

Plants on which chamois were observed to feed were:—

*Aciphylla colensoi*  
*Celmisia coriacea*  
*Celmisia spectabilis* var. *angustifolia*  
*Chionochloa flavescens*  
*C. pallens*  
*Coprosma serrulata*  
*Dracophyllum uniflorum*  
*Helichrysum selago*  
*Hydrocotyle novae-zealandiae*  
*Microseris scapigera*  
*Nothofagus solandri* var. *cliffortioides*  
*Poa colensoi*  
*Podocarpus nivalis*  
*Ranunculus insignis*  
*Schoenus pauciflorus*

Visual observations give only a partial indication of their diet, and usually only the bigger plants can be recognised, largely due to the distance of the chamois from the observer. On some occasions subsequent examination of communities on which chamois had been observed feeding revealed evidence of browsing on a number of plants which the chamois had not been seen to eat. The following plants in addition to those listed above showed signs of browsing by chamois and/or deer.

*Aciphylla monroi*  
*Aristotelia fruticosa*  
*Astelia cockaynei*  
*Chionochloa australis*  
*C. rubra*  
*Coprosma pseudocuneata*  
*Gaultheria antipoda*  
*Gentiana* sp.  
*Hymenantha alpina*  
*Luzula campestris*  
*Neopanax colensoi*  
*Poa novae-zealandiae*  
*Phyllocladus alpinus*  
*Senecio bidwillii*  
*Uncinia* sp.  
*Viola cunninghamii*

Forty-six chamois were shot during February and March 1962 from catchments close to Cupola Basin, and some identifiable plant

fragments were obtained from the rumen. Between 75 and 85 per cent of the plant fragments were grasses, including leaves, stalks, and seed heads, but only *Poa colensoi*, *Chionochloa pallens*, *Gaultheria antipoda*, *Hydrocotyle novae-zealandiae*, and *Gentiana* sp. were identified. Wodzicki (1950) lists only six species which were identified after field examination of stomach contents of chamois.

Briedermann (1961) in discussing the food of chamois in Saxonian Switzerland, considered that the species are eaten in proportion to their abundance in the chamois habitat. Direct observations in Cupola Basin and evidence from stomach contents indicate that chamois eat a large quantity of grass species, not necessarily corresponding to the abundance available.

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## SHEEP IN THE TUSSOCK GRASSLANDS

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Much has been written and spoken about the deterioration and destruction of the tussock grasslands under European occupancy yet an appropriate opening to this paper is a con-

clusion drawn by A. H. Cockayne in 1910—“It is generally said that the effect of stock has been to reduce very largely what the run-holders call ‘the finer and better grasses’. If

a certain portion of the original vegetation has been more or less eliminated the remarkable feature of the present day montane tussock grasslands in areas of moderate rainfall is that the dominant growth form has remained permanently the same in spite of burning and grazing."

Three factors are of importance in the historical background. The first is that when the tussock grasslands were taken up as sheep runs about a century ago, the immediate object was to increase the stock numbers as fast as possible. By 1877 there were half a million sheep on two runs in the Upper Clutha, and the sheep figures for Otago have been estimated at 70,000 in 1854, increasing to two million in 1868 (Roxburgh 1957). The second factor is that much of the country was burnt first to facilitate access and stock movement, and later at regular intervals to provide palatable regrowth from the dominant tussock grasses. The third factor is that sheep are selective in their grazing, choosing not only between plants but also between parts of plants, and their preferences change with the season. The introduction of sheep must therefore have had a profound effect on grasslands which had developed in the absence of grazing animals.

Today the tussock grasslands are a complex mosaic of plant communities occupying a wide range of habitats covering some 10-12 million acres and supporting populations of rabbits, hares, deer, thar, chamois, opossums and grass grubs as well as about two and a half million sheep and 40,000 head of cattle. As a domestic animal, however, the sheep differs considerably from the wild populations in that its grazing behaviour is to some extent determined by man. In addition to seasonal movement of stock runholders have used several tools, separately and in combination, in the management of these pastures. These include fire, subdivision, oversowing and topdressing. This multiplicity of factors makes it difficult to assess the role of sheep grazing alone.

After a century of use the obvious modification has been the continued removal of the vegetative growth of preferred species. What is more difficult to assess is whether, and to what extent, sheep grazing has induced changes in species composition. Such changes include the loss of, or gain in species, changes in the balance of existing species, changes in the boundaries between adjacent communities and the invasion by exotic species. The most

probable botanical modifications would include the reduction in abundance of palatable species with perhaps an increase in palatable mat formers, and the spread of unpalatable shrubs.

In an attempt to assess the extent of modification of the tussock grasslands by sheep grazing four lines of enquiry will be discussed briefly:—

1. *Comparison between early descriptions and photographs of the vegetation and current botanical studies.*

The comments of the early explorers and surveyors convey an impression of large tracts of tall impenetrable tussocks and vast thickets of matagouri (*Discaria toumatou*) and *Aciphylla* species. Cockayne (1921) in his description divides the grasslands into three main types, low tussock, red tussock, and tall or snow tussock with a large number of associated species in each. These main divisions are still recognisable today and the same accompanying species are present. There is no evidence of loss of species but there has been invasion by exotic species of grasses and other herbs. In his discussion of the current status of the tall tussock grasslands, Connor (1960) comments that more intensive botanical study has revealed a more complex pattern in the snow tussock communities. The available evidence points more to an increase in knowledge of the tussock grasslands, particularly of their status, composition and condition, than to any particular modification due to grazing by sheep.

