LICHENS

of New Zealand

An Introductory Illustrated Guide

Allison Knight

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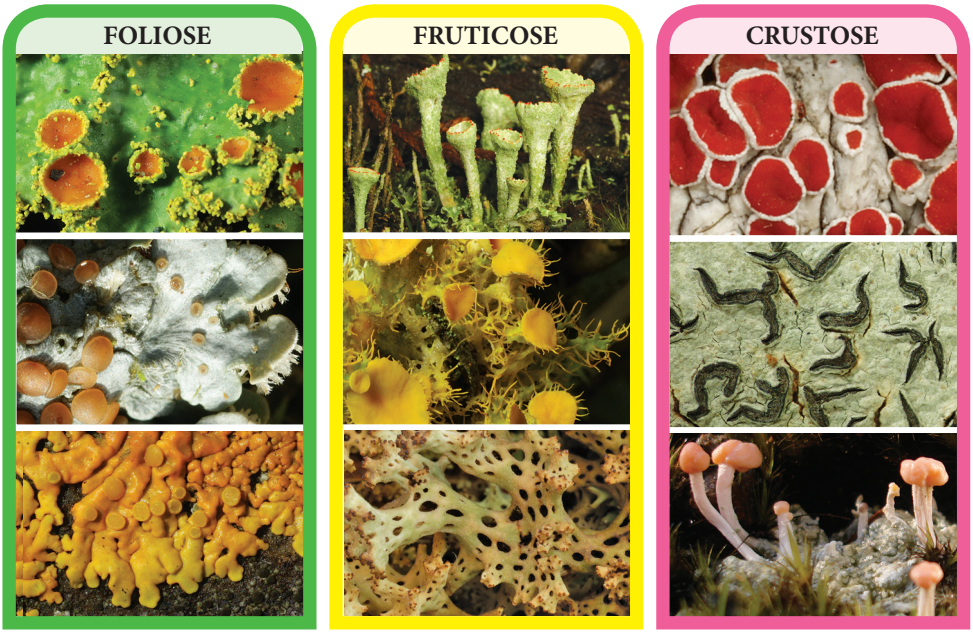
Contents



What is a lichen?

Surprisingly, a lichen is not a single organism, yet every lichen reproduces in a recognizable form and has a scientific name. Scientifically, a lichen is a fungus (mycobiont) living in an intimate, or symbiotic, partnership with a photosynthetic partner (photobiont)—either a green alga or a cyanobacterium, or both. In other words, lichens are 'fungi that have discovered agriculture'. The fungus is genetically unique, which is why all lichens are named after the fungal 'farmer'. Photobionts tend to associate with a range of fungi. The algal (or cyanobacterial) 'crop' uses energy from the sun to produce enough carbohydrates to nourish both partners. The fungus absorbs water and minerals, provides protection from the elements, anchorage and an extended surface area for photosynthesis. Combined, fungus and photobiont can live almost anywhere, from the Equator to the Arctic, the sea-shore to the mountain tops—a far wider range than other plants. Lichens have even survived exposure to outer space! Enhancing their resilience is the ability to manufacture protective chemicals. Over 1000 different lichen chemicals are known, some potentially useful to humans. For protection against UV-B irradiation there are various sunscreens, including chemicals that can convert UV light into visible light. To ward off disease and crowding many lichens make antibiotics, including anti-bacterial, anti-fungal and anti-cancer agents. For defence against browsing some produce pesticides or abrasive crystals. Ecologically speaking, lichens contribute a great deal to our environment and, with 20000 known globally, and more being described every day, add considerably to the world's biodiversity. They colonize, stabilize and enrich bare soil and rock, thus fertilizing and restoring disturbed land. Because they are slow growing and can live for hundreds of years, lichens sequester significant amounts of carbon, yet they can respond rapidly to environmental stresses and are important indicators of pollution and of climate change. There are many reasons why we should get to know these remarkable partnerships.

New Zealand Ecosystems and Lichens

New Zealand's wide range of ecosystems support an exceptionally rich lichen flora. This approaches 2,000 species with more to be discovered—10% of the world's lichens in 0.18 % of global land area! Our main islands stretch from latitude 34°– 47° South; outlying islands extend this to 29°– 52° S, creating a wide climatic range—from tropical to subtropical in the north to subantarctic in the south, with a long cool temperate band in between. Around 85 million years ago the original lowland landmass split off from Gondwanaland. The native Forest & Shrubland Ecosystem section is closest to these origins and contains the greatest diversity of lichens. The main mountain uplift began around 5 million years ago, forming a backbone of mountain ranges and creating the relatively recent lichen habitats covered in the Alpine & Subalpine Ecosystem. There are thousands of kilometres of coastline and rivers, and the surrounding areas form the basis of the Coastal & Freshwater Ecosystem section. Māori arrived and began clearing forest around 1300 AD; Europeans followed suit from around 1800 AD. The Urban & Pastoral Ecosystem section covers areas modified by humans. Lichens play a vital, yet under-recognised, role in all ecosystems, and add almost as many species as seed plants to national biodiversity.

Using this guide

Habitats and Substrates. The layout is divided into the 4 broad colour-coded ecosystems described in the introduction. Some lichens have very specific habitats, others are widespread; if your lichen is not in one section it pays to check the others.

The main substrate is abbreviated after the name of each species:

t: tree-living. On bark (corticolous), bare wood (lignicolous) or leaves (foliicolous)

g: ground-living (terricolous). On soil, sand, decaying matter, moss or low vegetation

r: rock-living (saxicolous). Also on roads, paths, concrete, brick, glass or metal.

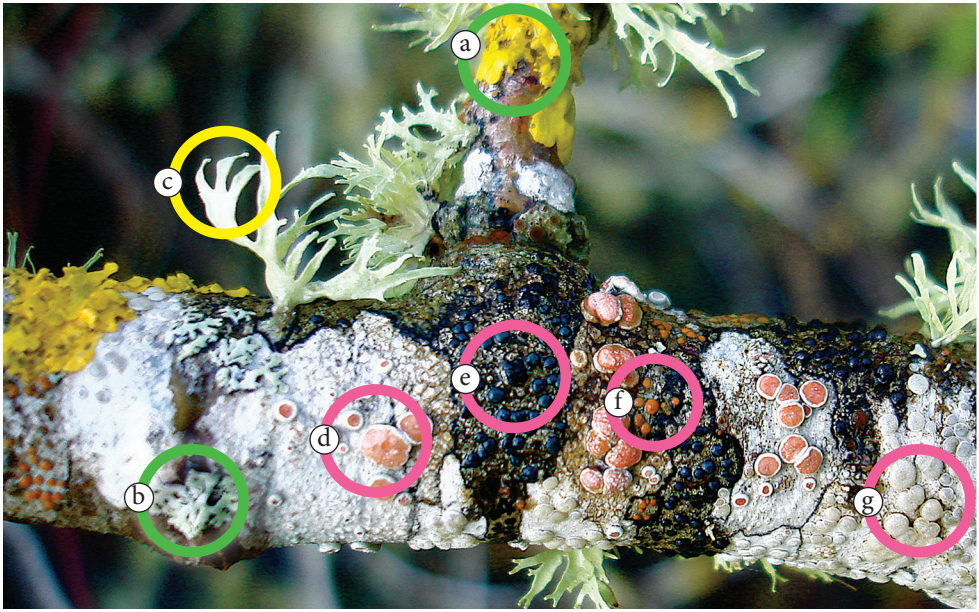
Growth forms. Within each ecosystem, the species are arranged according to the form of the lichen body (thallus). Growth forms are grouped into 3 broad colour-coded categories:

Foliose: flattened, leaf-like lobes with distinct upper and lower surfaces. With care these can be lifted from the substrate—easier when wet. Look for attachment structures on the lower surface and distinctive slits, holes or reproductive structures on the upper surface (see glossary). Foliose lichens are arranged in descending order of lobe width, which varies from greater than 50 mm in some *Sticta* and *Pseudocyphellaria* to less than 0.5 mm in tiny *Hyperphyscia adglutinata*. Finally come **squamulose** lichens, which have individual, scale-like lobes, discrete or overlapping and often tiny, but still with a distinct lower surface. (Squamulose, stalked *Cladonia* may be placed in the fruticose section).

Fruticose: **3-dimensional twiggy or shrubby thallus**. These catch the light from all angles, hence the encircling layer of algae under the outer cortex. Note the branching pattern—single or divided, cylindrical or flattened, upright or dangling, hollow or solid. Stalks are hollow in *Cladonia* and *Cladia* and solid in *Leifidium* and *Stereocaulon*, while *Usnea* has a distinctive central cord (axis).

Crustose: a flattened crust with no lower surface. Fungal filaments (hyphae) extend into the substrate. The thallus can be smooth, rough or cracked, continuous or in discrete lumps (areolate), or entirely embedded in the substrate. Species within ecosystems are grouped by reproductive structures: sexual apothecia or perithecia; asexual vegetative propagules.

Identification. First note the habitat and substrate and then determine the growth form. Wet the lichen and split the thallus to determine the photobiont (green or darkly cyanobacterial—see glossary). The illustrated species have green algae as the main photobiont unless specified as cyanobacterial (cyano.). Use a hand lens and check glossary for other identifying features. Chemical tests and/or microscopic examination of thallus or spores are often needed to reliably identify to species level. Photographs are just a rough guide. Consult the 3 volumes of the Flora of New Zealand Lichens[1,2] for full details.



ABOVE: Lichen covered twig, Orokonui, Dunedin. Typical growth forms:

- **Foliose**: a, *Xanthoria parietina*; b, narrow-lobed *Physcia jackii*.
- **Fruticose**: c, immature *Ramalina* sp. with flattened branches
- **Crustose,** disc fruits: d, pink *Haematomma babingtonii*; e, black *Lecidella elaeochroma*; f, orange *Caloplaca subpyracea*; g, white *Lecanora carpinea*.

Scale. The largest foliose, fruticose or crustose lichens can extend over 50 cm wide or long, while the smallest lichens in each group may have lobes or fruiting bodies less than 1 mm wide. Image size is reduced for the largest lichens; smaller lichens are magnified to show identifying details that could be seen through a 10x lens. Some glossary images may be more highly magnified to show details best seen under a microscope.

Names. Few New Zealand lichens have consistent common names. Names in this guide follow the 2007 Flora of New Zealand Lichens[2] in order to facilitate access to full descriptions. Names that have been updated since are marked with*. Check for current names on the New Zealand Plant Database: http://nzflora.landcareresearch.co.nz

Glossary. Terms in blue in the text are defined in the glossary, which illustrates details that are useful for identification. Related features are grouped together in 5 sections: 1, Photobionts and colour; 2, Growth form variants; 3, Sterile fungal features; 4, Vegetative reproduction; 5, Sexual reproduction.

Collecting. Have a clear purpose, a permit from the Department of Conservation or permission from the landowner. Take the least amount needed for identification. Lichens grow so slowly that regeneration could take years. Dry lichens store well in paper packets.

URBAN & PASTORAL
—areas modified by humans

ABOVE: Saddle Hill, Dunedin

Cleared land inhabited by people, introduced plants, animals and foreign materials presents habitats very different from the original sheltered forest. Farms and towns only sprung up in the 19th century, which in evolutionary terms is very recent. Perhaps it is not surprising that the lowest diversity of lichens occurs in these areas. Now modified environments cover 75% of the land. This section starts close to home: 86% of New Zealand's 4.4 million people live in urban areas and over 30 million animals are farmed in rural areas. Grazed arid areas and lowland tussock grasslands are also covered. Windblown *Xanthoparmelia semiviridis* is one of a suite of lichens threatened by development of arid South Island areas. Since human activity extends above treeline, into the forest and along the coast and waterways, there is some overlap with the other 3 sections.

