burning and no domestic stock (Hokitika river catchment) have been described elsewhere (Wraight, 1960).

In other instances, trampling of the sward is of greater consequence than grazing. On Lake Ellesmere Spit, there was far more moss cover, within the sward, in lightly and moderately grazed than in heavily grazed annual grassland. (Table 1). The reduction in moss cover is attributable to trampling; it is evident also in the Wairau alpine grasslands. (Table 2). Damage to or modification of alpine grassland swards by trampling is particularly significant where *Chionochloa rubra* or *C. australis* is the dominant species. Both are unpalatable and few of their associate species are palatable or susceptible to grazing. Where such grasslands are extensive they are little damaged by animals, but where they occur over small areas within a mass of more palatable grassland, and particularly where they lie across frequented animal travel routes, they may suffer severe trampling damage. The sward is rapidly cut up by hoof action and the underlying soils (typically peat or deep, "fluffy", dark organic soils), are rapidly lost through erosion.

REFERENCES

ALLRED, R. W., 1952. Influence of shrub invasion on U.S. rangelands. *Proc. 6th Int. Grassland Congr.* 578.

BOYKO, H., 1952. Shrub invasion and grass competition. *Proc. 6th Int. Grassland Congr.* 624.

BROWN, DOROTHY, 1954. Methods of surveying and measuring vegetation. *Commonwealth Bureau Pasture and Field Crops, Hurley, Berks. Bull.* 42: 223.

DYKSTERHUIS, E. J., 1952. Determining the condition and trend of ranges (natural pastures). *Proc. 6th Int. Grassland Congr.* 1322–27.

JONES, M. G., 1933. Grassland management and its influence on the sward. Pt. I. Factors influencing the growth of pasture plants. *Emp. J. Exp. Agric.* 1: 43–57.

TALBOT, M. W., BISWELL, H. H., and HORMAY, A. L., 1939. Fluctuations in the annual vegetation of California. *Ecology* 20: 394–402.

WEAVER, H. E., and HANSEN, W. W., 1941. Native midwestern pastures—their origin, composition and degeneration. *Univ. Nebraska, Conserv. Surv. Div. Conserv. Bull.* 22.

WEINMAN, HANS, 1952. Carbohydrate reserves in grasses. *Proc. 6th Int. Grassland Congr.* 655–60.

WRAIGHT, M. J., 1957. The Ecology of Lake Ellesmere Spit. *M.Agr.Sc. thesis (Cant. Agric. Coll).*

WRAIGHT, M. J., 1960. The alpine grasslands of the Hokitika River catchment, Westland. *N.Z. J. Sci.* 3: 306–32.

WRAIGHT, M. J., 1963. The alpine and upper montane grasslands of the Wairau River catchment, Marlborough. *N.Z.J. Bot.* 1: 351–76.

A NOTE ON THE CHAMOIS IN NEW ZEALAND

A. H. C. CHRISTIE

N.Z. Forest Service, Wellington.

CLASSIFICATION

The 11 sub-species of chamois *(Rupicapra rupicapra* L. 1758, a member of the F. Bovidae, S. F. Caprinae) are the only members of the genus *Rupicapra* Blainville, 1816 (Simpson 1945). The New Zealand chamois are from the sub-species *Rupicapra rupicapra rupicapra*, native to the Central European Alps.

PHYSICAL CHARACTERS

Chamois look similar to the domestic goat, but differ by having relatively longer legs, a more erect neck, more pointed ears and in the shape and curve of the horns. Riney (1955) gives a general description of the chamois, with an illustration.

Average measurements for four classes of chamois are given in Table 1.

TABLE 1. *Average measurements (in mm.) for four classes of chamois.*

	No. of specimens	Weight (kg.)	Length (incl. tail)	Height at shoulder	Length of horns
Adult male	15*	37	1260	890	250
Adult female	20	23	1130	800	190
Sub-Adult (6 mth.-2 yrs.)	8	14	910	670	110
Young (less than 6 months)	3	5	670	480	Nil

* The weights Riney (1955) gives for adult males appear to be slightly low.

The overall colour of the coat varies seasonally although individual differences occur. Adults are usually almost black in winter and brownish-fawn in summer.

