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Summer and Autumn Activity Patterns in the Vicuña

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We studied the activity patterns of vicuña *(Vicugna vicugna)* in Aprapampa INTA station, during February (summer) and April (autumn) 1988. The station is located in a dry grassland more than 3,500 meters above sea level in the Puna region of northwestern Argentina. We recorded the number of animals foraging, moving, resting, standing and drinking during daylight hours using an instantaneous scanning sampling method. Vicuñas spent most of their diurnal time in both seasons foraging, but they foraged more ($P < 0.004$) and rested less ($P < 0.001$) in autumn than in summer. In summer, vicuñas had 2 peaks of foraging activity one early in the morning and the other in the evening. These peaks were not evident in autumn. There was a daily midday peak in the use of water sources in both months that seemed to be related to the diel climatic fluctuations.

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Introduction

Different aspects of activity patterns have been documented for many wild ungulates including cervids (Moen, 1978; Eriksson et al., 1981; Renecker & Hudson, 1989), cattle (Jingfors, 1982; Beekman & Prins, 1989), sheep (Aldermann et al., 1989), and gazelles (Jarman & Jarman, 1973; Walther, 1973). Three main conclusions can be drawn from these studies. First, in comparison to other animal groups, wild ruminants spend most of their time foraging and ruminating. Second, most ungulates show well defined daily activity patterns characterized by their digestive physiology and by changes in light conditions (Eriksson et al., 1981). Finally, climate and social relationships also influence activity patterns (Cederlund, 1981).

Vicuña ecology and behaviour have been studied principally in Peruvian populations (Koford, 1957; Franklin, 1974, 1983) with most of the research conducted in the Pampa Galeras National Park. In that population, a pattern of daily movements from sleeping to feeding territories has been described (Franklin, 1974; Bosch & Svendsen, 1987), although some families remained in the same area (Menard, 1982). Grazing was the main activity of adults (Koford, 1957; Menard, 1982; Franklin, 1983; Bosch & Svendsen, 1987).

Maintenance of water balance and body temperature are 2 major physiological problems that animals in deserts must address (Alderman et al., 1989). Like most desert animals, vicuñas obtain water from oxidative metabolism and from food, but they differ in that they need a daily supply of free water (Koford, 1957). This "obligate drinker" characteristic substantially affects their ecology and behaviour, including their daily movements and social activities (Franklin, 1974, 1983; Menard, 1982; Bosch & Svendsen, 1987; Vilá & Roig, 1992).

The Puna region of Argentina is a high altitude semi-desert characterized by a mean annual precipitation of less than 300 mm concentrated in summer (December-March). The diel temperature variation is more than 20°C which is greater than seasonal fluctuation in mean temperature.

Both variability in weather conditions, mainly temperature and humidity, and availability of water are expected to affect daily and seasonal activity patterns of vicuñas. Thus, we studied activity patterns of vicuñas in relation to these factors and compared our results with those reported for other wild ungulates.

Methods

We conducted the field work during February and April, 1988 at Abrapampa Experimental Station of the National Institute of Agricultural Technology (INTA). The station is located in a high altitude dry grassland more than 3500 m above sea level in the Puna region of Jujuy Province, NW Argentina. The vegetation is dominated by tall perennial bunchgrasses *Festuca* sp. and *Distichlis humilis*, with perennial rhizomatous grasses and several forbs occurring between bunchgrasses (J. Bertoni, pers. commun.). The vicuña stock in the station comprised approximately 600 animals. They live in four 100-ha paddocks with natural pasture bordered by a wire fence, which prevent sheep and llamas from entering the field but were easily jumped by vicuñas.

Daily observations were distributed equally from 0800 to 1900 h from a 6.5-m-high observatory hut with the aid of 8x30 binoculars and a 20x40 telescope. Approximately 190 vicuñas could be viewed in one paddock that included a small natural pond (25 m diameter) where to vicuñas went daily to drink.

Activity was classified into 4 categories: (1) foraging, when the animal was standing or walking with its head close to the ground; (2) resting, or lying on the ground; (3) moving, when the animal walked or ran with its head up; and (4) standing, with its head up. The number of vicuñas engaged in each activity, and the presence or absence of vicuñas at less than 5 m from the border of the pond were recorded using an instantaneous scanning sampling method (Altmann, 1974). Scans were taken every 30 min. During each diel observation period, ambient temperature and humidity were recorded hourly. Tall vegetation imposed restrictions on visibility, which especially affected the observation of resting behaviour (for a discussion of the consequences of such limitations, see Turner, 1979).

