Bio Factsheet

Number 84

Xerophytes and Hydrophytes

Xerophytes are plants which are morphologically adapted to dry conditions i.e. arid or semi arid environments. It is wrong to say that all xerophytes prefer dry conditions - many grow better in moist environments than dry environments - however they do have the innate capacity to respond to and survive drought conditions. In contrast, **hydrophytes** are adapted to grow in habitually wet environments. This Factsheet compares Xerophytes and Hydrophytes.

Perhaps the best known Xerophytes are succulents such as the Cactacea. Typically, succulents possess:
- extensive, shallow root systems, for rapid absorption of even light rainfall.
- large, thin-walled cells in stems and roots for water storage
- low surface area : volume ratio
- roots which quickly grow new root hairs following rainfall
- high concentrations of pentose compounds which may increase the water holding capacity of cells

Xerophytes possess many other features which:

1. Increase their ability to absorb any available water.
2. Reduce their water loss.

These features include:
- pale, waxy, hairy or scaled leaves, which are therefore highly reflective (this reduces their temperature, hence reduces water loss).
- thickened epidermis to reduce cuticular transpiration.
- reduced leaf area. E.g. replacement of true leaves by thorns (cactus/gorse). (Stems may be green and photosynthetic to compensate for the loss of leaf area).
- reduced number and size of stomata.
- sunken stomata e.g. Erica and Privet. Stomata may also be in grooves or surrounded by hairs. The effect of these adaptations is to create a pocket of water vapour which hence decreases water loss by transpiration.
- well-developed sclerenchyma or other mechanical tissue (prevents collapse due to wilting)
- well-developed tap roots.

In contrast, hydrophytes are often found growing in water. The water offers support so hydrophytes need little mechanical supporting tissue (sclerenchyma) and instead have parenchyma with many air spaces; such tissue is called **aerenchyma**. The water reduces both the amount of light reaching the plant and the speed of gaseous diffusion (gases diffuse through liquids slower than they do through air). In order to maximise the amount of light available for photosynthesis, aquatic hydrophytes often possess:

- large thin leaves
- epidermal cells which contain chloroplasts
- much aerenchyma for rapid gas exchange and flotation (Fig 1)
- Thin cuticle

> ***Remember** - carbon dioxide is readily soluble in water but oxygen is not. Oxygen thus accumulates in the aerenchyma which acts as an oxygen 'store'. Aerenchyma may also transport oxygen from the aerial parts to submerged parts - a process aided by the movement of the plant caused by water currents.*

Since the water offers buoyancy, aquatic hydrophytes often possess poorly developed root systems as nutrients are absorbed by the epidermal cells).

Aerial and submerged leaves on the same plant may be morphologically different-such plants are said to show **dimorphism**.

> **Common examples**
> Xerophytes:
> Ammophila arenaria (marram grass), Pinus sylvestris (Scots pine)
>
> Hydrophytes:
> Potamogeton natans (Broadleaved Pondweed), Nymphaea alba (Water Lily)

> ***Exam Hint** -The most common exam questions:*
> 1. *Ask you to suggest reasons for the adaptations of named xerophytes and hydrophytes – they may give you common examples e.g. Ammophila, Pinus (xerophytes), Potamogeton, Nymphaea (hydrophytes) or really unusual ones, but it doesn't matter because the principles are exactly the same.*
> 2. *Give you a drawing of part of a plant and then ask you to suggest and explain what type of habitat it grows in.*

Fig 1. TS stem Potamogeton natans (Broadleaved Pondweed)

