THE SENSITIVITY OF CHAMOIS AND RED DEER TO TEMPERATURE FLUCTUATIONS

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INTRODUCTION

Research was begun in 1960 on various aspects of the ecology of red deer (*Cervus elaphus*) and chamois (*Rupicapra rupicapra*) at Cupola Basin, Nelson Lakes National Park. Cupola Basin, previously described by Christie (1964), joins the Travers River 12 miles from the head of Lake Rotoiti which in turn is 60 miles from Nelson.

Red deer in the area are descended from stock imported from Thorndon Hall, England, and liberated in Nelson Province in 1861. Subsequently, there were a number of other liberations around the province and the deer became firmly established. They colonised Cupola Basin about 1915 (C. M. H. Clarke, pers. comm.) and have been there ever since, with peak numbers during the late 1920's and early 1930's. Chamois were liberated in the Mt Cook area in 1907 and dispersed rapidly. Chamois probably colonised Cupola Basin about 1937–38 as they were first seen on Mt Robert, Lake Rotoiti, in 1940 (M. R. Clarke, pers. comm.).

The investigations begun in 1960 were developed in 1962 into a detailed study of behaviour and utilisation of habitat by deer and chamois. A series of 20 observation periods (or "counts") were undertaken each month from two points simultaneously. Each count lasted 1½ hours and all the area observable from the two points was scanned systematically. Four counts were done each day — at dawn, mid-morning, mid-afternoon and dusk. Times of counting during the year are adjusted so that each count starts at the same time relative to the sunrise and sunset. For each count weather details recorded include direction the weather was coming from, wind force, temperature, precipitation, cloud cover, and "pleasantness" (a subjective summary divided into nine categories). For each animal was recorded its location, species, age, sex, activity and feeding intensity (Table 1), habitat, food being taken, and the type of plant community being occupied. Four hundred and forty-three counts from the hut and 545 counts from the hide have resulted in approximately 12,000 animal records.

TABLE 1. *Scales of activity and feeding intensity.*

ACTIVITY:		FEEDING INTENSITY:	
Lying, head down	= 0	0	= 0
Lying, head erect	= 1	to ¼ time	= 1
Standing	= 2	¼ to ½	= 2
Walking, feeding	= 3	½ to ¾	= 3
Walking	= 4	¾ to full time	= 4
Running, trot	= 5		
Running, gallop	= 6		

As the work progressed, it was frequently observed that in summer chamois responded dramatically to both relatively hot and cold weather. In hot weather they were often observed lying on remnant snow patches or in shaded situations, whereas in cool weather they moved rapidly into the shelter of boulders or into the bush. These observations suggested a very narrow tolerance range when chamois are in the summer coat. With the change to winter pelage in April, however, chamois show few signs of stress and their diurnal rhythm of activity is noticeably affected by only extremely unpleasant (blizzard) conditions. This pattern of tolerance to temperature variations and especially to the difference between seasons is hypothesised as reflecting adaptations of chamois to the less erratic, native European summer climate (in which the mean temperature is similar to that in New Zealand) and to the milder New Zealand winter. If substantiated, this offers an insight into the rapid northerly dispersal of chamois from the liberation point.

Red deer at Cupola Basin, unlike chamois, appeared to tolerate greater fluctuations of temperature in summer but a narrower range in winter.

Therefore, to develop this idea, the levels of physical activity and feeding intensity observed were compared with variations in weather.

TEMPERATURE DATA

Figure 1 shows temperature data from three stations representing the timber line climate of the native habitat of chamois at Obergurgl, Austria (Hampel 1961), low altitude deer habitat at Brae House, Wester Ross, Scotland (Darling 1937), and at Cupola Basin.

