SOILS AND VEGETATION OF SECRETARY ISLAND

P. WARDLE

Botany Division, Department of Scientific and Industrial Research, Lincoln

Western Fiordland provides a unique combination of geology, topography, climate and vegetation. The rocks throughout are granites, schists and gneisses which are extremely hard and resistant to weathering, softer sedimentary rocks being found only in the extreme south-west. The raw glacial topography developed during the Pleistocene has scarcely been modified, and is characterised by irregular summits, precipitous fiord walls, and spurs worn by ice. The climate is excessively wet, and though cool, is equable. Exposure to prevailing westerly winds is an important factor on headlands and on the 'tops'. Up to an altitude of about 3000 ft. the vegetation consists of forest and scrub, nearly all the communities being mixtures of beeches, podocarps and broad-leaved hardwoods, while the open tops are occupied by tussock grasslands and herb-fields.

As elsewhere in New Zealand, the character of the vegetation varies according to altitude, but there are few areas outside Fiordland where the effects of rock, soil type, and topography are so apparent. I had the opportunity to investigate these effects when Professor Baylis invited me to join his excursions to Secretary Island. We had time to examine only the eastern end of the island from Blanket Bay to the summit ridge, which rises to nearly 4000 ft., the landscape consisting in part of rolling, ice-worn terrain and in part of steep slopes which are broken here and there by precipitous ledges. The whole area is more or less sheltered from the prevailing winds, except on western aspects near the summit ridge. Our investigations were practically confined to apparently stable communities of long standing, and consequently I shall be making no reference to certain important processes of soil development and plant succession which are characteristic of Fiordland; for example, colonisation of landslide scars.

The chart (Fig. 1) summarises my results. Edaphic classes are arranged along the horizontal axis, and the altitudinal gradation in climate is represented by the vertical axis. Needless to say, this representation greatly oversimplifies matters. For instance, although the edaphic classes shown on the left of the chart are more fertile than those on the right, the various factors of drainage, soil depth and so on are too complex to be adequately portrayed as a linear sequence. The chart also does not illustrate the importance of aspect and exposure at high altitudes. I have attempted to put related plant communities adjacent to each other on the table wherever possible, and have shown the existence of transitions with broken lines. In addition, there are transitions between IA and IVA, and between IIIA and IVA. Class V communities, generally, intergrade with Class VII communities. I expect also that Class I communities intergrade with Class VII, though I saw no instances on Secretary Island.

A brief description of the plant communities follows:

Class I. Community growing on a peat soil with relatively high pH and the water table near the surface.

IA (*Nothofagus cliffortiodes-Podocarpus dacrydioides* forest) is based on a single stand in which mountain beech (*Nothofagus cliffortioides*) is the main canopy species, but kamahi (*Weinmannia racemosa*) and rata (*Metrosideros umbellata*) are also important. The unique feature of the community, however, is the presence of kahikatea (*Podocarpus dacrydioides*).

Class II. Communities occupying weakly weathered sands which are deep, moist and well-drained. Such soils are developed on recently consolidated alluvium and talus.

IIA (*Hoheria* forest) is dominated by mountain ribbonwood (*Hoheria glabrata*), though silver beech (*Nothofagus menziesii*) is present as a scattered overstorey. Beneath the trees, there is a dense growth of *Polystichum vestitum*.

IIB (*Olearia-Hoheria* scrub) is a stunted ridge-crest variant of IIA, and is distinguished by the co-dominance of *Olearia colensoi*.

Class III. Communities occupying moderately weathered and moderately leached sandy loams which are deep, moist and well-drained.

In IIIA (*Weinmannia/Cyathea* forest) kamahi (*Weinmannia racemosa*) is dominant, but the most characteristic feature is the abundance of the tree fern *Cyathea smithii*. *Melicytus ramiflorus* and *Hedycarya arborea* were seen only in this community.

IIIB (*Nothofagus menziesii/Polystichum* forest) is a small stand at 1700 ft. dominated by silver beech, and with dense *Polystichum vestitum* on the floor.

Class IV. Communities occurring on soils which are of considerable depth, but less freely drained than soils of Class III. The somewhat impeded drainage is due either to the fine soil texture or to moderate slope.

IVA (*Nothofagus-Weinmannia-Podocarp* forest) is the densest and tallest forest community on the island. Dominance is shared by silver beech, mountain beech, kamahi, rimu (*Dacrydium cupressinum*), and miro (*Podocarpus ferrugineus*), and there is a vigorous development of *Blechnum discolor*, except on wetter ground where it is replaced by *B. capense*. *Senecio reinoldii*, *Olearia oporina* and *Dracophyllum longifolium* occur along the littoral fringe of the forest.

