IDENTIFICATION KEY

C.B. de Jong, 2008, 2011, Resource Ecology

Unless otherwise stated pictures in this paper are from the reference collection by C.B. de Jong.
Terminology of epidermis features is from Watson, L., and Dallwitz, M.J. 1992 onwards.

In microhistological diet analysis of herbivores, epidermis and/or cuticle fragments of plants and sometimes animals are used for identification. Identifying and measuring 100 fragments of at least 0.01 mm^2 in 20 transects gives a quantitative estimate of at least 5% of the total ingested dry matter (Stewart, 1967). Fragments measuring under 0.01 mm^2 cannot be used as in many species they do not show suficient significant details (Van der Steege, 1981; Buil, 1982).
Epidermis fragments of dry fruits are found in several layers, measuring them can give a very rough indication of ingested dry fruit matter.

Diet analysis of herbivores and omnivores.

Fragments that are useless for diet analysis.

Animal fragments in herbivore dung: hairs or feathers of the same species, Arthropod fragments ingested with plants. Fragments of dung beetles etc.
Plant material picked up with food plants: grass anthers and awns, dead conifer needles.
Internal tissue of food plants: Most plant parenchyma, xylem vessels.

Fragments that can give an indication of diet composition

Plant fragments measuring under 0.01 mm^2, including loose hairs and glands.
Specific parenchyma cells e.g. arm cells.
Secondary xylem (wood splinters, can be counted).
Secondary cork (tree bark, fragments can be counted).
Hairs or feathers of prey animals in omnivorous species (can be scored).

Fragments to be used for a *very rough* quantitative analysis.

Corky outside of seeds and dry fruits: measuring all layers found
Invertebrate epidermis and cuticle (omnivorous rodents!)

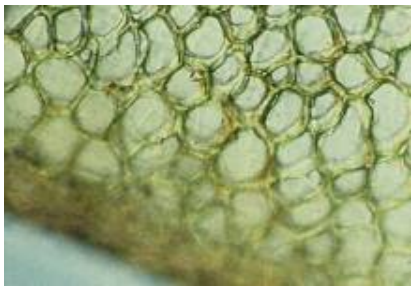
Fragments to be used for quantitative diet analysis.

Buds and thin woody twigs: **corky epidermis.**
Leaves, stems and juicy fruits: **epidermis and cuticle**.

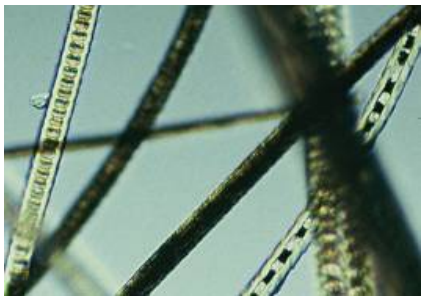
ANIMAL FRAGMENTS

In herbivore diets, plant fragments are the food to be identified. However, some insects will be ingested and also hairs or feathers of the animals themselves. In diets of omnivorous animals like rodents small invertebrates are more common and have to be taken into account as diet components.

Animal hairs and insect cuticles can look deceptively like plant epidermis.

