

# Gastrointestinal parasites of bottlenose dolphins *Tursiops truncatus* from the extreme southwestern Atlantic, with notes on diet composition

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**ABSTRACT:** We surveyed the gastrointestinal tracts of 6 bottlenose dolphins *Tursiops truncatus* from Patagonia to check for helminth parasites and characterize dolphin diet. All dolphins harbored parasites (6477 helminths). We recorded 7 species, including nematodes *Anisakis simplex* s.l., *Pseudoterranova decipiens*, acanthocephalans *Corynosoma cetaceum*, *C. australe*, and digeneans *Braunina cordiformis*, *Pholeter gastrophilus* and *Synthesium tursionis*. Among the gastric helminths, the most prevalent species were *C. cetaceum* and *A. simplex* while *C. australe* and *S. tursionis* inhabited the intestine at low prevalence. This is the first report of *C. australe* and *P. decipiens* in bottlenose dolphins. Regarding diet, 5 stomachs contained food remains (consisting of 103 prey items). The most important prey species were *Geotria australis* and *Stromateus brasiliensis*, but their role in parasite transmission is unclear. At the community level, the gastrointestinal parasite community of *T. truncatus* was depauperate and strongly overlapped the community described for pelagic dolphins inhabiting Patagonia, suggesting a strong local influence in shaping helminth communities. Nevertheless, these observations are at odds with the notion that oceanic cetaceans have comparatively poorer helminth fauna than neritic species such as bottlenose dolphins, due to the lower likelihood of parasite exchange.

**KEY WORDS:** *Tursiops truncatus* · *Corynosoma* · *Anisakis* · *Pseudoterranova* · *Braunina* · *Pholeter* · *Synthesium* · Patagonia · Argentina · Southwestern Atlantic

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## INTRODUCTION

Studies of parasite assemblages produce valuable information about various aspects of marine mammals. Parasites have proved especially useful markers of contemporary and historical ecological and evolutionary relationships, providing information on

host ecology, biogeography and phylogeny (Hoberg & Klassen 2002, Byers 2009). Furthermore, parasites are important biological tags for characterizing useful information about host social structure, stock identity, movements and other ecological aspects which are relevant for population conservation and management (Aznar et al. 1995, MacKenzie 2002).

Parasitism can also cause disease, which may have a considerable impact on marine mammal populations, and can even have an impact on human public health and economics (Harwood & Hall 1990, Dubey et al. 2003).

Research into the parasite fauna of marine mammals is on the rise, particularly in odontocetes inhabiting the southwestern Atlantic. Aznar et al. (1994) conducted one of the first studies in this area, reporting on helminth communities of franciscana *Pontoporia blainvillei* in Argentine waters. Dans et al. (1999) reported the gastrointestinal helminths of the dusky dolphin *Lagenorhynchus obscurus* off the Patagonian coast. More recently, novel information has been published on Commerson's dolphin *Cephalorhynchus commersonii* (Berón-Vera et al. 2001), the hourglass dolphin *L. cruciger* (Fernández et al. 2003) and on the common dolphin *Delphinus delphis* (Berón-Vera et al. 2007). Other studies have described occasional strandings of poorly known cetaceans, such as spectacled porpoises *Phocoena dioptrica*, Burmeister's porpoise *Phocoena spinipinnis*, Gray's beaked whale *Mesoplodon grayi*, Cuvier's beaked whale *Ziphius cavirostris*, sperm whale *Physeter macrocephalus* and Hector's beaked whale *Mesoplodon hectori* (Aznar et al. 2003, Berón-Vera et al. 2008, Nikolov et al. 2010). These studies explored parasite transmission within a trophic web, as well as host habitat distribution, reporting new helminth taxa or describing helminth communities of by-caught or stranded dolphins.

