanding the causes, effects, and control measures for algal blooms is essential for maintaining healthy aquatic ecosystems.

Causes of Algal Blooms

1. **Nutrient Enrichment (Eutrophication):**
   - Excess nutrients, especially nitrogen and phosphorus, from agricultural runoff, sewage, and industrial discharges stimulate algal growth.
2. **Light Availability:**
   - Increased light penetration due to clear water or seasonal changes enhances photosynthesis in algae.
3. **Temperature:**
   - Warmer water temperatures can accelerate algal growth rates.
4. **Hydrology:**
   - Stagnant or slow-moving water bodies support algal accumulation.
5. **pH and CO_2:**
   - Algae thrive in specific pH ranges and CO_2 availability.

Types of Algal Blooms

1. **Cyanobacteria (Blue-Green Algae):**
   - Can produce toxins harmful to humans and animals.
2. **Dinoflagellates:**
   - Responsible for red tides, which can be toxic and lead to fish kills.
3. **Diatoms:**
   - Often form brownish blooms; some species can produce domoic acid, a neurotoxin.

Effects of Algal Blooms

1. **Oxygen Depletion:**
   - Decomposition of dead algae consumes dissolved oxygen, leading to hypoxia or anoxia, which can cause fish kills.
2. **Toxin Production:**
   - Some algae produce toxins that can harm aquatic life, animals, and humans.
3. **Aesthetic and Recreational Impact:**
   - Algal blooms can produce unpleasant odors, taste, and appearance, affecting recreational activities and drinking water quality.
4. **Ecosystem Disruption:**
   - Dense blooms block sunlight, affecting submerged vegetation and altering food webs.

Monitoring and Assessment

1. **Water Sampling:**
   - Regular collection of water samples to analyze nutrient levels, algal species, and concentrations.
2. **Remote Sensing:**
   - Use of satellite imagery and aerial photography to detect and monitor bloom extents and patterns.
3. **In Situ Sensors:**
   - Deployment of sensors to measure parameters like chlorophyll-a, turbidity, dissolved oxygen, and temperature.
4. **Microscopic Examination:**
   - Identification of algal species through microscopic analysis of water samples.

Control Measures

1. **Nutrient Management:**
   - Reducing nutrient inputs through agricultural best practices, wastewater treatment upgrades, and controlled use of fertilizers.
2. **Chemical Control:**
   - Use of algaecides like copper sulfate, though this method can have ecological side effects and is often a short-term solution.
3. **Biological Control:**
   - Introduction of algal predators or competitors, such as certain fish species or other microorganisms.
4. **Physical Control:**
   - Aeration to increase oxygen levels and circulation, shading to reduce light availability, and manual removal of algal mats.
5. **Policy and Regulation:**
   - Implementation of regulations to control nutrient loading from agricultural and industrial sources.

Case Studies and Examples

1. **Lake Erie:**
   - Known for severe cyanobacterial blooms, primarily driven by agricultural runoff. Efforts include nutrient management strategies and public awareness campaigns.
2. **Chesapeake Bay:**
   - Faces eutrophication and hypoxia issues due to nutrient loading. Measures include watershed management and riparian buffer restoration.
3. **Florida Red Tides:**
   - Caused by Karenia brevis, leading to fish kills and respiratory issues in humans. Management involves monitoring and bloom prediction models.

Future Directions

1. **Research and Innovation:**
   - Continued research on algal bloom dynamics, genetic studies of harmful algae, and development of more effective control technologies.
2. **Integrated Water Resource Management:**

- Holistic approaches combining land use planning, sustainable agricultural practices, and advanced wastewater treatment.

3. **Public Education and Engagement:**
    - Raising awareness about the causes and impacts of algal blooms and promoting community involvement in prevention efforts.

By comprehensively understanding and addressing the causes and effects of algal blooms, effective control and mitigation strategies can be developed and implemented to protect water quality and aquatic ecosystems.

5. Types of Shrimp Pond Aerators and Their Functions

A shrimp pond aerator is one of the main components in aquaculture, especially in intensive and super-intensive ponds. An aerator is a tool that serves to dissolve free oxygen into pond water.

The existence of a water wheel and other supporting equipment for shrimp growth in aquaculture is intended so that ponds can become a comfortable ecosystem for shrimp growth. So that shrimp can grow optimally.

Shrimp pond aerator functions to create aeration. Aeration is a process of increasing the oxygen content in the aquatic environment to ensure that the organisms that live in it get an adequate supply of oxygen and live healthily.

