

Stomach nematodes of three sympatric species of anatid birds off the coast of Patagonia

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Abstract

The present study focuses on the nematode community in the stomachs of three sympatric anatid bird species from the Central Patagonian coast, Argentina. The bird species include the Chubut steamer duck, *Tachyeres leucocephalus*, the crested duck, *Lophonetta specularioides*, and the black-necked swan, *Cygnus melancoryphus*. Up to 138 nematodes representing five species were recovered from 10 of the 13 ducks examined, with an overall prevalence of 77% and a mean intensity of 13.8. Nematodes isolated from the gizzard were *Streptocara formosensis* and *Sciadiocara legendrei* (Acuariidae) in *T. leucocephalus*, and *Epomidiostomum vogelsangi* (Amidostomatidae) in *C. melancoryphus*, whereas *Echinuria uncinata* (Acuariidae) and *Tetrameres (Petrowimeres) fisispina* (Tetrameriidae) were found in the proventriculus of *L. specularioides*. In particular, *S. legendrei* was registered for the first time in South America and *T. leucocephalus*, whereas *T. fisispina* represents a new record in Argentina and *L. specularioides*. Moreover, *E. vogelsangi* and *E. uncinata* were isolated in Patagonia for the first time. The birds studied herein are sympatric in their distribution, and two of them are syntopic breeders; however, they were infected with different parasite species. This situation could be partially due to their diet or their seasonal movements, or a combination of both. Despite the low number of hosts examined, this work enhances our knowledge about parasites from a frequently occurring group of birds on the Patagonian coast, a subject that has not been studied extensively in South America.

Introduction

Waterfowl are widespread and clearly linked to aquatic environments, where each species shows a preference for a certain kind of habitat (Delacour, 1975; Carboneras, 1992). In particular, members of the family Anatidae make up an important element of both freshwater and marine aquatic ecosystems, and have varied diets and feeding methods (Carboneras, 1992;

Baldassarre & Bolen, 2006). Hence, they have the greatest chance of contact with invasive forms of parasitic worms.

Although the helminth community of wild ducks has been well studied in North American, European and Asian species (McDonald, 1974; Kavetska, 2005; Atkinson *et al.*, 2008; Kavetska *et al.*, 2012), little is known about the helminth communities of ducks in other parts of the world. In particular, the knowledge of nematodes from anatids in South America is very scarce. Most investigations have been carried out in Chile, Mexico (González *et al.*, 2005; Mercado Reyes *et al.*, 2010; Martínez Haro *et al.*, 2012) and Brazil (Vicente *et al.*, 1996; Vianna Mohr, 2001),

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while information about Argentina is still lacking (da Silveira *et al.*, 2006; Agüero & Diaz, 2013).

Patagonia harbours about 23 anatid species, with about 30% of them being residents (i.e. present in the area throughout the year with null or local movements), while others are considered partial migrants with both resident and migrant populations (Coconier & Blanco, 2005). Of the species studied here, two are residents: the Chubut steamer duck, *Tachyeres leucocephalus* (Humphrey and Thompson, 1981), and the crested duck, *Lophonetta specularioides* (King, 1828), while the black-necked swan, *Cygnus melancoryphus* (Molina, 1782) is a partial neotropical migrant. *Tachyeres leucocephalus* is a flightless marine endemic bird that lives along a small section of the Patagonian coastline in Argentina (Agüero *et al.*, 2012), and it breeds in syntopy with *L. specularioides* on the northern San Jorge Gulf, Chubut. On the other hand, *C. melancoryphus* dwells in freshwater and brackish-water marshes. After breeding, some of the southern Patagonia populations migrate northward along the eastern, central and western Patagonian routes. Opportunistic movements were also recorded in relation to drought conditions (Blanco *et al.*, 2008).

The aim of this study was to record new data of nematodes in these three sympatric anatid bird species from the central Patagonian coast in Argentina, and to provide information about the diet of their hosts.