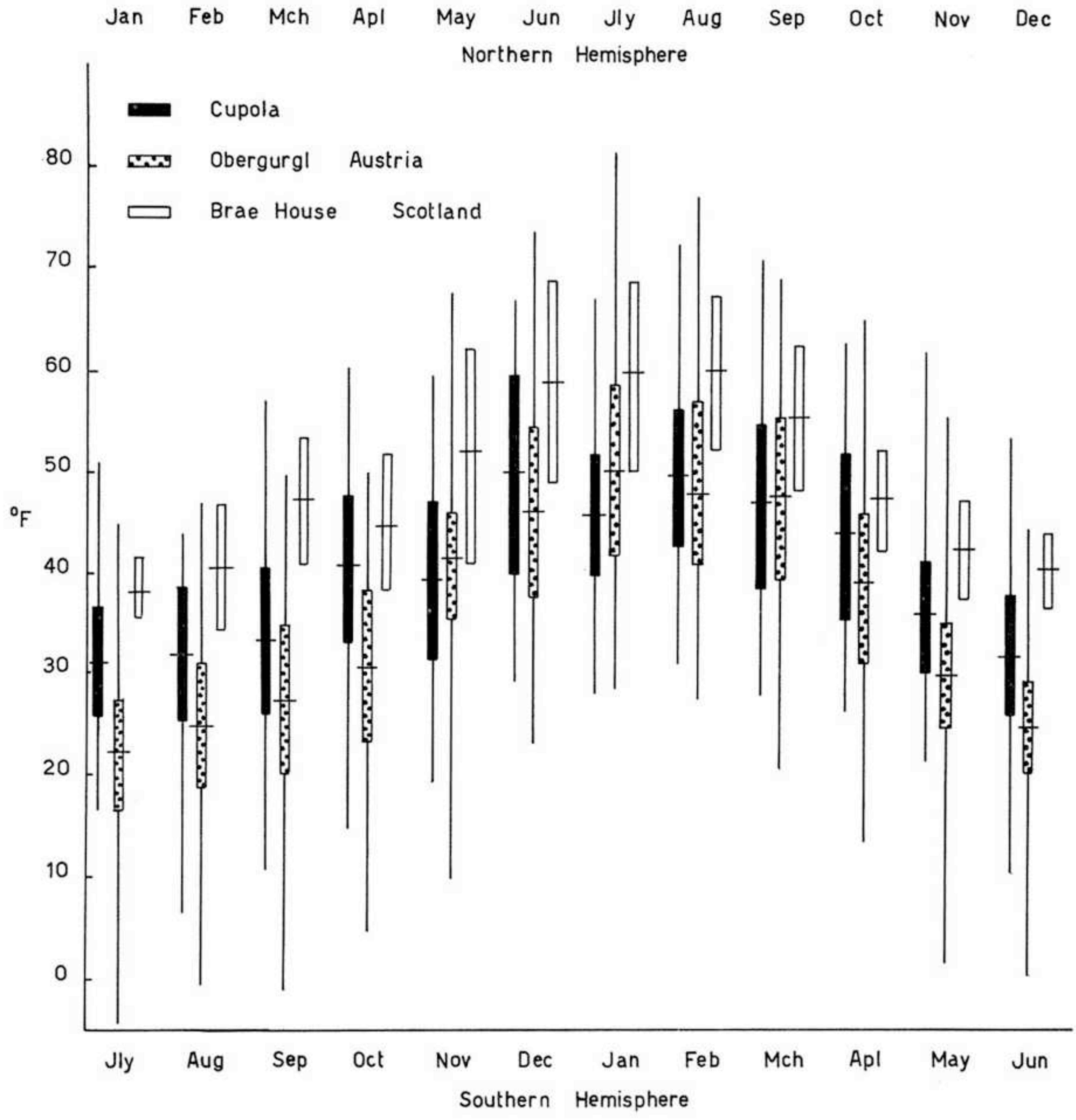

FIGURE 1. *Temperature data from three weather stations located in New Zealand, Austria and Scotland. The solid portion of each entry designates monthly mean temperature range: the upper limit the mean maximum and the lower limit the mean minimum, with the mean temperature indicated by the horizontal line. The single line extension indicates the extreme maximum and minimum. (Extremes were not given in the data from Brae House.)*