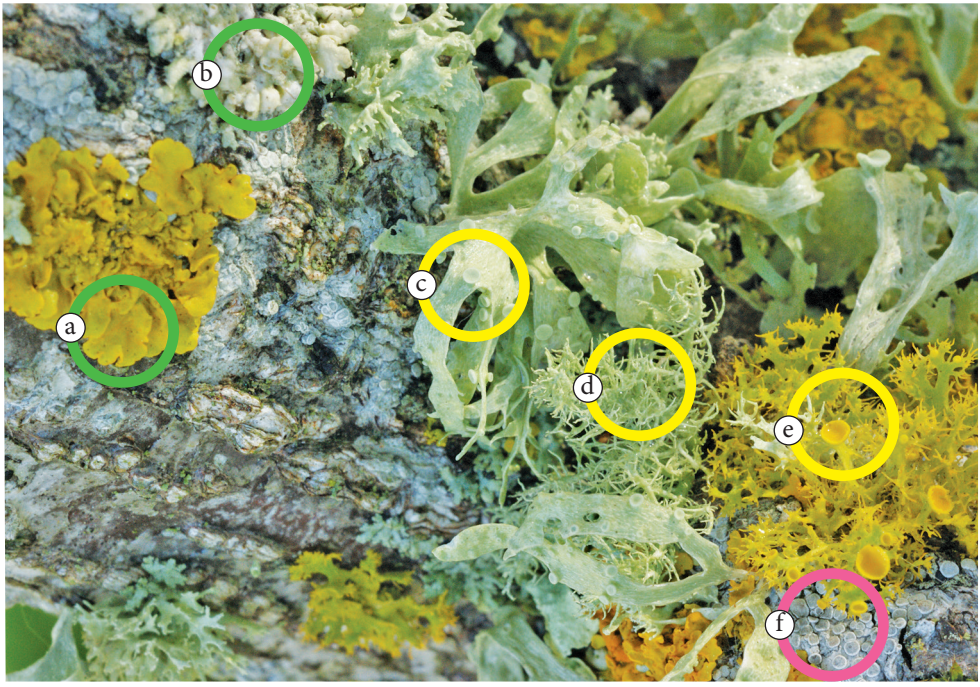
As lichens extract all the nutrients they need from air and water, all they need for growth is moisture, sunlight, clean air and somewhere to perch. Adaptable lichens now occupy many unnatural habitats: bare and painted wood, gravel, asphalt, masonry, concrete, glass, rubber, wire, metal, bricks, tiles, plastic, wind netting, cloth, twine, leather, bones etc. Some form extensive swards: grey green *Xanthoparmelia scabrosa* spreads over sheltered footpaths and roads. Orange *Xanthoria parietina*, which arrived with settlers, *Candelaria*, *Candelariella* or *Caloplaca* species can turn trees, roofs, concrete or bare wood golden, while

Lecanora carpinea paints bark white. The extra light that deciduous trees allow in winter encourages *Physcia adscendens* and other cosmopolitan lichens. Higher light does not suit many large foliose lichens, but fruticose *Usnea* and *Ramalina* species thrive on well-lit bark and wood.

Air pollution can limit lichen growth in cities. Dust, smoke, exhaust fumes, industrial pollution, acid rain, rain shadows and deep shade all limit the amount of light or clean water available, to the extent that the centres of some cities become lichen deserts. As the air gets cleaner away from dense buildings and busy roads, the diversity, health and abundance of lichens increases, although agricultural chemicals and other farmland pollution, especially elevated nitrogen from fertilizer and animal waste, impact adversely on lichen growth and diversity.

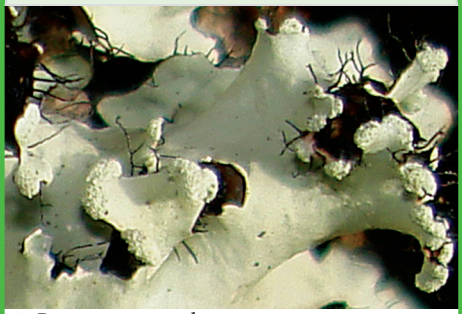
Lichens are important colonizers and stabilizers of disturbed ground. *Dibaeis arcuata* and *Baeomyces heteromorphus* form pale, spreading crusts on roadside and trackside banks that consolidate the soil and pave the way for further succession.

The following 52 images of town and country lichens are arranged by growth form.



ABOVE: Urban lichen community on rose branch, Dunedin. Typical growth forms:
Foliose: a, *Xanthoria parietina*; b, *Physcia adscendens*.
Fruticose: c, *Ramalina celastri*; d, *Usnea cornuta*; e, *Teloschistes chrysophthalmus*.
Crustose: f, *Lecanora carpinea*.

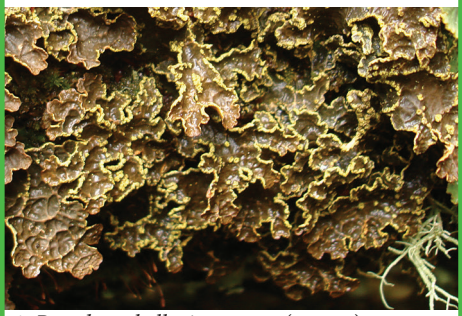
FOLIOSE—wide lobes



1. *Parmotrema perlatum* **t**

2. *Punctelia borreri* **g,t**

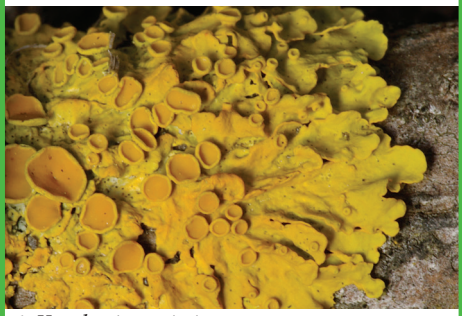
3. *Peltigera polydactylon* (cyano.) **g**



4. *Pseudocyphellaria crocata* (cyano.) **t,r**

FOLIOSE—wide to medium lobes

5. *Punctelia subrudecta* **t**



6. *Xanthoria parietina* **t**

7. *Parmelina labrosa* **t**

8. *Xanthoparmelia scabrosa* **r**

FOLIOSE—narrow lobes

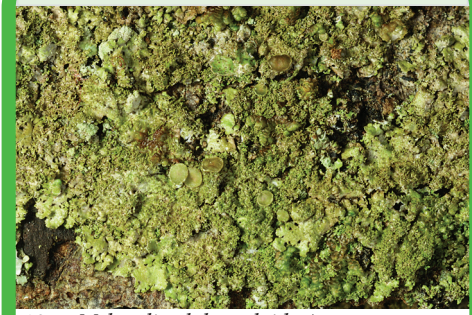
9. *Xanthoparmelia verisidiosa* **r**

10. *Dirinaria applanata* **t**

11. *Heterodermia speciosa* **t**

12. *Hyperphyscia plinthiza* **t**

FOLIOSE—narrow or inflated lobes



13. *Melanelia glabratuloides** **t**

14. *Hypogymnia subphysodes* **t**

15. *Menegazzia subpertusa* **t**

16. *Menegazzia neozelandica* **t**

FOLIOSE—narrow lobes

17. *Physcia caesia* **r**

18. *Physcia jackii* **t**

19. *Xanthoparmelia semiviridis* **g**

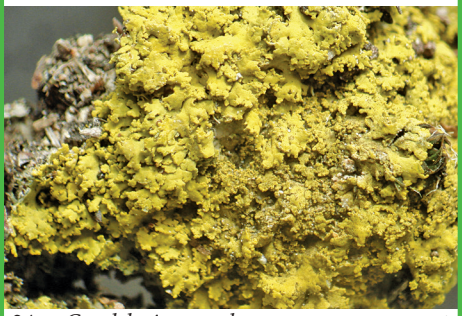
20. *Xanthoparmelia reptans* **g**

—narrow or scale-like (squamulose)

21. *Physcia adscendens* **t,r**

22. *Hyperphyscia adglutinata* **t**

23. *Peltula euploca* (cyano.) **r**



24. *Candelaria concolor* **t**

FRUTICOSE—unbranched

25. *Cladonia chlorophaea* **g**

26. *Cladonia fimbriata* **g**

27. *Cladonia floerkeana* **g**

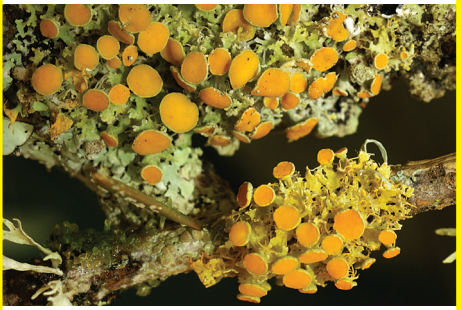
28. *Teloschistes velifer* **r,t**

FRUTICOSE—mostly unbranched

29. *Ramalina celastri* **t,r**

30. *Ramalina glaucescens* **t**

31. *Teloschistes chrysophthalmus* **t**



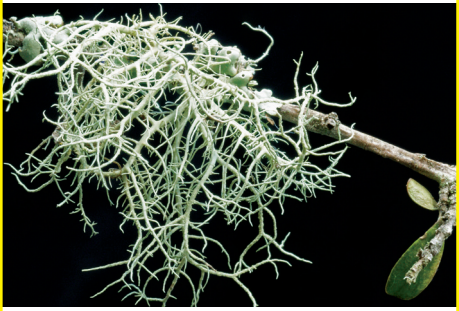
32. *Teloschistes sieberianus* **t**

FRUTICOSE—branched

33. *Stereocaulon ramulosum* **r,g**

34. *Cladia aggregata* **g**

35. *Usnea cornuta* **t**



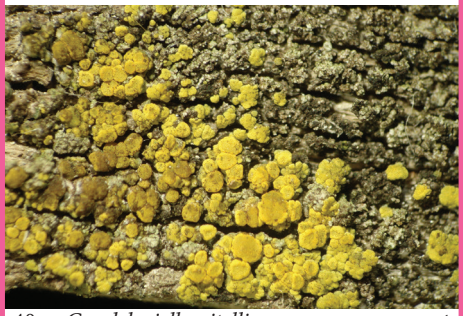
36. *Usnea inermis* **t**

CRUSTOSE—rimmed fruit

37. *Haematomma babingtonii* **t**

38. *Lecanora carpinea* **g**

39. *Diploschistes muscorum* ssp *bartlettii* **t**

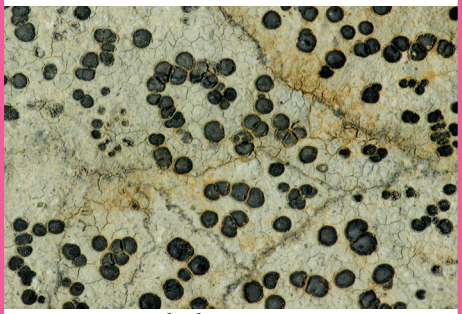


40. *Candelariella vitellina* **t**

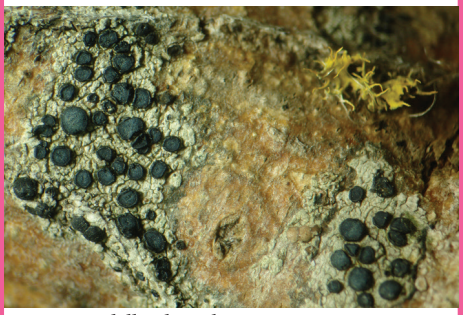
CRUSTOSE—unrimmed fruit

41. *Buellia porulosa* **t**

42. *Pyrrhospora laeta** **t**



43. *Paraporpidia leptocarpa* **r,g**

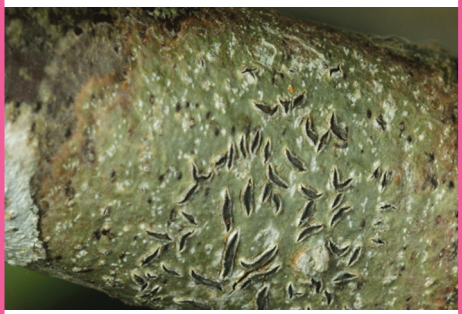


44. *Lecidella elaeochroma* **t**

CRUSTOSE—distorted fruit (lirellae)

45. *Arthonia radiata* **t**

46. *Graphis librata* **t**



47. *Phaeographina arechavaletae** **t**

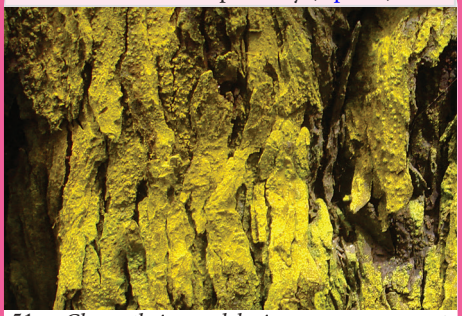
48. *Thalloloma subvelata* **t**

CRUSTOSE—stalked fruit

49. *Dibaeis arcuata* **g,r**

50. *Baeomyces heteromorphus* **g,r**

CRUSTOSE—powdery (leprose)



51. *Chrysothrix candelaris* **t**

52. *Lepraria lobificans* **g,t**

ABOVE: 'Freshwater' cyanobacterial lichens, John O'Groats River, Fiordland. a, *Leioderma pycnophorum*; b, *Collema* sp.; c, *Degelia gayana*; d, *Pannaria euphylla* (arrow to cephalodium)

