Neotrop. Helminthol., 5(1), 2011

ISSN: 2218-6425 impreso / ISSN: 1995-1043 on line

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ASOCIACIÓN PERUANA DE HELMINTOLOGÍA E INVERTEBRADOS AFINES

ORIGINAL ARTICLE/ ARTÍCULO ORIGINAL

HELMINTHFAUNA OF MAGELLANIC PENGUIN (*SPHENISCUS MAGELLANICUS* FOSTER, 1781) PROCEEDING FROM ILHA COMPRIDA, SOUTH COAST, STATE OF SÃO PAULO, BRAZIL

FAUNA DE HELMINTOS DEL PINGÜINO DE MAGALLANES (*SPHENISCUS MAGELLANICUS* FOSTER, 1781) DE LA ILHA COMPRIDA, COSTA SUR, ESTADO DE SÃO PAULO, BRASIL

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Suggested citation: do Prado, M.I.B.M., Santos-Lópes, A.R. & da Silva, R.J. 2011. Helminthfauna of Magellanic Penguin (*Spheniscus magellanicus* Foster, 1781) proceeding from Ilha Comprida, South Coast, State of São Paulo, Brazil. Neotropical Helminthology, vol. 5, n° 1, pp. 50-55.

Abstract

The present study aims to identify the helminth fauna of *Spheniscus magellanicus* Foster, 1781 from the municipality of Ilha Comprida, southern São Paulo State. A total of 28 individuals were analyzed, resulting in an identification of three helminth species: *Contracaecum pelagicum* Johnston & Mawson, 1942, *Cardiocephaloides physalis* Sudarikov, 1959 and *Tetrabotrium lutzi* Parona, 1901. *Contracaecum pelagicum* and *C. physalis* were core species, while *T. lutzi* was considered a satellite species. All individuals examined were infected with at least one species (overall prevalence = 100%). The host specimens were all juveniles and the infection may be associated with food items eaten during migration to the Brazilian Coast.

Key-words: Cestoda - Helminthes - Nematoda - Marine birds - Parasitic diseases - Trematoda.

Resumen

Este estudio tuvo como objetivo identificar los helmintos parásitos de *Spheniscus magellanicus* Foster, 1781 de la municipalidad de Ilha Comprida, a lo largo de la costa sur de Sao Paulo, Brasil. Un total de 28 individuos fueron analizados, dando como resultado la identificación de tres especies de helmintos: *Contracaecum pelagicum* Johnston & Mawson, 1942, *Cardiocephaloides physalis* Sudarikov, 1959 y *Tetrabothrium lutzi* Parona, 1901. *Contracaecum pelagicum* y *C. physalis* se caracterizan como especies core, mientras que *T. lutzi* se considera una especie satélite. Todos los individuos examinados estaban infectados con al menos una especie, con una prevalencia del 100%. Los especímenes hospedadores fueron todos juveniles y el patrón de la infección puede estar asociado con la alimentación durante la migración a la costa brasileña.

Palabras clave: Aves marinas - Cestoda - Enfermedades parasitarias - Helmintos - Nematoda - Trematoda.

INTRODUCTION

Penguins are birds, exclusively oceanic, which modified its wings in flaps adapting to the aquatic way of life. All species are restricted to the southern hemisphere (Sick, 1997). On the coast of South America and its islands there are seven penguin species, three of them endemic and belonging to the genus *Spheniscus* Brisson, 1760. Species of this genus live further to the north than the other representatives of the group. *Spheniscus magellanicus* Foster, 1781 is the largest and most abundant species, reproducing in coast of Argentina, Chile and Falkland Islands in the period between November and January, spending short breaks in the sea for food. After the reproductive season, about the end of February, the annual migration begins towards the Brazilian coast. This migration occurs through ocean currents and aims to increase the abundance of foraging, which also leads to an increased diversity of foraging (Sick, 1997; Gilpin, 2007).

The majority of population that reaches the Brazilian Coast is of young penguins. It is common to find individuals dead on the beaches during the winter, some specimens reaching the northeast coast of Brazil. Some factors may be associated with and worsen the killing of these birds, including: climate change resulting in changes in streams and incorrect route of migration of animals (Sick, 1997), population increases, which may lead to an increase of young people killed, once there is a bigger number of birds born and with more individuals there is a greater competition for food; and overfishing, the human action that causes animals to seek food farther from the coast, leading to ingestion of a diet different from the usual, resulting in nutritional deficiency of nestlings and young penguins (González-Acuña *et al.*, 2008).

The host-parasite relationship occurs in an interspecific way and may affect the life of the host. In many cases, it remains invisible until the parasites reach epidemic proportions and interfere in the host abundance. However, the study of helminths of a complex life cycle provides important information about the hosts, such as diet, migratory routes, foraging areas (Campbell *et al.*, 1980; Marcogliese, 2004).

