

## Observations of Interactions between Puma, *Puma concolor*, and Introduced European Red Deer, *Cervus elaphus*, in Patagonia

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Direct observations of interactions between native Puma (*Puma concolor*) and introduced European Red Deer (*Cervus elaphus*) in Patagonia are discussed with respect to the absence of evolutionary sympatry. Although the founding stock of European Red Deer had been lacking natural predation pressure for considerable time due to the previous extinction of large predators, these observations suggested that inherent antipredator behavior of European Red Deer toward this novel predator, once detected, was effective and may partially explain the success of European Red Deer as an invasive species. Puma behavior supported the view that they are a generalist predator which opportunistically utilizes new prey species like European Red Deer.

Key Words: European Red Deer, *Cervus elaphus*, Puma, *Puma concolor*; introduced species, predation, behavior, interaction, Argentina.

The role of large predators in regulating northern cervids continues to be debated. This function of large predators has to be viewed from a historical-evolutionary angle; how predators affect prey populations in modern human-modified settings can be expected to differ greatly (Berger 1998; Flueck 2000). The evolution of large predators appears to be a systemic functional response as shown by re-evolving ecomorphs among very distant taxonomic groups. Furthermore, ecologically complete northern systems had several predator species with different hunting strategies and several prey species which thus prevented coevolution (Flueck 2000). Parts of Patagonia represent a natural experiment in south-temperate Argentina where European Red Deer (*Cervus elaphus elaphus*) were introduced during the 1920s (Flueck and Smith-Flueck 1993) to areas with native Puma (*Puma concolor*). As the Puma has only occurred in the Americas, these two species have no evolutionary history of sympatry. Furthermore, the native large predators had been extinct for a considerable time in areas of Europe where the European Red Deer originated, and immediate memory of such predators was thus absent.

Hornocker's (1970) work showed that direct observations of attempts by Puma to capture prey was nearly impossible and very few reports have been made previously, mostly stories by hunters (see Robinette et al. 1959). A few additional accounts are based on interpretation of tracks in the snow (Robinette et al. 1959). During many years of studying Puma, Seidensticker et al. (1973: 31) never observed Mule Deer (*Odocoileus hemionus*) or American Elk (*Cervus elaphus nelsoni*) mobbing a Puma, and I found no reference to a cervid fighting off a Puma successfully. Here I report on direct observations of interactions between Puma and European Red Deer.

### Study Area

The study area is in the western foothill portion of the province of Neuquén, Argentina (40°58'S, 71°12'W). The topography is primarily mountainous with most features formed by glacial processes. The dominant climate is temperate with main precipitation occurring between April and September. There is an abrupt precipitational gradient from west to east due to the rain shadow effect of the Andes which results in a strongly defined vegetation structure and floristic composition. The study site is between 900 and 1200 m elevation and represents the ecotone between forest and steppe. Patches of forests are characterized by "Ñire" trees (*Nothofagus antarctica*) and "Ciprés" (*Austrocedrus chilensis*) at lower elevations and are replaced by "Lenga" trees (*Nothofagus pumilio*) at higher elevations. Forest patches at lower elevations alternate with wet grasslands ("mallines") with abundant growth of herbaceous plants, whereas at high elevation they are replaced by grass-dominated steppe of "Coirón Amargo" (*Stipa speciosa* var. *major*) and "Coirón Dulce" (*Festuca pallens*), with variable occurrence of brush species like "Neneo" (*Mulinum spinosum*), "Calafate" (*Berberis* spp.) and "Espino Negro" (*Colletia spinosissima*). Riparian areas also contain galleries of small trees like "Radal" (*Lomatia hirsuta*), "Maitén" trees (*Maytenus boaria*) and "Laura" (*Schinus molle*).

### Methods and Results

Observations of interactions between European Red Deer and Puma were recorded while stalking alone during field work to collect deer for reproductive studies. Here I report on two such incidents.

On 10 November 1999 at 20:15 h I was returning to camp at a pace faster than stalking as it was getting

late and the deer had not yet descended into the flat open feeding areas below surrounding hills which they use for cover during midday hours. The area I traversed was semi-open with patches of grassland interspersed with some patches of trees like Laura, Radal, and Cypress, typical of the acetone here. There were also patches of brush, predominantly Espino Negro and Calafate. As I was about to pass a stand of Radal, which was approximately 10 m in diameter, I heard the alarm bark of a European Red Deer cow about 20 m away coming from within the stand. I stopped immediately, believing that she must have seen me through the Radal trees, particularly as the same had happened only a short while earlier with a cow which was bedded in a similar tree patch. I thus waited in anticipation that this animal might step out of the trees in curiosity, in which case I would have collected her as well. Looking with binoculars, I could see her move behind the trees and affirmed that she had not yet left.

Suddenly, she barked again and came charging toward me through the patch of trees. Once she was in sight, I saw that she was pursuing an adult Puma, and it was clear that the barking was aimed at the predator and not at me. The Puma stopped shortly after getting out into the open, but as the cow came charging again, the Puma took off and the cow chased the cat around a circular patch of Espino Negro of about 7 m in diameter and 1 m in height. The fast chase took the animals around this bush patch twice, until the Puma apparently stopped out of sight behind the bush. The cow then stopped in front of it and commenced barking again. Finally the cow trotted back toward the patch of trees on the same path where she had come from, only to turn around suddenly and charge toward the patch of bush, stamping in front of it and barking continuously. Four times she repeated this behavioral pattern of trotting away and turning back, but when she finally reduced her aggressiveness and appeared about to retreat, I got ready to collect her. As she turned to enter the trees and was obviously walking away from the scene, I shot, which caused her to run through the tree patch on the same path on which she had originally come out.