COASTAL & FRESHWATER
—near the sea or in moist places

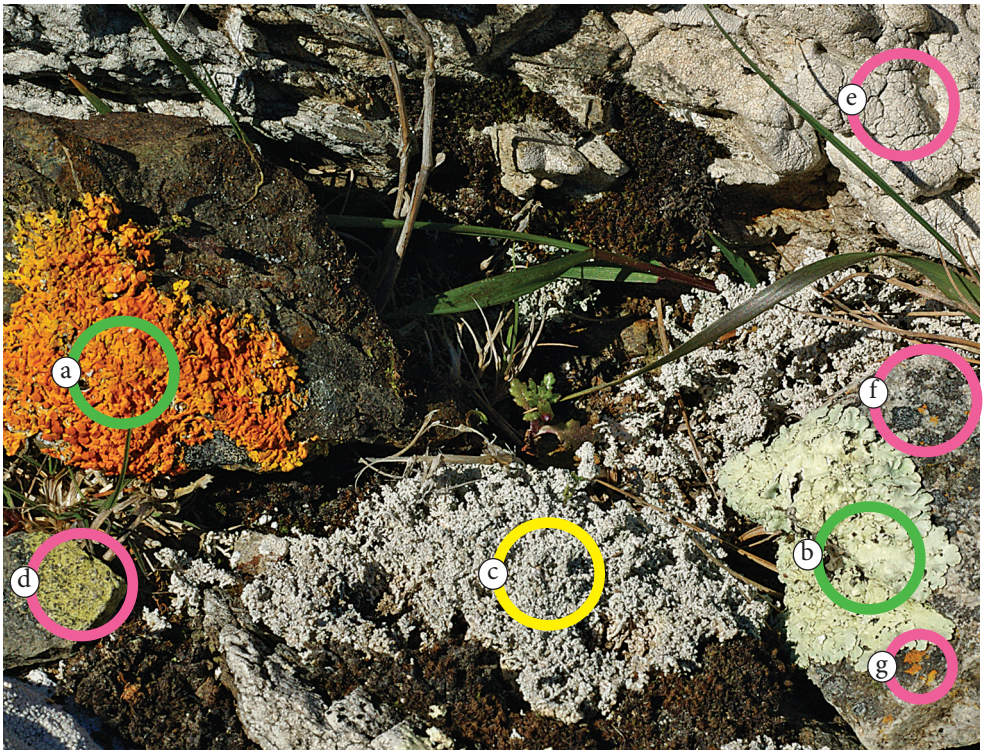
ABOVE: Coast, river and lake shores, wetlands and rainforest, Lake McKerrow, Fiordland.

New Zealand has over 15000 km of coastline and over 75% of the population lives within 10 km of the sea. There are a staggering 425000 km of rivers and streams and over 4000 lakes. The Coastal and Freshwater section covers these diverse habitats. As many coastal and freshwater areas border or cross farmland, forest and human habitation, there is some crossover with the Urban & Pastoral and Forest & Shrubland sections.

The open coast is exposed to sun, wind and lashing waves. Zonation of lichens on the rocky shore can be marked. Below the tide line black *Verrucaria* creates a black 'tar slick' zone, with orange, crustose *Caloplaca* above. The splash zone is inhabited by more crusts and by bright orange, small foliose *Xanthoria ligulata**; these merge into a broad, white zone dominated by *Pertusaria* species. Above that live less firmly attached species such as foliose *Flavoparmelia* and *Parmotrema*, and fruticose, pixie cup *Cladonia* species. Coastal trees, such as pohutakawa in the north and rata/kamahi forests in the south, support distinct lichen communities, as do estuarine shrubs such as salt marsh ribbonwood. Widespread *Rinodina thiomela*, a greenish-yellow crust, lives on rocks close to the coast, by estuaries or by freshwater.

Exposed river and lakeside habitats include eroding ground, bark and bare

wood. Other freshwater sites are damp places near ponds, wetlands, bogs, drips and trickles. Periodically inundated habitats range from the exposed, rolling stones of east coast braided rivers to damp ditches or shady stream banks. Some lichens from the moistest places in rain and mist forests are also included in this section. Lichens grow best in repeated wet/dry situations. They can only photosynthesize when moist. Green algae use water vapour and can survive with mist alone, but do not cope with being sodden. Cyanobacteria can photosynthesize when saturated, enabling them to tolerate the wettest sites, hence their abundance in this section. Cyanobacterial *Pseudocyphellaria* and *Sticta* species thrive in moist, shady forests, while *Peltigera* species are rapid colonizers of damp banks and rotting logs. Genera containing both green algae and bundles of cyanobacteria (cephalodia) are also well adapted to damp places. *Pannaria* species are common in moist forests, while *Placopsis* and *Stereocaulon* are important early colonizers and stabilizers of riverbeds, ditches and damp banks. The mushroom-fruited (basidiomycete) lichens *Lichenomphalia* and *Multiclavula mucida* inhabit damp substrates.



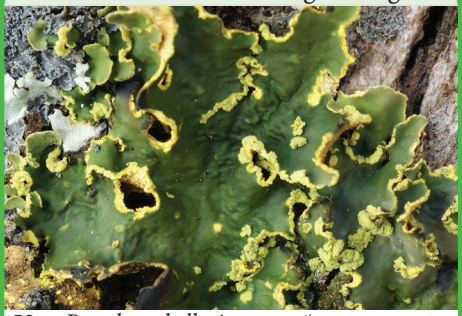
ABOVE: Coastal lichens, Akatore, Otago. Typical growth forms.

Foliose: a, *Xanthoria ligulata**; b, *Flavoparmelia haysomii*.

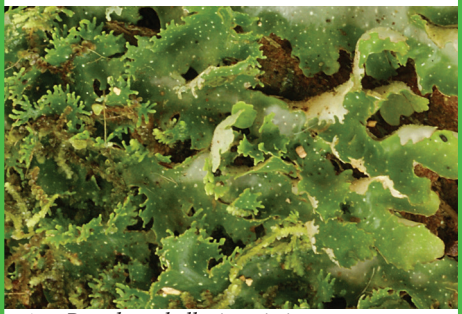
Fruticose: c, *Stereocaulon corticatulum*.

Crustose: d, *Rinodina thiomela*; e, *Pertusaria graphica*; f, black *Buellia stellulata*; g, orange *Caloplaca* sp.

