Unit II - Ecological Adaptations.

General Introduction:-

- It is very rare to find plants growing as an isolated individuals. They usually occur in groups.
- This groupism is due to response ~~of~~ to the same set of environmental conditions in which they grow.
- Groups of plants growing under the same set of environmental factors constitute the ecological groups.
- Depending upon the amount of water available, there are three ecological groups, viz. hydrophytes, mesophytes and xerophytes.
- Hydrophytes are the plants which grow in plenty of water e.g ponds, lakes, streams, rivers, ocean etc.
- The mesophytes grow in places with moderate water supply e.g. in the plains of temperate and tropical zones.
- The xerophytes grow in extreme dry habitats ie. where the amount of water in the soil is very less e.g. deserts, alpine peaks, sand hills, etc.
- According to Warming (1895) besides above mentioned three groups, there are 6 other groups of plants viz. halophytes, lithophytes, epiphytes, psammophytes (growing on sand), oxylophytes (growing on acidic soil) and chasmophytes (growing on rock).

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* Hydrophytes

- Hydrophytes grow in water, or in soil which is saturated with water or is covered with water.
- Water may be fresh or saline.
- The common freshwater bodies are ponds, lakes, streams, and rivers.
- The plants which grow in freshwater are called freshwater plants.

① vascular hydrophytes :-

The hydrophytes which posses vascular tissue ie xylem and phloem are called vascular hydrophytes.

- The vascular hydrophytes may be arranged into three fairly natural groups, viz. submerged plants, floating plants and amphibious plants.

② Nonvascular hydrophytes :-

- The hydrophytes which lacks the vascular tissue in them are called nonvascular hydrophytes.

- The nonvascular hydrophytes constitute the phytoplanktons.

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* Vascular hydrophytes

(2) submerged hydrophytes :-

- These are rooted hydrophytes.
- They are completly submerged in water ie they grow below the surface of water.
- They generally present in shallow regions of water where the plants can get adequate supply of light.
- The submerged hydrophytes can be of two types,
  (a) plants with long stems. They bear small leaves at the nodes. Ex. Hydrilla
  (b) plants with tuberous stem. They bear cauline (leaf arising on main axis) leaves. The leaves are thin and ribbon shaped. Ex vallisneria.

(b) Floating hydrophytes :-

- Floating hydrophytes are those plants which can float on the surface of water.
- These are again of two types,
  (1) Free floating forms and
  (2) Floating but rooted forms.

(1) Free floating forms

- These plants are not attached to soil. But they can freely float on the surface of water.

- They grow in large number in ponds and pools.
- They aggregate on the surface of water in such a way that the water surface is completely invisible.
- some forms have very large leaves which rise above in the air, e.g. water hyacinth.
- There are also some smaller forms e.g. pistia.
- A Third form of floating aquatics comprise still smaller forms. e.g. Azolla.

Floating but rooted forms

- These aquatics are rooted in mud but their leaves are floating on the surface of water.
- They normally grow in shallow regions.
- Ex water lily (Nymphea).

(C) Amphibious Plants :-

- These are the plants of which the basal part is normally submerged in water and the shoots extend well above the surface of water in the air.
- Generally they present in shallow water. Ex: Typha, Hygrophilla, etc.

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Adaptations in hydrophytes

1. Submerged plants (EX Hydrilla)
Hydrilla is a rooted submerged hydrophyte ie it grows completely below the water.
- It generally present in shallow region of water.
- It shows following adaptations,

* Morphological adaptations :-
- Roots are greatly reduced in size. Roots are mostly unbranched. They lack root hairs.
- The stem is thin and delicate due to lack of mechanical tissue.
- Leaves are reduced in size and thickness. They are thin, linear or ribbon like to escape from the effect of strong water current
- They multiply by vegetative mode of reproduction except in few cases.

* Anatomical adaptations :-

T. S. of Hydrilla stem shows following anatomical adaptations,

- T. S. of Hydrilla stem shows total absence of cuticle because they have to absorb water and nutrients directly through the entire surface of the plant body.
- Due to absence of any need for mechanical strength, the vascular bundles do not develop near the ~~pt~~ periphery and cortex region becomes very large.

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3- conducting elements e.g. xylem vessels are very few in number and are non-lignified.

- presence of large number of air cavities in the cortex region for the purpose of gas exchange and storage. Gases like O_2 and CO_2 are stored within these air cavities. These air chambers / cavities give buoyancy (Lightness, able to float) to the plants.
- The stem is soft and spongy.
- The mesophyll is not differentiated into palisade and spongy parenchyma. It is mostly of spongy type.
- Chloroplasts are present in epidermal cells too.

