Exercise 16

Aim: To determine the water-holding capacity of soils

Principle: Water holding capacity of the soil is the amount of water retained in the capillary spaces of the soil after the percolation of gravitational water into the deeper layers. Water holding capacity depends upon the capillary pore spaces in the soil. Sandy soil has very low water holding capacity, whereas clayey soils have very high water holding capacity.

Requirement: Soil samples from different sites (garden, road side, bank of river, paddy field etc.), Gooch crucible (china clay crucible with perforated bottom), filter-paper, pestle and mortar, petridish, beaker, glass rod, balance and blotting paper

Procedure

(i) Dig a small pit about 10cm x 10cm x 10cm, Scoop 100–300 g of soil from the pit and collect it in a small polythene bag.

(ii) Remove the pebbles and large lumps from the soil sample.

(iii) Pass the soil through a coarse sieve to remove small lumps and dead decaying leaves and twigs.

(iv) Spread the soil into a thin layer on a sheet of blotting paper or old newspaper and sun dry it for 2–3 hours or dry it in a pan kept on stove. Alternatively dry the soil sample in oven at 108^0C for 1 hour.

(v) With the help of pestle and mortar grind the sample into fine powder.

(vi) Put a small disc of blotting paper at the base of the Gooch crucible. Weigh the crucible along with the blotting paper and note its weight.

(vii) Transfer the soil sample into the crucible. Tap the rim of the crucible gently several times with the help of glass rod so that soil is compactly filled and forms a uniform layer at the top. Add more soil if necessary.

(viii) Weigh the crucible along with soil sample and note its weight.

(ix) Fill the petridish with water and place two small glass rods in it parallel to and at a small distance from each other.

(x) Place the crucible on the two glass rods in such a manner that its bottom is in contact with water.

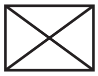
(xi) Leave the set up undisturbed till water appears at the upper surface of the soil. Wait till entire soil surface is wet.

(xii) Remove the crucible and allow all the gravitational water to flow out from the bottom. When no more water percolates, wipe the bottom dry with the blotting paper.

(xiii) Weigh the crucible and note its weight.

Observation

Record your observation in the following table.
Calculate the % water holding capacity of the soil as follows.

Weight of crucible + blotting paper:	A g
Weight of crucible + blotting paper + soil sample before experiment:	B g
Weight of dry soil:	B - A= Cg
Weight of crucible + blotting paper + wet soil sample after experiment:	D g
Weight of wet soil after the experiment:	D - A= Eg
Mass of water absorbed by soil:	E - C= Ng
% Water holding capacity:	

Tabulate your results as shown below

Sample No.	Wt. of Crucible + blotting paper (A)	Wt. of Crucible + blotting paper + soil sample (B)	Wt. of soil sample (B-A) = (C)	Wt. of crucible + blotting paper + wet soil (D)	Wt. of wet soil (D-A) = E	Amount of water absorbed (E-C) = N	% water holding capacity 
A Garden soil							
B Road side soil							
C…….							
D………							

Discussion

Compare % water holding capacity of soil collected from different habitat conditions. The variation in water holding capacity is due to varying proportion of sand, silt and clay in the soil of different habitats. Soil with very high proportion of sand have very low water holding capacity due to large pore spaces between the particles which enables the water to percolate freely into deeper layers leaving upper layers practically dry. In clay soil, due to very small size of the pore spaces (fine capillaries) the water is retained in the capillary spaces as capillary water. In these soil the water does not percolate freely. Soil with more or less equal proportion of sand, silt and clay (loam soil) combines the properties of sand and clay and therefore has optimum water holding capacity and optimum soil-air for root growth.

Questions

1. What are heavy soil and light soil?
2. Give examples of a plant seen in heavy soil and light soil.
3. How does pore space determine the % water holding capacity of soil?
4. Why is clay soil often referred to as physiologically dry soil?
5. Which type of soil is suitable for cultivation of crop plants?
6. How can water-holding capacity of soil be improved?
7. Dead decomposed organic matter is usually added in the fields before the cultivation of crops. Apart from providing the mineral nutrients, what additional role does organic matter play in the cultivation of crop plants?

Exercise 17

Aim: To study the ecological adaptations in plants living in xeric and hydric conditions

Principle: Successful adjustment of plants and animals under prevailing environmental conditions is known as **adaptation**. For terrestrial plants, the habitats vary from extremely dry conditions as in deserts to extremely wet conditions as in marsh lands. For aquatic plants the habitats may vary from deep water bodies like oceans and lakes to shallow ponds and pools. The plants are adapted to diurnal, seasonal or annual fluctuations of the habitat conditions. For land plants the main limiting factor is the availability of soil water whereas, for aquatic plants the main limiting factors are the fluctuations in water level, availability of gases like CO_2 and O_2 and the light intensity. Adaptation of land plants are primarily for conservation of available soil water, avoidance of bright sunlight and intense heat and for aquatic plants, adaptation are for conservation of gases and efficient utilization of available sunlight.

