A lichen species list for Motu Kaikoura, Fitzroy Harbour, Great Barrier Island

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Introduction
Motu Kaikoura (Kaikoura Island) is a 535 ha island off the coast of Great Barrier Island, North Island, New Zealand. The island was purchased by the Crown in 2004 as a reserve. The island has been heavily modified by farming, fires, bush clearances and the impacts of exotic mammals such as fallow deer (Dama dama), ship rats (Rattus rattus) and cats (Felis catus). The vegetation of the island is now dominated by tea tree (Kunzea and Leptospermum), small patches of broadleaf forest and bare rocky areas (Cameron 2007). A number of vegetation surveys since 2006 recorded a total of 381 species of higher plants (68% native), but bryophytes were not systematically studied (Cameron 2007), and lichens and fungi were not studied at all. Only one specimen (Stereocaulon ramulosum (AK283628)) was found in the Auckland Museum herbarium (AK), collected by Jonathan Boow and Bec Stanley in 2003.

Fallow deer have had perhaps the greatest impact on the vegetation of the island, having been present since the 1930s (Cameron 1995) and were estimated to have reached numbers as high as c. 360 individuals (Cameron 2007). Deer were eradicated by shooting, but a recent attempt to eradicate rats failed. However, rats continue to be controlled through trapping and poisoning. A number of permanent quadrats have been set up on Motu Kaikoura to monitor any changes in the vegetation after pest removal, but this has not included monitoring of lichen cover. While it is clear that the deer had a serious impact on the higher plants, it is not clear what, if any, impact they had on lichens. There is limited information available on the prevalence of lichens in the diet of fallow deer in New Zealand. Nugent (1990) found that fallow deer ate significant quantities of fungi and lichens in beech forests in Otago, particularly species of Usnea. He commented that the use of lichen may indicate “poor quality habitat”. Forsyth et al. (2002) studied the diet preferences of introduced ungulates in New Zealand and found that some lichens (Pseudocyphellaria and Usnea) were preferred, while others like Cladonia and Sticta species were avoided by fallow deer or red deer (Cervus elaphus).

For this reason, the Motu Kaikoura Trust and Unitec Faculty of Social and Health Sciences funded four trips (July and December 2008, December 2009 and 2010) to the island to catalogue the lichen diversity (see Appendix) and investigate any changes to the lichens after the removal of the deer.

Area surveyed
Over the four trips, most of the island was surveyed, with particular emphasis on the area around the lodge, the pine forest and kanuka forest between the lodge and airstrip, the airstrip, the scrub, around the airstrip, the forested gully up from Houseboat Bay, the Ngati Rehua track, Taraire Valley, Bradshaw Cove, Waitetuna Bay, track to Mt Overlook and the track from there back to the lodge. Six permanent quadrats (Fig. 1) were also set up on rocky substrates between the lodge and Taraire Valley and within Taraire Valley. Ten kanuka trees in the upper part of Taraire Valley were surveyed with horizontal quadrats (relevé). These quadrats will be monitored annually for any changes to lichen diversity or cover.

Fig. 1. Map of the island showing the quadrat sites. (created by G. Aguilar).

Lichens of the general habitats visited
(modified from Cameron 2007)

Badlands/scrub
The badlands are poor in lichens, with only sparse small thalli of Menegazzia neozelandica and Parmelia labrosa on the twigs of kanuka (Kunzea ericoides), manuka (Leptospermum scoparium) and Hakea spp. Small white patches of the soil crust Baeomyces heteromorphus can be seen on eroded banks, although not usually with their characteristic lolly-pink fruiting structures. Scattered speckles of Stereocaulon vesuvianum are present on andesite boulders. Very occasional clumps of the red and white Cladonia floerkiana can be found on clay soil in sheltered spots (Fig. 2).

Kanuka forest and scrub
The kanuka forest and associated scrub are also poor in lichens, with only a few species found on the trunks
Fig. 2. *Cladonia floerkiana*, track between airstrip and Mt Overlook, July 2008. All Photos D. J. Blanchon.

Fig. 3. Fruiting *Pseudocyphellaria* species on a kanuka, upper Taraire Valley, December 2008.

Fig. 4. *Sticta*, kanuka trunk, upper Taraire Valley, July 2008.

Fig. 5. *Pseudocyphellaria poculifera*, on fallen branch in light gap, Taraire Valley, July 2008.

Fig. 6. *Strigula delicata* on fallen taraire leaf, from Taraire Valley, December 2009.