T. S. of Hydrilla:- shows following characters.

① Epidermis:- This is outermost layer of cells. cuticle is absent.

② cortex:- It occupies most of the part.

- It is made of many, large air chambers. Air chambers are seperated from one another by partitions called diaphragms.

——— x ———

⟹ Adaptation defⁿ:- Any feature of an organism or its part which enables it to exist under conditions of habitat is called adaptation.

③ Endodermis :- Distinct endodermis and pericycle are present which enclose vascular tissue ⑦

④ Vascular tissue :- It is extremely reduced.
- Most of the tissue phloem
- ~~Xylem is represented by single large element.~~

② ~~Floating but rooted hydrophytes (Ex: Nymphea).~~

<u>Hydrophytic characters of Hydrilla</u>

① Epidermis is made of thin walled cells
② cuticle is absent.
③ Absence of mechanical tissue
④ Arenchyma and air chambers present.
⑤ Extremely reduced xylem.
⑥ comparatively well developed phloem.

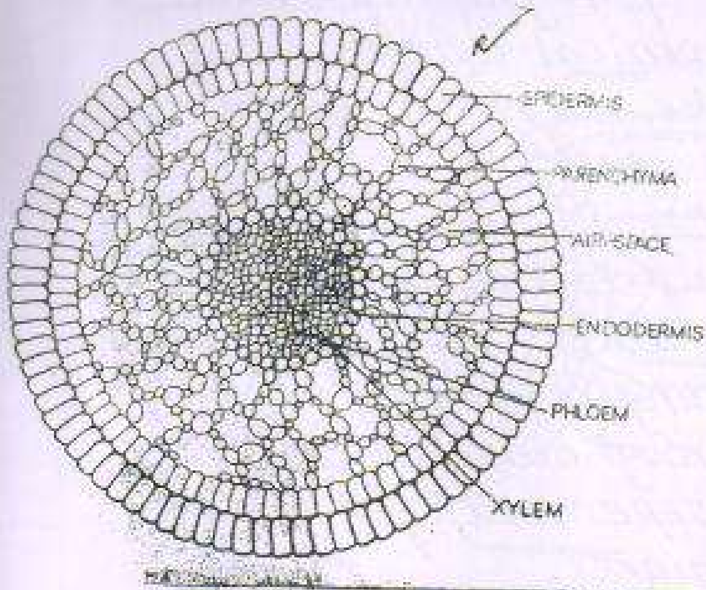

Fig. 54. T.S. Hydrilla Stem.

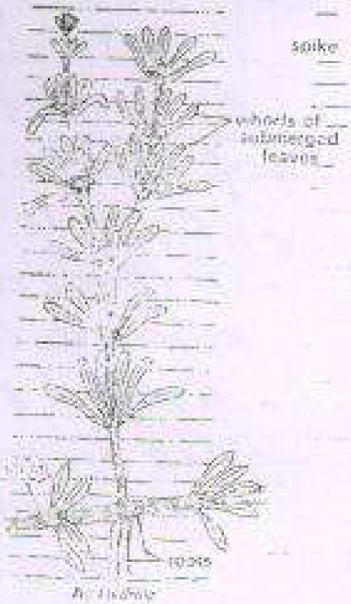

Fig :-

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② Floating but rooted hydrophytes
(Ex: Nymphea).

Morphological adaptations :-

- Roots are poorly developed.
- Roots are produced from horizontal stems, root stocks, or tubers.
- petioles are very well developed and elongated.
- Air cavities are well developed within petioles.
- Leaves are covered with wax to prevent the wetting ([illegible]) of the upper surface.

Anatomical adaptations :-

- T. S. of petiole of Nymphea shows following anatomical adaptations.

Epidermis :- It is the outermost layer made of parenchymatous cells.
- cuticle is absent.
- Hypodermis :- it is present just below the epidermis. The cells are compactly arranged.
- Ground tissue :- Many large air chambers are distributed throughout this region. Air chambers are seperated ~~by~~ from one another by diaphragms.
- Vascular tissue :- Vascular bundles are distributed throughout the ground tissue.
- vascular bundles are poorly developed.
- Xylem is represented by a single, large element.
- Phloem is scattered all around the xylem.

Hydrophytic characters

1. cells of epidermis are thin walled
2. cuticle absent
3. ~~Absence of mechanical tissue~~
4. Ground tissue parenchymatous
5. Presence of arenchyma.
6. Vascular tissues poorly developed.