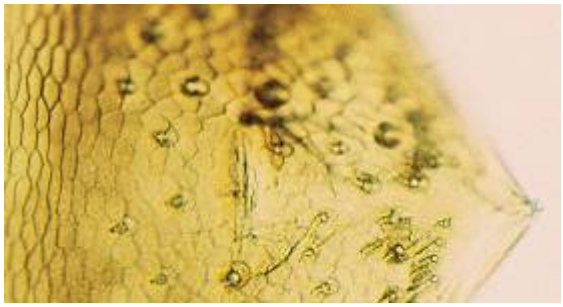


Hair of red deer *Cervus elaphus* ,

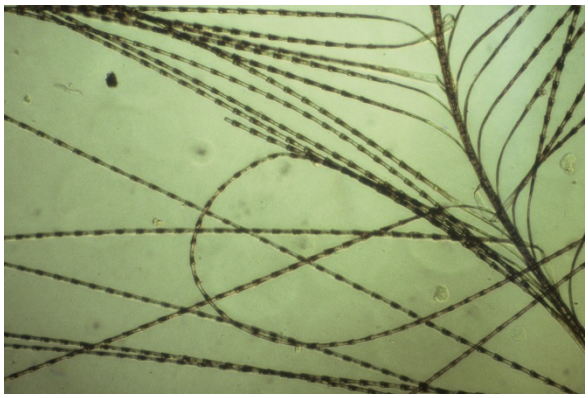


Hairs of rabbit *Oryctolagus cuniculus*

In faeces of omnivorous or carnivorous Arthropod cuticles are diet components and can be counted and measured as plant cuticles. Hairs or feathers of prey animals can be scored.



Tip of Arthropod abdomen from mouse stomach (*Mastomys* 2)



Feather *Anurophasis*

PLANT FRAGMENTS THAT CANNOT BE USED FOR DIET ANALYSIS.

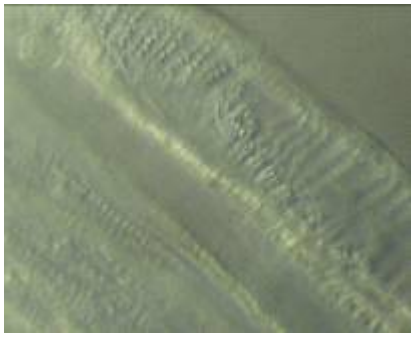
Anthers can be recognized as such but show a very similar pattern and cannot be identified further than dicot or monocot. Grass anthers (and awns) break off easily and spread all over the vegetation.

Anthers of dicots:

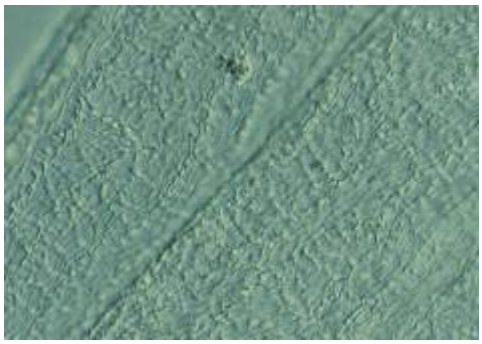
Quercus robur anther

Sambucus nigra anther

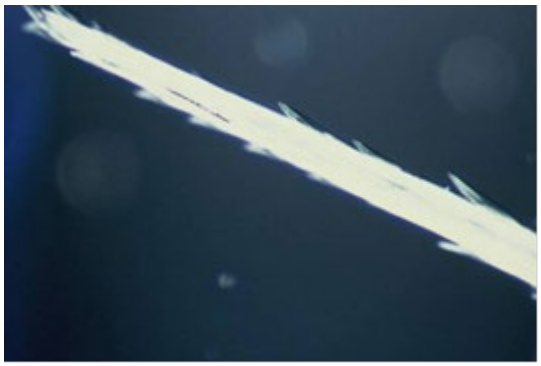
Anthers of grasses:



Agrostis capillaris anther



Holcus lanatus anther

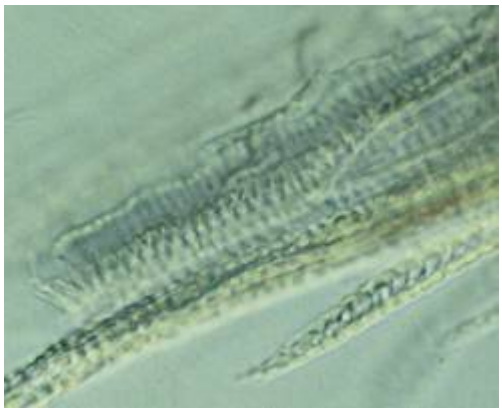


Grass awn (Aristida kerstingii)

PLANT FRAGMENTS THAT CAN GIVE AN INDICATION OF DIET COMPOSITION.
Loose hairs and inner tissue fragments can be an indication for the presence of a certain species but have to be ignored for quantitative analysis.