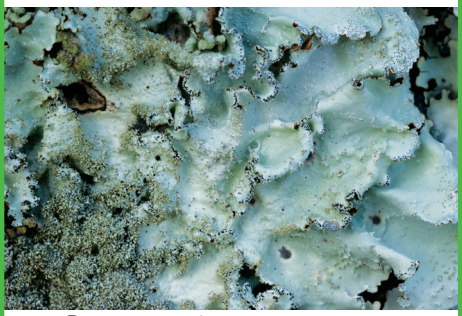
FOLIOSE—wide lobes, green algal



53. *Pseudocyphellaria aurata** **t,r**



54. *Pseudocyphellaria episticta* **t**



55. *Parmotrema tinctorum* **t,r**

56. *Parmotrema reticulatum* **t,r**

—wide lobes, cyanobacterial

57. *Sticta fuliginosa* **t.r**

58. *Peltigera dolichorhiza* **g**

59. *Pseudocyphellaria dissimilis* **g ,t,r**

60. *Pseudocyphellaria fimbriatoides* **g ,t**

—wide lobes, cyanobacterial

61. *Collema subconveniens* (dry) **t**

62. *Collema laeve* **t**

63. *Degelia gayana* **t**

64. *Nephroma cellulosum* **t**

—wide to narrow lobes, cyanobacterial

65. *Leptogium coralloideum* **t**

66. *Leioderma sorediatum* **t**

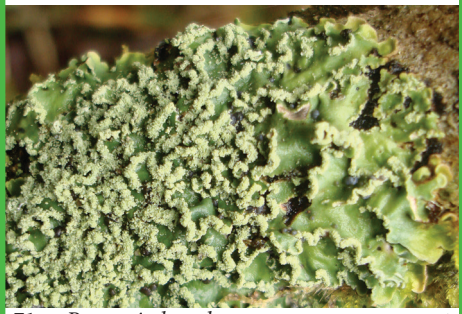
67. *Physma chilense* **t**

68. *Pannaria elixii* **t**

—narrow lobes, green algal

69. *Heterodermia lutescens* **r**

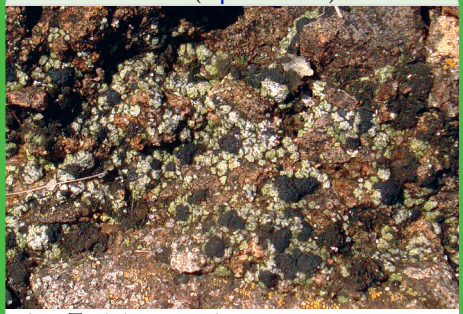
70. *Xanthoria ligulata** **r**



71. *Pannaria leproloma* **t**

72. *Pannaria microphyllizans* **t**

—scale-like (squamulose) lobes



73. *Toninia aromatica* **r**

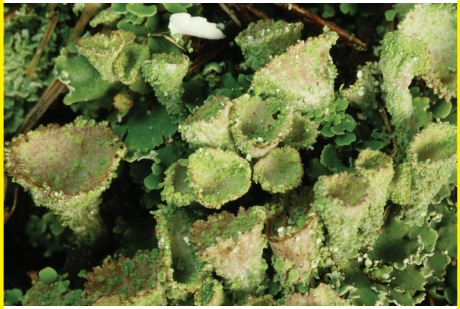
74. *Neophyllis melacarpa* **g,t**

75. *Pannaria immixta* (cyano.) **r**

76. *Parmeliella nigrocincta* (cyano.) **t**

FRUTICOSE—unbranched

77. *Cladonia humilis* **g**



78. *Cladonia pyxidata* **g**

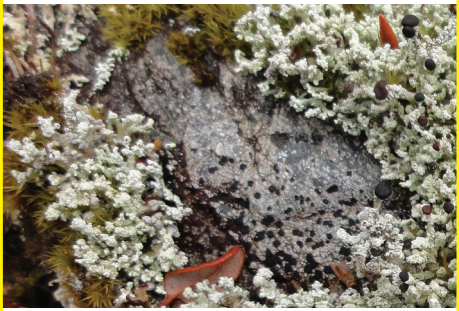
79. *Siphula fragilis** **g**

80. *Siphula decumbens* **g**

FRUTICOSE—branched

81. *Cladia retipora* **g**

82. *Cladonia confusa* **g**

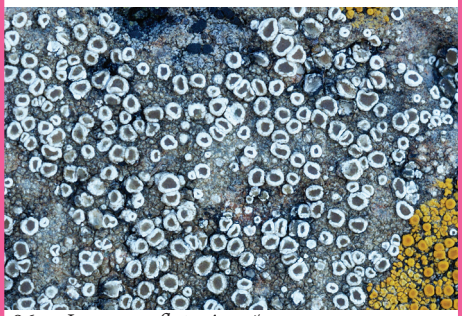


83. *Stereocaulon corticatulum* **r**

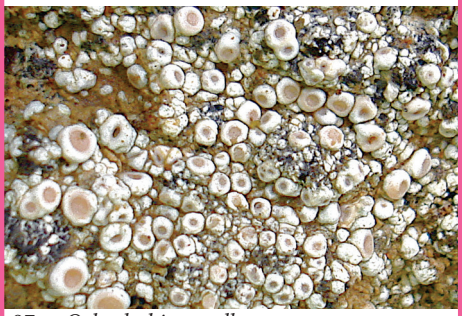
84. *Usnea rubicunda* **t**

CRUSTOSE—rimmed fruit, coastal

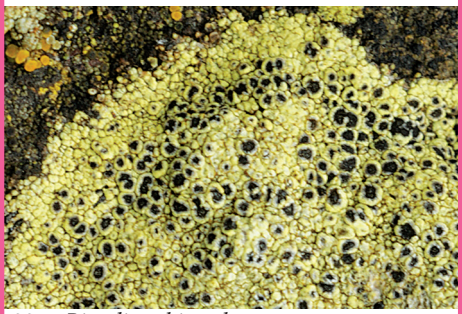
85. *Caloplaca circumlutosa* **r**



86. *Lecanora flotoviana** **r**



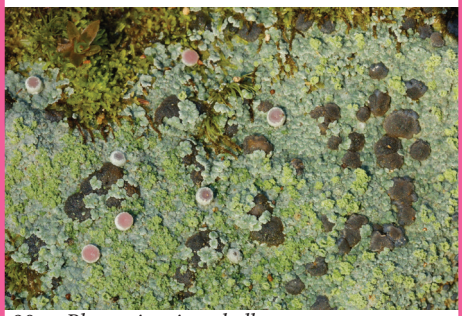
87. *Ochrolechia parella* **r**



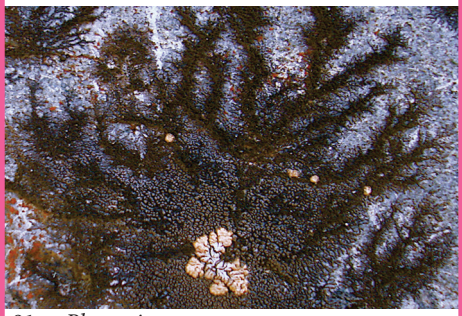
88. *Rinodina thiomela* **r**

Squamulose/Crustose—rimmed fruit

89. *Placopsis illita* **r**



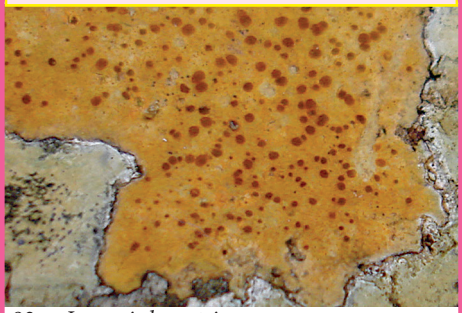
90. *Placopsis microphylla* **r**



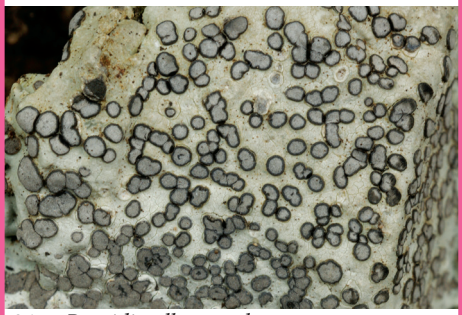
91. *Placopsis perrugosa* **r**

92. *Tephromela atra* **r**

CRUSTOSE—unrimmed fruit

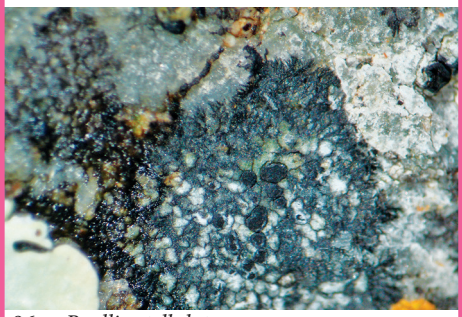


93. *Ionaspis lacustris* **r**



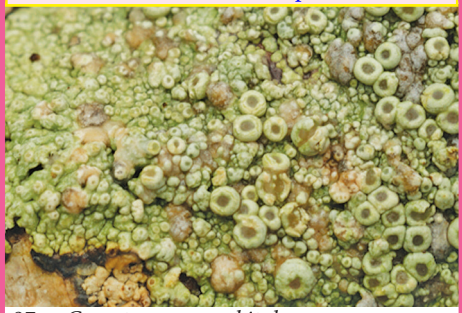
94. *Porpidia albocaerulescens* **r**

95. *Buellia albula* **r**



96. *Buellia stellulata* **r**

CRUST—enclosed fruit (perithecioid)



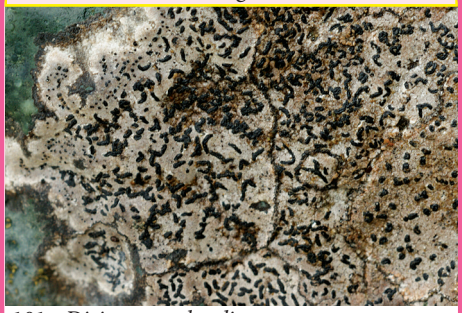
97. *Coccotrema cucurbitula* **r**

98. *Diploschistes scruposus* **r**

99. *Pertusaria graphica* **r**

100. *Verrucaria maura* **r**

CRUSTOSE—elongated fruit (lirellae)



101. *Dirina neozelandica* **r**

102. *Opegrapha diaphoriza* **r**

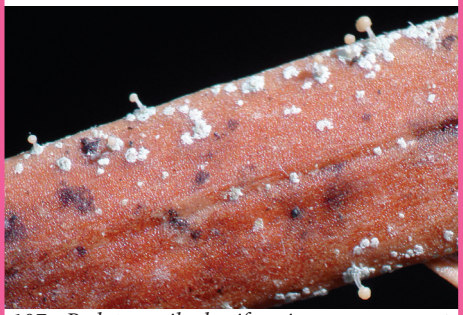
103. *Enterographa subgelatinosa* **r**

104. *Enterographa bella* **t**

CRUSTOSE—stalked/ leaf-living

105. *Metus conglomeratus* **g**

106. *Lichenomphalia alpina* **g**



107. *Podotara pilophoriformis* **t**

108. *Strigula* sp. **t**

FOREST & SHRUBLAND
—native trees & shrubs below treeline

ABOVE: Rain forest and shrubland with no treeline, Coromandel Peninsula.

Ancient New Zealand was covered in lowland forest, so it is not surprising that the forest lichen flora is particularly well developed. This Forest & Shrubland section covers lichen habitats amongst native trees and shrubs below treeline. Shrubland habitats above treeline are treated in the Alpine & Subalpine section. Some cyanobacterial species from moist forest habitats are illustrated in the Coastal & Freshwater section.

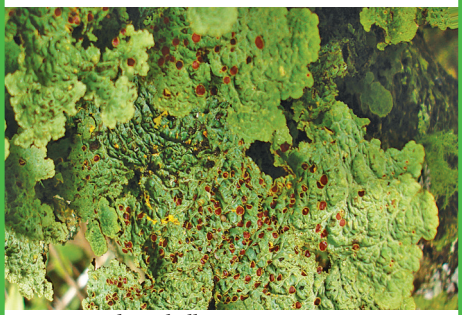
Our native evergreen forest flora differs considerably from the Northern Hemisphere deciduous and conifer forests, having evolved in isolation and the absence of ground mammals. Dispersal from Australia, the Pacific Islands and South America has added to the mix of forest species. Forests dominated by southern beech (*Nothofagus*) occur in colder, drier areas. Magnificent podocarp forests—totara, kahikatea in moist lowland areas, and giant kauri in the north—have been decimated by fire and logging. Northern pohutukawa and rata typify the coast. Broad-leaved trees intermingle with larger forest trees, giving way to shrubs in the understorey and the forest edge. New Zealand has an exceptional number of small-leaved, often divaricating, shrubs from many genera, perhaps driven by pressure from the original toothless browsing fauna. Manuka and kanuka dominate the grey shrubland, along with species of *Coprosma* and other small leaved shrubs.

Lichen habitats range from deep shade near the ground inside the forest to high light on canopy or open shrubland twigs; from very humid bark and rock in rainforest or mist forest to scorchingly dry perches in sparse, stony shrubland. Pristine rainforests harbour our most spectacular large lichens and New Zealand is a centre of diversity for the wide-lobed foliose genera *Pseudocyphellaria* and *Sticta*, distinguished by the type of pits on their lower surfaces. In the shelter of the forest the protective outer cortex is thinner. Dry, it is opaque and greyish; when wet, many shades of green algae and cyanobacteria show through. Narrow, inflated lobes are characteristic of *Menegazzia* and *Hypogymnia*. *Menegazzia* is distinguished by holes through the upper surface. White crusts splashed over trunks and branches could be *Phlyctis*, *Pertusaria* or *Thelotrema* species. Dangling or tufted strands of yellowish-green old man's beard (*Usnea*) add an ethereal touch to twigs and branches in goblin forests near treeline. Grey straps of *Ramalina* live among them on the lower forest edge. Tiny leaf-living (foliicolous) genera such as *Strigula* and *Byssoloma*, and the beautiful *Enterographa bella*, are most likely to be found on leaves and ferns in moist forest.

ABOVE: Mist forest lichen community on bark, Lewis Pass, Canterbury. Growth forms.
Foliose: a, *Pseudocyphellaria rubella**; b, *Menegazzia pertransita*.
Fruticose: c, *Usnea articulata*.
Crustose: d, *Pertusaria* sp.; e, *Thelotrema lepadinum*

FOLIOSE—very wide lobes

109. *Sticta latifrons* **t,g**



110. *Pseudocyphellaria coronata* **t**

111. *Pseudocyphellaria colensoi* **t**

112. *Pseudocyphellaria lividofusca* **t**

FOLIOSE—wide, smooth lobes

113. *Pseudocyphellaria homoeophylla* **g,t**

114. *Nephroma australe* **t,r**

115. *Lobaria adscripta* **t,r**

116. *Parmelia tenuirima* **t**

FOLIOSE—smooth or dimpled lobes

117. *Sticta cinereoglauca* **t**

118. *Sticta subcaperata* **t**

119. *Pseudocyphellaria rufovirescens* **t,g**

120. *Pseudocyphellaria faveolata* **t,g**

FOLIOSE—divided lobe margins

121. *Sticta filix* **t,g**

122. *Pseudocyphellaria multifida* **t**

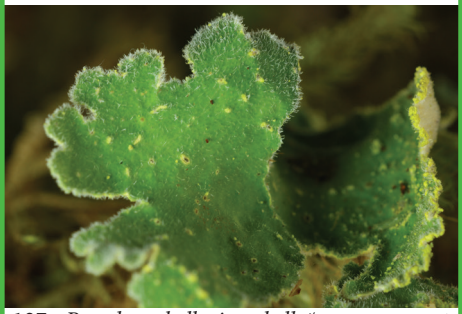
123. *Bunodophoron scrobiculatum* **t,g**

124. *Pseudocyphellaria glabra* **t,g**

—finely divided, hairy or granular

125. *Pseudocyphellaria pickeringii* **t,g**

126. *Punctelia subflava* **t,r**



127. *Pseudocyphellaria rubella** **t**

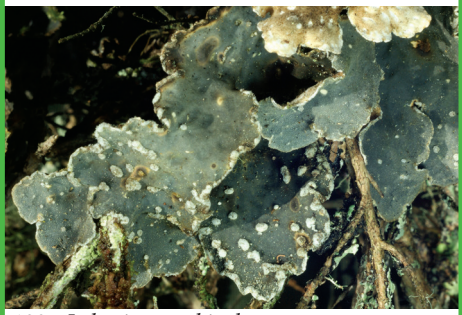
128. *Pseudocyphellaria granulata* **t**

