Article

Checklist of Helminth Parasites and Epizoites in Common Dolphins from Coastal Peru and Ecuador

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ABSTRACT: Data on helminth parasites and epizoites is presented for the long-beaked and short-beaked common dolphins from the Southeast Pacific. Sampling in 1985-2000 was conducted mainly at six fishing ports in Peru and Ecuador where cetaceans were landed. From a total of 473 common dolphins sampled, we identified helminths including three species of Trematoda: *Nasitrema globicephalae*, *Pholeter gastrophilus* and *Braunina cordiformis*; three species of Nematoda, which includes *Anisakis* spp., *Crassicauda* sp. and *Halocercus* sp.; and two cestodes *Tetrabothrius forsteri* and *Clistobothrium delphini* (formerly *Phyllobothrium delphini*). No acanthocephalans were observed. No statistically significant sexual and ontogenetic variation in helminth prevalence was detected after which samples were pooled. The highest prevalence in the long-beaked common dolphin (n=440) was observed for *N. globicephalae* (96.3%) in cranial sinuses, *Crassicauda* sp. (83.3%) in mammary glands, *Crassicauda* sp. (78.8%) infesting the cranial sinuses, followed by *Cl. delphini* (28.6%) in the blubber and *P. gastrophilus* and *B. cordiformis* (20.4%) in the digestive tract. Although comparative testing was unfeasible due to minimal samples of short-beaked common dolphin (n=33), several of the same helminth species were found, but not *N. globicephalae* nor *B. cordiformis*. No cyamids were encountered while pseudo-stalked barnacles *Xenobalanus globicipitis* were common. No new (global) helminth host records are revealed for common dolphins, but this study presents a first checklist of parasites separately for the Southeast Pacific long-beaked and short-beaked common dolphins. Future work should include exhaustive laboratory-based necropsies, enhanced sampling of the short-beaked form, focus on intermediate hosts and parasitic pathology, including potential human health impact from consumption of small cetaceans.

Keywords: helminths; parasitology; *Delphinus;* common dolphins; Southeast Pacific Ocean; Peru; Ecuador

INTRODUCTION

Landings of small cetaceans in Peruvian maritime ports, both through by-catch and direct takes for consumption and bait, were monitored periodically by the authors and collaborators from 1984 till 2000 (*e.g.* Read *et al.*, 1988; Van Waerebeek and Reyes, 1994 a,b;

García-Godos, 1992; Van Waerebeek *et al.*, 1994a, 1997, 1999). The examination and sampling of hundreds of freshly dead dolphins and porpoises allowed the study of multiple biological and health parameters (*e.g.*, Van Waerebeek, 1992; García-Godos *et al.*, 2007; Van Bressem *et al.*, 1998, 2006, 2007). In Ecuador, a dolphin by-catch monitoring programme with limited biological sampling was conducted between 1992 and 1993 (Félix and Samaniego, 1994). This type of programme provided a unique opportunity to study the parasitic fauna in largely unbiased samples of by-catches of several small cetacean species in Peru. However, in Ecuador, the sample of short-snouted common dolphins was skewed towards juveniles, possibly due to fishermen selectively discarding the largest animals offshore.

Many studies on the metazoan parasite fauna of marine mammals have focused on their impact on population dynamics through morbidity and mortality (*e.g.*, Ridgway and Dailey, 1972; Perrin and Powers, 1980; Lambertsen, 1986; Morimitsu *et al.*, 1992; Raga *et al.*, 1997), or have studied their use as biological tags (*e.g.* Dailey and Otto, 1982; Van Waerebeek *et al.*, 1990; Dailey and Vogelbein, 1991). Other parasitological research examined marine mammal helminths as potential causes of zoonotic disease in humans and explored their paths of transmission (*e.g.* Tantalean, 1994; Miyazaki, 1999; McCarthy and Moore, 2000; Goldsmid, 2005). However, all such studies imply a fair knowledge of the baseline level of parasite burden on the marine mammal host before they can be successfully interpreted. Unfortunately, such information is often not available.

