



Checklist of helminth parasites of cetaceans from Brazil

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Abstract

Based on published records and unpublished information retrieved from the Helminthological Collection of the Oswaldo Cruz Institute (CHIOC), a checklist of the helminth parasites of cetaceans from Brazil was generated. A total of 215 records of 18 species of helminths were associated with 22 species of cetaceans in Brazil. Six species determined only to genus were also included. The majority of these helminth species are nematodes (33.3%) and trematodes (33.3%), which total 66.6% of the helminth fauna of cetaceans from Brazil. The Acanthocephala represents 22.2% of species, and the Cestoda 11.1%.

Key words: helminth, biodiversity, Cetacea, Brazil

Introduction

Brazil is the fifth largest country in the world and has the highest species diversity of all of the megadiversity countries, accounting for roughly 14% of the world's biota (Lewinsohn & Prado 2002). Helminth species are the most diverse group of metazoan parasites of vertebrates and are recognized as an important component of global biodiversity (Poulin & Morand 2004). Research efforts directed at documenting parasite species have increased recently. As knowledge of parasite biodiversity is dependent on previous studies of host biodiversity, the loss of host species diversity implies a possible loss of parasite species diversity.

Living Cetacea comprise 89 species distributed in all oceans and seas (Fordyce 2002). Differences in water masses in the South Atlantic makes the Brazilian coast a place with a high cetacean biodiversity. To date, 44 species of cetaceans have been recorded in Brazilian waters (Souza *et al.* 2005). The abundance and distribution patterns of the cetacean species are heterogeneous. Some species are known based on a few stranded specimens collected and may represent extralimital records (e.g. Commerson's dolphin, *Cephalorhynchus commersonii* (Lacépède) (Odontoceti, Delphinidae), Peale's dolphin, *Lagenorhynchus australis* (Peale) (Odontoceti, Delphinidae) and the Southern right whale dolphin, *Lissodelphis peronii* (Lacépède) (Odontoceti, Delphinidae) - and some species of beaked whales, like the recently published record of Arnoux's beaked whale *Berardius arnuxii* Duvernoy (Odontoceti, Ziphiidae) (Siciliano & Santos 2003). But at least 31 cetacean species use the Brazilian waters on a regular basis. This group comprises the whales (e.g. Southern right, humpback, Antarctic and dwarf minke whales) which migrate seasonally with the

purpose of mating and reproduction. However, the main group of Brazilian cetaceans is comprised of tropical species living under the strong influence of the Brazilian Current. Some species are restricted to coastal waters like the Guiana dolphin, *Sotalia guianensis* (van Bénédén) (Odontoceti, Delphinidae), that occupies shallow coastal bays surrounded by mangroves but also is found in open coastal waters. Surprisingly, also within this group is the rough-toothed dolphin, *Steno bredanensis* (Lesson) (Odontoceti, Delphinidae), that is distributed in marine waters of the lower continental shelf. A local upwelling condition also attracts the Bryde's whale, *Balaenoptera edeni* Anderson (Mysticeti, Balaenopteridae), to feed on abundant Brazilian sardines and small crustaceans (Siciliano *et al.* 2004).

Disease is a frequent cause of death in marine mammal populations; infectious agents include bacteria, viruses, fungi, protozoa, and animal parasites (Cowan 2002; Harwood 2002). Marine mammals can contract cancer, tuberculosis, herpes, arthritis, and other diseases that might not immediately be thought of as wildlife diseases (Berta *et al.* 2006). These diseases have received a great deal of attention from marine mammal biologists and veterinarians. Although parasites may be present in marine mammals that are considered healthy and functioning normally in their societies, parasites may also cause disease that can result in death. A large number of endoparasite species have been identified from marine mammals. Parasites may be present in many organ systems in the body, but are generally found in the respiratory, digestive, circulatory, and reproductive systems (Jefferson *et al.* 2007).

Some previous publications (Yamaguti 1959, 1963, 1971; Travassos 1965; Travassos *et al.* 1969; Schmidt 1986; Vicente *et al.* 1997) included records of helminth parasites of cetaceans inside on generalized compilations, and also the first list of helminth parasites of whales in Brazil (Muniz-Pereira *et al.* 1999).

