THE LAST KANUKA LANDSCAPE ON THE CANTERBURY PLAINS?

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INTRODUCTION

In the past the Canterbury Plains have been occupied by woodland, scrub, and short tussocklands on free-draining, dry, or disturbed sites (Molloy *et al.* 1963), podocarp forests on the more stable, moist or fine-textured soils (Molloy 1969, 1995), and open wetlands where forest had not had time to establish since previous disturbance (Meurk 1988a). The Eyrewell, Maronan, and Bankside districts on the Plains, and the Culverden Basin supported extensive low forests, woodlands, and shrublands of kanuka (*Kunzea ericoides*) at the time of European settlement (Molloy 1969). This vegetation, simple in composition, was the product of low rainfall, droughty soils, and temperature extremes, with the effects of periodic (natural and Polynesian) fire, minor windthrow, and snow break superimposed. The soils typical of the former kanuka stands include stony yellow grey earths such as Lismore, Chertsey, and Balmoral terrace soils and recent soils on river floodplains (cf. Molloy 1988).

Today there are only six significant areas of kanuka vegetation remaining in the whole of the Canterbury Plains and Culverden Basin. These areas are mostly small or fragmentary and total less than 200 ha. Over half of this area is in one reserve at Medbury, Culverden Basin (Meurk 1988b), only recently acquired through the Forest Heritage Fund. Another fairly large but discontinuous area occurs on private land in association with the Culverden Scientific Reserve, which itself is approx. 8 ha of scrub and grassland 1-2 m tall (Meurk *et al.* 1989).

On the Canterbury Plains all patches are less than 20 ha in extent, and the few reserves are less than 5 ha. The Bankside Scientific Reserve north of the Rakaia River, on Eyre-Paparua recent soils of intermediate terraces, has been described by Molloy (1970). The indigenous vascular flora comprised 76 species (including those in a water race), of which *Iphigenia novae-zelandiae, Carmichaelia monroi, Raoulia subsericea, Isolepis caligenis*, and *Stackhousia minima* were notable. Eighteen mosses, 3 liverworts (Macmillan 1976), and 39 lichens have also been recorded there. The area of the reserve is 2.4 ha, although there is a similar grazed block adjacent to it (Meurk *et al.* 1989).

There are a few small patches of the original Maronan kanuka inland of Tinwald on Lismore soils of high terraces. The largest patch has been protected as a paddock border by a covenant with the Queen Elizabeth II Trust. A few other small, severely depleted stands and a thin line of kanuka along a road and water race occur nearby. Some limited woodlands on Rakaia Island contain kanuka, and are protected under the conditions of the lease from the Canterbury Regional Council (CRC). These have been described by Molloy (1971, 1983). A few individual kanuka trees have been observed on Rangitata Island and on

McLeans Island, where currently they are at risk of being crowded out by CRC plantation forestry.

A valuable stand of kanuka lies adjacent to the Eyrewell Plantation on 'Claxby Farm.' This 16 ha block is the largest remaining example of this woodland type on the Plains. A protective management agreement over most of this land is currently being negotiated between DoC and the landholder, Mr Marmaduke Spencer-Bower, who recalls the clearance of much of the surrounding country with swamp ploughs over half a century ago.

Further west, between Eyrewell Plantation and Burnt Hill - in the vicinity of the existing Eyrewell Scientific Reserve, which itself is only about 2.3 ha (Molloy and Ives 1972) - is perhaps one of the most significant kanuka areas on the Plains in terms of species diversity, size and viability of the stands, and landscape continuity. It is one of the very few areas in the whole of the Canterbury Plains where one can gain some impression of the primitive landscape, where there are substantial core sanctuaries (up to 10 ha) with connecting shelter belts and hedgerows of kanuka which, from some perspectives, dominate the skyline. This might be regarded as the 'last kanuka landscape on the Canterbury Plains.' However, none of these places are safe from development, especially in view of the imminent irrigation scheme in the district. Some of these lands have been recently sold as firewood blocks - so attrition continues, despite the regional rarity and natural representativeness of these woodlands.