In the Southeast Pacific (SEP) region, the parasite fauna of only three small odontocetes has been studied in some detail, *i.e.* coastal and offshore ecotypes of the common bottlenose dolphin *Tursiops truncatus* (Reyes, 1989; Van Waerebeek *et al.*, 1990), the dusky dolphin *Lagenorhynchus obscurus* (Van Waerebeek, 1992; Van Waerebeek *et al.*, 1993), currently renamed as *Sagmatias obscurus* (Vollmer *et al.*, 2019) and the Burmeister's porpoise *Phocoena spinipinnis* (Reyes and Van Waerebeek, 1995). Except for a few records and case studies on helminths from common dolphins *Delphinus* (sub) spp. (Van Bressem *et al.*, 2006; Tantalean y Escalante, 1987; Van Waerebeek *et al.*, 1994a; Alfaro-Shigueto *et al.*, 1994[1]; Alfaro-Shigueto, 1994), the parasitology of common dolphins *Delphinus* (sub) spp. of the SEP has not been thoroughly documented. One significant finding was an osteopathological study of skull damage, so-called 'basket-like' osteolytic lesions, diagnostic for some *Crassicauda* species infestation (Raga *et al.*, 1982). Such lesions were encountered in 26.5% of Peruvian common dolphins (n= 98) and did not differ among sex and age classes (Van Bressem *et al.*, 2006). *Crassicauda* sp. was responsible for 78.8 % of all osteolytic cranial lesions (Van Bressem *et al.*, 2006). Although the scope of this study is not the taxonomy and nomenclature of *Delphinus* spp. in the Eastern Pacific Ocean, it is important to highlight that the long-beaked common dolphin in the North East Pacific, since Heyning and Perrin (1994) has been referred to as *Delphinus capensis,* but has recently been suggested to represent a subspecies that may be called *D. delphis bairdii* Tomilin, 1957 (Perrin, 2022), however as yet a nomen dubium. Van Waerebeek *et al.* (1994) recognised the similarity of the neritic long-beaked common dolphin in the SEP with the coastal common dolphins off California and Baja California, thus was also considered as *D. capensis.* Further work is needed to evaluate the (sub)species status of the genus, however the long-beaked and the short-beaked common dolphins in the SEP hold substantial morphological differences. They are widely distributed, parapatrically in Peruvian waters and off the north and central coasts of Chile (Van Waerebeek *et al.*, 1994 a,b[2]; Sanino *et al.*, 2003; Reyes,

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[1] Alfaro-Shigueto, J., Van Waerebeek, K., Van Bressem, M.F. and Reyes, J.C. (1994) Parásitos de *Delphinus capensis* en el Pacífico Suroriental. Page 80 *in* Abstracts, Sexta Reunión de Trabajo de Especialistas en Mamíferos Acuáticos, 24-28 Octubre de 1994, Florianópolis, Brasil.

[2] Van Waerebeek, K., Reyes. J. and Van Bressem, M. (1994b) Presencia de dos especies de *Delphinus* en el Pacífico sureste. Anais 6ª RT Especialistas em Mamíferos Aquáticos da América do Sul. Florianópolis, Brasil 1994. p. 78.

2009). The large majority (more than 99%) of common dolphins taken in coastal fisheries and landed at Peruvian ports in the 1980s and 1990s were the long-beaked form (Van Waerebeek *et al.*, 1994a). Whilst in Ecuador only the short-beaked form has been reported (Félix and Samaniego, 1994; Castro and Van Waerebeek, 2019). From 1985 to 2000 we had access to 473 by-caught common dolphins of the SEP Ocean. Such unique opportunity allowed for a thorough examination of helminth and phoront species composition. Here we offer a first checklist and basic epidemiological information of helminth parasites and phoronts in common dolphins from the SEP. We also compare parasite prevalence from other small cetacean populations in the study region and briefly review and summarize published helminth parasite records for common dolphins from other regions.

MATERIAL AND METHODS

We examined 473 common dolphins *Delphinus* (sub) spp. from Peru and Ecuador for the presence of helminth parasites and epizoites. The freshly dead dolphins (condition code 2) were landed for human consumption and for bait in ports in the period 1985-2000. Most dolphins were captured in neritic waters in multifilament gillnets either as bycatch or as a directed take (harpooned). A smaller number were netted by pelagic purse-seiners (Read *et al.*, 1988; García-Godos, 1992; Van Waerebeek and Reyes, 1994; Van Waerebeek *et al.*, 1997). We examined 440 long-beaked common dolphins from Peru and 33 short-beaked common dolphins, 30 from Ecuador and 3 from Peru. Several juvenile dolphins but no neonates or calves were included in the Peruvian study sample, while in Ecuador 78% of specimens were calves or juveniles of 80-130 cm length.

