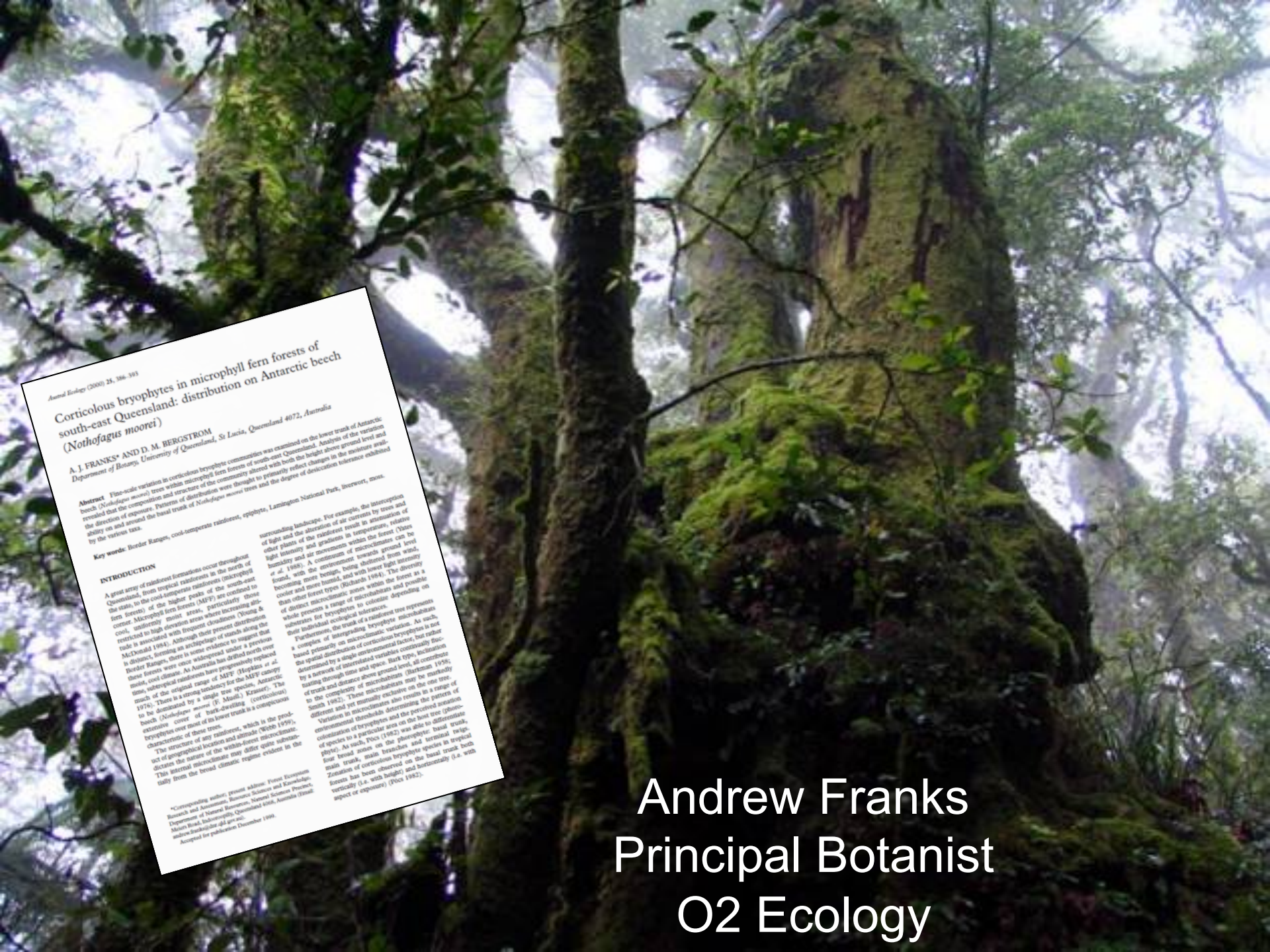
The Wonderful World of the Bryophytes



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Corticolous bryophytes in microphyll fern forests of south-east Queensland: distribution on Antarctic beech (*Nothofagus moorei*)

A. J. FRANKS* AND D. M. BERGSTROM
Department of Botany, University of Queensland, St Lucia, Queensland 4072, Australia

Abstract Fine-scale variation in corticolous bryophyte communities was examined on the lower trunk of Antarctic beech (*Nothofagus moorei*) trees within microphyll fern forests of south-east Queensland. Analysis of the variation revealed that the composition and structure of the community altered with both the height above ground level and the direction of exposure. Patterns of distribution were thought to primarily reflect changes in the moisture availability on and around the basal trunk of *Nothofagus moorei* trees and the degree of desiccation tolerance exhibited by the various taxa.

Key words: Border Ranges, cool-temperate rainforest, epiphyte, Lamington National Park, liverwort, moss.

INTRODUCTION

A great array of rainforest formations occur throughout Queensland, from tropical rainforests in the north of the state, to the cool-temperate rainforests (microphyll fern forests) of the higher peaks of the south-east corner. Microphyll fern forests (MFF) are confined to cool, uniformly moist areas, particularly those restricted to high elevation areas where increasing altitude is associated with frequent cloudiness (Young & McDonald 1984). Although their present distribution is distinct, forming an archipelago of stands along the Border Ranges, there is some evidence to suggest that these forests were once widespread under a previous more, cool climate. As Australia has drifted north over time, subtropical rainforests have progressively replaced much of the original range of MFF (Hopkins *et al.* 1976). There is a strong tendency for the MFF canopy to be dominated by a single tree species, Antarctic beech (*Nothofagus moorei* (F. Muell.) Krasser). The extensive cover of bark-dwelling (corticolous) bryophytes over most of the lower trunk is a conspicuous characteristic of these trees.

The structure of any rainforest, which is the product of geographical location and altitude (Webb 1959), dictates the nature of the within-forest microclimate. This internal microclimate may differ quite substantially from the broad climatic regime evident in the surrounding landscape. For example, the interception of light and the alteration of air currents by trees and other plants of the rainforest result in attenuation of light intensity and gradients in temperature, relative humidity and air movements within the forest (Nunez *et al.* 1988). A continuum of microclimates can be found, with the environment towards ground level becoming more benign, being sheltered from wind, cooler and more humid, and with lower light intensity than other forest types (Richards 1964). The diversity of distinct microclimatic zones within the forest as a whole presents a range of microhabitats and possible substrates for bryophytes to colonize depending on their individual ecological tolerances.

Furthermore, the trunk of a rainforest tree represents a complex of intergrading bryophyte microhabitats based primarily on microclimatic variation. As such, the spatial distribution of corticolous bryophytes is not determined by a single environmental factor, but rather by a network of interrelated variables continually fluctuating through time and space. Bark type, inclination of trunk and distance above ground level, all contribute to the complexity of microhabitats (Barkman 1958; Smith 1982). These microhabitats may be markedly different and yet mutually exclusive on the one tree. Variation in microclimates also results in a range of environmental thresholds determining the pattern of colonization of bryophytes and the perceived zonation of species to a particular area on the host tree (phorophyte). As such, Pócs (1982) was able to differentiate four broad zones on the phorophyte: basal trunk, main trunk, main branches and terminal twigs. Zonation of corticolous bryophyte species in tropical forests has been observed on the basal trunk both vertically (i.e. with height) and horizontally (i.e. with aspect or exposure) (Pócs 1982).

*Corresponding author; present address: Forest Ecosystem Research and Assessment, Resource Sciences and Knowledge, Department of Natural Resources, Mines and Energy, Meiers Road, Indooroopilly, Queensland 4068, Australia (franks.andrew@dme.qld.gov.au).
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Andrew Franks
Principal Botanist
O2 Ecology

What is a bryophyte?