Fig. 7. *Baeomyces heteromorphus*, shaded roadside banks between lodge and airstrip, July 2008.
Fig. 8. *Pseudocyphellaria carpoloma* on shaded bluff, Ngati Rehua track, July 2008.

Fig. 9. *Leprocaulon arbuscula* on volcanic breccia, Ngati Rehua track, July 2008.

Fig. 10. *Xanthoparmelia* species on top of inland bluff, Ngati Rehua track, July 2008.

Fig. 11. *Jackelixia ligulata* on coastal rocks below Mt Overlook, July 2008.

Fig. 12. Top House orchard, with plum tree festooned in lichens, July 2008.

Fig. 13. *Teloschistes flavicans* on plum tree in Top House orchard, July 2008.
and branches. In more sheltered sites, small thalli of *Parmelina labrosa*, *Menegazzia neozealandica* and occasional hanging fat tubes of *Hypogymnia subphysodes* are growing on branches and twigs. Green or brown clumps of *Cladia aggregata* are found in some of the light gaps. The white coral lichen (*Cladia retipora*) is only rarely present in some areas on soil, with a particularly good site above Houseboat Bay. It is possible that this usually common species was being eaten by deer. Rocks in shaded sites sometimes have patches of the bluish crustose *Porpidia albocaerulescens*, while those in the open are covered in species of *Heterodermia, Parmotrema* and *Xanthoparmelia*.

**Broadleaf forest**

Pockets of broadleaf forest in watersheds support the highest number of lichen species on the island, perhaps because of the shade and higher humidity but also the diversity of substrates available. The different bark types of taraire (*Beilschmiedia taraire*), kohekohe (*Dysoxylon spectabile*), pohutukawa (*Metrosideros excelsa*) and old kanuka (*Kunzea ericoides*), and the shaded bluffs and boulders all provide habitats quite different from the drier kanuka trunks elsewhere on the island. The trunks of taraire and kohekohe support mainly crustose lichens, including *Porina exocha*, but the greatest diversity can be found at the tops of the valleys on the trunks of mature kanuka. A range of large foliose lichens, particularly species of *Pseuocyclhella*, *Sticta* (*Fig. 4*), *Peltigera* and *Pannaria* are conspicuous. The bright yellow-green thalli of *Pseuocyclhella aurata* and *P. poculifera* (*Fig. 5*) are reasonably common on trunks of kanuka in light gaps. Many of these species are also present on shaded rock faces, and the rock faces near the track in Taraire Valley are covered in unusually large sheets of the yellow-green *Porina exocha*. Fallen leaves of taraire are covered in silvery or green spots of the folliculous (leaf-dwelling) lichen, *Strigula delicata* (*Fig. 6*).

**Kauri-associated forest**

The kauri forest (*Agathis australis*) was not visited by the authors, but pieces of bark were brought back to the lodge by Maureen Young and Alison Wesley. These supported a range of lichen species, including *Menegazzia aucklandica*, *Parmelia testacea*, *Parmotrema grayanum* and *P. reticulatum* and *Usnea rubicunda*.

**Pine forest**

Pine forest (*Pinus pinaster* and *P. radiata*) supports a reasonable range of lichens, with foliose lichens ranging from the small *Parmelinospis afrorevoluta* to larger inflated thalli of *Hypogymnia subphysodes* and large paint-like patches of the leprose lichens such as the bright yellow *Chrysothrix candelaris*, dull yellow *Lepraria cf. eburnea* and grey-green *Lepraria incana*. A number of lichen species such as species of *Usnea* and *Parmotrema* grow in the canopy and can be found on the ground after storms. The fruticose *Stereocaulon ramulosum* can be seen on exposed clay banks, and in some areas, large white patches of *Baeomyces heteromorphus*, with bright lolly-pink podetia (*Fig. 7*) can also be found.

**Inland bluffs**

The inland bluffs were noted as being botanically interesting by Cameron (2007), and the lichens found on these sites are similarly interesting. The sides of most of the bluffs are covered in mats of bryophytes and filmy ferns (particularly *Hymenophyllum sanguinolentum*) and they are also covered in an extensive range of lichens. The shadier parts support species of the large foliose *Pseuocyclhella, Sticta* and *Peltigera* (*Fig. 8*), while sunnier spots have long strands of the fruticose lichens *Ramalina australiensis, Usnea rubicunda* and occasionally *Heterodermia leucomela*. Of most interest were the sites where the rarely collected *Leprocaulon arbuscula* could be found on shaded vertical bluffs of volcanic breccia (*Fig. 9*). The well-lit tops of the bluffs are covered in stunted brown clumps of *Cladia aggregata* and patches of species of *Xanthoparmelia* (*Fig. 10*), *Heterodermia*, *Cladonia* and *Parmotrema*.

