

# Note

## Cougars (*Puma concolor*) Killed by North American Porcupines (*Erethizon dorsatum*)

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Predation is inherently risky, and Cougars (*Puma concolor*) are occasionally injured while hunting prey. Between 2001 and 2015, we documented the cause of death of 59 Cougars (22 subadults and 37 adults) in the Southern Yellowstone Ecosystem, Wyoming. Here we report on 2 animals (9% of subadult mortalities) killed as a result of complications after hunting North American Porcupines (*Erethizon dorsatum*). We also report an observation of a Cougar killed in Venezuela by quills of a Prehensile-tailed Porcupine (*Coendou prehensilis*). Porcupines may kill and wound more Cougars than previously suspected and may be an important cause of mortality, at least for subadult animals.

Key Words: Cougar; Puma; *Puma concolor*; North American Porcupine; *Erethizon dorsatum*; fitness consequences; mortality; predation

### Introduction

Predation is inherently risky and, thus, it is no surprise that Cougars (*Puma concolor*) are injured from time to time while hunting prey many times their size (e.g., Ross *et al.* 1995). Cougars have been tossed from the backs of large ungulates, slammed into trees, and punctured by tree limbs or antlers while hunting deer (*Odocoileus* spp.), Elk (*Cervus elaphus*), and Bighorn Sheep (*Ovis canadensis*) (Ross *et al.* 1995; Murphy and Ruth 2010). Cougars have also died from injuries sustained in falls associated with hunting Bighorn Sheep in steep terrain (Ross *et al.* 1995; Murphy and Ruth 2010).

The much smaller North American Porcupine (*Erethizon dorsatum*) also presents a danger to Cougars and other carnivores (Mukherjee and Heithaus 2013; Katzner *et al.* 2015). The porcupine is unique among North American mammals in that it has weapons to deter potential predators. Each porcupine is covered by approximately 30 000 quills — sharp, rigid, hollow hairs, 2–10 cm long, each tipped with 700–800 barbs (Cho *et al.* 2012). Barbs increase the ease with which quills penetrate skin, as well as the difficulty of removing them. In fact, researchers have found that quills penetrate skin with only 56% of the force required to pierce the same tissue with a hypodermic needle (Cho *et al.* 2012).

Cougars hunt porcupines wherever the 2 species are sympatric, and North American Porcupines (e.g., Anderson 1983; Ackerman *et al.* 1984; Knopff *et al.* 2010) and southern porcupine species, such as *Sphiggurus mexicanus* (López-González and González-Romero 1998) and *Coendou mexicanus* (Chinchilla 1997; Foster *et al.* 2010), in Central and South America are a common prey listed in studies of Cougar diet. Although porcupines generally constitute only a small percentage

of Cougar diet, occasionally they make up a larger proportion. For example, Robinette *et al.* (1959) reported that porcupines accounted for 19% of items found in 277 Cougar intestinal tracts and scats and 275 stomachs collected in Utah and Nevada. Knopff *et al.* (2010) reported that porcupines made up a larger percentage of subadult than adult Cougar diets (13.52% versus 0.76%), suggesting that not all Cougars hunt porcupines equally.

Speculation on the dangers associated with hunting porcupines varies. Robinette *et al.* (1959) reported 3 Cougar kittens killed by quills as a result of complications after hunting porcupines and suggested the dangers were real. In contrast, Maser and Rohweder (1983) reported that Cougars do not appear to be in any danger from porcupines, because they found numerous Cougars with partly digested quills in their stomachs. In fact, there is some evidence that Cougars have defensive mechanisms to protect their digestive tracts from porcupine quills. Ferguson *et al.* (2011) investigated internal nodules in the gastrointestinal tracts of Cougars: 83% of 160 Cougars exhibited nodules; 14% of all small nodules (< 2 cm diameter) encapsulated quills, and 4 Cougars exhibited larger nodules with quills.

The danger of porcupine quills is that those that enter a predator's internal cavities may migrate unpredictably and, over extended periods, may pierce vital organs. For example, Johnson *et al.* (2006) conducted a review of 296 Domestic Dogs (*Canis familiaris*) treated for porcupine quills. Veterinarians removed all exterior quills immediately, but some dogs returned for additional treatment because of complications that were interior and overlooked during initial visits. These complications became apparent as long as 192 days after the incident with the porcupine. Six dogs developed lameness, 4 developed peri-ocular complications, and 28 developed large abscesses requiring surgery. Johnson *et al.* (2006)

also noted that quill migration was not correlated with the original entry point of the quills, nor did the number of quills that migrated correlate with complications.

