



Vigilance behaviour of the year-round territorial vicuña (*Vicugna vicugna*) outside the breeding season: Influence of group size, social factors and distance to a water source

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ABSTRACT

We conducted focal observations of vicuña, a year-around territorial mammal, to compare vigilance behaviour between territorial and bachelor males outside the reproductive season. We hypothesized that the time spent vigilant would depend on male social status, considering the potential effects of several variables: sampling year, group size, distances to the nearest neighbour and to a *vega* (mountain wetland). We fit GLM models to assess how these variables, and their interactions, affected time allocation of territorial and bachelor males. We found non significant differences between territorial and bachelor males in the time devoted to vigilance behaviour. Vigilance of territorial males was influenced by the sampling year and the distance to the *vega*. In turn, vigilance in bachelor males was influenced mainly by the sampling year, the group size and the distance to the *vega*. Our results suggest that sampling year and distance to the *vega* are more important than social factors in conditioning the behaviour of male vicuñas, during the non-reproductive season. Future studies of behaviour in water-dependant ungulates, should consider the influence of water and forage availabilities, and the interactions between group size and other variables.

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1. Introduction

Vigilance behaviour has been historically considered as an antipredator defence (Pulliam, 1973), but is also associated with protection against competitors, which are usually conspecifics (Elgar, 1989; Alberts, 1994; Yáber and Herrera, 1994; Artiss and Martin, 1995; Slotow and Rothstein, 1995). Other factors such as social status might influence the level of vigilance (Bertram, 1980; Cameron and Du Toit, 2005). In particular, in some ungulate species, territorial males are more vigilant than non-territorial males, because leader males compete for females and must avoid same-sex aggression from conspecifics (Roberts, 1988; Artiss and Martin, 1995).

In addition to social status, group size may influence the level of vigilance of gregarious mammals. Specifically, an inverse relationship between vigilance and group size in ungulates has been reported in several studies. Many of those studies documented that larger groups detect a predator sooner and that individual vigilance rates are lower for animals living in large groups (Underwood, 1982; Elgar, 1989; Illius and Fitzgibbon, 1994; Beauchamp, 2003). However, these effects of group size are not universal, as it depends on species identity, season, local environment conditions and social factors (Elgar, 1989; Bednekoff and Ritter, 1994; Burger and Gochfield, 1994; Shorrocks and Cockayne, 2005; Périquet et al., 2010). Indeed, some studies found that individuals responded more to the proximity of neighbours (social factors) than to group size, suggesting a negative influence of nearest neighbours on the amount of time devoted to vigilance (Treves, 1998; Hirsch, 2002; Cameron and du Toit, 2005).

Overall, it is assumed that vigilance behaviour is not mutually exclusive with processing food but that it usually is with food searching and handling (Frid, 1997). Therefore, being vigilant is costly in terms of energy gain and rate of food intake (Caraco,

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1979; Underwood, 1982). During the dry season, when resource availability is low, the trade-off between vigilance and food search is specially strong (Illus and Fitzgibbon, 1994). In this context of resources scarcity, animals living in groups would tend to be spaced from each other to reduce foraging interference, taking greater risks as hunger levels increase (Thouless, 1990). In water-dependant species living in dry environments, foraging near a waterhole can be detrimental in terms of an increased intra-specific interactions. On the other hand, the presence of other individuals near a water source may decrease the perceived risk of predation, allowing an animal to reduce the time it spends vigilant for potential predators (Fitzgibbon, 1990).

The vicuña is a polygynous ungulate with a stable social structure: familial groups with a territorial male and several females with their offspring, bachelor groups composed of non-territorial males and, solo individuals with or without an established territory (Koford, 1957; Franklin, 1983). Territorial males defend a high quality territory all year round from the intrusion of other males and tend to remain distant from their group (Vilá, 1995). They are also more aggressive than any other individual of this species and display a strong intolerance towards bachelors (Vilá, 1992, 1995). In contrast, bachelor males, usually occupy marginal areas with low-quality forage and perform different activities synchronously (Franklin, 1983; Cajal 1985; Vilá and Cassini, 1993; Mosca Torres and Puig, 2010).

Even though vicuñas are adapted to desert conditions, they drink water almost every day (Koford, 1957; Franklin, 1983), specially during drought conditions (Vilá and Cassini, 1993; Mosca Torres and Puig, 2012). In our study site water availability was scarce and only one *vega* (mountain wetland) was used by all social groups simultaneously (Mosca Torres and Puig, 2012).