**Rocky outcrops**

The exposed rocky outcrops were more difficult to reach, but when investigated they supported a range of *Xanthoparmelia, Parmotrema, Cladonia* species, *Heterodermia obscurata* and *Cladia aggregata*.

**Stream margins**

Most of the streams on the island were dry when visited in December, but the stream still flowing below the Top House plunged through a cut in the rocky cliff. This area supported moisture-loving cyanobacterial lichens such as *Pseuocyclhella dissimilis* and *Leptogium denticulatum* and bluish patches of *Porpidia albocaerulescens*.

**Rocky shore**

The rocky beaches and cliffs support the bright orange *Jackelixia ligulata* (formerly *Xanthoria ligulata*) (*Fig. 11*) and white splashes of the “bird-dropping lichen” *Poeltiaria turgescens*. The grey *Physcia erumpens* can be found on rocks above the high-tide mark. Yellow spots of *Rhizocarpon geographicum* are rare. The fruticose *Ramalina australiensis* is not uncommon on the cliffs at several points around the island. The similar, but less common *R. meridionalis* was collected at Waitetuna Bay. This species is largely restricted to rocky peninsulas and islands off the east coast of Northland (*Blanchon and Bannister 2002*), and has been collected nearby at a number of sites on Great Barrier Island (*e.g.* Oruawharo Bay, AK 169325) and associated islands (*e.g.* Rakitu Island, AK 166151). On rocks below the high tide mark, the black marine lichen, *Lichina pygmaea* is locally abundant at most of the rocky bays.
Mangroves
Some large mangroves were found at Houseboat Bay. Few lichens were found, but the cyanobacterial *Leptogium aucklandicum* was reasonably common, as was the graphid *Thalloloma subvellata*.

Top House orchard
The orchard at the Top House supported a large number of lichen species. In particular, the two plum trees (*Prunus persica*) and the pear (*Pyrus communis*) had a range of typical orchard lichens growing on the trunks and branches (Fig. 12), with *Usnea rubicunda*, *Parmotrema reticulatum* and *Ramalina celsi* most abundant. More unusual was the presence of typical native forest lichens such as *Menegazzia neozelandica*, *Sticta martini*, *Heteroderma leucomela* and *Porina exocha*. The most interesting find was a clump of the bright orange *Teloschistes flavicans* (Fig. 13), which is uncommon on the mainland, although it can be found on other offshore islands.

Comparison with nearby islands
Hayward and Hayward (1986) recorded 247 lichen taxa from Great Barrier and adjacent islands, and their list included most of the lichens found on Motu Kaikoura. Smaller studies of parts of Great Barrier island, include that of Dakin and Galloway (1980), who found 27 largely montane lichen species on Hirakimata (Mt Hobson), and Hayward and Hayward (1973), who reported 40 species from habitats near Whangaparapara. The most useful comparison is with Rakitu Island off the east coast of Great Barrier, where Hayward and Hayward (1982) reported 124 species from this 350 ha island. Motu Kaikoura is larger (535 ha), but to date we have only identified 114 species from the island. It is likely that Rakitu island has a larger lichen flora due to its more diverse and intact vegetation.

Conclusion
Despite the relatively small size of the island and the poor state of the vegetation, there were a high number of lichen species present. Some of the more unusual species seem to be restricted in their distribution. Particularly important habitats include the Top House orchard, broadleaf forest areas and shaded inland bluffs. Removal of the deer may result in the recovery of some lichens or recolonisation by others if they were in fact being eaten by the deer. Conversely, recovery by grasses and other vascular plants may impact negatively on soil and rock-dwelling lichens. In some of our quadrats this appears to be already the case (unpublished observations).

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References

Appendix: Motu Kaikoura lichen species list.