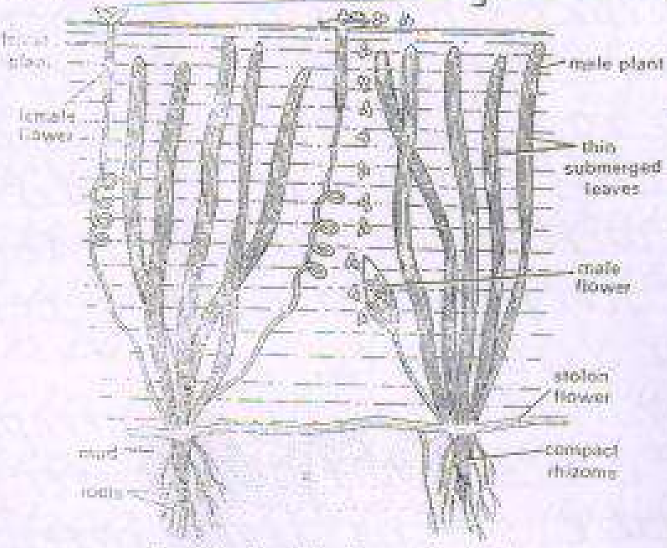

Fig. 8.2—Rooted submerged hydrophytes.

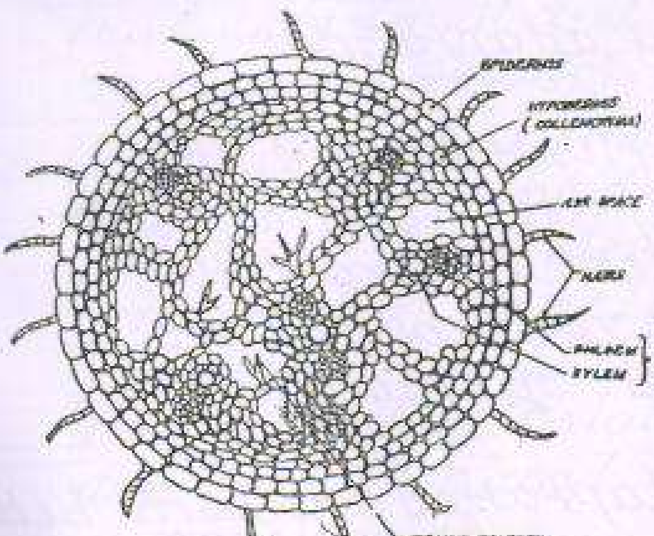

Fig. 56. T. S. *Nymphaea* petiole.

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✗ Xerophytes.

- In places like deserts, sand hills and alpine peaks there is acute shortage of water and the rate of transpiration is often rapid. In such xeric habitats, the plants are greatly modified in form to withstand unfavourable conditions. Such plants are called xerophytic plants or xerophytes.
- The dominant factors of xerophytic habitat are scarcity of water, high temperature, strong light intensity, high wind velocity.
- To face such an adverse conditions the plants make various morphological and anatomical adaptations.

Morphological adaptations.

- The xerophytic plants face adverse condition of dryness in several ways for two important requirements,
  (i) Increased root absorption.
  (ii) Reduced rate of transpiration.

- The various adaptation are listed below,
- The xerophytes have a very deep and extensive root system which reaches the deeper layers of soil water. The root system is several times larger than the aerial portion.

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It may as deep as 129 feet below the surface of soil.

- The stem is stunted in growth and its branching gives the plant a bushy appearance.
- some plants of xerophytes have underground stems to tide over the dry season ex. saccharum.
- plants like Acacia, Zizyphus have very hard and woody stems. They are covered with thick bark.
- certain xerophytic plants have completely dispensed with the leaves to check transpiration ex. capparis aphylla.
- In many xerophytic plants, the leaves are reduced to scaly or spiny structures to reduce the rate of transpiration. ex. Asparagus, casuarina, etc.
- Many xerophytes are Microphyllous ie they have very small and narrow leaf blades to reduce the transpiring area.
- certain xerophytic plants shed their leaves during the dry period.
- In plants like Nerium, the leaf surfaces are shining to reflect away light and temp.
- In plants like Calotropis procera, the leaves are very thick and leathery to reduce transpiration.
- The leaves of many xerophytic plants have a waxy coating on the upper surface. They are also covered with a dense mass of hairs.
- some of the grasses are folded in such a manner that the stomata are completely protected.