The principal ports where biological sampling was implemented included (Figure 1), in Peru, Cerro Azul (13°03'S,76°30'W), Pucusana (12°29'S,76°49'W), Ancón (11°50'S,77°10'W) and Chimbote (09°04'S,78°35'W) (Van Waerebeek and Reyes, 1994); in Ecuador, Santa Rosa (02°12' S, 80°57'W) and Puerto López (01° 34' S, 80° 49' W) (Félix and Samaniego, 1994).

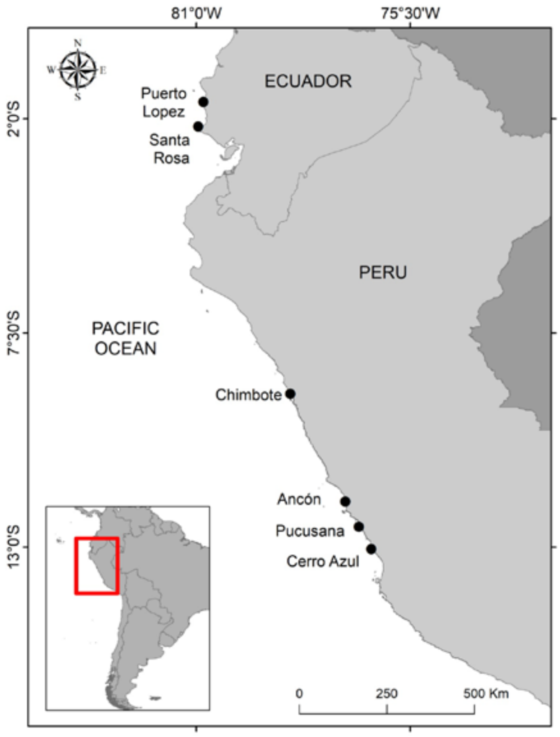

Figure 1. Main ports in Peru and Ecuador where bycaught common dolphins were examined and sampled for helminth parasites in the period 1985-2000. .

Sexual maturity status of the sample of long-beaked common dolphin was based on macroscopic inspection of gonads, *i.e.* presence of semen in epididymides or presence of at least one corpus albicans or corpus luteum in at least one ovary. For males and females whose gonads could not be examined, maturity was inferred from standard body length (SL), *i.e.* males and females smaller than, respectively, 215 cm and 200 cm, were considered immature, while males and females larger than, respectively, 220 cm and 210 cm were considered mature (Van Bressem *et al.*, 2006; CEPEC data archives, Lima, Peru). Animals of intermediate lengths (males between 215 and 220 cm and females between 200 and 210 cm) were classified 'of unknown maturity' (Van Bressem *et al.*, 2006) and removed from the sample when comparing sexually immature and mature dolphins.

Sampling in Ecuador was performed opportunistically during a fisheries interaction study (Samaniego, 1994). Moreover, the bringing to port of by-caught dolphins depended entirely on the fishermen's goodwill; hence only a small number of specimens and limited information on parasite prevalence and intensity is available. In Peru, due to high commercial value of dolphin carcasses, access to internal organs in fish markets was limited and depended on the cooperation of fishmongers. In return for evisceration (labor), the authors were allowed to collect several organs from the thoracic and abdominal cavities. Limited time, due to simultaneous sampling of several specimens in crowded fish markets, often forced researchers to forego examination of certain organs so as not to compromise accuracy in others. Thus, sample sizes were highly variable, and here detailed for each organ in the Results section. Sampling methodology followed Van Waerebeek *et al.* (1993); briefly, the integument and body orifices including blowhole, anus and urogenital slit, as well as flukes, flippers and dorsal fins, were macroscopically examined *in situ* for the presence of cutaneous conditions (see Van Bressem *et al.*, 2006) and epibionts, *i.e.* barnacles and cyamids. The integument and abdominal cavity was accessed through a cut of 80-100 cm length midventrally and most of the gastrointestinal tract (posterior oesophagus, fore-, main and pyloric stomachs, ampulla duodenalis, duodenum and intestines), gonads and occasionally the lungs and kidneys were also analysed. The heart and liver, organs with commercial value, and mammary glands could rarely be examined. Heads, after removal of mandibles, were sectioned ventro-laterally as to expose the cranial sinuses, which were then thoroughly flushed with seawater to dislodge and collect helminth parasites with sieves and determine parasite intensity. Finally, the rinsed heads were again inspected macroscopically for any helminths overlooked or imbedded in the mucosa. A subsample of skulls was retained as museum specimens and for osteopathology studies (*e.g.* Raga *et al.*, 1982; Van Bressem *et al.*, 2006).

