Sphagnum

the biology of a habitat manipulator

EXTRACT

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Foreword

Sphagnum mosses are an important botanical feature of peat producing bogland. However, despite the vital role they play in bog creation and maintenance they are often overlooked and ignored. This is probably due to their innocuous appearance. Often even professional conservationists know little about these facinating plants. Books on *Sphagnum* mosses are often overly complex and written for the specialist moss biologist.

Thus I have written a short simple introduction about *Sphagnum* moss biology. This has been done out of personal interest. This is a self-published book. It has been independantly produced with no institutional or academic assistance. Please have understanding for this. I hope it is of general use and helps others understand these mosses. It was fun to write. Suggestions welcome: mark_david_walker@yahoo.co.uk

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Mark Walker

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Chapter 1

What are *Sphagnum* mosses?

Sphagnum! In common parlance these plants are known as ‘peat mosses’ or 'bog-mosses'. This is indicative of the preferred habitat of these plants and the fact that their semi-decomposed remains are the main component of peat. However the name *Sphagnum* definitely sounds more scientific and interesting. *Sphagnum* are mosses, but a discrete and special type, placed within their own genus. The name is derived from the Greek word ‘sphagnos’ which was originally used to denote a small shrub or moss.

The characteristic form of *Sphagnum* mosses.

Sphagnum mosses are found exclusively in wet habitats. There is disagreement as to how many species of *Sphagnum* moss there actually are, but most authorities

recognise approximately 120 around the world. Around 34 of these are found in the United Kingdom. *Sphagnum* mosses are special in that they can totally dominate the habitat in which they live. The rather unpretentious and innocuous appearance belies the ability these plants have to manipulate entire landscapes. *Sphagnum* mosses have an array of unique biological properties making them superb habitat manipulators.

What exactly are mosses?

Mosses do not have the tube like vessels, known as the xylem and phloem, which are used to transport water and dissolved sugars around. Such vessels are seen in many other plants. Mosses are thus known as 'non-vascular' plants while those with this network of vessels are known as vascular plants.

Since mosses lack such vascular tissues they need to be small in size. If they were large they would be unable to supply water and dissolved sugars to areas of the plant distant from water gathering cells. This lack of vascular tissue also means mosses are constrained as to where they can live. They must remain in locations which are relatively moist and which thus ensure all parts of the plant are close to moisture. Obtaining or living close to water is therefore a priority for many moss species.

Does this lack of specialized vascular tissue mean mosses are primitive? Not necessarily. Mosses are very successful at what they do. They have specialized on colonising watery habitats; something they have succeeded in doing excellently.

Mosses on a tree trunk.

Rather than being considered a disadvantage or a limitation, the small size of mosses should be seen as advantageous. It allows them to quickly colonize areas which other plants are excluded from and to make the best use of poor habitats.

Sphagnum mosses often dominate upland moorland habitats.

Mosses require constant moisture. One strategy used in order to remain moist is to simply avoid dry areas. Many types of moss live exclusively in wet habitats. Another strategy is to become dormant when it is not wet enough. Many species simply stop metabolising when they become desiccated and wait for conditions to become more favourable before resuming normal life processes. Effectively they enter a form of dormancy.

Sphagnum mosses have yet another strategy. They can actively control the environment in which they live, so that it remains wet enough for them. They can thus be rightly termed as habitat manipulators or habitat makers.

Sphagnum mosses have unique biological properties meaning that once they have become established in a habitat, it remains exactly as they require.

Sphagnum mosses possess special water retaining cells, called hyaline cells, which soak up water and release it slowly. This means the habitat is kept constantly wet and moist: just how *Sphagnum* mosses like it. They also actively acidify the habitat they live within by producing special acidic chemicals and adding hydrogen ions; this prevents other plants, which can't tolerate such conditions, from growing. Other plants might remove too much water leading to the habitat drying out.

What makes the *Sphagnum* different from the other mosses?

Sphagnum are classified along with the mosses within the Bryophytes. However, they differ from the 'typical' mosses in various ways; they are a special type of moss.