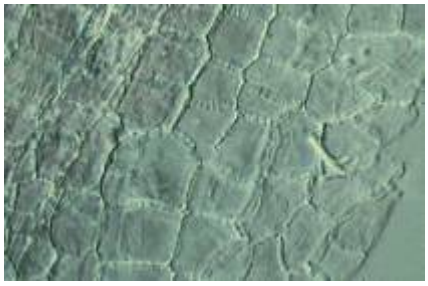
Inner tissue fragments of plants

1. Secondary xylem, wood splinters — USE AS INDICATION, COUNT OR IGNORE
   Counting of wood splinters can be used as an indication for the thickness of browsed branches.

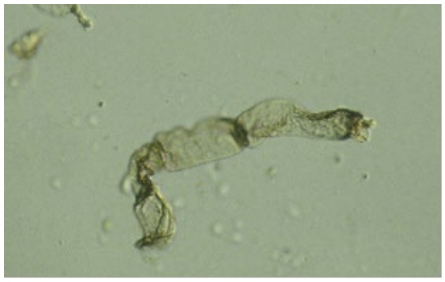


Sorbus aucuparia secondary xylem

Vascular tissue, parenchyma, trichome — USE AS INDICATION OR IGNORE

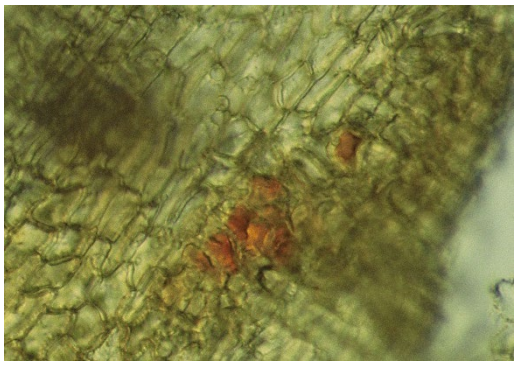


Salix vinimalis cork parenchyma

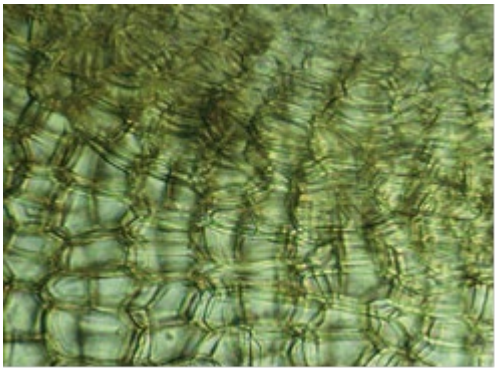


Trichome of *Cirsium* or *Taraxacum* from faeces *Cervus*

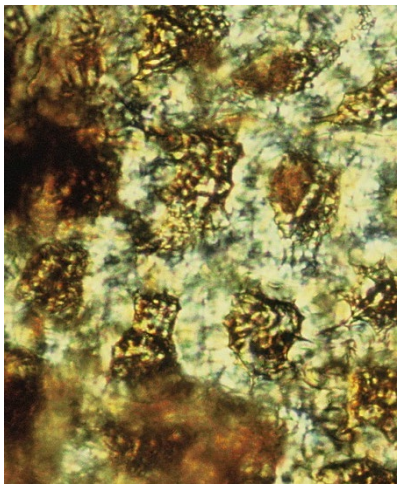
Cork-like fragments that consist of many layers (tree bark or mesocarp of dry fruits).
TREE BARK (COUNT OR IGNORE)



Crataegus monogyna bark of twig



Quercus robur bark of twig

 *Pinus sylvestris* old tree bark

Arm cells

Mesophyll cells with large intercellular spaces; occuring in graminoids growing in marshes