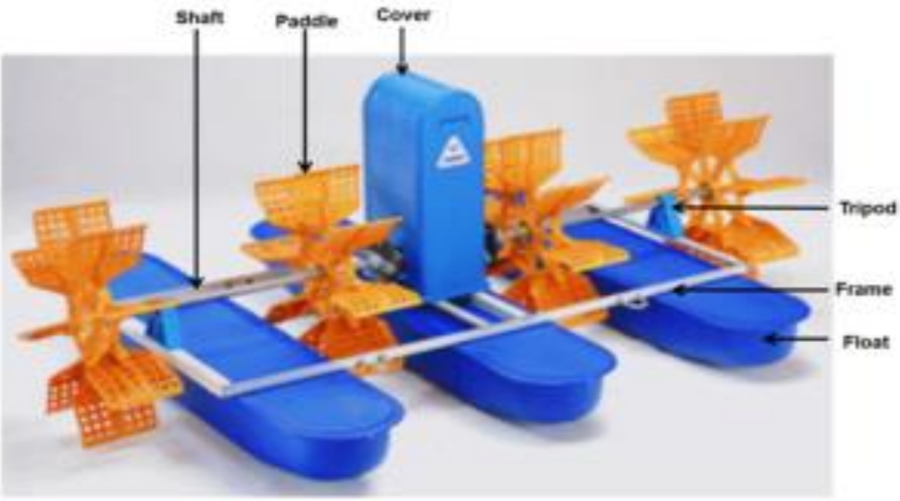
In this article, let's discover the types of waterwheels commonly used in shrimp ponds and their functions!

The Function of the Shrimp Pond Aerator

1. Increasing the supply of oxygen in the water stabilizes the biological processes of shrimp.
2. Ensuring the shrimp get an adequate supply of dissolved oxygen
3. Improve the quality of the water where shrimp live.
4. Helps distribute nutrients and feed evenly into the pond.
5. Make it easier for pond bottom manure to be directed to the disposal center so that the pond bottom is easier to clean.

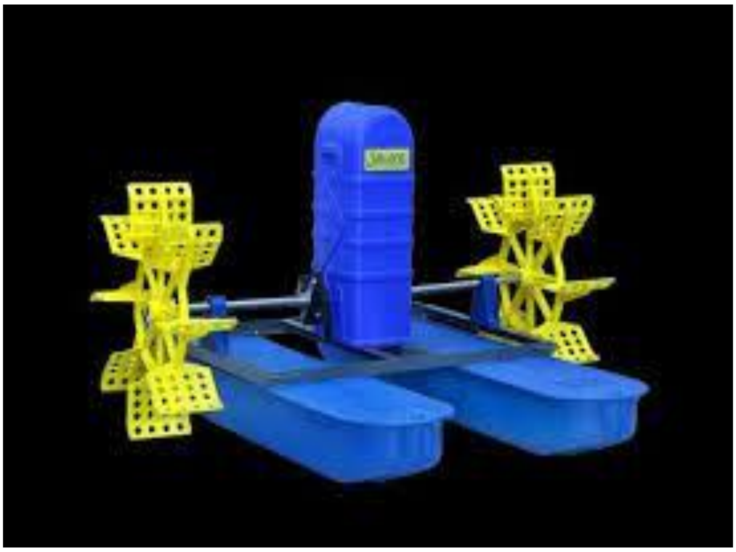
Types of Pond Aerators

1. Pond Waterwheel with Paddle Wheel



In terms of performance, the paddle-wheel water wheel is the most effective aerator on the pond surface. The parts consist of a frame, motor, float, clutch, deceleration engine, bearings, and paddle wheel.

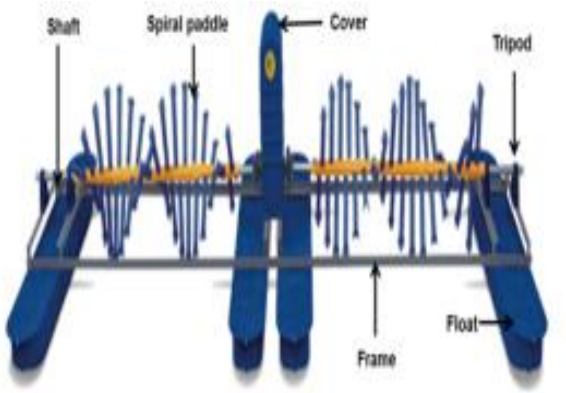
This waterwheel works by splashing water into the air and capturing oxygen to increase the DO content. The more bubbles produced, the more oxygen is captured.



