Bryophytes of Mount Tomah Botanic Garden

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Abstract

Ramsay, Helen[1], Alison Downing[2] & W.B. Schofield[3] ([1]National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000; [2]School of Biological Sciences, Macquarie University, Sydney, Australia 2109; [3]Botany Department, University of British Columbia, Vancouver, B.C. V6G 2B1, Canada) 1990. Bryophytes of Mount Tomah Botanic Garden. Cunninghamia 2(2): 295–303. A total of 85 species, including 63 mosses, 21 liverworts, and one hornwort have been collected in the Mount Tomah Botanic Garden. The species present include those native to a remnant of closed forest and those present in the cultivated garden area at Mount Tomah opened as a cold climate annexe to the Royal Botanic Gardens Sydney in 1987. Several names have been added to the list of species previously known from the Central Tablelands (CT) region of New South Wales.

Introduction

The Mount Tomah Botanic Garden, was developed as an extension of the Royal Botanic Gardens Sydney, for the cultivation and display of cool-climate plants of the world, especially those from the Southern Hemisphere (Rodd 1987a).

Mount Tomah (an Aboriginal word referring to 'tree ferns' (Ingram 1987)), is about 120 km from Sydney and 850 metres above sea level, and is one of several peaks capped with Tertiary basalt in the Blue Mountains north of the Grose River Valley. The basalt cap overlays Triassic shales and sandstones that have been exposed by weathering (Pickett 1987, Branagan & Packham 1967).

The Garden, covering some 31 hectares, contains two valuable pockets of temperate rainforest characterised by Sassafras (*Doryphora sassafras*), Coachwood (*Ceratopetalum apetalum*), and Blackwood (*Acacia melanoxylon*), the tree ferns *Dicksonia* and *Cyathea*, as well as mosses, lichens and epiphytes. The garden is situated in wet sclerophyll forest, dominated by Brown Barrel (*Eucalyptus fastigiata*). Specimens of Southern Beech (*Nothofagus*) including *N. moorei*, one of three *Nothofagus* species present in the garden and *N. procera*, the deciduous Southern Beech from Chile line the garden entrance. The 18 hectares of formal garden, contain cool-climate taxa including *Rhododendrons*, members of the Proteaceae, selected conifers etc.

A large rock garden has been created from local basalt, and includes a cascade and ponds as well as a scree slope and *Sphagnum* bog. Limestone has been imported from Portland, west of the Blue Mountains, to feature calcium-loving plants from around the world. Mature trees and shrubs, present on the site prior to its development as a Botanic Garden, have been retained. These include traditionally cultivated Northern Hemisphere temperate plants such as deciduous oaks and flowering fruit trees.

The natural vegetation in which bryophytes are found is still present on much of the site. This includes Closed-forest dominated by Sassafras and Blackwood on basaltic soils on the southern slopes and in gullies; Tall Closed-forest dominated by Coachwood and Sassafras, restricted to sheltered deep gullies on

sandstone with a downwash from basalt and shale. The diversity of bryophytes is highest in closed forests.

The elevation, and distance from the sea, provide Mount Tomah with a substantially higher rainfall (annual average 1541 mm) than most areas on the adjoining coastal plains (Rodd 1987b). Precipitation is generally highest in January and February (summer) when warm moist air mixes with the cooler air of the mountains. High rainfall and mists provide ideal conditions for the growth of bryophytes. In winter months rainfall is lower and cool clear days predominate. Occasionally day temperatures may not rise above 5°C and cool winds blowing from the Southern Highlands bring light snow (that melts quickly) on two or three days per year. Temperatures in summer are mild to warm ranging from 14°C–25°C in January but have reached as high as 36°C in 1985, and in winter (June–July) the average ranges from 3–10°C.

