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DAILY MOVEMENT AND ACTIVITY OF FEMALE AND JUVENILE HIMALAYAN THAR *(HEMITRAGUS JEMLAHICUS)* IN THE EASTERN SOUTHERN ALPS, NEW ZEALAND

Summary: About 30 female and juvenile Himalayan thar *(Hemitragus jemlahicus)* were observed over 2 years on a 200 ha study area. At dawn, thar were at low altitudes and most were feeding. They ascended during the morning to spend the middle of the day resting at high altitudes. In the afternoon they descended again, with increasing feeding activity, to reach low altitudes at dusk. The vertical movement was 450 m in summer and 150 m in winter. The proportion of the day spent feeding was highest in November-February and lowest in August-September. Resting behaviour was more frequent in March-May and August-October than at other times. The proportion of the day spent standing increased threefold during June-July. The feeding pressure during daylight on four vegetation associations showed that tall snow tussock grasslands at high altitudes were likely to be the most susceptible to modification. Lower altitude associations, such as short tussock grasslands and matagouri scrub, received more intense feeding pressure during spring, but were rarely used in winter.

Keywords: Thar, tahr, Hemitragus jemlahicus, movement patterns, social behaviour, habitats, range use, Canterbury, New Zealand.

Introduction

Thar *(Hemitragus jemlahicus)* are social caprids native to the Himalayas. They were intitially introduced to the Southern Alps of New Zealand in 1904 and 1909 (Caughley, 1970a). They were intitially protected from hunting, but by the 1930s concern over their impact on alpine vegetation and downstream water and soil quality led to Government-funded control. Unrestricted recreational hunting followed, and most recently, commercial game meat recovery. The combined effects of this exploitation, particularly the intensive helicopter-based commercial hunting between 1972-75, dramatically decreased thar numbers (Tustin and Challies, 1978) and their breeding range (Parkes and Tustin, 1985).

Deleterious effects of thar on alpine vegetation, particularly at high densities, have often been described (e.g., Anderson and Henderson, 1961; Burrows, 1974; Douglas, 1984), but only Caughley (1970b) objectively measured thar impact on the vegetation. He related the decrease in tall snow tussocks *(Chionochloa* spp.) and increase in short-sward grasses (e.g., *Poa colensoi)* to increasing densities of thar after colonisation.

The objective of this study was to record how thar used range and vegetation resources in a bluff system by following the movements and activity of a small herd of resident females and their offspring. We also discuss the likely impact of thar on the four major vegetation associations in the area by measuring the time spent feeding in each.

Study Area

The study area was a north-facing bluff system close to the confluence of the North Branch with the main Godley River on the eastern side of the Southern Alps (170°32'E, 43°36'8). About 200 ha of bluff were observed, ranging from 800 m a.s.l. at the stream bed to 2200 m a.s.l. at the ridge top and extending across 2000 m (Fig. 1). The area is typical of preferred thar habitat on the eastern side of the Alps and consists of steep dissected country, vegetated below about 1550 m a.s.l. Tall snow tussock and mixed short podocarp scrub dominate the upper vegetated slopes, grading into matagouri *(Discaria toumatou)* scrub and short-sward tussock grasslands on the lower slopes. Rock outcrops, loose screes, talus slopes, and avalanche chutes dissect the area (Fig. 2).

Breeding populations of thar first occupied the Godley River catchment about 1948 (Caughley, 1970a) and by the early 1970s densities of thar were high (Tustin, 1980). Commercial exploitation and Government control dramatically reduced the population during the 1970s, and the study area has been occupied by about 30 thar since 1976. These animals form a loosely cohesive group, with transitory sub-groupings based on female-offspring associations. About five adult males were present at anyone time during the rut and winter (late April-August), but were absent during the rest of the year.

