

Fatal Aerosacculitis and Pneumonia Associated with *Eucoleus* sp. (Nematoda: Capillaridae) in the Lungs of a Peregrine Falcon (*Falco peregrinus*)

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ABSTRACT: A Peregrine Falcon (*Falco peregrinus*) died of verminous and bacterial pneumonia and aerosacculitis associated with capillarid nematodes of the genus *Eucoleus*. This represents an aberrant location for these helminths in avian hosts. Although positive identification was not possible, the worms resembled *Eucoleus aerophilus*, a species not reported previously from birds.

A disabled, wild, male, adult Peregrine Falcon (*Falco peregrinus*) was captured on the ground near Trois-Rivières, Quebec, Canada (46°22'40"N, 72°44'2"W) in April 2010. The bird died during transportation to a rehabilitation center, where a postmortem examination was performed the same day. The falcon was emaciated, with a mass of 427 g compared with the normal male mean weight (\pm SD) of 652 \pm 52.4 g (Dunning, 2007). The walls of all air sacs and the coelomic serosal surfaces were covered with multifocal, slightly elevated, yellow, fibrinous plaques, 1–3 mm in diameter. Between 20 and 30 nematodes, 0.12–0.18 mm in maximum width and 25–41 mm long (measured on thawed and then preserved specimens), were embedded in the pleural surface (Fig. 1) and throughout both lungs.

Tissue samples were fixed in 10% buffered formalin, embedded in paraffin, sectioned at 3 μ m, stained with hematoxylin-phloxine-saffron, and examined by light microscopy. The air sac walls were covered with a fibrinous exudate containing degenerate heterophils, bacterial colonies (gram-positive cocci), and nematode eggs. The superficial bronchi and parabronchi were markedly distended with

mucoid material containing bacterial colonies, sections of adult nematodes, and similar nematode eggs (Fig. 2). The adjacent pulmonary parenchyma was congested and collapsed. Large numbers of eggs, surrounded by a suppurative to pyogranulomatous inflammatory reaction, were observed on the intestinal and pancreatic serosal surfaces. Bacterial culture of lung tissue yielded low numbers of *Staphylococcus* sp. and *Enterococcus* sp.

The parasitic and bacterial bronchopneumonia, aerosacculitis, and serositis were of sufficient intensity to have resulted in emaciation and death of this bird. In similar lungworm infections, the bacterial pneumonia was identified as a consequence of parasitic migration from the digestive system to the lungs and air sacs, with secondary bacterial contamination (Lavoie et al., 1999).

Nematodes collected at postmortem examination were preserved in glycerine-ethanol-formalin solution (respectively, 5%-85%-10%), and these and additional worms recovered from thawed lung samples were cleared in glycerol. The overall morphology and morphometrics of the adults, eggs, faintly sclerotized spicule (visible in one specimen), and spinose spicular sheath indicated that the parasites belonged to the genus *Eucoleus*. For comparison, we obtained *Eucoleus contortus* from the esophagus of a Ring-billed Gull (*Larus delawarensis*) near Montreal, Québec, with additional specimens from the US National Parasite Collection (24873, 28697, USNPC, USDA, Beltsville, Maryland, USA).

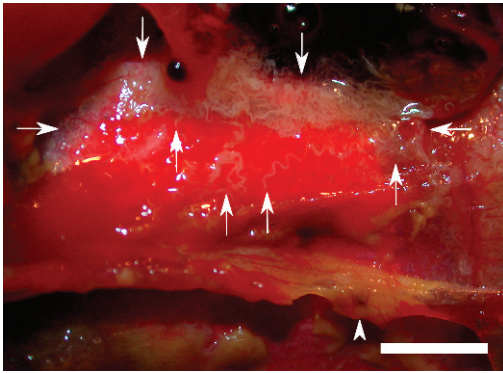


FIGURE 1. Ventral surface of the right lung of a Peregrine Falcon (*Falco peregrinus*) from Quebec, Canada, infected with numerous nematodes (*Eucoles cf. aerophilus*; arrows). The adjacent air sac walls are thickened by exudate (arrowhead). Bar=500 μ m.