After picking up my gear, I came around a bush and went towards the trees. Immediately, I saw the Puma jump out of a tree behind that patch of bush, and follow the deer on the same path through the trees. I then entered the tree patch, having to hunch down to pass through the trail. As I reached the other side, still in a hunched position, I saw the head of a Puma appear at about 15 m from behind a patch of bunch grass; it must have heard me coming through the trees. Looking through the binoculars, I determined it was a cub of the previous year. Still looking through my binoculars, I saw the head of the mother Puma pop up, and without hesitating she approached me to within 10 m. Apparently this was the first she knew of my presence and she began to snarl, which could be

clearly heard. After 30 seconds of staring straight at me, she sat down, but kept looking directly at me and snarling periodically. She then appeared to relax in the sense that she would start to look from side to side, blinking slowly, and she was no longer in an alert position.

As the sun had set and I needed to collect information on the cow before dark, I decided after about 5 minutes to move on ahead. I stood up which immediately put the Puma into alert mode. She stood up, started to snarl continuously and stared at me. As I made a first few steps towards her, it became clear that she would rather move back than hold her position, so I continued to move forward. She retreated as much as I would move forward. Approximately 5 m out into the open, I could again see the cub which immediately retreated into the brush upon seeing me. At 15 m from the trees I found the dead cow, while the female Puma stood 10 m away still snarling. As I started to make brisker movements, like taking off the backpack, she retreated farther away and out of sight behind the brush. The thorax of the European Red Deer had already been torn open by the Puma.

The European Red Deer cow was of average body size for this region (Flueck, unpublished data), except girth (116 cm) which was 10% below average. She had absolutely no fat reserves (sternum, rump, omentum, kidney). This was probably due to extreme drought conditions during spring through fall of 1999. Body conditions in fall of 1999 were so low that only 56% of adult females conceived (Flueck 2001) as compared to 100% in previous years. This 14-year-old female had given birth to a calf 1-2 days earlier as evidenced by the still enlarged uterus and the large but hard udder. Furthermore, in the trees I found remains of a calf which had been partially scavenged at least a day earlier; cause of death could not be determined.

The second observation occurred on 17 November 1996, while I was stalking in an area of hilly grassland interspersed with brush. At 18:15 h, I heard a European Red Deer cow bark on the other side of a canyon and shortly after, I observed her running nervously back and forth in a semi circle at a patch of Espino Negro brush, about 5×10 m in area and 1 m tall. Then a calf cried and approximately 5 minutes later cried again. It was obvious that the female had a problem with the calf. Shortly after, I saw an animal body appear from behind the brush patch and enter it. A few minutes later, the female stopped barking and trotted away down the hill. I then went to the spot and as I slowly approached the brush about where the animal had entered earlier, an adult Puma fled crossing the brush patch. Right at the edge was a dead calf which was barely eaten. The Puma had dragged it from some distance when crossing the brush patch. The calf, a male, had body measurements indicating it weighed 11 to 12 kg (Flueck, unpublished data), and several features indicating it was only a few days old (first incisors were out only 4 mm; umbilical scab).

## Discussion

Puma in Patagonia are large predators and comparable to or surpass the largest races known from the nearctic (Iriarte et al. 1990). Franklin et al. (1999) reported average weights for female and male Patagonian Puma as 47.5 and 75.8 kg, respectively. Female Puma are known to increase their kill rate several fold when accompanied by cubs and can be expected to increase their aggressiveness. It is thus of interest that a European Red Deer female at the energetically most stressful period right after birthing coupled with nutritional stress from the drought was able to chase a female Puma which had young, up a tree. It indicates that the defense behavior of European Red Deer towards a discovered novel predator like Puma was effective in preventing the death of the mother. In the first case, the cause of the earlier death of the calf is unknown, and as it is common for a cow to remain in the vicinity of a recently born calf after it dies, it explains the aggressive behavior toward the Puma which likely could have prevented predation on the offspring. In the second case, the mother could not prevent predation of her calf by Puma; however, the learning event might enhance the probability that a future offspring might survive. Innate antipredator behavior of introduced European Red Deer therefore, appears successful in assuring adequate numbers of offspring to survive against the native Puma hunting strategy. The loss of exposure to large predators for the founding stock in their original habitat did not prevent the establishment of the founding populations in Patagonia, indicating that rapid learning to defend against Puma must have occurred. Other cervids had become naive to their large predators which became locally extinct, but adapted quickly once these predators reappeared. This was clearly shown for Roe Deer (*Capreolus capreolus*), when Lynx (*Lynx lynx*) were reintroduced (Breitenmoser and Haller 1993), and Moose (*Alces alces*) with offspring after reestablishment of Wolves (*Canis lupus*) and Bears (*Ursus arctos*) (Berger et al. 2001).

On a larger scale, it is also clear that Puma in Patagonia, as the major predator of introduced European Red Deer, are not able to prevent them from increasing numerically (Flueck et al. 2003). Furthermore, as Puma and deer occur across extensive landscapes with no human-related mortality factors for Puma, I postulate that intrinsic mechanisms are responsible for preventing Puma populations from reaching densities where they would exert a control over the deer populations (Flueck 2000). Puma prey frequently on European Red Deer indicating their generalistic and opportunistic feeding behavior. Although about 80% of the natural mortality of adult female deer was due to Puma, annual survival rate of these deer remained high at 91% (Flueck et al. 2004).

These observations support existing studies that the Puma behaves as a generalist predator which can opportunistically adapt to new prey species. Furthermore, they demonstrate that European Red Deer have an ample repertoire of innate antipredator behavior which may partially account for their success as an invasive species.

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