The analysis of ecological aspects of parasite-host is poorly investigated, but the focus on this area is increasing. Because they have diversified diet, seabirds are important objects of study and they may be hosts of helminths in different trophic levels (Esch & Fernandez, 1993). In Brazil there are few studies about helminth parasites of marine birds, although they occur in the country and many of them use the Brazilian Coast as a feeding ground, including the species *S. magellanicus*.

Helminthological studies involving this species are not very abundant; among them there are the works of Díaz (2006) and González-Acuña *et al*. (2008). In Brazil, they are further reduced, because these birds are restricted to the south portion of the country. Studies on the helminthfauna of *S. magellanicus* were conducted with host collected from Rio Grande do Sul (Bassi *et al.,* 2008), Rio de Janeiro (Pinto *et al*., 2007) and Espírito Santo State (Ederli *et al*., 2009).

This study aims to identify endoparasites contained in the digestive tract of *S. magellanicus* that migrates to the Brazilian Coast at the time of reproductive rest.

MATERIALS AND METHODS

Penguins (n = 28) were collected on the beaches of Pedrinhas, municipality of Ilha Comprida, southern coast of São Paulo, from July to September 2008. The studied specimens were found dead but the total sample showed good storage conditions and were kept frozen at - 5 °C. The animals underwent a biometrics prior to necropsy, recording the total length of the body, beak, wing, foot and body circumference. Necropsies were done at Instituto de Pesquisas de Cananéia (IPeC) in Cananéia municipality and the helminths collected were analyzed at the Laboratório de Parasitologia de Animais Silvestres, Departamento de Parasitologia, Instituto de Biociências, Unesp, Botucatu municipality, São Paulo State, Brazil.

Nematodes were collected, fixed in heated AFA solution, and for identification, were cleared with lactophenol. The identification was based on Yamaguti (1961), Vicente *et al.* (1995) and Diaz (2006). The cestodes and trematodes were fixed in cold AFA solution under coverslip pressure and

then were stained with carmine and cleared in eugenol or creosote. The identification of cestodes was based on Diaz (2006) and trematodes on Travassos *et al*. (1969), Yamaguti (1971) and Diaz (2006).

All collected helminths were deposited in the Coleção Helmintológica do Instituto de Biociências de Botucatu (CHIBB), Universidade Estadual Paulista, municipality of Botucatu, São Paulo State, Brazil.

Prevalence, mean intensity of infection and mean abundance were calculated according to Bush *et al*. (1997).

RESULTS

All individuals (n = 28) studied were parasitized (overall prevalence = 100%), and a total of 3811 parasites was recovered. The mean intensity of infection was 146.6 ± 19.4. All hosts were juveniles, and their biometrics presented as follows: body length - 44.6 ± 3.4 cm, circumference of the body - 38.3 ± 2.1 cm, wing length - 16.6 ± 2.5 cm, length of the nozzle - 5.4 ± 0.5 cm and length of the foot - 11 ± 0.7 cm.

The helminthfauna *S. magellanicus* was composed only by three species: *Contracaecum pelagicum* Johnston & Mawson, 1942 (Nematoda), *Cardiocephaloides physalis* Sudarikov, 1959 (Digenea) and *Tetrabothrium lutzi* Parona, 1901 (Cestoda). All species were found in the digestive tract, distributed between the stomach and small intestine (Table 1).

Contracaecum pelagicum was found in the stomach and small intestine of the studied birds. In the first organ it was found in abundance, occupying its entire length, making a total of 2435 individuals among 23 hosts. In the small intestine, relative abundance was lower, since it was found only 727 individuals in 21 hosts. Considering both site of infection, the prevalence was 96.4%, with high mean abundance and mean intensity of infection. *Cardiocephaloides physalis* was found only in the small intestine and there were 460 individuals among 19 hosts. This species occurred in high prevalence but low abundance and intensity of infection. *Tetrabothrium lutzi*, in the same way of *C. physalis*, was located exclusively in the small intestine, more specifically in the duodenum. It was found 189 individuals in 10 hosts (Table 1).

DISCUSSION

This study evaluated the helminth fauna of *S. magellanicus* from the municipality of Ilha Comprida, São Paulo State, Brazil. Among the three helminth species found, two of them were core species (*C. pelagicum* and *C. physalis*) and one was satellite (*T. lutzi*), as defined by Bush *et al.* (1997). All specimens studied were infected with at least one species of helminth, a fact also noted by Diaz (2006). However, studies with *S. magellanicus* in Chile (66.6%) (González-Acuña *et al*., 2008) do not found a high prevalence as reported in this study.