The horns, carried by both sexes, are the most characteristic feature of chamois. They rise above and a little in front of the eyes, growing upwards and slightly forwards, usually parallel as far as the beginning of the sharply recurved hooks where they diverge, often considerably. The horns of the male are usually thicker and do not diverge as far as do those of the female. The width between the horns at the curve can exceed 200 mm., and in exceptional cases can reach 340 mm. (Couturier 1938).

The ability of chamois to move over steep, precipitous country is well known and it is not often that chamois encounter cliffs which they are unable to traverse. They can move over rough terrain with remarkable speed. Three chamois disturbed at the base of some cliffs in southern Nelson moved up the bluffs, covering approximately 1,000 yards and rising 1,500 feet, in eleven minutes before disappearing.

INTRODUCTION AND DISTRIBUTION IN NEW ZEALAND

Eight chamois (two males and six females, two of which were pregnant) were liberated in the Mt. Cook area in 1907. Thomson (1922) and Donne (1924) discuss the difficulty that was experienced in obtaining and transporting the chamois. A second introduction was suggested in 1911, but it was not until 1914 that two more chamois were obtained and released in the same area as the earlier liberation.

They increased in numbers rapidly; Donne (1924) reported 20 well-conditioned animals in one herd in 1917, close to the point of liberation, and Thomson (1922, p. 61) reported that by 1920 "the flock (was) increasing fast and the animals are in a very fine condition,