There is a gap in my observations on Class IV soils until 1000 ft. By this altitude, many of the low altitude species have become rare or absent, and co-dominance is shared by silver beech and kamahi (IVB, *Nothofagus menziesii-Weinmannia* forest).

IVC (*Nothofagus menziesii/Olearia* forest) is the most extensive type of subalpine forest. Silver beech is the only large tree, and usually forms an open canopy over an understorey of subalpine scrub in which *Olearia colensoi* is the main species.

Above 2800–3000 ft. the forest passes into mixed snow-tussock and herbfield communities (IVD).

Class V. Communities occupying soils which are underlain by solid rock at a depth of 6–24 in., and which therefore are much less freely drained than soils of Class IV.

VA (*Dacrydium intermedium* forest) is a stunted forest community in which *D. intermedium* is usually dominant, but mountain beech, *Dacrydium biforme*, kamahi and manuka (*Leptospermum scoparium*) may rise to co-dominance. There is a thick mantle of bryophytes dominated by *Dicranoloma billiardieri*. *Dacrydium biforme* and manuka not only occur as trees, but in this and related communities they also form extensive patches of semi-prostrate stems a few inches tall, which are adventitiously rooted in the moss.

VB (*Nothofagus cliffortioides-Dacrydium biforme* scrub) is the subalpine scrub equivalent of VA, being distinguished especially by the absence of *Dacrydium intermedium*.

VC (*Nothofagus cliffortioides-N. menziesii-Dacrydium biforme* scrub) is almost identical with VB, but soils are deeper, and silver beech is present, often growing as a prostrate, layering shrub.

Class VI. Communities occupying the very shallow soils which are developed over rock ridges. At lower altitudes there may be up to 12 in. of peaty soil overlying the rock, but above 2000 ft. soil is mostly confined to crevices.

VIA (*Dacrydium intermedium* scrub) is floristically closely similar to VA, but the dominant species are stunted to form a more or less open scrub. VIB communities, like VB communities, are mainly distinguished by the absence of *Dacrydium intermedium*.

Class VII. Communities which occupy wet hollows and drainage channels.

VIIA (*Dacrydium biforme* forest) is bog forest dominated by *Dacrydium biforme*. This community grows on water-logged