—granular (sorediate) & cyanobacterial

129. *Pseudocyphellaria crocata* shade form **t,r**

130. *Pseudocyphellaria intricata* **t**

131. *Sticta limbata* **t**



132. *Lobarina scrobiculata* **t**

FOLIOSE—wide lobes, cyanobacterial

133. *Peltigera nana* **g**

134. *Nephroma rufum* **t**

135. *Nephroma plumbeum* var. *isidiatum* **t**

136. *Degelia duplomarginata* **t**

—narrow lobes, cyanobacterial

137. *"Dendriscocaulon dendroides"* **g**

138. *Leioderma pycnophorum* **t**

139. *Erioderma leylandii* **t**

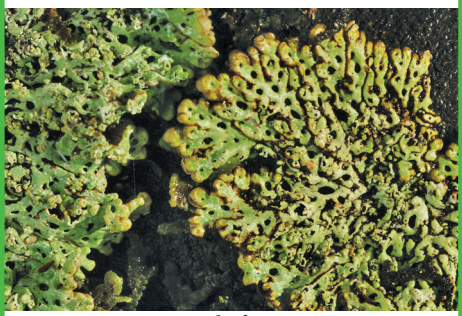
140. *Coccocarpia erythroxyli* **t**

FOLIOSE—inflated lobes

141. *Hypogymnia turgidula* **t**

142. *Menegazzia pertransita* **t**

143. *Menegazzia dielsii* **t**

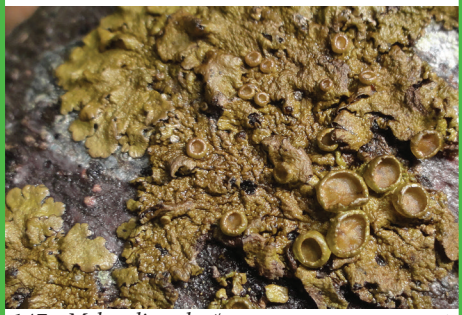


144. *Menegazzia nothofagi* **t,r**

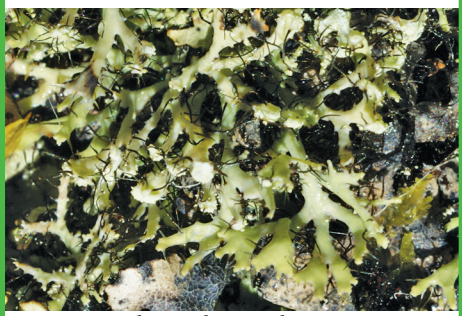
FOLIOSE—narrow lobes

145. *Bunodophoron australe* **t,g**

146. *Bunodophoron insigne* **t,g**



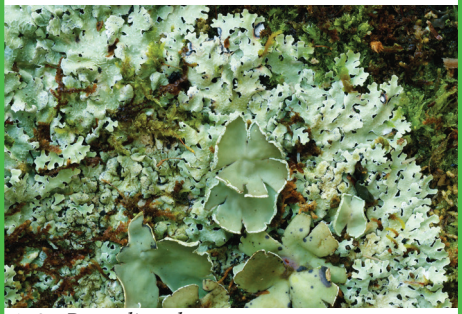
147. *Melanelia calva** **t**



148. *Heterodermia leucomela* **t**

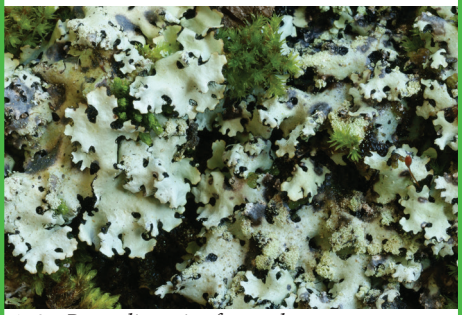
FOLIOSE—narrow lobes

149. *Pannoparmelia angustata* **t**



150. *Parmelia subtestacea* **t**

151. *Parmelina pseudorelicina* **t**



152. *Parmelinopsis afrorevoluta* **t**

FOLIOSE—narrow lobes, cephalodia

153. *Sticta martinii* **t,r**

154. *Pannaria sphinctrina* **t**

155. *Pannaria euphylla* **t**

156. *Pannaria xanthomelana* **t**

—scale-like (squamulose) lobes

157. *Psoroma asperellum* **t**

158. *Psoroma melanizum* **g**

159. *Trapeliopsis congregans* **g**

160. *Cladonia darwinii* **g**

FRUTICOSE—branched

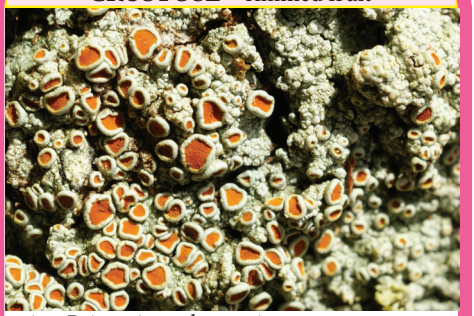
161. *Leifidium tenerum* **g,t**

162. *Sphaerophorus stereocauloides* **t,g**

163. *Usnea articulata* **t**

164. *Usnea ciliifera* **t**

CRUSTOSE—rimmed fruit



165. *Brigantiaea chrysosticta* **t**

166. *Ochrolechia pallescens* **t**

167. *Pertusaria truncata* **t**

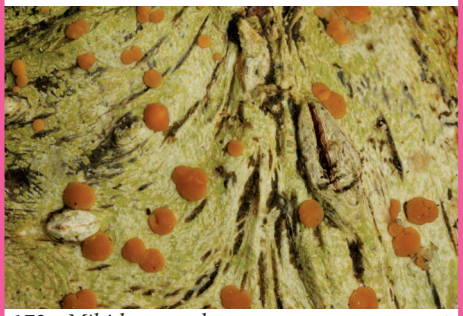
168. *Phlyctis subuncinata* **t**

CRUSTOSE—unrimmed fruit

169. *Megalaria grossa* **t**

170. *Dibaeis absoluta* **g**

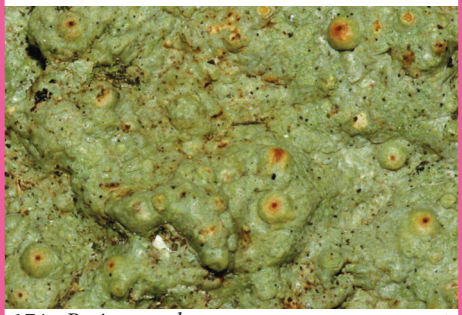
171. *Megalospora gompholoma* **t**



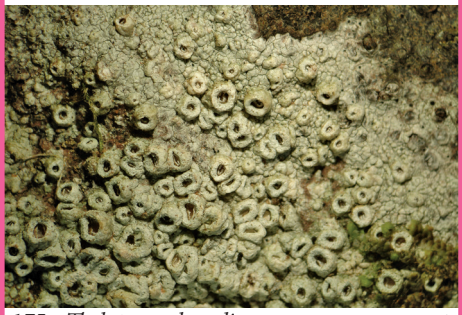
172. *Miltidea ceroplasta* **t**

—enclosed fruit (perithecioid)

173. *Pyrenula deliquescens* **t**



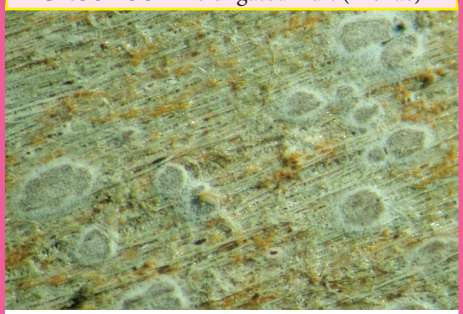
174. *Porina exocha* **t**



175. *Thelotrema lepadinum* **t**

176. *Topeliopsis decorticans* **r**

CRUSTOSE—elongated fruit (lirellae)



177. *Arthonia cinereopruinosa* **t**

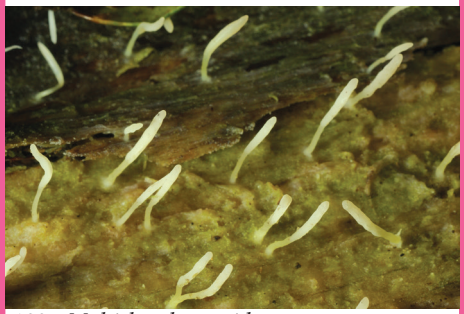
178. *Enterographa pallidella* **t**

179. *Leiorreuma exaltatum* **t**

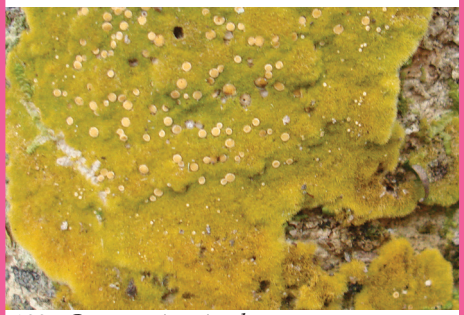
180. *Phaeographis inusta* **t**

—stalked fruit or felt-like thallus

181. *Chaenotheca brunneola* **t**



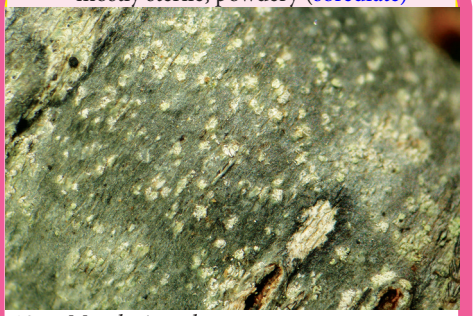
182. *Multiclavula mucida* **g,r**



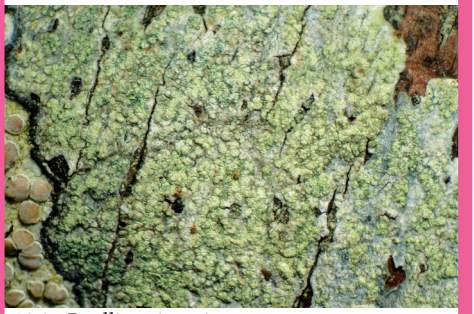
183. *Coenogonium implexum* **t**

184. *Sagenidium molle* **t**

—mostly sterile, powdery (sorediate)

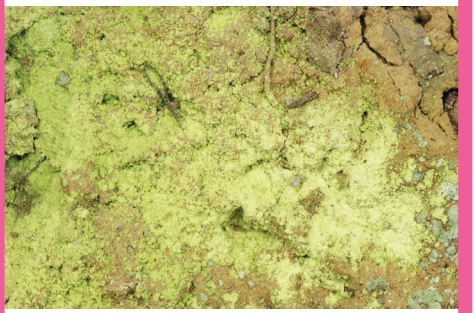


185. *Megalaria pulverea* **t**



186. *Buellia griseovirens* **t**

187. *Pertusaria novaezelandiae* **t**



188. *Psilolechia lucida* **g,r**

ALPINE & SUBALPINE —habitats above treeline

ABOVE: Subalpine shrubs, tussock grassland and alpine rocks, Lake Marion, Fiordland.

New Zealand's mountains are around 5 million years young and are still being pushed up and eroded down as the Pacific and Australian tectonic plates collide and slide, continually creating new habitats for lichens to colonize. This section covers alpine and subalpine habitats above treeline.

Treeline rises with mean summer temperature. In the far north all vegetation is below treeline. It comes in at 1500 m on the volcanoes of the central plateau. Other North Is. alpine areas are: Mt Taranaki to the west; Hikurangi to the east; the crests of the Kaweka, Kaimanawa, Ruahine and Tararua ranges. The South Island has the highest mountains and the most extensive areas of alpine and subalpine habitats. Treeline ranges from 1250 m in the centre of the Southern Alps to below 1000 m on the coast. On Rakiura (Stewart Is) it falls from 900 m to sea level and in the Subantarctic Islands nearly all vegetation is above treeline.

Subalpine shrubs provide a brief zone of shelter and bark for lichens to grow on. Above that there are niches among increasingly stunted plants, from tussock grasslands to herbfields, to pygmy cushionfields. When these give out, tough lichens grow on bare soil and rock, up to nearly 3600 m on the summit rocks of Mt Cook. As the survival of other plants decreases with increasing altitude, lichens make an increasing contribution to the diversity and cover of the alpine flora, until they dominate completely. The lichen symbiosis has developed

amazing strategies to deal with extremes of blazing sun, high UV-B irradiation, heavy cloud, repeated freeze-thawing, blasting wind, hail and deep snow.

There are few big, leafy lichens in alpine areas and in open spaces there is not much green showing through; shrubby forms do surprisingly well and there are many crusts, sometimes coating entire rock surfaces in a mosaic of colour. Brown, black and white dominate, with splashes of orange and yellow. Various strategies protect from harmful UV-B rays. Sunscreens include orange parietin (*Teloschistes fasciculatus*, *Xanthoria elegans**) and dark pigments such as melanin (brown *Xanthoparmelia and Bryoria*, blackened *Umbilicaria* and *Pseudephebe*). Alpine *Usnea* species protect their most sensitive dividing cells in apothecia and branch tips with a purplish black pigment. Levels of pigment vary with the level of radiation. Other lichens produce a thick, white reflective coating (*Thamnolia*, *Siphula*, *Lecanora*, and *Pertusaria* species). Pruina of calcium oxalate crystals often protects sensitive cells. Some *Rhizocarpon*, *Thamnolia* and brown *Xanthoparmelia* species can convert UV light into visible light. In the cortex this could render the rays harmless; in the medulla it could increase the amount of light available for photosynthesis.

ABOVE: Alpine rock lichen community, Mt Tennyson, Southland. Typical growth forms.

Foliose: a, *Xanthoparmelia* sp., with brown melanoid sunscreeen.

Fruticose: b, *Bryoria austromontana*.