On the basis of availability of water, plants are classified as:

(a) Xerophytes: These are plants growing in extreme dry conditions throughout the year. For example, plants growing in deserts (psammophytes), on rock (lithophytes) or alpine plants growing above 14000 feet altitude.

(b) Mesophytes: These are plants growing in soils with optimum soil water conditions prevailing for major part of the year.

(c) Hydrophytes: These are aquatic plants growing in fresh to marine water.

The morphological, anatomical and physiological attributes of terrestrial plants are different from the aquatic plants.

Requirement: Plant specimens from xeric and hydric habitat conditions. The specimens from xeric condition may include a few cacti, succulents (Euphorbia, *Bryophyllum*, Kelancho) cycas leaves, pine needles, twigs of *Acacia*, *Nerium*, *Parkinsonia*, *Casuarina* etc. The aquatic plants: *Salvinia*, *Eichornia*, *Pistia*, *Hydrilla*, *Vallisnaria*, *Utricularia*, *Lymnophila;* some reeds like *Typha*, *Phragmites*, amphibious plants like *Marsilea* and halophyte like *Rhizophora*. Beakers, glassjars, microscope, slide, coverslips and rajor blades

Procedure

Prepare temporary stained transverse sections of leaf, stem and root of the specimens. Study the morphological and anatomical features of the plants collected and look for the following adaptations. Write the name of the plant in which a particular adaptation is observed.

Observations

Record your observation in the given tables:

Xerophytes

Adaptations	Modifications (Morphological / Anatomical)	Examples (from the specimen collected)
1. Conservation of Water	a. Leaves few or absent or represented by spines only b. Petiole modified into leaf like structure c. Stem reduced, branching sparse d. In some cases stem flattened, leaf like, green, photosynthetic in nature	------
2. Storage of Water	Thick, fleshy and succulent leaves as well as stem	--------
3. Prevention of loss of water by transpiration	a. Intercellular spaces reduced b. Spongy parenchyma/ palisade parenchyma present c. Stomata on lower surface, sunken in stomatal pits d. Leaves needle like e. Thick cuticle on leaf surface	---------
4. Prevention of excessive heat	a. Leaves covered with dense hairs; b. Leaf surfaces shiny or glaborous c. Leaf blade remains rolled during the day	-------------
5. Efficient mechanism of water absorption	a. Long and profusely branched roots b. Dense root hairs c. Well developed xylem	-----------------

Hydrophytes

Adaptations	Modifications (Morphological / Anatomical)	Examples
1. Buoyancy and resistance to currents of water	a. Leaves long and cylindrical b. Petioles flexible to withstand currents of water and to carry the leaf blade on the surface of water c. Petioles are modified into air pockets d. Leaf blade pale green in colour, finely dissected e. Leaf blade waxy with thin cuticle	
2. Transpiration	a. Stomata absent b. Stomata present on upper surface of leaves	
3. Absorption of water	a. Poorly developed roots b. Root hairs absent c. Roots with air pocket to help in buoyancy	
4. Gaseous circulation and storage of air	Parenchymatous tissue of stem, roots, petioles and leaves modified into aeranchyma in the form of air channels in a. Root b. Stem c. Petiole d. Leaf	
5. Mechanical tissues	a. Poorly developed xylem b. Poorly developed sclerenchyma c. Sclerides present	

Questions

1. Give three adaptive features of water hyacinth suitable to aquatic life.
2. What are the features present in plants of xeric habitat for the prevention of loss of water?
3. What is the importance of succulent leaves and stem for a xerophytic plant?
4. Why is air stored between tissues in aquatic plants?

Exercise 18

Aim: To study the adaptations in animals living in xeric and hydric conditions

Principle: The aquatic ecosystem exhibits a different pattern of abiotic factors as compared to those in terrestrial ecosystem. The temperature of the water, penetration of sun light, the physicochemical characteristics of water body affect the growth and survival of the biotic community. In order to overcome the cumulatory effects of these factors, certain morphological and anatomical features, as well as physiological processes develop in the organisms. These modifications in animals are called adaptive features. We will study adaptations in selected animals living in aquatic and xeric condition.