Materials and methods

Thirteen anatids – four *T. leucocephalus*, five *L. specularioides* and four *C. melancoryphus* – were examined for stomach nematodes. All specimens were observed dying on the coast and were found dead some days later and collected. *Tachyeres leucocephalus* specimens were found during the summers of 2007/2010/2012 and *L. specularioides* during the summer of 2008 and 2014, all of them in the northern San Jorge Gulf, Chubut Province (45°02'S; 65°52'W). *Cygnus melancoryphus* specimens were collected in the Nuevo Gulf, Chubut Province (42°02'S; 65°52'W) during the summers of 2004/2009/2012; and also on the Bahía Engaño coast (43°20'S; 65°02'W) during the summer of 2014. Birds were necropsied to dissect the entire alimentary tract, isolating the proventriculus and gizzard for parasitological inspection. Nematodes found were counted and preserved in 70% ethanol, and studied in temporary mounts of either lactophenol or 25% glycerine-alcohol. Drawings were made with the aid of a camera lucida. Several specimens were dried using the critical point method, examined by scanning electron microscopy (SEM) (Philips SEM 505[®]; Philips, Amsterdam, The Netherlands), and photographed. Voucher specimens were deposited in the Helminthological Collection of the Museo de La Plata (MLP He 6661, 7021, 7022, 7023 and 7024), La Plata, Argentina, and the Parasitological Collection of the Centro Nacional Patagónico (CNP-Par-60, 93, 94 and 95), Puerto Madryn, Argentina. Also, the stomach contents were examined under 8× to 64× magnification, and fragments of invertebrates resistant to digestion were identified using published guides (Boschi *et al.*, 1992), reference collections hosted at the Centro Nacional Patagónico and by consulting taxonomy

specialists. Prevalence (P) and mean intensity (MI) were calculated following Bush *et al.* (1997).

Results

Five nematode species, including four spirurids and one strongylid, were found in the proventriculus and under the koilin lining of the gizzard in 10 of the 13 ducks examined. The spirurid *Echinuria uncinata* (Rudolphi, 1819), belonging to the family Acuariidae and sub-family Acuariinae, was found in the lumen of the proventriculus of two *L. specularioides* (P = 40%; MI = 11.5). This species is recognized by the length of cordons, position of the minute deirids, lateral rows of spines, and by the morphology of the terminal male genitalia (fig. 1a–c). *Tetrameres (Petrowimeres) fisispina* (Diesing, 1861), belonging to the family Tetrameriidae, was found in the proventricular glands of two *L. specularioides* (P = 40%; MI = 9.5). The species was identified by the features of the cephalic extremity and morphology of the male spiculae. *Streptocara formosensis* (Sugimoto, 1930), belonging to the family Acuariidae and sub-family Seuratiinae, parasitized the gizzard of three *T. leucocephalus* (P = 75%; MI = 7). This species is recognized on the basis of the anterior extremity morphology, buccal capsule length, deirids, distribution of papillae, features of the male spiculae and the vulva position of females. *Streptocara formosensis* is easily distinguished from other species in the genus by the absence of the cephalic collar. *Sciadiocara legendrei* (Petter, 1967), belonging to the family Acuariidae and sub-family Schistorophiinae, was found in only one of the steamer ducks (P = 25%; MI = 3), and could be identified by the morphology of the ptilinae in the anterior extremity, number of papillae and features of the spiculae of males, and the vulva position of females. The strongylid *Epomidiostomum vogelsangi* (Travassos, 1937), belonging to the family Amidostomatidae, parasitized all *C. melancoryphus* examined (P = 100%; MI = 18.5). The species is identified and easily distinguished from other strongylid species by the morphology of the male caudal bursa, and by the presence of four 'epaulette-like' structures in the anterior end, deeply incised into 3–4 lobes and carrying 2–3 teeth each (fig. 1d–f).

The gizzard and proventriculus were not occupied simultaneously in any duck. Co-infection was observed only in the proventriculus of one crested duck (i.e. *T. fisispina* and *E. uncinata*).

Examination of stomach contents showed that Chubut steamer ducks feed on crustaceans (*Cyrtograpsus* spp. and isopods), molluscs of the Mytilidae family and polychaetes of the Nereiididae family. Crested ducks mainly foraged on crustaceans such as anfipods, cladocerans and crabs of the genus *Cyrtograpsus*. Only one bird fed on polychaetes of the Nereiididae family. Interestingly, the stomachs of black-necked swans were empty and we could not identify any organic matter.