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Anatomical adaptations

- Leaves of many xerophytic plants have thick cuticle on the upper surface and sometimes even on lower surface to check transpiration.
- The epidermal cells are thick walled to reduce transpiration. Some plants like Nerium have many layers of epidermis both on the upper as well as the lower surfaces of leaf.
- The stomata are greatly reduced in number and mostly present on the lower surface of the leaf to avoid direct light.
- The stomata are mostly located in deep pits. The pits / cavities are filled with large number of hairs. Such stomata are called sunken stomata.
- The hypodermis is composed of thick walled sclerenchyma cells to check evaporation of water.

Meso phyll tissue

- The spongy parenchyma cells are comparatively fewer in number and have very small intercellular spaces. The cells are loosely arranged and form large air chambers.
- The palisade parenchyma is many layered and is well developed.

It is well developed not only in the upper portion of the leaf but also in the lower portion to check evaporation of water.

It lies just below the upper epidermis and 4-5 cells deep.

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- Many v.b. are present in the leaf.
- The water conducting elements are well developed i.e. xylem.

* Xerophytic characters of Nerium leaf

1. presence of thick cuticle
2. Both epidermal layers are multilayered
3. stomata only in the lower epidermis and highly sunken.
4. stomata covered with thick envelope of hairs.
5. presence of palisade near both epidermal layers.
6. well developed vascular tissues.

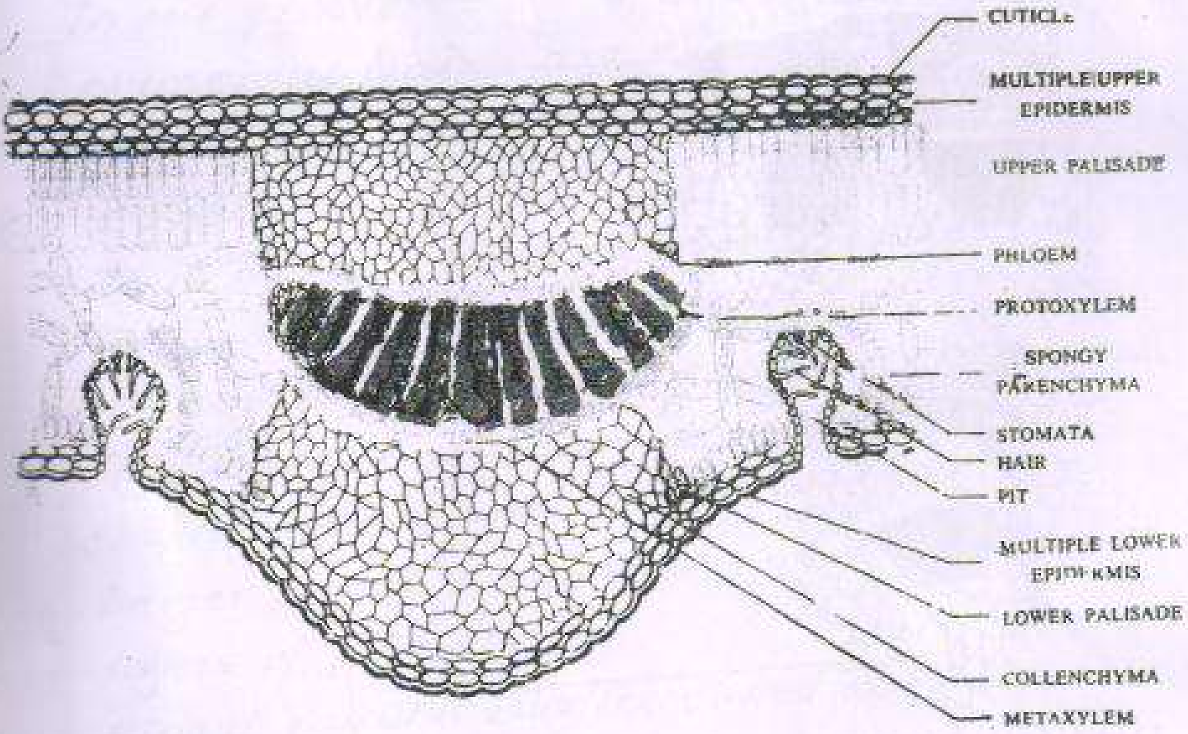

Fig. 64 T. S. Nerium leaf

Fig :-

Xerophytic characters of casuarina

(1) presence of thick cuticle
(2) stomata sunken and covered with hairs
(3) sclerenchymatous hypodermis.
(4) presence of palisade in the cortex
(5) well developed vascular tissue

