

## Morphological adaptations in xerophytes

### XEROPHYTES

Xerophytes are all such plants which inhabit in a condition where there is deficiency of absorbable water on the substratum. In real term it is difficult to define xerophylophilous nature of soil or atmosphere. Daubenmire (1950) defined xerophytes as 'plants which grow on substrata that usually become depleted of growth water to a depth of at least 2 decimeters during a normal season'. However, Oppenheimer (1960) has ~~not~~ rightly favours a much broader interpretation of xerophilous nature including all the morphological, anatomical and physiological modifications which may assist the plant to cope with environmental water deficit.

So, in general term all the plants of arid zone excluding the margins of streams or lakes, plants with shallow roots growing from regions of heavy rainfall as well as plants from barks or rocks are xerophytes.

On the basis of their morphological, anatomical, ~~and~~ physiological adaptations and life cycle pattern, xerophytes are generally classified into following types:

- a/ Ephemerals.
- b/ Succulents.
- c/ Non-succulents drought resistant.

#### Ⓐ Ephemerals

They are such plants which avoid dry season and hence called 'drought evaders'. They are short lived annuals of arid zone completing life cycle in 6-8 weeks where sufficient moisture is available in soil. With their small size and large shoots in relation to roots, they are well adapted to dry habitats. The dry phase is carried by the seeds.

Some authors do not call them true xerophytes. Examples are Argemone mexicana, Solanum xanthocarpum, Tephrosia purpurea, Cassia tora etc.

#### Ⓑ Succulents

These plants suffer from dryness in external environment only. They store water during rainy season and utilize during drought. They are also known as 'malacophyllous' when with fleshy leaves and 'Cactus' when with fleshy stems.

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They all have water storage tissue either in leaves (Aloe, Bryophyllum, Yucca, Peperomia, Agave etc.) or stems (Opuntia, Euphorbia splendens etc.) or even in roots (Asparagus, Caiba parviflora etc.)

In them the organs other than succulent parts are much reduced as having fibrous and shallow roots, reduced spinous leaves

They have very less stomata and no stomatal transpiration during day. They have gaseous exchange during night and utilize  $CO_2$  during night (CAM Pathway)

In Opuntia stem becomes fleshy green leaf like covered with spines (modified leaves). It is known as Phylloclade.

Succulents have generally very thick <sup>cuticle</sup> and sometimes wax layer also. Sap and latex have been found in many Euphorbias and Cacti.

### (c) Non Succulent drought resistant

These are the true xerophytes who suffer from dryness both in their internal as well as external environment. The plants are woody trees, shrubs or herbs. The common are Nerium, Casuarina, Calotropis procera, Acacia nilotica, Zizyphus jujuba, Prosopis etc. They possess a number of morphological, anatomical and physiological ~~also~~ specialities which enable them to withstand critical dry condition.

They have very extensive root system as in Calotropis. There are many peculiarities in leaves (no leaf in Capparis) like rolling of leaves (Ammophila), heavy cuticle over leaf surfaces, sunken stomata (Nerium), shining blades, sclerenchymatous hypodermis, trichomous epidermis, reduced leaves

Stems are rigid and woody. In grasses shoot/root ratio has been found reduced. Plants contain excess of sulphahydryl molecules and sclereids in leaves.

Physiologically, osmotic pressure remains high and this helps in delaying or preventing irreversible changes in protoplasmic colloids which might take place under extreme desiccation. In case of 'microphyllous' leaves of Casuarina (reduced scaly leaf), potential transpiration per unit area increases and reduced size does not reduce the rate of transpiration.



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### Roots

1. There are two types of adaptations, one in succulents and other in non-succulent drought resistant.
2. In succulents, the root system is shallow and roots are fibrous.
3. In *Asparagus* the roots become fleshy and store water. Such roots contain mucilage also.
4. In the major group of non-succulents, the root system is very much developed and extensive. In *Prosopis* and *Alfalfa* the roots grow to the depths of 19.5 m. and 38.7 m respectively. The roots of *Calotropis procera* also grow very deep in soil.
5. In *Opuntia* (succulent) the root hair extends to the root tip.

### Stems

1. In succulents, stems become fleshy, green, leaf like covered with spines. In *Euphorbia* also it becomes fleshy and green.
2. Waxy coating is also found in some extreme xeric plants.
3. In non-succulents, the stems are woody, dry, hard, ridged and covered with thick bark. Cork is also found in many plants.
4. Sometimes as in *Argemone mexicana*, *Solanum xanthocarpum*, *Carthamus oxyanthus* stems are covered with spines.

### Leaves

1. In succulents like *Opuntia* leaves are modified into spines.
2. In drought resistant like *Casuarina* the leaves are reduced to scale like. They are needle like in *Pinus* and with minute leaflets in *Acacia*. Such xerophytes are also known as microphyllous.
3. In many xerophytic herbaceous plants, leaves roll inwardly to protect stomata as in *Poa*, *Ammophila*, *Agropyron* and others. Motor cells in them help in rolling.
4. In many xerophytes, stomata are found in pits (*Nerium*) or groove (*Casuarina*) or they may be sunken independent sunken stomata in *Pinus*, *Hakea* or *Agave*.
5. Presence of hair is also important character. Pits or grooves on leaf have many hairs to avoid reduce the rate of transpiration. Hairs

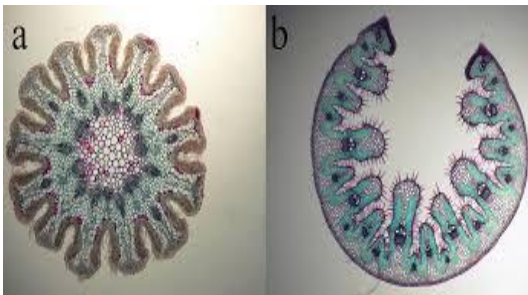
Morphological adaptations in xerophytes



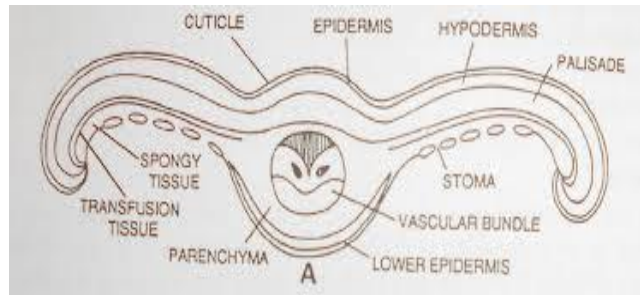
*Euphorbia*



*Agave leaves*



*Ammophila* stem and leaf



*Cycas* leaflet

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are also found on leaf epidermal surfaces. Pubescent hairs - are covered on entire leaf surface in *Calotropis*. Trichomes (hard spine like hairs) are found in *Ammophila*, *Casuarina* on upper epidermis rolled inwardly and in ~~grove~~ grooves in *Casuarina*. Leaves with hairs are known as 'trichophyllous'.

6. Foliage leaves are thick, fleshy and succulent (as in succulents) or tough and leathery with hairs (as in drought resistant). ~~and~~ Still in others, leaves are shiny and glazed to reflect light and heat.