Requirement: Animal specimen/models of xeric (rat, camel, squirrel) and hydric (fish, frog, prawn, etc.) conditions

Procedure

Observe the animals provided and note down their adaptive features in the observation table with example.

Observations

Hydric adaptations

Features	Adaptations	Example (For students)
Body colour	(a) On dorsal surface (b) On ventral surface	
Body contour	(a) Streamlined (b) Disappearance of neck constriction (c) Tail enlargement (d) Position of external nostrils (e) Loss of external ears (f) Position of eyes (g) Presence of eye protecting membrane	
Locomotory	(a) Fins or fin-like expansions of the body wall (b) Loss of limbs (c) Webbed feet	

Integument	Presence of dermal/epidermal derivatives (a) Scales (b) Hairs (c) Mucous glands (d) Oil glands	
Mouth	(a) Position (b) Presence of teeth a. Upper jaw b. Lower jaw	
Respiratory organs	(a) Gills/lungs (b) Cutaneous	

Xeric adaptations

Features	Adaptations	
Moisture getting	(a) Preference for juices as food (b) Hygroscopic skin	
Moisture Conservations	(a) Storage of water in body (b) Avoidance of evaporation (non-perspiring)	
Body colour	(a) Protective mimicry (b) Predating mimicry	
Body contour	(a) Position of a. Nostrils directly upward b. Reduction to pin-head size (b) Position of eyes a. Covering of eyes b. Size	
Skin	(a) Hard (b) Spiny (c) Poison glands	
Limbs	(a) Speed (b) Long slender (c) Padded feet	
Scrotum	Present or Absent	

Discussion

You may have noticed many features in the body of aquatic animals which support their life. As the different aquatic bodies vary to a great extent, there are many other adaptive features you may notice. For example the aquatic organism in ponds, lakes, river and sea.

Questions

1. Name the features that helps a frog for aquatic life.
2. What are the adaptations present in xeric animals for conservation of water?

Exercise 19

Aim: To determine the pH of different water and soil samples

Principle: The pH value of a water/soil sample can be determined by (i) indicator dye method, (ii) electrometric method using a pH meter and (iii) colorimetric method. For routine purposes the indicator dye method using universal pH indicator solution (containing a wide range of pH indicator dyes) or paper strips containing the pH indicators are preferred though it is not as accurate as the electrometric method.

Requirement: Soil or water samples A, B and C collected from different sites (for example soils from road side, garden, humus rich sites; water samples from borewell, handpump, pond, sewage), balance, weights, filter paper, distilled water, measuring cylinder (50 mL), droppers, cavity tile, funnel, beakers (100 mL), funnel stand, universal pH indicator solution and pH indicator paper (narrow range and broad range)

Procedure

(i) Weigh 10 g of the soil sample A. Add 50 mL of distilled water to soil sample to make a soil solution.

(ii) Filter the soil solution through a filter paper and collect the filtrate in a beaker. Label it as soil solution -A.

(iii) Take a clean dry porcelain cavity tile. Place 5 drops of soil solution A in three cavities of the tile as shown in Fig. 19.1.

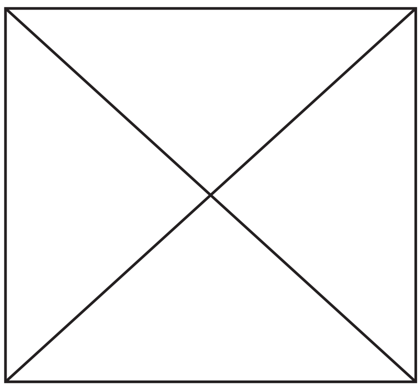


Fig. 19.1 Porcelain cavity tile

(iv) To the 5 drops of soil solution present in one cavity add 5 drops of universal pH indicator solution. Note the colour developed and compare it with the colour chart given on the universal pH indicator solution bottle.

(v) To the soil solution present in the second cavity, dip a small strip of broad range pH indicator paper (pH 2-11). Note the colour and compare with the colour chart given on the broad range indicator paper and get a rough estimate of pH of the sample solution.

(vi) Choose a suitable narrow range pH indicator paper (for e.g. If the pH of soil is determined by you as 8.0, choose a narrow range 7.0 to 9.0) and dip a small strip of it in the soil solution present in the third cavity. Note the colour developed and determine the pH to the nearest possible value with the help of the colour chart.

Repeat the same steps for determining the pH of sample B and C. Follow the same procedure for water samples collected from different sites.

Observation

Record your observations in the given table.

Table: Measurement of pH of soil samples A, B and C

pH value as determined by	Soil Samples		
	A	B	C
Universal indicator solution			
Broad range indicator paper			
Narrow range indicator paper			

Discussion

Based on the pH values obtained, categorise the samples into acidic, basic, neutral type.