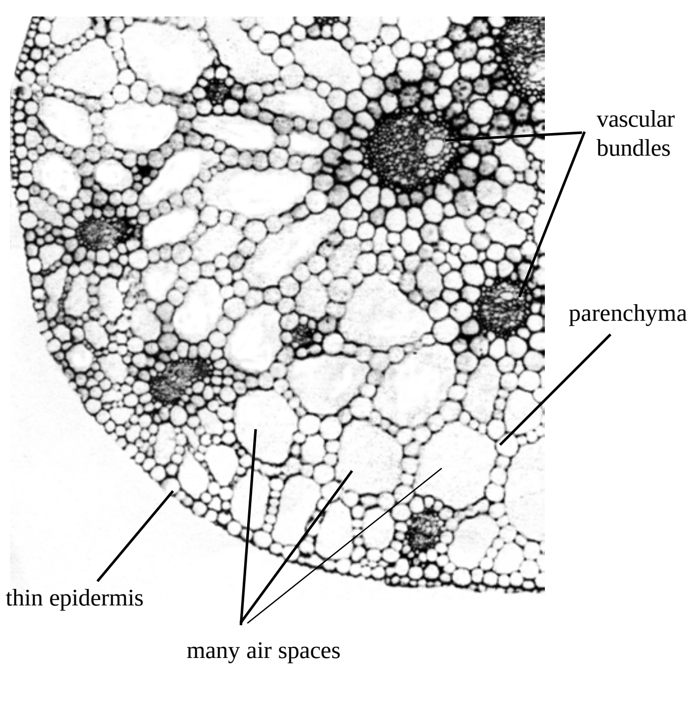


Fig 2. TS Pinus sylvestris (Scots Pine) needle

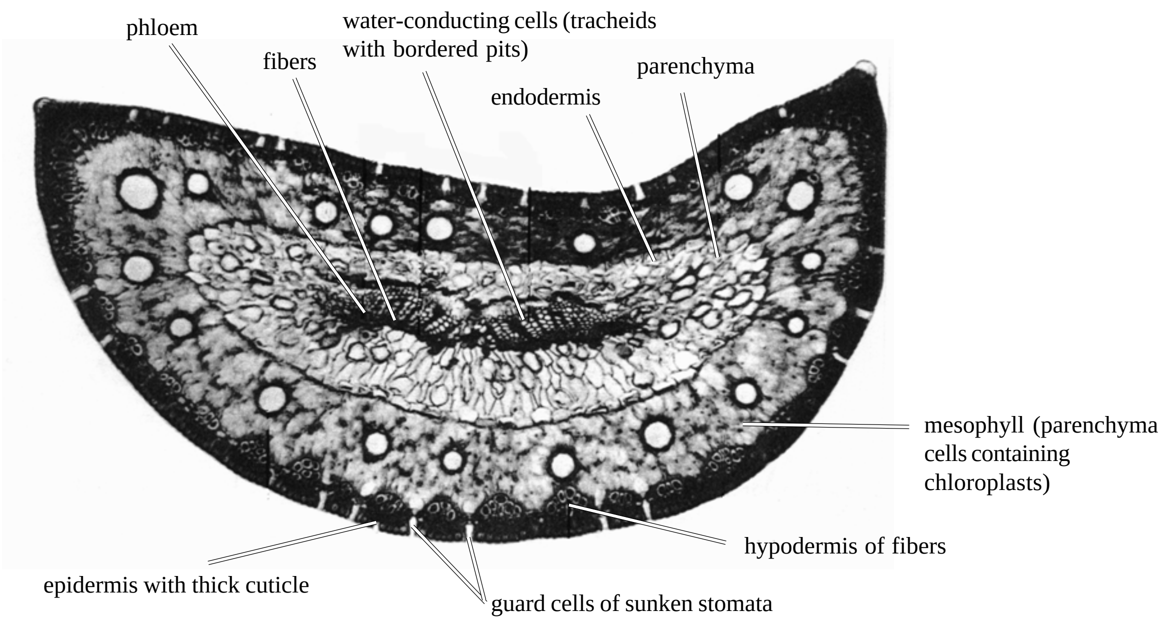


Fig 3. TS leaf of marram grass (Ammophila arenaria)

