

Short Note

First records of culpeo (*Lycalopex culpaeus*) attacks and cooperative defense by guanacos (*Lama guanicoe*)

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Predation is considered one of the principal selective forces involved in the evolution of social species (Wilson 1975). The main benefits of social group formation include the reduction of the per capita probability of falling victim to predation when group size increases (dilution effect; Hamilton 1971) and increases in the ability to detect predators within a safe distance (Pulliam and Caraco 1984) and the ability for cooperative defense. Cooperative defense involves the participation of two or more individuals in the defense against a predator, either by displaying a defensive formation or a communal attack against the predator (Wilson 1975).

Among ungulates cooperative defense is traditionally associated with highly social species of large body size, such as musk oxen (*Ovibos moschatus*), eland (*Taurotragus oryx*), or water buffalo (*Bubalus bubalis*). Smaller-bodied species often depend mainly upon the benefits of dilution and early detection to reduce the risk of predation (Jarman 1974, Wilson 1975). Some exceptions have been recorded, however, for species of intermediate sizes, such as bighorn sheep (*Ovis canadensis*) (Shank 1977) and mule deer (*Odocoileus hemionus*) (Lingle and Pellis 2002), which have been seen to react aggressively and simultaneously when attacked by coyotes (*Canis latrans*).

The guanaco (*Lama guanicoe*) is an intermediate sized (100–120 kg), highly polygynous, and social ungulate that inhabits western and southern South America (Puig and Videla 1995). The only predator on guanacos that

has been reported so far is the puma (*Puma concolor*, 62 kg) (Wilson 1984, Bank et al. 2002), which is a solitary hunter that stalks its prey (Hornocker 1970). Puma predation may have significant demographic consequences for guanacos (Sarno et al. 1999, Bank et al. 2002), preventing or slowing the recovery of some low-density populations (Novaro and Walker 2005). The behavioral response of guanacos to attacks by pumas is to flee once the predator is detected, accompanied by frequent alarm calls by conspecifics (Franklin 1982, Bank and Franklin 1998). This reaction is expected for an ungulate of this size, for which the effects of dilution and early detection may be the main anti-predator benefits derived from forming social groups. Group formation in other mammals increases foraging efficiency or promotes cooperation in the rearing of the young, but in guanacos it appears to be associated mainly with avoiding predation (Franklin 1982, Marino and Baldi 2008).

The only guanaco population that is entirely free from puma predation today is on the island of Tierra del Fuego at the southern tip of South America. Pumas have been absent from this island likely during most of the last 10–12,000 years since the rise in sea level isolated it from the continent (Massone Mezzano 2001). The Tierra del Fuego population currently numbers approximately 60,000 guanacos, after a sharp decline during the last century due to the expansion of sheep ranching (Raedeke 1979, Bonino and Fernandez 1994). The only native terrestrial predator in Tierra del Fuego is the culpeo (*Lycalopex culpaeus lycoides*), which weighs up to 14 kg and coexists with pumas and guanacos through most of the latter's range in South America (Franklin 1982, Novaro 1997). The smaller chilla (*Lycalopex griseus*, 3 kg) was introduced from the continent in the 1950s and is now abundant in the steppe landscape of the northern part of the island (Jaksic and Yañez 1983).

There are no published records of culpeo attacks on guanacos and researchers studying culpeo diets that have encountered guanaco remains have assumed that guanacos were consumed as carrion (Johnson and Franklin 1994, other references in Novaro 1997). Unconfirmed reports from local people throughout the ranges of both species, however, indicate that culpeos may occasionally prey on guanacos up to 1 year of age, and Bridges (1988) cites reports by the local Selknam people of culpeos attacking guanacos. Culpeos, similar to most canids, are cursorial predators that instead of stalking their prey rely on pursuing and exhausting it to be able to catch it (Carbone et al. 2007). In this study, we report for the first time two types of observations: attacks by culpeos on young guanacos and cooperative defense by a guanaco group in Tierra del Fuego.

Observations were made during daylight hours in January (austral summer) and June 2007 near the Vicuña ranger station of Karukinka Natural Park in Chilean Tierra del Fuego (54°08'20.5" S, 68°42'16.8" W). The habitat was a forest-grassland mosaic of Southern beech trees (*Nothofagus pumilio* and *Nothofagus antarctica*) and meadows. In Tierra del Fuego, as in most studied sites, there is a guanaco birthing pulse during December (Raedeke 1979). Guanaco young weigh approximately 12 kg at birth and 33 kg by the following June (Sarno et al. 1999, B. Gonzalez personal communication).