This study is the third of a series published by Vieira *et al.* (2008) and Muniz-Pereira *et al.* (2009), that encompass the Brazilian fauna of helminth parasites of vertebrates, in a form of lists, covering their hosts, site of location and geographical distribution.

This is also the first attempt to include many records from cetacean host species from the Helminthological Collection of the Oswaldo Cruz Institute (CHIOC), Rio de Janeiro, Brazil, along with updated information based on literature, adding data to the previous scattered publications.

Material and methods

The list of parasite species of Brazilian cetaceans was based on previously published records and on unrecorded specimens from the database of the Helminthological Collection of the Oswaldo Cruz Institute (CHIOC).

The checklist follows the classification and systematic arrangement of Gibson *et al.* (2002) and Jones *et al.* (2005) for Digenea, Khalil *et al.* (1994) for Cestoda, Vicente *et al.* (1997) for Nematoda, and Amin (1985, 1987) for Acanthocephala.

The species of helminths are presented in alphabetical order, followed by hosts (specific name), site of infection, localities and references (between parentheses, in chronological sequence). In addition, the checklist included helminth species recorded only to genus level (undetermined species). Helminth species names follow the most recent taxonomic literature.

Higher-level classification of hosts follows Wilson & Reeder (2005), and Caballero *et al.* (2007). Mention of helminths and host species in this list does not imply that the authors agree with their validity or taxonomy.

Host species were arranged in alphabetical order. The catalog number of each helminth was included for all species with type specimens and voucher specimens deposited in CHIOC.

Results

In the current study we listed a total of 215 records, comprising 18 species of helminths associated with 22 species of cetaceans in Brazil. Six undetermined helminth species were also included.

The majority of these helminth species are nematodes (6 species, 33.3%) and trematodes (6 species, 33.3%), which total 66.6% (12 species) of the helminth fauna of cetaceans from Brazil. The Acanthocephala represent 22.2% of species (4 species), and the Cestoda 11.1% of species (2 species).

In Brazilian waters, 44 species of cetaceans occur have been recorded to date (Souza *et al.* 2005). Of these, 22 species (50%), distributed in four families, have records of helminth parasites. The families Balaenopteridae and Delphinidae show the greatest richness of helminths, with six and 1 species, respectively. The families of hosts with lower richness of species are Iniidae, with one nematode species [*Anisakis insignis* (Diesing) (Anisakidae)] (Diesing 1851; Vicente *et al.* 1997), and Phocoenidae, also with one nematode species [*Anisakis simplex* (Rudolphi) (Anisakidae)] (Pinedo *et al.* 2002).

The cetacean species with the highest number of records was *Balaenoptera borealis* (Lesson) (Mysticeti, Balaenopteridae), totaling 80 records for six species of helminths (four nematodes and two digeneans) of helminths. *Feresa attenuata* (Gray) (Odontoceti, Delphinidae), *Peponocephala electra* (Gray) (Odontoceti, Delphinidae), *Phocoena dioptrica* Lahille (Odontoceti, Phocoenidae), *Stenella clymene* (Gray) (Odontoceti, Delphinidae), and *S. longirostris* (Gray) (Odontoceti, Delphinidae) have only one record of helminths in Brazil (Zerbini & Santos 1997; Pinedo *et al.* 2002; Motta *et al.* 2008).

Parasite-host list

Phylum Acanthocephala Rudolphi

Class Palaeacanthocephala Meyer

Order Polymorphida Petrochenko

Family Polymorphidae Meyer

***Bolbosoma capitatum* (von Linstow)**

Balaenoptera edeni (Anderson), intestine, Rio de Janeiro (Pinto *et al.* 2004) (CHIOC 35304, 36449a-c).

Globicephala melas (Traill), small intestine, unspecified locality (Machado-Filho 1964) (CHIOC 29832 – 29835).

Pseudorca crassidens (Owen), intestine, Rio Grande do Sul (Andrade *et al.* 2001).

Stenella coeruleoalba (Meyen), intestine, São Paulo (Rosas *et al.* 2002).

***Bolbosoma* sp.**

Pontoporia blainvillei (Gervais & d'Orbigny), unspecified site of infection, Rio Grande do Sul (Di Benedetto & Ramos 2001).

Sotalia guianensis (van Bénédén), stomach, Paraná (Marigo *et al.* 2010).