Other mammalian herbivores premanently present in the study area were brush-tailed possums *(Trichosurus vulpecula),* hares *(Lepus europaeus),* and rabbits
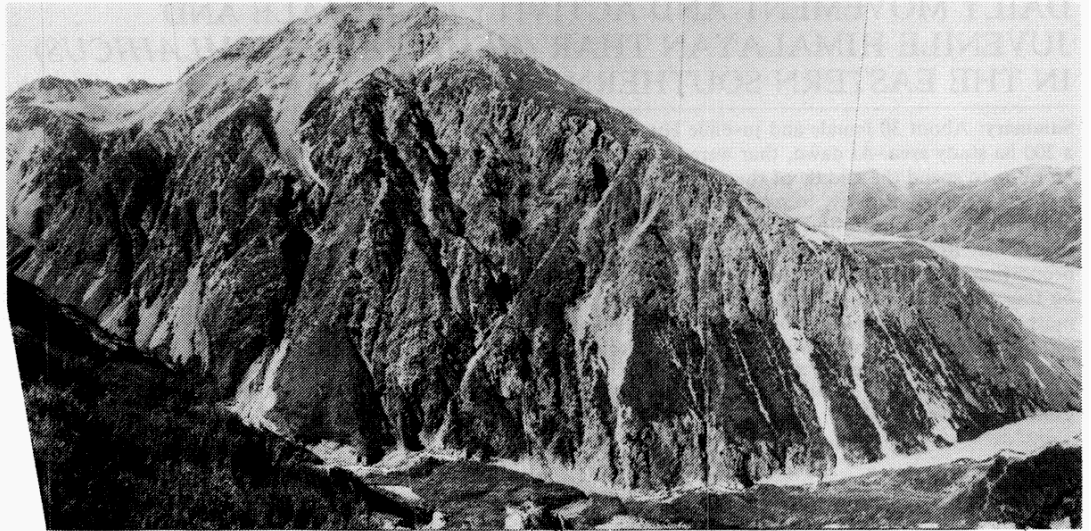
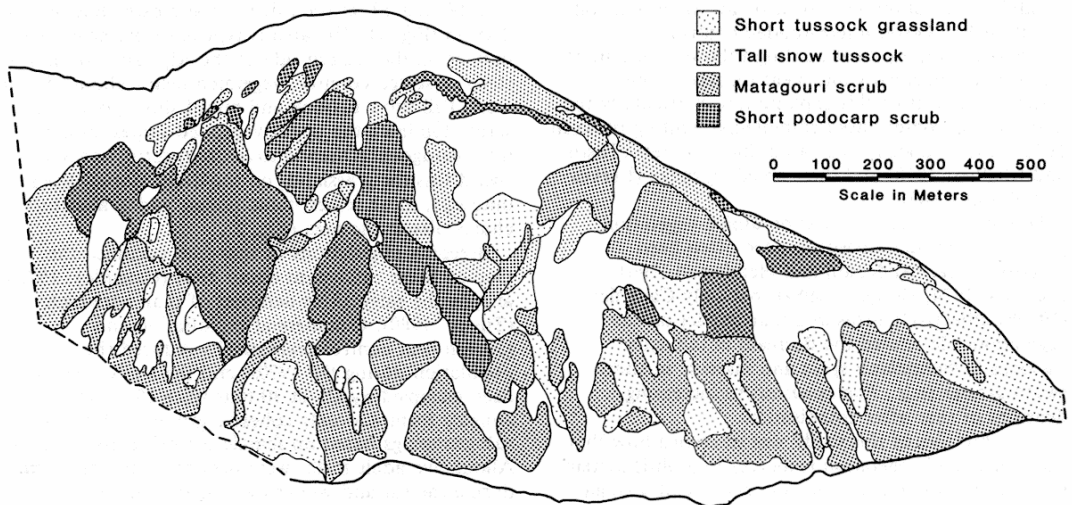Figure 1.: *Oblique panorama of the North Branch study area from the observation site in summer 1986.*

Figure 2: *Extent and location of the four major vegetation associations in the North Branch study area.*

(Oryctolagus cuniculus). Domestic sheep *(Ovis aries)* were occasionally present on the lower slopes during summer. Red deer *(Cervus elaphus scoticus)* and chamois *(Rupicapra rupicapra),* live in the vicinity, but were not seen within the study area.

Methods

Thar were watched on an average of nine consecutive days during most months between June 1976 and June 1978 from a hut at 1200 m a.s.l. on the opposite slopes, using two spotting telescopes mounted as a pair. Viewing distances ranged from 600 m to 2500 m, but most of the area was within 1900 m of the hut. Observations began at dawn and finished at dusk. Night observations were attemped on several moonlit nights, using a light-intensifier coupled to a telephoto lens. These were not successful as, although some thar could be seen, their behaviour could not be defined.