The Canterbury Botanical Society arranged to visit the largest of the remnant stands of kanuka in the Burnt Hill district on 8 April 1995. Previously the Society had visited the major stand on the 'Claxby' property. This report describes the sites visited, and attempts to put them in the context of their history and importance as benchmarks for the future. A tabulated comparison is made with the Eyrewell Scientific Reserve. It should be noted that the season and duration of our survey was not ideal for observing spring ephemerals, orchids, or graminoids. This may account for the relatively small floras reported here, despite the large size of the patches by comparison with the Eyrewell Reserve. Finally, some management recommendations are made.

DESCRIPTIONS OF FIVE KEY SITES

The following notes describe the main characteristics of each site, and a species list is appended. The PNA numbers refer to the database for the Survey of the Canterbury Plains conducted by Jenny Steven (pers. comm.) for the Department of Conservation. Map Series 260 grid references are given. The land here for most of the sites lies at 215-235 m elevation, and is an aggradational surface of glacial outwash gravel approx. 20 000 years old. The soils developed in this loess-capped stony substrate are mapped as the Lismore set (Molloy and Ives 1972) - typical of large sweeps of the mid to upper Canterbury Plains that formerly supported extensive kanuka woodland.

Site 1 Canterbury Plains PNA Number-896 (L35/2442300.5756200); Malbon Farm Manager: T. Barton

This 10 ha area is one of the 2 largest remaining blocks of kanuka woodland and shrubland remaining on the Canterbury Plains (border of Upper Plains Ecological District). The kanuka is up to 6 m tall, and the oldest stems may be 50-100 years old. According to the manager there has been considerable increase in height of the bushes over the past 25 years. Possibly it has been in a recovery phase since some former burn-off. Where the canopy of kanuka is dense there is a thick carpet of moss on the ground, dominated by *Hypnum cupressiforme*, with occasional herbs such as *Dichondra repens*, *Leptinella serrulata*, and some grasses. The main woody associate of the kanuka is mingimingi (*Cyathodes juniperina*). There is one pine tree at the southwest corner.

There are natural openings in the woodland where danthonia grass, lichens, mosses (especially *Racomitrium lanuginosum*), and both indigenous and introduced herbs occur, including some interesting species such as *Stackhousia minima*. Surprisingly, neither *Muehlenbeckia axillaris* nor the scabweeds (*Raoulia* spp.) were observed. These species are commonly associated with kanuka on flood plain terraces. Presumably the high terraces have lost these elements typical of the younger, fresher soils. Some stunted matagouri (*Discaria toumatou*) was noted, but *Melicytus alpinus* was not seen, though expected.

Rotary-slashed lanes have been cut through the block in a cross-shape dividing the whole into quadrants. This is for the purpose of providing stock and lambing shelter from winter cold and periodic heavy snowfalls. Along these lanes kanuka is regenerating, but they are also a locus for establishment of gorse. There is a water race running along the eastern boundary, and this is scheduled to be upgraded to take four times the current flow.

Animals: sheep, wild cat, grey warbler, pipit, hedge sparrow, Australian magpie, red admiral, manuka beetle, ladybird

Site 2 Canterbury Plains PNA Number-896A (L35/2443300.5755400); Malbon Farm Manager: T. Barton

This area is about 2 ha with a substantial artificial pond in the northwest corner. It has been fenced from stock for the past 10 years, although rabbits, hares, and possums are ubiquitous.

The excavated pond has large trout in it. Some crack willow and Lombardy poplar have been planted at the northern end. Gorse and broom are well established around the boundaries and openings. Spike sedge (*Eleocharis acuta*) and pond weed (*Potamogeton cheesemanii*) are the dominant indigenous species in and around the

pond. Other pond-margin species are *Juncus articulatus*[1], *Myosotis caespitosa**, *Trifolium repens**, *Mimulus guttatus**, *Juncus gregiflorus*, *Festuca arundinacea**, *Cynosurus cristatus**, *Agrostis capillaris**, *Juncus bufonius**, *Blechnum minus*, *Veronica catenata**, *Sagina procumbens**, *Juncus planifolius*, and *Carex secta*.