Bottlenose dolphins *Tursiops truncatus* inhabit a wide range of coastal and pelagic habitats throughout tropical and temperate waters worldwide (Leatherwood & Reeves 1990, Wells & Scott 1999). In the Southern Hemisphere, bottlenose dolphins live as far south as Tierra del Fuego, South Africa, Australia, and New Zealand. Limits to this species' range appear to be temperature-related, either directly or indirectly through prey distribution (Coscarella et al. 2012). This species is one of the most intensively studied odontocete species worldwide (Wells & Scott 1999). However, data are scarce for the southwestern Atlantic *Tursiops* populations, and more information is required on several aspects of their life history and stock identity to better understand regional ecology and population trends. These include natural mortality factors, feeding habits, fishery interactions, and parasites. The lack of such information delays the design and implementation of management and conservation actions.

Most literature concerning the parasite fauna of bottlenose dolphins comes from checklists (e.g. Dai-

ley & Brownell 1972) or studies focusing on a single helminth species (e.g. Raga et al. 1985a,b, Fernández et al. 1994), and most studies have been conducted in the Northern Hemisphere. One of the most recent surveys of bottlenose dolphin parasite fauna was performed by Quiñones et al. (2013) in the Mediterranean. Researchers have found the following taxa among the gastrointestinal community of *Tursiops truncatus*: the digeneans *Braunina cordiformis*, *Synthesium tursionis*, *Brachycladium atlanticum*, and *Pholeter gastrophilus*; the acanthocephalans *Bolbosoma* sp. and *Corynosoma cetaceum*; the nematode *Anisakis simplex*; and the cestodes *Tetrabothrius forsteri*, *Diphyllobothrium* sp. and *Strobilocephalus triangularis* (Schryver et al. 1967, Dailey & Brownell 1972 and references therein, Bowie 1984 and references therein, Quiñones et al. 2013). However, there are no community-based analyses of the parasites of *T. truncatus* in the Argentine shelf, including Patagonia. Our lack of knowledge about this species in the region is probably due to the low frequency of dolphin strandings or by-catches.

The paucity of published data on parasites inhabiting bottlenose dolphins in Patagonian waters and the need to gather more detailed information regarding their biology and ecology prompted the present study. Our main objective was to describe the gastrointestinal parasite fauna at the infra and component population levels in the southern limit of *Tursiops truncatus*' distribution in the southwestern Atlantic. We also characterized their diet in order to assess potential helminth transmission routes.

## MATERIALS AND METHODS

### Parasitological analysis

A total of 6 dead, stranded bottlenose dolphins (4 females, 1 male, and 1 individual of unknown sex) were recovered from the northern Patagonia coast (40° 30' to 43° 30' S, 64° to 65° W) between 1997 and 2012. All specimens were in a stage of decomposition of 2 to 3, sensu Geraci & Lounsbury (2005). Animals were necropsied within 24 h of stranding using standard techniques (Geraci & Lounsbury 2005), either in the field or laboratory. Body length ranged from 205 to 324 cm (mean  $\pm$  SD: 289.9  $\pm$  48.6; Table 1).

Following post-mortem examination, the complete digestive tract was removed from the carcasses and kept frozen at  $-20^{\circ}\text{C}$ . After thawing, each stomach chamber (i.e. forestomach, main stomach, pyloric stomach and duodenal ampulla) was analyzed sepa-

Table 1. *Tursiops truncatus* sampling data. F: female; M: male; ND: not determined. Dates are d/mo/yr

ID	Sex	Size (cm)	Stranding date
Tur tru 001	F	319	11/07/1997
Tur tru 002	F	300	22/12/1999
Tur tru 004	F	301.5	21/07/2005
Tur tru 005	F	205	21/07/2008
Tur tru 006	ND	ND	07/09/2008
Tur tru 009	M	324	11/04/2012

rately. Intestinal tracts from 5 individuals (specimen Tur tru 002 was in poor condition, and was therefore excluded from the analysis) were divided into 20 sections of equal length. Parasites were isolated from food contents and recovered with a 0.2 mm mesh sieve. Additionally, the stomach and intestinal walls were examined, and attached worms collected. Parasites were flushed in saline solution, fixed and preserved in 70% ethanol until examination.

