Topic: Anatomical Adaptation in Xerophytes

B.Sc. Botany (Sub.) II

Group: B

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Anatomical Adaptation in Xerophytes

They grow in deserts or in very dry places; they may withstand a prolonged period of drought uninjured, for this purpose they have certain peculiar adaptations. The xerophytic plants have to guard against excessive evaporation of water; this they do by reducing evaporating surface. Plants form a long tap root which goes deep into the sub-soil in search of moisture. To retain the water absorbed by the roots; the leaves and stems of certain plants become very thick and fleshy (*Aloe, Agave*).

Water tissue develops in them for storing up water; this is further facilitated by the abundance of mucilage contained in them. Multiple epidermis sometimes evolves in the leaf (*Nerium*). Modification of the stem into the phylloclade for storing water and food and at the same time performing functions of leaves is characteristic of many desert plants (viz. Opuntia and other cacti).

In xerophytes certain structural features are also common. Leaves are thick and leathery, well evolved cuticle and abundant hairs. Well differentiated mesophyll is also present, and there is often more than one layer of palisade tissue (*Nerium*).

The walls of epidermal and sub-epidermal cells are frequently lignified, and distinct hypodermis may be present. They have a well-developed vascular system and often an

abundance of sclerenchyma, either in the form of sclereids of fibres. The leaf is sometimes cylindrical or rolled.

This organization is to protect the stomata, which can show peripheral photosynthetic tissue and central water storage tissue showing thick cuticle, thickenings on the radial and outer walls of the epidermal cells and sunken stomata exist in furrows. Some fleshy leaves (*Sedum*) contain abundant thin-walled cells, the water storage tissue.

The anatomical features of the xerophytes are as follows-

Epidermis and Thick Cuticle

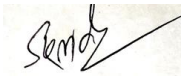
Heavy cuticularization and extreme cutinization of the epidermis and even of sub-epidermal cells are common in xerophytes. The thickness of the cuticle shows different gradations. In certain cases the thickness of cuticle is only slightly greater than normal, like that of plants of semi-xerophytic habitats. In extreme xerophytes the cuticle may be as thick as, thicker as, the diameter of the epidermal cell.

In addition to the presence of thick cuticle, the walls of epiderml cells become cutinized and sometimes also those of underlying cell. Along with well-evolved cutinized layers the epidermal and subepidermal cells also become lignified. In some cases the covering of wax is formed on the epidermis (*Calotropis*). The epidermal cells are usually radially elongated. In the leaves of *Nerium* and *Ficus*, the epidermis becomes multilayered.

In many xerophytes in addition to a cutinized epidermis, single to multi-layered hypodermis is also present. In most plants, the hypodermis of leaves is morphologically mesophyll and can be in the form of a sheet of fibrous tissue or a layer of sclereids. The hypodermis of the stems seems to be a part of the cortex. The hypodermis of stems and leaves can be cutinized to lignified. In many plants, the mucilage, gums and tanning are commonly found in hypodermis.

Hairs

In several xerophytic plants, especially those of alpine regions exposed to strong winds, a covering of matted epidermal hairs on the underside of the leaves prevent water loss. Hairs can



also be abundant over the entire aerial part of the plant. The thick matting of hairs also prevents rapid evaporation through stomata. The xerophytes that contain abundant hairs, on their leaves and stems, are commonly called trichophyllous.

Structure of Stomata

The stomata are very minute opening produced in the epidermal layer in green aerial parts of the plants. The stomata are essential for intake of carbon dioxide and oxygen and or the passage inward and outward of other gases. The evaporation of the surplus water takes place by the stomata. When the stomata are open, water escapes even when water loss is harmful to the plant.

This way, the reduction of transpiration is of great importance in xerophytes. The xerophytes can contain less stomata, either by reduction of leaf surface or of stomatal number per unit area. To reduce excessive transpiration usually the stomata that remain sunken in pits are formed. Such stomata are commonly called sunken stomata (*Hakea, Agave*). In certain cases the stomata are found in groups and they remain confined to depressions found on leaf surface (*Nerium*) generally the depressions attack of wind gusts.

Sclerenchyma

The xerophytes commonly have a large proportion of sclerenchyma in their leaf structure than is observed normally in mesophytes. The sclerenchyma is either found in groups or in continuous sheets.

Rolling of Leaves

The leaves of several xerophytic grasses roll tightly under dry conditions. In these grasses, the stomata are confirmed to the ventral surface of the leaf, so that when the leaf edges roll inward, the stomata are effectively shut away from the outside air. As the stomata are situated on the inner surface of the leaf, the air enclosed by the rolled leaf soon becomes saturated with water arid the outward water diffusion stops.