Crustose: c, *Rhizocarpon geographicum*; d, *Pertusaria otagoana*

FOLIOSE—wide lobes

189. *Pseudocyphellaria maculata* (cyano.) **g**

190. *Pseudocyphellaria degelii* **g,t**

191. *Parmelia signifera* **r**

192. *Parmelia sulcata* **r**

FOLIOSE—wide lobes

193. *Umbilicaria nylanderiana* **r**

194. *Umbilicaria umbilicarioides* **r**

195. *Umbilicaria vellea* **r**

196. *Solorina crocea* **g**

FOLIOSE—narrow lobes

197. *Hypogymnia lugubris* **g,t**

198. *Menegazzia inflata* **t**

199. *Hypotrachyna sinuosa* **t**

200. *Everniastrum sorocheilum* **t**

FOLIOSE—narrow lobes

201. *Xanthoria elegans** **r**

202. *Xanthoparmelia* sp. (brown sunscreen) **r**

203. *Xanthoparmelia stygiodes* **r**

204. *Icmadophila splachnirima* **g**

—scale-like (squamulose) lobes

205. *Trapeliopsis colensoi* **g**

206. *Toninia bullata* **g,r**

207. *Psoroma paleaceum* **g**

208. *Psoroma hypnorum* **g**

FRUTICOSE—unbranched

209. *Cladonia murrayi* **g**

210. *Cladonia pleurota* **g**

211. *Stereocaulon gregarium* **r**

212. *Usnea acromelana* **r**

FRUTICOSE—no or few branches

213. *Thamnolia vermicularis* **g**

214. *Siphula dissoluta* **g**

215. *Siphula fastigiata* **g**

216. *Siphula foliacea** **g**

FRUTICOSE—branched

217. *Cladia sullivanii* **g**

218. *Bunodophoron ramuliferum* **t,r,**

219. *Usnea ciliata* **r**

220. *Stereocaulon colensoi* **r**

FRUTICOSE—branched

221. *Usnea torulosa* **r**

222. *Alectoria nigricans** **g**

223. *Pseudephebe pubescens* **r**

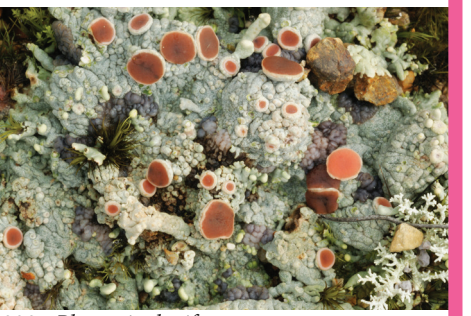
224. *Teloschistes fasciculatus* **r**

CRUSTOSE—rimmed fruit

225. *Haematomma alpinum* **t**

226. *Ochrolechia xanthostoma* **g**

227. *Placopsis brevilobata* **r**



228. *Placopsis clavifera* **r,gw**

CRUSTOSE—rimmed fruit

229. *Lecanora epibryon* ssp. *broccha* **g**

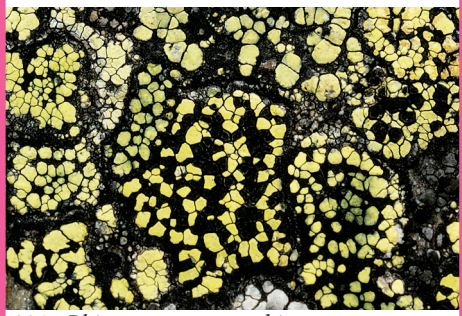
230. *Lecanora rupicola* **r**

231. *Lecanora farinacea* **r**

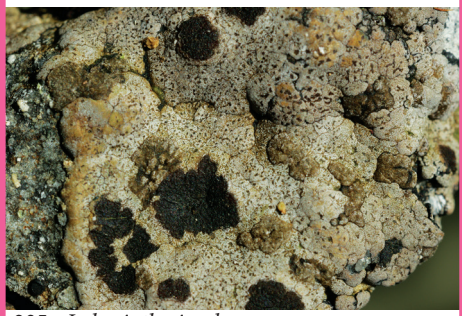
232. *Lecanora polytropa* **r**

CRUSTOSE—unrimmed fruit

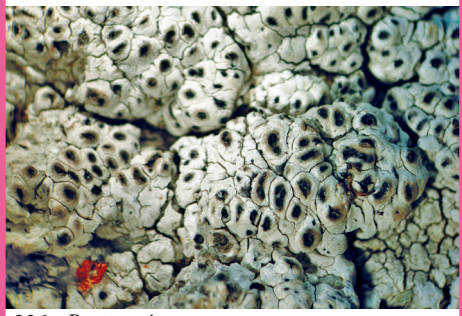
233. *Poeltiaria coromandelica* **r**



234. *Rhizocarpon geographicum* **r**

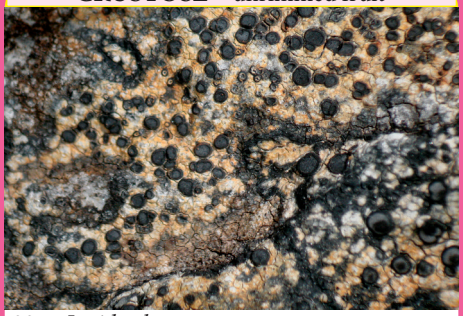


235. *Labyrintha implexa* **r**



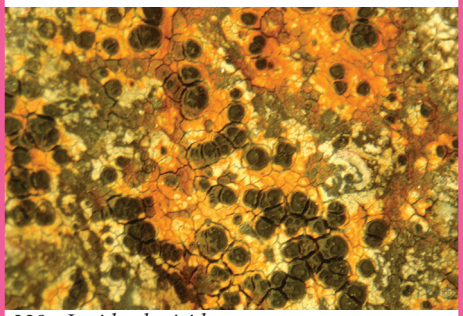
236. *Pertusaria otagoana* **r**

CRUSTOSE—unrimmed fruit

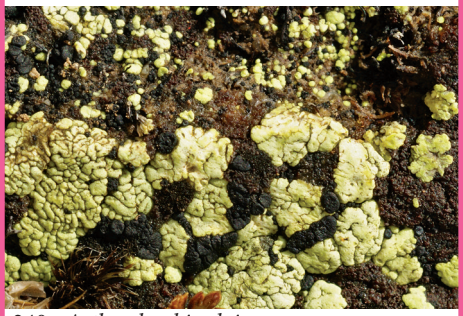


237. *Lecidea lygomma* **r**

238. *Porpidia macrocarpa* **r**

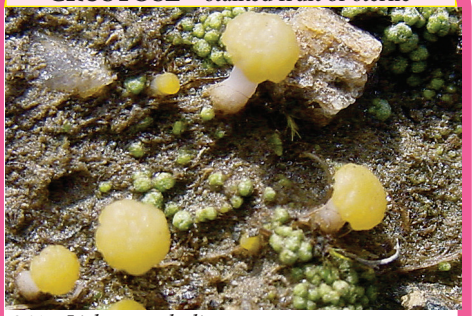


239. *Lecidea lapicida* **r**

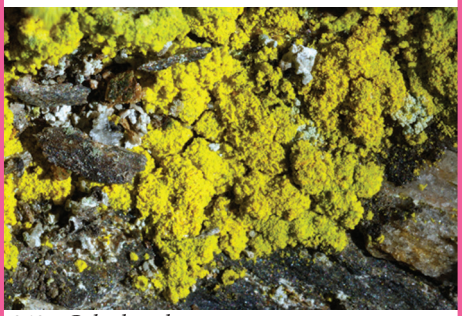


240. *Arthrorhaphis alpina* **g,r**

CRUSTOSE—stalked fruit or sterile

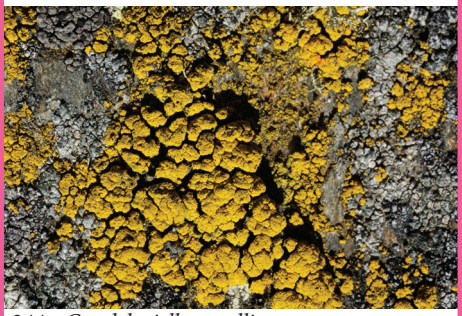


241. *Lichenomphalia* sp. **g**



242. *Caloplaca lutea* **r**

243. *Lepraria neglecta* **r**



244. *Candelariella coralliza* **r**

1.Photobionts and Colour: wetness, sunscreens and crystals

Colour: A useful but variable identifying feature. Photobiont colour is best seen when the lichen is wet. It can be masked by overlying cortex, sunscreen or crystals.

Photobiont: The photosynthetic partner; either a green alga, and/or a cyanobacterium. Usually found in a layer just under the outer cortex, but is scattered throughout in *Collema* and *Leptogium*. Reproduces asexually. Only a few hundred photobiont species are known globally.

Green alg*a/ae* 1, 2: The photosynthetic partner in over 80% of NZ lichens; often *Trebouxia* or *Trentepohlia* species. Rarely free-living.
1. *Usnea cornuta*. Cross section of thallus showing: a, outer cortex; b, green algal layer; c, medulla; d, axis.
2. *Pseudocyphellaria coriacea.* a, Dry, grey, opaque upper cortex; b, Green algae show through wet cortex.

Cyanobacter*ium/ia* (blue-green algae) 3–7: In 15% of NZ lichens; often *Nostoc*. Can fix nitrogen and thrive in damp places. The 'jelly lichens' *Collema* and *Leptogium* are cyanobacterial, as are many *Pseudocyphellaria*. Colours: grey, black, brown or dark green.
3. *Collema glaucophthalmum*. a, Wet lobes are swollen and jelly-like. b, Dry thallus is dark, crisp and flat.
4. *Pseudocyphellaria lividofusca.* Dry, grey lobe tips. Dark cyanobacteria show through wet cortex.

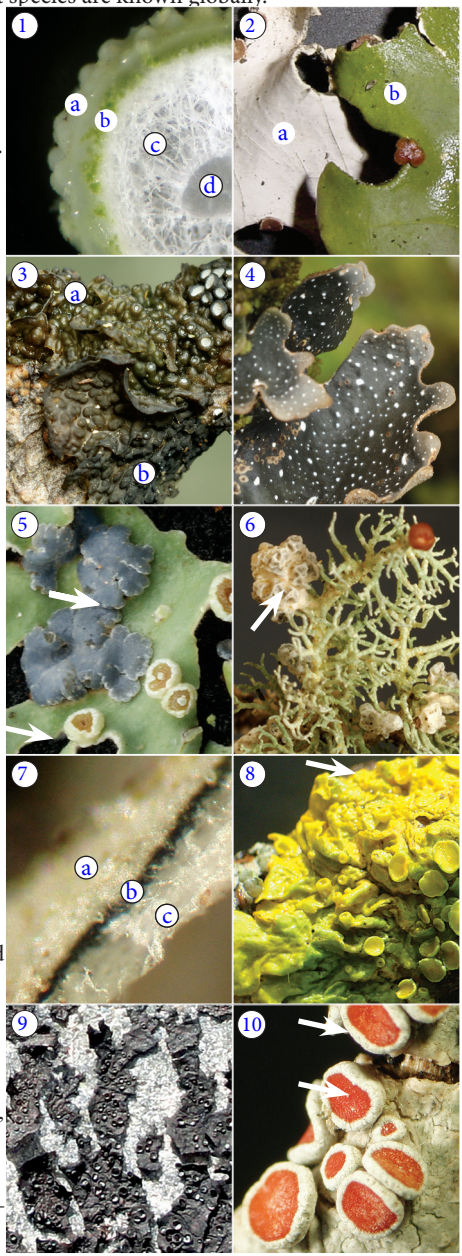
Cephalod*ium/ia* 5, 6, 14, 18, 20, 46: Nodule of cyanobacteria in (e.g. *Pseudocyphellaria*, *Sticta*, *Lobaria*) or on (e.g. *Placopsis*, *Psoroma*) a green algal thallus. Adds nutrient in damp or depleted habitats.
5. *Pannaria xanthomelana*. Blue-grey cephalodia.
6. *Stereocaulon ramulosum*. Stalked cephalodium.

Cortex 1–4, 7, 8: Outer layer of compacted hyphae. Opaque when dry, translucent when wet (2–4). Thicker in exposed sites. Can contain **sunscreen** that masks algal colour e.g. parietin, melanin.
7. *Peltigera didactyla.* Split through thallus showing: a, cortex; b, cyanobacterial layer; c, cortex.
8. *Xanthoria parietina.* Cortex contains more orange parietin above, where it is more exposed.

Melanoid sunscreens occur in both green algal (9) and cyanobacterial lichens (4), and darken from brown to black with increasing UV exposure.
9. *Xanthoparmelia malcolmii.* Green algae protected by black melanoid sunscreen in the overlying cortex.

Pruina 10, 51–53: Crystals, usually calcium oxalate, that protect fruit and tender tips from sun or grazing.

Pruinose 10, 51–53: With pruina.
10. *Haematomma babingtonii*. White-rimmed red apothecial discs protected by a thin layer of white pruina.



2. Growth form variations

The 3 broad growth forms, **Foliose**, **Fruticose** and **Crustose**, are described in the introduction and illustrated throughout. The fungal partner usually provides the architectural bulk (1, 7).

Thall*us/i*: 1, 2, 7, 11, 12. The body of the lichen, containing photobiont surrounded by fungus.

Mycobiont: The fungal partner in a lichen. Fruit bodies (apothecia, perithecia etc.) and prothallus are solely fungal, as are the protective cortex, the medulla and the attachment structures.

Lichenized: A fungus that has adapted to living with an algal and/or a cyanobacterial partner.

Ascomycete 11, 12: Member of the cup-fruiting phylum Ascomycota. Over 99% of NZ lichens are ascomyctes.
11. *Parmelia subtestacea*. a, cupped apothecia; b, thallus.
12. *Dibaeis arcuata*. a, convex, stalked pink apothecium; b, thallus; c, **podetia** (stalks).

Basidiomycete 13: Member of the mushroom-fruiting phylum Basidiomycota.
Make up less than 1% of NZ lichens. Produce mushroom-like fruit on a strongly algal crust.
13. *Lichenomphalia alpina*. Basidiomycete lichen.