Altitude (to the nearest 50 m) was recorded for all thar seen within an hour of dawn; at noon; and within an hour of dusk.   .

Daytime activity was quantified by selecting a subgroup of thar, usually of 8-10 animals, at dawn and monitoring their movements and activity until dusk. If the entire subgroup disappeared, a new one was selected. If it divided, the larger fraction was followed; it if joined with another subgroup, all animals were monitored. At 5-minute intervals throughout the day the activity of each animal within the subgroup was recorded, as feeding, resting, standing, moving, or grooming.

Analysis was based on these data pooled into half-hour periods, either starting at dawn or extending back from dusk. The variation of each activity within the half-hour from day to day within and between months formed the basic information. The half-hourly frequencies of each activity were transformed with an arcsin (square root) function. Analysis of variance for data that violated distributional assumptions was used (Harris, 1976) and differences were tested with the Least Significant Difference (LSD) test. Results are presented as back-transformed means, with 95% confidence limits and letters representing the results of the LSD tests.

We also pooled the half-hourly observations into equivalent, but not necessarily equal, parts of the day to allow a general analysis of diurnal activity, Le., rather than a month by month analysis.
These periods were:
  dawn - the first 1.5 hours after daylight,
  morning - from the end of dawn until 1.5 hours
         before midday,
  noon - 1.5 hours either side of midday,
  afternoon - 1.5 hours after midday until the start of
  dusk, and
  dusk - the last 1.5 hours of daylight.
We also pooled the data by month across all years for the whole study period.

Four major vegetation associations were recognised in the study area (Appendix 1). The planar area of each association was calculated from oblique photographs taken from the observation site (Figs. 1, 2). The vegetation association in which all thar were seen (including animals not in the intensively monitored group) was noted at half-hourly intervals, for about 5 days each month.

Records from mature males (over 3 years old) and from unweaned juveniles (those seen before April) were excluded from all analyses, the former because they were not present all year, and the latter because they were often hidden.

Results

Validity of pooling observations of activity

Pooling groups of 5-minute recordings into unequal periods of daytime was justified. The patterns of half-hourly frequencies of each activity (especially feeding and resting) were so similar across months that a generalisation that accounted for different daylengths lost no information.

Pooling by months across years was less valid. Year had a significant effect ($p < 0.05$) in 17 out of the 60 month/activity interactions. For the two main activities, we were not justified in pooling feeding in January-April or resting in January-February. However, as the monthly patterns of these activities were consistent across years and differences were not consistently greater in one year, we accepted the pooled data despite the differences.

Daily and monthly movements

Thar moved in regular and distinct vertical patterns each day throughout the bluff system (Fig. 3). Typically, thar were at low altitudes when first seen at dawn. By noon they had climbed high amongst the bluffs, often well above the limit of vegetation. During mid to late afternoon they descended, usually directly and rapidly, to reach the lower altitudes again before dusk. Often, and especially during October-December, they ascended a little way before dark. They remained at low altitudes overnight and when located at dawn were usually close to where they were last seen the night before. However, the altitude of dawn sightings was, on average, higher than those at

dusk, suggesting that animals either move during the night, or start moving just before dawn. All subgroups showed remarkably similar patterns of movements, and daily timing of the various elements of these patterns was often synchronous between the subgroups.

The amplitude of these daily vertical movements varied with time of year (Fig. 3). In summer (December-February), thar moved vertically an average of 400-450 m, but only 150-200 m in winter (June-July). They were seen at high altitudes in late autumn and winter (May-August) when they spent the noon period at or above the vegetation limit (1550 m a.s.l), and descended only to 1400 m a.s.l. at dusk. During spring and early summer (September-December), thar were at much lower altitudes, spending the noon period between 1300-1400 m a.s.l. and descending to below 1100 m a.s.l. at dusk.
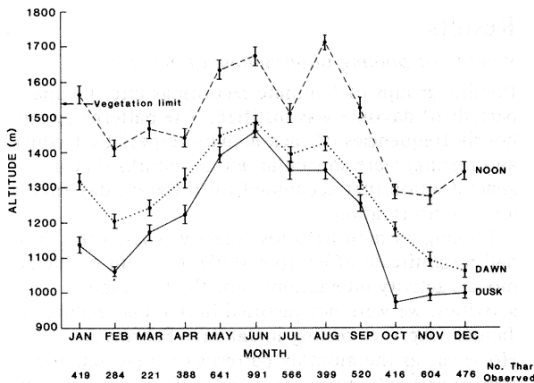