Cetacean sectioning and parasite sampling was normally completed within the next 2 to 10 hours after landing. Although evisceration often occurred at night under artificial lighting, the macroscopic examination of organs and parasite quantification was performed during daylight. In Peru, parasites were handled following a standard protocol (Dailey, 1978) and were stored in 70% ethanol. Selected trematode specimens were coloured with haematoxilin and mounted in Canada balsam. Nematodes were cleared with lactophenol. Species identification was aided by Dr. R. Verano of the *Departamento de Parasitología, Facultad de Ciencias, Universidad Ricardo Palma*, Lima. Internal structures were studied and measured with a stereoscope and a binocular compound microscope. Specific voucher specimens and the original dataset are archived at the *Museo de Delfines, Centro Peruano de Estudios Cetológicos* (CEPEC), Pucusana, Peru.

In Ecuador, dolphins were also examined externally and internally at the landing port. Parasites were stored in an aqueous solution of ethanol (40%), formalin (5%) and glycerin in a proportion 2:2:1. Reference specimens were deposited at the *Pontificia Universidad Católica del Ecuador* (PUCE) in Quito, Ecuador.

During the field research phase in Peru we classified small phyllobothrid tapeworm larvae found in the blubber of delphinids (see Van Waerebeek *et al.*, 1990; 1993) as *Phyllobothrium delphini* (Bosc, 1802) and the significantly larger larvae encountered in multiple organs and tissues including serous membrane as *Monorygma grimaldii* (Moniez, 1899), according earlier understandings (*e.g.*, Testa and Dailey, 1977; Geraci *et al.*, 1978). However, recent taxonomic studies, based on both molecular genetics and morphology, have renamed these, respectively, *Clistobothrium delphini* and *Cl. grimaldii* (Agusti *et al.*, 2005a,b; Caira *et al.*, 2020), nomenclature used in this paper.

For each parasite species reported, the details on the number of dolphins examined and infested, the organ or location of infestation, and the smallest infested and smallest examined host were determined. Intensity of infestation was only occasionally noted.

Associated pathology as detected through macroscopic examination is briefly reported. Eight long-beaked common dolphin specimens of unknown sex were evidently discarded to estimate the prevalence by host sex. In the long-beaked common dolphin we compared the relationship of host sex and the maturity state with the parasite prevalence through a logistic regression analysis. Parasite prevalence (frequency of hosts infected with a specific parasite species) was calculated as the number of infested hosts divided by the total number of hosts examined x100. Confidence intervals (95% CI) for prevalence were computed by the modified Wald method (Agresti and Coull, 1998), which is considered more accurate than the classic so-called ‘exact’ methods. For comparisons between parasite prevalence, chi-square tests and two-sided Fisher's exact tests were applied. Statistical significance evaluation was set at α= 0.05. Cloud-based algorithms were used (https://www.graphpad.com/quickcalcs).

To facilitate the comparison with other geographical regions, a chart of metazoan parasites reported for common dolphins *Delphinus* spp. worldwide was produced (Table 2).

RESULTS

HOST: Long-beaked Common Dolphin (Peru) (n= 440)

Maturity and Sexual variation

Numerical data on the prevalence and sample sizes for parasites of long-beaked common dolphin sampled in Peru are given in Table 1. A series of two-tailed Fisher's tests did not reject the H° hypothesis (all p >0.074) of zero difference in prevalence between male and female dolphins for any of the helminth parasites studied. A logistic regression analysis showed that neither significant sexual variation (Logistic: Wald-chi-square = 2.95, p= 0.085) nor maturity state (Logistic: Wald-chi-square = 2.70, P= 0.10) differences existed in the presence of parasites. Due to a larger sample size for pseudo-stalked barnacles, we ran a logistic regression analysis that showed that females and males are equally likely to be parasitized (Logistic: Wald-chi-square = 0.57, p= 0.44). For every 1 cm increase in body length there was in average 1.025 times as likely (95% Wald’s confidence limits = 1.011 - 1.039) that a dolphin be parasitized (Logistic: Wald-chi-square = 12.68, p= 0.0004). It was concluded that no significant sexual variation in parasitism existed and therefore the discussion does not further discriminate between the sexes and maturity status of hosts.

