First Record of Parasites from Cougars (*Puma concolor*) in Manitoba, Canada

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Dare, O. K., and W. G. Watkins. 2012. First record of parasites from Cougars (*Puma concolor*) in Manitoba, Canada. Canadian Field-Naturalist 126(4): 324–327.

Cougars (*Puma concolor*) are a rare sighting in Manitoba. This is the first report on Cougar parasites in Manitoba and the first record of *Taenia omissa* for the province. These data provide an important baseline that will inform future research on parasite profiles and predator–prey interactions between these large carnivores and other wildlife in the province.

Key Words: helminths, cestode, tapeworms, nematode, roundworms, Cougar, *Puma concolor*, *Taenia omissa*, *Toxocara cati,* Manitoba.

The Cougar (*Puma concolor*) is a rare species in Manitoba; only one confirmed sighting per year has been recorded since 2001. Historical accounts are few, but it seems likely that the range of the species extended to the north as far as southern Manitoba at the time of European settlement. Cougars were generally assumed to have been extirpated from the province until 1973, when an adult male Cougar was shot by a landowner. This event and a review of well-documented sightings established the Cougar as being resident (Nero and Wrigley 1977). However, 31 years passed before another dead Cougar was turned over to wildlife management authorities. In 2004, an adult female Cougar was also shot by a landowner. One month later and 97 km away, an adult male was caught by a licensed trapper in a power snare set for Coyotes (*Canis latrans*). The propensity to scavenge makes Cougars susceptible to baited traps set for Gray Wolves (*Canis lupus*) or Coyotes (Knopff et al. 2010), and a fourth Cougar (the third adult male), was discovered in a trap set for Coyotes close to the Canada–U.S. border south of Boissevain in January 2011.

The ratio of male to female Cougars that have been killed in Manitoba and the lack of any confirmed sightings of kittens over the last 10 years make it unclear whether the few animals found in recent years are members of a resident cryptic population or are dispersing into or through the province from populations elsewhere. The nearest known breeding population is found in North Dakota, and a recent evaluation of potential dispersal corridors in the U.S. Midwest noted several that potentially connect the Badlands of North Dakota to southern Manitoba (LaRue and Nielsen 2008). There is little evidence to suggest that Cougars in Manitoba may have come from the Cypress Hills population on the Alberta–Saskatchewan border to the west.

Although the source of the few Cougars observed in Manitoba remains unknown, the identification of their associated parasites provides a basis for further investigation into where these Cougars have been, that is, host range dispersal and possible source of intermediate host species. We report our observations of parasites found in the Cougar caught in January 2011 and, within the limits of our single sample, discuss our findings.

Methods

The young male trapped in 2011 weighed 65.9 kg, making it the heaviest Cougar reported from Manitoba in the modern era. Its age was based on dentition and coat, and was estimated to be 3–5 years. It was skinned and the carcass was kept frozen until necropsy. The hide was preserved for display at the Manitoba Museum. Weights of the male and female adult Cougars killed in 2004 were 52.2 kg and 41.3 kg, respectively; the weight of the male killed in 1973 was 41.3 kg (Nero and Wrigley 1977).

A gross pathological examination of the carcass of the young male caught in 2011 for body condition and tissue lesions was followed by a closer examination of organs, fat, and musculature for helminth (parasitic worm) infection by sectioning pieces and pressing between plates of glass. The lungs were cut open with scissors along air passages. The eyes and brain were not examined. The intestines were sliced open and gently rinsed into a basin with warm water. The wash was then passed through two sieves of different mesh sizes to collect the contents. Helminths were found in only the small intestine.