2. Spiral Aerators

A spiral aerator is an improvised form of a paddle-wheel water wheel, the difference being the shape of the wheels. As the name suggests, this aerator wheel is spiral. In addition, there are several other differences, such as reducing the gearbox or reducer, handle, and connecting shaft.

Meanwhile, in terms of how it works, spiral aerators also sprinkle water into the air to capture oxygen. However, it gets many more bubbles than a regular paddle wheel waterwheel.



3. Pump Sprayer Aerator

A pump aerator is a type of aerator that works by drawing water into a vertical tube and then sprinkling it into the air to capture oxygen. The water will be deflected radially and then fall back to the surface in an umbrella-like pattern.

This type of aerator is widely chosen because it does not require much special care. However, its use can only reach a small area, while it needs to be optimal in large sizes.

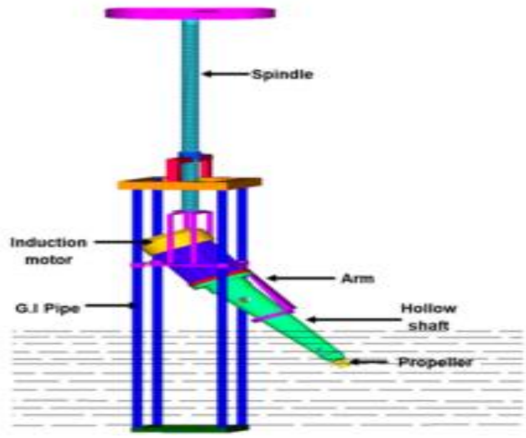
In-use pump aerators are usually used in small ponds or can also be used in large ponds but in combination with other types of aerators.

4. Vertical Pump Aerator

A vertical pump aerator has the same working principle as a pump aerator, which is to draw water into the pump tube and then sprinkle it into the air.

Vertical pump aerators are more suitable for small ponds up to 0.25 Ha because the splash produced by this aerator is not as big as a waterwheel. Meanwhile, the capacity ranges from 1 kW to more than 50 kW.

5. Jet Aerators



The jet aerator consists of a shrimp pond water wheel composed of a frame, air suction pipe, propeller, and driving motor. Unlike other types of aerators, the propellers of this aerator are in the water.

The way it works starts with a propeller rotating in the water and sucking in air from outside the pool through a pipe. After the air is sucked in and enters the water, bubbles will appear, indicating that the oxygen supply is starting to enter.

Long arm aerators

Aquaculture activity is increasing day by day throughout the word. To develop Aquaculture, we require good soil, good water source & electricity. To overcome the issue of unavailability of electricity, we developed this long arm aerator which can work with diesel engine.

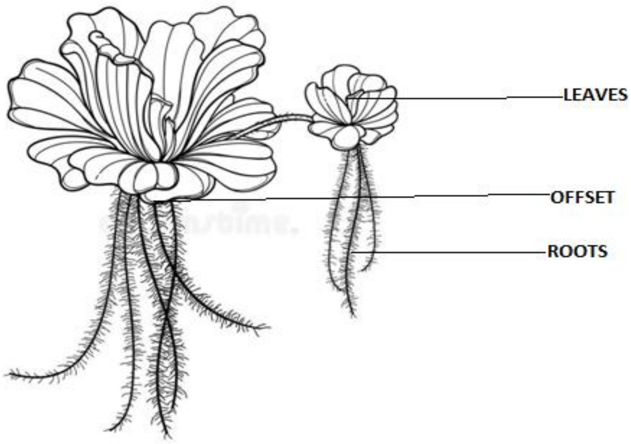
Some times pond size extra large and we cannot be able to create enough oxygen and water current by regular Paddle Wheel Aerator, while this 8 Paddle Long Arm Aerator can give good oxygen as well as good water current also. We create proper alignment for this Long Arm Aerator by use proper parts like Assamble Impeller, HDPE Floats. So, we get proper water current and more oxygen as Paddle Wheel Aerator. By proper parts of Long Arm Aerator we get minimum power loss compare to other Long Arm Aerator.