All individual helminths collected from each host were counted under a stereomicroscope. Nematodes were cleared in alcohol-glycerin (1:1), and digeneans were stained with iron acetocarmine for identification (Georgiev et al. 1986). We used ecological terminology following Bush et al. (1997), and estimated infection parameters according to Rózsa et al. (2000). The 95% confidence intervals (CI) for prevalence and species richness were set with Sterne's exact method (Reiczigel 2003); 95% CIs of mean intensity and mean abundance were estimated with 20 000 bootstrap replications using the statistical software Quantitative Parasitology v.3 (Reiczigel & Rózsa 2005). Species richness was computed as the mean number of parasite species present per host examined at the infracommunity (individual dolphin) level. The component community was expressed as the total number of parasite species found. Site selection was analyzed for each helminth species on an infrapopulation basis. The distribution of the most prevalent species across the stomach chambers was determined at the infra- and component population levels, following Aznar et al. (2003).

Voucher specimens were deposited at the Natural History Museum of London, UK (Accession numbers: *Pholeter gastrophilus*, NHMUK 2013.11.29.1–2; *Braunina cordiformis*, NHMUK 2013.11.29.3–4; *Braunina cordiformis*, NHMUK 2013.11.29.5–8; and *Synthesium tursionis*, NHMUK2013.11.29.9). Nematodes and acanthocephalans were added to the collections of the Marine Mammals Laboratory (CENPAT-CONICET, Puerto Madryn, Argentina) and the Marine Zoology Unit, University of Valencia.

## Diet

The dolphins' diet was characterized by diagnosing hard items (otoliths, bones, and cephalopod beaks) recovered from stomach contents. Intact prey (rarely found) were immediately identified, measured with digital calipers ( $\pm 0.01$  mm) and weighed with an electronic balance ( $\pm 0.01$  g). All prey remains were identified to the lowest possible taxonomic level using the reference collections of the Marine Mammals Laboratory (CENPAT-CONICET, Puerto Madryn, Argentina) and the IBMPAS (San Antonio Oeste, Argentina), and published catalogs (Clarke 1986, Gosztonyi & Kuba 1996, Volpedo & Echeverría 2000). The total number of consumed fish was determined from counts of left, right and unassigned otoliths. The minimal number per species was obtained as the sum of half the number of otoliths rounded up to the nearest whole number. The number of cephalopods was estimated as the maximum number of lower or upper beaks (Pierce & Boyle 1991). The size (total length [TL] of fish and dorsal mantle length [DML] of squid in cm) and wet weight (g) of prey was estimated from hard parts with allometric regressions. To minimize the underestimation of length or weight, only undamaged otoliths and beaks were measured. When digested or broken pieces were found in a stomach, the measurements for these elements were assigned from a random sample of undigested and whole parts from the same stomach (Koen Alonso et al. 1998). The importance of prey was determined using the percent frequency of incidence (%FO), the percentage by number (%N), the percentage by estimated wet weight (%W) and the index of relative importance (%IRI; Pinkas et al. 1971, modified by Cortés 1997).

## RESULTS

### Parasite fauna

All bottlenose dolphins harbored helminths. A total of 6477 specimens were collected, of which 78 were nematodes, 6046 acanthocephalans and 352 digeneans. The gastrointestinal component community was composed of 7 species: the nematodes *Anisakis simplex* s.l. and *Pseudoterranova decipiens*; the acanthocephalans *Corynosoma cetaceum* and *C. australe*; and the digeneans *Braunina cordiformis*, *Pholeter gastrophilus* and *Synthesium tursionis*.

Infection parameters (prevalence, mean intensity and mean abundance) are shown in Table 2. The 2

Table 2. *Tursiops truncatus*. Infection parameters for the helminth species in stomachs (n = 6) and/or intestines (n = 5) of bottlenose dolphins from Patagonia, Argentina