***Bolbosoma turbinella* (Diesing)**

Balaenoptera borealis (Lesson), small intestine, Rio de Janeiro (Machado-Filho 1964, Muniz-Pereira *et al.* 1999) (CHIOC 29781 – 29831, 29836).

Pontoporia blainvillei (Gervais & d'Orbigny), stomach, large intestine, Rio Grande do Sul (Marigo *et al.* 2002; Silva & Cousin 2004; Silva & Cousin 2006a).

Stenella coeruleoalba (Meyen), intestine, São Paulo (Rosas *et al.* 2002).

***Corynosoma australe* Johnston**

Pontoporia blainvillei (Gervais & d'Orbigny), stomach, intestine, Rio Grande do Sul (Marigo *et al.* 2002; Silva & Cousin 2004).

***Corynosoma* sp.**

Pontoporia blainvillei (Gervais & d'Orbigny), unspecified site of infection, Rio Grande do Sul (Di Benedetto & Ramos 2001).

***Polymorphus (Polymorphus) cetaceum* (Johnston & Best)**

Pontoporia blainvillei (Gervais & d'Orbigny), stomach, Rio Grande do Sul (Di Benedetto & Ramos 2001; Marigo *et al.* 2002; Silva & Cousin 2004, 2006b).

Phylum Nematoda (Rudolphi)**Superfamily Ascaridoidea Railliet & Henry****Family Anisakidae Skrjabin & Karokhin*****Anisakis insignis* (Diesing)**

Inia geoffrensis (Blainville), intestine, Amazonas (Diesing 1851; Vicente *et al.* 1997).

***Anisakis physeteris* Baylis**

Balaenoptera borealis (Lesson), unspecified site of infection, unspecified locality (Pinto *et al.* 2004).

Balaenoptera physalus (Linnaeus), unspecified site of infection, unspecified locality (Pinto *et al.* 2004).

Kogia breviceps (Blainville), stomach, Fernando de Noronha Archipelago, Rio de Janeiro (Santos & Lodi 1998; Pinto *et al.* 2004) (CHIOC 33539).

Physeter catodon Linnaeus, stomach, Rio de Janeiro (Muniz-Pereira *et al.* 1999) (CHIOC 29602, 29603, 29659, 29662, 29665 - 29667, 29669, 29670, 29691).

***Anisakis simplex* (Rudolphi)**

Feresa attenuata (Gray), stomach, São Paulo (Zerbini & Santos 1997).

Phocoena dioptrica Lahille, stomach, Rio Grande do Sul (Pinedo *et al.* 2002).

Pseudorca crassidens (Owen), stomach, Rio Grande do Sul (Andrade *et al.* 2001; Pinto *et al.* 2004).

***Anisakis* sp.**

Grampus griseus (Cuvier), stomach, intestine, Bahia (Maia-Nogueira 2000).

Peponocephala electra (Gray), stomach, Ceará (Motta *et al.* 2008).

Kogia breviceps (Blainville), stomach, Ceará (Motta *et al.* 2008).

Stenella clymene (Gray) stomach, Ceará (Motta *et al.* 2008).

Stenella longirostris (Gray), stomach, Ceará (Motta *et al.* 2008).

Stenella coeruleoalba (Meyen), intestine, São Paulo (Rosas *et al.* 2002).

Steno bredanensis (Cuvier), stomach, Ceará (Motta *et al.* 2008).

Sotalia guianensis (van Bénédén), stomach, Paraná (Marigo *et al.* 2010)

***Anisakis typica* Diesing**

Pontoporia blainvillei (Gervais & d'Orbigny), stomach, Rio Grande do Sul (Di Benedetto & Ramos 2001; Marigo *et al.* 2002; Silva & Cousin 2004).

Sotalia guianensis (van Bénédén), stomach, Rio de Janeiro (Santos *et al.* 1996; Di Benedetto & Ramos 2001, 2004; Melo *et al.* 2006) (CHIOC 32966).

Stenella coeruleoalba (Meyen), stomach, Bahia (Maia-Nogueira *et al.* 2001).

***Contracaecum* sp.**

Sotalia guianensis (van Bénédén) stomach, Espírito Santo (Borobia & Barros 1989; Di Benedetto & Ramos, 2001).