Contracaecum pelagicum showed high prevalence and mean intensity of infection as observed in the studies of Pazos (2006) and Díaz *et al*. (2000). This nematode can infect several hosts and it was first recorded in black brow albatross (*Diomedea melanophris* Temmick, 1828) in Australia and since then the infection was reported in other seabirds as brown booby (*Sula leucogaster* Boddaert, 1783) (Silva *et al.*, 2005). In Brazil, this parasite was identified in populations of *S. magellanicus* from various regions, such as Rio Grande do Sul (Bassi *et al*., 2008) and Espírito Santo (Ederli *et al*., 2009) and has been found distributed between the stomach and intestine. Larvae of *C. pellagicum* were found in fish (Timi, 2003) and cephalopods (Cremonte & Laurenti, 2005 *apud* Diaz, 2006), preys that serve as food for these birds and, therefore, act in the transmission of this parasite to birds. During the pelagic time, *S. magellanicus* presents changes in eating patterns and the main food items are cephalopods, *Argonauta nodosa* Lightfoot, 1786, *Loligo plei* Blainville, 1823 and *Loligo sanpaulensis* Brakoniecki, 1984 (Pinto *et al*., 2007). This change creates a nutritional deficiency making juvenile weaker and more propense to death (Pinto *et al*., 2007, González-Acuña *et al*., 2008), which would explain the high mortality rate of individuals that reach the coast (Pinto *et al*., 2007).

For *C. physalis,* prevalence also was high, but the mean intensity of infection was low in comparison to data presented by Díaz (2006), in which a high prevalence (55.6%) and intensity of infection (153) was observed. This genus has very similar morphology between their representatives and it is composed by seven species (Dubois, 1968). Among the birds, their hosts are distributed in three families Laridae, Anatidae and Procellaridae

(Dubois, 1968; Abdel-Aal *et al*., 2004). The larvae of trematodes have been reported parasitizing the eyes of *Engraulis anchoita* Hubbs *et* Marinni, 1935, fish that represents a major part of the diet of *S. magellanicus* (Timi *et al.*, 1999).

Regarding *T. lutzi* the prevalence was 36%, which conflicts with studies conducted in regions of Argentina. In individuals of the region of the Peninsula Valdes, this cestode had a high prevalence (85.6%) and average intensity of infection (521) (Díaz, 2006). This cestode is one of the most representatives of poultry helminths, parasitizing five orders: prey items, Pelecaniformes, Charadriiformes, Gaviformes and Sphenisciformes (Hoberg, 1989). For the genus *Spheniscus*, we have five species of tetrabothriids described and only two of these species were reported infecting *S. magellanicus*: *T. lutzi* and *Tetrabothrius eudyptidis* Loennberg, 1896.

Analysis of stomachal contents allowed determining the diet of these animals and it was observed that there is a change in the diet following the action of fishing industries and latitudinal variation (Frere *et al*., 1996; Putz *et al*., 2001). The diet is no longer composed mostly by fish, being replaced for cephalopods. The effort to find food by parents increases, the amount of food given to the offspring decreases and beyond that, digestion of the offspring becomes more difficult. These variations produce changes in the nutritional development of the nestlings and juveniles, resulting in death or physical weakness (Pinto *et al.*, 2007; González-Acuña *et al.,* 2008).

A final analysis that can be done about the parasite community of *S. magellanicus* is related to the concepts of interactive and isolationist communities (Holmes, 1987). Typically, endothermic hosts harbor interactive communities of parasites and ectothermic hosts provides home to isolationist communities, but this does not happen with the helminth species of *S. magellanicus,* which presents isolationist communities. This could be related to factors such as limited diet, pelagic habit and simple digestive tract (few niches to be occupied) (Díaz, 2006). This study corroborates the data obtained by Díaz (2006), mainly in relation to the diet change. Consuming fewer items, the diversity of helminths is low and these species do not interact.

Table 1. Prevalence, intensity of infection, abundance and site of infection of the helminths collected in *Spheniscus magellanicus* (n = 28) from the municipality of Ilha Comprida, southern coast, State of São Paulo, Brazil.

Helminth species	TNP	P	MII ± SE	MA ± SE	SI
Contracaecum pelagicum CHIBB 5129-5132	3162	96,4	126,5 ±19,6	121,6 ± 19,4	Stomach and small intestine
Cardiocephaloides physalis CHIBB 5133	727	75	24,2 ± 6,1	17,7 ± 4,9	Small intestine
Tetrabothrius lutzi CHIBB 5134	189	36	18,9 ± 5,85	14,53 ± 7,27	Small intestine

*Numbers in the first column is the accession number of voucher species in CHIBB - Coleção Helmintológica of the Instituto de Biociências, Universidade Estadual Paulista; TNP, total number of parasites; P, prevalence; MII, mean intensity of infection; MA, mean abundance; SI, site of infection; SE , standard error.

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Received April 5, 2011.
Accepted May 28, 2011.

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