Data are presented as (1) mean percentages of each activity and (2) percentage of scans with vicuñas at the pond. To meet assumptions of normality and homogeneity of variance, we used arcsine-square root transformations on all percentage data (Sokal & Rolph, 1981). Differences in activity budgets and climate between seasons were tested by 1-way ANOVA. The observed relations of time of day with mean percent activity were adjusted to quadratic regression models.

Results

We conducted 190 scans in summer and 139 in autumn. Daily activity budgets of vicuñas were similar, but daily patterns of foraging and resting varied significantly between seasons (Table 1). They spent most of their diurnal time foraging in both seasons, but they foraged significantly more ($P < 0.004$) and rested less ($P < 0.001$) in autumn than in summer.

Table 1. Percentage (and SE) of vicuñas observed in different diurnal activities in summer and autumn, 1988 at the Abrapampa INTA Station, Jujuy, Argentina, and results of the comparison with a 1-way ANOVA analysis.

Activity	Summer	Autumn	F-test
Forage	70.6 (12.0)	74.8 (9.0)	8.62**
Rest	4.8 (5.5)	3.0 (3.4)	12.27**
Move	11.2 (9.3)	10.5 (6.8)	NS
Stand	13.8 (8.6)	12.3 (5.6)	NS

Vicuñas showed differences between seasons in diurnal activity patterns (Fig. 1). During summer, vicuñas foraged mainly early in the morning and late in the afternoon (Fig. 1a, solid squares, broken lines). These data were fitted to a negative quadratic regression model ($F = 11.16$, $P < 0.001$). Summer "resting" and "standing" activities showed an opposite significant trend, with a peak near midday and declining percentages towards early morning and evening (Figs. 1b

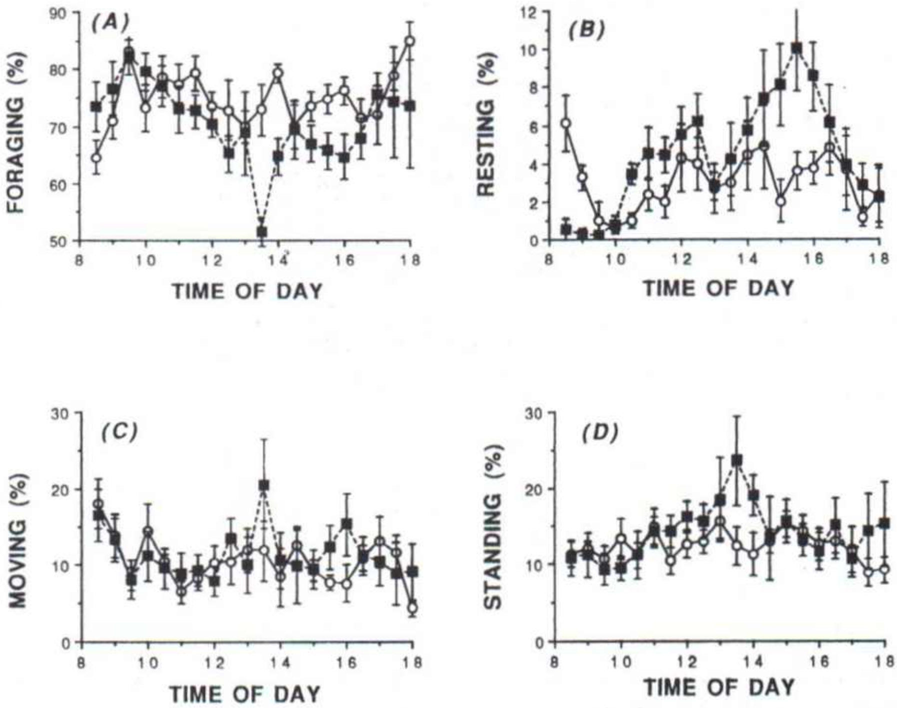

Fig. 1. Daily patterns of forage (A), rest (B), move (C) and stand (D) activities (percentage +/–SE) Abrapampa Fiels Station, 1988. Summer, (solid squares, broken lines) and autumn (open circles, solid lines).

