PHOTO: ALISON POULIOT

The CRYPTOGAMIC GARDEN

ECOLOGIST AND PHOTOGRAPHER ALISON POULIOT DELVES INTO THE UNHERALDED WORLD OF MOSSES, LIVERWORTS, LICHENS AND MORE, EXPLAINING THEIR VALUABLE ROLE IN THE GARDEN.

Cryptogam. It's an enchanting name that feels good, rolling off the tongue. And these plants feel good beneath the fingertips, too, if you stroke their many textured forms.

Cryptogams comprise a kooky coterie of taxonomically unrelated organisms: the bryophytes (mosses, liverworts, hornworts); ferns, fern allies and algae; as well as lichens and other fungi.

While the collective 'cryptogams' contravenes convenient categories for ordering life, they commonly cohabit, sharing many lifestyle and habitat preferences.

But having enticed you with the broad stroke of cryptogams, it is such a big group that I'm going to home in on bryophytes and lichens – more than enough to keep us interested.

Bryophytes and lichens, like other cryptogams, are cryptic and inconspicuous. They don't loom overhead or flaunt showy flowers. Theirs is a world in miniature, although their actions are far-reaching.

It's all about changing spatial scales – coming in close to observe the depths and details of these arcane organisms. What bryophytes and lichens lack in the more familiar vascular plant features (such as seeds and flowers) they make up for with intricate specialised structures to advance their most important mission – to disperse spores.

The ways we think about gardens are shaped by shifts in aesthetic taste and growing knowledge. In recent years, the notion of the 'wood wide web' – the underground alliances between fungi and plants – has inspired many gardeners to accommodate the dynamism and complexities of other garden ecologies.

This integrates not just plants, but soils, lichens and bryophytes, as well as other cryptogams and myriad microorganisms that work their wonder in the subterrain. So let's begin delving into their

Opposite: Reproductive structures of the umbrella liverwort, *Marchantia berteroana.*

Above: Lichens and moss often live in intimate association. Pictured is the lichen *Pseudocyphellaria dissimilis* and the moss *Wijkia extenuata*.

world. Further along in the article are specific descriptions of the plant groups, but let's start by looking at their unheralded role in the garden and environment.

In the garden

These small organisms do good things in gardens. They make bare soils more inhabitable for plants by trapping moisture and windblown nutrients, providing a sheltered and moist seed bed. Like higher plants, bryophytes take in carbon dioxide and release oxygen into the atmosphere, enabling us to breathe. Because of their slow decay rates in some environments, bryophytes can sequester large amounts of organic carbon, stopping its release into the atmosphere and slowing global warming.

Probably most exciting to gardeners in this eroded and soil-deprived continent is that lichens create soil, albeit very slowly, enriching it further when they themselves die and decompose. Almost all plants require soil before they can colonise. Bryophytes and lichens not only create soils but they also stabilise them, providing architecture and the necessary conditions for plants to establish and grow.

In drier gardens they are especially important in holding soil together as part of biological soil crusts, preventing erosion by intercepting surface run-off and regulating water filtration. Hence, encouraging carpets of mosses and lichens provides the dual benefit of retaining moisture and flood control. Bryophytes in particular, quickly absorb large volumes of water during heavy rain then slowly release it, enabling other plants to benefit from it for longer periods.

Many garden birds use mosses and lichens to line and camouflage their nests. Invertebrates such as moths and butterflies, bevies of beetles, lacewings and bristletails either live in, feast on or disguise themselves as bryophytes or lichens. In turn, these invertebrates are consumed by organisms further up the food chain. And what nicer nook for a frog to nestle in than a damp bed of bryophytes.

Reimagining lawns

Moss growing in lawns adds not only habitat diversity but subtle shades of tone, texture and sensoriality. Think of the tactile delights of walking barefoot on a mossy lawn. Moss lawns stay greener longer than grass lawns and require less maintenance. Moss cover protects underlying soil from drying and moderates surface temperatures.