The bryophytes of Mount Tomah

Although the study of bryophytes was well advanced in Victoria by the mid 1800s, knowledge of the bryophytes in New South Wales and in particular in the Blue Mountains only started around the mid 1880s. In 1883 J. H. Maiden appointed W. Forsyth to take charge of the bryophytes at the National Herbarium of New South Wales (NSW). Within two years Forsyth had collected some 1200 specimens, many of which came from the Blue Mountains. The oldest specimens at the Herbarium from Mount Tomah are those of C. T. Musson (1886) and J. H. Maiden (1898). The earliest species obtained from Mount Tomah were *Dicranoloma dicarpum, Leptodon smithii, Fissidens pallidus, Pogonatum subulatum, Pyrrhobryum parramattense, Camptochaete ramulosa, Hypnodendron vitiense* subsp. *australe* (Forsyth 1899) (names quoted are their present ones). Since then few bryophyte specimens from Mount Tomah have been deposited at NSW until this study. All collections made for this study will be deposited at NSW for future reference.

The aim of the present study was to determine the species present and their distribution in the Garden in its early stage of development, as a basis for future studies. With this in mind several permanent sites have been set up for future analysis. These include selected limestone and basalt boulders and sections of the rock walls in exposed and shaded situations.

This preliminary list is presented as a basis for studies and comparison of individual bryophyte populations, and species richness over time.

In the future the bryoflora is likely to change both in species composition and in the area occupied by bryophytes as a result of dispersal by spores and fragments. Colonisation of bare rock, soil, the bark of trees and shrubs will occur as shade and humidity increase with time.

Species List

The list presented here (Table 1) includes bryophytes present at the end of May 1989. In most cases they represent species natural to the area but, where rock or soil has been imported, new species may have been introduced. Soil, rocks and plants imported for use in the gardens may have introduced spores and fragments of bryophytes with the ability to reproduce vegetatively. The trunks

of imported tree ferns may have introduced some new species. Most of the rock associated with the gardens is local basalt but the limestone boulders came from a district on the western slopes. As a number of mosses grow only on limestones it will be interesting to see which species appear on the limestone boulders which at this stage are bare except for small colonies of *Tortula muralis.*

The list has been divided into two sections the garden area and rainforest area (identifications based on Scott & Stone 1976, Scott 1985, some recent literature and the collections at NSW).

The garden area

The garden area covers the crest of the mountain and includes a number of habitat types with respect to the bryophytes they support —

a. Stone walls built of local basalt.
b. Large rock outcrops, natural or constructed.
c. Imported limestone and calcareous habitats.
d. Exposed soil in lawns, garden beds and along paths.
e. Tree trunks and branches, tree fern trunks.
f. Wet or boggy areas e.g. cascade and *Sphagnum* bog.
g. Small rainforest on eastern side.

Bryophytes of the closed-forest on the northwestern side of Bells Line of Road

This remnant of the original rainforest occurs along both sides of a stream in a small gully. Open forest of *Eucalyptus* species adjoins the rainforest on the upper slopes. The habitats suitable for bryophytes are —

a. Rocks in the stream or wet soil on the bank
b. Rock surfaces or sheltered rock shelves in the forest.
c. Fallen tree and tree fern trunks.
d. Branches and trunks of living trees and shrubs.
e. Soil surfaces under rocky overhangs, on damp slopes.

Table 1. Checklist of bryophytes in the Mount Tomah Botanic Garden

(* New species record for Central Tablelands [CT] See Ramsay 1984. Name changes since Ramsay 1984a given in [].)