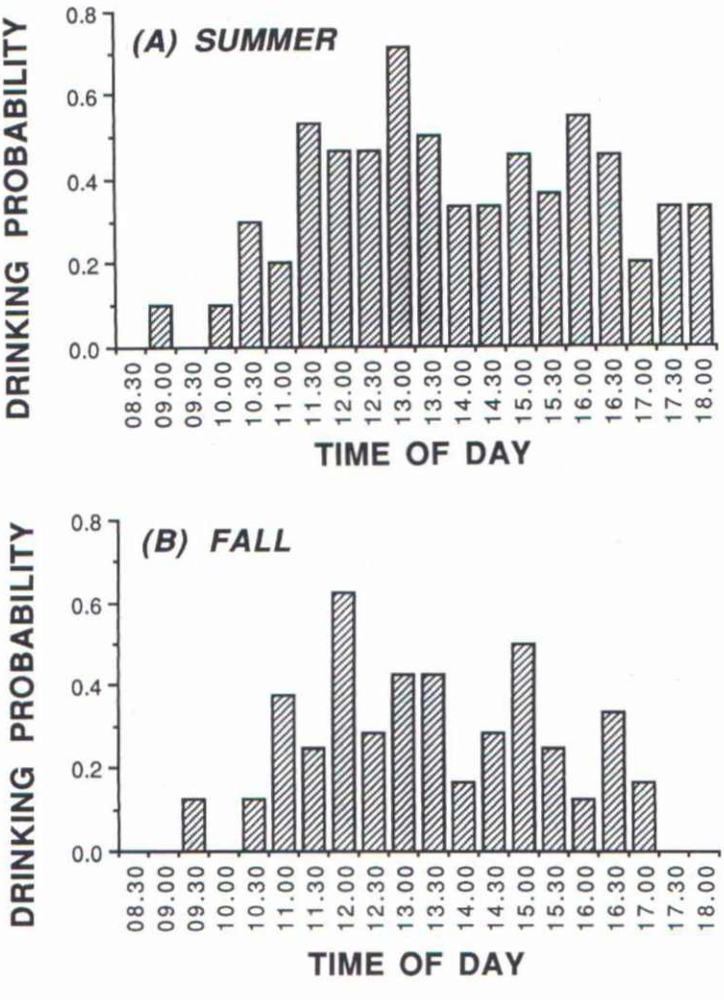

Fig. 2. Probabilities of finding vicuñas at the water pond in summer (A) and autumn (B).

and 1d, solid squares, broken lines) (fit to positive quadratic regression models: resting: $F = 35.4$ $P < 0.001$, and standing $F = 5.2$ $P < 0.006$). These diurnal patterns of activities were not observed in autumn (Fig. 1 open circles, solid lines).

Drinking behaviour of vicuña followed a diel cycle (Fig. 2). Both in summer and autumn, the probability of observing vicuñas at the pond increased markedly from early morning to the peak at midday. However, drinking patterns during the afternoon differed among seasons. In summer, the probability of observing drinking vicuñas remained high throughout the afternoon (Fig. 2a), while in autumn this probability decreased consistently and reached zero in the evening (Fig. 2b).

Mean summer (16.2 ± 4.3°C) and autumn (10.8 ± 5.4°) temperatures signifi-

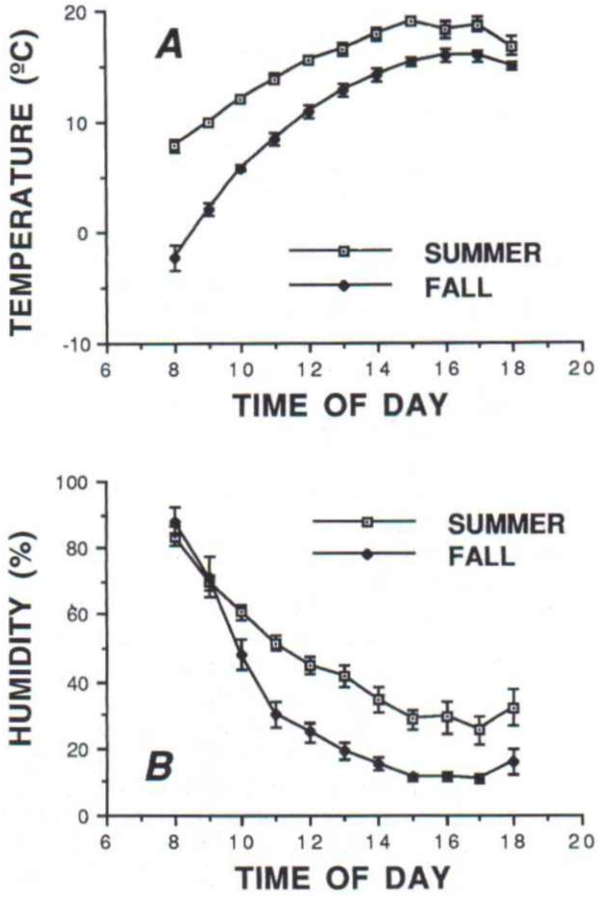

Fig. 3. Hourly mean temperature (A) and humidity (B) in autumn (solid squares) and summer (open squares).

cantly differed ($P < 0.001$). Mean summer humidity ($40.5 \pm 20.8\%$) was higher ($P < 0.001$) than autumn humidity ($28.4 \pm 22.9\%$). Greater variation in daily temperature and humidity was observed in autumn than in summer (Fig. 3).