6. Collection and study of aquatic weeds

PISTIA

(water cabbage, water lettuce)

Clade:	Angiosperms
Clade:	Monocots
Order:	Alismatales



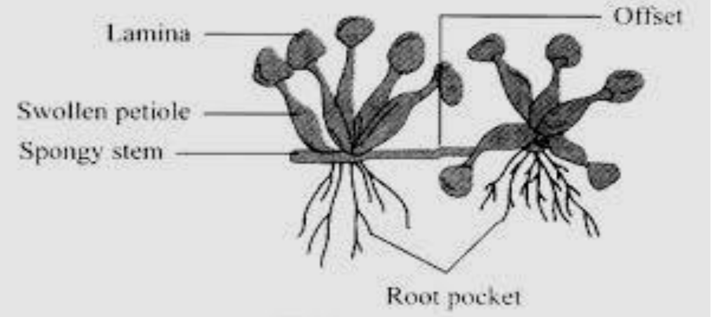
PISTIA

- Pistia stratiotes is a perennial monocotyledon with thick, soft leaves that form a rosette.
- It floats on the surface of the water, its roots hanging submersed beneath floating leaves.
- The leaves can measure 2 – 15 cm long and are light green, with parallel venations and wavy margins.
- The surface of the leaves is covered in short, white hairs which form basket-like structures that can trap air bubbles and increase the plant's buoyancy.
- The spongy parenchyma with large intercellular spaces in the leaves also aids the plant in floating.
- The flowers are dioeciously, lack petals, and are hidden in the middle of the plant amongst the leaves.
- Pistoia steatites are found in slow-moving rivers, lakes, and ponds.

The species also require slightly acidic water in the pH range of 6.5 - 7.2 for optimal growth.

Eichhornia

Phylum : Magnoliophyta
Class: Liliopsida
Order : Liliales
Family: Pontederiaceae



Eichhornia **showing offset**

IDENTIFICATION POINTS

- Exotic, introduced from Brazil
- Multiplies rapidly
- Present in stagnant water bodies and slow moving rivers
- Leaves broad, swollen at the base of the leaf stock, filled with air – aides in floating
- Flowers purplish pink
- On plant can give rise to 1000-1200 in 4 months
- Forms fodder
- Used for breeding gold fish and common carp

Ottelia

Family:	Hydrocharitaceae
Genus:	Ottelia
Species:	**O. alismoides**

- It is common attached and sub merged hydrophytee growing in shallow stagnant water.
- Steam: precluded and propagates by stones.
- Leaves are radical some are sub merged and others that near the surface of water
- Lower leaves are narrow and elliptical upper leaves are round and cordite with many margin.
- Roots are adventitious types.

Nymphea

Scientific name: Nelumbo

Family: Nelumbonaceae

Order: Proteales

Kingdom: Plantae

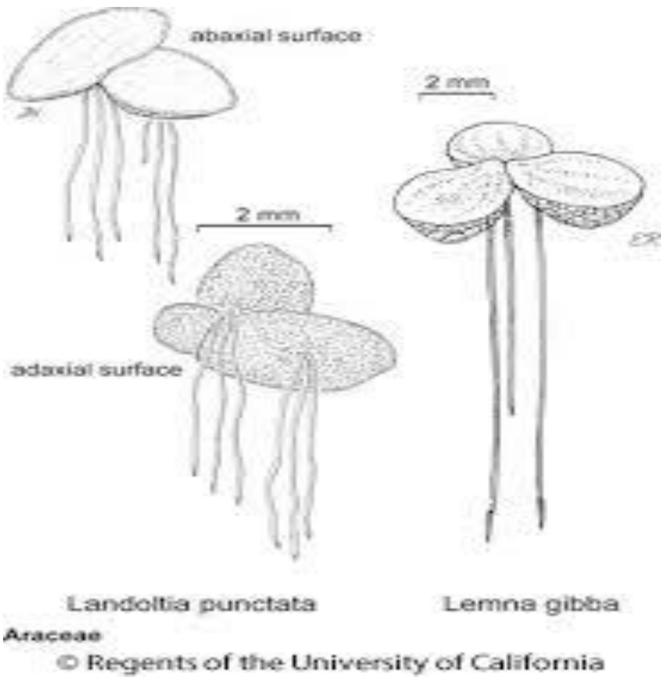
IDENTIFICATION POINTS

- Perennial, found in stagnant waters
- Leaves raised about water surface
- Diameter 60-90cm
- Leaf margins upturned
- Petiole attached to middle of each blade
- Large flowers pinkish red in colour