The balance of the block is dominated by reasonably tall (2-3 m) kanuka woodland - possibly responding to the raised water table. Otherwise the structure and associated species are similar to the previous site, with the notable addition of three coprosmas (*Coprosma propinqua* - present very rarely in the former block; *C. rhamnoides*, *C. crassifolia*) and the greater incidence of Scottish broom throughout, and some marginal gorse.

Animals: possum

The whole of Malbon Farm has substantial hedgerows and shelter belts of kanuka which create an indigenous landscape unity rarely seen elsewhere on the Plains.

Site 3 L35/2440800.5756300; Abberly Lodge
Owner-Manager: Mr Prescott-Bellagh

This 3.5 ha block is taller and more continuous than any of the other blocks examined. This may reflect its being at the highest end of the rainfall gradient, on deeper soils, or perhaps it has had a longer recovery period since the last disturbance. It is actually just into the High Plains Ecological District; all other sites are technically in the Lower Plains. There is a pine shelter belt running along the southwestern boundary.

Again the species are somewhat similar to the previous two sites, but the understorey of the kanuka is dominated by *Coprosma rhamnoides* with only occasional *Cyathodes juniperina*. There is a greater diversity of other woodland-associated species, but very few open grassland species. One unusual record was the presence of *Mazus radicans* in a damp mossy carpet under the dense shade of the continuous kanuka canopy. *Muehlenbeckia complexa* and *Rubus schmidelioides* were recorded only at this site. The forest margin has quite vigorous gorse bushes. Goats occasionally graze this stand.

Animals: possum, fantail, silvereye, blackbird, greenfinch

Site 4 (L35/2444200.5758700)
Owner-Manager: John Crawford

This is a fairly open stand close to, but larger than, the Eyrewell Scientific Reserve. It is being grazed extensively by sheep, and there are strong infestations of gorse (around the borders) and broom in patches throughout. There are also several pine

[1] * denotes an adventive species

trees towering over the kanuka. The openings are dominated by exotic grasses (browntop, sweet vernal) and clover. The species otherwise are similar to those described above. Some cut kanuka stems were noted on the northern side. One of these had a diameter of about 100 mm at about 200 mm above ground level, and 48 growth rings could be discerned with the unaided eye.

The *Cyathodes juniperina* was in fruit, with both red and white 'berries' evident.

Animals: grey warbler, praying mantis

Eyrewell Scientific Reserve (L35/2444800.5757900); Wrights Road

The climate, vegetation, soils, and history of this Reserve have been comprehensively described by Molloy and Ives (1972). It has an area of 2.3 ha, and has been fenced from stock since its acquisition as a reserve in about 1970. The three major plant communities within the reserve were Low Kanuka Forest, Kanuka-Manuka Shrubland, and Danthonia Grassland. At the time of their survey, Molloy and Ives recorded 73 indigenous vascular species and 28 adventive species. The notable species recorded among the natives were *Stackhousia minima, Raoulia subsericea, Brachyglottis bellidioides, Deyeuxia avenoides, Microlaena stipoides, Pomaderris phylicifolia* var. *ericifolia, Coprosma intertexta, Ranunculus reflexus* form, and *Lagenifera strangulata*. The dominant adventives were sweet vernal, *Aira caryophyllea*, and some gorse and Scottish broom.