On January 15 2007, as we observed a guanaco group of nine adults and seven newly born young moving through a patch of *N. pumilio* forest from approximately 50 m away, the young were attacked by an adult culpeo which started chasing them around a clump of *Berberis* sp. bushes. Two adult guanacos cornered the culpeo against a fallen tree and kicked it repeatedly with their front legs. The culpeo withdrew and repeated its charge at the young, with the adult guanacos charging again after the culpeo. The struggle lasted approximately 3 min. Eventually, the culpeo gave up and left. After the culpeo was gone the guanaco group quickly moved into a nearby meadow. One adult was bleeding from the nose and another from the neck, but we could not determine if these injuries were inflicted by the culpeo or if the guanacos hurt themselves against fallen trees or bushes during the struggle. We could not see if any of the young were bitten inside the clump of bushes and none of the young appeared injured, but the group was sighted the following day and only six young were observed.

During late January 2007, on five occasions we observed that guanacos from different family groups in the same study area reacted in a consistent manner to sightings and barks of culpeo and chilla. This response included the group quickly coming together, always where the young guanacos were, some adults approaching the sighted culpeo or chilla or the forest patch from where the barking came, and the group remaining vigilant until the predator left.

On June 13 2007, we observed an adult culpeo chasing a young guanaco in a snow-covered forest clearing around a dam built by invasive Canadian beavers (*Castor canadensis*) (Figure 1). The chase was observed during 5 min after the guanaco and culpeo came out of a *N. pumilio* forest patch, and continued at least until both guanaco and culpeo re-entered the same forest patch. Inside the clearing, both animals ran past within 5 m of the observers and both panted heavily, suggesting that the chase had been going on for some time when the animals came into the clearing. Wool that was the color and length of guanaco hair hung from the culpeo's muzzle, indicating that the culpeo had bitten the guanaco.

Guanaco young are not expelled from family groups before the spring when they approach 1 year of age. As this guanaco was approximately 6 months old, it is possible that the culpeo had separated the young from its group before we spotted them. We cannot confirm this, however, because we did not observe the young interact with other guanacos nearby.

A comparison of our observations with those in previous studies (Bank and Franklin 1998) highlights the



Figure 1 Culpeo chasing a young guanaco in Karukinka, Tierra del Fuego, Chile. The chase occurred in a beaver meadow (A). Wool, possibly from the guanaco, was visible hanging from the culpeo's mouth (B). Photos by C. Briceño.

behavioral plasticity of guanacos in displaying different anti-predatory strategies (flight or active defense) when faced with two predators that differ in body size and hunting strategy. A response based on detecting the predator at a certain distance and fleeing can be effective in facing a predator, such as the puma, which does not pursue its prey long distance, but may not be effective when faced with a cursorial predator (Creel and Creel 2002), such as the culpeo. The size difference between adult guanacos and culpeos, on the other hand, may make the risk of confrontation acceptable to guanacos.

Cooperative defense by guanacos when threatened by culpeos may be an additional advantage of social group formation that adds to the benefits of dilution and early detection. This advantage is likely most significant during the first weeks after birth, when guanacos are most vulnerable to predation by culpeos due to their small size. Our records are similar to observations of interactions between female mule deer and coyotes, in which survival of the young depends upon the aggressiveness with which female deer defend them (Lingle and Pellis 2002). Our observations also support the findings of Sarno et al. (1999), who reported that the young of more aggressive female guanacos were more likely to survive during the first year of life, although much of this advantage of aggressiveness may be related to dominance over other guanaco females. It is likely that in guanacos, as with mule deer, the probability that the young are protected successfully from predators increases as the number of

females in the group becomes larger, highlighting the impact that social behavior can have on demographic parameters (Lingle and Pellis 2002, Marino and Baldi 2008). Because culpeos occur almost everywhere where guanacos are present, and culpeos can be locally abundant (Novaro and Walker 2005), it is important to document how often culpeo attacks are successful and what are the demographic consequences of culpeo predation for guanaco populations.

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