 *Juncus effusus*

FRAGMENTS TO BE USED FOR A VERY ROUGH QUANTITATIVE ANALYSIS

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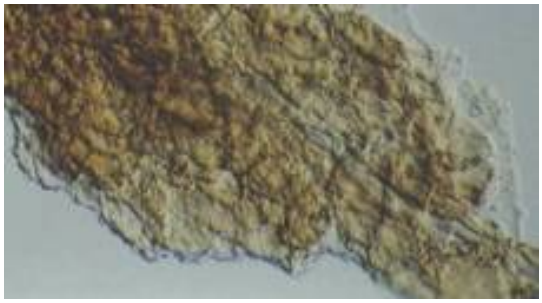
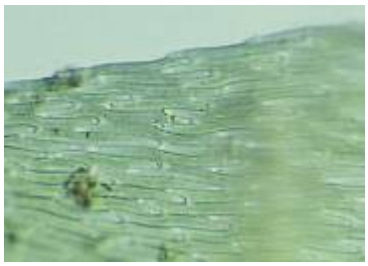
FRUIT MESOCARP e.g. oak (MEASURE)

 *Quercus robur* mesocarp (Faeces *Capreolus*)

Quantitative diet analysis (key)

Plant tissue fragment consisting of one closed layer of cells (epidermis)

1. Epidermis fragment at least 0,01 mm2 2
2. Epidermis cells not differentiated from inner issue, all cells contain chloroplasts or hyaline cells are positioned between cells containing chloroplasts: BRYOPHYTA

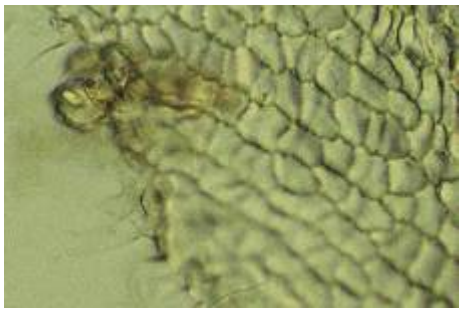


Moss spec.

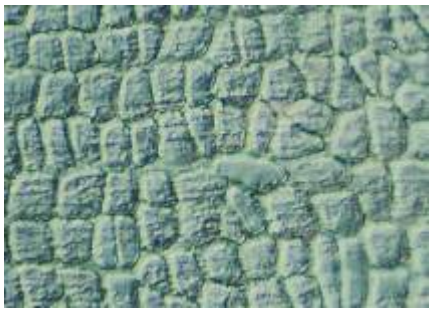
Sphagnum spec.

Epidermis cells differentiated from inner tissue 3

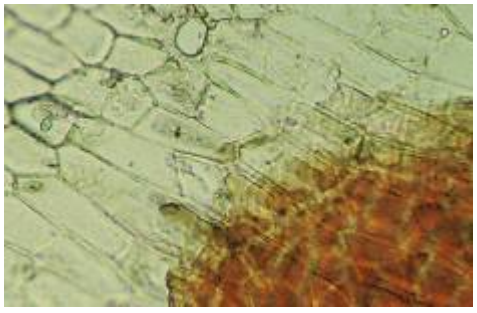
3. Walls of epidermis cells thin or thick, not corky. Epidermis cells arranged more or less parallel.. 4
   Walls of epidermis cells corky, cells arranged more or less parallel, cells more or less isodiametric. BUD SCALE OR STEM OF WOODY DICOT, EXOCARP OF HARD-WALLED FRUIT