Table 1. Prevalence of helminth parasites and epizoites in long-beaked common dolphins from Peru.

		MALES			**FEMALES**			**Indet. sex**		**POOLED SAMPLE**			
	Affected organs	**N (ex)**	**N (inf)**	**Prev**	**N (ex)**	**N (inf)**	**Prev**	**N(ex)**	**N(inf)**	**N (ex)**	**N (inf)**	**Prev**	**95% CI**
TREMATODA													
Nasitrema globicephalae	cranial sinuses	15	15	100	12	11	91.7	6	3	33	29	87.9	72.1 – 95.8
Pholeter gastrophilus	main stomach	70	6	8.6	42	1	2.4	1	0	113	7	6.19	2.82 – 12.5
	pyloric stomach	70	11	15.7	42	15	35.7	1	0	113	26	23.0	16.2 – 31.6
	duodenum	39	1	2.6	22	1	4.5	0	0	61	2	3.28	0.25 – 11.8

	c. gastrointestinal tract	34	5	14.7	20	6	30.0	0	0	54	11	20.4	11.6 – 33.1
Braunina cordiformis	main stomach	70	0	0	42	1	2.4	1	0	113	1	0.88	<0.0001 – 5.33
	pyloric stomach	70	11	15.7	42	8	19	1	0	113	19	16.8	10.9 – 24.9
	duodenum	39	4	10.3	22	1	4.5	0	0	61	5	8.20	3.16 – 18.2
	c. gastrointestinal tract	34	6	17.6	20	5	25	0	0	54	11	20.4	11.6 – 33.1
NEMATODA													
Anisakis sp.	forestomach	70	8	11.4	42	2	4.8	1	0	113	10	8.85	4.71 – 15.7
	duodenum	39	0	0	22	1	4.5	0	0	61	1	1.64	<0.0001 – 9.55
	c. gastrointestinal tract	34	1	2.9	20	2	10	0	0	54	3	5.56	1.32 – 15.7
Crassicauda sp.	cranial sinuses	15	1	6.67	12	0	0	6	1	33	2	6.06	0.76 – 21.7
Crassicauda sp.	mammary glands	0	0	0	5	4	80	0	0	5	4	80.0	36.0 – 97.9
Halocercus sp.	lungs	18	2	11.1	8	0	0	1	0	27	2	7.41	0.96 – 24.5
CESTODA													
Tetrabothrius forsteri	pyloric stomach	70	2	2.9	42	0	0	0	0	112	2	1.79	0.09 – 6.68
	duodenum	39	2	5.1	22	3	13.6	0	0	61	5	8.20	3.16 – 18.2
	intestines	35	1	2.9	21	5	23.8	0	0	56	6	10.7	4.65 – 21.8
	c. gastrointestinal tract	34	5	14.7	20	3	15.0	0	0	54	8	14.8	7.44 – 26.9
Clistobothrium delphini	blubber, anogenital area	5	1	20	2	1	50	0	0	7	2	28.6	7.56 – 64.8
EPIZOITES													
Xenobalanus globicipitis	fluke and flippers	243	13	5.3	124	15	12.1			365	28	7.67	5.33 – 10.9

Abbreviations: N(ex) = number examined; N(inf) = number infested; Prev = % prevalence; c = complete gastrointestinal tract examined;.
CI = 95% confidence intervals (modified Wald method).

1.1. Cranial sinuses (n= 33)

Trematoda: Nasitrematidae

Nasitrema globicephalae (Neiland et al., 1970)

All flukes encountered in the ventral cranial sinuses of the infested long-beaked common dolphins belonged to a single *Nasitrema* morphotype identified as *N. globicephalae* based on the lanceolate and rounded body shape, length range (9.5 - 22 mm) and internal morphology, as described by Neiland *et al.* (1970) and observed in other cetacean species from the same location (Alfaro-Shigueto, 1994). The cranial sinuses of 96.3% of dolphins (n= 29) were parasitized (Table 1), mostly in the pterygoid sinuses but also around the ear bones. No brain tissue was examined. The mean intensity was 15.3 flukes per host (SD ± 13.6, range 2-57, n= 22). The mucosae of the cranial sinuses showed no macroscopically visible lesions. The smallest infested dolphin (AGG-112, female) measured 170.0 cm. A 136 cm juvenile female (JCR-1108) was negative for this trematode.