The other mosses do not normally have vascular tubes. However, they do have a complex set of semi-xylem and semi-phloem like tubes. These are known as hydroids and leptoids. Water moves along hydroids, and sugars move along leptoids. *Sphagnum* mosses lack even these more ‘advanced’ moss features. They are probably not

necessary as *Sphagnum* mosses live in constantly wet habitats anyway meaning such transport mechanisms are not required.

Another feature which the other mosses possess is a thickened mid-rib, known as a costa, running down the stem. *Sphagnum* mosses do not need such a strengthening agent as they live suspended in water. The surrounding water provides all the support *Sphagnum* mosses need. However, like the other mosses, *Sphagnum* are typically only one cell thick.
Sphagnum mosses have a life-cycle similar to other mosses. There are two growth forms, the spore producing sporophyte and the gamete producing gametophyte. This will be explained in more detail later.

Other key features which differentiate *Sphagnum* mossesfrom other mosses and which can be considered as characteristic of the *Sphagnum* genus are:

Branching: The pattern of branches is distinctive to *Sphagnum* and not seen in other mosses. Bundles of two or more branches erupt from the stem; these are called 'fascicles' and are a unique feature of *Sphagnum* mosses.

Protenema: A protonema is basically a collection of cells from which a new moss plant grows. In *Sphagnum* mosses this initial stage before the gametophyte grows is known as being 'thalloid'. This means to have a flattish structure. In other mosses cell fibres are in a rather more complex network like structure.

Pseudopodium: In *Sphagnum* mosses, the spore producing sporophyte grows upon a structure known as a pseudopodium. This literally means a 'false foot'. This is a kind of short stem. Other mosses possess a proper supporting ‘foot’ like structure.

Peristome: Unlike other mosses *Sphagnum* mosses have no peristome. Spores grow in a capsule and are released into the environment from the capsule through a hole called an operculum. This has teeth controlling release. The peristome is a structure around the operculum, which helps spores disperse in the air. As *Sphagnum* mosses nearly always live in water such a structure is not needed.

Hyalodermis: *Sphagnum* mosses have a layer of clear cells known as the hyalodermis which cover the stem. This is not seen in other mosses.

Rhizoids: Although mosses do not have roots, they do have rhizoids which provide support. These are short hair like structures sticking out from the bottom of the growing plant. *Sphagnum* mosses receive all the support they need from the water surrounding them so they do not even possess these; they are totally absent.

Cells: There are two distinct types of cells; those that photosynthesise known as the Chlorophyllose cells, and special water-bearing cells known as Hyaline or Retort cells. Hyaline cells are unique to *Sphagnum* mosses. The way they are arranged is distinct in each *Sphagnum* species.

A note on naming

Traditionally the common name for members of the *Sphagnum* genus was 'bog-mosses'. However it has become increasingly common to use the genus name 'Sphagnum' as the common name and in a common sense.

Normally when mentioned in text a Linnaean binomial name is placed in italics or underlined. This helps identify what is the scientifically recognised name and avoid confusion. The scientific name allows precision in naming. As the name 'Sphagnum' is actually the genus name it

should therefore be placed in italics. However, it is often not now that it is frequently used in the common sense. Here, the name *Sphagnum* is placed in Italics, however please be aware that others may not do so.

Bogs: The *Sphagnum* ecosystem

When one thinks of typical *Sphagnum* moss habitat one thinks of bogs. The Collins Dictionary of Botany (2006) defines a bog as:

> 'A region of badly drained permanently wet land that is subject to high rainfall and has a persistently moist atmosphere.'

Bogs are watery areas where organic material accumulates. Because they are waterlogged rotting is incomplete meaning that peat forms. The rate that organic nutrients are added to them is greater than the rate at which nutrients are used up. Thus over time bogs typically become more nutrient rich. There are various different forms of bog such as mires, fens, or quagmires. These vary in how they receive water and in nutrient richness.

Although bogs form in various ways, in general they begin to form where rainfall is great or where drainage is poor. This results in the accumulation of water. They often start

to develop in hollows or dips. *Sphagnum* mosses are the dominant form of vegetation in many bogs, and actively aid bog creation and persistence.