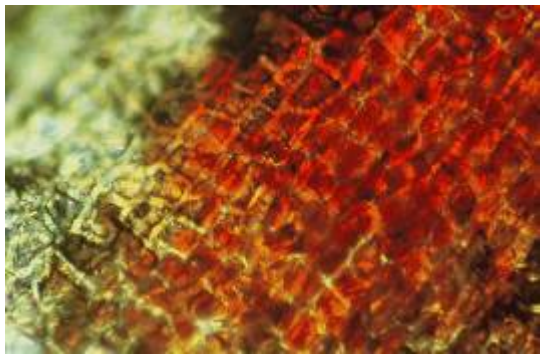
Acer pseudoplatanus (bud)



Quercus robur (fruit exocarp)



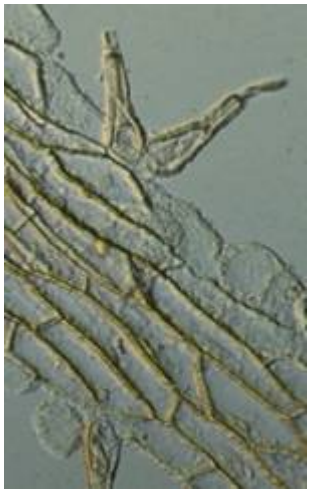
Fagus sylvatica stem (epidermis and cork)



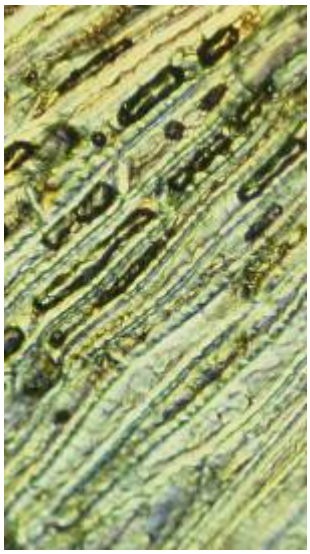
Frangula alnus stem (cork)

Cells arranged in another way 11

4. Most cells elongate. rectangular or spindle-shaped,
Shorter cell walls at an oblique angle to longer walls. ` STEM, BRACT OR VEIN OF BROAD-LEAVED PLANT, LEAF CUSHION OF GYMNOSPERM, FRUIT OF DICOTYLEDON

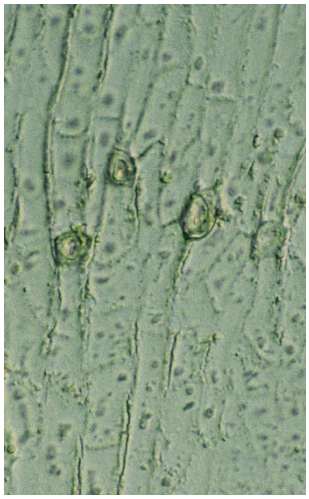


Quercus robur (leaf vein)



Picea abies (leaf cushion)

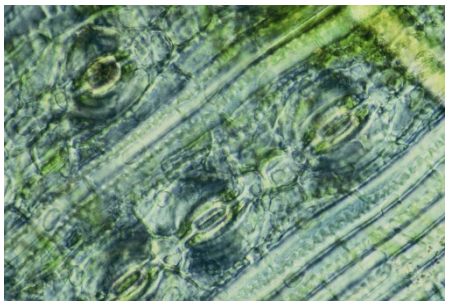
Stellaria graminea (fruit integument)



Ehretia rigida main leaf vein or stalk

Shorter cell walls more or less at a right angle to the long axis of the cells LEAVES OF GYMNOSPERMS OR MONOCOTS OR DICOTS WITH LINEAR LEAVES 5