***Pseudoterranova* sp.**

Balaenoptera borealis (Lesson), unspecified site of infection, unspecified locality (Pinto *et al.* 2004).

Balaenoptera physalus (Linnaeus), unspecified site of infection, unspecified locality (Pinto *et al.* 2004).

Kogia breviceps (Blainville), stomach, Fernando de Noronha Archipelago (Santos & Lodi 1998; Pinto *et al.* 2004) (CHIOC 33540).

Superfamily Habronematoidea Railliet & Henry**Family Tetrameridae Travassos*****Crassicauda crassicauda* (Creplin)**

Balaenoptera borealis (Lesson), penis, urethra, intestine, Rio de Janeiro (Muniz-Pereira *et al.* 1999; Pinto *et al.* 2004) (CHIOC 29663, 29664, 29672, 29674-29678, 29695).

Balaenoptera physalus (Linnaeus), penis, urethra, intestine, Rio de Janeiro (Muniz-Pereira *et al.* 1999; Pinto *et al.* 2004).

Kogia breviceps (Blainville), unspecified site of infection, unspecified locality (Pinto *et al.* 2004).

Superfamily Metastrongyloidea Lane**Family Pseudalidae Railliet & Henry*****Halocercus brasiliensis* Lins de Almeida**

Sotalia guianensis (van Bénédén), lung, trachea, Rio de Janeiro, São Paulo, Paraná (Lins de Almeida 1933; Silva & Best 1996; Santos *et al.* 1996; Vicente *et al.* 1997; Di Benedetto & Ramos 2001, 2004; Melo *et al.* 2006; Marigo *et al.* 2010) (CHIOC 7481 – holotype and allotype, 7482 – paratypes, 10062, 32967).

Stenella coeruleoalba (Meyen), bronchi, bronchioles, São Paulo (Rosas *et al.* 2002).

Phylum Platyhelminthes Gegenbaur**Class Cestoda van Beneden****Order Tetrphyllidea Carus****Family Phyllobothriidae Braum*****Monorygma grimaldi* (Moniz) (Larvae)**

Stenella coeruleoalba (Meyen), body musculature, epididymis, subcutaneous tissue, blubber, Bahia, São Paulo (Maia-Nogueira *et al.* 2001; Rosas *et al.* 2002).

***Phyllobothrium delphini* (Bosc) (Larvae)**

Steno bredanensis (Cuvier), stomach, Rio Grande do Sul (Ott & Danilewicz 1996).

Class Trematoda Rudolphi**Order Digenea van Beneden****Family Brauninidae Wolf*****Braunina cordiformis* Wolf**

Delphinus delphis (Linnaeus), stomach, intestine, unspecified locality (Travassos *et al.* 1969; Pinto *et al.* 2004).

Sotalia guianensis (van Bénédén), stomach, Rio de Janeiro, Paraná (Santos *et al.* 1996; Di Benedetto & Ramos 2001, 2004; Pinto *et al.* 2004; Melo *et al.* 2006; Marigo *et al.* 2010) (CHIOC 32695).

Steno bredanensis (Cuvier), stomach, Rio de Janeiro, Rio Grande do Sul (Santos *et al.* 1996; Ott & Danilewicz 1996; Pinto *et al.* 2004).

Tursiops truncatus (Montagu), stomach, Rio de Janeiro (Santos *et al.* 1996; Pinto *et al.* 2004).

Family Brachycladiidae Odhner***Lecithodesmus goliath* (van Beneden)**

Balaenoptera borealis (Lesson), liver, bile duct, Rio de Janeiro (Travassos *et al.* 1969; Muniz-Pereira *et al.* 1999; Pinto *et al.* 2004) (CHIOC 27225, 29627 – 29633, 27224a-f, 27226a-c).

***Nasitrema* sp.**

Grampus griseus (Cuvier), central nervous system, Bahia (Maia-Nogueira 2000).

Sotalia guianensis (van Bénédén), nasal cavity, Rio de Janeiro (Di Benedetto & Ramos 2001, 2004; Melo *et al.* 2006).

Tursiops truncatus (Montagu), nasal cavity, Rio de Janeiro (Santos *et al.* 1996; Pinto *et al.* 2004).