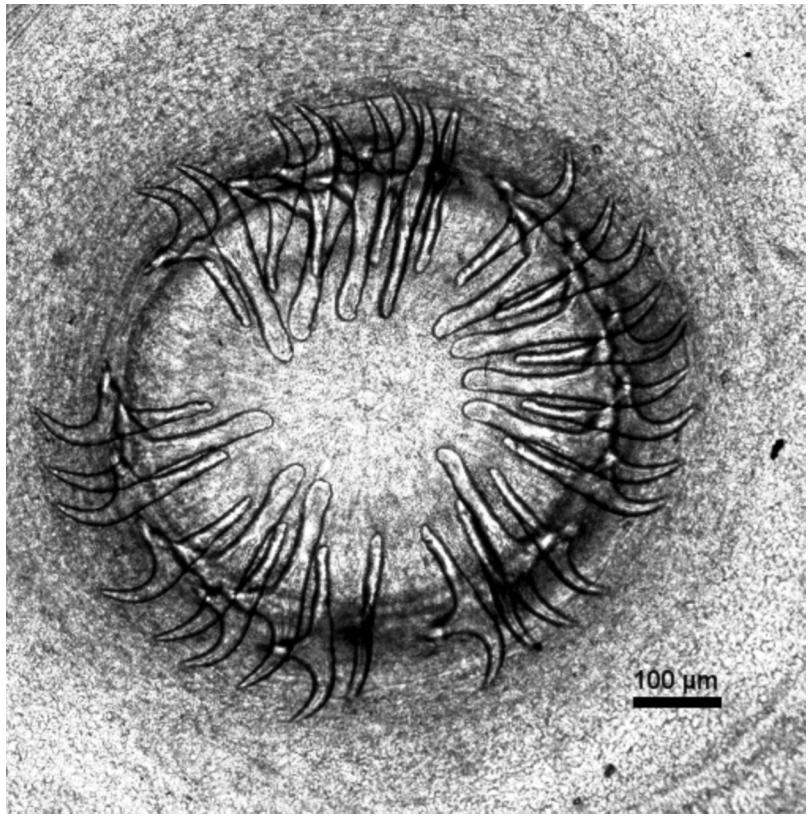

FIGURE 1. *En face* view of slide-mounted rostellar hooks of *Taenia omissa* recovered from the gastrointestinal tract of a Cougar (*Puma concolor*) from Manitoba, Canada (magnification 20×). Large hooks ranged in size from 246.5 to 276.0 µm; small hooks ranged from 177.5 to 221.8 µm.

Cestodes (tapeworms) were relaxed in physiological saline for 6 hours during transportation to another wet lab for closer examination, and measurements of length and width for each worm were taken. The cestodes were then processed using standard methods of fixation in Bouin's fixative (picric acid, acetic acid, formaldehyde) and stored in 70% ethanol.

Nematodes (roundworms) were placed in 95% ethanol during transportation to the wet lab, then transferred to 70% glycerol solution (glycerol: 70% ethanol) to clear within 10 hours of collection.

Results

Fifteen adult cestodes were found, ranging from 139 mm to 694 mm in length (mean 293.9 mm, SE 4.0). Strobila widths, measured at the widest (most mature) proglottids, ranged from 10 to 11 mm (mean 10.5 mm, SE 0.11). The rostellum of each cestode was sliced off, cleared with a few drops of xylene, placed *en face* onto a microscope slide, and mounted under a coverslip to observe the hooks (Figure 1). The hooks were measured with the use of a microscope eyepiece graticule at 20× magnification. Blade and handle lengths were also measured for each hook, as described by Riser (1956) (Table 1). The shape and size of the hooks and strobilar widths are consistent with those reported for *Taenia omissa* from North American felids (Riser 1956; Rausch 1981; Loos-Frank 2000; Jones and Pybus 2001). Four of the 15 worms had lost their rostellar hooks and thus the species could not be confirmed for these specimens; however, the characteristic width and shape of the strobila distinguished these worms from other similar species, such as *Taenia rileyi* (Rausch et al. 1983). Reference specimens were deposited in the Manitoba Museum (accession numbers TMM 54921 and 54922).

Seven nematodes were found and identified by their characteristically prominent cervical lateral alae as *Toxocara cati* (Fisher 2003). Five of these worms were identified as females and two as males possessing characteristic digitiform tails with spicules (Eberhard and Alfano 1998). Reference specimens have been deposited in the Manitoba Museum (accession numbers TMM 54923 and 54924).

TABLE 1. Rostellar hook length measurements for *Taenia omissa*. Measurements include whole hook, blade, and handle lengths for small and large hooks from 11 cestodes. Mean, standard error, and range of lengths are reported.

Taenia omissa hooks	Whole length (µm)	Blade (µm)	Handle (µm)
Large (n = 37)	259.7 ± 0.9 (246.5–276.1)	87.3 ± 1.0 (64.1–98.6)	172.4 ± 1.4 (162.7–197.2)
Small (n = 117)	193.7 ± 0.9 (177.5–221.8)	75.3 ± 0.4 (64.1–83.8)	118.5 ± 1.1 (93.7–152.8)

In comparison to the two dead Cougars examined in 2004, the 2011 specimen was relatively free of pathologies. Scarring consistent with past blunt trauma was evident on the internal organs of both animals killed in 2004. The male exhibited scar tissue on the right lung, the pancreas, and along the duodenum. The female's injuries were more severe. Scar tissue was evident on her spleen; her diaphragm, although healed, had been perforated. A fold of mesenteric membrane protruded through the perforation, held tightly in place by scar tissue. Breathing must have been compromised for some time following the injury, and the presence of old North American Porcupine (*Erethizon dorsatus*) quills in the front legs and throat area of the animal suggest that she may have compensated for an inability to run down larger prey by hunting small mammals. Specimens believed to be *Taenia omissa* and *Toxocara cati* were retrieved from both animals (January 22, 2005), but this information cannot be verified, as notes and voucher specimens have been lost in a fire (Lane Graham, personal communications, Jan–Mar 2005).