Bryophytes:

"Bryophyte" is a collective term for three distinct groups of plants

Bryophytes:

Mosses
(Bryophyta)

Hornworts
(Anthocerotophyta)

Liverworts
leafy & thallose
(Marchantiophyta)

These are NOT bryophytes...

fruticose lichen

***Coenogonium* sp.**

filamentous
micro-lichen

foliose lichen

and nor are these...

← *Crepidomanes saxifragoides,* a filmy fern (fronds <2 cm)

Selaginella ciliaris, a fern-like plant (Lycophyta) →

← Spanish moss, a bromeliad

and neither are these...

← Club moss, a lycopod

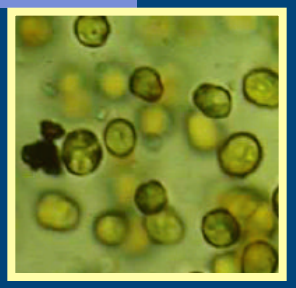
Iceland moss, a lichen →

← Irish moss, an algae

Introduction to Bryophytes

Evolution of plants

Unicellular algae



Multi-cellular algae

Non-vascular plants – **bryophytes**

Vascular non-seed plants – ferns

Seed non-flowering plants - gymnosperms

Flowering plants - angiosperms

Bryophytes


MOSS


leafy LIVERWORT


thalloid


HORNWORT

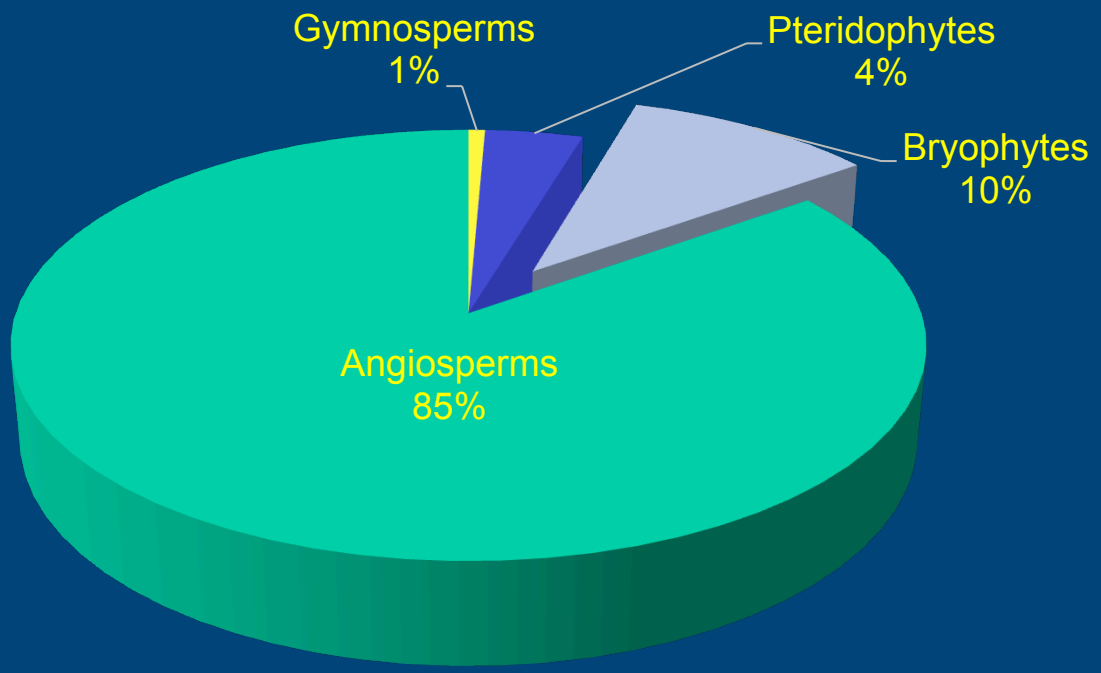
Approx. 20,000 extant species worldwide in the three bryophyte groups:

Mosses (12,700 species)

Liverworts (7,000 species)

Hornworts (150 species)

Census of the Queensland Flora (2013)



	Angiosperms	Gymnosperms	Pteridophytes	Bryophytes
NT	418	8	23	0
V	355	10	26	0
E	182	9	13	0
X	12	0	10	0
Total	967	27	72	0

Characteristics of bryophytes

Bryophytes are distinguished from all other plants by features they do not possess

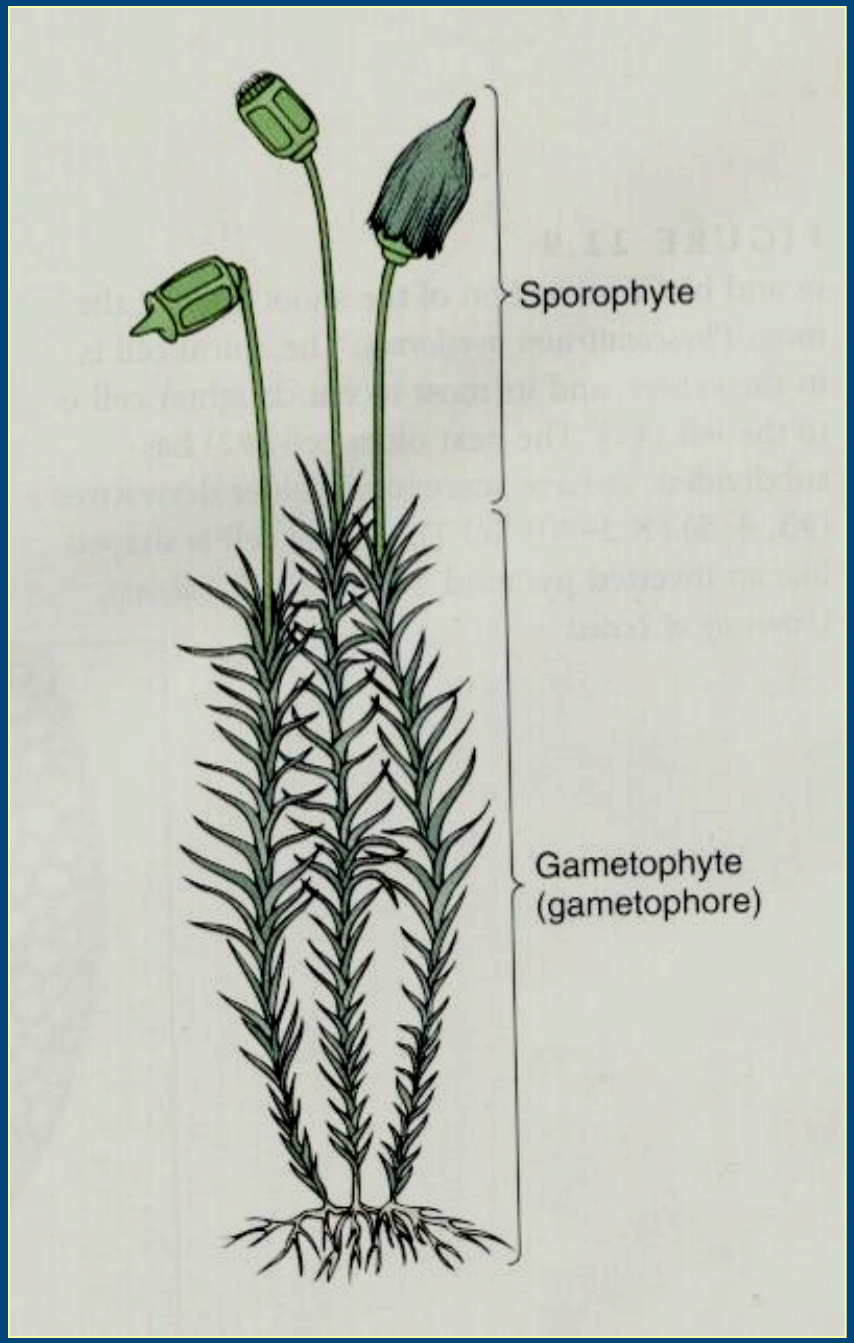
All bryophytes lack:

- Flowers and seeds (produce spores)
- Woody material (lignin)
- Roots (have rhizoids)
- Vascular system
- Cuticle layer

Characteristics of bryophytes

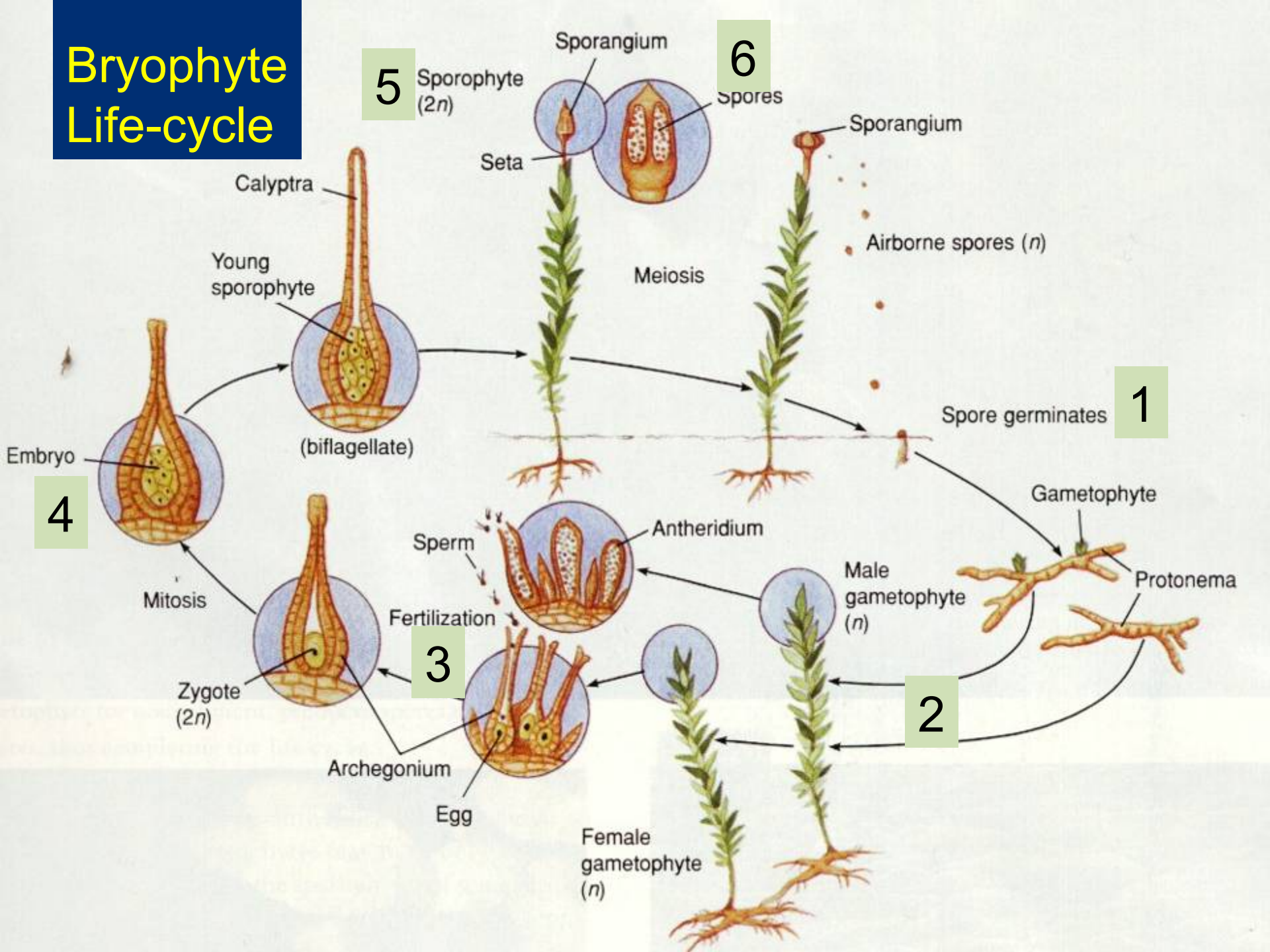
- Small size (few mm to <1m)
- Alternation of generations lifecycle
- Gametophyte dominant phase
- Simple unbranched dependent sporophyte
- Poikilohydric: no/little regulation of H_2O relations, drying-rehydration cycles
- Tolerant to desiccation
- Totipotency: fragments regenerate new plants
- Grow as turfs, cushions, mats, hanging



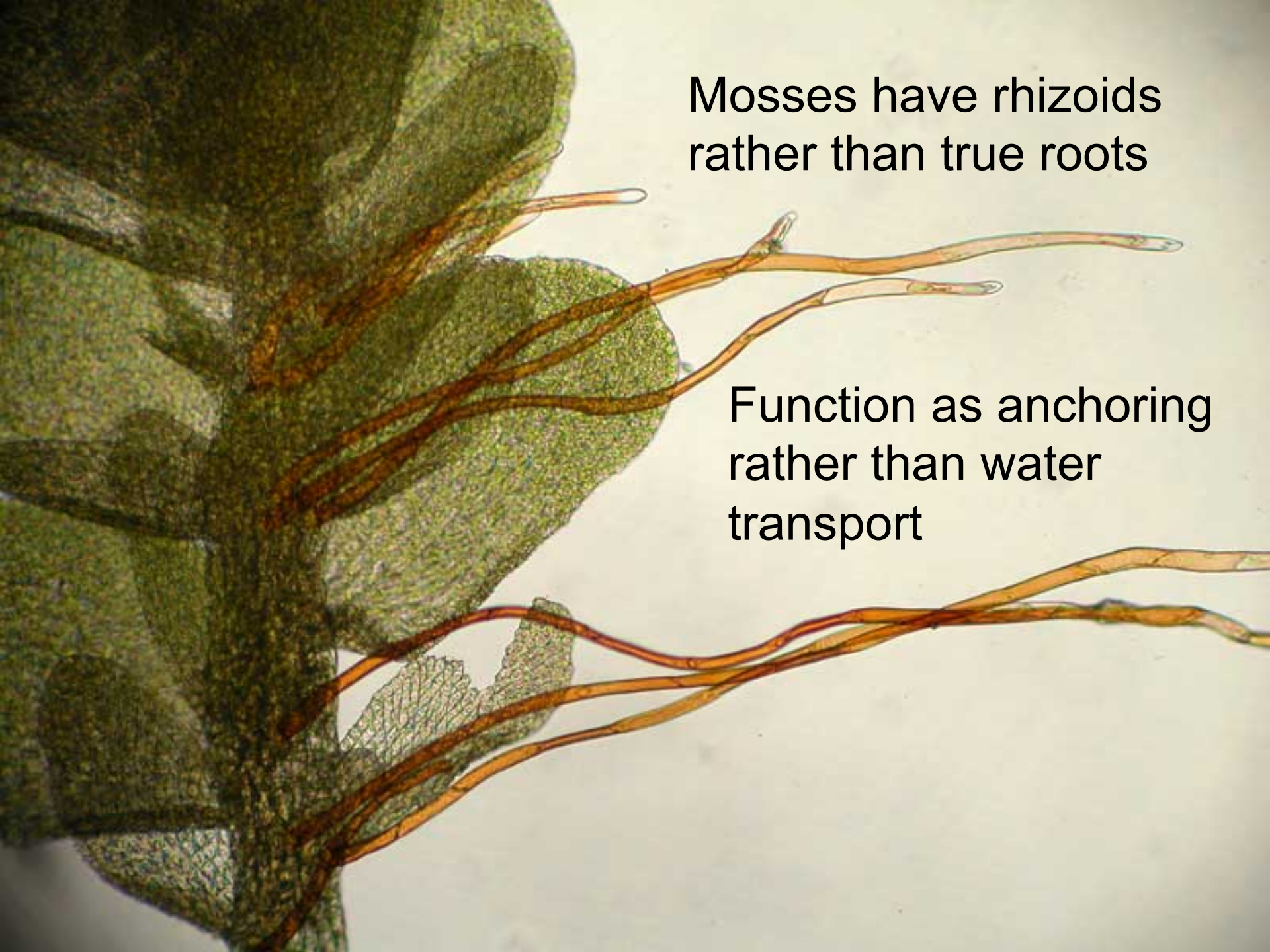
Gametophyte is the plant body which supports the sporophyte

Bryophyte Life-cycle



Amazing bryophytes
Just add water...