Prothall*us/i* 14, 16, 20: Mat of fungal hyphae extending beyond thallus.
14. *Psoroma asperellum*. a, black prothallus; b, cephalodia; c, squamules

Areolate 15: Thallus or cortex made of discrete, discontinuous lumps.
15. *Candelariella vitellina*. a, areolate thallus; b, rimmed apothecia

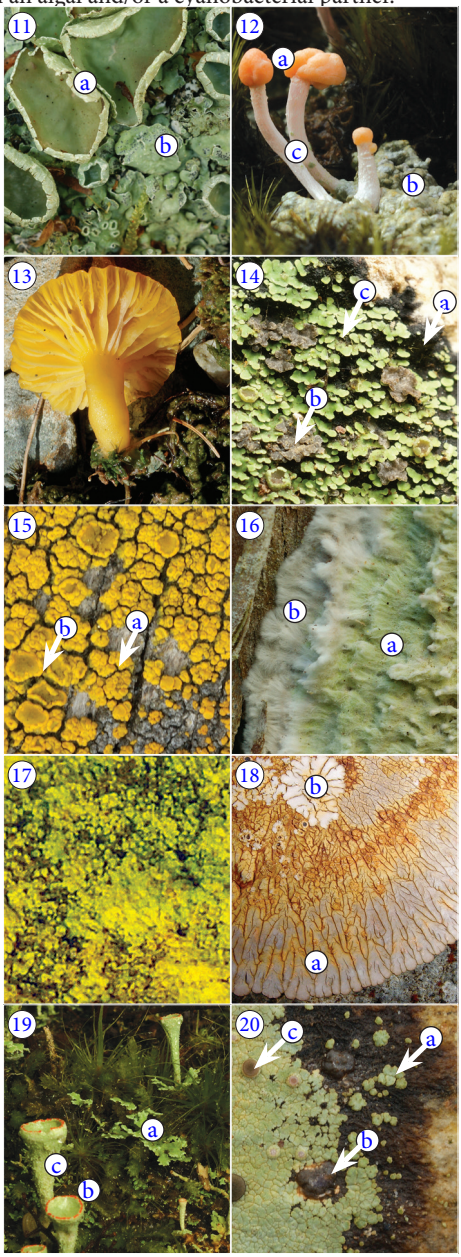
Filamentous 16: Thread-like or woolly.
16. *Sagenidium molle*. a, filamentous thallus with green algae; b, white, fungal prothallus.

Leprose 17: Powdery thallus with no cortex: made entirely of soredia.
17. *Chrysothrix candelaris*. Leprose thallus.

Placodioid 18: Crustose in the centre with radiating marginal lobes.
18. *Placopsis* sp. a, placodioid thallus; b, placodioid cephalodium.

Squamules 14, 19, 20, 41: Individual scale-like lobes with a distinct lower surface.

Squamulose 14, 19, 20, 41: With squamules.
19. *Cladonia pleurota*. a, foliose squamules; b, red apothecia; c. **podetium** (fruticose stalk).
20. *Placopsis illita*. a, green squamules on a black prothallus; b, cephalodium; c, apothecium.



3a. Sterile fungal features: pores, slits, holes and pits GLOSSARY

The outer cortex or the thallus may have specific round or elongated pores exposing the medulla, or holes right though to a hollow centre or even right though the thallus. These are possibly to aid gas exchange, evaporation or hydration. Pits and wrinkles may also be distinguishing features.

Medulla 1, 7, 22: An inner layer of loosely woven hyphae, usually white, sometimes orange, yellow, cream or black. The colour of the medulla may show through gaps in the cortex (cyphellae and pseudochphellae 21–26), or when there are patches with no photobiont (maculae 27).

Cyphell*a/ae* 21, 36: Roundish, rimmed, depressed, pores in the lower cortex, lined with a smooth layer of medulla. In NZ only found in *Sticta*.
21. *Sticta latifrons*. Cyphellae with white lining and rims surrounded by brown tomentum.

Pseudocyphell*a/ae* 22–26: Round to slit-like pores or gaps in the upper or lower cortex revealing the medulla. Occur in 16 genera.
22. *Pseudocyphellaria colensoi*. Raised, rough pseudocyphellae exposing yellow medulla.

Punctate 23, 24: Scattered with tiny holes.
23. *Punctelia borreri*. Punctate. pseudocyphellae on upper (**laminal)** surface.
24. *Pseudocyphellaria lividofusca*. Punctate pseudocyphellae on upper surface.

Pseudocyphellae as slits in cortex (25, 26) are diagnostic for *Parmelia* and *Alectoria* and present in some *Ramalina* and *Usnea* species.
25. *Parmelia signifera*. Slitted pseudocyphellae.
26. A*lectoria nigricans**. Stalk of fruticose lichen with slit-like pseudocyphellae.

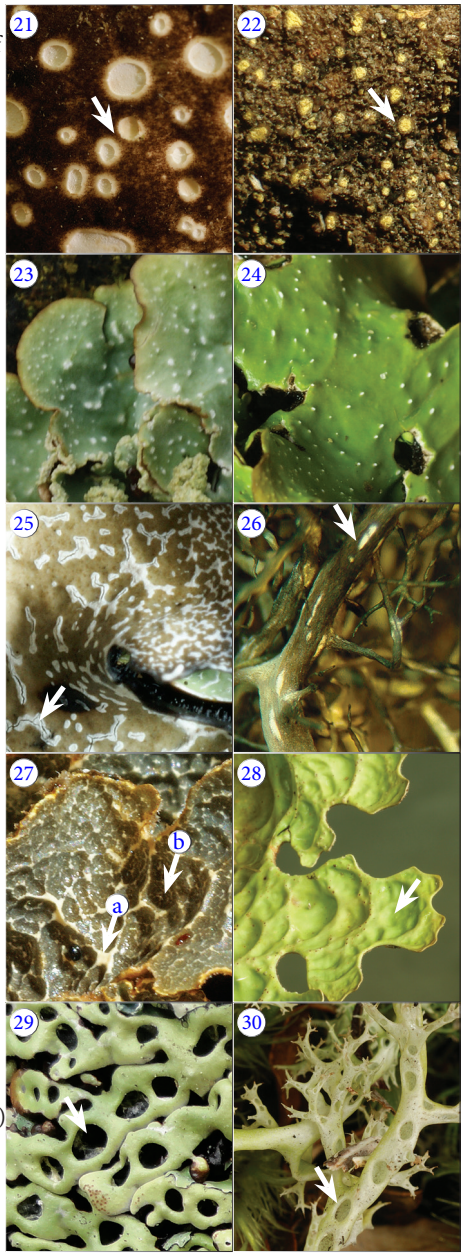
Macul*a/ae* 27. Pale patches under unbroken cortex caused by gaps in the algal layer below.

Maculate 27: With maculae.

Faveol*a/ae* 27, 28: A series of ridged, shallow, honeycombed depressions or pits. Present in at least 14 genera. Diagnostic for some species.

Faveolate 27, 28: With faveolae.
27. *Pseudocyphellaria maculata*. a, pale maculate ridge; b, faveolate depression.
28. *Pseudocyphellaria faveolata*. Shallowly faveolate.

Perforate 28, 29: With **perforations** (holes) through cortex or thallus. Characteristic of the outer surface of *Menegazzia* and *Cladia*, the lower surface of some *Hypogymnia* and the **axils** (branching points) of some *Cladonia*.
29. *Menegazzia pertransita*. Perforations.
30. *Cladia aggregata*. Perforate stalks.



GLOSSARY 3b.Sterile fungal features: hairs, bristles, roots and veins

Attachment and other organs made mainly of fungal hyphae are important for identificaction. Take care to examine the lower surface of foliose lichens.

Hypha*/ae*: Individual thread-like fungal filaments that form the cortex, medulla, prothallus and all fruitbodies. Hyphae can also form projections of various thicknesses that aid identification e.g. tomentum, rhizines and rhizomorphs, which are attachment organs on the lower surface of foliose lichens. Cilia project horizontally from margins or vertically from thallus or isidia.

Cili*um/ia* 21, 31–33: Stiff, short hairs e.g. projecting from the margin of *Parmotrema*, *Heterodermia* and *Everniastrum* lobes and the edge of *Teloschistes* and *Usnea* apothecia.

Ciliate 21, 31–33: With cilia.
31. *Teloschistes chrysophthalmus*. Ciliate margins of apothecia and branches.
32. *Physcia adscendens*. a, cilium; b, rhizine.

Rhizine 33, 34, 39, 40: Attachment bristle of bundled hyphae projecting from the lower surface. Characteristic of Parmeliaceae family and several other foliose genera.

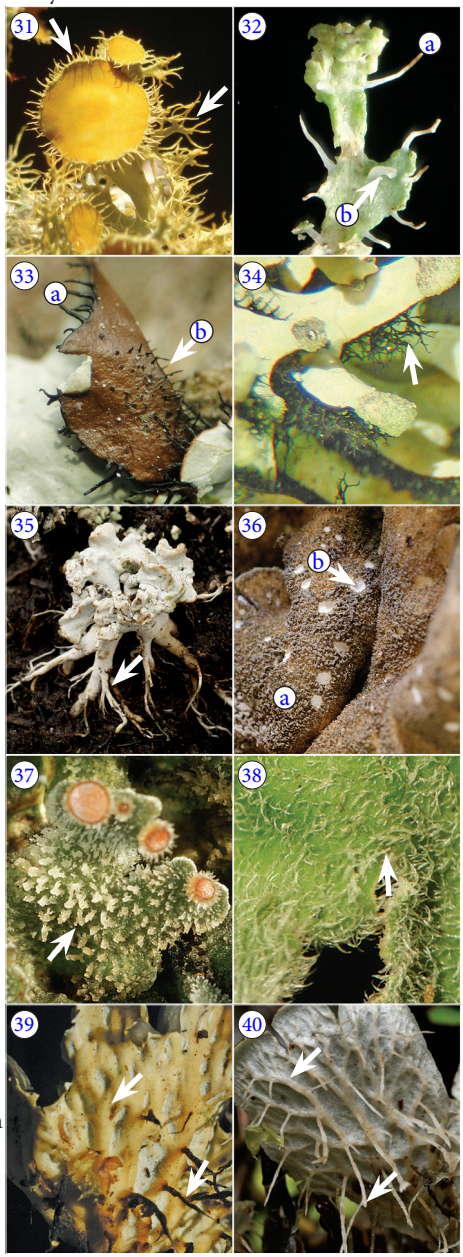
Rhizinate 33, 34, 39, 40: With rhizines.
33. *Parmotrema perlatum*. a, cilia; b, rhizines.
34. *Hypotrachyna sinuosa*. Branched rhizines.

Rhizomorph 36: Root-like structure characteristic of *Siphula*. Few other lichens deeply penetrate the substrate; most perch on it.
35. *Siphula dissoluta*. Anchoring rhizomorph.

Tomentum 21, 22, 36–38: Fine, silky, often matted hairs on upper, lower or outer surface. Diagnostic for some species of *Sticta*, *Pseudocyphellaria*, *Peltigera Erioderma*, *Dendriscocaulon* and *Leptogium*.
36. *Sticta limbata*. a, brown tomentum on lower cortex; b, white cyphellae.

Tomentose 21, 22, 36 –38: With tomentum.
37. *Erioderma leylandii*. Tufted tomentum on upper surface.
38. *Pseudocyphellaria gretae*. Tomentose upper surface.

Vein 39, 40: Bundled longitudinal strands of hyphae, often bulging. Distinguishing feature of *Peltigera* species.
39. *Peltigera polydactylon*. Wide, flat, cream veins with projecting black rhizines on lower surface.
40. *Peltigera dolichorhiza*. White, narrow raised veins with long white projecting rhizines.



4. Vegetative reproduction: powders, pieces and budding

GLOSSARY

Vegetative propagules: A common form of asexual reproduction in lichens. Soredia, isidia, phyllidia and other lichen fragments contain both algal and fungal partners and are important for short distance dispersal. They can be easily broken, washed, blown or carried off to propagate new lichens. Budding of fungal hyphae in specialised structures like pycnidia produces microscopic asexual fungal spores (conidia) that can be blown long distances, but then need to find a photobiont to form a fresh lichen partnership.

Sored*ium/ia* 17, 41–44: Vegetative propagules consisting of powdery granules with no cortex, made up of hyphae entwining photobiont cells. .

Sorediate 17, 41–44: With soredia

Farinose 41: With fine, flour-like soredia

41. *Cladonia fimbriata*. Farinose soredia.

42. *Pseudocyphellaria granulata*. Granular soredia.

Soral*ium/ia* 43, 44: Distinct patches with no cortex where soredia are formed. Can be diagnostic within the 3 main growth forms.

43. *Heterodermia speciosa*. Marginal soralia.

44. *Menegazzia subpertusa*. Soralia on laminal (upper) surface.

Isid*ium/ia* 45–47: Small, mostly cylindrical, easily detached projections of the thallus. Vegetative propagules with surrounding cortex and photobiont. Can erode into soredia.

Isidiate 45–47: With isidia.

45. *Xanthoparmelia scabrosa*. Globose isidia.