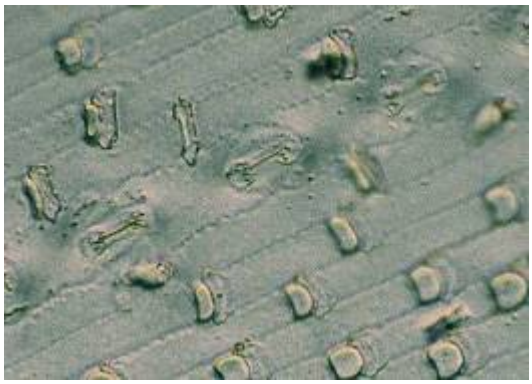
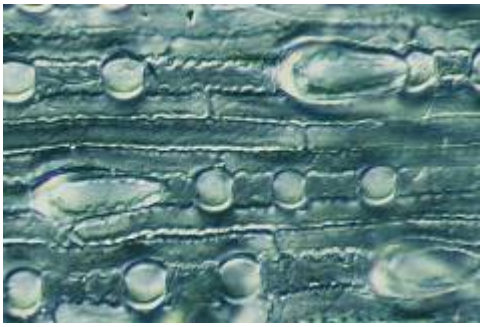
5. Guard cells of stomata in a deep hollow below the level of other epidermis cells LEAVES OF GYMNOSPERMS


Picea abies

Guard cells of stomata more or less level with other epidermis cells
MONOCOTS OR DICOTS WITH LINEAR LEAVES 6

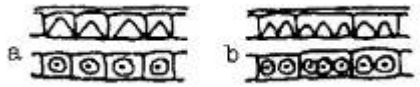
6 . Stomata paracytic (subsidiary cells parallel with guard cells) 7
Subsidiary cells in a different pattern or no clear subsidiary cells present 8

7 . Between the long epidermis cells short cells (cork cells, silica cells, hairs) are placed in a regular pattern, single, in pairs or rows. Guard cells of stomata dumbbell-shaped POACEAE

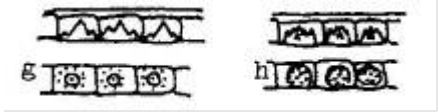


Left: *Sporobolus pyramidalis* : stomata, cork cells and silica cells.
Right: *Chloris gayana*: cork cells and silica cells, prickle hairs.

No short cells between the long ones, guard cells not dumbbell-shaped 8

8. Cells containing conical silica bodies in costal or short intercostal rows CYPERACEAE
Silica crystals in cell walls 9
No silica bodies present 10

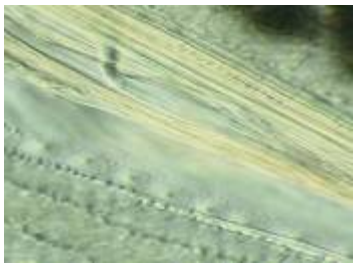


(one-pointed silica bodies, one or more per cell

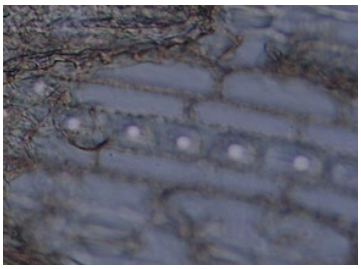


composite silica bodies

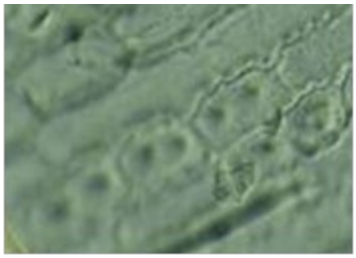
(Metcalfe 1957, Wesseloo, 1984)



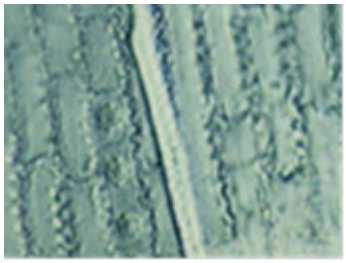
Carex otrubae (a)



Cyperus papyrus(a)

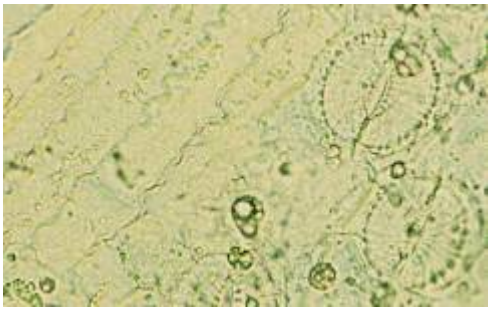


Scirpus maritimus (b)