Crassicauda sp. (Leiper and Atkinson, 1914)

Nematoda: Tetrameridae

Adult crassicaudid roundworms of several cm-length were found in the ventral, mainly pterygoid, cranial sinuses of two dolphins of the 33 examined (prevalence 6.06%; Table 1). Sexual variation in prevalence cannot be tested because there is but a single positive dolphin of known sex. That male dolphin had one nematode, intensity for the other was not noted. *Crassicauda* nematodes were partly buried in the air sinus wall of surrounding bone tissue. Their fragile bodies did not permit the collection of complete nematodes under field conditions. Some necrotized, crater-shaped mucosal tissue was evident at the attachment site. The smallest dolphin examined was a 136 cm female. Interestingly, the two dolphins that were infested (KVW-2362, -2366) were landed on consecutive days (10 and 11 January 1993) at Chimbote port and both were immature-sized.

1.2. Gastrointestinal tract (n= 54)

Trematoda: Heterophyidae

Pholeter gastrophilus (Kossack, 1910) *Odhner, 1914*

Pholeter gastrophilus were found as cysts embedded in the gastric mucosae of the gastrointestinal tract (n= 54) (20.4%). (Table 1). This fluke was found less frequently in the main stomach and duodenum and was entirely absent from the forestomach and post-duodenal intestines (Table 1). *Pholeter gastrophilus* intensity was low, usually one or two flukes per host sampled. The smallest parasitized dolphin was a female of 184.5 cm (KVW-522), although the smallest dolphin examined was a 136 cm female.

Trematoda: Brauninidae

Braunina cordiformis (Wolf, 1903)

Of 54 gastrointestinal tracts studied (forestomach to duodenum), 11 were infested with *B. cordiformis* (prevalence 20.4%). The trematode was most commonly found in the pyloric stomach and duodenum, rarely in the main stomach and never in the forestomach or the intestines (Table 1). *Braunina cordiformis* occurred mostly as a singleton (median= 1, n= 8) but was also found in clusters of 2-10 individuals, strongly attached to the mucosa although without indications of macroscopic mucosal lesions. This trematode was found in association with *P. gastrophilus* in 5.36% of pyloric stomachs. The smallest host individual examined and infested (in pyloric stomach) was a 136 cm female.

Nematoda: Anisakidae

Anisakis sp. (Dujardin, 1845)

This nematode was confidently identified only to the genus level. Of 54 gastrointestinal tracts examined, 3 were infested (prevalence 5.6 %). However, anisakid roundworms infested 8.9 % of the forestomachs examined. It was not encountered in the main and pyloric stomachs, except for one 216.5 cm dolphin, where it was found in the duodenum. In other parts of the intestine *Anisakis* sp. was not encountered (Table 1). Median intensity of infestation was 1.5 anisakid roundworms (range 1-5, n= 8) and no macroscopic lesions were observed. The smallest parasitized dolphin was a 189.5 cm female (JCR-1851), while the smallest examined was a 136 cm female. *Anisakis* spp. nematodes have been reported in the gastrointestinal system of common dolphins worldwide (Table 2).

Table 2. Overview of known metazoan parasites and epizoites in common dolphins *Delphinus* spp. Acronyms: not reported (NR), Eastern Tropical Pacific (ETP). Sources are listed below the table.