Helminth species	Prevalence (95% CI)		Intensity		Abundance Mean (95% CI)		
			Mean (95% CI)	Range			
<b>Nematoda</b>							
<i>Anisakis simplex</i> s.l.	83.3	(41.1–99.2)	10.4	(3.0–28.4)	1–35	8.7	(2.33–25.3)
<i>Pseudoterranova decipiens</i>	16.7	(0.9–58.9)	301.0			50.2	(0–100)
<b>Acanthocephala</b>							
<i>Corynosoma cetaceum</i>	83.3	(41.1–99.2)	1198.8	(349–1520)	90–1629	999	(287–1460)
<i>Corynosoma australe</i> <sup>a</sup>	40.0	(7.6–81.1)	26.0	(2.0–50.0)	2–50	10.4	(0–30.4)
<b>Trematoda</b>							
<i>Braunina cordiformis</i>	50.0	(15.3–84.7)	11.7	(2.0–19.3)	2–25	5.8	(0.67–17)
<i>Pholeter gastrophilus</i>	33.3	(6.3–72.9)	9.0	(8.0–9.0)	8–10	3.0	(0–6.3)
<i>Synthesium tursionis</i> <sup>a</sup>	40.0	(7.6–81.1)	12.5	(1.0–12.5)	1–24	5.0	(0–14.8)

<sup>a</sup>These species were only found in intestines

most prevalent species (>80%) were the nematode *Anisakis simplex* and the acanthocephalan *Corynosoma cetaceum*. *A. simplex* occurred free in the forestomach, main stomach and pyloric stomach (Table 3). No gastric ulcers associated with this species were found. By contrast, *C. cetaceum*, the parasite with the highest mean abundance and intensity, was fixed to the wall of the main stomach, pyloric stomach and duodenal ampulla, reaching the highest relative abundance in the pyloric stomach ( $75.5 \pm 42.4$ ; Table 3). Only 1 host harbored *Pseudoterranova decipiens*, mainly in the forestomach (83.7%; Table 3) and at high intensity (301; Table 2). The gastric digeneans *Braunina cordiformis* and *Pholeter gastrophilus* had a prevalence of 50% and 33.3%, respectively (Table 2). Adults of *B. cordiformis* were attached to the wall of the main stomach, pyloric stomach and duodenal ampulla and, in the same chambers, adults of *P. gastrophilus* were found in gastric cysts (Table 3). Only 3 helminth species were identified from the intestine: *Corynosoma australe* and *Synthesium tursionis*, with similar prevalence (40.0%; Table 2), and 1 ind. of *C. cetaceum*, probably due to migration from the stomach. There was no clear distribution pattern of *C. australe* and *S. tursionis*, which were recovered from the duodenum to the large intestine.

All helminth species were found in adult stages. In addition, 4 forms were found either as third (L3) or fourth-stage (L4) larvae (the nematodes *Anisakis simplex* and *Pseudoterranova decipiens*) or putative juveniles (*Corynosoma australe* and *Synthesium tursionis*) (Table 3). The nematode *A. simplex* was present mainly at larval stage (92.3% of ind.; 8 L3s and 40 L4s from 5 hosts), and larvae were identified as Type 1 (*A. simplex*). This morphotype includes 5 spe-

cies, i.e. the 3 sibling species of the *A. simplex* species complex (*A. simplex* subspecies, *A. simplex* C and *A. pegreffii*), *A. typica* and *A. ziphidarum*, which cannot be identified at the larval stage (Mattiucci et al. 2002). Regarding *P. decipiens*, larvae comprising 53 L3s and 148 L4s (66.8% of ind.) were recovered from the host's stomach. This species also comprises genetically differentiated sibling species (*P. decipiens* complex: *P. decipiens* [s.s.], *P. krabbei*, *P. bulbosa*, *P. azarasi* and *P. decipiens* E) with particular geographic and host distributions (Mattiucci et al. 1998, Paggi et al. 2000, Mattiucci & Nascetti 2008). Putative juveniles of *C. australe* (2 ind.) and *S. tursionis* (21 ind.) were recovered from the intestine of one host.

At infracommunity level, species richness ranged from 1 to 5 species, with a mean of 3.33 (95% CI: 1.83 to 4.0). One host (16.7%) was infected with 1 helminth species; 2 (33.3%) with 3 species; 2 (33.3%) with 4 species, while a single host (16.7%) harbored 5 parasite species. *Corynosoma cetaceum* dominated the infracommunities, accounting for on average  $77.6 \pm 40.1\%$  of the total gastrointestinal helminths.

## Diet

Five bottlenose dolphins had food remains in their stomachs. In general, stomach contents were in an advanced state of digestion, and mostly composed of hard parts (beaks, bones and otoliths). In total, 103 prey items were recorded, with a total estimated biomass of 22.3 kg and a mean  $\pm$  SD of  $7.4 \pm 4.6$  kg per stomach. The mean number of prey items per stomach was  $20.6 \pm 0.014$ .