Japanese gardens often feature moss as a central and grounding element, creating a sense of serenity, space and simplicity. Swap grass with moss and you can spend Sunday mornings doing something more exciting than wrestling with the mower.

As they seek out nooks and crannies, mosses provide a sense of continuity in a garden, clothing exposed patches and uniting disparate aspects. They are a logical choice for shadier areas of your garden where many vascular plants struggle to establish. If we offer the right conditions, bryophytes invite themselves into our gardens, offering an exciting tension between control and creative chaos.

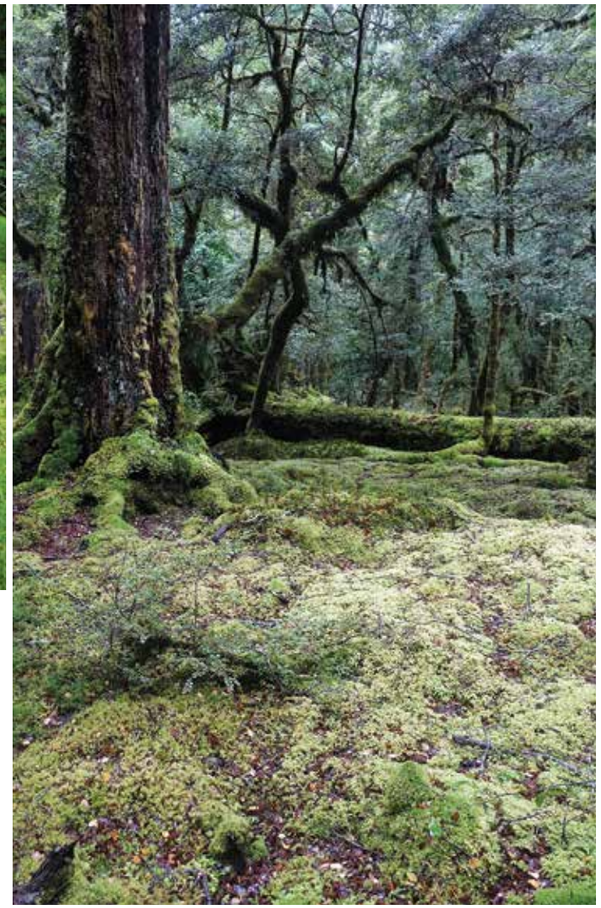
Growing interest in vertical gardens or 'living walls' as well as rooftop gardens, is increasing the popularity of bryophytes. Green walls are popping up in offices and airports, extolled for their calming effect on human inhabitants. They are also efficient biofilters, reducing air and noise pollution, while rooftop gardens provide insulation, moderating temperatures and reducing energy to heat and cool.

PHOTO: ALISON POULIOT

Above: Moss is often a feature of Japanese gardens, giving a sense of serenity and space.

Right: Trunks of the *Nothofagus* species of tree and the forest floor are covered with bryophytes.

Below right: A frog in its mossy haven.



PHOTOS: TOP: ISTOCK/TOP AND BELOW RIGHT: ALISON POULIOT

Be encouraging

It's easy to accommodate these organisms in our gardens as it largely involves simply leaving them be. Bare soil does not occur naturally in nature, at least not for long. When it does, these organisms quickly move in and try to cover it up again before it blows or washes away, or gets compacted or baked by the sun.

To actively encourage cryptogams in your garden, entice them with nice homes, rather than collect them from 'the wild', as many are vulnerable.

You can maximise their chance to establish by retaining organic matter (with diverse size, age and species structure); creating heterogeneity (by creating microhabitats and microclimates); and minimising disturbance wherever possible – avoid digging, over-watering, raking, burning or compacting the soil.

And of course, avoid all toxic chemicals. So rather than reaching for the high pressure hose to blast them from your garden wall, remember that diverse bryophyte and lichen communities in gardens indicate good health.