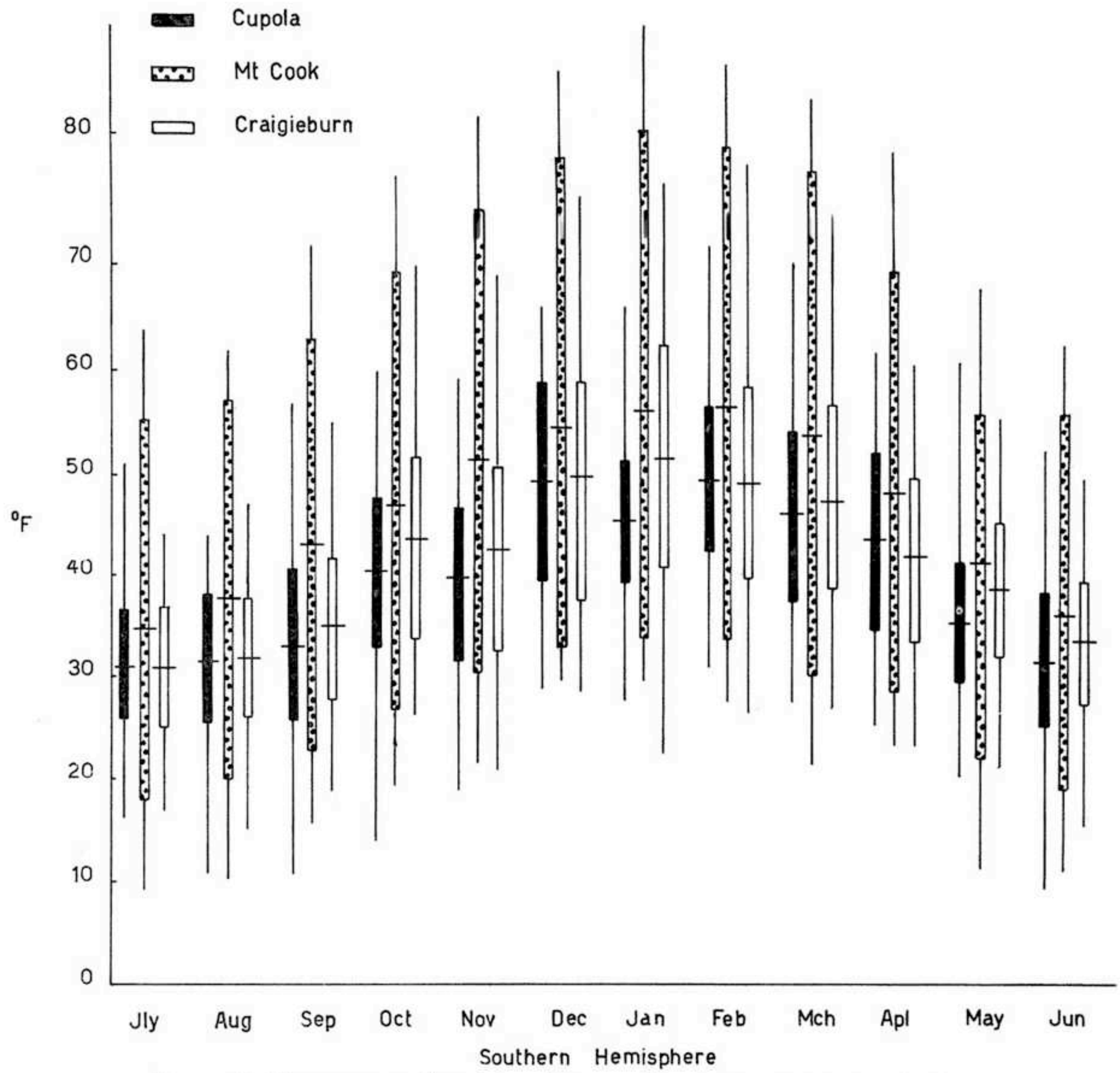

FIGURE 2. *Temperature data from three weather stations in New Zealand.*

Temperatures recorded at Brae House are, on the average, highest, with the widest range in summer. Those for Obergurgl are lower in winter than at Cupola Basin, and similar in summer. Extreme ranges of temperatures at Obergurgl are slightly higher in most months than at Cupola Basin.

Figure 2 shows temperature data from three other stations in New Zealand: The Hermitage, Mt Cook (N.Z. Met. S. Misc. Pub. 122), Craigieburn, North Canterbury (Morris, 1965), and Cupola Basin. The diurnal and seasonal temperature ranges recorded at Mt Cook are the widest and the means a little higher than at the other two stations. Characteristics of temperature at the Craigieburn timber line stations are intermediate between those recorded at The Hermitage and Cupola Basin. They indicate a greater difference than at Cupola Basin between summer and winter mean temperatures and a larger range between daily maxima and minima than are recorded at Cupola Basin. All stations display wider monthly ranges in summer than in winter.