Discussion

This first record of Cougar parasites for Manitoba is consistent with helminth species and burdens previously documented for other Cougars in North America (see Rausch et al. 1983). *Toxocara cati* is often found in wild felids and has been reported in Cougars in the U.S.A. (Rausch et al. 1983). Infection by this nematode occurs through the ingestion of eggs or second stage larvae (L2) in tissues of a number of small mammal prey species (Despommier 2003).

Cougars are believed to be exclusive definitive hosts of *Taenia omissa,* and this cestode has been recovered from Cougars across their full range, from British Columbia and Alberta, as well as from several states along the west coast of the U.S.A. and Colombia (Rausch 1981; Rausch et al. 1983; Waid and Pence 1988). White-tailed Deer (*Odocoileus virginianus*) and Mule Deer (*Odocoileus hemionus*) are the intermediate hosts for *Taenia omissa* (Forrester and Rausch 1990; Pybus 1990). Analysis of the intestinal contents of the necropsied Cougar revealed White-tailed Deer hair remains identified to species by experts from the Manitoba Museum. High densities of White-tailed Deer populate southwestern Manitoba (Manitoba Conservation 2007), and it is possible that the Cougar acquired infections from local White-tailed Deer populations; however, as discussed below, the presence of intermediate hosts may be only one factor in acquisition of infection. Although Mule Deer are found in southwestern Manitoba, they are extremely rare and are listed as a threatened species under the Manitoba Endangered Species Act. The Wildlife Branch of Manitoba Conservation receives a handful of reports of sightings (4 or 5) per year, but exact numbers of Mule Deer are unknown.

Parasites can serve as a useful surrogate for determining ecological and trophic linkages among host species (Hoberg and Mcgee 1982; Hoberg 2010). The transmission of parasites is often intimately linked to trophic interactions among predator and prey species, and parasites with complex lifecycles are most often transmitted from one host to another along a food chain. For parasites that infect few host species, high densities and frequent interaction among hosts are required to ensure continued transmission (Torchin et al. 2003; Torres et al. 2006; Hoberg 2010). Studies have shown that high densities of hosts can relate to the accumulation of parasite species (Morand and Poulin 1998). Furthermore, hosts, including large carnivores that live in low densities within small geographical ranges, have been found to be depauperate in parasite species (Torres et al. 2006). Thus, particularly for host-specific species, parasite survival is intimately linked to the presence and density of unique host species, and the loss of a single host species in the chain of a parasite's lifecycle may lead to local extirpation.

This intimate association offers the opportunity to use parasite species as indicators of the presence of host species that comprise the lifecycle and also provides a coarse measure of the density of definitive and intermediate hosts. Such information is particularly valuable for species that are cryptic or otherwise difficult to study. Thus, one explanation for the observed low parasite species richness in this Cougar could be the presence of only a small resident population of Cougars with limited ranges of movement.

Loss of parasite species may also occur during extra-range host dispersal, in which host movement into new habitats presents conditions that may not be conducive for the continuation of host-specific lifecycles (see Torchin et al. 2003; Colautti et al. 2004). Thus, the low parasite richness observed in this Cougar may relate to "parasite release," whereby hosts lose parasites associated with enzootic ranges and fail to acquire new parasites in newly established ranges. Hosts may also lose parasites from home ranges and acquire new parasites from the newly established ranges (Hoberg and

Mcgee 1982; Torchin et al. 2003). These two latter mechanisms may or may not be dependent on the density of the host species.

We acknowledge that this is a single sample and we thus cannot draw any conclusions concerning the mechanisms that would explain our findings. Further research on any future Cougars in Manitoba and an examination of White-tailed Deer in the vicinity are needed to confirm the region as a potential source of infection.

This report provides an important foundation for parasite research on Cougars in Manitoba and intermediate hosts, and it contributes to the general body of knowledge on parasite infections in this cryptic felid species.

Acknowledgements

We are grateful to Lane Graham for providing some historical context for previously examined Cougars in the province and for his directions on the technical aspects of parasite identification. We thank Mark Swendrowski for the initial pathological examination of the carcass and the Biology Department at Brandon University and Bernadette Ardelli for the use of laboratory space and a departmental microscope for the examination and preservation of helminth specimens. Four anonymous referees made helpful comments on earlier versions of this manuscript. Financial support for this study was provided by Manitoba Conservation, Manitoba Agriculture, Food and Rural Initiatives (MAFRI), and by the Natural Sciences and Engineering Research Council (NSERC) of Canada.

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Received 15 November 2011
Accepted 16 March 2012