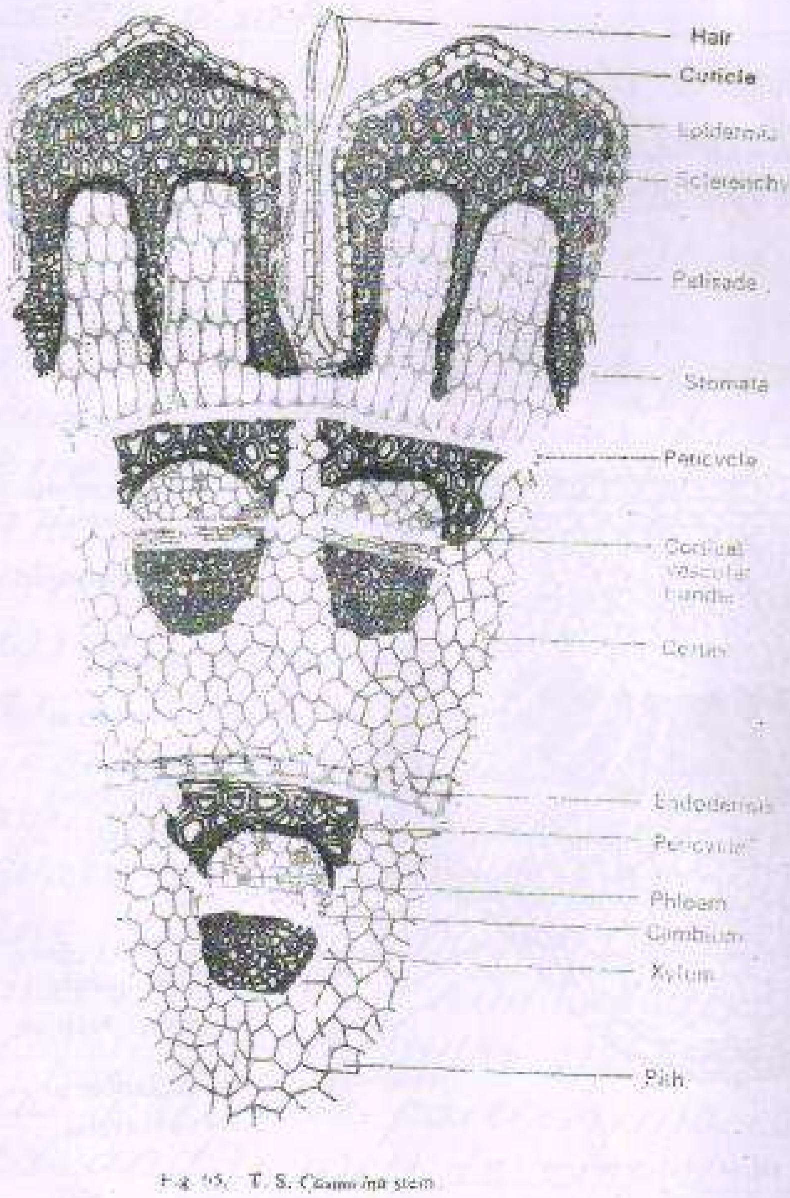

Fig. 55. T. S. Casuarina stem

Fig :-

Casuarina stem T.S

The T.S. of casuarina stem shows ridges and grooves. Ridges are almost traingular in shape.
The section shows the following characters,

① Epidermis:-
- This is an outermost single row of cells.
- The cells are highly cuticularised.
- Stomata are highly sunken and occur in the grooves.
- Numerous hairs are present in the grooves and around the stomata.

② Cortex:-
It is differentiated into hypodermis, palisade and parenchyma.
- Hypodermis is present below the epidermis. It is made of sclerenchyma, arranged in T-shaped patches.
- Larger part of the cortex is made of several layers of parenchyma.
- Ring of vascular bundles called cortical vascular bundles is present in the parenchymatous region. These are situated below the ridges.

③ Endodermis:-
It is single layered.

④ Vascular tissue :-
- Vascular bundles are arranged in a ring.
- vascular bundles are well developed.
- A sclerenchymatous patch is present above each vascular bundles.
- In bet^n two vascular bundles, a parenchymatous region is present.

⑤ pith :-
A well developed parenchymatous pith is present in the centre.

* Xerophytic characters of casuarina stem

The anatomy shows following xerophytic characters,
① presence of thick cuticle.
② stomata sunken and covered with hairs.
③ sclerenchymatous hypodermis and bundle cap.
④ presence of palisade in the cortex
⑤ well developed vascular tissue.
⑥

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* General characters of Halophytes

The plants which grow in saline soils or which inhabit saline soils are called halophytes.