During the reproductive season (wet season), the vigilance behaviour of territorial males increased and grazing decreased with the number of females in the families, suggesting that males increased their mating success through vigilance activities and incurred a high cost of decreased time to feed (Vilá and Cassini, 1994). Moreover, during the reproductive season is probably to observe bachelors initiating aggressions towards territorial males and becoming in the new territorial male (Vilá, 1992). However, little is known about the vigilance behaviour of vicuñas outside the breeding season (dry season), although several authors observed agonistic interactions between territorial and bachelor males in different vicuña populations in this season (Cassini et al., 2009).

We investigated vigilance behaviour in territorial and bachelor male vicuñas outside the reproductive season that co-occur with the decrease of resource availability. First, we hypothesized that the time spent vigilant will be different according to the type of male (territorial and bachelor males), taking into account the differences in social status and reproductive interests. Therefore, and related to territorial defence, we predict that territorial males will spend more time vigilant than bachelors and as number of females in the group increase, at the expense of time devoted to other activities. Second, we hypothesized that bachelor males will benefit from the anti-predatory advantages of living in group. Thus, as group size increases we expect that bachelors will devote less time to being vigilant and more time to other activities such as eating and walking in search of food. Third, because social interactions may influence vicuñas' behaviour, we investigated whether the time invested by bachelor vicuñas in vigilance is affected by distance to the nearest neighbour. Given the decrease in forage availability during the dry season in the study site, we predicted that an individual would devote more time to foraging as it moves away from its nearest neighbour to reduce foraging interference, taking greater risks as hunger levels increase. Thus, the time spent vigilant would decrease as inter-individual distance amongst vicuñas increases, in contrast to the time devoted to foraging. We did not consider this

variable for territorial male models, because they were generally far apart from the rest of the group without any sign of cohesion as observed in bachelor groups. Finally, we tested whether the presence of many conspecific competitors in the *vega* influences the amount of time devoted to vigilance by both, territorial and bachelor males. We expected that territorial males would spend more time in vigilance in the *vega* than away from it due to the presence of potential conspecific competitors, while bachelors would spend less time in vigilance in the *vega* because of the presence of many individuals that may decrease the perceived risk of predation.

2. Material and methods

The study was carried out in Los Andes Reserve (14,400 km²), a protected area in the West of Salta province (Argentina), within the Puna biogeographic province (Cabrera and Willink, 1980). The climate is cool and dry, with broad daily and seasonal temperature ranges (−2 °C to 18 °C in summer, −12 °C to 16 °C in winter), low rainfall (130 mm/yr) occurring only in summer (December–March) and intense frosts. Food availability is extremely limited during the dry season (winter), when forage is too mature and of low quality (San Martín and Bryant, 1989; Van Saun, 2006).

The selected sampling site is located in a place called “Unquillal” located at 24°27'S and 67°12'W, with an approximate area of 11.6 km². Density of vicuñas in the study area is 22.2 indiv./km², comparatively much higher than the surrounding areas (0.75 indiv./km², Baigún et al., 2008). The vegetation is dominated by a low shrub layer, complemented by several grasses of the Poaceae family (*Stipa*, *Poa* and *Festuca*). A *vega* (permanent mountain wetland) was present on a steep slope (>30°) with a dense layer of species of Cyperaceae and Juncaceae families, accompanied by some grasses. The *vega* was the only water source available for vicuñas of different social categories. During the winters of 2006 and 2007, plant cover was scarce (28%), whereas plant diversity and forage availability decreased compared to the reproductive season (Mosca Torres, 2010).

Territorial and bachelor male vicuñas were randomly selected using focal animal sampling (Altmann, 1974; Martin and Bateson, 1991). Territorial males were distinguished from bachelor males because they tend to be some metres away from females and calves of the group, often showing territorial displays towards other vicuñas, as chases and defecating (Franklin, 1983; Marino and Baldi, 2014). In contrast, bachelor groups are composed mostly by juvenile and adult males who perform different activities synchronously and are often aggregated (Vilá and Cassini, 1993; Marino and Baldi, 2014). Group size was recorded as the number of individuals in the group at the beginning of a sampling. The distance between individuals was used to determine the group size only for bachelor groups because territorial males tend to be away from the rest of the group as was mentioned before. We considered an individual as part of a bachelor group if it was less as 100 m away from the rest. Familial individuals were classified by sex; although females and calves were not sampled in this study, the number of both was recorded. We measured the distance to the nearest neighbour in vicuña units (VU), each unit corresponding to the length of an adult vicuña, approximately 1 m. Finally, we categorized the distance to the *vega* as: in the *vega* (0–5 m), close (5–50 m), medium (50–150 m) and away (>150 m) from it.

The time devoted to different activities by both types of males was recorded during 15 min. We observed an average of five territorial and bachelor males per day and no individual of the same group was sampled twice a day. Vicuñas at the study site were not marked, therefore repeated sampling of the same individual was actively avoided by selecting subsequent territorial males foraging away from the previous male. To reduce the probability that the

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