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<tr>
<th>Lichens</th>
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<th>Voucher</th>
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<td><em>Baeomyces heteromorphus</em></td>
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<td><em>Caloplaca litoralis</em></td>
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*References:*
Cladonia chlorophaea  Unitec 4626  Physcia erumpens  Unitec 4566
Cladonia floerkiiana  Unitec 4109  Physcia poncinsii  Unitec 4084
Coccoloba palmicola  Unitec 3176  Poeltariar turgescens  Unitec 4177
Collema kaualeense  Unitec 3420  Porina exocha  Unitec 3163
Degelia durietzii  Unitec 4167  Porpidia albocaerulescens  Unitec 4601
Dirinia planata  Unitec 4100  Pseudocyphellaria aurata  Unitec 3154
Flavoparmelia haywardiana  Unitec 4081  Pseudocyphellaria carpoloma  Unitec 3155
Fuscodermia limbatum  Unitec 3395  Pseudocyphellaria chloroleuca  Unitec 3926
Heterodermia chilensis  Unitec 4565  Pseudocyphellaria crocata  Unitec 3149
Heterodermia japonica  Unitec 3184  Pseudocyphellaria dissimilis  Unitec 4567
Heterodermia leucomela  Unitec 3166  Pseudocyphellaria haywardiorum  Unitec 3356
Heterodermia microphyla  Unitec 3717  Pseudocyphellaria montagnei  Unitec 3388
Heterodermia obscursata  Unitec 3185  Pseudocyphellaria multifida  Unitec 3148
Heterodermia speciosa  Unitec 3916  Pseudocyphellaria pickeringii  Unitec 3391
Hypogymnia subphysodes  Unitec 4108  Pseudocyphellaria poculifera  Unitec 3152
Jackelixia ligulata  Unitec 4552  Pseudocyphellaria rubella  Unitec 3151
Leccana intumescenti  Unitec 4170  Pseudocyphellaria wilkinsii  Unitec 3167
Leclidella elaeochromata  Unitec 4103  Punctelia borreri  Unitec 4091
Leioorrhea exaltata  Unitec 4101  Punctelia perreticulata  Unitec 3193
Lepraria cf. eburneaa  Unitec 4557  Punctelia subflava  Unitec 3196
Lepraria incana  Unitec 4166  Pyrenula sp.  Unitec 4501
Leprocaulon arbuscula  Unitec 4155  Pyxine subcinerea  Unitec 4169
Leptogium aucklandicum  Unitec 4154  Ramalina australiensis  Unitec 3162
Leptogium cyanescens  Unitec 3187  Ramalina celastri  Unitec 4105
Leptogium dentifurum  Unitec 4568  Ramalina meridionalis  Unitec 4553
Leptogium propagiferum  Unitec 4153  Ramalina peruvian  Unitec 3159
Lichina pygmaea  Unitec 3426  Rhizocarpon geographicum  Unitec 3414
Megalospora atrorubicans subsp. australis  Unitec 4600  Stereocaulon corticatulum  Unitec 3189
Megalospora gompholoma subsp. gompholoma  Unitec 4590  Stereocaulon ramulosum  Unitec 3418
Megalospora gompholoma subsp. gompholoma  Unitec 4590  Stereocaulon vesuvianum  Unitec 4113
Menegazzia aucklandica  Unitec 4582  Sticta fuliginosa  Unitec 3355
Menegazzia neozelandica  Unitec 3198  Sticta lacera  Unitec 3928
Osmundaria araneosa  Unitec 3497  Sticta latifrons  Unitec 3378
Osmundaria araneosa  Unitec 3497  Sticta martini  Unitec 3195
Pannaria araneosa  Unitec 3497  Sticta squamata  Unitec 3423
Pannaria crenulata  Unitec 3174  Sticta subcaperata  Unitec 3361
Pannaria immixa  Unitec 3171  Strigula delicata  Unitec 4569
Pannaria aff patagonica  Unitec 3172  Strigula fossulicola  Unitec 4572
Pannaria subcrustacea  Unitec 3175  Teloschistes flavicans  Unitec 3191
Parmelia testacea  Unitec 4579  Teloschistes sieberianus  Unitec 3192
Parmelia conlaborosa  Unitec 4088  Teloschistes xanthorioides  Unitec 4082
Parmelia fabrosa  Unitec 4106  Tephromela atro  Unitec 4168
Parmelinopsis affrevoluta  Unitec 4107  Thalloloma subvellata  Unitec 4178
Parmotrema austrocyprinatum  Unitec 3180  Thelotrema lepidinum  Unitec 4092
Parmotrema cetratum  Unitec 3161  Xanthoparmelia australasica  Unitec 4593
Parmotrema crinitum  Unitec 3168  Xanthoparmelia furcata  Unitec 3194
Parmotrema grayanum  Unitec 4578  Xanthoparmelia isidigera  Unitec 4596
Parmotrema millisii  Unitec 3922  Xanthoparmelia scabrosa  Unitec 3197
Parmotrema perlatum  Unitec 3911  Xanthoparmelia verrucella  Unitec 4595
Parmotrema reticulatum  Unitec 3181  Usnea angulata  Unitec 4554
Parmotrema subtinctorum  Unitec 3177  Usnea rubicunda  Unitec 4581
Peltigera nana  Unitec 3424
Pertusaria subplanaica  Unitec 4576