The halophytic plants are tolerent to the concentration of soluble inorganic salts viz. sodium chloride, magnesium chloride and magnesium sulphate.

They grow and complete their life cycle in the habitats with a high salt content.

- The halophytes are usually characterized by xeromorphic features. They are given below,

1) Habit :- Majority of halophytes are shrubs, but a few of them are herbaceous. They grow in the tropical and subtropical regions.

2) Roots :- Halophytes develop many shallow normal roots. In addition to normal roots many stilt or prop roots develop from the aerial branches of stem for efficient anchorage in muddy or loose sandy soil.

3) - The soil in coastal region is poorly aerated and it contains very little amount of oxygen because of water logging. Under such conditions, the roots of halophytes do not get sufficient aeration. In order to compensate

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this lack of aeration, the halophytes develop special type of negatively geo-trophic roots called pneumatophores or breathing roots.

- The pneumatophores usually develop from the underground roots and project in the air above the surface of mud and water.
- They appear as peg (pin or bolt) like structures.
- The tips of these respiratory roots may be pointed.
- They possess numerous lenticels on their surface and internally having prominent arenchyma enclosing large air cavities.
- Through these lenticels gaseous exchange takes place and arenchyma helps in the conduction of air down to roots.

phytes develop special type af negatively geotropic roots, called *pneumatophores* or breathing roots (Fig. 10·1). The pneumatophores

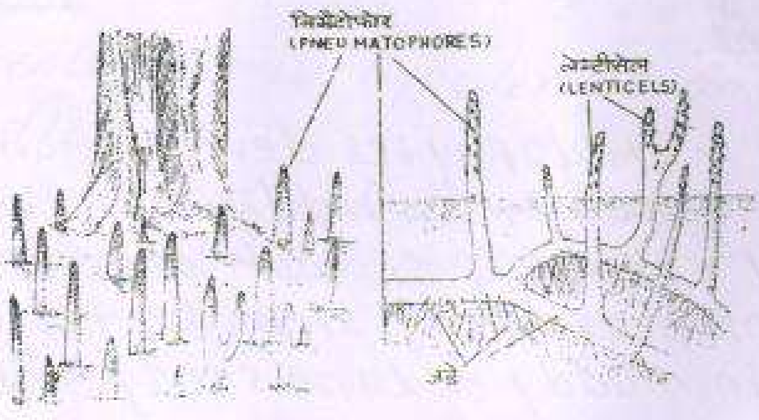

Fig. 10·1—Pneumatophores of mangrove plant.

...ally develop from the underground roots and project in the air

Fig. pnematophores.

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③ Stem: stems in several halophytes is succulent. This succulence is due to presence of common salt and they are known to cause succulence.

④ Leaves :- Leaves may be thin, small, leathery and spiny to minimize loss of water in transpiration.

- The leaves of certain halophytes are often glassy in appearance.
- Some species of halophytes are aphyllous.
- Stems and leaves of coastal halophytes show additional adaptation. Their surfaces are densely covered with trichomes.
- Leaves of submerged ~~b~~ marine halophytes have poorly developed vascular system. They are adapted to absorb water and nutrients from the medium directly.
- The leaves are evergreen which have water storage tissue and thick cuticle.
- Some halophytes exhibit vivipary ie. seed germinate before the fruit break off from the plant.

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* Mangroves

- In tropical and sub-tropical regions, halophytes form a typical seashore vegetation called mangrove formations

- In our country mangrooves can be seen on seacoasts of Bombay (Elephanta caves) and Kerela, near the estuarine deltas of the Ganges and Godavari and in Andaman and Nicobar islands.
  All these places are frequently water-logged.
- The mangroove formations have a characteristic vegetation which forms a dense forest of small evergreen trees.
- The habitat is characterized by
  (i) sandy, loose, swampy and saline soil
  (ii) high rainfall
  (iii) high humidity in the atmosphere and
  (iv) Almost uniform temp. throughout the year.

- The mangrooves ~~a~~ show many characteristic adaptive features.

(1) Stilt roots :- They produce large number of stilt roots.

(2) Formation of pnematophores.

(3) Vivipary :-

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* Vivipary :- The mangroves show the phenomenon of viviparous germination, i.e. the seeds start germinating while the fruit is still attached to the mother plant.
- There is no resting stage in the seed and its germination takes place immediately after it is formed.
- This is supposed to ensure the germination of the seed into a new plant under adverse conditions when it fall on the ground.
- The seedling falls down in an upright manner and the radicle of root gets embedded in the soil. In this way the already developed plumule portion does not come in contact with a saline soil which may be otherwise injurious to it.