Evidence of 6 indigenous and 5 exotic birds was reported, along with hedgehogs and possums within the reserve, and rabbits and hares outside. The long absence of grazing mammals has resulted in the take-over of the original grassland community by exotic species, probably to the detriment of the native flora. This was where many of the herbaceous species were formerly observed. In the sites visited by us the *Raoulia, Pomaderris, Coprosma, Ranunculus*, and *Lagenifera* spp. were not observed, although about a dozen low bushes of *Pomaderris phylicifolia* were observed at another site scattered along the southeastern extension of Thongcaster Rd (GR L35/2446500.5753500), mixed with recently cut Scottish broom.

Claxby Farm Canterbury Plains PNA Number-2196 (M35/2463800.5753100),
75 m a.s.l.; Hetherton Rd, Eyrewell Plantation
Owner: M. Spencer-Bower

This is a rather attenuated but large kanuka stand with openings and an occasional large pine tree that has spread from the adjacent Eyrewell plantation. It is bordered to the southeast by cultivated danthonia-exotic grassland. The soil is mapped as Lismore, and in other respects appears quite similar to the other sites described here. The presence or prominence of *Clematis, Lagenifera, Microtis, Muehlenbeckia axillaris*, and a *Senecio*, and absence of *Coprosma* spp. are somewhat distinctive.

Water races in the vicinity had the following species: *Agrostis capillaris**, *Anthoxanthum odoratum**, *Breutelia ?pendula*, *Carex ovalis**, *Centella uniflora*, *Cynosurus cristatus**, *Eleocharis acuta*, *Elodea canadensis**, *Gnaphalium audax*, *Hypnum cupressiforme*, *Isolepis setacea**, *Juncus articulatus**, *J. bufonius**, *J. planifolius*, *Mimulus moschatus**, *Montia fontana*, *Myosotis caespitosa**, *Myosotis* sp.***, *Rorippa microphyllum**, *Potamogeton cheesemanii*, *Prunella vulgaris**, *Ranunculus glabrifolius*, *Ranunculus 'maculatus'*, *Rytidosperma* sp., *Sagina procumbens**, *Senecio glomeratus*, *Trifolium repens**, and *Vulpia bromoides**. A water race on Pesters Rd had *Cortaderia richardii*, *Potamogeton cheesemanii*, and *Schoenus pauciflorus*.

Animals: skink

Discussion and Conclusions

All of these sites are valuable in their own right. We can imagine that the original extensive woodlands, stretching across parts of the Canterbury Plains, displayed subtle variations in structure and species composition that reflected gradients of soil texture and fertility, climate, disturbance frequency, and chance dispersal events. The small fragments that are left to us encapsulate various parts of these complex natural gradients and the historical setting to the subsequent farm development. Each has its own suite of species - a piece of the jig-saw; each is different, and tells us something more about the natural environment.

The long-term future of these woodland ecosystems, including their animal inhabitants, will depend on there being large enough areas to encompass the full diversity of species and afford adequate buffering from weed and pest invasion and from incompatible, adjacent farming practices. We would argue that the Canterbury Plains kanuka resource has fallen beneath its landscape sustainability given that there will inevitably be periodic fires and other natural disturbances. Not only must the areas be large enough to resist weed invasion (ensuring that the core is insulated from gorse and broom shrubs that would otherwise establish a seed bank ready to respond to disturbance), but there must be a connectivity in the landscape through, for instance, the medium of hedgerows, shelterbelts, road berms, and amenity plantings using appropriate indigenous species. Thus in the event of disturbance there are multiple seed sources that will facilitate recolonisation of disturbed sites by indigenous organisms, and there will perhaps be escape routes for wildlife.