Species	Substratum	Location
THE GARDEN AREA		
MOSSES (***Bryopsida***)		
Barbula calycina	soil	front entrance
**Barbula* cf. *rehmannii*	soil	crevices, limestone boulders
Barbula unguiculata	soil	crevices, rock wall
Breutelia pendula	rock	near *Sphagnum* bog
Bryum argenteum	soil	crevices in rock walls and in paving
Bryum billardieri var. *billardieri*	soil	front *Rhododendron* garden
Bryum capillare	soil	basalt, with emergent boulders, picnic area
Bryum dichotomum	soil	crevices in front rock wall rock garden near cascade
Bryum sauteri	soil	rock garden near entrance, behind barbecue
Campylopus introflexus	soil	on occasional sandstone rock of front entrance wall
Ceratodon purpureus	soil	barbecue area and in crevices in front entrance wall
Dicranella dietricheae	soil	earth banks, roadside, with *Pogonatum subulatum*
Ditrichum difficile	soil	trackside bank, west side
Fabronia australis	bark	conifers, western side of service area
Fissidens leptocladus	soil	front *Rhododendron* garden
Funaria hygrometrica	soil	rock garden
Grimmia pulvinata var. *africana*	rock	exposed on basalt of front entrance wall
Hedwigidium integrifolium	rock, bark	boulders near picnic area, front entrance wall, trees (*Fraxinus*)
**Hypnum cupressiforme* var. *mossmannianum*	soil, bark	crevices in wall of path leading to conifer collection, tree fern trunks in eastern rain forest, *Cryptomeria* bark
Leptodon smithii	bark	*Juglans,* scree slope of rock garden
Leptostomum inclinans	bark	*Quercus*, northern lawn
Macrocoma tenue subsp. *tenue*	bark	exotic trees (*Fraxinus*), southern side of car park
Macromitrium ligulare	bark	exotic trees (*Juglans*) with *Leptodon smithii*
**Orthotrichum assimile*	bark	exotic trees
Papillaria flavo-limbata	bark, rock	tree branches, eastern rainforest, rocks near barbecue area
Philonotis tenuis	very wet soil	rock garden, near cascade

Species	Substratum	Location
Pogonatum subulatum	soil	earth banks, near front entrance
Ptychomitrium australe	rock	on basalt of front entrance wall, eastern rainforest, rock garden
**Sphagnum australe*	bog	in rock garden
Thuidium sparsum	rock, bark tree fern	on *Dicksonia antarctica*, eastern rainforest, front entrance wall
Tortula muralis	rock	entrance rock wall, limestone in rock garden
Tortula papillosa	bark	trunks of exotic trees (*Metasequoia*) with *Metzgeria, Macrocoma, Frullania*
Trachycarpidium brisbanicum	soil	rock garden
Weissia controversa	soil	crevices in front entrance wall
Wijkia extenuata	bark	trunks of conifers in conifer collection
LIVERWORTS (*Hepaticopsida*)		
Cephaloziella exiliflora	soil	mixed with moss (*Campylopus*) on sandstone face of front entrance wall
Chiloscyphus semiteres	rock	boulder behind barbecue area, eastern rainforest
Frullania clavata	bark	trunks of exotic trees, with *Macrocoma, Hedwigia, Metzgeria*
Frullania falciloba	bark	trunks of exotic trees (*Juglans*), top of rock garden, on (*Quercus*) in northern lawn
Frullania monocera	bark, tree fern	*Dicksonia antarctica,* exotic tree trunks (*Fraxinus*) with *Metzgeria, Hedwigia*
Frullania probosciphora	bark	trunks of exotic trees (*Fraxinus*)
Frullania squarrulosa	bark	trunks of exotic trees
Lejeunea drummondii	tree fern	*Dicksonia antarctica,* eastern rain forest
Lunularia cruciata	soil	rock garden
Marchantia polymorpha var. *aquatica*	soil	between boulders in rock garden
Metzgeria decipiens	bark	tree ferns, trunks of exotic trees (*Metasequoia, Cryptomeria*) with *Macrocoma, Tortula papillosa*
Metzgeria furcata	bark	trunk of Beech (*Fagus*) in northern lawn on *Metasequoia,* with *Metzgeria, Macrocoma, Tortula papillosa*
Porella crawfordii	rock	boulders near barbecue area