(4) Shrubs and trees :- Mangrooves are mostly shrubs and trees.

(5) Xerophytic nature :-
- Stem is succulent
- Leaves are small, succulent, thick and spiny to check transpiration.
- Leaves have water storage tissues.
- Leaves have thick cuticle
- Stomata are sunken.

⇒

(6) Economic Importance :-

- Mangroves have great economic importance. They provide timber, fodder, vegetables, starch, medicines, bark, etc.
- They also act as good sand binders.
- Alcohol is obtained by distilling the juice secreted by the inflorescence of Nipa sps.

(7) The sp. like Ceriops and Heretiera are dominant in the sunderban region of India, Avicennia alba and A. Marina are characteristic of Godavari delta of Andhra.

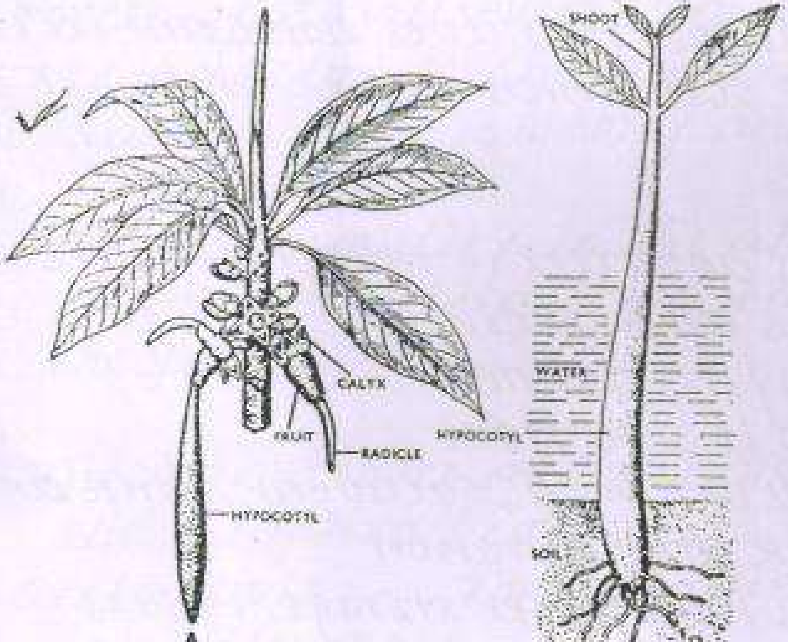

Fig. 71. Viviparous germination in mangroves.
A. Twig of *Rhizophora* showing viviparous germination.
B. A seedling attached to soil.

Fig: Vivipary

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* Epiphytes

(Epi - above, phytam - plan,

- Epiphytes are the plants which grow on other plants but unlike parasites they are not dependent on host plant for their nutrition. They manufacture their own food material.
- They can grow in places where there is ~~plenty~~ of regular rainfall and plenty of humidity in the atmosphere. such a situation normally obtains in tropical rain forests and coniferous forests of the mountains.
- Epiphytes absorb suffient moisture from the atmosphere and mineral nutrients from the decaying bark of the host plants upon which they are situated.
- As they are autotrophic in nature, they manufacture their own food from water and CO_2 in presence of sunlight.
- They are not rooted in the soil.
- They are most common on tree trunks. They also grow on horizontal branches and in forks of trees.
- The epiphytes bear at least two types of root ie clinging roots and aerial roots. The epiphytes fix themselves to the host by means of the clinging roots while the aerial roots absorb moisture from the atmosphere.
- The aerial roots of many tropical epiphytes belonging orchidaceae hang in air.
- The aerial roots have a special type of absorbing tissue called <u>velamen</u>.

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- Epiphytic vegetation is very rich in moist and cold regions, but poor in dry and cold areas. In north-western Himalaya the epiphytic species are much less in number as compared to those present in the eastern Himalaya.
- In tropical rain forests also the epiphytic species found at the top of trees.