Discussion

Foraging behaviour was the most frequently observed diurnal activity of vicuñas, as reported for other ungulates. Other studies have found daily foraging time of 80% for African buffalo *Syncerus cafer* and wildebeest *Connochaetes taurinus* (Beekman & Prins, 1989), 50-70% for horses (Duncan, 1985), 50-60% for cattle (Stobbs, 1970), approximately 40% for moose *Alces alces* (Renecker & Hudson, 1989), 62-76% for isard *Rupicapra pyrenaica* (Pépin et al., 1991), 51-62% for guanaco *Lama guanicoe* (Garrido et al., 1981), and 44-62% for waterbuck *Kobus defassa* (Spinage, 1968). The lowest percentage (26%) is reported by Risenhoover (1986) for moose during winter.

The Puna region had distinct annual seasons: a wet period during summer and a dry period during winter. In a study on Puna pastures, Pfister et al., (1989) reported that biomass and crude protein content of vegetation declines from March (i.e. the end of the wet period) throughout the winter. This seasonal variability in climatic and vegetation conditions can explain the seasonal changes that are observed in activity budgets of vicuña. The increase in foraging time is probably associated with a decrease in mean daily temperatures (lower ambient temperatures increase the cost of thermal regulation) and a decline in pasture quality which forces vicuñas to spend more time foraging. Bosch & Svendsen (1987) found no difference in time allocated to foraging in relation to season in the Pampa Galeras population. This Peruvian Park is located in a more "wet" puna with a mean of more than 450 mm of precipitation (Franklin, 1983), so the decline in pasture quality may be weaker and the difference might be observed later in the dry season and not at the beginning as in this work.

Desert ruminants show trends in seasonal time activity budgets similar to the one found in this study. For example, desert bighorn sheep *Ovis canadensis mexicana* increased their foraging time from 26% in summer to 42% in autumn, and decreased resting time from 38% to 28% respectively (Alderman et al., 1989). Pfister et al. (1989) reported an increase in foraging time per feeding station from the summer to winter in domestic camelids, alpaca *Lama pacos* and llama *Lama glama,* and sheep from the Peruvian Puna.

On the contrary, northern wild ruminants exhibit an increase in activity (mainly foraging) during summer and a progressive decrease throughout winter. These patterns have been observed repeatedly in cervids (Georgii, 1981; Risenhoover, 1986; Cederlund, 1989; Green & Bear, 1990). This reduction in activity has been regarded as an energy conservation strategy against the cold winter environment and appears to occur in parallel with a reduction in metabolic rate (Georgii, 1981). Another interpretation is that winter foraging behaviour is constrained by rumination time, which increases as forage quality declines during winter (Cederlund, 1989).

In summer vicuñas showed daily rhythms of activity with 2 peaks of foraging, one early in the morning and the other in the evening, with peaks of resting and standing around at noon. These daily rhythms disappeared in autumn probably because vicuñas require greater foraging time to meet their nutritional requirement as the mean temperature decreased or the caloric value of the forage declined.

Crepuscular activity patterns have been described in deer (Erriksson et al., 1981; Georgii, 1981; Cederlund, 1989; Beier & McCullough, 1990), moose (Cederlund, 1989), bighorn sheep (Alderman et al., 1989), gazelle (Walther, 1973), and many other ungulates.

Drinking behaviour also showed diurnal rhythms. During early morning vicuñas probably obtain water from moisture on vegetation which may explain why they were not observed at the pond. As the day went on, humidity declined and temperature increased, and more animals were found visiting the pond. In autumn, these movements towards the pond are expected to be more synchronized because humidity declined more rapidly during morning and reached a minimum of midday. In summer, temperatures were higher than in autumn. These variations in climate should explain why the probability of observing vicuñas at the pond was greater in summer and remained high during the afternoon. The dependence of vicuñas on surface water has been previously observed in other Puna areas, where animals moved during the morning from the mountains to water sources located at lower altitudes (Menard, 1982; Franklin, 1983; Hoffman et al., 1983; Vilá & Roig, 1992).

In summary, the vicuñas' activity patterns seem to be adapted to the extreme climatic conditions of the Puna desert, especially to the great daily variation in temperature and humidity and the seasonal changes in food availability, as well as to the distribution and abundance of water sources.

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