TABLE 2. *Weather statistics for the four periods in which counts were made.*

	CLOUD COVER (NO. OF DAYS)				PRECIPITATION (NO. OF DAYS)			TEMPERATURE				
	0/8	1–4/8	5–7/8	8/8	0	rain	snow	mean max.	mean min.	ext. max.	ext. min.	max/min. 2
January 1964	—	1	—	19	3	14	3	44.9	33.5	52.5	28.0	39.2
February 1964	6	6	3	5	19	1	0	58.4	42.0	72.0	35.5	50.2
August 1963	5	—	1	14	7	8	5	37.8	25.0	43.0	7.0	31.4
August 1965	9	4	2	5	16	1	3	41.0	26.6	44.0	23.0	33.8

DATA ON BEHAVIOUR

Data drawn from observations in contrasting weather in the series of summer and winter counts were examined to determine whether we had evidence of the postulated differences in behaviour. The data were for January 1964, February 1964, August 1963 and August 1965.

In January 1964 the weather was unseasonally bad. As can be seen from Table 2, nineteen of the 20 counts had a cloud cover of 8/8ths, snow fell during three of the counts and precipitation of some sort (including snow) fell during 17. Temperatures were low for mid-summer with an average of 39.2°F. Weather was very different during the following month; it was clear and fine with temperatures higher than those in January.

The weather differences between the two series of winter counts were not quite so marked. Precipitation of some sort fell during 13 counts in August 1963 as against only four in August 1965. Average temperature in August 1963 was below freezing point and reached an extreme minimum of 7°F. The average temperature in August 1965 was 33.8°F., and although this is not much higher than in 1963, it was, as indicated above, associated with more pleasant weather. The extreme minimum in August 1965 was considerably higher than in August 1963.

Activity and feeding intensity is described in this paper as the average for all animals observed, each being watched for about two minutes during each count. "Activity" is a record of the level of physical movement in six units ranging from sleep to a full gallop, and "feeding intensity", recorded in five units, is a description of the proportion of the two-minute spell the animal spent foraging, biting food, or masticating. It does not include ruminating, e.g., the level of chamois activity recorded in dawn counts in January 1964 (Table 4) was obtained by summing and averaging the records for all 46 observations (Table 3). The statistics given are in this way based on 1,839 observations, distributed as follows:

TABLE 3. *Frequency distribution of observation periods.*

CHAMOIS	Jan. 1964	Feb. 1964	August 1963	August 1965
Dawn	46	102	22	27
Mid-morning	95	87	29	80
Mid-afternoon	49	114	21	60
Dusk	86	80	17	58
DEER				
Dawn	25	92	47	24
Mid-morning	71	51	69	49
Mid-afternoon	47	55	82	24
Dusk	42	80	79	29

DISCUSSION

For deer during summer the only effect of weather that could be discerned from the activity and feeding intensity data was that deer moved more and spent more time feeding in mid-afternoon during wet cold weather (Fig. 3) ($X^2 = 14.62$, $P < 0.05$ for activity. $X^2 = 9.88$, $P < 0.05$ for feeding). On the other hand, the behaviour of chamois differed markedly at all times of the day except mid-morning. Compared with fine weather, activity is increased and feeding intensity is reduced during poor weather (Fig. 4).

In winter, activity of deer again differed only during one period, mid-afternoon, when they were more active during poor weather ($X^2 = 19.03$, $P < 0.01$). The only significant difference of feeding intensity between good and bad weather is in the mid-morning count period when deer feed more intensively during bad weather ($X^2 = 13.33$, $P < 0.01$).

Activity and feeding by chamois in good and bad winter weather does not differ as much as in summer, the record indicating differences in only four of the eight comparisons in contrast to seven out of eight in summer (Table 4).

TABLE 4. *Mean levels of activity and feeding intensity determined in routine counts.*

