

## Air Sac Nematode (*Serratospiculum tendo*) Infection in an Austral Peregrine Falcon (*Falco peregrinus cassini*) in Argentina

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**ABSTRACT:** We report a case of air sac nematode (*Serratospiculum tendo*) infection in an adult male Austral Peregrine Falcon (*Falco peregrinus cassini*) admitted to a rehabilitation center in Mendoza Province, Argentina, in September 2017. This case of air sac nematodes reported in an Argentine raptor is only the second report of *S. tendo* in South America. We recommend examination of all raptors, especially those falcon species that include insects in their diet and inhabit open lands and those in rehabilitation centers or kept for falconry, education, or captive breeding. Fecal analysis and microscopic examination of oral swabs for evidence of parasites are simple noninvasive diagnostic procedures that allow easy detection of these parasites under field and captive circumstances.

**Key words:** Argentina, *Falco peregrinus cassini*, Mendoza province, Peregrine Falcon, *Serratospiculum tendo*.

Air sacs infections by species of filarial nematodes (Order Spirurida; Family Diplotriaeidae) have been reported for several species of birds of prey (Honisch and Krone 2008). Most species of air sac nematodes belong to the genus *Serratospiculum* and *Serratospiculoides* (Honisch and Krone 2008). Infections in falcons (Family Falconidae, Genus *Falco*) appears to be common (Samour and Naldo 2001; Santoro et al. 2016; Veiga et al. 2017) with a high overall prevalence in this group. For example, *Serratospiculum seurati* occurs commonly in falcons in the Middle East, both in wild and captive birds (Al Timimi et al. 2009). Reports on the occurrence of air sac nematodes in accipitrids are proportionally less common (Sternler and Espinosa 1988; Ackerman et al. 1992; Taft et al. 1993), suggesting air sac

nematodes are less prevalent in this group. Recently, Samour and Naldo (2001), Tarello (2006), and Veiga et al. (2017) reviewed the clinical, pathologic, and epizootiologic aspects of this parasitosis.

Air sac nematodes are known to occur in Peregrine Falcons (*Falco peregrinus*) in Asia, Europe, Australasia, and North America (Bain and Mawson 1981; Krone 2000; Green et al. 2006; Al Timimi et al. 2009; Santoro et al. 2016; Veiga et al. 2017). Recently, Gomez-Puerta et al. (2014) described a case of serratospiculosis associated with *Serratospiculum tendo* in a local Peregrine Falcon (subspecies not indicated) from Peru, that seems to be the first report of this nematode from South America. Herein, we report a case of serratospiculosis in an Austral Peregrine Falcon (*Falco peregrinus cassini*), expanding its known geographic distribution in South America and in Austral Peregrine Falcons, and, to generate interest within the wildlife disease community, investigate the presence of these nematodes in South American birds of prey.

On 2 September 2017, an adult Austral Peregrine Falcon was found in Maipú Department, Mendoza Province, Argentina, on the ground and unable to fly. The bird was captured, placed in a carrier and brought the same day to the Wildlife Rehabilitation Center Fundación Cullunche for medical treatment. On initial presentation, the bird was dehydrated and depressed and had a drooping left wing. On physical examination and a ventrodorsal radiograph, a caudal-ventral luxation of the left elbow was diag-



FIGURE 1. Air sac nematodes (*Serratospiculum tendo*) in the left caudal thoracic air sac of an Austral Peregrine Falcon (*Falco peregrinus cassini*) collected in September 2017 in Mendoza Province, Argentina.

nosed and considered responsible for the overall clinical presentation. Despite treatment with antibiotics, fluids, an anti-inflammatory drug, B complex vitamins, supportive therapy, and force-feeding, the bird died on 18 September 2017.

A partial gross postmortem examination the following day by the attending veterinarian revealed no obvious gross lesions on the lungs, liver, kidneys, intestine, or spleen. Air sacs appeared normal except for nematodes filling the space in the left caudal thoracic sacs (Fig. 1).

Sections of liver and kidney were fixed in 10% buffered formaldehyde, stained with H&E, and observed under optic microscopy

with 100 $\times$  and 400 $\times$  magnification. Nematodes were stored in 70% ethanol, cleared with lactophenol, and examined with an optic microscope and stereomicroscope. Characteristic structures were measured and used to identify the parasites. A bronchoalveolar lavage with isotonic saline was centrifuged at 1,000  $\times$  G for 5 min, and the sediment was examined microscopically for parasite eggs. Feces were collected directly from the cloaca of the falcon and analyzed by the formaldehyde-ether technique (Ritchie 1948). The fluid in which the nematodes had been stored also was examined for eggs. All eggs were measured (length and width) with a micrometer, and the mean, range, and SD were determined.

Six nematodes were found: five female anterior ends and one complete male. Microscopically, characteristic epaulets occurred on each anterior end and the females had no cuticle ornaments. The distance of the vulvae from the anterior end was 1,333.3  $\mu$ m (Fig. 2a). Eggs were present in the uterus of all females. Mean length of eggs ( $n=63$ ) was 46.1  $\mu$ m (SD=5.8; range, 32.1–58.3  $\mu$ m) and the mean width was 29.2  $\mu$ m (SD=5.76; range, 15.72–38.27  $\mu$ m). Eggs also were found in the feces and bronchoalveolar lavage of the falcon (Fig. 2b). In the male, the left spicule was 1,062.2  $\mu$ m long, and the right spicule was 430.6  $\mu$ m (Fig. 2c), with an area rugosa in the caudal end (Fig. 2d). The nematodes were identified as *S. tendo* (Bain and Mawson 1981; Anderson et al. 2009)

Histopathology revealed moderate, diffuse, active-chronic hepatitis with severe lymphocytic infiltrates and a small number of heterophils. Mild congestion and moderate glomerulonephritis was observed in the kidney section.