PARASITE or EPIZOITE (as reported)	LOCALITY	AFFECTED ORGAN	SOURCE
TREMATODA			
Brachycladium atlanticum (Abril, Balbuena & Raga, 1991) Gibson, 2005	Mediterranean Sea	Liver	1,2

Brachycladium delphini (Poirier, 1886) Looss, 1899	Atlantic, Atlantic (Black Sea), Mediterranean	Liver	3,4,5,6,7,8,9,10,11
Brachycladium palliatum (Looss, 1885) Looss, 1899	Atlantic, Atlantic (Black Sea)	Bile ducts	3,4,5,6,8,9,10,11,12,13
Braunina cordiformis Wolf, 1903	Atlantic, Atlantic (Black Sea)	Digestive tract	5,6,8,9,10,14,15,16,17
Campula oblonga Cobbold, 1858	Atlantic		18,12
Galactosomum erinaceum (Poirier, 1886)	Atlantic, Atlantic (Black Sea)	intestines	3,5,6,9,10
Nasitrema delphini Neiland, Rice & Holden, 1970	Pacific	Cranial sinuses	8,19,20,21,22,23,24
Nasitrema globicephalae Nieland, Rice & Holden, 1970	Pacific	Cranial sinuses	22,23,25
Nasitrema sp.	Atlantic, Pacific	Cranial sinuses	22,25,26,27,28,29
Nasitrema stenosoma Neiland, Rice & Holden, 1970	Pacific		22
Nasitrema lanceolatum Neiland, Rice & Holden, 1970	Pacific		23
Oschmarinella rochebruni (Poirier, 1886) Gibson & Bray, 1997	Pacific, Atlantic, Atlantic (Black Sea)	Liver and pancreas	3,4,5,6,8,9,10,12,16,22,23,25,28,30
Pholeter gastrophilus (Kossack, 1910)	Atlantic, Black Sea	Duodenum	9,10,13,16,12,30,31
Synthesium tursionis (Marchi, 1873)	Pacific	Intestines	33,34
Synthesium delamurei (Raga & Balbuena, 1988)	Mediterranean Sea		35
Amphimerus lancea (Diesing, 1850)	Atlantic		36
NEMATODA			
Anisakis simplex (Rudolphi, 1809) sensu lato	Atlantic, Black Sea, Pacific, South Africa		3,5,6,9,12,13,16,22,25,28,37,38,39,40,41
Anisakis simplex (Rudolphi, 1809) sensu stricto	Atlantic		42
Anisakis sp.	Chimbote, Peru	Intestines	29
Anisakis sp.	SE coast of South Africa	Stomach	43
Anisakis typica (Diesing, 1860)	Atlantic, Black Sea, Pacific		3,5,6,9,22,37,38,44
Anisakis pegreffii Campana-Rouget & Biocca, 1955	Mediterranean, Atlantic		42
Crassicauda sp.	Pacific		11,27
Crassicauda crassicauda (Creplin, 1829)	Atlantic		9
Halocercus delphini (Baylis & Daubney, 1925)	Atlantic, Black Sea, Mediterranean, Pacific		3,5,6,9,12,24,38,39,45,46,47
Halocercus delphini (Baylis & Daubney, 1925)	NR	Bronchi	3,48
Halocercus delphini Baylis and Daubney, 1925	Wales, South Africa and unknown locality	Bronchi	38
Halocercus delphini Baylis and Daubney, 1925	Atlantic Ocean (British Islands)	Bronchi	5
Halocercus kleinenbergi Delamure, 1951	Black Sea, South Africa	Lungs	6,9,13, according to 5
Halocercus invaginatus (Quekett, 1841)	Arctic		49,50
Halocercus lagenorhynchi Baylis & Daubney, 1925	Atlantic, Indian Ocean		51,52
Halocercus sp.	Pacific		11
Skrjabinalius cryptocephalus Delyamure, 1942	Atlantic (Black Sea), Pacific	Lungs	6,13,24, according to 5
Skrjabinalius guevarai Gallego & Selva, 1979	Atlantic, Mediterranean Sea		51,53
Stenurus minor (Kuhn, 1829)	Arctic		49
CESTODA			
Clistobothrium delphini (Bosc, 1802)	Atlantic, Atlantic (Black Sea), Pacific		6,9,10,12,14,20,22,23,25,38,39,54,55,56, according to 3 and 5
Clistobothrium grimaldii (Moniez, 1899)	Atlantic, Atlantic (Black Sea), Pacific		6,9,10,12,22,23,25,38,39,56,57, according to 5
Diphyllobothrium stemmacephalum Cobbold, 1858	Atlantic (Black Sea)	Intestines	6, 13, according to 3
Strobilocephalus triangularis (Diesing, 1850)	Pacific	NR	25
Tetrabothrius forsteri (Krefft, 1871)	Atlantic (Black Sea), Pacific, Mediterranean	NR	6,9,25,35,54, according to 3 and 5
Diphyllobothrium lanceolatum (Krabbe, 1865)	Arctic		49
Scolex pleuronectis'	Pacific, Mediterranean		22,35
Tetrabothrius diplosoma Guiart, 1935	Atlantic		9
ACANTHOCEPHALA			
Bolbosoma vasculosum (Rudolphi, 1819)	Atlantic (Black Sea), Mediterranean Sea	Intestines	6,9,58, according to 5
Corynosoma cetaceum (Johnston, 1943)	Atlantic, Atlantic (Black Sea), Indian Ocean	Intestines	6,8,9,16,59,60, according to 5
Corynosoma strumosum (Rudolphi, 1802)	Arctic		49
Corynosoma sp.	Pacific	Intestines	5
CIRRIPEDIA			