Left: To really appreciate bryophytes and lichens, pop your trowel down for a moment and don a x10 hand lens. You can pick one up from optometrists or scientific suppliers for under $20.

Right: The distinctive drum-like capsules of the moss *Polytrichum*.

Opposite: A microcosm of lichens and mosses in a tapestry of colour.

BRYOPHYTES

Let's start with bryophytes – among them hornworts, mosses and liverworts. They are sometimes called 'lower', 'simple' or 'primitive plants', but these denigrating descriptors bely their superb survival skills and success.

Bryophytes existed long before flowering plants. They colonise some of the most extreme habitats on earth; exhibit resourceful responses to harsh conditions, especially extended periods of dessication (extreme dryness) and sub-zero conditions; and deter hungry herbivores with an artillery of chemical defences.

Bryophytes don't have vascular systems. Rather, they obtain water and nutrients by absorbing them directly through their surfaces and circulating them inside specialised cells. Some have rudimentary internal conducting systems or other structures such as scales, hairs and ridges to assist external water conduction. Nor do they have true roots, although many have root-like anchoring structures called rhizoids, but without the absorptive functions of true roots.

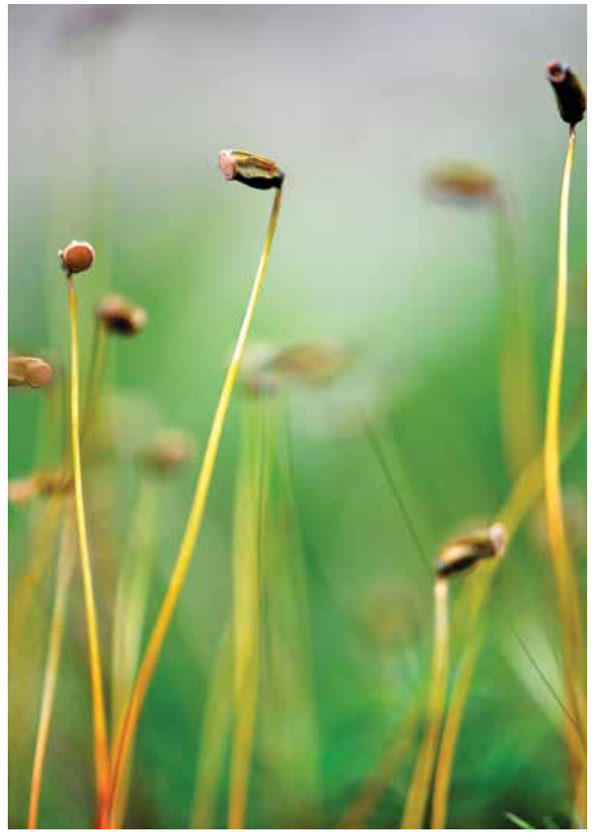
Bryophytes are opportunists, colonising many different surfaces including rock and soil, wood and bone and even human constructions such as concrete, roof tiles and the odd old boot. They have been around awhile, appearing over 450 million years ago.

While many bryophytes dwell in damper areas of the garden, some thrive in hostile environments such as deserts, where they constitute the major flora because of their size advantage and tolerance to desiccation.

Many employ ingenious strategies for minimising water loss by curling up or dipping in and out of dormancy. A dispensary of chemicals such as anti-freeze agents allow alpine bryophytes to ride out cold winters.

Mosses

The most familiar of the bryophytes are the mosses. Liverworts are sometimes mistaken for mosses, which are commonly assumed to be any green thing lying on the ground. The most obvious difference in mosses is their clearly differentiated stems with simple-shaped, ribbed leaves, unlike the deeply lobed or segmented leaves of liverworts.



Mosses first appeared about 400 million years ago and almost 1100 species have been described in Australia. Some can endure the low temperatures and short growing seasons of Australia's sub-Antarctic islands, where along with lichens they comprise the main vegetation.