Record the plant species present in the site from which the samples are collected.

Note for teachers: The colour developed should be noted against direct sun light. Also, sometimes the soil solution colour may interfere with the readings. Thus one has to be careful while making the observations.

Questions

1. What will be the pH of chalk (calcareous) soil?
2. pH measurement with indicator paper is not very accurate. Comment.
3. Water logged soils are acidic. Comment.
4. Why are soil around mineral mining areas acidic?

Exercise 20

Aim: To study turbidity of water samples

Principle: Various characters that control the quality of water are taste, smell, colour, amount of dissolved nutrients, dissolved O_2 and CO_2, pH and different types of plants and animals and their density. Turbidity of the water body determines the depth upto which light can penetrate and thus affects the distribution and photosynthesis of phytoplanktons and macrophytes. More turbid the water body less is the thickness of its photic zone.

In polluted water bodies turbidity is due to:

1. Effluents: A water body which receives domestic sewage, run off from adjacent agricultural fields and liquid wastes from nearby small and large industries remains turbid.
2. Planktons: A water body may be turbid due to very high density of phytoplanktons and zooplanktons, especially when the water body is rich in nutrients.

I. Secchi's Disc method

Requirement: Secchi's Disc, rope of moderate thickness, meter rod, black and white paints; paint brush. Prepare a Secchi's disc by taking an iron disc of about 6 inches diameter, to which a weight is attached in the centre on one side and an iron hook on the other side. Tie a plastic rope of sufficient length to the hook. Divide the upper surface of the disc into 4 equal segments and paint two of these white and the other two segments black in such a way that black and white segments alternate with each other (Fig. 20.1).

Procedure

(i) Visit a nearby pond.

(ii) Reach to the center of the pond in a small boat.

(iii) Slowly immerse the Secchi disc into water vertically holding the rope tightly in the hand till the black and white segments of the disc just begin to disappear. On reaching to a particular depth, the disc becomes completely invisible. Mark the length of the rope when the disc just disappears (say A cm).

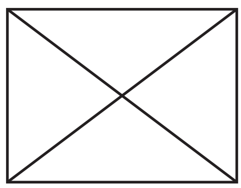
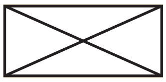


Fig. 20.1 A Secchi's Disc

(iv) Slowly pull up the disc and find out the length of the rope where the black and white segments of the disc just reappear (say B cm).

(v) Find out the mean length (X) of the rope by the following method.



(vi) Repeat the process at different sites of the pond.

Tabulate the results in the given table

Water body	**Depth at which Disc disappears (A cm)**	**Depth at which disc reappears (B cm)**	**Depth of Photic zone** 
Pond Site 1 Site 2 Site 3			
-			
-			

Observations

The value X represents the depth of the photic zone upto which sunlight penetrates in the water body and photosynthesis takes place.

Discussion

Greater the value of 'X' less turbid is the water. In crystal clear deep lakes, the value of 'X' will be very high indicating, thereby, that the water body does not have large quantities of flocculating silt or organic matter residues. This may be due to no discharge of effluents or domestic sewage into the water body. The high clarity of water is also an indication of very less density of phyto and zooplanktons. These water bodies are called as non-productive or oligotrophic, while highly turbid water bodies are eutrophic in nature.

Precautions

Students are advised to perform this experiment under the strict supervision of teacher to prevent incidents due to drowning.

II. Measurement of turbidity using measuring cylinder

Requirements: Water samples from different sources, three measuring cylinders (500mL) of the same height.

Procedure

(i) Collect about 2 liters each water samples from different sources.

(ii) Transfer 500ml of water sample in the measuring cylinders of same volume and height.

(iii) Mark the three cylinders A, B and C and leave them undisturbed overnight.

Observations

Observe the amount of sediment settled at the bottom of each cylinder and also note whether the water above the sediment is still turbid.

Record your observations in the following table:

Water sample	Thickness of sediment	Clarity of water—turbid/ semiturbid/clear
'A'		
'B'		
'C'		

Discussion

- Do all the samples show same amount of sediments?
- Which sample shows maximum sedimentation and correlate it with the source of the sample?
- Find out whether in all the cylinders, water above the sediment is clear or turbid. Explain with reasons.
- Draw conclusions on the basis of the observations.

Questions

1. Is turbid water fit for drinking? Explain.
2. Why is the penetration of sunlight in any water body important?
3. Green plants are seen only in photic zone. Comment.
4. It is a common practice to use alum for clearing turbid waters. Explain.
5. Turbidity of water body varies with season. Comment.