Air sac nematodes have not been previously described in a raptor from Argentina, and ours is only the second report of *S. tendo* in a Peregrine Falcon for South America. Austral Peregrine Falcons are common in Mendoza Province, inhabiting mountain, desert, and semidesert areas, where they seem to be year-round residents. There are no detailed studies of this population, and many aspects of

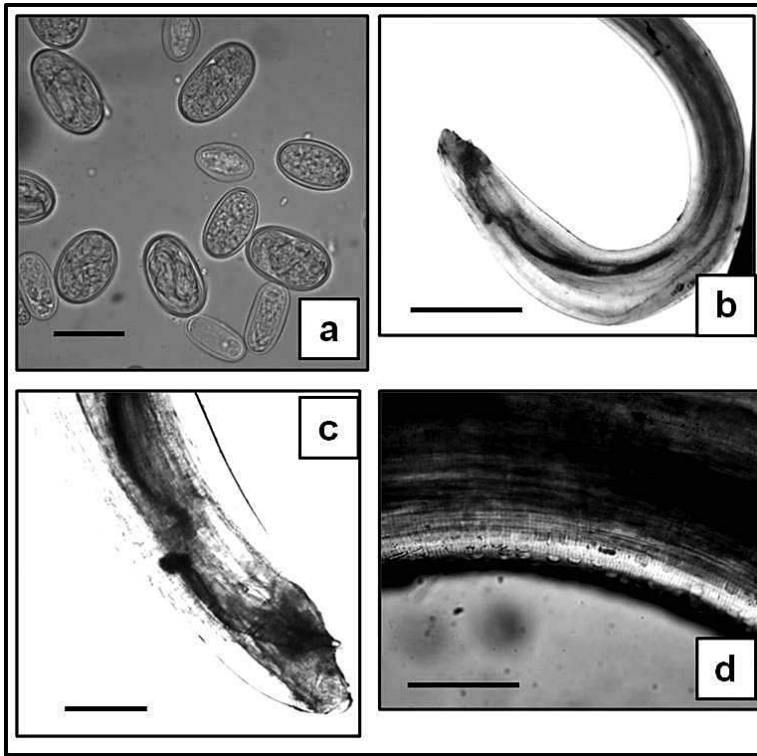


FIGURE 2. Air sac nematodes (*Serratospiculum tendo*) recovered from an Austral Peregrine Falcon (*Falco peregrinus cassini*) collected in September 2017 in Mendoza Province, Argentina. (a) Eggs from female uterus. Bar=0.04 mm. Caudal end of male nematode: (b) left spicule, bar=0.5 mm; (c) right spicule, bar=0.21 mm; (d) area rugosa, bar=0.5 mm.

Austral Peregrine Falcon ecology in Mendoza Province remain unknown.

Although Peregrine Falcons are mainly ornithophagous, invertebrates can be primary or secondary prey items. Air sac parasites have a heteroxenous life cycle (Bain and Mawson 1981; Samour and Naldo 2001), and raptors become infected by the ingestion of insects, mainly Orthoptera, such as beetles, locusts, and grasshoppers (Samour and Naldo 2001; Tarello 2006; Santoro et al. 2016). Once released in the proventriculus, L3 stages migrate through the proventricular wall, reach the air sacs, and become adults. Inside the air sacs, adult female nematodes lay embryonated eggs that are coughed up and swallowed, excreted with the feces, and then ingested by insects.

Clinical signs are usually unapparent; thus, air sac nematodes usually remain undetected.

They are commonly found during gross postmortem examination or by examination of feces. Commonly reported lesions are air sacculitis and necrosis of liver, kidneys, and lungs (Samour and Naldo 2001; Tarello 2006; Santoro et al. 2016). Sometimes infection may be fatal (Ward and Fairchild 1972; Kocan and Gordon 1976; Santoro et al. 2016). The air sacs of the Austral Peregrine Falcon in this case were normal. It was not clear if the lesions observed in the liver and kidney were a result of infection or other causes.

Imaging (radiographs of air sacs) and, in some cases, clinical manifestations of a respiratory problem, such as dyspnea or intolerance to exercise, can support a presumptive diagnosis. However, definitive diagnosis of serratospiculosis requires detection of embryonated eggs in fecal samples or oral

swabs or parasites in air sacs (Samour and Naldo 2001).

Fractures were associated with infection in 25 Peregrine Falcons in Italy (Santoro et al. 2016). The falcon in this case had an elbow luxation on the same side the parasites were found. Whether birds are more susceptible to trauma because of balance problem as a result of nematodes occupying the air sac space is unknown and requires further investigation.

We recommend examination of all raptors, especially those falcon species that include insects in their diet and inhabit open lands, such as Peregrine Falcon (*Falco peregrinus*), American Kestrel (*Falco sparverius*), and Aplomado Falcon (*Falco femoralis*), by fecal analysis and microscopic examination of oral swabs to detect air sac nematode infection in Argentine raptors.

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