	SUMMER						WINTER					
	Mean Activity			Mean Feeding			Mean Activity			Mean Feeding		
	Jan 1964	Feb 1964	X^2	Jan 1964	Feb 1964	X^2	Aug 1963	Aug 1965	X^2	Aug 1963	Aug 1965	X^2
Chamois												
Dawn	2.29	2.46	12.04*	2.21	2.90	11.46**	1.68	1.35	2.95 ns	0.95	1.23	8.16*
Mid-morning	2.45	2.29	34.74****	2.29	2.03	7.48 ns	1.96	2.37	15.73**	1.52	2.41	12.81**
Mid-afternoon	2.34	2.22	17.94***	1.70	2.76	21.38****	1.94	1.88	5.36 ns	1.05	1.10	6.16 ns
Dusk	2.72	2.42	17.06***	2.58	3.47	19.57****	2.00	2.14	2.66 ns	2.44	1.88	11.29**
Seasonal mean	2.45	2.34		2.19	2.79		1.89	1.93		1.49	1.65	
Deer												
Dawn	2.61	2.57	6.27 ns	2.78	3.39	6.34 ns	1.46	1.67	5.98 ns	1.30	0.58	9.28*
Mid-morning	2.36	2.61	3.88 ns	2.58	3.10	8.85 ns	2.11	2.04	6.15 ns	2.14	1.75	13.33***
Mid-afternoon	2.40	1.88	14.62**	2.96	1.85	9.87**	1.95	2.08	19.00***	2.36	2.33	3.86 ns
Dusk	2.50	2.40	10.88*	3.19	3.50	5.15 ns	2.42	2.45	3.67 ns	3.01	2.86	3.19 ns
Seasonal mean	2.46	2.36		2.87	2.96		1.98	2.06		2.20	1.88	

Values of X^2 ns = not significant
* = 10% or less
** = 5% or less
*** = 1% or less
**** = 0.1% or less

Degress of freedom: All comparisons of activity based on 6 classes (Table 1) in 2 periods, giving 5 d.f. Feeding intensity based on 5 classes in 2 periods, giving 4 d.f.

Interesting comparisons between the total monthly amounts of activity and feeding intensity in summer and winter are summarised in Figures 3 and 4. The averages of activity and feeding intensity for both species are most noticeably reduced in winter compared with summer. The animals are not only moving less but they are feeding far less. This feature is unambiguous for chamois because these animals are almost entirely diurnal and therefore all their activity is observed. Such behaviour seems, at first sight, a curious way of maintaining body condition in winter. One would expect them to feed more extensively. I suggest that it may reflect a physiological adaptation to the reduced amount of food available in winter, a very efficient insulating coat and, perhaps most important, a winter climate which is much less severe than the native European alpine climate.

