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Further study of *Codiostomum struthionis* (Horst, 1885) Railliet and Henry, 1911 (Nematoda, Strongylidae) parasite of ostriches (*Struthio camelus* Linnaeus, 1758) (Aves, Struthioniformes)

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Abstract

Codiostomum struthionis is a nematode parasite of the ostrich caecum. Little is known about its pathology, being considered by many authors as a non-pathogenic parasite. Infections by *C. struthionis* are sometimes overlooked because its eggs are indistinguishable from another ostrich nematode, *Libyostrongylus* spp. Fecal cultures and infective larvae identification are necessary for proper identification. The aim of this study is to provide improved morphological characterization of adults and infective larvae of *C. struthionis*. Ten caeca of adult ostriches were collected and washed in 0.09% saline solution. Male and female nematodes were collected and quantified separately. Nematodes were fixed in A.F.A. for optical microscopy or fixed in Karnovsky solution for scanning electron microscopy. To obtain infective larvae, fecal samples were collected at sites of high concentration of parasites in the caeca and fecal cultured. The resultant larvae were identified and measured with light microscope at 400×. Nine of the 10 slaughtered ostriches were parasitized by *C. struthionis*. All nematodes were found in the distal third of the caeca. A total of 566 parasites were recovered (234 males and 332 females). All the cultured larvae had characteristics of *C. struthionis* (rounded cephalic region with a flat extremity, an acute larvae tail termination and a long and filamentous sheath tail). All the adult parasites were characterized as *C. struthionis*. Through the analysis of the infective larvae it was determined that the morphology of the larvae tail was the best trait to use in the distinction of this species (live bird diagnosis).

Keywords: Strongylidae; *Codiostomum struthionis*; Ostriches; *Struthio camelus*; Ratite; Nematoda; Infective larvae

1. Introduction

The most frequent gastrointestinal parasites reported in ostriches are the helminthes, *Libyostrongylus* spp., *Houttuynia struthionis* and *Codiostomum struthionis* (Craig and Diamond, 1996). *C. struthionis* is a parasite of the caeca, where it feeds on the caecal mucus, and is

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considered specific to the ostrich (Craig and Diamond, 1996). It was originally described as *Sclerostoma struthionis* by Horst in 1885. In 1911, Railliet and Hanry established the genus *Codiostomum,* with *C. struthionis* the only species of this genus. Since then there has little research regarding this nematode. It has been found in Europe (Ponce Gordo et al., 2002), South Africa (Popova, 1955) and possibly in Greece, where Sotiraki et al. (2001) found typical eggs of Strongylidae, but did not make fecal cultures to confirm the diagnosis. Infections by *C. struthionis* are frequently overlooked because its eggs are indistinguishable from of those of the smaller pathogenic ostrich wireworm *Libyostrongylus* spp. and fecal cultures should be done to differentiate the species using the infective larvae. These present a pointed-tipped tail and long and filamentous sheath tail, similar to a whip, typical of the Strongylidae (Craig and Diamond, 1996), while the infective larvae of the genus *Libyostrongylus* present a knob at the tail tip which is the diagnostic character for this genus with a short to medium length sheath tail. The sheath tail of *C. struthionis* infective larvae is similar to that of *L. dentatus*, long and filamentous that can cause an error in the diagnosis (Ederli et al., 2008). Its pathology is still little understood, but it is considered by many authors to be a non-pathogenic parasite (Huchzermeyer, 1998), but it can cause anemia and hinder normal development (Craig and Diamond, 1996). Due to its supposed inoffensiveness, Huchzermeyer (1998) discarded the necessity to treat the birds for infections by these nematodes, although benzimidazol and lavamizol seem to be efficacious against these parasites (Craig and Diamond, 1996).

The nematode life cycle has not yet been determined but it is believed that is simple and direct, typical of the Strongylidae (Soulsby, 1982). The ultrastructure is still little known, and there are a few studies on this subject, that only report the similarity of its eggs to those of *Libyostrongylus* spp., an ostrich proventriculus parasite, responsible for high mortality rates among young birds.

The aim of the present study was to carry out morphological characterization of adults and infective larvae of *C. struthionis*, as little is known about the morphology, ultrastructure and biology of this parasite.

2. Materials and methods

2.1. Nematodes

Ten caeca of adult ostriches were obtained from a slaughter-house in Quissamã, Rio de Janeiro state, Brazil (22°05′23″S; 41°41′48″W) and examined from the presence of parasites. Nematode specimens were collected and washed in phosphate buffered saline solution and fixed in hot A.F.A. (70° GL ethanol, 93%; formaldehyde, 5%; glacial acetic acid, 2%) or 2.5% glutaraldehyde. Male and female nematode identification and distinctions were made under a stereomicroscope (10–50 magnification).

Specimens deposited in the Australian Helminthological Collection (AHC), South Australian Museum (SAM), Adelaide, Australia, AHC 420, AHC 872 and AHC 874, and the in United States National Parasite Collection (USNPC), USDA, ARS, Beltsville, Maryland, USNPC 024522.00, USNPC 025463.00, USNPC 031865.00 were examined for comparative identifications.

Representative specimens were deposited in the United States National Parasite Collection (USNPC), USDA, ARS, Beltsville, MD, 20705, USA (USNPC no. 100687); in the Helminthological Collection of the Oswaldo Cruz Institute (CHIOC), Fundação Oswaldo Cruz, Rio de Janeiro, Brazil (CHIOC no. 35541) and in the Australian Helminthological Collection (AHC), South Australian Museum (SAM), Adelaide, Australia (AHC no. 34998).

2.2. Infective larvae

Fecal samples were collected from sites of high infection in the caeca. Fecal cultures were conducted with these samples according to the coproculture technique described by Bonadiman et al. (2006). Infective larvae were transferred to Falcon tubes (15 ml) and stored in a refrigerator. Within 24 h, a drop of distilled water containing larvae was placed on a slide and either heated for some second on a lamp flame, and identified, quantified and measured with aid of a Zeiss-Axiostar Plus light microscope equipped with a digital camera (Canon-PowerShot A640) for image capture and Software Zeiss AxionVision Sample Images for image analysis. Larvae were also drawn with the aid of an Axioplan Zeiss light microscope equipped with a camera lucida.

2.3. Light microscopy and measurements of adult nematodes

The nematodes were fixed in hot A.F.A. (70 °C) overnight, transferred to a solution containing 70% ethanol and 5% glycerin, cleared with lactophenol (one part distillated water, two parts glycerin, one part lactic acid, one part phenic acid) and creosote, mounted on slides and observed in a light microscope.