Species	Substratum	Location
THE RAINFOREST (RF)		
MOSSES (***Bryopsida***)		
Achrophyllum dentatum	rock	near stream
Barbula calycina	soil bank	above RF
Camptochaete arbuscula	rock	wet sandstone boulder in RF *Ceratopetalum* & *Doryphora* and near stream
Camptochaete gracilis	rock	near stream
Camptochaete vaga	rock, bar	boulders, rock outcrops
Campylopus introflexus	soil, rock	in more open areas of forest
Ceratodon purpureus	soil	colonising roadside earth bank above rainforest
Cryphaea exannulata	bark	tree branches near edge of RF
Dawsonia polytrichoides	soil	disturbed soil on track above RF
Dicranoloma serratum	bark	tree, edge of RF
Ditrichum difficile	soil	earth bank above RF
Fissidens humilis	soil	shaded bank
Fissidens leptocladus	soil	shaded bank
Fissidens pallidus	soil	shaded earth banks in open forest of *Eucalyptus fastigiata,* under rock outcrops & fallen logs
Fissidens taylorii	soil	shaded bank near stream
Hampeella pallens	bark	tree trunks and branches
Hypnodendron vitiense subsp. *australe*	soil, rock	in or near stream
**Hypnum cupressiforme* var. *filiforme*	bark	tree branch on shaded bank above stream
**Hypnum cupressiforme* var. *mossmannianum*	bark	on trunk of *Doryphora sassafras*
Hypopterygium rotulatum	rock	in and near stream
Leptodon smithii	bark	on trunks of trees well above stream
Leptostomum inclinans	bark	high on upper trunk of *Doryphora sassafras*
Macrocoma tenue subsp. *tenue*	bark	above stream
Macromitrium archeri	bark	tree branches, edge of RF
Macromitrium involutifolium	tree fern	*Dicksonia antarctica,* edge of RF
Macromitrium ligulare	bark	tree branches, edge of RF
Mittenia plumula	soil	shaded bank near stream
Papillaria amblyacis	bark, rock	tree branches, dense part of forest near stream
Papillaria crocea	bark, rock	tree branches, dense part of forest near stream
Papillaria flavolimbata	bark, rock	tree branches, dense part of forest near stream

Species	Substratum	Location
Papillaria flexicauli	rock, bark	festooning shrubs
Philonotis tenuis	soil, rock	wet sandstone weeping wall shaded moist earth banks
Pogonatum subulatum	soil	roadside earth bank above RF
Pyrrhobryum parramattense	rock, bark	rocks in stream, bases of trees
Racopilum cuspidigerum var. *cuspidigerum*	rock, bark	rocks in stream, fallen logs
Rhaphidorrhynchium amoenum	rock, bark	fallen logs
Rhynchostegium tenuifolium	bark	rotten, fallen logs
Schizomeria bryoides [Mielichhoferia bryoides]	soil	earth bank
Sematophyllum contiguum	soil	gully above stream
Thuidium cymbifolium	rock	above & near stream
Thuidium sparsum	rock	above & near stream
Wijkia extenuata	bark	tree trunks, fallen logs, stumps
HORNWORTS (*Anthocerotopsida*)		
Megaceros gracilis	rock, soil	stream & stream bank
LIVERWORTS (*Hepaticopsida*)		
Balantiopsis diplophylla	soil	stream bank with *Lepidozia, Chiloscyphus, Telaranea*
Chiloscyphus argutus	soil	stream bank, with *Lepidozia, Balantiopsis, Telaranea*
Frullania falciloba	bark	with other *Frullania* species on trees on outer edge of RF
Frullania monocera	bark	with other *Frullania* species on trees on outer edge of RF
Frullania pentapleura	bark	with other *Frullania* species on trees on outer edge of RF
Frullania probosciphora	bark	with other *Frullania* species on trees on outer edge of RF
Frullania squarrulosa	bark	with other *Frullania* species on trees on outer edge of RF
Hymenophyton flabellatum	soil, rock	near stream
Lepidozia laevifolia	soil	shaded bank
Metzgeria decipiens	tree fern	*Dicksonia antarctica*
Porella crawfordii	bark	exposed tree root
Symphyogyna podophylla	soil	moist shaded bank, near stream
Telaranea dispa	soil	stream bank, with *Lepidozia, Balantiopsis, & Chiloscyphus*
Tylimanthus tenellus	tree fern	*Dicksonia antarctica* with *Macromitrium involutifolium*