A proposed irrigation scheme for the area on the north side of the Waimakariri River could result in changes to the hydrology in the vicinity of the kanuka stands. In comparing Site 1 with Site 2 (which has a higher water table resulting from the creation of a small reservoir) we can make some predictions of the consequences of a raised water table. We predict that accelerated growth of woody species would result, including that of kanuka. A higher water table may make the site more suitable for colonisation by some native species (e.g., *Coprosma* spp.), but we also believe it would make the site more prone to invasion by introduced woody species, in particular gorse and broom. We also believe that the most

deleterious effects would be on the small remaining open 'frost flat' herbfields, which are probably maintained as open sites in part by drought. A raising of water table in the immediate vicinity, resulting from irrigation, would probably render these herbfields susceptible to colonisation by dense, exotic grasses and woody weeds that would overtop and eliminate the herbs. It should be noted that there is irrigation adjacent to the Culverden and Maronan kanuka patches, and although no vegetation changes attributable to this impact alone have been observed, further investigation could be worthwhile. In the event that the capacity of the Waimakariri-Ashley canal is upgraded for the irrigation scheme, disturbance of adjacent indigenous habitat during construction should be prevented.

Undeveloped soils such as those found in these woodland refuges are invaluable benchmarks for agricultural and soil science (Arand *et al.* 1991). Without such benchmarks it becomes impossible to analyse and interpret trends in surrounding farmland on similar soils, especially once irrigation is applied extensively. For example, a great deal of work has gone into understanding the changes and degradation that have taken place in the Mackenzie Basin. How much have the natural fertility and organic levels in the soils been depleted or restored? Unfortunately there are no benchmarks of undisturbed land for comparison, so interpretation involves inspired deduction that is always open to dispute. If there are representative 'controls' these can be used forever after to monitor the changes associated with management, whether it be grazing, oversowing and topdressing, cropping, orcharding or irrigation for dairy cattle. Such monitoring is an important prerequisite to the meaningful administration of the Resource Management Act, which is underpinned by the ability to recognise compliance or departure from sustainable practices.

From a heritage point of view there are few other areas on the Plains where it is still possible to see at least some horizons occupied by indigenous vegetation. In a very real sense it could be said that the Burnt Hill area offers the last opportunity to preserve such a heritage landscape - hence the title of this article. This is surely a cause for some reflection and resolution that those few examples that remain should be retained. It is hoped that a formula can be found to allow the protection (in the wider landscape sense) and enhancement of these communities, and that the principles and sentiments embodied in the Resource Management Act are satisfied. Certainly, the collective value of these woodlands fulfills many of these principles: in achieving the sustainable management of natural resources there must be provision for matters of national importance - protection of outstanding natural features and landscapes ..., and protection of significant indigenous vegetation and ... habitats. Furthermore, regard must be given to intrinsic values of ecosystems. In the end, the good will of the landowner is paramount. It is to be hoped that the local community will identify with their landscape and feel protective towards it. We do emphasise that the historical forms of grazing management of these shrub-grasslands need not be drastically changed, as outlined below. Indeed, some grazing regime is probably essential for the maintenance of particular floristic elements.

Beyond the formal protection of these kanuka lands, there are important management considerations that must be addressed before the plant and animal associations can be considered safe from further deterioration. Most of the small reserves have had stock excluded for the past 25 years (reflecting the experience of the conservation agencies of

historically dealing only with large forested reserves, for which such action is appropriate) and the minor herbaceous species have largely been replaced by rank exotic grasses such as browntop and sweet vernal. The dilemma is that the grazing to control this grass growth may be detrimental to other palatable elements of the flora. Meurk *et al.* (1989) have conducted a preliminary investigation of the effects of excluding grazing animals from some of these reserves. They concluded that extensive grazing should be one of the tools for optimising biodiversity for at least some parts of the larger reserves. We believe that low-intensity grazing by sheep in these kanuka remnants may maintain the greatest diversity of indigenous species, at least in the grassland openings. By contrast, grazing by goats, observed in one remnant (Site 3), is likely to reduce biodiversity. In this closed kanuka woodland goats may selectively eliminate certain species (e.g., coprosmas), hinder regeneration, and prevent possible colonisation by other native plants. Weed control by other means will be necessary if gorse and broom are to be prevented from occupying all the open parts of the woodland complex.

Hawkweeds are now omnipresent in these remnants, and will need to be monitored. Grazing levels may be adjusted to impose some control. Wilding pines should be eliminated before they gain a foothold; they will otherwise greatly alter the natural structure of the woodlands, and cause damage when they fall.