Many bryophytes can dry out and rehydrate without permanent damage.
This trait is called ‘poikilohydry’


Mosses have rhizoids rather than true roots
Function as anchoring rather than water transport

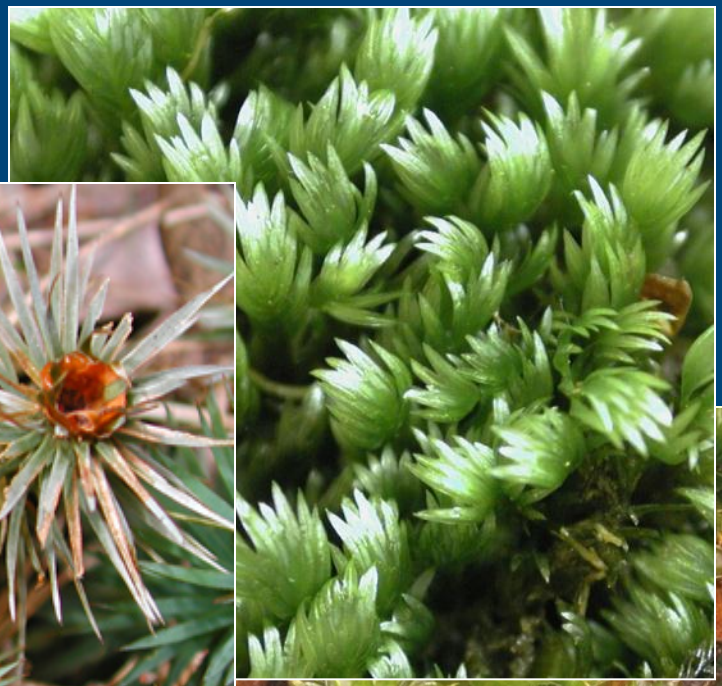
Characteristics of bryophytes

- High diversity in mesic environments
- Main flora in frigid polar environment
- Primary succession (after lichen): enhance rock weathering, trap particles, aid soil formation
- Grow from coastal to alpine habitats, arid zone to rainforest to polar areas
- Occur on a variety of substrates:
  - soil, rock, tree trunks, leaves, other bryophytes, bones, rotting wood, walls, roads etc.




The Mosses, Liverworts and Hornworts

Mosses



Mosses

- Most diverse and largest group of bryophytes with 12,700 species

- Small (1-2mm tall) – large (*Dawsonia* 50cm)

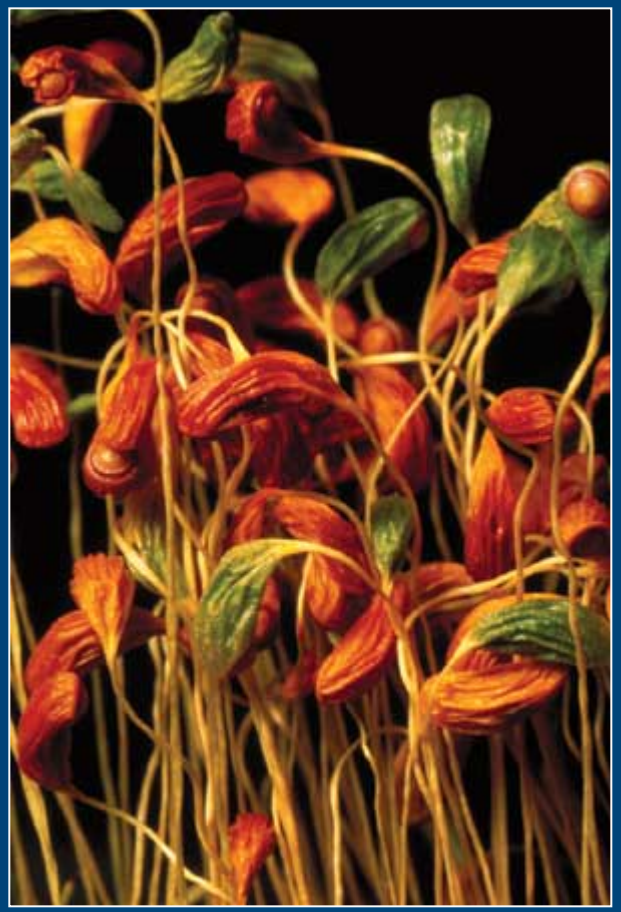
- Luminous (glowing) in cave entrances *Schistostega* with lens-like cells to concentrate dim light

Mosses

CHARACTERISTICS:

- Leafy, erect and little branched or creeping with many branches
- 'Leaves' 1 cell thick, generally spirally arranged on stem (Note: there are always exceptions!)
- Costa (leaf midrib) may be present
- Leaves may have serrated margins but never with lobes
- Seta elongates over extended period
- Sporophyte = foot, seta, and capsule

Characteristics of mosses…



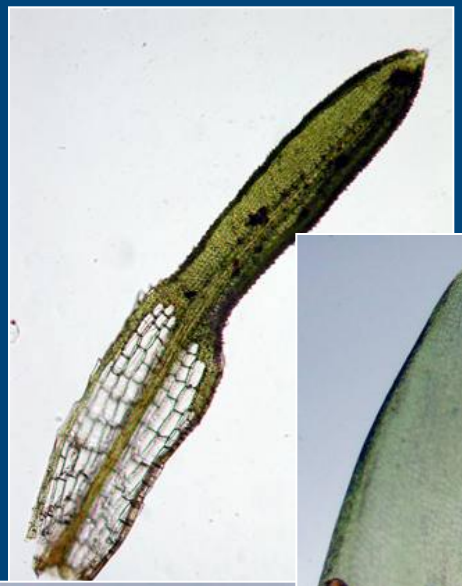
http://www.anbg.gov.au/cryptogams/underworld/panel-2/images-large/B6.jpg&imgrefurl

http://www.microscopy-uk.org.uk/mag/artjul98/jpmoss.html

The sporangium in mosses is called a capsule.

Movement of a single or double circle of teeth inside the mouth of the capsule – the peristome teeth – allow spores to disperse.

Characteristics of mosses…



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*

The costa may be absent, single, or double; leaves may be bordered or not; margins may be serrated or entire…

Characteristics of mosses…


Leptodictyum sp.