Mosses of the cosmopolitan genus *Polytrichum* prefer the damp but cope with dry spells by twisting their leaves around their stems to minimise water loss. An extra row of photosynthetic lamellae on the upper surface of their leaves enables them to trap moist air between them, further reducing water loss and protecting their photosynthetic cells.

Liverworts

These moss-like plants were the first bryophytes, appearing at least 450 million years ago. They have diversified to over 7000 species with about 900 described from Australia.

The name liverwort is derived from the lobate leaf-like green structures (gametophytes) that resemble lobes of the liver. Liverworts are mostly found in damp locations as they have no cuticle to prevent desiccation. There are two main types: thallose liverworts have a flattened, plate-like body (thallus), often topped with umbrella-like sexual organs. Leafy liverworts have flattened 'leaves' growing out from a stem.

PHOTOS: ALISON POULIOT

GLOSSARY

- DESSICATION: To be completely dry.
- KINGDOM: One of the great divisions of natural organisms (for example, plants, animals, fungi).
- LAMELLAE: Thin sheets of cells standing up along the midrib of the leaf.
- LOBATE: Having a lobe.
- SPOROPHYTE: Asexual life-cycle phase in some plants.
- SPORES: Reproductive bodies that become detached from the parent and give rise to a new individual.
- SUBSTRATE: Ground or other solid object to which organisms can attach.
- THALLUS: A simple vegetative plant body.

Above: Often dubbed 'extremophiles', lichens can withstand extreme environments like this frozen waterfall.

Hornworts

These bryophytes are similar to liverworts but are not leafy. As their names suggest, they are characterised by elongated horn-like structures (sporophytes) that grow from a greenish, flattish sheet. This differentiates them from liverworts, which have shorter sporophytes.

Some hornworts are aquatic and provide important habitat for invertebrates and fish 'fry' as well as oxygenating water. About 30 species have been described in Australia of approximately 250 worldwide.

LICHENS

Lichens are not bryophytes but are classified in the Kingdom Fungi. They are thought to have appeared on earth about 700 million years ago and their best trick was to team up and double their talents. Lichens epitomise the notion of symbiosis and comprise intimate associations between fungi and algae (and often cyanobacteria). What one partner lacks, the other provides, expanding the ecological range of both. The alga produces carbohydrates through photosynthesis. The fungus reciprocates by providing a dwelling with the algal cells securely wrapped up by the fungal hyphae in a structure called a thallus. As an extra treat the fungus supplies the alga with mineral nutrients extracted from the substrate through enzyme secretion.

The coral lichen (*Cladia retipora*) was the first lichen to be described in Australia, by French naturalist Jacques Labillardière in 1792. Lichens are the most well studied group of fungi in Australia with over 3700 species described.

LICHEN MONITORS

- Lichens are especially useful air-quality indicators because of their sensitivity to pollutants such as nitric and sulfuric acids. Air quality can be tracked using changes in lichen community composition, abundance and distribution. Epiphytic lichens (those growing on trees) are often used because their lack of roots and location above the ground means they receive greater exposure to air pollutants. For example, the beard lichen (*Usnea longissimi*), pictured above, grows only in areas of low sulphur dioxide pollution.
- Scientists have put lichens to good use in other areas of research. Lichenometry involves the use of lichen measurements to determine the age of rock surfaces, for example, to date stone walls, sea-level changes, river flooding, glacier retreat and moraine formation. The crustose lichen genus *Rhizocarpon* is a popular choice in such research because of its low radial growth rates and longevity.
- Lichens have also been used in geological prospecting. Because they can accumulate heavy metals such as copper, lead and zinc, they are used to indicate the presence of particular mineral deposits.

Alison Pouliot is an ecologist and environmental photographer and honorary fellow at the ANU. Her recent book, *The Allure of Fungi*, documents a forgotten corner of the natural world that is both beguiling and fundamental to life. Visit *alisonpouliot.com*

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