## Methods

Between 2001 and 2015, we fit 114 Cougars of all ages with VHF and GPS collars (Vectronics, Berlin, Germany; Lotek Wireless, Richmond Hill, Ontario) to study demographics and spatial and foraging ecology. The study took place in the Southern Yellowstone Ecosystem (see Elbroch *et al.* 2013 for a description of the study area). All collars were equipped with mortality sensors, which alerted us when collars had not moved for more than 8 h. We investigated sites where Cougars died to determine the cause of death. A veterinarian conducted necropsies to assess interior and exterior clues, and we sent blood and tissue samples to the Wyoming State Veterinary Laboratory for disease analyses.

## Results

Over the study period, we documented the cause of death for 22 subadult and 37 adult Cougars (Elbroch and Quigley, unpublished data), and here we report the details of 2 animals killed as a result of complications after hunting porcupines. These represent 9.0% of subadult mortalities and 3.4% of total mortalities. Subadults died primarily from starvation or were killed by predators (each accounted for 18% of mortalities), and adults were primarily killed by people (49% of mortalities). We also report an opportunistic observation of a Cougar killed by quills of a Prehensile-tailed Porcupine (*Coendou prehensilis*) in the Llanos of Venezuela.

M34, a 15-month-old male Cougar from northwest Wyoming, was found dead on 14 September 2005. His underside, chest, neck, and one side of his face (including the ocular cavity) were completely covered by hundreds of deeply, embedded quills. No further details were recorded, and the cause of death was considered complications from porcupine quills.

F99, a 16-month-old female Cougar from northwest Wyoming, successfully killed a porcupine on 16 November 2014 but later died on 13 December 2014. A necropsy revealed porcupine quills in her chest and abdominal cavities. Her entire chest cavity was dotted with wounds from migrating quills that had entered through her chest, and the quills themselves were evident in her lungs, chest cavity walls, and fibrin clots. One lung had completely failed and consolidated because of damage from migrating quills, and the other was significantly wounded. The veterinarian concluded that she died from lung failure, resulting from complications from porcupine quills.

In February 1996, RH found the carcass of a subadult Cougar estimated to be 3 years old, at the edge of a dry watercourse on a private cattle ranch called Hato Piñero in the Llanos of Venezuela (8°56'N, 68°04'W). The carcass held scattered quills of a Prehensile-tailed Porcupine. Some of the larger quills had perforated the

bones of the braincase and were embedded in the brain. This was determined to be the cause of death.

## Discussion

Numerous carnivores prey on porcupines, and likely many incur increased risk of injury or death from quills acquired while killing the animal or after eating it (Mukherjee and Heithaus 2013; Katzner *et al.* 2015). Quick (1953) reported that some American Marten (*Martes americana*), Fisher (*Pekania pennanti*), Canadian Lynx (*Lynx canadensis*), Ermine (*Mustela erminea*), Red Fox (*Vulpes vulpes*), and American Mink (*Neovison vison*) trapped in British Columbia between 1947 and 1949 had quills embedded in them, emphasizing the diversity of carnivores potentially impacted by hunting porcupines.

In some areas, Cougars are the primary predator of porcupines (Sweitzer 1996), and, thus, they may suffer more from such complications than other predators. For example in a study of Cougar stomach contents in agricultural and prairie environments of North and South Dakotas, Thompson *et al.* (2009) reported that 12 of 14 Cougars examined exhibited porcupine quills (the Cougars were primarily killed by vehicles and legal hunters).

Determining the full extent to which Cougars suffer injury or mortality from hunting porcupines requires vigilance by researchers during necropsies. Only with greater awareness among wildlife researchers studying Cougars can we ascertain the frequency with which they suffer injury or death following the hunting of porcupines. With more accurate numbers of injuries and mortalities, we may be able to determine how this may influence Cougar population dynamics. More Cougars may die following encounters with porcupines than previously suspected, and this may be an important cause of mortality for young Cougars.