Leaves commonly spirally arranged on the stem…

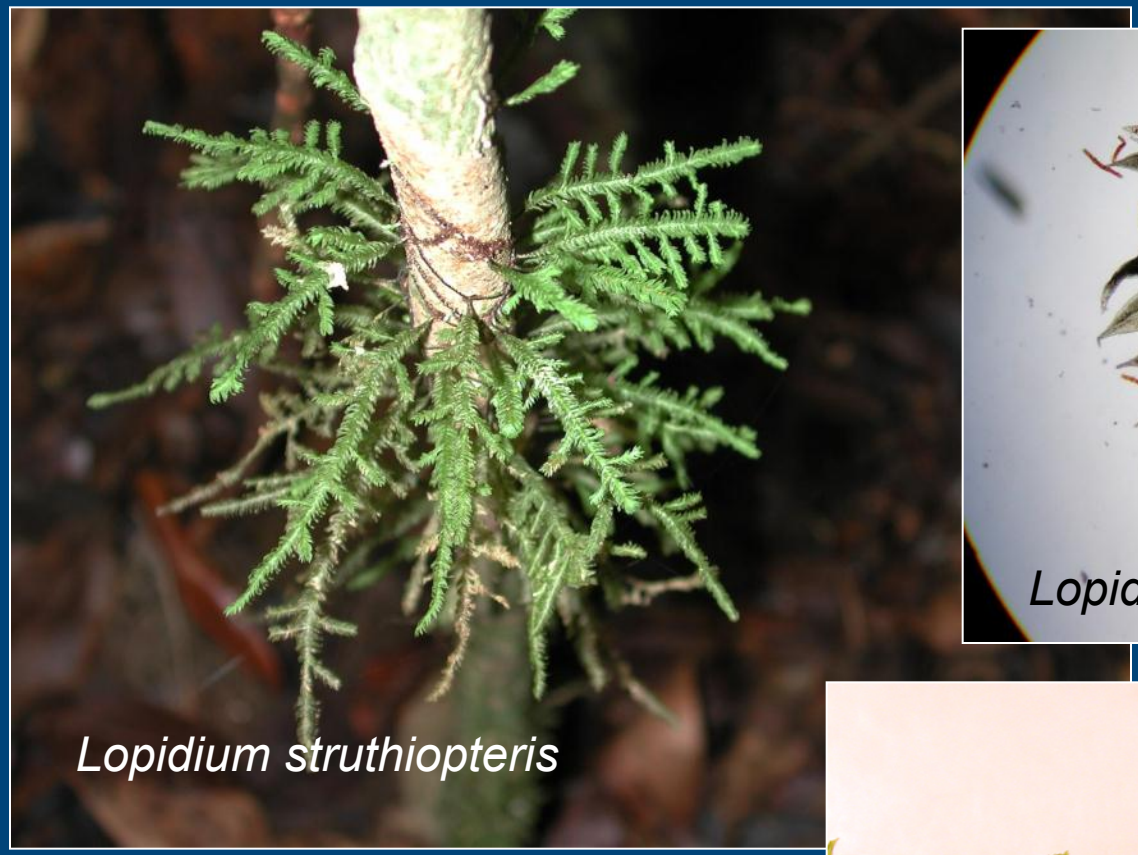

Hypnodendron vitiense


Campylopus sp.


Leucobryum candidum

*

Characteristics of mosses…


Lopidium struthiopteris


Lopidium struthiopteris

…or not spirally arranged


Mesochaete taxiforme

Brachymenium nepalense


Mesochaete taxiforme

Sphagnum (main species of peat bogs)

Peat moss holds 20-30 times its weight as water: absorbing rainfall and snow melt, slow release of water for even stream flow and reduced erosion

Produce acids (pH 3) and antibiotics

Acidity/anaerobic conditions: preserve "Peat bog bodies" 2000-3000 years old

Leafy Liverworts

Jungermanniales

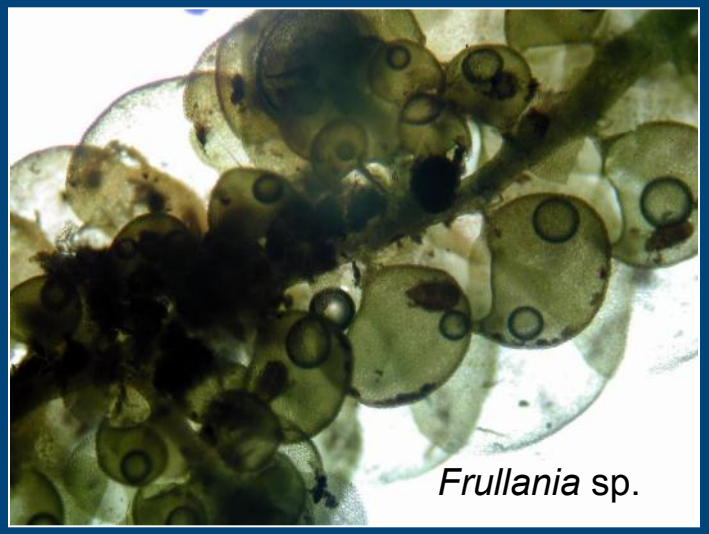
85% of Liverworts

Leafy Liverworts

CHARACTERISTICS:

- Leafy, often flattened
- 'Leaves' usually 1 cell thick, generally arranged in 2 rows either side of the stem, often with a row of 'underleaves' beneath
- Costa never present in leaves
- Sporophyte = foot, seta, and capsule
- Most liverworts have elaters + spores in capsule and spores are shed rapidly
- Rhizoids unicellular

Characteristics of leafy liverworts...

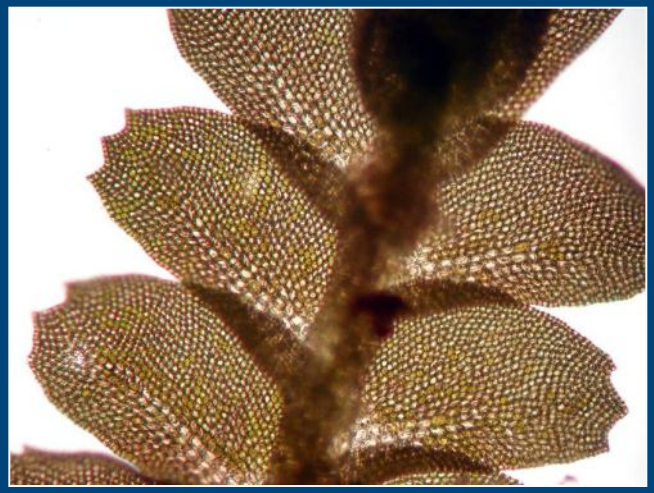


The stem generally bears two lateral and one ventral row of leaves. Leaf shape is highly variable.


Bazzania corbieri

Characteristics of leafy liverworts...