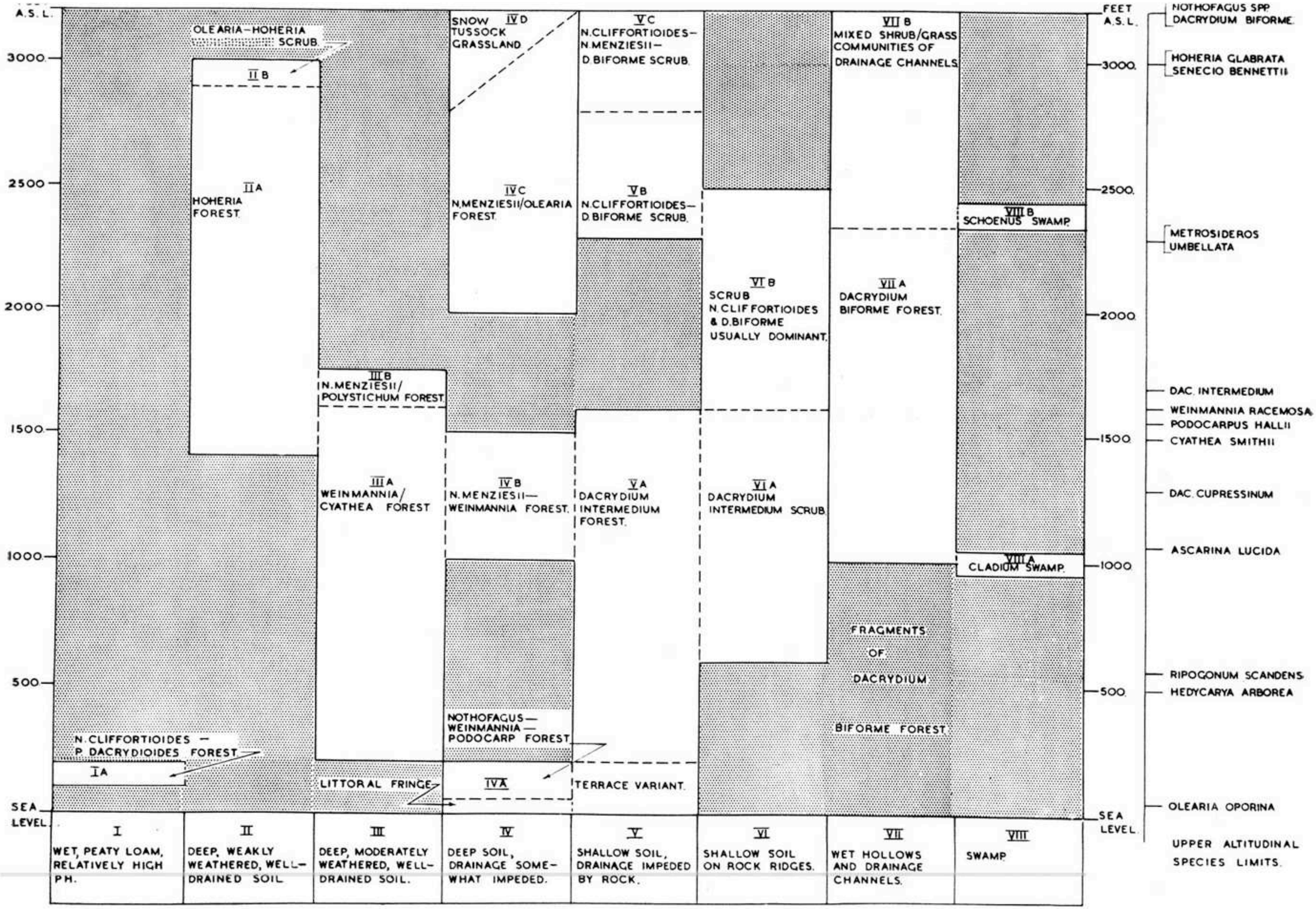

FIGURE 1. *Tabular representation of distribution of plant communities in relation to soil and altitude. Stippling indicates potential sites which were not encountered on Secretary Island.*

peats or peaty loams, which are covered by thick moss (consisting mainly of *Dicranoloma*, not *Sphagnum*).

VIIB includes mixed scrub/grass communities of drainage channels. These communities are wet variants of grassland and subalpine scrub, rather than bog.

Class VIII. VIIIA and B include communities growing in swamps, with deep peats and water lying on the surface. These were not recorded in any detail.

The relationship between soil and vegetation on Secretary Island is summed up in the foliowing paragraph:

The communities included in Classes I–IV are taller, denser, and floristically richer than those in Classes V–VIII, and the leaves of most species belonging to the former communities are green or dark green, and of medium size, in contrast to the small yellowish or brownish leaves of most species belonging to the latter communities. Soils of Classes I–IV are thus evidently more fertile than those of Classes V–VIII. However, chemical analyses of seven soil samples, carried out at Rukuhia Soil Research Station, indicated relatively high nutrient contents only under the *Nothofagus cliffortioides-Podocarpus dacrydioides* and the *Weinmannia/Cyathea* communities. Under the remaining communities fertility appears to be primarily related to the depth of soil available for exploitation. Soils of Classes V–VIII are either actually shallow because of solid rock lying near the surface, or effectively shallow because of high water tables, and this may be sufficient explanation of their infertility.

Values for total exchangeable bases for the seven soils are as follows:

Weinmannia/Cyathea forest	26.3
Nothofagus cliffortioides-Podocarpus dacrydioides forest	18.0
Dacrydium intermedium scrub	4.1
Nothofagus menziesii/Olearia forest	2.1
Hoheria forest	1.1
Dacrydium intermedium forest	0.9
Nothofagus cliffortioides-Dacrydium biforme scrub	0.6

In the first two examples, comparatively high fertility would be expected from the presence of species such as *Melicytus ramiflorus* and *Podocarpus dacrydioides*, but in the remaining five examples there is obviously no consistent relationship between the vigour of the stand and base status. There is, however, good agreement between vigour of stand and depth of soil available for exploitation.

Wright and Miller (1952) discuss a wide range of soils and types of vegetation of south-west Fiordland. Our Secretary Island soils appear to correspond with five of their series, but on the whole show less acccumulation of peat. Whereas Wright and Miller record accumulation to depths of up to 24 inches, Secretary Island soils usually had only 0–6 inches of peat, and there was seldom more than 12 inches. This may be because our area is somewhat warmer and less exposed than the extreme south-west corner of Fiordland, where Wright and Miller based their work.

A fuller account of the plant communities is being prepared for later publication.

REFERENCE

WRIGHT, A. C. S. and MILLER, R. B., 1952. Soils of South-west Fiordland. *Soil Bureau Bull.* (n.s.) 7. Wellington, N.Z.