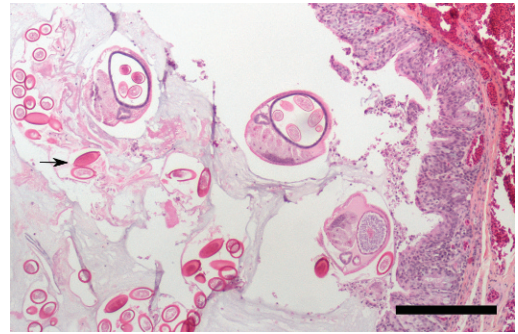


FIGURE 2. Sections of the lumen of a markedly distended secondary bronchus of a Peregrine Falcon (*Falco peregrinus*) from Quebec, Canada. The enlarged lumen is filled with adult nematodes (*Eucoles cf. aerophilus*) and characteristic bipolar eggs (arrow) surrounded by a mucopurulent exudate. Bar=200 μ m. Hematoxylin-phloxine-saffron stain.

However, the worms from the falcon lungs differed morphologically from this and other species of capillarids known from the avian gastrointestinal tract (Read, 1949; Baruš and Sergejeva, 1989a, b). The worms were most similar to *Eucoles aerophilus*. In females, the ratio of the length of the esophagus to that of the entire worm was 1:4.3, similar to descriptions by Butterworth and Beverly-Burton (1980), who found ratios ranging from 1:4.5 to 6.1. The slight bulge in the anterior lip of the vulva, which was otherwise unadorned, resembled descriptions and depictions of *E. aerophilus* by Butterworth and Beverly-Burton (1980) and Romashov (2000). However, both males and females had fewer (<36) stichocytes than are typically found in *E. aerophilus* (>40), and the esophagus to body length ratio in one male (1:5.2) differed from those reported by Butterworth and Beverly-Burton (1980) and Romashov (2000) (1:2.6–3.9). Specimens have been deposited in the USNPC (*E. cf. aerophilus* ex *F. peregrinus*, accession 105089.00, and *E. contortus* ex *L. delawarensis*, accession 105306.00).

Capillarids infecting mammals and birds are considered tissue specific, and several authors have ascribed diagnostic

importance to both the host and organ infected (Butterworth and Beverly-Burton, 1980; Baruš and Sergejeva, 1989a, b). Whether these specimens are *E. aerophilus* s.s., they are, to our knowledge, the first report of capillarid nematodes in the avian respiratory system. Capillarids of birds have been recorded only in the gastrointestinal tract and are infrequently observed in Peregrine Falcons (Yabsley, 2008). In contrast, *E. aerophilus* and related species occur in the airways of mammalian carnivores (Anderson, 2000) but have not been found in birds. While we believe this is a case of an aberrant avian host infected with a mammalian respiratory parasite, we cannot exclude other possibilities. In particular, these nematodes could represent an undescribed species or an ectopic infection of an avian intestinal parasite, but we consider these scenarios unlikely. Molecular data are necessary to definitively assign these specimens to *E. aerophilus* or other described species. However, molecular data from capillarids currently available for comparison are fragmentary (Zhu et al. 2000; Honisch and Krone, 2008).

Maladaptation of the host to the parasite could explain the strong immune reaction and emaciation of the falcon.

Nematodes typically found in the respiratory tract of birds of prey (*Cyathostoma*, *Serratospiculum*, *Serratospiculoides*) often cause no visible disease but are sometimes associated with bacterial or fungal respiratory infections (Fernando and Barta, 2009; Sterner and Cole, 2009) and host mortality (Lavoie et al., 1999). The condition of this falcon could also relate to the intensity of infection, which was higher than that typically reported for capillarids in either birds or mammals (Butterworth and Beverley-Burton, 1999; Yabsley, 2008).

If, as we suspect, this parasite is *E. aerophilus*, it is not clear what could have led to this unusual infection. Mammalian hosts acquire *E. aerophilus* by preying on infected earthworms (Anderson, 2000). Earthworms have not been recorded in the diet of Peregrine Falcons, which feed mostly on birds and occasionally on mammals and insects (Ellis et al., 2004). We speculate that the falcon could have become infected after preying on a bird that recently consumed earthworms.

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Submitted for publication 7 November 2011.

Accepted 25 February 2012.