Bazzania subtilis

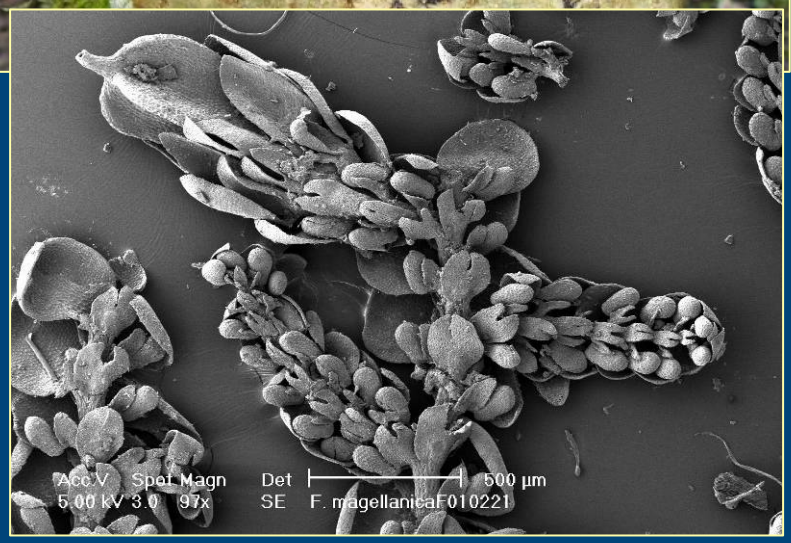


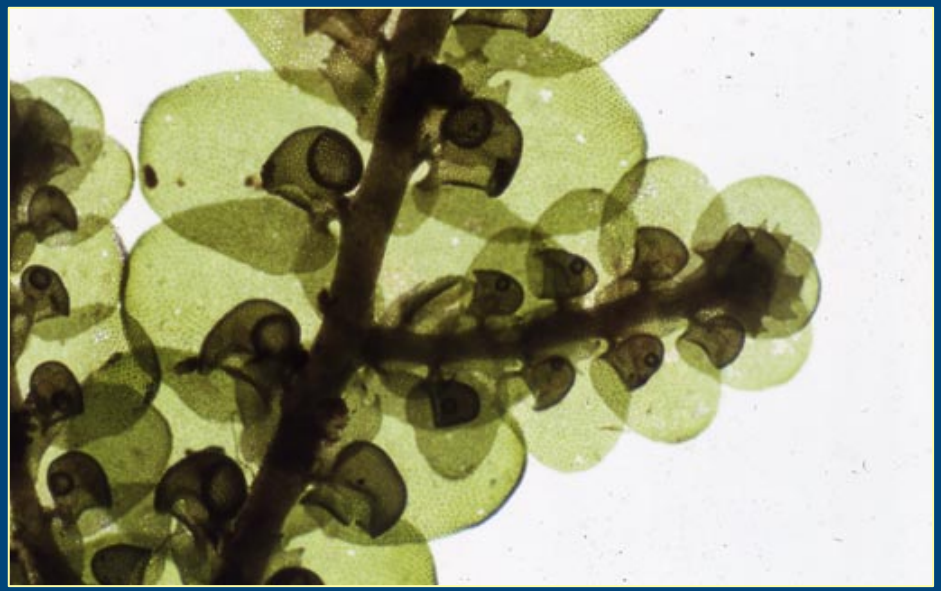
Bazzania vittata

Bazzania corbieri

Underleaf morphology is an important character used when distinguishing between species

Leafy liverwort - *Frullania*





Characteristics of leafy liverworts...

The seta elongates rapidly by water uptake and the capsule splits into four valves. The spores are dispersed by drying and twisting of elaters.

Bazzania sp. capsules

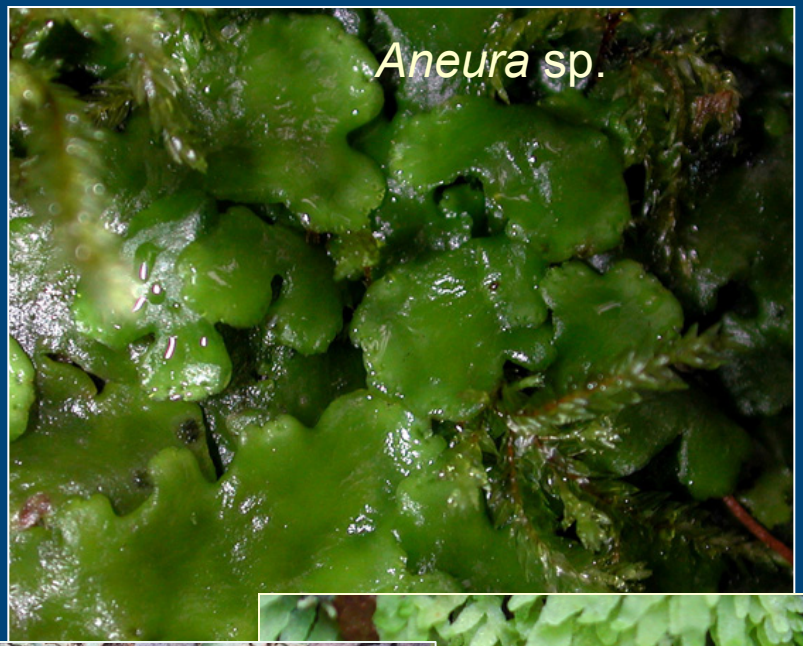
Trichocolea sp.


Bazzania corbieri capsules

Thallose Liverworts

Metzgeriales & Marchantiales

(together comprise 15% of liverworts)



Thallose Liverworts

CHARACTERISTICS:

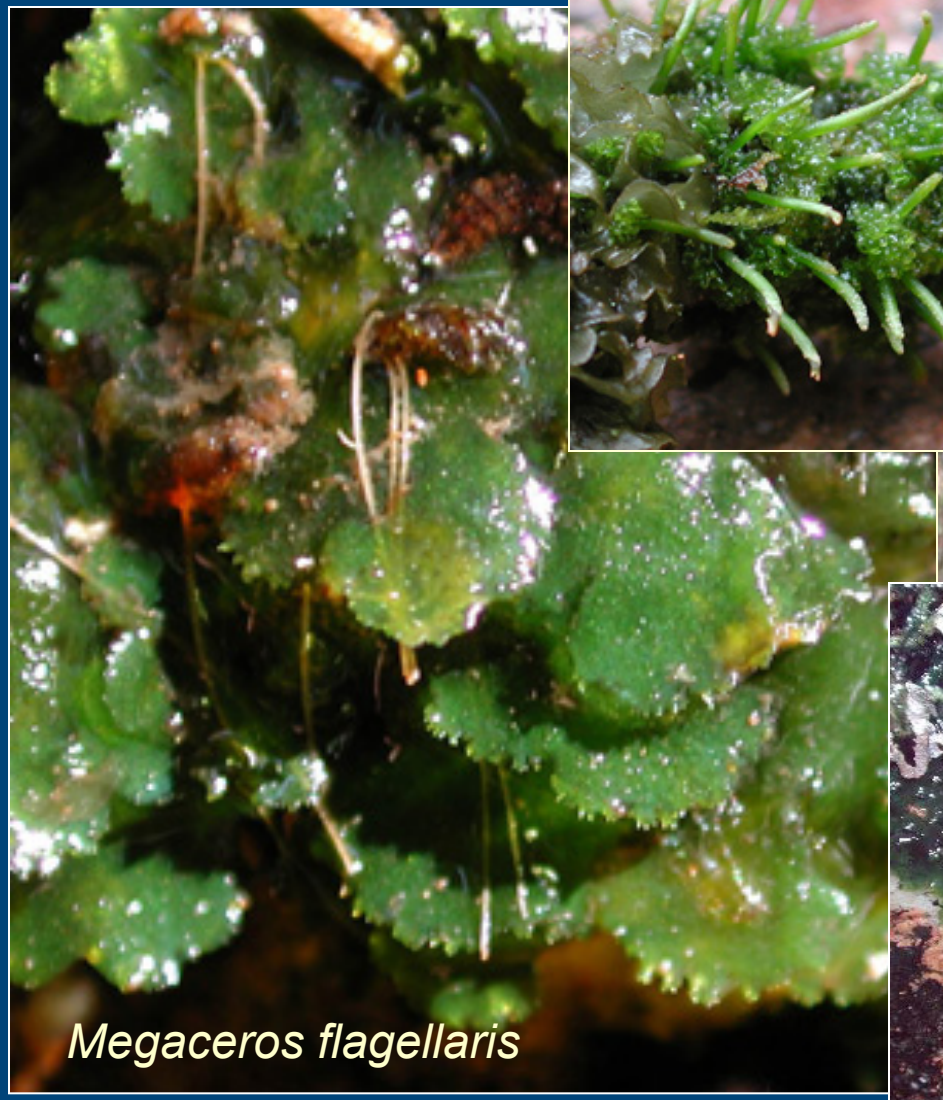
- Strap-shaped plant body (thallus)
- Thallus 1-many cells thick, ± midrib
- Many chloroplasts per cell (c.f. hornworts)
- Reproductive bodies various (simple/complex)
- Sporophyte = foot, seta (often), and capsule
- Many liverworts have elaters + spores in capsule
- Spores shed rapidly


Asterella sp. with archegoniophores
Asterella sp.