Figure 3: *Mean monthly altitudes in m a.s.l. (95% confidence intervals) of sightings of all thar recorded at dawn, midday, and dusk, North Branch study area.*

Patterns of daily activity

Feeding and resting were the most frequent daytime activities. Thar rested in the middle of the day and fed during their morning ascent and afternoon descent, with feeding peaks at the dawn and dusk periods. Feeding was significantly more frequent during dusk than dawn, and also more frequent during the afternoon descent than during the morning ascent. It was least frequent during the noon period. Resting was an uncommon activity during the dawn and dusk periods, but was the most common activity around

noon (Fig. 4). These two main daytime activities showed these same patterns for all months (Fig. 5).

Moving, standing, and grooming were less common daytime activities, accounting for less than 10% of observations. Taken over the whole year, moving or standing occurred significantly more often at dawn and less often at noon than at other periods. Grooming was more frequently seen during the morning and afternoon than during other periods (Fig. 4). However, unlike feeding and resting, these minor activities showed only a few patterns that were consistent for all months - thar spent more time moving during dawn and less during noon than in other periods in most months.

Night-time activities could not be measured. The animals did not move far at night so active foraging seems unlikely to have occurred. However, the fact that thar were usually feeding as the light failed and when first seen in the morning suggests that some feeding continued into the night.

Monthly changes in daytime activity

The frequency of each activity (except moving) varied significantly during the year (p < 0.001). Thar spent more time feeding during November-February and less time feeding during August-September than during other months. Frequency of resting showed the reverse pattern. The time animals spent standing increased threefold during June-July. Grooming was a fairly consistent minor activity throughout the year (Fig. 6).

Daytime feeding activity by vegetation association

The impact of thar on the four main vegetation associations over a whole year can be inferred from the time they spend feeding in each association, assuming that little or no feeding occurs at night. Thar fed more intensely when they were in the short 'tussock grasslands and matagouri scrub than when in the short podocarp scrub or tall snow tussock. However, they spent less time during the daytime in the former associations than in the latter. Therefore, by accounting for the relative areas of the four vegetation associations and ignoring any differences in susceptibility of plants to browse, we ranked the associations with an index of feeding intensity (Table 1). This suggests that short tussock grassland may suffer least and tall snow tussock most from the effects of thar browsing.

The main impact of thar browsing on the Four associations occurred at different times of the year (Table 2). Thar fed in tall snow tussock and podocarp scrub all year, but rarely fed in the matagouri scrub between May and September or in the short tussock in
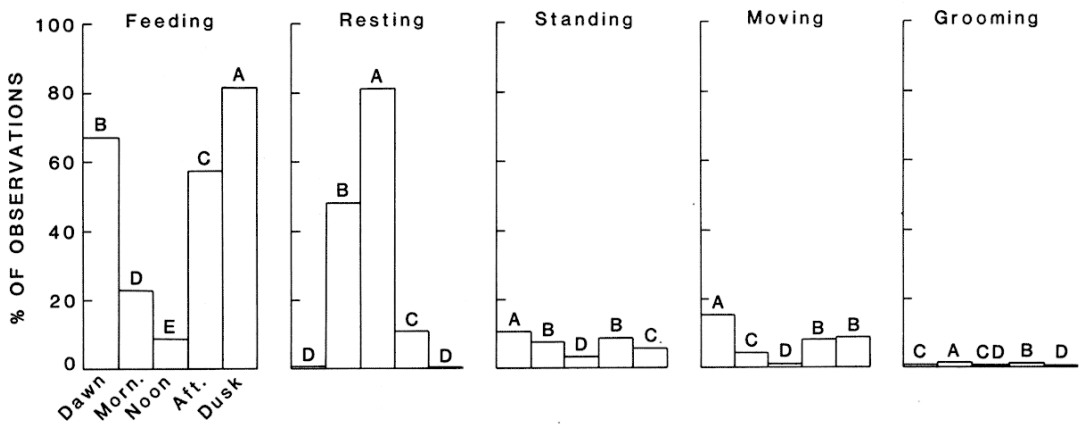
Figure 4: *Frequency of five activities during five daytime periods. Bars with the same letters within each activity denote no significant difference (P 0.05) between periods.*
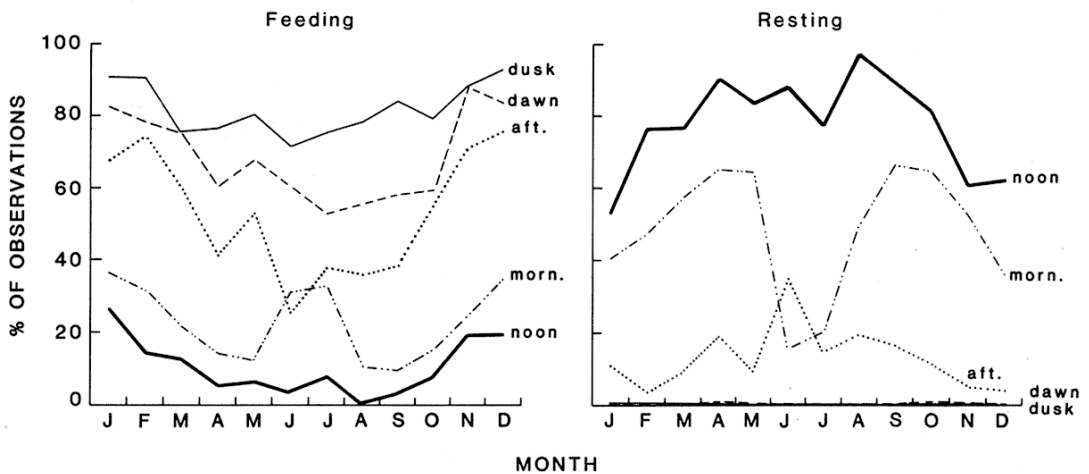