Discussion

Echinuria uncinata is a very common and widely distributed helminth of waterfowl, and has been found associated with granulomas (nodules) in the gizzard wall,

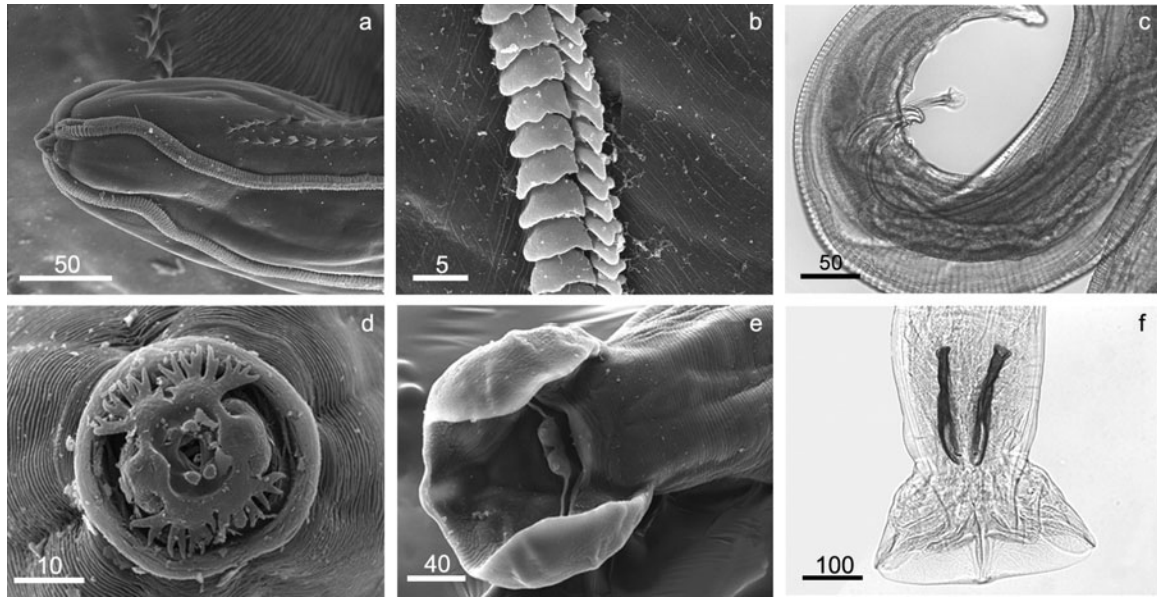


Fig. 1. (a–c) Morphology of *Echinuria uncinata*, showing: (a) the anterior end with cordons; (b) detail of cordons and (c) lateral view of male showing spiculae. (d–f) Morphology of *Epomidiostomum vogelsangi*, showing: (d) the anterior end, apical view showing the ‘epaulette-like’ structures, and (e) and (f) posterior extremity of male showing papillae and spiculae, ventral views. All scale bar values are given in micrometres.

the proventriculus and, rarely, in the oesophagus. This nematode species has been reported in several species of Anseriformes (Anatidae) and Charadriiformes in Europe, Asia, Africa and North America (McDonald, 1969, 1974). The first record of this parasite from South America, and particularly in northern Argentina, was recorded by da Silveira *et al.* (2006) in the rosy-billed pochard (*Netta peposaca*). Although, *E. uncinata* was recovered from *L. specularioides* in the northern hemisphere (McDonald, 1969), our findings represent the first record of this nematode in this bird species in southern Argentina. *Echinuria uncinata* has an indirect life cycle, as crustaceans of the genus *Daphnia* and *Ceriodaphnia* (Cladocera) are the first intermediate hosts (Anderson, 2000). Although we did not find this type of prey in the stomachs examined, it is probable that the ducks in the present study became infected by cladocerans. The absence of small crustaceans in the examined hosts may be due to the fact that they are quickly and almost completely digested, so they would be under-represented in stomach contents (Swanson & Bartonek, 1970).