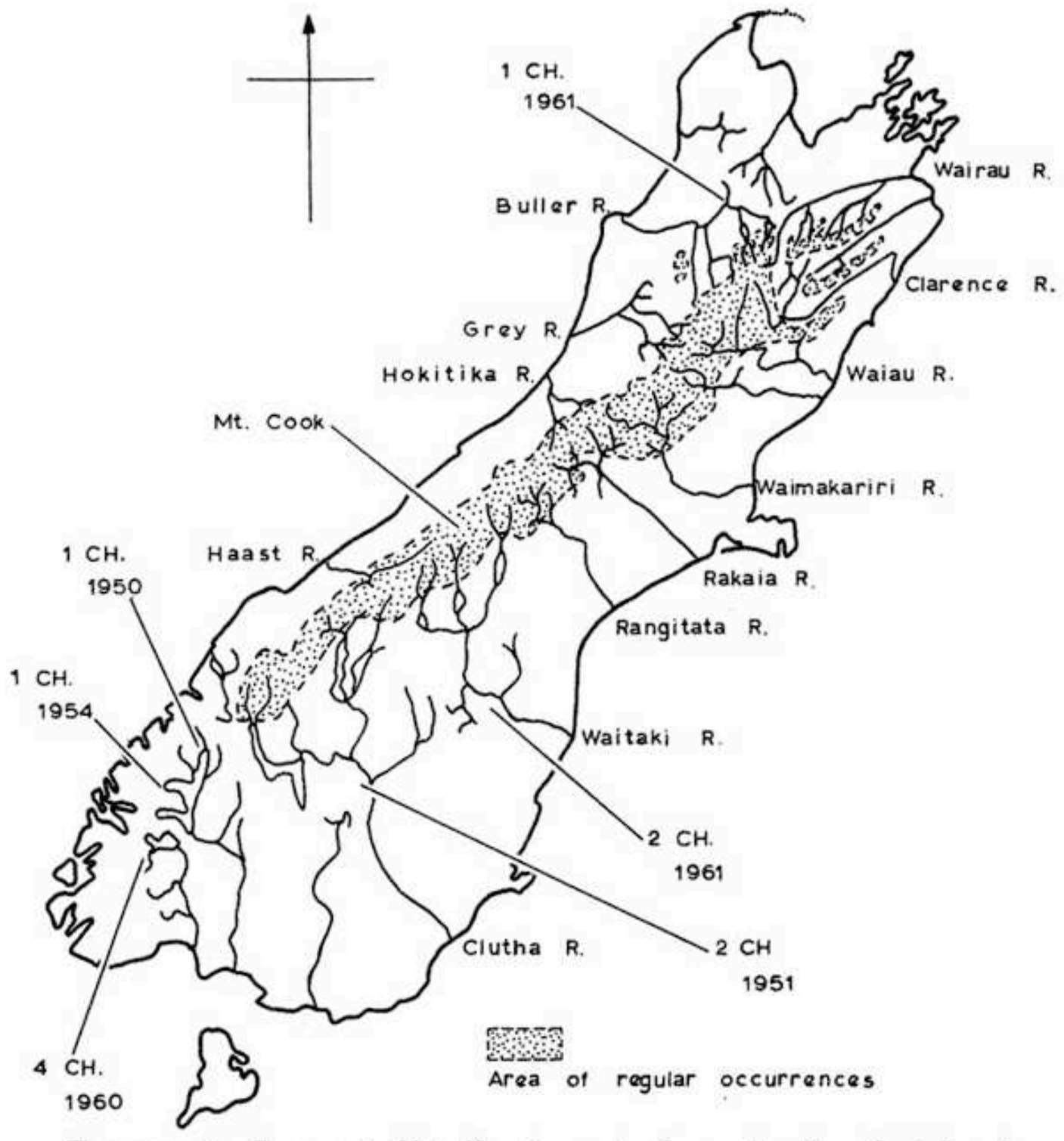

FIGURE 1. *Present distribution of chamois, South Island, New Zealand.*

herds of 30, 40 and 70 being noticed at one time." Yerex in 1934 (unpublished report, Department of Internal Affairs) stated that herds had reached Mt. Brewster, near Haast Pass, in the south and Hope Pass in the north.

The present distribution of chamois is shown in Figure 1. The established populations extend about 215 miles north and 120 miles south of the original liberation point, and a few animals occur over wider areas; they are probably still increasing their range. Wodzicki (1961) gives a distribution map of chamois which show some differences to the one presented in this paper, due, most probably, to being based on less accurate information.

Riney (1955) noted that chamois have spread a greater distance from the point of liberation than any of the other ungulates introduced into New Zealand. Taking the Hermitage, Mt. Cook, as the point of liberation in 1907 and an observation in 1940 at Mt. Robert (R. Clark, pers. comm.), Lake Rotoiti, as the date of arrival at that point, and assuming that the chamois have dispersed along the main divide, the rate of spread is approximately six miles per year. Wodzicki (1961, p. 146) ascribes this to the particularly favourable alpine niche found in New Zealand, "possibly superior to that in Europe." The lack of predators, the more favourable climatic conditions, the early years of protection and the inaccessibility of their range have all contributed to their wide dispersal. The thar *(Hemitragus jemlahicus)* also dispersing along the Southern Alps have averaged only 1.4 miles per year (G. Caughley, pers. comm.).

Present Study Area—Location, Extent and Vegetation Cover

Although chamois have been in New Zealand for over 50 years, little information has been recorded on their ecology. To help fill this gap a study was begun in 1960 of a chamois population in Cupola Basin, Nelson Lakes National Park. Cupola Basin is situated in the catchment of the Travers River which enters Lake Rotoiti and in turn gives rise to the Buller River. Cupola (or Hakano) Creek, the main creek draining Cupola Basin, joins the Travers River 12 miles from the head of Lake Rotoiti. The altitude ranges from 2,630 feet at the Cupola-Travers River junction to 7,396 feet at the summit of Mt. Cupola. The basin is approximately 3,100 acres, of which 28 per cent is beech forest and scrub up to 4,000-4,600 feet, and 32 per cent is alpine grassland. The remaining 40 per cent is composed of fellfield*, bare rock, scree and permanent snow.

Scrub is present only in isolated patches, the beech forest giving way directly to alpine grassland in most places. The height to which permanent vegetation extends varies considerably, but it is generally between 5,000 and 6,000 feet.

The vegetation was divided into three main types for the study.

1. Beech forest. This is dominated by mountain beech *(Nothofagus solandri* var. *cliffortioides)* with scattered silver beech *(N. menziesii)* occurring mainly on north-facing aspects. Cedar *(Libocedrus bidwillii)* and red beech *(N. fusca)* are also present though confined to a small area close to junction of Cupola Creek and the Travers River.
2. Shrubland. Two important communities† occur.
   (a) Mountain beech scrub, a dense, impenetrable stand, with few plant species present.
   (b) Mixed scrub, dominated by *Podocarpus nivalis*, *Dracophyllum uniflorum* and *Coprosma pseudocuneata.*
3. Alpine grassland. Three major and two minor communities occur.
   (a) Snowgrass *(Chionochloa pallens-C. flavescens)* community, occurring on a wide range of slopes with varying aspects, but tending to be best developed on slopes of less than 45°, with a northerly aspect.
   (b) *Poa colensoi* community, most commonly found on steep well-drained slopes of any aspect.
   (c) *Chionochloa australis* community, best developed above snowgrass communities and on southerly aspects.