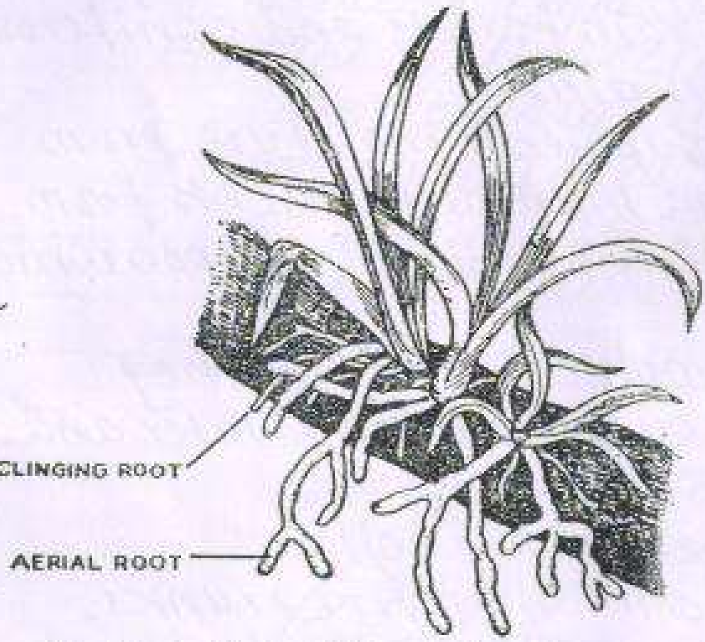

Fig. 72. An epiphytic orchid plant showing aerial roots.

Fig: Epiphytic roots

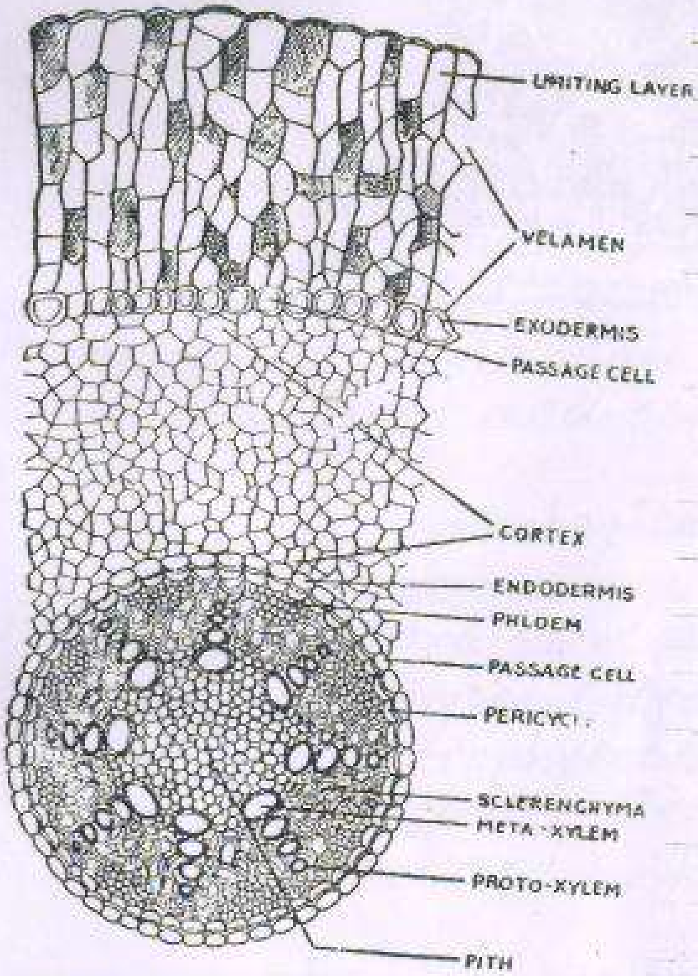

Fig. 73. T. S. of an aerial root of orchid showing velamen.

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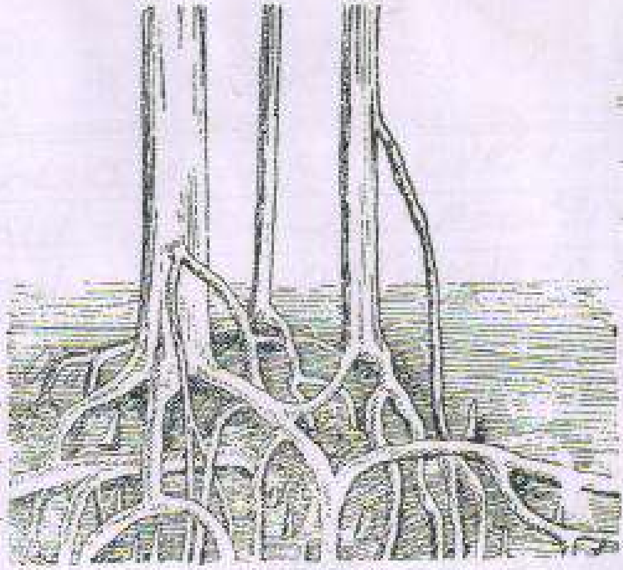

Fig. 10·2.--Supporting or stilt roots of mangrove plants developing from the trunk.

... roots may be