LEMNA

class: monocotyledon

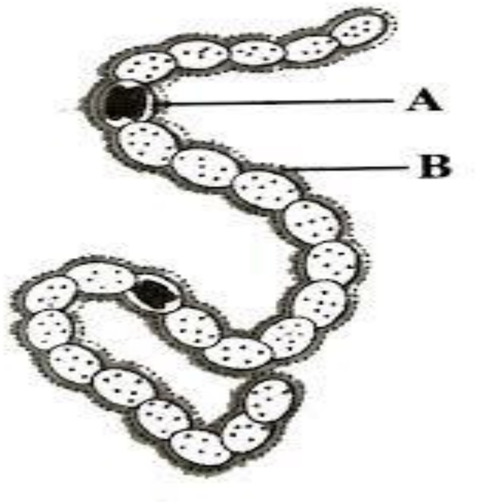
family: lemnaceae



Identification points:

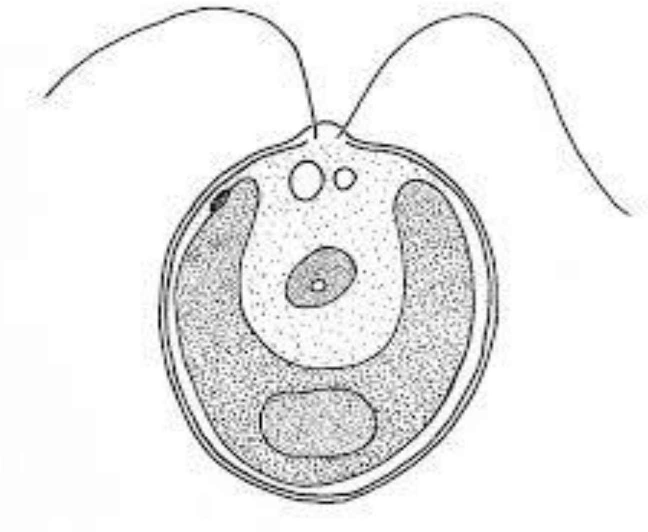
- Common name duck weed
- These are small, free floating, gregarious hydrophytes found in ponds and pools of still water.
- The plan t body shows no distinction of steam and leaves it look life thallus.
- Leaves light green in colour, floating ,scale like fronds
- Roots are un branched and hair less.
- Each root possesses a smooth root pocket or root sheath.

Nostoc



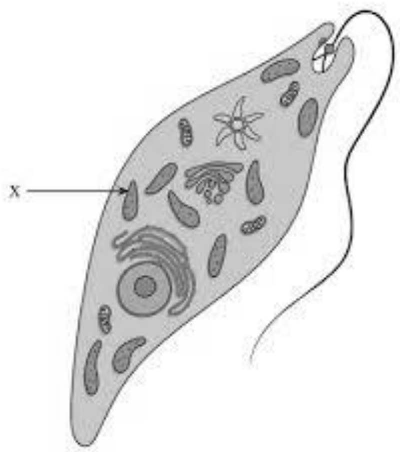
- Nostoc occurs in ball like masses in the water
- The balls of the plant body look bluish or brownish and may attain the size of hen’s eggs
- Each filament has its own mucilaginous sheath
- Each filament is made of rounded or Mimili form cells with intercalary heterocyst’s
- Heterocysts perform different functions fragmentation, strage and propagation.

CHLAMYDOMONOUS



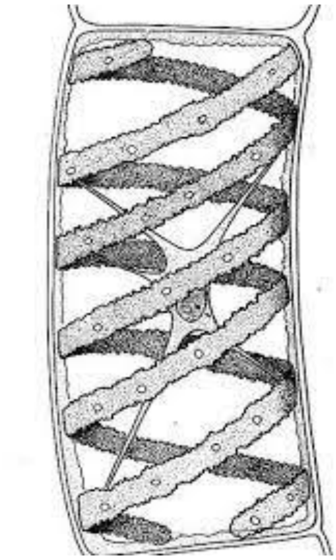
- It is a free swimming organism found in fresh water
- It is more or less pear shaped with a cellulose cell wall
- A pair of flagella of equal size is present at the anterior end
- A red eye spot is present
- A single nucleus lies in the colour less cytoplasm filling the cup shape chloroplast

EUGLENA



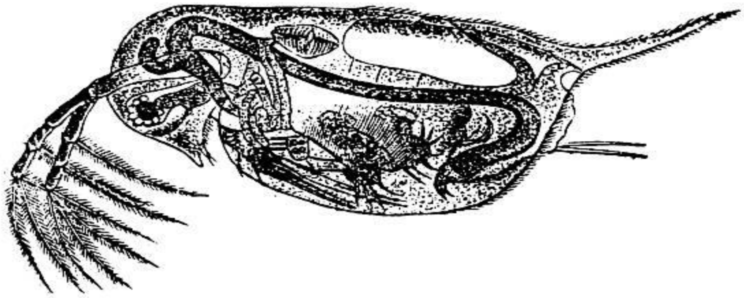
- Body is spindle shaped covered with pellicle,
- single with like flagella at the anterior part large
- sphericical nucleus towards the posterior part of body.
- Chromatiphores, paramycium bodies, contractile vacuales are present in endoplasam.