46. *Placopsis clavifera*. **Clavate** (club-shaped) isidia.

47. *Xanthoparmelia isidiigera*. Branched isidia.

Phyllid*ium/ia* 48, 49: Flattened isidia, with distinct lower surface. Can co-occur or develop from isidia. Often diagnostic, especially in *Pseudocyphellaria*.

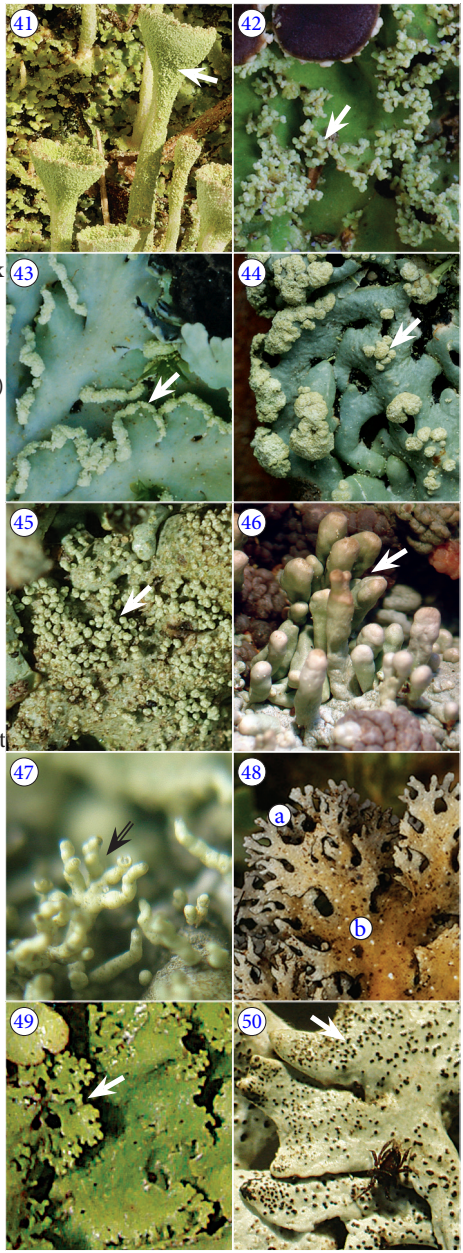
48. *Pseudocyphellaria dissimilis*. a, Phyllidia, showing distinct lower surface; b, pseudocyphellae

49. *Punctelia subflava*. Branched phyllidia.

Pycnid*ium/ia* 50: Small globose structures, immersed or protruding, where tiny spores (conidia) are budded off from specialised hyphae by mitosis. Pycnidia ppear as dark dots in Parmeliaceae and as pale bulges in *Ramalina* and *Thamnolia*.

50. *Hypogymnia turgidula*. Black pycnidia.

Conidioma*/ata*: Conidia-bearing structures, usually pycnidia.



GLOSSARY 5. Sexual reproduction: types of fruit bodies

Asc*us/i*: Sac-like structures in Ascomycetes, which sexually produce ascospores (microscopic fungal spores) in a fruit body. This is usually an apothecium, sometimes a perithecium. Ascospores are easily blown long distances, but then have to find a photobiont partner to form a new lichen.

Basid*ium/ia*: structures in Basidiomyctes (mushroom-fruited fungi or lichens) where fungal spores are produced sexually by meiosis.

Apothec*ium/ia* 51–58: Ascomycete fruit with exposed disc; cupped, flat, inverted, rimmed or not.

Rim or **thalline margin** 11, 51, 52: **Lecanorine** type apothecia have a rim of thallus, the same colour as thallus, containing photobiont cells.
51. *Brigantiaea chrysosticta*. Rim of thallus around apothecial disc covered in thick orange pruina.
52. *Collema glaucophthalmum*. Rimmed, flat apothecia with thickly white-pruinose discs.

Unrimmed 53: Apothecia without a thalline margin. May have a **proper margin** (rim of fungal tissue) of a similar colour to, or slightly different from, the apothecial disc, but have no rim of thallus tissue.
53. *Megaloblastenia marginiflexa*. Dark proper margin around disc with thin white pruina.

Mazed*ium/ia* 54–56: An apothecium which dissolves into loose, dark powder.
54. *Bunodophoron scrobiculatum*. Black, powdery mazedium; foliose lichen.

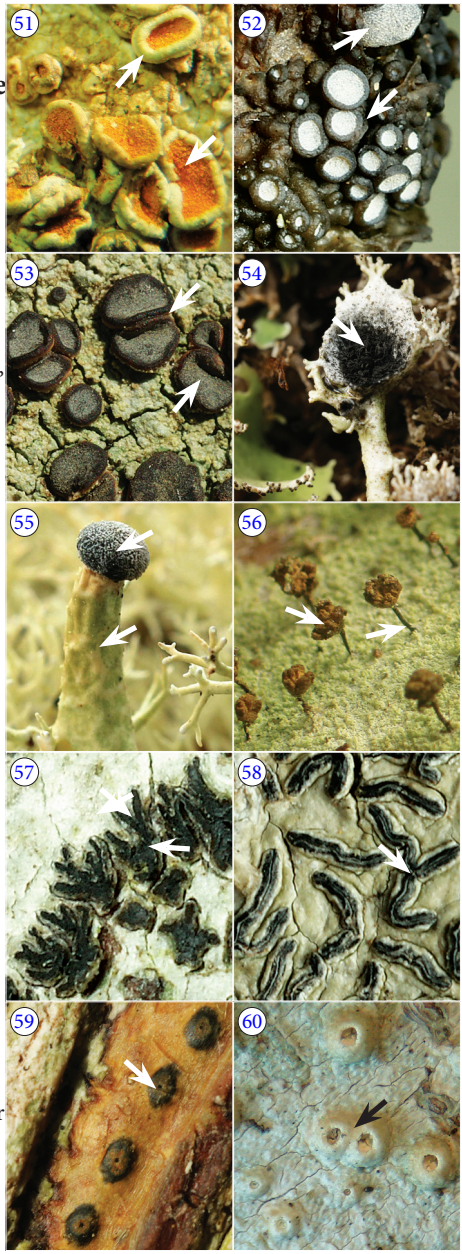
Stalked apothecia 12, 19, 55–56: Occur in all growth forms (not usually as mazedia).
55. *Leifidium tenerum*. Fruticose lichen with stalked mazedium.
56. *Chaenotheca brunneola*. Crustose 'pin lichen' with stalked mazedia.

Lirell*a/ae* 57, 58: Distorted or elongated apothecia. Sometimes look like hieroglyphics.

Lirellate 57, 58: With lirellae. Crustose 'script' lichens or 'graphids' have lirellae.
57. *Arthonia radiata*. Distorted apothecia.
58. *Graphis librata*. A 'graphid' with lirellate fruit.

Perithec*ium/ia* 59: Pimple-like fruit body with a central pore enclosed by thallus.
59. *Pyrenula deliquescens*. Black perithecia.

Perithecioid 60: With partially enclosed volcano or perithecia-like fruit bodies.
60. *Thelotrema lepadinum*. Perithecioid fruit.



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FURTHER RESOURCES

BOOKS and ARTICLES

1. Flora of New Zealand: Lichens. DJ Galloway. 1985. Govt. Printer, Welllington.

2. Flora of New Zealand: Lichens, 2nd, revised edition, Vols. 1 & 2. DJ Galloway. 2007.Manaaki Whenua Press, Lincoln.—*together all 3 Flora volumes give full descriptions of all NZ lichens.*

New Zealand Lichens: Checklist, Key and Glossary. WM Malcolm & DJ Galloway. 1997. Museum of New Zealand, Wellington. —*contains a very helpful illustrated glossary.*

New Zealand Lichens. B & N Malcolm. 2000 & 2008. Micro- Optics Press, Nelson. —*NZ lichen photos and fascinating details.*

Conservation Status of New Zealand Lichens. P de Lange, D Galloway, D Blanchon, A Knight, G Cowcroft, R Hitchmough. NZ Journal Botany 50(3): 303–363—*has updated names, new species*

Above the Treeline. A Mark 2012. Craig Potton Publishing —*Chapter on alpine lichens by D Galloway with photos by J Ledingham*

Lichens of Rainforest in Tasmania and South-Eastern Australia. G Kantvilas, SJ Jarman & BA Fuhrer. 1999. ABRS Canberra. —*photos of many lichens also occurrring in NZ*

Lichens. W Purvis. 2000. Smithsonion Press, Washington DC—*introducing the wonderful world of lichens globally*

ONLINE SITES

Flora of New Zealand Lichens: http://floraseries.landcareresearch.co.nz/pages/Index.aspx —*all the NZ Lichen flora online*

New Zealand Plant Database: http://nzflora.landcareresearch.co.nz/ —*use search menu to look for updated names and new species.*

Australian Lichen Checklist: http://www.anbg.gov.au/abrs/lichenlist/introduction.html —*with 1400 images and 3 extra keys.*

Australasian Lichenology: ed. WM Malcolm. http://www.anbg.gov.au/abrs/lichenlist/Australasian_Lichenology.html —*publishes new discoveries and articles*

British Lichens: http://www.britishlichens.co.uk/index.html —*with a beginners guide to lichens and an illustrated key arranged by growth form.*

Irish Lichens: http://www.irishlichens.ie/index.html —*searchable 3 different ways.*

Lichens of North America: http://www.lichens.com/index.html — *with links to over 6300 lichen images.*

HANDS-ON The annual **John Child Bryophyte and Lichen Workshop**—*welcomes everyone from beginner to expert. (contact author for details)*

ACKNOWLEDGEMENTS

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Cover Illustrations

Outside cover. Common urban lichens on concrete and stone, Dunedin.
Lichen species (all foliose), in decreasing order of lobe width: *Flavoparmelia haysomii, Xanthoria parietina, Xanthoparmelia verisidiosa, Physcia caesia, Physcia adscendens*

Contents Page. Lichen species by growth form (in colour-coded borders). Top to bottom:

- **Foliose**. *Pseudocyphellaria colensoi*, *Degelia gayana*, *Xanthoria ligulata**
- **Fruticose**. *Cladonia pleurota,Teloschistes chrysophthalmus, Cladia sullivanii*
- **Crustose**. *Haematomma alpinum,Thalloloma subvelata, Dibaeis arcuata*

The photograph on page 15 was taken by Doug Knight, all others were taken by the author.

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LICHENS of New Zealand

An Introductory Illustrated guide

This introductory guide celebrates the extraordinary diversity of New Zealand lichens with images of over 250 mostly common and widespread species, plus a glossary illustrating over 60 useful identifying features.

The images are arranged in 4 broad colour-coded ecosystems:

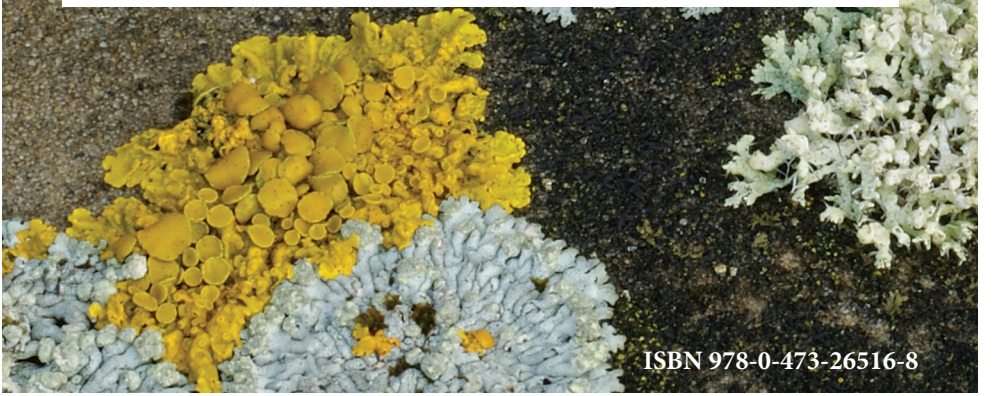
- Urban & Pastoral - areas modified by humans
- Coastal & Freshwater - near the sea or in moist places
- Forest & Shrubland - native forests and shrublands below treeline
- Alpine & Subalpine - habitats above treeline

Each ecosystem is then arranged by the 3 main lichen growth forms:

- Foliose - leafy lobes with a distinct upper and lower surface.
- Fruticose - 3-dimensional twiggy or shrubby lichens
- Crustose - flattened crusts with no lower surface

These growth forms are further subdivided in a way designed to complement the introductory keys in the comprehensive Flora of New Zealand Lichens.

New Zealand is exceptionally rich in lichens and harbours around 10% of the world's lichen species. They are an important, yet often overlooked, component of every ecosystem from the seashore to the mountaintops, and contribute over 1800 taxa to New Zealand's biodiversity, with more waiting to be discovered.



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