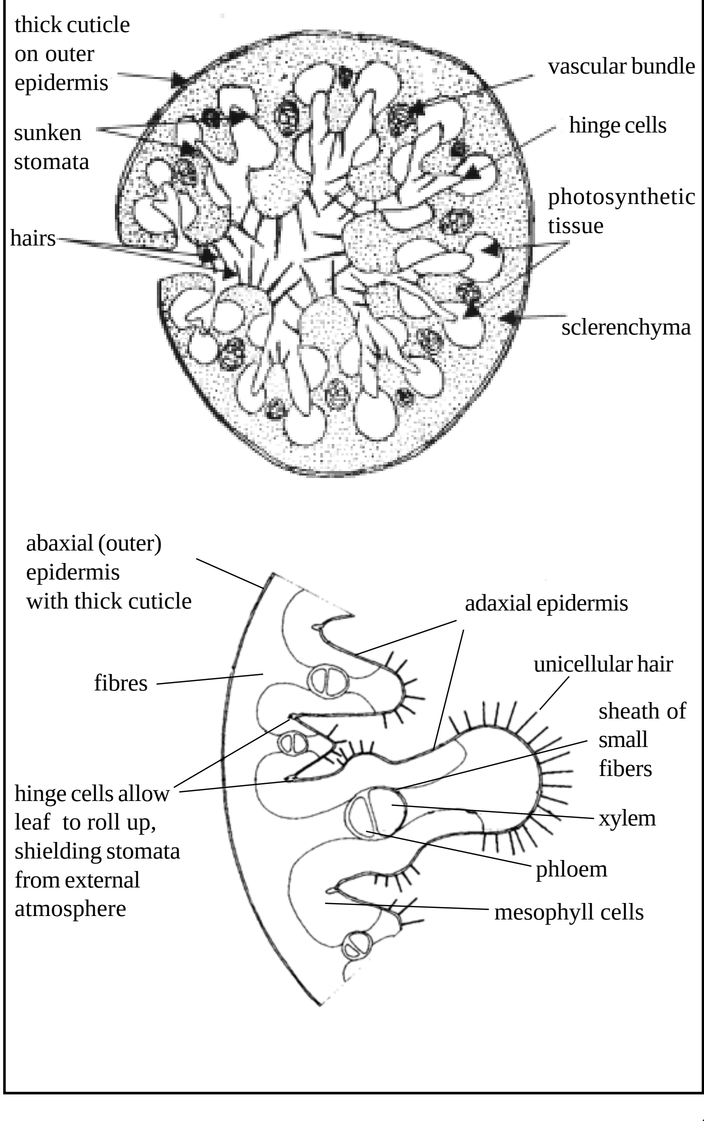
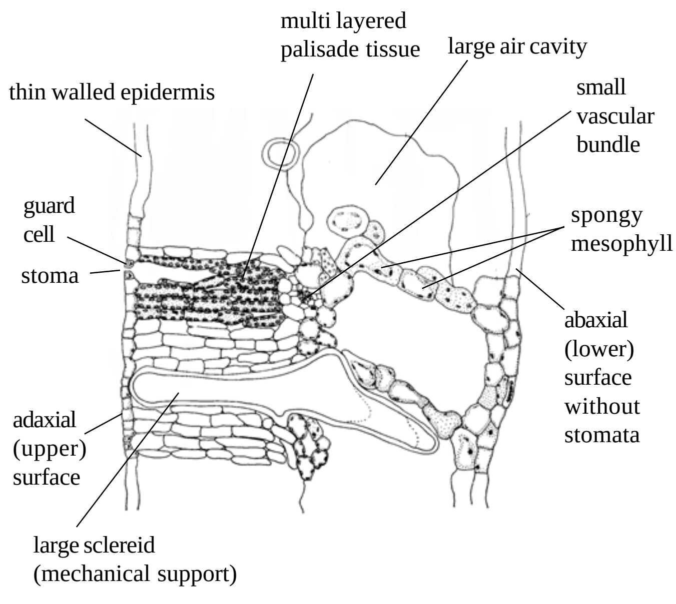
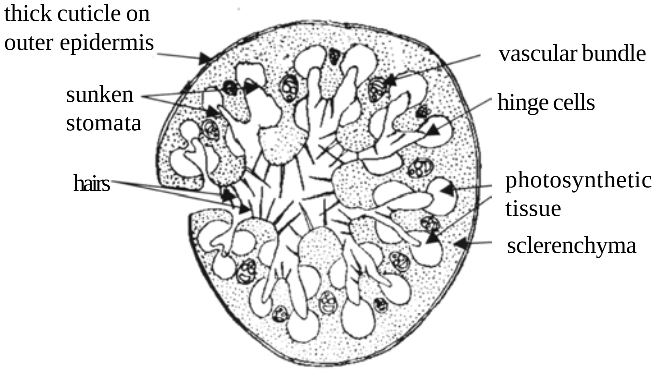


Fig 4. TS leaf of Water Lily (Nymphaea)



Practice Questions

1. The diagram shows a section through the leaf of the xerophytic plant, Marram grass (Ammophila arenaria) which grows on sand dunes.