***Synthesium pontoporiae* (Raga, Aznar, Balbuena & Dailey)**

Pontoporia blainvillei (Gervais & d'Orbigny), stomach, small intestine, Rio Grande do Sul, São Paulo, Paraná (Silva & Cousin 2004; Marigo *et al.* 2002; Marigo *et al.* 2008).

***Synthesium tursionis* (Marchi)**

Tursiops truncatus (Montagu), small intestine, Santa Catarina (Marigo *et al.* 2008).

Sotalia guianensis (van Bénédén), intestine, Paraná, São Paulo (Marigo *et al.* 2010).

Family Notocotyliidae Lühe***Ogmogaster antarcticus* Johnston**

Balaenoptera borealis (Lesson), intestine, rectum, Rio de Janeiro (Muniz-Pereira *et al.* 1999; Pinto *et al.* 2004) (CHIOC 29754, 29764, 33974a-i, 33975a-h).

Balaenoptera physalus (Linnaeus), intestine, rectum, Rio de Janeiro (Muniz-Pereira *et al.* 1999; Pinto *et al.* 2004) (CHIOC 33974a-c).

Family Opisthorchiidae Braun***Amphimerus lancea* (Diesing)**

Delphinus delphis (Linnaeus), unspecified site of infection, unspecified locality (Pinto *et al.* 2004).

Sotalia fluviatilis (Gervais), biliary duct, Amazonas (Diesing 1850; Travassos *et al.* 1969).

Host-parasite list

Order Cetacea

Suborder Mysticeti

Family Balaenopteridae

Balaenoptera borealis

Anisakis physeteris
Bolbosoma turbinella
Crassicauda crassicauda
Lecithodesmus goliath
Ogmogaster antarcticus
Pseudoterranova sp.

Balaenoptera edeni

Bolbosoma capitatum

Balaenoptera physalus

Anisakis physeteris
Crassicauda crassicauda
Ogmogaster antarcticus
Pseudoterranova sp.

Suborder Odontoceti

Family Physeteridae

Kogia breviceps

Anisakis physeteris
Anisakis sp.
Crassicauda crassicauda
Pseudoterranova sp.

Physeter catodon

Anisakis physeteris

Physeter macrocephalus

Anisakis physeteris

Family Delphinidae

Delphinus delphis

Amphimerus lancea
Braunina cordiformis

Feresa attenuata

Anisakis simplex

Grampus griseus

Anisakis sp.

Nasitrema sp.

Peponocephala electra

Anisakis sp.

Globicephala melas

Bolbosoma capitatum

Pseudorca crassidens

Anisakis simplex

Bolbosoma capitatum

Sotalia fluviatilis

Amphimerus lancea

Sotalia guianensis

Anisakis sp.

Anisakis typica

Bolbosoma sp.

Braunina cordiformis

Contracaecum sp.

Halocercus brasiliensis

Nasitrema sp.

Synthesium tursionis

Stenella coeruleoalba

Anisakis sp.

Bolbosoma capitatum

Bolbosoma turbinella

Anisakis typica

Halocercus brasiliensis

Monorygma grimaldi

Stenella clymene

Anisakis sp.

Stenella longirostris

Anisakis sp.

Steno bredanensis

Anisakis sp.

Braunina cordiformis

Phyllobothrium delphini

Tursiops truncatus*Braunina cordiformis**Nasitrema* sp.*Synthesium tursionis***Family Phocoenidae*****Phocoena dioptrica****Anisakis simplex***Family Iniidae*****Inia geoffrensis****Anisakis insignis***Family Pontoporiidae*****Pontoporia blainvillei****Anisakis typica**Bolbosoma* sp.*Bolbosoma turbinella**Corynosoma australe**Corynosoma* sp.*Polymorphus (Polymorphus) cetaceum**Synthesium pontoporiae*

In Brazil, helminths belonging to four groups and nine families have been recorded from six families of Cetacea (Table 1). Only Anisakidae (Nematoda, Ascaridoidea) have been reported for all host families. In contrast, nematodes of the family Pseudalidae (Metastrongyloidea), three families of Digenea (Brauninidae, Notocotyliidae, Opisthorchiidae), and one family of Cestoda (Phyllobothriidae) were reported in only one host family (Table 1).