   The minor communities are dominated by:
   (d) *Schoenus pauciflorus*, found on very poorly drained sites, near the timber line.
   (e) *Chionochloa rubra*, found on poorly drained, flat sites, above the timber line.

ANIMALS

Feral sheep and cattle occurred in the Upper Travers Valley and Cupola Basin prior to 1930. They appeared to have died as the result of a very heavy snowfall during the winter of 1929; certainly none have been reported since that

---

* Fellfield is defined here as an area with a vegetation cover of 50 per cent or less. Areas occupied by another community, which has been depleted to the extent that less than 50 per cent of the ground is covered by vegetation, are not included as fellfield.

† The term community is used here for a plant grouping that is distinct and clearly recognisable on the ground. The communities agree in their formation and development, but differ in floristic composition among themselves and to some degree in habitat (Carpenter 1956).

time (D. Cummings, pers. comm.). Red deer *(Cervus elaphus)*, hares *(Lepus europaeus)*, opossums *(Trichosurus vulpecula)*, mice *(Mus musculus)* and 21 species of birds occur in varying degrees of abundance in addition to the chamois, which occupies a particular niche in this environment.

The number of chamois present at any one time averages 30 with a variation from 0 to 55. This works out at one animal per 100 acres, or if the area under beech forest is excluded, one to 75 acres. This is somewhat higher than the figure given by Briedermann (1961), one per 126 acres, for chamois in their natural habitat in the Elbsandstein district.

METHODS FOR CHAMOIS STUDY

Chamois which could be observed through a telescope (15-60 power × 60) were counted at three-hour intervals throughout the day, and the tally for the day compiled from these figures. Records were kept of the age (adult, two years and over; sub-adult, one-two years; and young, up to one year), and sex of each animal observed, which gives by accumulation of all observations a picture of the composition of the population. In addition, activity was recorded under the groupings of alertness, feeding intensity, movement, social activities and inter- and intra-specific relations. The bulk of the observations were made during the summer months.

RESULTS

Of the 433 animals observed over the study period, 54 per cent could not be sexed with certainty. It was not possible to distinguish the sex of young animals in the field. The ratio between adult males and females is approximately 1 to 2 although it should be noted that this is based on only 46% of the adult population observed. Briedermann (1961) gives the sex ratio of chamois of the Elbsandstein district as from 1 to 2, to 1 to 3.

Daily Activity Pattern for Chamois

Chamois seemed largely inactive at night since on a number of occasions they were observed at the same position at first light in the morning as they were on the preceding evening. Klette (1911) however believed chamois graze on moonlight nights.