Eriophorum vaginatum (g)

9. Silica crystals in cell walls Equisetaceae



Equisetum arvense 2

No silica cells present ACORACEAE, ALOACEAE, AMARYLLIDACEAE, ASPARAGACEAE, DRACAENACEA, JUNCACEAE, JUNCAGINACEAE, TYPHACEAE,

10. Dicots with linear leaves (exceptional)

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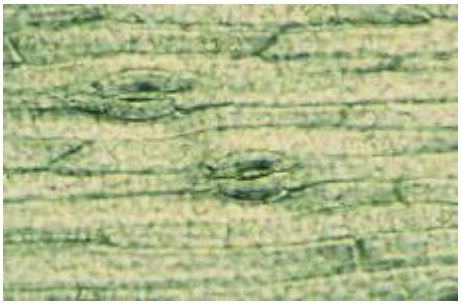
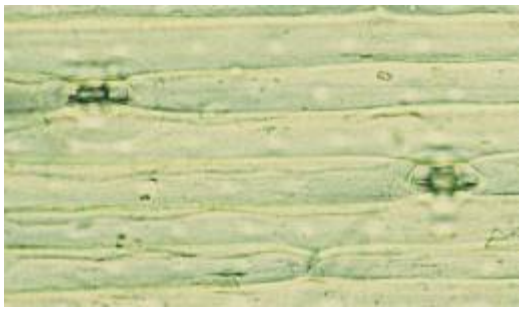


Arenaria capillaris leaf 1

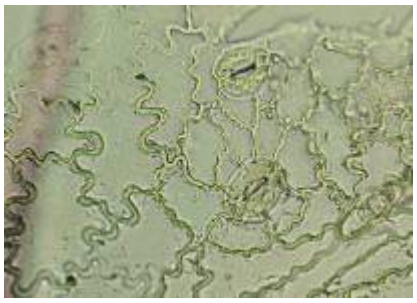
Non-graminoid monocots with linear leaves



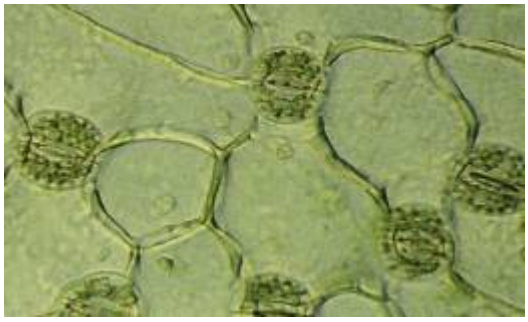
Allium leucocephalum leaf 2

11 Cells not arranged parallel, usually isodiametric. Epidermis cells more or less thin-walled, cell walls straight, bent or wavy.
LEAF OF DICOTYLEDON, FERN OR BROAD-LEAVED MONOCOTYLEDON

Plastids only present in guard cells of stomata
LEAF OF DICOTYLEDON OR SOME MONOCOTYLEDONEOUS FAMILIES.



Fagus sylvatica



Polygonatum multiflorum

Plastids present in all epidermis cells LEAF OF FERNS

Dryopteris dilatata

Stomata tetracytic
Cells thin-walled ARACEAE, COMMELINACEAE

Commelina diffusa

Cells thick-walled, square or angular, same size or smaller than stomata. ARECACEAE

Borassus spec.

References

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Watson, L., and Dallwitz, M.J. 1992 onwards. The grass genera of the world: descriptions, illustrations, identification, and information retrieval; including synonyms, morphology, anatomy, physiology, phytochemistry, cytology, classification, pathogens, world and local distribution, and references. Version: 23rd April 2010. http://delta-intkey.com