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Gastrointestinal helminths of Commerson's dolphins *Cephalorhynchus commersonii* from central Patagonia and Tierra del Fuego

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ABSTRACT: The stomachs and intestines of 9 Commerson's dolphins incidentally caught in trawl nets in central Patagonia and 23 stranded on beaches in Tierra del Fuego were surveyed for helminth parasites. A total of 267 individuals belonging to 4 species of parasites (1 nematode, 3 digeneans) were found in the dolphins from the first area: *Anisakis* sp. (larvae type 1 = *A. simplex*), *Braunina cordiformis*, *Hadwenius* sp. and *Pholeter gastrophilus*. In the Tierra del Fuego dolphins, 142 specimens belonging to 3 species (2 nematodes, 1 digenean, 1 cestode) were found: *A. simplex*, *Hadwenius* sp. and *Strobilocephalus triangularis*. Only 2 of the helminth species were shared in the 2 study areas, *A. simplex* and *Hadwenius* sp., and both were more common in central Patagonia. Among the species, *A. simplex* was most prevalent and abundant in both study areas. In Tierra del Fuego, adults of *A. simplex* appeared in only 1 host. *Hadwenius* sp., *P. gastrophilus* and *S. triangularis* are new host records for Commerson's dolphin. Species diversity and species richness were low in both study areas. Helminth communities were more diverse in central Patagonia ($t = 1.97$, df = 258, $p < 0.05$) and species richness was higher in central Patagonia (S = 4). No differences in diversity were observed between females and males of central Patagonia ($t = 1.97$, df = 139, $p < 0.05$) and between females of central Patagonia and Tierra del Fuego. The results may suggest some differences in habitat use, diet and sex between Commerson's dolphin populations in the 2 study areas.

KEY WORDS: Commerson's dolphin · *Cephalorhynchus commersonii* · Gastrointestinal parasites · *Hadwenius* sp. · *Pholeter gastrophilus* · *Strobilocephalus triangularis* · Central Patagonia · Tierra del Fuego

INTRODUCTION

There are few studies of marine mammal parasites and their ecology from the southwestern South Atlantic Ocean. This is in part due to a lack of taxonomic studies and in part to the difficulties in following the life cycles of parasites between different hosts. Among the most relevant studies, information is available for the South American sea lion *Otaria flavescens* (Morini & Boero 1960, George-Nascimento & Marini 1992), the franciscana *Pontoporia blainvillei* (Aznar et al. 1994, 1995), the dusky dolphin *Lagenorhynchus*

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obscurus (Dans et al. 1999), the tucuxi *Sotalia fluviatilis* and the rough-toothed dolphin *Steno bredanensis* on the southeastern coast of Brazil (Santos et al. 1996).

Commerson's dolphin *Cephalorhynchus commersonii* is one of the most common marine mammals of the region, and is endemic to cold temperate and subantarctic waters of the southern hemisphere. Its distribution off South America ranges from 41° 30′ S to 55° S in the southwestern South Atlantic, the Straight of La Maire and Drake Passage, with isolated sightings as far as the South Shetland Islands (Goodall et al. 1988). Commerson's dolphins inhabit open coastal areas (bays, estuaries and fjords) and occasionally enter tidal rivers. A separate population or stock occurs off the Kerguelen Islands in the Indian Ocean.

Information available on the parasite fauna of *Cephalorhynchus* species is scarce. The parasites of Hector's dolphins *C. hectori* and their parasitological lesions were described and reviewed by Hutton et al. (1987) and MacKenzie (1987). In Commerson's dolphins, most of the information on parasites came from occasional findings in feeding habit studies (Greenwood & Taylor 1979, Robineau & Dumhamel 1984, Bastida et al. 1988), general descriptions of the host's biology and ecology (Goodall et al. 1988, Robineau & De Buffrenil 1988, Goodall 1994) and living conditions in captivity (Gewalt 1979, Spotte et al. 1979, Dunn et al. 1982, Cornell et al. 1988).