Stomach contents contained almost exclusively fish, comprising 77.7% of prey items (6 species, 80 ind.),

Table 3. Helminth species (see Table 2 for full names) in bottlenose dolphins *Tursiops truncatus*, indicating collection site, stage and percentage of the component populations (%CP) and infrapopulations (%IP) (mean  $\pm$  SD). Nematode developmental stages: third-stage larvae (L3), fourth-stage larvae (L4), and adult (Ad). Digenean and acanthocephalan developmental stages: putative juveniles (Juv) and adult (Ad)

Location in intestine	Nematoda			Acanthocephala			Trematoda							
	<i>A. simplex</i> s.l.	<i>P. decipiens</i>	<i>C. cetaceum</i>	<i>C. australe</i>	<i>B. cordiformis</i>	<i>P. gastrophilus</i>	<i>S. tursionis</i>	Stage	%IP	Stage	%IP	Stage	%IP	
Forestomach	L3, L4, Ad	57.7	53.1 $\pm$ 50.5	L3, L4, Ad	83.7	-	-	-	-	-	-	-	-	
Main stomach	L3, L4	23.07	6.8 $\pm$ 15.3	L3, L4, Ad	10.9	Ad	26.7	0.2 $\pm$ 0.3	Ad	8.6	34.7 $\pm$ 56.6	Ad	66.6	62.5 $\pm$ 53.0
Pyloric stomach	L3, L4	19.2	40 $\pm$ 54.7	-	-	Ad	75.4	75.5 $\pm$ 42.4	Ad	22.8	33.3 $\pm$ 57.7	Ad	11.1	12.5 $\pm$ 17.7
Duodenal ampulla	-	-	-	L4, Ad	5.3	Ad	24.4	24.3 $\pm$ 42.6	Ad	68.6	32 $\pm$ 35.3	Ad	22.2	25 $\pm$ 35.3
Intestine	-	-	-	-	-	Ad	-	-	Juv, Ad	-	-	-	-	Juv, Ad

<sup>a</sup>Only in 1 host

while the remainder was comprised of cephalopods (4 species, 20 ind.) and crustaceans (2 ind.; Table 4). Pouched lamprey *Geotria australis* was the most important prey (%IRI = 69.3%), representing 64.5% of the estimated weight and 49.5% of the total number of prey. Southwest Atlantic butterflyfish *Stromateus brasiliensis* ranked second in importance (%IRI = 14.09%), representing 17.5% of the total number and 28.9% of the total weight of prey, with an overall occurrence of 20%. Two species of cephalopods, the Patagonian squid *Loligo gahi* and Patagonian octopus *Octopus tehuelchus*, were also prevalent in the bottlenose dolphins' diet, with %IRI > 5%. In terms of ecological groups, benthic species were dominant.

## DISCUSSION

Bottlenose dolphins from Patagonia in the southwestern Atlantic were found to harbor 7 gastrointestinal helminth species, 5 of which infect other odontocete species: *Corynosoma cetaceum*, *Braunina cordiformis*, *Anisakis simplex*, *Pholeter gastrophilus* and *Synthesium tursionis* (Herrerias et al. 1997, Berón-Vera et al. 2008). The 3 latter species also infect *T. truncatus* in the northern hemisphere (Bowie 1984, Raga et al. 1985a,b, Abollo et al. 1998, Aznar et al. 2006, Quiñones et al. 2013). The other 2 helminths, *C. australe* and *Pseudoterranova decipiens*, commonly infect pinnipeds (Aznar et al. 2004, Sardella et al. 2005, Hernández-Orts et al. 2013), and their finding in bottlenose dolphins constitutes a new host record.

The gastric helminths were differentially distributed across stomach chambers. According to site selection, the nematodes occurred mostly in the forestomach, *Pholeter gastrophilus* in the main stomach, *Corynosoma cetaceum* in the pyloric stomach and *Braunina cordiformis* in the duodenal ampulla. Two species, *Corynosoma australe* and *Synthesium tursionis*, were restricted to the intestine (Table 3). Each stomach chamber and intestinal section in a dolphin can be considered as a separate microhabitat (Berón-Vera et al. 2007).