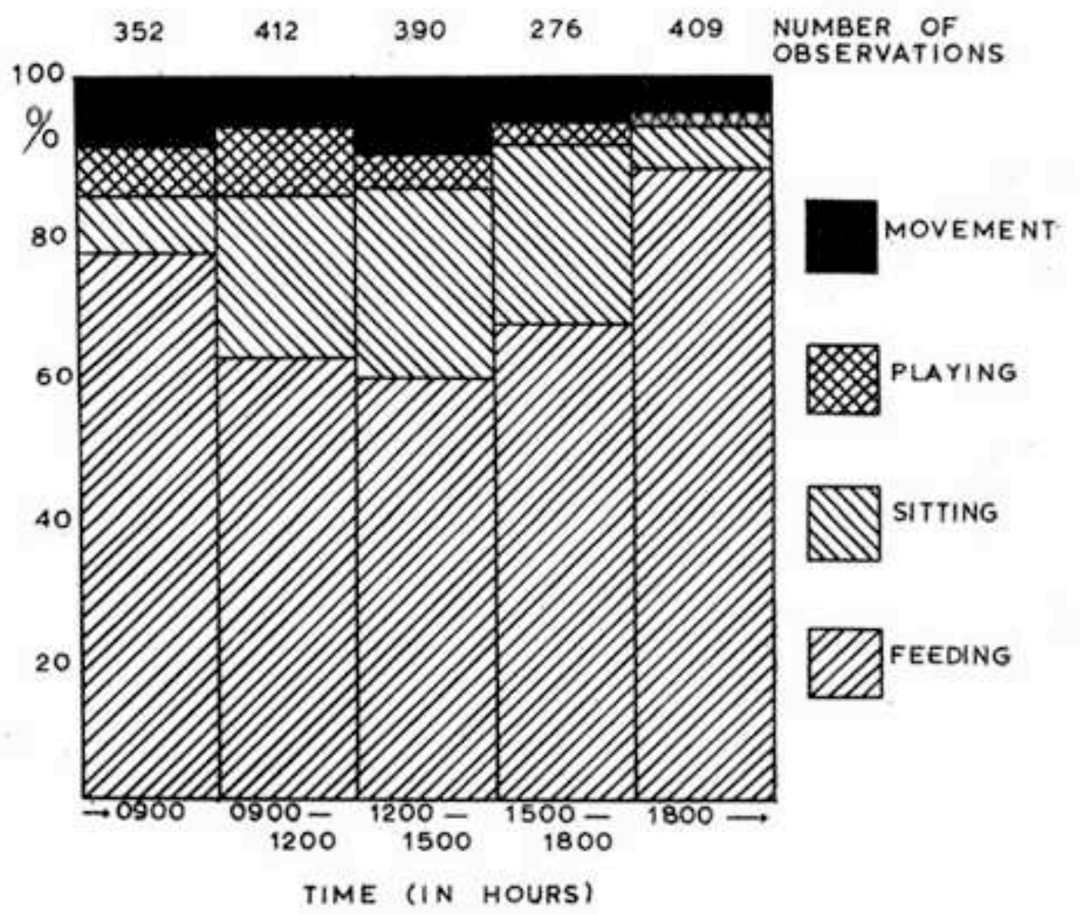

FIGURE 2. *Activity of chamois shown as a percentage over three-hour periods.*

Figure 2 shows for three-hour periods the percentage of chamois engaged in each of the principal activities defined above. The time spent on feeding was at a maximum early in the morning and again late in the evening whereas forward movement was generally less at those peak feeding times. There were not sufficient observations made over the year to detect any seasonal change of activity pattern.

Habitat Preference and Utilization

The areas on which the highest densities of chamois were observed were steep, well-drained slopes where the dominant plant is *Poa colensoi*. Numerous rock outcrops provide shelter and refuge for the animals. Over the period of this study chamois appeared to show little seasonal change in habitat preference and entered the scrub and beech forest only in periods of rain or snow.

Fuschlberger (quoted by Briedermann 1961, p. 158) stated of the chamois "it eats just about everything which is green." Nerl (1962) in observations of chamois in an enclosure found that although a wide range of foods were given to them, none were specially preferred.

In January, 1962, an adult male was observed feeding on a small knoll of approximately one quarter acre for three days, illustrating the small amount of movement sometimes displayed when feeding. Briedermann (1961, p. 157) noted that "it is astonishing on how small an area bucks can graze for many hours."

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.
Hymenanthera 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.

REFERENCES

BRIEDERMANN, von L., 1961. Untersuchungen uber das Gamswild in Elbsandsteigebeit. *Z. Jagdwiss* 7 (4): 139–166.

CARPENTER, J. R., 1956. *An Ecological Glossary*. Hafner Publishing Co., New York.

COUTURIER, M. A. J., 1938. *Le Chamois*. B. Arthaud. Ed., Grenoble.

DONNE, T. E., 1924. *The Game Animals of New Zealand*. John Murray, London.

KLETTE, C., 1911. *Notes on the Chamois in New Zealand*. Blundell Bros. Ltd., Wellington.

NERL, W., 1962. Die Haltung von Gamswild im Gatter. *Z. Jagdwiss* 8 (1): 32–34.

RINEY, T., 1955. Identification of Big Game Animals in New Zealand. *Dom. Mus. Handbook No.* 4.

SIMPSON, G., 1945. The principles of classification and classification of mammals. *Amer. Mus. J.* 1–350.

THOMSON, G. M., 1922. *The naturalisation of animals and plants in New Zealand*. Cambridge Univ. Press.

WODZICKI, K. A., 1950. Introduced mammals of New Zealand. *N.Z. D.S.I.R. Bull.* 98:1–255.

WODZICKI, K. A., 1961. Ecology and management of introduced ungulates in New Zealand. *La Terre et le Vie*, 1: 130–157.

SHEEP IN THE TUSSOCK GRASSLANDS

B. H. HERCUS

Department of Agriculture, Christchurch

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 conclusion drawn by A. H. Cockayne in 1910—"It is generally said that the effect of stock has been to reduce very largely what the runholders call 'the finer and better grasses'. If