In Patagonian waters, the Commerson's dolphin is one of the small cetaceans that are subject to incidental mortality in trawl and coastal gillnet fisheries (Crespo et al. 1994, 1997, Goodall et al. 1994). The lack of parasitological knowledge and difficult access to entangled or stranded individuals motivated this study in these dolphins of the southwestern South Atlantic. The main objective was to determine the gastrointestinal parasite fauna and its prevalence, intensity and spatial distribution. In light of our knowledge of the diet of Commerson's dolphins, we investigated potential transmission routes for helminths. We also discuss the potential existence of 1 or more ecological stocks between central Patagonia and Tierra del Fuego dolphins based on parasites as possible biological tags (Mead & Potter 1990, Van Waerebeek et al. 1990, Balbuena et al. 1995).

MATERIALS AND METHODS

Thirty-two specimens were collected either as by-catch in fisheries or stranded on the coast: 9 were from central Patagonia and 23 from Tierra del Fuego. Those of the former locality, 7 of which were female, were incidentally caught in trawl nets in Golfo San Jorge (45 to 47° S) between 1992 and 1994 (Fig. 1). Those from the latter locality were collected on beaches and evidently died in shore-set gillnets between January and April 1995. Fourteen of the 23 animals were female.

The dolphins entangled by trawlers in central Patagonia were frozen on board, and landed and stored in Puerto Madryn until examination. The stomachs and intestines were separated and kept frozen at –20°C. In Tierra del Fuego, the sampling procedures were compromised by the bad state of the specimens. Of the 23 animals sampled, only 9 were completely necropsied, while only the stomach was collected from the rest.

The stomachs and intestines were examined for parasites. All stomach compartments were analyzed. The intestines were opened following Aznar et al. (1997). Total recovery of parasites was attempted. The stomachs and intestines were washed and helminths were separated from food items using a series of sieves of different mesh size. All parasites were washed in saline solution, fixed and preserved in 70% ethanol. Prevalence, mean abundance and mean intensity were calculated following Bush et al. (1997).

Diversity was studied by means of the Shannon-Wiener Index (Krebs 1989). Differences in diversity of the parasite faunas of the 2 areas were tested using the Welch *t*-test (Zar 1996).

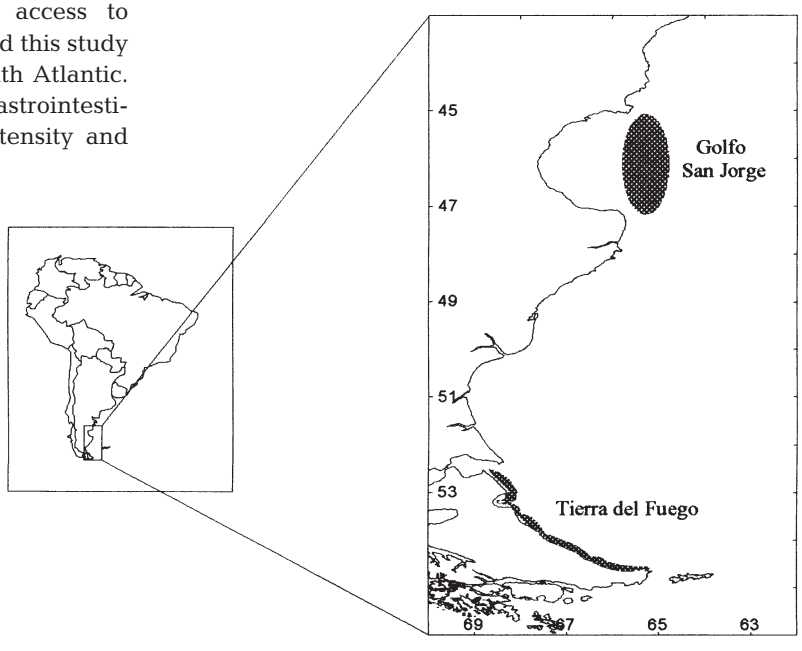

Fig. 1. Study area: central Patagonia (Golfo San Jorge) and coast of Tierra del Fuego

RESULTS

A total of 409 individual parasites belonging to 7 species were found. Of these, 267 individuals belonging to 4 species (*Anisakis* sp. Type 1 larva = *A. simplex*, *Braunina cordiformis*, *Hadwenius* sp. and *Pholeter gastrophilus*) were found in the dolphins from central Patagonia. In Tierra del Fuego, 142 specimens belonging to 3 helminth species were found (*Anisakis* sp. Type 1 larva = *A. simplex*, *A. simplex*, *Hadwenius* sp. and *Strobilocephalus triangularis*). *Hadwenius* sp., *P. gastrophilus* and *S. triangularis* are new host records for Commerson's dolphin.