Finally, some attention should be given to the plight of *Pomaderris phylicifolia* at this, its natural southern limit. Its stronghold along Thongcaster Road should be carefully managed by 'surgical' control of the competing Scottish broom, and propagating and planting more shrubs on suitable sites throughout the district. The same recommendation applies to the locally rare *Coprosma intertexta*.

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APPENDIX

Plant Species Recorded at the Five Key Sites

* = adventive species, x = present, O = occasional, L = locally common, C = common, D = dominant, + = present in vicinity.

VASCULAR SPECIES	SITE 1	SITE 2	SITE 3	SITE 4	EYREWELL RESERVE	CLAXBY
Acaena novae-zelandiae					x	+
*Agrostis capillaris**	O	x	x	x	x	+
*Aira caryophyllea**	O		x	x	x	x
*Anthoxanthum odoratum**	C	O	x	x	x	x
Brachyglottis bellidioides	x		x		x	
Carex breviculmis	x	x	x		x	+
Carex resectans		x				
Carmichaelia 'common'	x	x			x	x
Cassinia leptophylla					x	+
Celmisia gracilenta	x				x	x
*Centaurea erythraea**						+
*Cerastium fontanum**				x	x	
*Cirsium vulgare**		x	x		x	
Clematis quadri-bracteolata	x					O
Coprosma crassifolia		L	x			
Coprosma propinqua	x	x	O		x	
Coprosma rhamnoides		x	C		x	
*Crepis capillaris**		x			x	
Cyathodes juniperina	C	x	O	O	x	C
*Cytisus scoparius**		L		C	x	
Deyeuxia avenoides	C	x	x		x	x
Dichelachne crinita			x		x	x
Dichondra repens		O	x	x	x	O
Discaria toumatou	O				x	+
Elymus solandri				x	x	x
*Festuca rubra**	x	x				
Galium propinquum	x				x	

Gnaphalium audax	x			C	x	x
*Hieracium lepidulum**		x	x			
*Hieracium pilosella**	x	x	x	x	x	x
*Hieracium praealtum**		x		x	x	
Hydrocotyle novae-zelandiae	x				x	
Hypericum gramineum	x	x			x	O
*Hypochaeris radicata**	C	x	x	O	x	x
Kunzea ericoides	D	D	D	D	x	D
Lagenifera cuneata?						?
Lagenifera strangulata					x	x
Leptinella serrulata (*L. pusilla*? at Claxby, *L. perpusilla* at Eyrewell)			O	x	x	O
Leptospermum scoparium	x				x	
Leucopogon fraseri	x	O	x	x	x	x
Mazus radicans			L			
Microlaena stipoides			O		x	+
Microtis unifolia						x
Muehlenbeckia axillaris					x	x
Muehlenbeckia complexa			x			
Nertera setulosa	x		O		x	
Oxalis exilis			x		x	
Poa cita		x			x	+
*Pinus radiata**	x			O		O
Pteridium esculentum						+
Rubus schmidelioides			x			
*Rumex acetosella**	x	x		x	x	+
Rytidosperma unarede + spp.	C	x	x	C	x	x
Senecio glomeratus		x	x			x
Senecio wairauensis (cf. CHR 185342)						x
Stackhousia minima	x			x	x	+
*Taraxacum officinale**		x				
Thelymitra sp.	x				x	+
*Trifolium dubium**		x			x	

*Trifolium repens**		x			x	
*Trifolium subterraneum**					x	x
*Ulex europaeus**	L	x	L	C	x	x
*Verbascum thapsus**				x	x	
Wahlenbergia albomarginata	x				x	
Wahlenbergia gracilis			x		x	