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### Literature Cited

- Ackerman, B. B., F. G. Lindzey, and T. P. Hemker.** 1984. Cougar food habits in southern Utah. *Journal of Wildlife Management* 48: 147–155.
- Anderson, A. E.** 1983. A Critical Review of Literature on Puma (*Felis concolor*). Special report 54. Colorado Division of Wildlife, Fort Collins, Colorado, USA.
- Chinchilla-Romero, F. A.** 1997. La dieta del jaguar (*Panthera onca*), el puma (*Felis concolor*) y el manigordo (*Felis pardalis*) en el Parque Nacional Corcovado, Costa Rica. *Revista de Biología Tropical* 45: 1223–1229.
- Cho, W. K., J. A. Ankrum, D. Guo, S. A. Chester, S. Y. Yang, A. Kashyap, G. A. Campbell, R. J. Wood, R. K. Rijal, R. Karnik, R. Langer, and J. M. Karp.** 2012. Microstructured barbs on the North American porcupine quill enable easy tissue penetration and difficult removal. *Proceedings of the National Academy of Science* 109: 21289–21294.
- Elbroch, L. M., P. E. Lendrum, J. Newby, H. Quigley, and D. Craighead.** 2013. Seasonal foraging ecology of non-migratory cougars in a system with migrating prey. *PLoS ONE* 8: e83375.
- Ferguson, J. A., K. Woodberry, C. M. Gillin, D. H. Jackson, J. L. Sanders, W. Madigan, R. J. Bildfell, and M. L. Kent.** 2011. Cylicospirura species (Nematoda: Spirocercaidae) and stomach nodules in cougars (*Puma concolor*) and bobcats (*Lynx rufus*) in Oregon. *Journal of Wildlife Diseases* 47: 140–153.
- Foster, R. J., B. J. Harmsen, B. Valdes, C. Pomilla, and C. P. Doncaster.** 2010. Food habits of sympatric jaguars and pumas across a gradient of human disturbance. *Journal of Zoology* 280: 309–318.
- Johnson, M. D., K. D. Magnusson, C. L. Shmon, and C. Waldner.** 2006. Porcupine quill injuries in dogs: a retrospective of 296 cases (1998–2002). *Canadian Veterinary Journal* 47: 677–682.
- Katzner, T., T. A. Miller, J. Rodrigue, and S. Shaffer.** 2015. A most dangerous game: death and injury to birds from porcupine quills. *Wilson Journal of Ornithology* 127: 102–108.
- Knopff, K. H., A. A. Knopff, A. Kortello, and M. S. Boyce.** 2010. Cougar kill rate and prey composition in a multiprey system. *Journal of Wildlife Management* 74: 1435–1447.
- López-González, C. A., and A. González-Romero.** 1998. A synthesis of current literature and knowledge about the ecology of the puma (*Puma concolor*, Linnaeus). *Acta Zoológica Mexicana* 75: 171–190.
- Maser, C., and R. S. Rohweder.** 1983. Winter food habits of cougars from northeastern Oregon. *Great Basin Naturalist* 43: 425–428.
- Mukherjee, S., and M. R. Heithaus.** 2013. Dangerous prey and daring predators: a review. *Biological Reviews of the Cambridge Philosophical Society* 88: 550–563.
- Murphy, K., and T. K. Ruth.** 2010. Diet and prey selection of the perfect predator. Pages 118–137 in *Cougar Ecology and Conservation*. Edited by M. Hornocker and S. Negri. University of Chicago Press, Chicago, Illinois, USA.
- Quick, H. F.** 1953. Occurrence of porcupine quills in carnivorous mammals. *Journal of Mammalogy* 34: 256–259.
- Robinette, W. L., J. S. Gashwiler, and O. W. Morris.** 1959. Food habits of the cougar in Utah and Nevada. *Journal of Wildlife Management* 23: 261–273.
- Ross, P. I., M. G. Jalkotzy, and P. Y. Daoust.** 1995. Fatal trauma sustained by cougars, *Felis concolor*, while attacking prey in southern Alberta. *Canadian Field-Naturalist* 109: 261–263.
- Sweitzer, R. A.** 1996. Predation or starvation: consequences of foraging decisions by porcupines (*Erethizon dorsatum*). *Journal of Mammalogy* 77: 1068–1077.
- Thompson, D. J., D. M. Fecske, J. A. Jenks, and A. R. Jarding.** 2009. Food habits of recolonizing cougars in the Dakotas: prey obtained from prairie and agricultural habitats. *American Midland Naturalist* 161: 69–75.

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