Larvae belonging to *Anisakis* were identified as Type 1 (= *A. simplex*) based on the presence of a boring tooth, a long ventriculus with an oblique ventricular-intestinal junction, an excretory pore at the base of the lips and a rounded tail possessing a mucron, and also based on the geographic distribution of the species (Berland 1961, Davey 1971, Pippy & Van Banning 1975, Grabda 1976, Smith & Wootten 1978).

Among the species found, *Anisakis simplex* showed the highest prevalence, abundance and intensity in both study areas (Table 1). It occurred free in the stomach and intestines as third and fourth larvae. In Tierra del Fuego, adult forms appeared in only 1 host. No gastric ulcers associated with this species were found. *Braunina cordiformis* was found attached to the wall of the duodenal ampoule, *Pholeter gastrophilus* appeared in gastric cysts, and *Hadwenius* sp. was found free in the duodenal ampoule and intestine. *Strobilocephalus triangularis* appeared fixed to the wall of the last part of the rectum.

Only 2 of the helminth species were common to both study areas: *Anisakis* sp. and *Hadwenius* sp. Both were more frequent in central Patagonia. The other species appeared in only 1 area or the other. *Braunina cordiformis* was found only in central Patagonia although its presence was expected in Tierra del Fuego, as it had been previously described for this area (McKenzie & Blair 1983). *Pholeter gastrophilus* was also found exclusively in central Patagonia. *A. simplex* and *Strobilocephalus triangularis* had low prevalence and were the only species occurring exclusively in Tierra del Fuego.

Diversity indices are shown in Tables 2 & 3. The gastrointestinal parasite community in the 2 study areas had low diversity values. Species richness was low in both localities (S = 4 in central Patagonia; S = 3 in Tierra del Fuego). The diversities of the helminth communities of the 2 areas differed significantly, that from central Patagonia being more diverse than that from Tierra del Fuego (t = 1.97, df = 258, $p < 0.05$). No differences in diversity were observed between females and males of central Patagonia (t = 1.97, df = 139, $p < 0.05$) and between females of central Patagonia and Tierra del Fuego.

Table 1. Parasitological indices calculated for the helminth species found in Commerson's dolphins from central Patagonia and Tierra del Fuego

Parasite	Parasite loads	Central Patagonia	Tierra del Fuego
Nematoda			
Anisakis simplex	Prevalence (%)	100	87
	Abundance (mean ± SD)	21 ± 15.8	8.1 ± 18.3
	Range of abundance	1–48	0–60
	Intensity (mean ± SD)	21 ± 15.8	9 ± 19.2
	Range of intensity	1–48	1–60
Digenea			
Braunina cordiformis	Prevalence (%)	55.6	0
	Abundance (mean ± SD)	3.3 ± 5.3	
	Range of abundance	0–16	
	Intensity (mean ± SD)	6 ± 6	
	Range of intensity	1–16	
Pholeter gastrophilus	Prevalence (%)	66.7	0
	Abundance (mean ± SD)	2.6 ± 2.6	
	Range of abundance	0–7	
	Intensity (mean ± SD)	3.8 ± 2.1	
	Range of intensity	2–7	
Hadwenius sp.	Prevalence (%)	55.6	13.1
	Abundance (mean ± SD)	2.9 ± 6	2.1 ± 5
	Range of abundance	0–18	0–17
	Intensity (mean ± SD)	5.2 ± 7.4	7 ± 8.7
	Range of intensity	1–18	2–17
Cestoda			
Strobilocephalus triangularis	Prevalence (%)	0	4.4
	Abundance (mean ± SD)		0.2 ± 0.6
	Range of abundance		0–2
	Intensity (mean ± SD)		2
	Range of intensity		2

