Succession in a New Zealand alpine cushion community: a Markovian model

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Abstract

A permanent plot in a low-alpine cushion/tussock/shrub community was mapped at ca. decade intervals from 1953 to 1984. Transition probabilities between vegetation types were calculated, and a Markovian model was fitted.

In spite of non-stationarity a Markov model was consistent with the observations, and produced reasonable predictions, especially for the major components of the vegetation. The model predictions were conservative in terms of future changes, in that future changes would be smaller than those observed, but such predictions could be supported by independent evidence, such as the nature of the non-stationarity, plant counts and seedling numbers.

The general pattern was of a decrease in the cover of both Chionochloa rigida tussocks and mixed turf, and an increase in the cover of cushion bog species, especially Donatia novae-zelandiae. Shrubs, the suggested climax, showed no tendency to increase. Known climatic changes cannot explain the trend, which therefore seems to be a local retrogressive succession. There may be a cycle of alternating cushion and turf.


Introduction

Succession features prominently in ecological theory, but records of actual transitions in vegetation cover are rather few. Those reported previously have generally been allogenic responses to human interference, such as barrage construction (Van Noordwijk et al., 1979) and exclusion of native herbivores (Gibson et al., 1983), or they have been of vegetation recovery from human interference such as cultivation (Pickett, 1982) and burning (Hobbs, 1983), or they deal with large-scale vegetation complexes (Van Dorp et al., 1985). We have investigated succession in a natural low-alpine community on the Maungatua Range, New Zealand.

Maungatua is a localised block-faulted upland of quartzofelspathic schist, 16 km from the coast of Otago in southeastern New Zealand (45° 52′ S). The summit is a flattened plateau which reaches 895 m elevation; the treeline of Nothofagus men-
ziesii is at ca 750 m. Our site was on this plateau at 870 m (Fig. 1). The vegetation of the plateau includes shrubs of Cassinia vauvilliersii, Dracophyllum longifolium, and Hebe odora, reaching heights of 0.5–2 m, and tussocks of the grass Chionochloa rigidida here reaching 0.5 m. There are also areas covered by cushion-forming species: especially Donatia novae-zelandiae, Phyllachne colensoi, Celmisia argentea, Oreobolus pectinatus. Cover by such species is complete on the small peat bogs that occupy depressions and some flat surfaces. Other areas comprise a turf with a range of intermixed low tufted or trailing species: Cyathodes pumila, Pernettya macrostigma, Dracophyllum prostratum, Drosera arcturi; with mosses and lichens: Dicranoloma robustum, Racomitrium lanuginosum, Cladia retipora and C. sullivani.

It has been assumed in the past that the ‘climax’ vegetation comprises dominating shrubs, but that Chionochloa cover can be induced by periodic fires, aboriginal and perhaps natural (Wardle & Mark, 1956; Molloy et al., 1963). Fires are now very rare.

In 1953 two permanent plots were established in the course of other work (Mark, 1954). The main plot (A) was 8 m × 8 m in size, with a smaller one (B) of 2 m × 2 m inside it to allow mapping at a finer scale. The vegetation was remapped three times at approximately decade intervals. This offers an opportunity to observe succession in a natural community.

**Methods**

The plots were established and mapped in 1953. For shrubs and the tussock grass Chionochloa rigidida individuals of each species were recorded. For the shorter vegetation, the fine scale of pattern made mapping of individual species impossible for plot A, resulting in eight categories:

1–3. Shrubs of three species: Cassinia vauvilliersii, Dracophyllum longifolium and Hebe odora;

4. Tussocks of the grass Chionochloa rigidida;

5. Cushion-forming species (mainly Donatia

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**Fig. 1.** Plot A in 1984. Behind the tussocks are many areas similar to the plot.