2. *Experimental work on the vegetation*

This has been mainly on the low or hard tussock country in which *Festuca novae-zelandiae* is the physiognomic dominant. From the early days agricultural research in this field has been concentrated on replacement of the tussock sward by "English" grasses and white clover on the better soils, and on the search for suitable species to rehabilitate the depleted country. Work on the tussock grasslands themselves and their response to variations in management is more recent and hence mainly short term.

- (a) Exclosures show an increase in vegetative growth of the resident species rather than a change in the species present; e.g. there has been spectacular growth of *Aciphylla* species inside a fence at 3,400 ft. in the Waitaki in just two years.

- (b) Transect studies comparing grazed and ungrazed treatments on the so-called depleted country in Central Otago suggested there were no differences in the species present, although differences in vegetative growth and in frequency of distribution were noted.
- (c) J. M. Hercus (1961) described visible improvement due to increased vegetative growth and seed set resulting from small changes in the grazing on two areas of the depleted country in Central Otago. The sheep are normally on the warm sunny faces of this winter country from May till December or later and thus the preferred species are heavily grazed during the period of active growth and they rarely show much leaf or set much seed.

### 3. *Sheep behaviour.*

The broad pattern of behaviour observed on the winter grazing country is that when allowed a choice the sheep concentrate on the sunny aspects from soon after the onset of frosts in winter until well on in summer when close continuous defoliation and lack of moisture prevent further plant growth on these aspects. This behaviour persists even in the presence of abundant feed on the adjacent shady aspects.

### 4. *Studies of diet*

Opinion on what sheep on the tussock country eat ranges from everything to a diet limited to only two or three species. This lack of precise information is hardly surprising when it is remembered that over 250 species have been recorded from the tussock grasslands and on any one hill slope it is not unusual to find 50 or more.

Cockayne (1919) drew up a list of relative palatabilities after watching sheep on Conical Hill at Hanmer. An interesting feature is that most of his list is made up of introduced species. Accompanying this article is a table listing the estimates of palatability given by Buchanan, Petrie, Cheeseman and Cockayne, and the opinions differ considerably.

Recently J. M. Hercus (1963) published the results of his studies of sheep grazing habits on a hillside near Lake Hawea. All species present in a ring thrown at random were rated according to the intensity with which they had been eaten. He listed 12 preferred species out of 55 native and 11 oversown species

available. The sheep wintered mainly on the native species and there were different times of grazing of the preferred species over the late autumn, winter and spring period.

Another method of studying the diet of grazing animals has been developed by B. H. Hercus (Crocker, 1959, Hercus 1961). The pilot study on sheep which were grazing on two distinct types of tussock grassland in Central Otago confirmed the results of J. M. Hercus and extended Cockayne's list of species eaten. Since then the method has been modified and improved by experiments using single species plots and stall fed animals (Hercus 1960). Some problems remain to be overcome before the method can be considered quantitatively, but meanwhile several projects are being studied on a qualitative (presence or absence) basis. These include:—

- (a) Diet on burnt snowgrass country. This is in conjunction with a study of the botanical changes that follow burning. Twenty samples are collected each year (over a period of years) on each of four sites.
- (b) The pattern of selection on unimproved fescue tussock country is being examined at seven localities which were sampled twice during the grazing period of November to April.
- (c) An attempt to determine whether the onset of Benmore disease or swamp fever in the Mackenzie country is associated with a change in diet.
- (d) To determine which plants the sheep on Campbell Island were eating in January 1961.

These projects are not yet completed but the results to date suggest that the diet in most cases is composed mainly of grasses, the small fine-leaved intertussock species, and that the selection is much wider than previously thought.

### CONCLUSIONS

It seems fairly safe to conclude that the species mentioned as eaten by all authors since Buchanan in 1869 have and still do contribute to the diet either substantially or occasionally. However this gives us little information on the extent of modification by grazing. None of the species given in Cockayne's table has disappeared and we have

little information on the relative abundance of these species in the past to compare with their present distribution and frequency. As in the comparison of botanical descriptions the obvious change is from a simple to a more detailed list of the species eaten.

These studies of diet form the first step in determining the effect of sheep on the tussock grasslands at the present time. The next step is to determine the effects of various levels and frequencies of defoliation on the plant, its rate of vegetative growth, flowering, seeding, and survival.

One important area for which little experimental evidence is available is the snowgrass country. There is a strong body of opinion that in the snowgrass the combined effects of fire and grazing have been responsible for deterioration in vegetative cover and stability. It seems likely that changes in the boundaries between the snowgrass and fescue communities have been due to, or aggravated by, the combined pressures of fire and sheep grazing. The snowgrass communities have been opened up during the time the land has been farmed and in the more stable localities there has been invasion of the inter-tussock area.

Finally, there have been visible changes in the tussock grasslands during their use for grazing by sheep. It is suggested that in some areas this is mainly a quantitative change in

vegetative growth, often with changes in the balance between individual species within the community. In many areas the combined effects of fire and grazing have served to open up the community and allow the invasion by exotic species leading to a richer or more varied inter-tussock flora than the original.

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## RELATIONS BETWEEN FERAL GOATS AND VEGETATION IN NEW ZEALAND

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This paper describes some relations between feral\* goats and vegetation, and attempts to show how understanding their reciprocal nature may assist in improving methods of controlling goats. Examples are drawn from the Rimutaka Range where goats, red deer, pigs and opossums are present; Mt. Egmont and the adjacent Pouakai Range where goats and opossums are present; and Cuvier Island,

24 miles east of Cape Colville, where goats were the only browsing mammals prior to their extermination in 1961. Methods used in this study follow those described by Atkinson (1963).

\* Feral animals are those that have reverted from the domestic to the wild state.