DISCUSSION

Only a few species and a few individuals of each species constitute the helminth fauna of Commerson's dolphins from the southwestern South Atlantic. The presence of *Anisakis* sp. L3 and L4 free in the stomach and intestine suggests post-mortem migration. Besides, the abnormal location in the intestine might be related to a digestion and elimination pattern of unsuccessful worms coming from the stomach (Dans et al. 1999). The higher prevalence of *Anisakis* sp. Type 1 larvae (= *A. simplex*) in central Patagonia and Tierra del Fuego is probably related to the low host specificity of this parasite in cetaceans, the principal hosts (Smith & Wootten 1978). This species was reported

Table 2. Diversity indices of Shannon-Wiener (H′ and mean-H′), variances of the indices (Var H′ and Var mean-H′), species richness (S) and number of parasites (N) of each study area. H′ was calculated by taking together all the individuals of each area; mean H′ corresponds to the mean individual gastrointestinal diversities of each area

	Central Patagonia	Tierra del Fuego
H′	0.923	0.59
Var H′	0.003	0.005
Mean-H′	0.59	0.17
Var mean-H′	0.156	0.09
S	4	3
N	267	104

in the southwestern South Atlantic parasitizing the dusky dolphin (Dans et al. 1999), the South American sea lion (E.A.C. unpubl. data), the bottlenose dolphin, *Tursiops truncatus*, and the common dolphin, *Delphinus delphis* (Berón-Vera unpubl. data); not all of these hosts come from the same feeding area or prey on the same species.

Anisakids found in Commerson's dolphins were mostly in larval stages and always appeared in low abundance, while in the dusky dolphins they are in the fifth stage or are adults and occur in higher abundance. This pattern might be explained by the fact that dusky dolphins are pelagic, whereas Commerson's dolphins are coastal, resulting in a lower rate of transmission, perhaps due to distributional differences of the intermediate hosts (Hays et al. 1998a). The absence of important intermediate hosts in the area (Hays et al. 1998b) and a distinct availability of intermediate hosts in the 2 areas may account for the differences. Potential intermediate hosts, such as crustaceans, cod, hake or anchovy, are probably more abundant in the feeding area of the dusky dolphins. This distribution may be attributed to the biology of these intermediate species (Hays et al. 1998a). In addition, Commerson's dolphins feed mainly on juvenile hake (small prey), contrary to dusky dolphins, while larger fish are expected to harbor more larvae (Hays et al. 1998b).

Table 3. Diversity indices of Shannon-Wiener (H′ and mean-H′) and variances of the indices (Var H′ and Var mean-H′) for females (F) and males (M) separately. See Table 2 for definintions

		Central Patagonia	Tierra del Fuego
F	H′	0.84	0.85
	Var H′	0.004	0.006
M	H′	0.98	0
	Var H′	0.008	0.0001
F	Mean-H′	0.604	0.29
	Var mean-H′	0.017	0.11
M	Mean-H′	0.544	0
	Var mean-H′	0.014	0.06

The Anisakid life cycle involves pelagic crustaceans and pelagic fish (Smith & Wootten 1978). *Anisakis* spp. are known in a number of marine fish, cod, redfish, herring, anchovy and hake (Henning 1974), although little information is available on fish and invertebrates as intermediate and paratenic hosts in the southwestern South Atlantic. Larval *A. simplex* were reported in hake, *Merluccius hubbsi* (Szidat 1955, MacKenzie & Longshaw 1995, Sardella & Timi 1996, Herreras et al. 2000), in flounder, *Paralichthys patagonicus* (Incorvaia & Díaz de Astarloa 1998), in pink-cusck-eel, *Genypterus blacodes* (Sardella et al. 1998), in mackerel, *Scomber japonicus* (Cremonte & Sardella 1997) and in shortfin squid, *Illex argentinus* (Gonzalez & Kroeck 2000). Further information on the parasite fauna of the prey of these 2 cetaceans is needed to assess their importance in the transmission of Anisakids.

