THE GREEN KINGDOM

All living organisms, from bacteria to Baobabs, share certain features. They all replicate using DNA, and convert the information stored in their DNA into products for building cellular machinery using fats, proteins and carbohydrates. Scientists work out the relationship between all living things by comparing outward appearances, and more importantly, microscopic cellular composition, and by grouping evolutionarily close organisms together on an evolutionary, or phylogenetic, tree. At the base of the tree is the 'Last Universal Common Ancestor' and at the very tips are the twigs which represent all species – living and extinct.

The factsheet in the September 2012 issue of *Veld & Flora*, vol. 98(3), outlines the basics of biodiversity classification, in which all life forms are grouped into three Domains – Archaea, Bacteria and Eukarya. The latter contains five Kingdoms: Protozoa, Chromista, Plantae, Fungi and Animalia. Be aware that classification schemes are constantly changing and shifting as new discoveries are made, especially in the 'nano-world'. In this factsheet we zoom in on plants and show how they are grouped within the Kingdom Plantae and placed on the phylogenetic tree according to shared characteristics that reflect evolutionary relationships.

THE KINGDOM PLANTAE

The most important feature of plants is a group of pigments called chlorophyll, which gives plants their green colour. Plants use chlorophyll to capture light energy, which fuels the manufacture of food in the form of carbohydrates. Plant life cycles all include an alternation of generations (a haploid-diploid life cycle).

Most plants are terrestrial. The first plants appear to have evolved from the green algae, which have enough physiological features of photosynthesis in common with modern plants to indicate this. One group of green algae, the charophytes (Charophyta; which include *Spirogyra*), is more closely related to plants than to the other green algae.

The fact that all plants have stomata except the liverworts (Hepaticophyta) suggests that liverworts were the earliest group to diverge. Other features used to distinguish different groups within the plant kingdom and to work out their evolutionary relationships, are reproductive strategies (spores, seeds, cones, fruits or flowers, sexual or asexual reproduction), and the presence or absence of features such as vascular tissue (specialized tissue for transporting water and nutrients – xylem and phloem), leaves and roots.

ANCESTRAL GREEN ALGAE

1

NON VASCULAR PLANTS

SEEDLESS

BRYOPHYTES

2

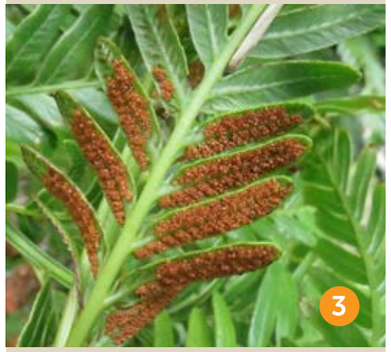
Hepaticophyta (liverworts)
Anthocerotophyta (hornworts)
Bryophyta (mosses)

Bryophytes are primitive plants that were amongst the first to colonise terrestrial habitats 700-450 million years ago. They lack an effective vascular system and thus form low-growing, dense cushions on the ground, on rocks, buildings and on the bark of trees. They require an external water film to reproduce as the sperm need to swim from the male reproductive organs to the eggs in the female organs.

VASCULAR PLANTS

SEEDLESS

PTERIDOPHYTES



3

Psilotophyta (whisk ferns)
Lycophyta (club mosses)
Equisetophyta (horsetails)
Polypodiophyta (ferns)

Pteridophytes dominated the Earth 350 million years ago. Like mosses, these primitive vascular plants need to grow in moist habitats because the sperm needs a film of water in order to reach the eggs in the female reproductive organs.

SEED-PRODUCING

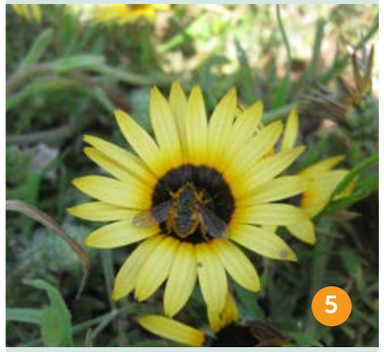
GYMNOSPERMS

4

CONE-BEARING
Ginkophyta (ginkgos)
Cycadophyta (cycads)
Gnetophyta (welwitschias)
Pinophyta (conifers)

Gymnosperms are non-flowering, cone-bearing seed plants that evolved about 365 million years ago and dominated the Earth from 245 – 65 million years ago. There are a few hundred species that occur today, and are mostly evergreen shrubs and trees with needle-like leaves. They produce cones instead of flowers. The seeds are naked in the sense that, at one stage of their development they are not enclosed within an ovary inside the cone.

ANGIOSPERMS



5

FLOWER-BEARING
Anthophyta (flowering plants)

The flowering plants, which contain seeds that are entirely enclosed in the protective ovaries that form the fruit when they mature, are the dominant terrestrial plants today. They evolved about 145 million years ago. Flowering plants are traditionally divided into two groups, based on the number of **cotyledons** on the embryo. Those with two cotyledons are called **dicotyledons** (dicots) while those with only one are called **monocotyledons** (monocots). Current hypotheses about the origin and diversification of flowering plants suggest that the dicots are actually the ancestral group from which the monocots (and others) evolved. Presently, four main groups are recognized: the **basal angiosperms** (a primitive group containing waterlilies), **magnoliids**, **monocots** and **eudicots**. The latter group have a very distinctive pollen structure and comprise well over half the living angiosperms today.

READ MORE

This factsheet follows on from the *Veld & Flora* Factsheet on Classification in the September 2012 issue of *Veld & Flora* 98(3). Available online: http://labpages.blogspot.com/2012/08/volume-983-september-2012.html.

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LINKS TO THE CURRICULUM

Grade 10, Life Sciences, Strand 4: Diversity, Change and Continuity. Topic: Biodiversity and classification, Content: Classification Schemes.

GRADE 11, Life Sciences, Strand 1: Diversity, Change and Continuity. Topic: Biodiversity of Plants. Learners should have a basic understanding of Phylogenetic Trees as reconstructions of evolutionary pathways. Content: Grouping of bryophytes, pteridophytes, gymnosperms and angiosperms.

PHOTOGRAPHS / IMAGES

1. The green alga *Cyanophora paradoxa* represents the earliest lineage to branch off from what became today's land plants. Drawing by Susanne Ruemmele, Bhattacharya Lab. (Reproduced from Albert-Ludwigs-Universität Freiburg. "Origin of photosynthesis revealed by a 'living fossil'"). *ScienceDaily*, 17 February 2012.

2. Moss showing spore capsule on a supporting stalk (seta). Photo: C. Voget.

3. The fern *Todea barbara* with spore capsules on the underside of the leaf. Photo: Diane Turner, iSpot.

4. A dinosaur in amongst the cycads (*Encephalartos latifrons*) at Kirstenbosch. Photo: C. Voget.

5. The daisy *Arctotheca calendula* with bee pollinator. Photo: C. Voget.

TEXT adapted by Caroline Voget from the book *The Story of Life and the Environment: An African perspective* by Jo van As, Johann du Preez, Leslie Brown and Nico Smit, published by Struik Nature.

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http://labpages.blogspot.com.