Other species recorded by Molloy and Ives (1972) were: *Acaena caesiiglauca, Aciphylla subflabellata, Botrychium australe, Caladenia lyallii, Carex colensoi, Coprosma intertexta, Craspedia uniflora, Dichondra brevifolia, Epilobium* sp., *Festuca novae-zelandiae, Galium perpusillum, Geranium microphyllum, G. sessiliflorum, Gonocarpus micranthus, Helichrysum filicaule, Hieracium lachenalii**, *Holcus lanatus**, *Leontodon taraxacoides**, *Linum catharticum**, *Luzula rufa, Melicytus alpinus, Mentha cunninghamii, Ophioglossum coriaceum, Oreomyrrhis rigida, Pelargonium inodorum, Pimelea* sp., *Pomaderris phylicifolia, Prasophyllum colensoi, Pterostylis mutica, Pyrrhanthera exigua, Ranunculus reflexus, Raoulia australis, R. monroi, R. subsericea, Rosa rubiginosa**, *Sagina apetala**, *Scleranthus brockiei, S. uniflorus, Spergularia rubra**, *Trifolium arvense**, *T. glomeratum**, *T. striatum**, *Vicia angustifolia**, *Viola cunninghamii, Vittadinia australis*, and *Vulpia bromoides**.

x = present on the ground, C = common on ground, E = epiphyte, R = occurring on rocks

NON-VASCULAR CRYPTOGAMIC SPECIES	SITE 1	SITE 2	SITE 3	SITE 4	EYREWELL RESERVE	CLAXBY
Lichens and Fungi						
Agaricales	x					
Buellia?			E			
Chrysothrix candelaris		E	E	E		E
Cladia aggregata	x	x	x	x	x	x
Cladonia capitellata	x	x	x	x		x
Cladonia chlorophaea	x	x	x	x		x
Cladonia cf. *enantia/crispata*						x
Cladonia fimbriata				x	x	
Cladonia pyxidata						x
Heterodermia speciosa						E
Hypogymnia spp.	E		E	E		E
Lecanora chlarotera						E

Lecanora cf. *cyamidea*			E			
Lecidea lapicida				R		R
Lycoperdon sp.	x					
Menegazzia cf. *dielsii*						E
Neofuscelia sp.	R					
Parmotrema perlata	E		E	E	x	E
Peltigera cf. *dolichorhiza*	x	x	x	x		x
Peltigera spuria	x					
Physcia sp.?				E		
Pseudocyphellaria crocata	E		E		x	E
Pseudocyphellaria delisea			E			
Ramalina sp.	E				x	
Teloschistes velifer	E		E	E	x	E
Tephromella atra						E
Usnea sp.	E	E			x	E
Xanthoparmelia mougeotina	R			R		R
Xanthoparmelia cf. *scabrosa*	R					

Bryophytes

Breutelia affinis	O	x	x	x		
Bryum argenteum				x	x	
Bryum billardierei		x	O	x		
Campylopus clavatus	x	x		x	x	x
Campylopus introflexus	x	x	x		x	
Chiloscyphus semiteres			x			E
Chiloscyphus cf. *subporosa*				E		
Chrysoblastella chilense						x
Dicranum billardierei?						x
Dicranum robustum			x			
Frullania sp.				E		
Frullania solanderiana			E			

Frullania spinifera			E			
Hypnum cupressiforme	C	C	C+E	C	x	C
Macrocoma tenue			E			
Metzgeria sp.			E			
Orthotrichum sp.			E			
Polytrichum juniperinum	O	x	O	O	x	O
Pottia truncata (bare soil in open)						x
Racomitrium lanuginosum	C	C	C	C	x	C
Siphonolejeunea nudipes			E	E		
Thuidium furfurosum			x	x		
Tortula papillosa				E		
Triquetrella papillata	O	O	x	O	x	O

The following additional species were reported by Molloy and Ives (1972): *Caloplaca citrina, Candelariella vitellina* (and/or *Chrysothrix candelaris*?), *Cladina leptoclada, Lecidea cinnabarina, Menegazzia pertusa, Parmelia conspersa*, and *Pertusaria* sp.