Discussion

Representatives of three classes of bryophytes, mosses (Bryopsida), hornworts (Anthocerotopsida), and liverworts (Hepaticopsida) occur in the gardens and natural forests of the Mount Tomah Botanic Garden. The wide variety of substrata available and the range of vegetation types have created habitats for a particularly diverse group of species. Bryophytes are most conspicuous in the closed-forests on the eastern slopes of the gardens and in the gully on the north western side of Bells Line of Road. The relatively cool and moist climate of Mount Tomah, combined with shade from the dense canopy of rainforest trees, protects bryophytes from desiccation by sun and wind. Bryophytes are found growing as colonisers of bare soil, rocks, fallen logs, as epiphytes on trunks of trees and tree ferns, branches or even the surface of leaves. They thrive on sheltered earth banks, and on rocks in or near streams and waterfalls. In providing a habitat for invertebrates, micro-algae and fungi they contribute to the eventual decomposition of fallen logs. Their ability to survive on exposed situations on soil, earth banks, rocks and walls as well as tree trunks is possible because of their xeromorphic and xerophytic adaptations to desiccation. Their presence often accelerates the weathering of rocks.

This preliminary list of 85 bryophytes includes 63 mosses, 21 hepatics and 1 anthocerote (hornwort): 35 mosses and 13 hepatics were collected from the main garden, 43 mosses, 14 hepatics and 1 anthocerote (hornwort) from the rainforest. Of these, 14 mosses and 6 hepatics occur throughout the garden; 28 mosses and 8 hepatics occur only in the rainforest and 20 mosses and 6 hepatics occur only in the gardens area. There are several new records of mosses for the CT region *Barbula* cf *rehmannii, Orthotrichum assimile, Racopilum cuspidigerum* var. *cuspidigerum, Hypnum cupressiforme* var. *filiforme,* and recent studies have eliminated *Thuidium furfurosum* from the area as specimens have been reidentified as *T. sparsum* (Touw & Haak 1990). Other name changes are indicated in the check list. Without any previous knowledge of hepatics present it is not possible to comment on them.

The species common throughout the gardens include colonisers of soil or rock such as *Bryum argenteum, B. dichotomum, Campylopus introflexus, Ceratodon purpureus, Fissidens* spp., *Pogonatum subulatum, Tortula muralis,* or epiphytes such as *Chiloscyphus semiteres, Frullania* spp., *Macrocoma tenue, Macromitrium ligulare, Thuidium sparsum, Wijkia extenuata.* Species found only in the shaded rainforest include those common on wet ground near streams e.g. *Camptochaete* sp, *Hypnodendron vitiense, Dawsonia polytrichoides, Hypopterygium rotulatum,* or epiphytes e.g. *Papillaria* sp, *Macromitrium* sp, *Dicranoloma serratum.* One species, *Sphagnum australe,* is known to be introduced.

While Mount Tomah occupies a mere 31 hectares in the Blue Mountains which form the northernmost limit of the Central Tablelands area (CT) of New South Wales (Anderson 1961, Ramsay 1984b), it is of interest to relate our findings to the bryoflora for the region. Ramsay (1984a, b) lists 90 genera and 203 species of mosses for the Central Tableland (CT) representing 38.3% N.S.W. species. Only mosses have been listed previously and there is no species list for hepatics for CT. Stephani & Watts (1914) described at least 25 species of hepatics based on specimens from the Blue Mountains.

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