Figure 5: *Intensity of feeding and resting by months during five daytime periods (dawn, morning, noon, afternoon, dusk).*

January and between May and September. In these latter associations thar increased their feeding abruptly in October. presumably in response to the spring growth of plants.

Discussion

We encountered three main problems in our study of thar activity. Firstly variability in thar activity was difficult to analyse adequately. We took account of
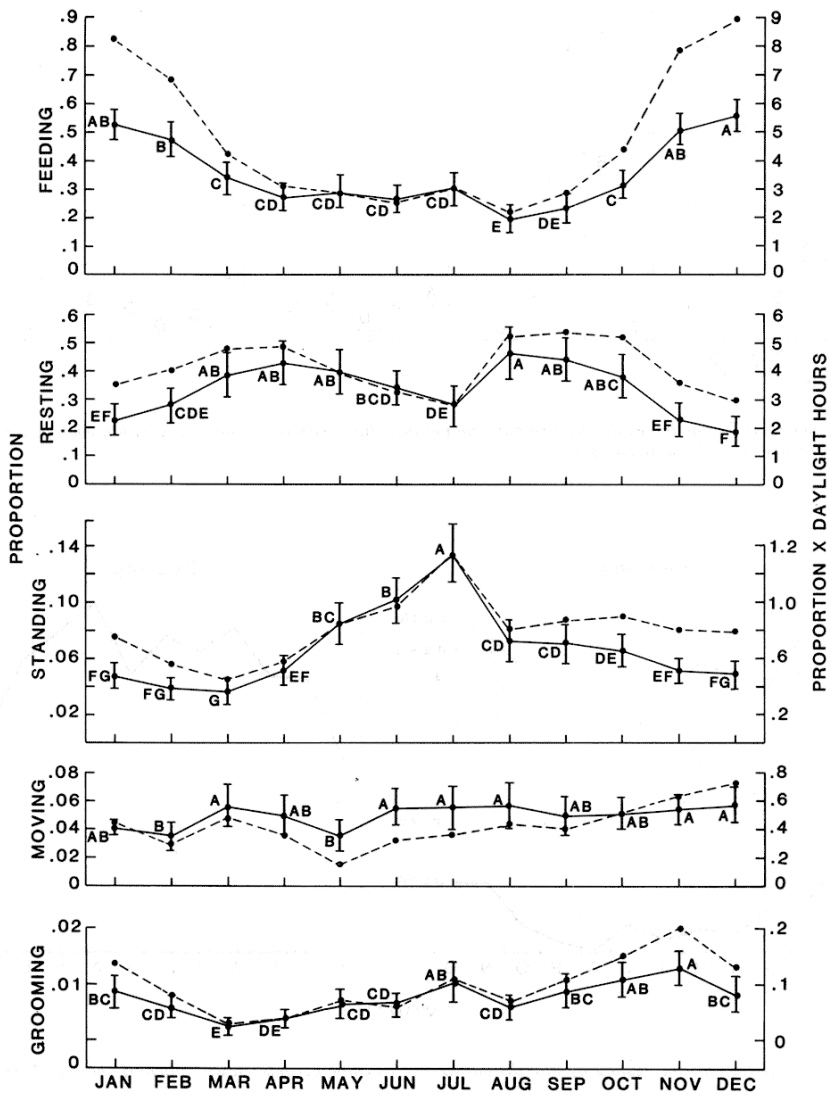
Figure 6: *Proportions of monthly observations in which thar were engaged in five activities (●—●). Means with the same letter are not significantly different within each activity. Proportions weighted by daylength (●···●).*