Infection data for *Anisakis simplex* indicated high prevalence, probably reflecting its incidence in intermediate hosts due to its low host specificity (Smith & Wootton 1978). However, its intensity was relatively low in bottlenose dolphins. Similar levels of infection have been reported in other coastal cetaceans from the southwestern Atlantic, possibly related to low transmission rates due to low availability of intermediate hosts in this ecosystem (Dans et al. 1999, Aznar et al. 2003, Berón-Vera et al. 2001, 2007). The structure of

Table 4. *Tursiops truncatus*. Diet composition recovered from bottlenose dolphins off Patagonia. EG: ecological group of the prey (B: benthic; DB: demersal-benthic; DP: demersal-pelagic; P: pelagic; NA: not assigned); %FO: percent frequency of occurrence; %N: percentage by number; %W: percentage by regression-estimated wet weight; %IRI: percent of index of relative importance; N: number of prey items

Prey species	EG	%FO	%N	%W	%IRI	N
<b>Fish</b>		<b>60.0</b>	<b>77.7</b>	<b>98.4</b>	<b>88.9</b>	<b>80</b>
<i>Geotria australis</i>	B	40.0	49.5	64.5	69.3	51
<i>Stromateus brasiliensis</i>	P	20.0	17.5	28.9	14.1	18
<i>Acanthistius brasilianus</i>	D	20.0	3.9	2.2	1.8	4
<i>Austrolycus depressiceps</i>	B	20.0	1.9	2.7	1.4	2
<i>Patagonotothen ramsayi</i>	D	20.0	1.9	0.05	0.6	2
<i>Merluccius hubbsi</i>	D	20.0	1.0	0.08	0.3	1
Unknown fish	NA	20.0	1.9			2
<b>Cephalopods</b>		<b>60.0</b>	<b>19.4</b>	<b>1.5</b>	<b>10.6</b>	<b>20</b>
<i>Loligo gahi</i>	D	40.0	8.7	0.3	5.5	9
<i>Octopus tehuelchus</i>	B	40.0	7.8	0.9	5.3	8
<i>Enteroctopus megalocyathus</i>	B	20.0		0.2	0.7	2
<i>Loligo sanpaulensis</i>	D	20.0	1.0			1
<b>Crustaceans</b>		<b>20.0</b>	<b>2.9</b>	<b>0.07</b>	<b>0.5</b>	<b>3</b>
<i>Artemesia longinaris</i>	D	20.0	1.9	0.05	0.6	2
Unknown crab	B	20.0	1.0	0.02	0.3	1
						103

*A. simplex* infrapopulations in bottlenose dolphins also follows the same pattern as other odontocetes. Larvae and adults are mainly found in the first stomach, suggesting that individuals of *A. simplex* tend to select the site where digestion begins (Aznar et al. 2003, Berón-Vera et al. 2007, 2008). *A. simplex* adults were restricted to the forestomach in bottlenose dolphins, as reported in *Delphinus delphis* and *Pontoporia blainvillei* (Aznar et al. 2003, Berón-Vera et al. 2001). Aznar et al. (2003) proposed that this restriction of *A. simplex* adults to the first chamber may reflect a mating enhancement strategy, or indicate that adults have stronger requirements for the resources provided by the forestomach. Moreover, the high prevalence of larval stages in numerous hosts may be interpreted as recent *A. simplex* recruitment through diet; it might also suggest that bottlenose dolphins are not its most common final host in the area (see below). The influx of parasites through coastal food webs enhances opportunities for many parasites to make contact with incidental hosts, in which they may or may not manage to reproduce at the ecological time, depending on compatibility filters (Raga et al. 2009).

The nematode *Pseudoterranova decipiens* was recovered from only 1 host (specimen Tur tru 002), which was afflicted with uterine adenocarcinoma (Sánchez et al. 2002). The poor health status of this host may have influenced the high infection rate of *P. decipiens*, which is typically observed in the gastrointesti-

nal tract of South American sea lions *Otaria flavescens* and fur seals *Arctocephalus australis* from the same area (Hernández-Orts et al. 2013). Aside from the accidental nature of this parasite infection, *P. decipiens* microhabitat preference corresponded to the pattern described for anisakids, with high prevalence in the first stomach chamber.