The digenean *Hadwenius* sp. is also shared between the 2 study areas and is a new host record for Commerson's dolphin. Although this helminth was not identified to species level due to poor preservation it may be the same (also not yet identified specifically) as that recently reported in dusky dolphins in the area (Dans et al. 1999). However, the site selected by the parasite in the host differs. In Commerson's dolphins, most appeared in the intestine (96% in central Patagonia and 100% in Tierra del Fuego), preferring the anterior-most region, as described for the other species in the genus (Fernández 1996). In dusky dolphins, *Hadwenius* sp. was found mostly in the stomach. The presence of these helminths in other sites in the host may indicate post-mortem migration (Fernández 1996).

Two other congeneric species were described in waters of the southern hemisphere. *Hadwenius pontoporiae* was recorded in the southwestern Atlantic in the intestine of the franciscana *Pontoporia blainvillei* (Raga et al. 1994) with a prevalence of 100% and *H. tursionis* was found in the Chilean dolphin *Cephalorhynchus eutropia* from the southeastern South Pacific (Figueroa 1988, Torres et al. 1992).

Pholeter gastrophilus is a generalist and cosmopolitan species. It is recorded for the first time in Commerson's dolphin. This species has been found in the franciscana from the coasts of Buenos Aires Province (Aznar et al. 1994) and in the dusky dolphin off Patagonia (Dans et al. 1999). In both hosts, it was considered a rare species, while in the present study it appeared in more than the 50% of Commerson's dolphins from central Patagonia.

Braunina cordiformis has been previously reported in Commerson's dolphin (Greenwood & Taylor 1979, McKenzie & Blair 1983) and in the dusky dolphin off

Patagonia, always in the duodenal ampoule (Dans et al. 1999). Recently, it has been found in a bottlenose dolphin and in common dolphins from the coasts of Patagonia (Berón-Vera unpubl. data).

Strobilocephalus triangularis is also a cosmopolitan parasite and exclusive to cetaceans. The low prevalence and abundance observed in Commerson's dolphins might be related more to the low sample size than to an accidental infection. It has not been described in any other hosts in the southwestern South Atlantic. This is, thus, a new host record for Commerson's dolphin and enlarges its distribution to include the coasts of Tierra del Fuego.

In this study, the helminth fauna of Commerson's dolphins of central Patagonia was found to differ from that of Tierra del Fuego. These differences are qualitative and quantitative and possibly result from differences in the hosts' diet in the 2 areas. The hosts feed in a pelagic area in central Patagonia and in the demersal-pelagic zone in Tierra del Fuego. In central Patagonia, the most important prey are juvenile Argentine hake *Merluccius hubbsi*, and the shortfin squid *Illex argentinus*, followed by the Patagonian squid *Loligo gahi*, the lesser shining bobtail *Semirossia tenera*, the anchovy *Engraulis anchoita*, the butter fish *Stromateus brasiliensis*, the southern cod *Patagonotothen ramsayi*, and the Argentine red shrimp *Pleoticus muelleri* (Crespo et al. 1997). Off Tierra del Fuego, Commerson's dolphins prey mostly on the southern sprat *Sprattus fuegensis*, the hoki *Macruronus magellanicus*, the Patagonian squid, the southern cod, *Patagonotothen* sp., and the silverside *Austroatherina* sp. (Bastida et al. 1988, M.K.A. unpubl. data). The differences between the 2 feeding areas probably explain the different composition of the parasitic faunas.

On the other hand, Commerson's dolphins from central Patagonia and the dusky dolphins off Patagonia share the same gastrointestinal parasite species, likely because most individuals of both species were collected in the same area. In addition, these 2 host species share the same prey species (overlapping feeders), with the exception of the Argentine shrimp (Crespo et al. 1997, Koen Alonso et al. 1998). Thus, the similarity of the parasitic fauna may be explained by the low host specificity, despite the differences in prevalence and intensity of some species.