Table 1: *The number of times thar where seen in four vegetation associations during daylight, the frequency (%) of feeding activity, and an index of feeding intensity, North Branch, June 1976-June 1978.*

Vegetation Association	Area (ha) (a)	No. observations (n)	% of n feeding (f)	feeding intensity fn/100a
Matagouri scrub	20	4883	67.3	164.3
Short tussock	14	2529	75.5	136.4
Podocarp scrub	34	14612	42.2	181.4
Tall tussock	26	14252	45.3	248.3

daily variability within equivalent diurnal periods, but ignored the known between-year variability identified in some months. We had some justification for doing this as the patterns of activity across months were similar in all years.

Secondly, the more vigorous activities were inherently more observable. For example, thar which were feeding or moving at dawn were more easily located than those resting or standing. However, once thar in the chosen subgroup were located, this bias decreased as the previous set of observations could be used to help find the animals. Location of all sub-groups was also easier after the first day of each monthly observation period when their likely location at dawn could be predicted.

Thirdly, and most importantly, it was not possible to determine where unseen thar were or what they were doing. In particular, we could not tell whether they were ever active during the night. At dawn, animals were usually close to where they were last seen the previous dusk, suggesting that they had not moved far at night. However, because animals were usually feeding actively when they were last seen, and again at dawn, it is likely that this activity extended into, and resumed during, darkness. This, as we discuss later, has implications for our conclusions on vegetation use.

Thar spent most of their day either feeding or resting, with most feeding concentrated around dawn and dusk. In this they are similar to their Himalayan ancestors (Schaller, 1973). Schaller did not detect any consistent daily pattern in the movements of the eastern Nepalese herd on the 20 days he watched them. In this respect, the North Branch animals are unlike their ancestors in that they moved up and down the mountain each day, varying only in the extent of movement according to the season. This pattern of movement and activity took place in all weather conditions in which thar could be observed. It also occurred in conditions when the thar could not be observed as the animals were behaving as expected at expected altitudes on days when weather conditions delayed observation. The only changes in behaviour due to weather we could detect were that thar took more sheltered routes during high winds and avoided avalanche chutes and deep snow after snow storms.

Thar tended to be at lower altitudes in spring, presumably to take advantage of the first flush of plant growth. They avoided these areas in winter and stayed on the steeper, snow-free bluffs at higher altitudes.

Although thar showed similar patterns of activity in

Table 2: *Monthly distribution of feeding frequency in four vegetation associations of thar, North Branch, 1976-1978.*

Month	Total Monthly Feeding Observations (A)	Proportion (%) of A spent in:			
		Tall Tussock	Podocarp Scrub	Matagouri Scrub	Short Tussock
Jan	1857	35.9	43.4	.17.4	3.2
Feb	1242	37.0	34.2	20.1	8.7
Mar	792	45.5	35.1	12.6	6.8
Apr	1029	39.0	36.2	9.4	15.4
May	1042	61.3	38.0	0.3	0.3
Jun	1948	58.7	41.2	0.0	0.0
Jul	1101	41.5	49.4	5.4	3.7
Aug	540	62.2	37.0	0.7	0.1
Sep	1174	29.8	62.4	4.3	3.5
Oct	1749	21.9	20.0	36.8	21.2
Nov	2889	22.7	17.4	37.3	22.5
Dec	2459	24.4	31.0	27.3	17.2

all months, particularly for feeding and resting, the frequency of some activities changed with the months. Most obviously, thar feed less and stand more in winter than during the rest of the year; foraging for low quality winter food is energetically costly.