*Corynosoma cetaceum* showed the highest mean abundance and intensity in bottlenose dolphins, and dominated the infracommunities (Tables 2 & 3). This species typically matures in the stomach and upper duodenum of its definitive cetacean hosts (Aznar et al. 2001), following a similar microhabitat selection pattern as *Pontoporia blainvillei* (Kagei et al. 1976, Aznar et al. 1994) and *Delphinus delphis* (Berón-Vera et al. 2007). Aznar et al. (2001) suggest that the pyloric stomach may provide *C. cetaceum* a

larger space in which to settle and reproduce. Considering its geographical range, the occurrence of this acanthocephalan in dolphins from the coast of Buenos Aires Province and northern Patagonia is possibly associated with the availability of intermediate hosts and host-parasite specificity. Indeed, *D. delphis*, *P. blainvillei* and *Tursiops truncatus* might be required as final hosts for *C. cetaceum* in this area.

The other acanthocephalan species, *Corynosoma australe*, is a widespread parasite in the intestine of otariids inhabiting cold-temperate waters of the Southern Hemisphere and may accidentally infect other marine mammals through their prey (Zdzitowiecki 1991). In Patagonia, Hernández-Orts et al. (2013) reported that *C. australe* was the most prevalent and abundant parasite in *Otaria flavescens* and *Arctocephalus australis*. Among small cetacean species, immature specimens of *C. australe* can inhabit the stomach of *Lagenorhynchus obscurus* (Dans et al. 1999), while both mature and immature individuals can occupy the posterior-most region of the intestine of the spectacled porpoise *Phocoena dioptrica* (Berón-Vera et al. 2008). In this study, the only 2 bottlenose dolphins harboring *C. australe* in their intestines were collected over a large spatio-temporal scale, suggesting that this dolphin species may be an occasional host for *C. australe* and may have been infected by consuming food resources of the definitive sympatric host.

The family Brauninidae is specific to delphinids; *Braunina cordiformis* attaches to the stomach lining and the duodenal ampulla (Schryver et al. 1967). This species was previously recorded in the stomach of *Tursiops truncatus*, marine tucuxi dolphin *Sotalia fluviatilis* (Santos et al. 1996) and estuarine dolphin *S. guianensis* (Marigo et al. 2010) from the south-eastern coast of Brazil. *B. cordiformis* has also been found infecting *Lagenorhynchus obscurus* (Dans et al. 1999), *Cephalorhynchus commersonii* (Berón-Vera et al. 2001) and *Delphinus delphis* (Berón-Vera et al. 2007) in Patagonia.

The digenean *Pholeter gastrophilus* is a well-known generalist and cosmopolitan parasite of odontocetes, and typically resides within fibrotic nodules in the submucosa of the glandular region of the stomach (Migaki et al. 1971). In small cetaceans off Patagonia, *P. gastrophilus* is considered uncommon, infecting *Delphinus delphis* (Berón-Vera et al. 2007) and *Lagenorhynchus obscurus* (Dans et al. 1999) with low prevalence (16 in *D. delphis* and 4.35 in *L. obscurus*) and intensity ( $4.0 \pm 3.38$  in *D. delphis* and 1 in *L. obscurus*). These values are slightly lower than parameters estimated in *Tursiops truncatus*; by contrast, *P. gastrophilus* was found in over 50% of *Cephalorhynchus commersonii* individuals (Berón-Vera et al. 2008). As described by Aznar et al. (2006) for bottlenose dolphins from the western Mediterranean, we also found that *P. gastrophilus* tended to settle in the main stomach. Different hypotheses have been formulated to explain microhabitat selection by this parasite, but the distribution pattern is not unique, and seems to be passively driven by features of the diet and digestive physiology of each host species (Aznar et al. 2006).