SPIROGYRA



- The filaments is green, unbranched and ribbon shaped
- The filament is multicellular cells in filament are cylindrical, longer than breath.
- The cell wall is composed of two layers – an inner cellulose and an outer pectin
- One to many spirally coiled ribbon shaped chloroplasts are present in each cell.
- Cells are uninucleate.
- Nucleus is suspended by protoplasmic threads.

DAPHNIA



- Generally called water flea
- Body is long , oval, soft laterally compressed ,transparent, enclosed in a bivalve shell.
- Head small depressed, antennules small eye is prominent.

VOLVOX

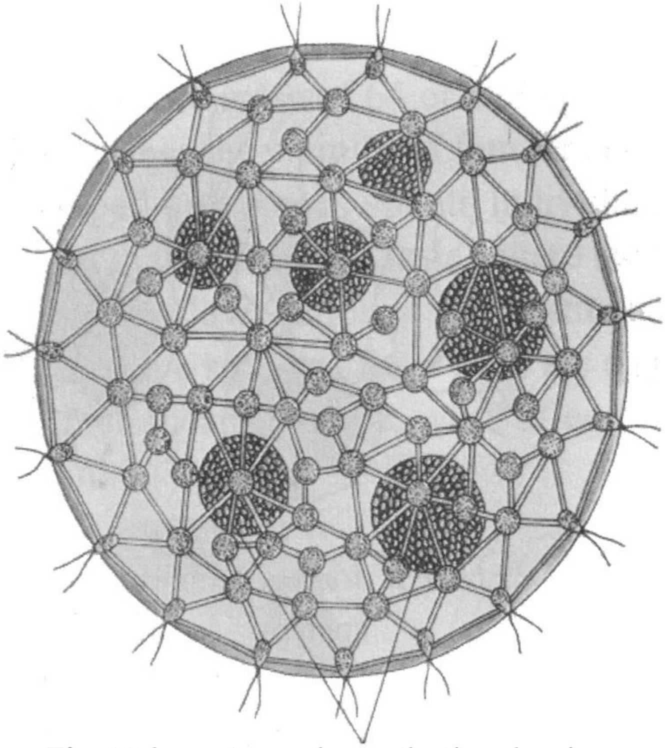
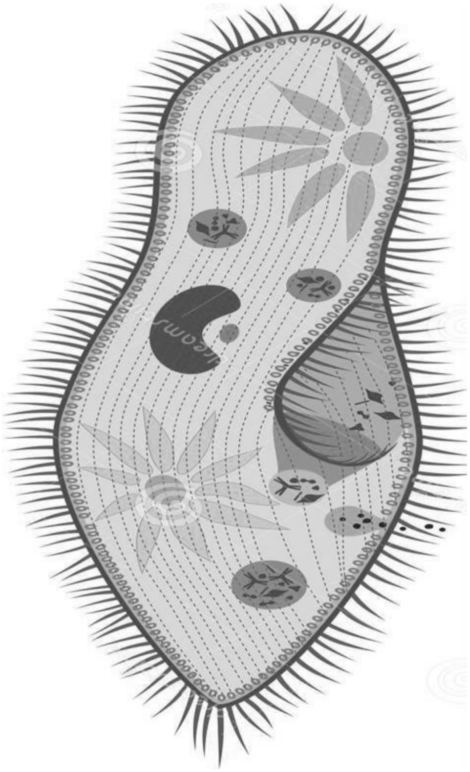


Fig: *Volvox.* Asexual reproduction showing daughter colonies.

- Volvox is a large , spherical, colonial , colonial ferm
- Body coverd with cellulose
- Colony with many individuvals or zooids
- Peripheral cells with flagella.

Paramecium



- Generally called slipper animalcule
- Body covered by pellicle and cilia are covered totally
- Two contractile vacuoles are present on either side of the body
- Small micro nucleus , bear sheped micronucleus are present
- At the posterior end a group of cilia are present.