Thar use of the four vegetation associations for daytime feeding shows that feeding intensity was greatest on the tall snow tussock. This association is floristically simplest, has the fewest introduced species, and because of its location at higher altitudes, is likely to be the slowest to recover from browse. Therefore, it is probably the most susceptible to damage by thar. Caughley's (1970b) observations that tall snow tussock changes to a short tussock sward under increasing thar densities support this inference.

The effect of thar on vegetation types is also dependent on the animals' seasonal movements. Thar do not go below 1200 m a.s.l. between May-September (Fig. 3), so they do not use the lower altitude vegetation associations (Fig. 2) for 5 months of the year. In contrast, thar range over the two higher altitude associations throughout the year, spending dusk and dawn (the two concentrated feeding periods) within these associations during May-September when the plants are not growing.

If feeding activity at night is more intensive than we assume, and if it also shows the same seasonal differences in extent as daytime feeding, night-time location of thar in the short tussock grassland and matagouri scrub during October-April (inferred from their observed dusk and dawn altitudes) could promote these two associations in the rankings shown in Table 1.

The thar density of about 1.5 animals/km² in North Branch during the study was maintained at about the same level at least until 1984 (Parkes, 1984, unpubl. report to the Minister of Forests), but has recently increased to 2.6/km² (L. Perriam, pers. comm.). This is a high density by present day standards, but much less than the peak densities found in similar eastern catchments before commercial exploitation, for example 32.9 thar/km² in Carneys Creek in 1965 (Tustin and Challies, 1978).

Acknowledgements

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Appendix I. Description of four major vegetation associations found in the study area.

1. Short Tussock Grassland
Occupies moderate to steep slopes (35-40°) near the mouth of North Branch and extends upstream into the matagouri association. Dominated by *Festuca novae-zelandiae, Agrostis tenuis,* and *Anthoxanthum odoratum,* which form a tight sward with other herbs. Scattered throughout it are *Aciphylla aurea, Chionochloa rigida* and bushes or patches of matagouri. *Chionochloa rigida* is more common in the

upstream extensions, especially as seedlings, but adult plants are often reduced or dead basal stumps. The short tussock grassland is considered to be induced by fire, and grazing by sheep, thar and other herbivores. Of the 60 species recorded, 47 were indigenous, but the dominant ground cover was formed by the 13 adventive species.

2. Matagouri Scrub
Forms dense to open thickets or strips along the edges of coalesced debris cones below steep bluffs. Dominated by matagouri *(Discaria toumatou)* up to 2.5 m tall, with scattered patches of shorter *Coprosma propinqua* and *Aristotelia /ruticosa*. The liane, *Rubus schmidelioides,* is frequently entwined among the scrub, with occasional *Clematis marata*. *Hypericum perloratum* dominates the ground cover beneath the matagouri canopy, with the grasses *Dactylis glomerata, Holcus lanatus,* and *Agrostis tenuis* more common where the canopy is more open. Of the 35 species recorded in this community, 22 were indigenous and 12 were adventive.

3. Short Podocarp Scrub
This largest association occupies the steeper slopes, ledges, and bluffs of exposed bedrock. Dominated by short, dense, spreading patches of snow totara *(Podocarpus nivalis)* with taller thickets (up to 1 m) of *Phyllocladus aspleniifolius* var. *alpinus, Corokia cotoneaster, Dracophyllum uniflorum,* matagouri, and *Pittosporum anomolum*. These scrub patches are interspersed with accumulating talus debris and exposed bedrock. On bedrock outcr.ops such species as *Colobanthus acicularis, Hebe cheesemanii*i, *Senecio bellidioides,* and *Gingidium decipiens* were recorded. Of the 58 species recorded, 49 were indigenous and 9 adventive, of which *Hypericum perforatum* was the most common.

4. Tall Snow Tussock

As a distinct community the tall snow tussock is now confined to higher altitudes. *Chionochloa rigida* is the sole dominant species. It forms a sward up to 1 m tall, but with only locally dense patches. About 25% of the area was exposed ground and litter. The rare grass, *Deyeuxia youngii* was recorded among 25 indigenous and two adventive species.