Bogland areas are found worldwide. They are found across large expanses of the northern temperate regions. The coolness and high rainfall of such locations aids their establishment and development. Large areas of bogland occur in Siberia, North America and in northern areas of Europe.

History of *Sphagnum* moss research

The study of *Sphagnum* mosses has a long and detailed history. Much of the early literature about *Sphagnum* biology was written in German and came from the German speaking world. This is where most discoveries about these mosses was made.

There were a number of challenges facing the botanists of the 19th century when studying *Sphagnum* mosses. The history of *Sphagnum* research can be broken down into a number of separate parts characterised by a number of milestones; either taxonomic, anatomical or reproductive.

Maybe the most important discovery was taxonomic, with the realisation that *Sphagnum* mosses were indeed a type

of moss, albeit a rather special and distinct one. The second major milestone in *Sphagnum* moss research was maybe the identification and recognition of the seperate different species. Or rather an appreciation that what appeared rather similar looking sets of plants were in fact many different kinds. This required an understanding of the unique structure of *Sphagnum* mosses and the discovery of the unique two cell structure they have. The final puzzle of *Sphagnum* biology was understanding their reproduction; despite the similarity with other mosses, there are notable differences.

The German Botanist Johann Jacob Dillenius mentioned *Sphagnum* mosses in his major work on the mosses the '*Historia Muscorum',* but his grouping of *Sphagnum* contained many non-*Sphagnum* mosses. Maybe the peculiar structure of *Sphagnum* mosses only became apparent to science with the work of English biologist John Ray. His synopsis '*Stirpium Britannicarum*' of 1724 clearly differentiated the *Sphagnum* as a genus.

History of *Sphagnum* moss discoveries:

Who and When	Discovery
Ancient Greek botanists, Pliny	Used the name '*Sphagnum*' to denote lichen and *Salvia* species

Dillenius 1719	Identified *Sphagnum* as a single genus in *Catalogus Plantarum sponte circa Gissam nascentium*
Dillenius 1741	Identified 16 species in the *Historia Muscorum*
Ehrhart 1780, 1785	Identified *S. cymbifolium*, *S. acutifolium* and *S. cuspidatum* in *Hannoversiches Magazin* and *Plantae Crypt. Exsic.*
Hedwig 1782	Described genus in *Fundamenta Muscorum*
Muller 1846	Described 17 species and used cellular features to aid species differentiation in *Synopsis Muscorum Frondosorum*
Wilson 1855	Identifies 9 British species in *Bryologia Britannica*
Moldenhawer 1812	Identified the two forms of cell present in *Beitrage zur Anatomie der Pflanzen*.
Hofmeister 1851	Described development of plants in *Vergleichende Untersuchungen*
Schimper 1858	Described how *Sphagnum* forms peat and described *Sphagnum* species in *Versuch einer Entwicklungs-geschichte der Torf-moose.*

Illustration of Fringed Bog-moss *S. fimbriatum*;
The book by Wilhelm-Philipp Schimper (1808-1880) is regarded as an important milestone in the *Sphagnum* moss research.

The great taxonomist Carl Linnaeus removed many non-*Sphagnum* species from the group in 1758. Jakob Ehrhart synthesised the genus *Sphagnum* into a form we would

recognise today in 1780. His groupings meant individual species could be added or differentiated easily.

The famous moss botanist Johann Hedwig dealt with *Sphagnum* mosses in 1782 in his famous '*Fundamentum historiae naturalis muscorum.'* Hedwig described the fruiting bodies and antheridia. Samuel Bridel in '*Bryologia Universa*' from 1826, described the genus in greater details and emphasised its distinctiveness.

The first to describe the unique structure of the leaves and stem was Johann Moldenhawer in his 1812 '*Beitrage zur Anatomie des Pflanzen'*. He was the first to notice the unique two cell structures seen in *Sphagnum* mosses.

The reproductive system used by *Sphagnum* mosses took some time to elucidate. Hedwig was the first to study the reproductive structures of *Sphagnum* mosses, describing the antheridia and the male sex cells. Later, in 1826, Nees von Essenbeck described their movement. The female reproductive structures were studied by the German Wilhelm Hofmeister who identified and described the archegonia and saw how the fruit developed.