The helminth species with the highest number of records was *Bolbosoma turbinella* (Acanthocephala, Polymorphidae), totaling 57 records. The larval stage of the cestode *Phyllobothrium delphini* (Tetraphyllidae, Phyllobothriidae) was recorded only one time in cetaceans from Brazil (Ott & Danilewicz 1996).

TABLE 1. Families of helminth parasites of cetaceans from Brazil and their distribution by host families.

	Digenea				Cestoda	Nematoda			Acanthocephala
	Braun	Brach	Notoc	Opist	Phyll	Anis	Tetr	Pseud	Polym
Balaenopteridae		+	+			+	+		+
Delphinidae	+	+		+	+	+		+	+
Iniidae						+			
Phocoenidae						+			
Physeteridae						+	+		
Pontoporidae		+				+			+

Anis = Anisakidae; Braun = Brauninidae; Brach = Brachycladiidae; Notoc = Notocotyliidae; Opist = Opisthorchiidae; Phyll = Phyllobothriidae; Polym = Polymorphidae; Pseud = Pseudalidae; Tetr = Tetrameridae.

Discussion

Descriptions of helminth parasites of Brazilian cetaceans date back to Diesing (1850, 1851). *Amphimerus lancea* (= *Distomum lancea*) was described by Diesing (1850) from specimens collected in *Sotalia fluviatilis* (= *Delphinus tucuschi*) (Odontoceti, Delphinidae), captured by the naturalist Johann Natterer in Barra do Rio Negro, Manaus, Amazonas, probably between 1833 and 1834 according to the reports of Vanzolini (2004). *Anisakis insignis* (= *Peritrachelius insignis*) was described by Diesing (1851) from specimens collected in *Inia geoffrensis* (= *Delphinus amazonicus*) (Odontoceti, Iniidae) captured by J. Natterer in the locality of Borba, on the margin of the Madeira River, Amazonas, between 1829 and 1830 (Vanzolini 2004).

The literature on helminth parasites of cetaceans from Brazil is fragmented, since studies are of regional scope or restricted to a particular host species (Santos *et al.* 1996; Santos & Lodi 1998; Muniz-Pereira *et al.* 1999; Andrade *et al.* 2001; Di Benedetto & Ramos 2001, 2004; Marigo *et al.* 2002; Pinto *et al.* 2004; Silva & Cousin 2004), or are part of general compilations of Brazilian helminths and not updated (Travassos *et al.* 1969; Vicente *et al.* 1997).

In cetacean populations, helminth infections usually have little effect on host health. The infections by acanthocephalans of the genus *Bolbosoma* (Palaeacanthocephala, Polymorphida) and *Corynosoma* (Palaeacanthocephala, Polymorphida) are restricted to local reactions of stomach and intestine surface (Silva & Cousin 2004, 2006a,b; Raga *et al.* 2008). However, in some host species significant damage can occur, such as ulcers caused by *Anisakis* spp. and *Pseudoterranova* spp. (Motta *et al.* 2008; Raga *et al.* 2008). As in other vertebrate host species, *Anisakis* spp. infect a wide range of cetacean hosts (Table 1).

In a few cases, helminths represent a major cause of mortality in host populations (Raga *et al.* 2008). The parasites can contribute significantly to host population dynamics influencing reproduction and survival of individuals. Raga *et al.* (2008) reported that females of *Lagenorhynchus acutus* (Gray, 1828) (Odontoceti, Delphinidae) had mastitis caused by infections of *Crassicauda* sp. (Habronematoidea, Tetrameridae), affecting the quality and quantity of the milk, and compromising the survival of the offspring. *Crassicauda* spp. also caused cranial damage in *Stenella attenuata* (Odontoceti, Delphinidae), accounting for approximately 10% of the mortality of this species in the Pacific Ocean (Raga *et al.* 2008).

Parasites are useful in information on host ecology, biogeography and phylogeny (Gardner & Campbell 1992; Raga *et al.* 2008), and also serve as indicators of current and historical ecological relationships (Aznar *et al.* 2001).

Due to the characteristics of cetacean host species, including biogeographical zones, pelagic environments and conservation aspects, the addition of helminthologists to the staff of projects involving cetaceans could contribute to a great extent to the knowledge of this host group.

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