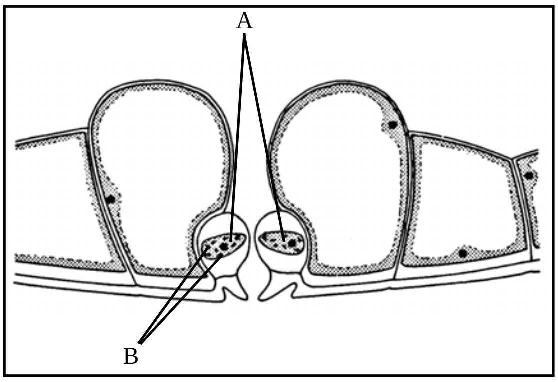


(a) Define the term xerophyte. 1

(b) State and explain the xerophytic features shown by Ammophila. 5

Total 6

2. The diagram shows details of the cells in the lower (abaxial) surface of a holly leaf.



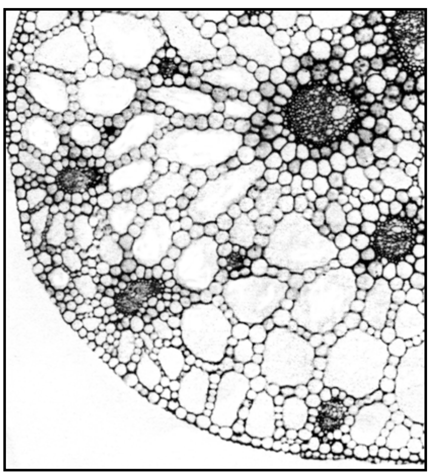
(a) Name :
(i) Cells A. 1

(ii) Organelles B. 1

(b) Explain why the arrangement of cells shown may be described as a xerophytic adaptation. 3

Total 5

3. The diagram shows a part of a transverse section through the stem of Broadleaved Pondweed (Potamogeton nutans).



State and explain the significance of three features of this stem which are typical of plants which are found in aquatic environments.

Feature 1. 1
Significance. 2

Feature 2. 1
Significance. 2

Feature 3. 1
Significance. 2

Total 9

Answers

1. (a) plant adapted to growing in arid/dry conditions/adapted to preventing water loss; 1

(b) small leaf surface area : volume ratio/rolled up leaf reduces surface area so reducing water loss/area exposed to sun/wind;
outer epidermis has no stomata;
outer epidermis has thick cuticle;
so reducing evaporation loss;
hairs reduce air movement around stomata and so reduce water loss/hold moist air around stomata;
hinge cells shrink if high transpiration rate occurs, causing leaf to roll up tighter/more thus reducing water loss; max 5
Total 6

2. (a) (i) guard cells; 1

(ii) chloroplasts; 1

(b) xerophytes are plants adapted to living on arid/dry conditions/have features which reduce water loss;
chamber in front of stomatal pore will reduce air movement;
thus increase immediate humidity/decrease diffusion gradient/water loss;
thickened cuticle reduces evaporation loss; max 3
Total 4

3. (a) Feature: large/many air spaces/aerenchyma; 1
Significance: provide buoyancy/helps leaf to float on/near surface; where light intensity is high/oxygen/CO_2 available; stores/transports oxygen; max 2

Feature: thin epidermis/no cuticle; 1
Significance: helps/speeds up gas exchange; no problem with transpiration loss; 2

Feature: central vascular bundles; 1
Significance: peripheral 'cylinder' of vascular bundles found in terrestrial plants gives strength/rigidity to stems which is not needed (in an aquatic environment); holds flowers above water allowing pollination/seed dispersal; max 2
Total 9

Acknowledgements;
This Factsheet was researched and written by Kevin Byrne
Curriculum Press, Unit 305B, The Big Peg, 120 Vyse Street, Birmingham. B18 6NF

ISSN 1351-5136