The parasite community is determined by ecological and evolutionary processes, which are associated with prey-predator interactions and host-parasite specificity (Aznar et al. 1994). According to these authors, evolutionary specificity inhibits colonization and, hence, the same host species in different areas (both biologically and physically different) may have a similarly structured helminth community, e.g., franciscanas from Buenos Aires province and Uruguay. There is a great similarity in the parasite community in the 2 areas, while in Buenos Aires only some helminths are shared with the Burmeister's porpoise *Phocoena spinnipinis*, an overlapping feeder (Aznar et al. 1994). For the period studied here, no host specificity was apparent, at least for central Patagonia. However, we believe that a greater number of animals should be analyzed to confirm our results.

The values obtained in this work correspond to low diversities (Magurran 1988) in the gastrointestinal parasitic fauna. The low species richness found in the 2 areas is consistent with the results for other odontocetes (Wazura et al. 1986, Balbuena & Raga 1993, Aznar et al. 1994, Brattey & Stenson 1995, Dans et al. 1999), although it differs from parasite communities of belugas, *Delphinapterus leucas*, in the St. Lawrence estuary. These hosts are not species poor (Measures et al. 1995) compared with other populations elsewhere (Wazura et al. 1986). This is a particular case as, despite the fact that belugas live in a small area, they have broad feeding habits and they are subjected to a high level of habitat degradation, and consequently are probably less resistant to parasites than other populations (Measures et al. 1995).

Low diversity is strongly related to host diet. All helminths found are transmitted through the food chain. In the study areas, Commerson's dolphins have a low diversity diet and prey mostly on small fish (M.K.A. et al. unpubl. data). A specialized or narrow range of prey in the diet decreases the probability of acquiring a high diversity of parasite groups. The consequence of this process is a parasite community with low diversity, consisting of many individuals (high intensity) belonging to few species (Aznar et al. 1994). In addition, larger hosts have more space and provide a wider diversity of niches for parasites (Poulin 1997). They also have a higher probability of ingesting parasites as they consume more potentially infected prey compared with small hosts (Poulin 1997). In the present case, prey are small. This may explain why the diversity and intensity of parasites that they may harbor are low.

Even though gastrointestinal parasitic diversity is low in both areas, in central Patagonia it is higher than that in Tierra del Fuego. The species and the number of species present in each community differed. *Anisakis simplex* was more abundant in central Patagonia than in Tierra del Fuego. This might be related to the diet of the hosts in the area. There are more larval *Anisakis* in pelagic species of fish (Marcogliese et al. 1996) and so eating more of these prey could lead to a higher abundance of this nematode.

Host diet, age, sex and range are the most important determinants of patterns of distribution of helminths (Bush 1990). Most of the differences found in Commerson's dolphins are due to a restrictive diet and to feeding on small prey. Little is known about the distrib-

ution range of this host off Patagonia. No information is available on seasonal movements, which would be necessary to assess this pattern. If seasonal movements existed, and if they were associated with a diet switch, then differences in prevalence and intensity, and changes in species composition would be expected. Host age may be a predictable pattern in marine mammals, as older (larger) animals require more prey (Innes et al. 1987) and, consequently, tend to harbor more diverse parasite communities (Balbuena & Raga 1993). This is true for pilot whales *Globicephala melas* (Balbuena & Raga 1993), although this association was not observed in Commerson's dolphins, perhaps because they are small cetaceans that increase little in size over the years. Concerning host gender, some association was apparently observed in Commerson's dolphins. In Tierra del Fuego, females had more diverse parasite communities than males. Males harbored only 1 species, *Anisakis simplex*. On the contrary, in central Patagonia, females and males did not differ in their parasite communities. In addition, females of both areas were equally diverse. Once more, the differences found might be related to differences in feeding habits, although no information about this is available.

Parasite infracommunities of females and males of central Patagonia were more diverse than those of females and males of Tierra del Fuego. Males followed the same pattern. A higher individual variation in Tierra del Fuego than in central Patagonia, with many hosts bearing 1 or no species, may explain this observation.

We believe that more information on host ecology is required to determine any likely trend in helminth distribution. This is the first study of gastrointestinal parasites of Commerson's dolphins off Patagonia. More samples are needed to further describe and analyze the helminth fauna of this cetacean and increase the information that parasites can provide on host ecology.

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