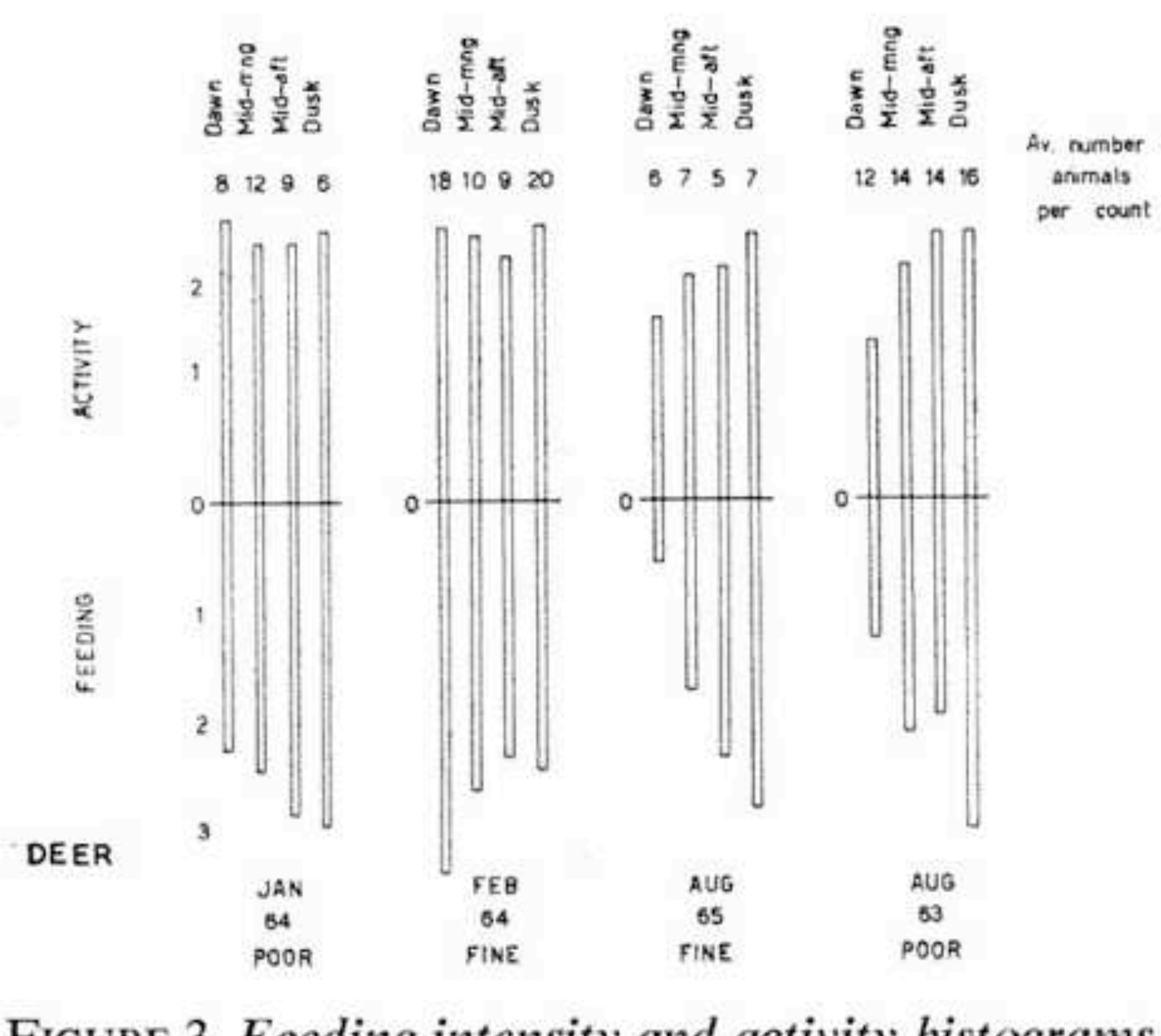

FIGURE 3. *Feeding intensity and activity histograms for deer in different seasons.*