*Synthesium tursionis* is another cosmopolitan intestinal digenean which has been reported in at least 17 odontocete species (Bowie 1984, Fernández et al. 2003, 2004, Marigo et al. 2008, 2010). In the Mediterranean Sea, this parasite exhibits high specificity for the bottlenose dolphin (Raga et al. 1985a, Fernández et al. 1994, Quiñones et al. 2013), while in the southwestern Atlantic it infects not only *Tursiops truncatus* (Marigo et al. 2008) but also *Sotalia guianensis* (Marigo et al. 2010). Regarding parasite stage, Quiñones et al. (2013) found a high prevalence of *S. tursionis* adults in the bottlenose dolphins from the Mediterranean Sea. As for *Anisakis simplex*, the wide range of larval stages observed (84% of total ind.) in southwestern Atlantic samples may suggest that *T. truncatus* is an incidental host, although it might well represent a case of recent recruitment. Similar to *Braunina cordiformis* and *Pholeter gas-*

*trophilus*, nothing is known about its life cycle, despite its widespread distribution.

Most marine mammal parasites are transmitted to the definitive host through their prey. Previous studies on the diet of bottlenose dolphins along the Argentinean coast are scarce due to their small population size and the fact they are seldom stranded or caught. Therefore, this study provides the first report on dolphin diet composition in this area, providing clues on potential parasite transmission routes. Among the prey identified, the pouched lamprey represented the highest relative contribution to *Tursiops truncatus* diet, but parasite fauna of this species has been poorly described. Lethbridge et al. (1983) reported the presence of plerocercoid larvae of *Pelichnobotrium* sp. and *Hepatoxylon trichiuri*, and recently Bao et al. (2013) recorded the presence of *Anisakis simplex* in the sea lamprey *Petromyzon marinus*; therefore, the role of lamprey in parasite transmission is unclear. On the Argentine continental shelf, the primary paratenic hosts known for *A. simplex* are the Argentine shortfin squid *Illex argentinus* (González & Kroeck 2000), the Argentine anchovy *Engraulis anchoita* (Timi 2003), and the common hake *Merluccius hubbsi* (Sardella & Timi 2004). However, these prey are not important components of the *T. truncatus* diet. Regarding the life cycle of *Corynosoma cetaceum* and *C. australe*, juveniles of both species have been found in at least 13 fish species on the Argentine continental shelf (see Timi et al. 2011). None of these prey species were identified from the dolphin stomachs analyzed here; however, most of them exhibit benthic habits and may represent potential prey in the Patagonian ecosystem. The non-specificity of the larval stages and the ecological ubiquity of acanthocephalans might have favored the high infection rates found in the bottlenose dolphin.

The parasite community of *Tursiops truncatus* is species-poor, and more so when we omit the parasite taxa for which the bottlenose dolphin is an uncommon host. This pattern has been described for marine mammals worldwide (Aznar et al. 2001). In Patagonia, parasitological studies on *Delphinus delphis* and *Lagenorhynchus obscurus*, sympatric species to bottlenose dolphins, reported 5 helminth species in their gastrointestinal tract, most of which we also identified in this study (Dans et al. 1999, Berón-Vera et al. 2007). This suggests a high overlap of the parasite community among these 3 dolphin species. However, common and dusky dolphins rely more on pelagic fish or squid species, while bottlenose dolphins share preponderantly benthic-demersal prey, more similar to the South American sea lion. According to the lit-

erature, at a local scale, the parasite fauna of pelagic species tends to be distinctive and comparatively poor compared to that of coastal hosts. This is due to the absence of intermediate hosts; thus, the likelihood of parasite exchange is decreased and infective stages are diluted in the pelagic environment (Hoberg & Adams 2000, Raga et al. 2009). Therefore, one might expect community species richness of parasites inhabiting bottlenose dolphins, a neritic species, to be higher than in pelagic species such as *D. delphis* and *L. obscurus*. Nevertheless, species richness is quite similar between them (considering the data available for *D. delphis* corresponds only to the gastric component; Dans et al. 1999, Berón-Vera et al. 2007), and our findings reveal there is a strong local influence shaping helminth communities in the gastrointestinal tract of bottlenose dolphins. To fully understand community similarity between host species and parasite transmission routes, we need additional data on host diet and parasite lifecycles for the southwestern Atlantic.

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