Streptocara formosensis appears to be a common parasite of anatids. It has been registered in a large number of Anseriformes, most of which are spread over the northern hemisphere (Gibson, 1968; Delacour, 1975; Carboneras, 1992; Królaczyk *et al.*, 2012). However, Agüero & Diaz (2013) enlarged the host and geographical distribution of this parasite by recording it for the first time in *T. leucocephalus* from South America. Our findings were consistent with those records and support the hypothesis that *Anas platyrhynchos* and/or *Cairina moschata* play a key role in the dispersion of this nematode species on both the Patagonian coast and in the Chubut steamer duck (Agüero & Diaz, 2013). Although the life cycle of

S. formosensis is still unknown, it is probably similar to that of *Streptocara crassicauda* (Creplin, 1829) (McDonald, 1969). In that sense, and according to the Chubut steamer ducks’ diet, intermediate hosts could be marine crustaceans, such as crabs (*Cyrtograpsus* spp.) and isopods, which seem to be the predominant prey items in this bird’s diet.

Sciadiocara legendrei has been recovered from waders around Europe, Australia and New Zealand (i.e. *Numenius phaeopus*, *Capella media*, *Larus novaehollandiae*, *Calidris canutus*, *Gelochelidon nilotica* and *Charadrius leschenaultii*) (Wong & Anderson, 1985; Wong & Lankester, 1985). Our findings from *T. leucocephalus* represent the first record of this parasite in America and in an anatic bird. Of the previously recorded hosts, *N. phaeopus* and *C. canutus* are migrants from the northern hemisphere and have been recorded from marine coasts of Patagonia, Argentina, during the austral summer (Narosky & Yzurieta, 2003). Taking into account that *T. leucocephalus* is an endemic flightless anatic from a small section of the Chubut marine coast, it is likely that *N. phaeopus* and *C. canutus* are involved in the transmission of this parasite. Since all hosts inhabit the marine environment, intermediate hosts are likely to be marine invertebrates, although there is no available information on this parasite’s life cycle.

Tetrameres fissispina has been recovered from wild and domestic ducks and geese, Podicipediformes, Ciconiiformes, Falconiformes, Galliformes, Gruiformes, Charadriiformes, Columbiformes and Strigiformes, in several parts of the world, including Brazil (McDonald 1969, 1974; Vicente *et al.*, 1996). Species of the genus *Tetrameres* have an indirect life cycle. The first intermediate host of *T. fissispina* could be aquatic arthropods such as cladocerans and amphipods, with birds becoming infected by

consuming these arthropods directly or indirectly using facultative hosts (Anderson, 2000). Taking into account that cladocerans were registered in the stomach contents of the hosts examined here, these invertebrates are probably involved in the transmission of this parasitic species to the definitive bird host. Our findings are the first record for *L. specularioides* from Argentina, and represent the southernmost record of this nematode species.

Although the genus *Epomidiostomum* is widely distributed among aquatic birds, mainly anseriforms, *E. vogelsangi* has been considered to be a rare parasite of waterfowl and has only been recorded twice, in captive *C. melancoryphus* from Rio Grande do Sul, Brazil (McDonald, 1969, 1974; Fedynich & Thomas, 2008). The life cycle of *E. vogelsangi* is unknown, but other species of the genus have a direct life cycle (Fedynich & Thomas, 2008). This is the first time that this nematode has been recorded in a wild bird and is its southernmost record (in Patagonia, Argentina).

Only one crested duck was co-infected, with *T. fissispina* and *E. uncinata* in the proventriculus, which is probably because of the different micro-niche that each parasite species would inhabit in the organ.

Tachyeres leucocephalus and *L. specularioides* breed in syntopy in the northern San Jorge Gulf, and they apparently feed in the same intertidal areas (M.L.A., pers. obs.) since they partially share invertebrate prey. However, present samples were not infected by the same nematodes. Unlike endemic flightless steamer ducks, crested ducks are considered mostly sedentary with some seasonal movements (Johnsgard, 2010). High-latitude breeders commonly disperse following the coast in winter (Carboneras, 1992). Thus, *L. specularioides* could be in contact with the natural hosts of both *E. uncinata* and *T. fissispina* in low latitudes and could contribute to the geographical dispersion of these nematodes.

More detailed information on the feeding habitats, diet and movements throughout the year are needed to make conclusions about the roles of these birds as definitive hosts of parasites and to elucidate life cycles of nematodes from these latitudes.

In spite of the low number of hosts examined, this work increases our knowledge about the parasites of a conspicuous bird group from Patagonia.

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Conflict of interest

None.

Ethical standards

The birds were collected with permission from the National Park Administration (Sample Permission no. 1352; Provincial Sample Permission Disp. no. 51/2014 DFyFS-SSG).

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