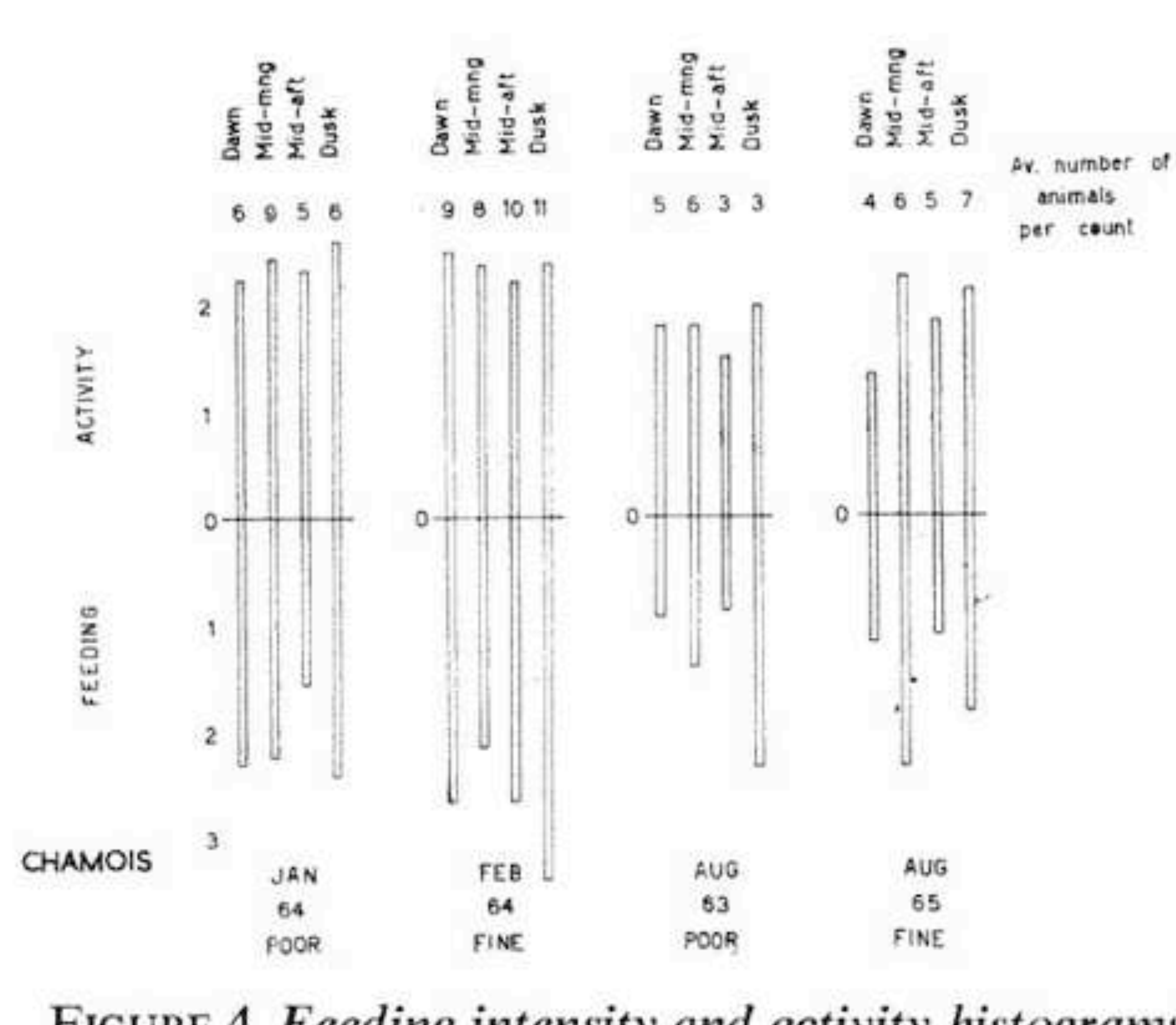

FIGURE 4. *Feeding intensity and activity histograms for chamois in different seasons.*

Chamois are clearly very sensitive to summer weather outside the European range (cf. Figs. 1 and 2), yet when weather is settled and "average" they appear at ease. In winter, on the other hand, which in New Zealand is much milder than in Europe (Fig. 2), they display activity which is little modified except in the very worst storms. There is a connection between these observations: the mean amplitude of temperature change from summer to winter is, in New Zealand, much less than in Europe, though the summer temperatures are about the same. Thus the need for insulation by summer pelage in New Zealand is, in general, about the same as in Europe, but in winter it is less. This suggests that, in New Zealand, any change would have to tend towards retention of the characters of the European summer pelage, at the same time reducing density of the winter coat. This has apparently not occurred but a behaviour change has apparently occurred instead.

It has been noted that red deer appear relatively indifferent to poor weather during summer at Cupola Basin (Table 4), and that in winter they show greater activity and greater feeding intensity during mid-morning and mid-afternoon of cold days than in fine weather. The relative indifference of deer to bad weather during the New Zealand summer is understandable when one considers summer temperatures in Scotland (Fig. 1) — it is generally cooler at Cupola Basin, and some level of indifference may therefore be expected. During this period they are largely diurnal. Winter data cannot, however, be interpreted with similar confidence. C. L. Batcheler (pers. comm.) points out that deer are active and feed about as intensively at night as during the day, especially when the moon is bright and temperatures are very cold. During clear frosty winter nights they feed more extensively and rest after sunrise. Thus their total feeding activity is not reflected by the routine daily observations, and accordingly the winter data are not adequate to test the hypothesis.

The extent to which chamois are tolerant to low temperatures in winter is shown by data which are being assembled for a later paper on their distribution. It is noticeable that immediately following the change to winter pelage chamois move 1,000–1,500 ft. higher in Cupola Basin to where there are lower temperatures and they remain in the highest-occurring vegetation until the heavier winter snows force them down. Providing some vegetation remains exposed they stay as high as possible.

This hypothesis goes some way towards explaining the dispersal of chamois and their present distribution (for the latter see Christie and Andrews 1965). They have spread 100 miles further north along the main divide than south, notwithstanding apparently suitable habitat in that direction. This unequal dispersal is possibly the result of the less frequent and less prolonged periods of bad summer weather in the more northerly parts of the main divide.

The hypothesis also suggests that the greater temperature fluctuations experienced east of the Southern Alps (see data from the Hermitage in Fig. 2) may limit population density and extension of chamois in this direction; on the western side chamois numbers have been and, in places still are, very high and the populations extend almost to sea-level (M. O'Reilly, pers. comm.). Diurnal temperature fluctuations there are comparatively small and the gradient with altitude smaller; this suggests the optimum temperature range in summer extends over a greater altitude than for the eastern side of the range and that this, combined with the plentiful food resources, has resulted in high numbers of chamois.

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SUMMARY

In summer, chamois at Cupola Basin (an alpine catchment approximately 60 miles south-west of Nelson) show a marked reaction to both relatively hot and cold weather. When in winter pelage they display few signs of stress. Red deer are less affected by temperature fluctuations in summer but winter observations are inconclusive on this point. These behavioural characteristics are believed to reflect adaptations to a climate that is different in New Zealand from that of their native Europe. This hypothesis may explain the unequal dispersal of chamois since liberation and the differences in population density through their present range.

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