Reduced Leaf Surface

In many xerophytes, reduction of the leaf surface partly checks water loss because the total exposed surface of the plant body is relatively small as compared with that of normal mesophytes (*Casuarina*). In such xerophytes the leaves are either scale-like or very small in size. Generally they are not found in the mature plant, or they persist as small scales or bracts.

In some plants the photosynthesis takes place in the stem where assimilatory tissues are well- developed. The reduction of leaf surface is usually accompanied by well-evolved sclerenchyma, water storage tissue and sunken stomata. Xerophytes, with reduced leaves, are called microphyllous.

Water Storage Tissue

Many fleshy xerophytes contain water storage tissue and mucilaginous substance in them. In leaves such tissues are situated beneath the upper or the lower epidermis or upon both sides of the leaf and sometimes in the centre too. The storage cells are visually large and often thin-walled, as in Begonia. The storage tissue can actually serve as a source of reserve water during drought. The xerophytes, that possess fleshy leaves or stems, are called malacophyllous.

Abundant Palisade Parenchyma

In the stems of several xerophytes, the palisade tissue is present (*Capparis decidua*). In the xerophytic leaves the palisade is abundant and completely arranged.

Latex Tubes

In many xerophytic stems and leaves the laticiferous canals are present (*Calotropis*, *Euphorbia*). Because of viscosity latex the transpiration is reduced to some extent.

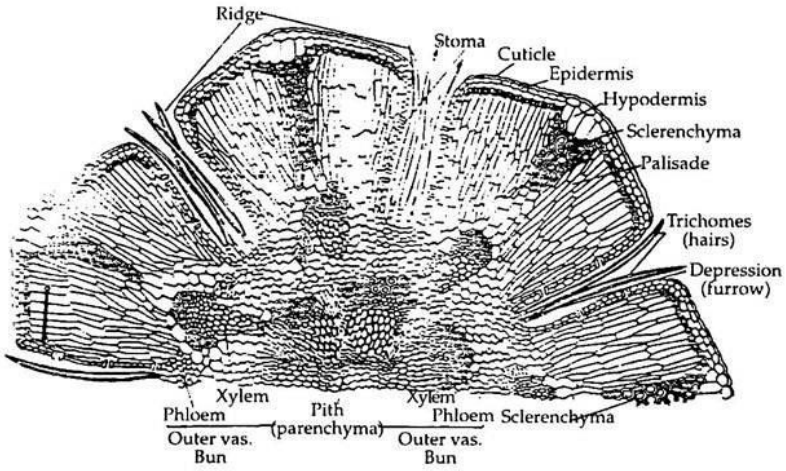


Fig. Xerophytes, T.S. of a xerophytic stem *Casuarina equisenfolia*—dicot).

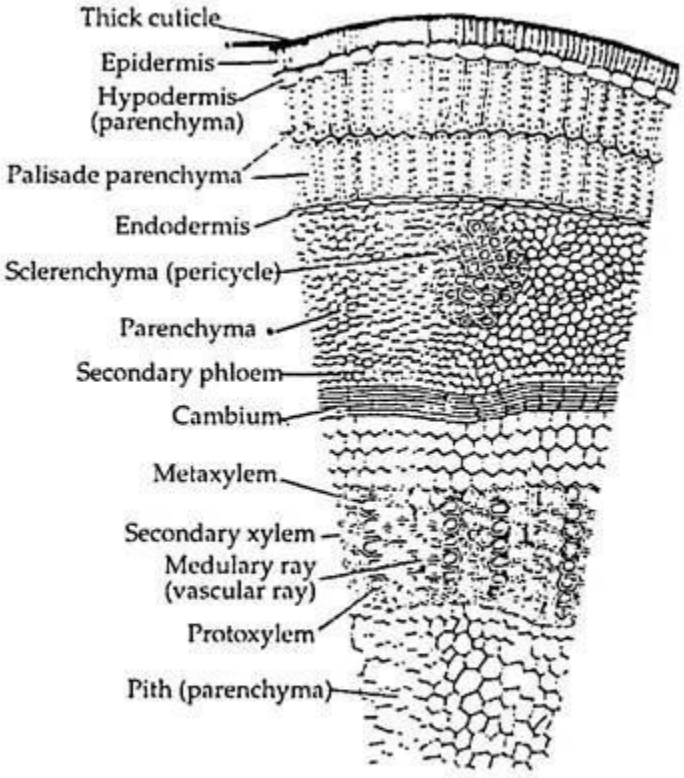


Fig. Anatomy of xerophytic stem. T.S. of stem of *Capparis decidua* (dicot.)—detail of a sector.