Splash cups with gemmae
= lense shaped pieces of
tissue, splashed
out of cup by raindrops
Asexual reproduction

Thalloid liverwort *Marchantia* with splash cups

Hornworts



Hornworts

Characteristics:

- Similar in appearance to thallose liverworts
- Thallus several cells thick
- Most hornworts have cavities containing colonial endosymbiont cyanobacteria (*Nostoc*)
- Only 1-6 chloroplasts per cell
- Endomycorrhizae common in internal thallus cells of most taxa
- Reproductive structures sunken in pits on dorsal surface
- Sporophyte a needle-shaped ‘horn’
- Pseudo-elaters assist in spore dispersal
- Stomata may occur in sporophyte
- Sporophyte photosynthetic, semi-independent


Phaeoceros sp.


Dendroceros crispatus

Bryophyte Ecology

Where are bryophytes found?

South Island of New Zealand, Franz Joseph Glacier

Bryophytes (together with algae and lichen) are the first species to colonise rocks; the green moss here is *Racomitrium colensoi*


Antarctic moss beds
Photo: Sha

Subantarctic islands have high bryophyte diversity

Hall of Mosses, Olympic National Park, Washington State


Rainforests
(*Papillaria flavolimbata*)

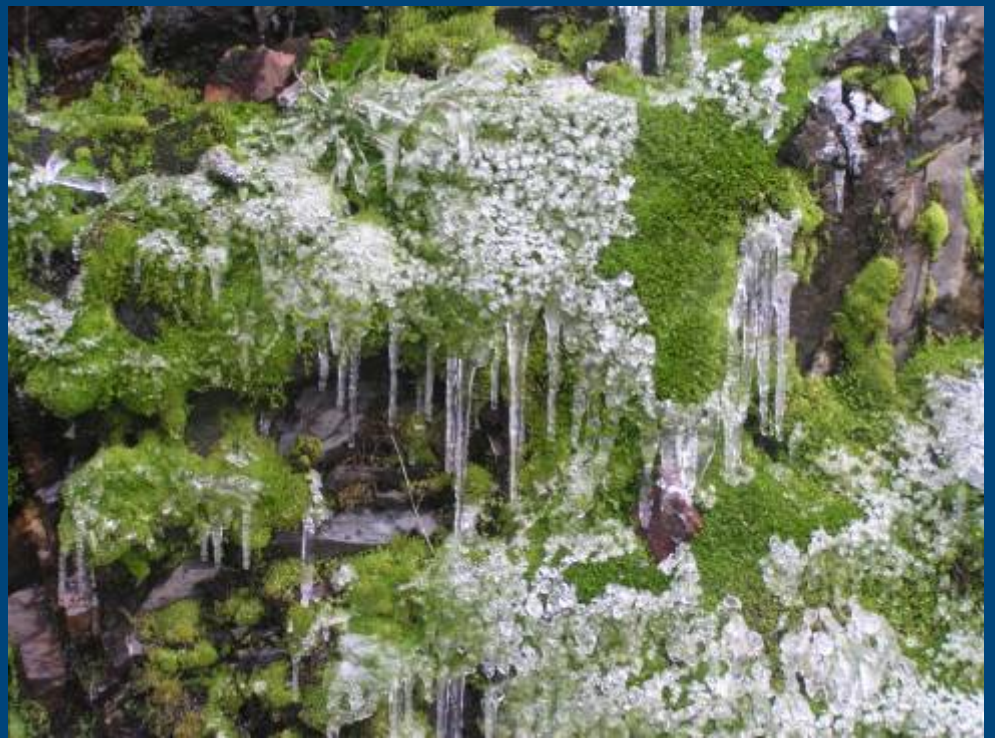
Dawsonia superba (Dawsoniaceae)
up to 50cm - one of the tallest mosses

Bryophytes occur in extreme environments: dry and hot central Australia

Microbiotic crusts covers soil surface. Taxa include algae, cyanobacteria, lichen and **bryophytes**

Bryophytes can grow (almost) anywhere widest habitat range of any plants

- On hot surfaces (up to 70°C)
- Withstand years of dehydration in deserts
- Most abundant plants in Antarctica
- Greatest diversity in moist habitats



To survive such extreme growth conditions, bryophytes produce antifreeze compounds and sunscreen

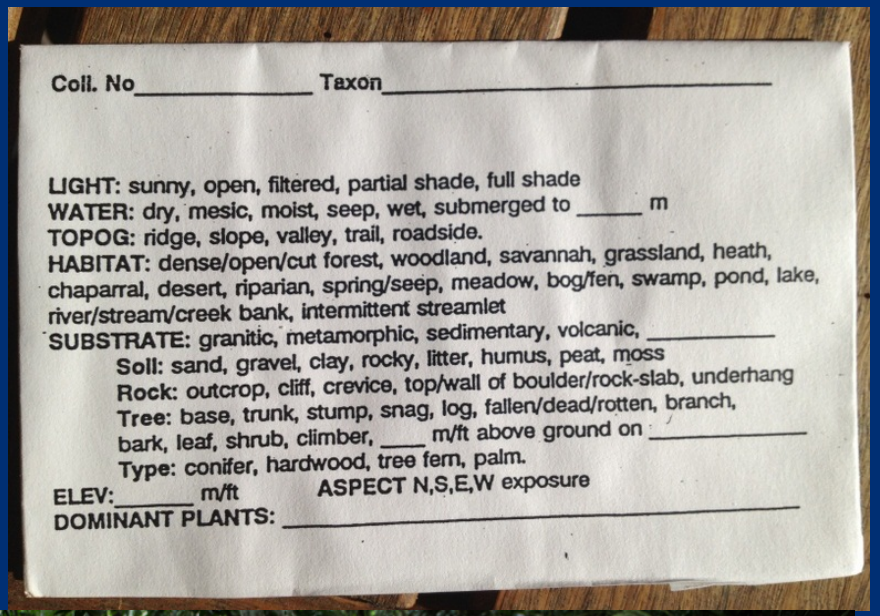
Bryophytes and ecosystem functioning:

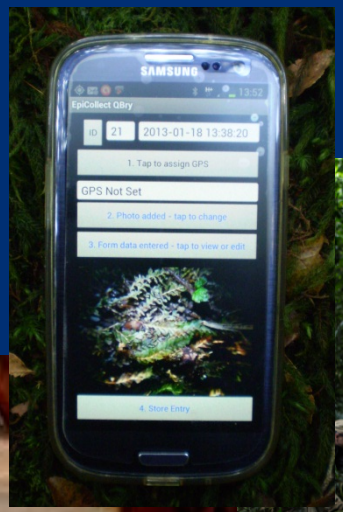
- Water balances
- Bio-indicators
- Nutrient cycling
- Soil binding
- Seed germination

Collecting & Identifying Bryophytes

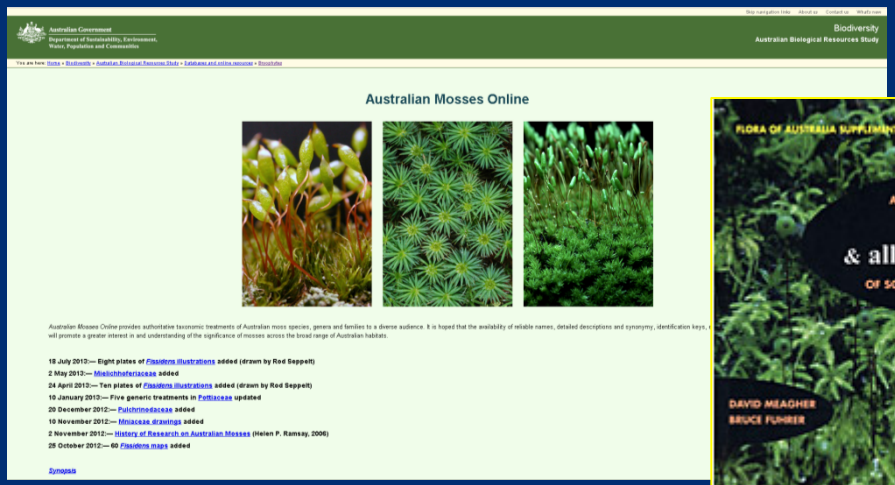
Collecting Bryophytes:

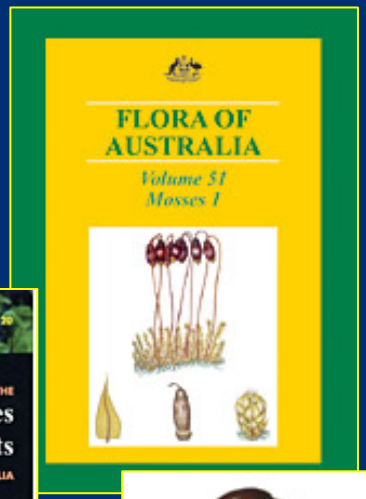
- Have required permit
- Do not over collect
- Collect straight into envelope
- Do not press
- Allow to dry

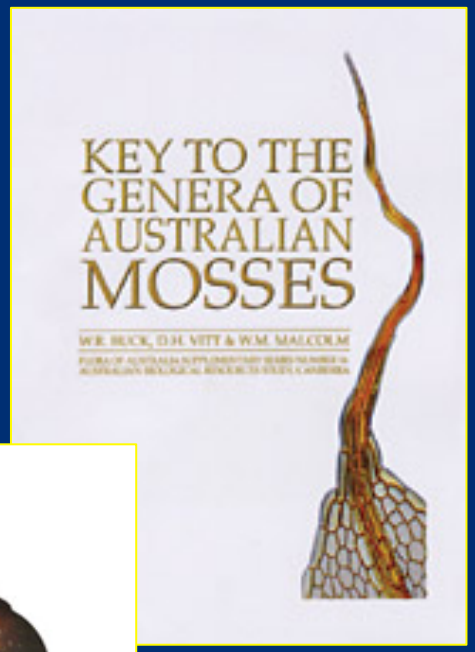


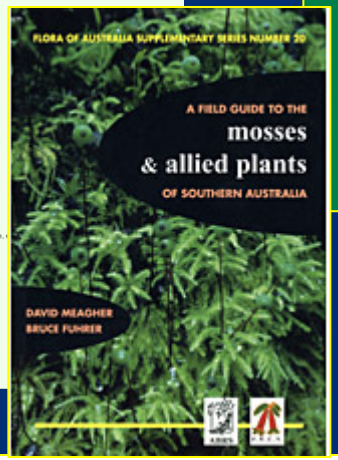


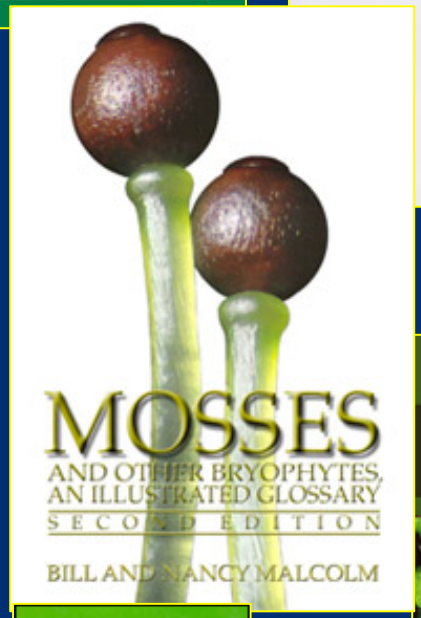
Identifying Bryophytes:

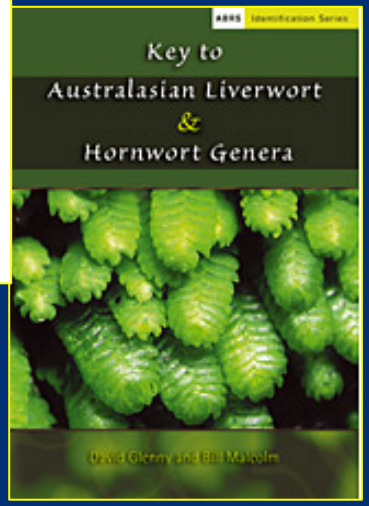








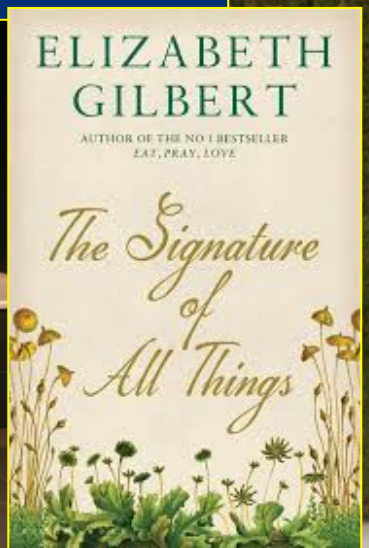


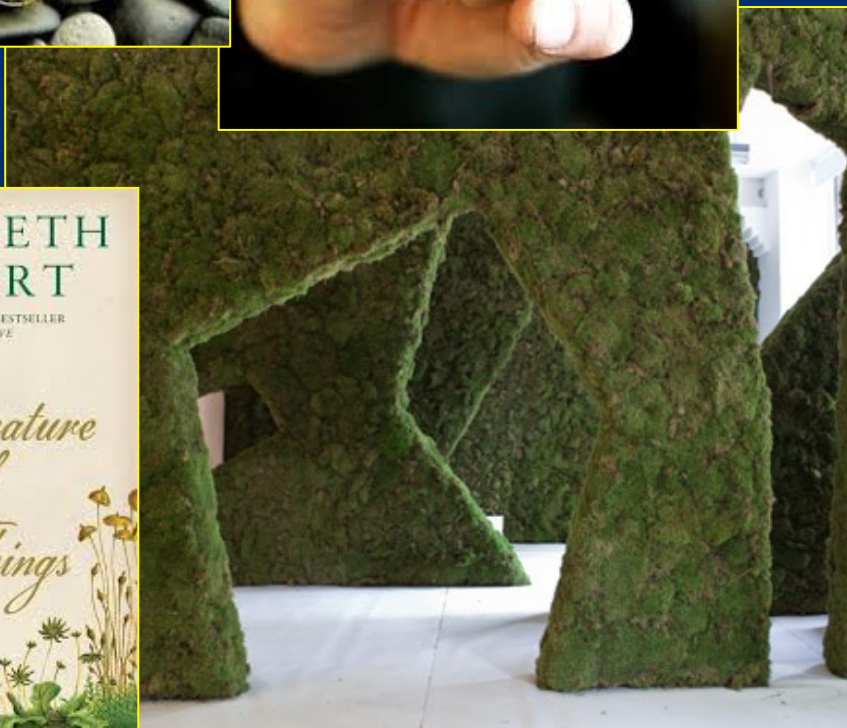


Bryophyte Uses

Bryophytes used for:

- Cushioning
- Peat/horticulture
- Fuel/heating
- Scotch whisky production
- Green roofs & walls



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Bryophyte art

Moss graffiti

Ingredients:

- moss (washed)
- water/beer
- sugar
- water retention gel
- buttermilk

Crumble moss; pour water.

Add water-retention gardening gel.

Add buttermilk.

Pulse blender until gel forms.

Transfer to a bucket.

Paint onto wood or rough concrete.

Mist weekly.

Watch your art grow.

http://www.popularmechanics.com

Lower Plants

Moss and lichen – lower plants,
the higher plant people say;
But if you give them half a chance,
they'll really make your day.
Miniature beauty – ecology too,
enough for your interest forever;
You'll need a scope and some chemicals few,
to unlock their secrets most clever.
So get out there – look around,
learn from the lichen and moss;
Treasure the mysteries of lower plants found,
and you'll never be at a loss.

- Ray Showman