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Xenobalanus sp.	Pacific, Mediterranean	Integument	22,61
Xenobalanus globicipitis (Steenstrup, 1851)	Mediterranean	Integument	62
Conchoderma virgatum Spengler, 1789			62
AMPHIPODA			
Cyamidae	SE coast of Southern Africa		43
Isocyamus delphini			63
Isocyamus deltobranchium Sedlak-Weinstein, 1992			62
Syncyamus aequus Lincoln & Hurley, 1981			62
Syncyamus pseudorcae Bowman, 1955			62
COPEPODA			62
Lepeophtheirus crassus (Wilson & Bere, 1936)			62
Pennella balaenoptera Koren & Danielssen, 1877			

1	Mateu et al., 2011	33	Tantalean and Cabrera, 1999
2	Fraija et al., 2016	34	Tantalean and Escalante, 1987
3	Baylis, 1932	35	Quiñones et al., 2013
4	Price, 1932	36	Magalhaes-Pinto et al., 2004.
5	Delyamure, 1955	37	Davey, 1971
6	Delyamure, 1957	38	Gibson and Harris, 1979
7	Hörning and Pilleri, 1969	39	Abollo et al., 1998
8	Yamaguti, 1971	40	Aznar et al., 2003
9	Yablokov et al., 1972	41	Krefft, 1871 in Johnston and Mawson, 194_
10	Raga and Balbuena, 1987	42	Mattiucci and Nascetti, 2008
11	Lehnert et al., 2017	43	Ross, 1984
12	Gibson et al., 1998	44	Pilleri, 1974
13	Birkun, 2002	45	Dougherty, 1943
14	Skrjabin et al., 1963	46	Yamaguti, 1951b
15	Travassos et al., 1969	47	Testi and Pilleri, 1969
16	Berón-Vera et al., 2007	48	Baylis and Daubney, 1925
17	Fraija-Fernández et al., 2015	49	Popova et al., 1971
18	Adams et al., 1998	50	Arnold and Gaskin, 1975
19	Neiland et al., 1970	51	Measures, 2001
20	Margolis and Dailey, 1972	52	Tomo et al., 2010
21	Appy, 1974	53	Raga et al., 1987a
22	Dailey and Walker, 1978	54	Guiart, 1935
23	Dailey, 1978	55	Williams, 1968
24	Spratt, 2002	56	Testa and Dailey, 1977
25	Dailey and Otto, 1982	57	Baer, 1932
26	Díaz-Delgado et al., 2018	58	Van Cleave, 1953
27	Walker and Cowan, 1981	59	Johnston and Best, 1937
28	Cowan et al., 1986	60	Schmidt and Dailey, 1971
29	Murga et al., 1986	61	Gruvel, 1905, 1920, in Dollfus, 1968
30	Ridgway and Dailey, 1972	62	Ten et al. 2022
31	Dollfus 1973/74	63	Leung, 1967
32	Pearson and Courtney, 1977		

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Cestoda: Tetrabothriidae

Tetrabothrius forsteri (Krefft, 1871)

Adult tetrabothrid tapeworms were found in 14.8 % of dolphins (n= 54) for which the entire digestive tract was examined (Table 1). *Tetrabothrius forsteri* occurred most often in the duodenum and intestines and rarely in the pyloric stomach (Table 1). The median intensity was 2 tapeworms per host (range 1-6, n= 9). No cestodes were observed in forestomachs (n= 112) or main stomachs (n= 61) (Table 1). The smallest dolphin parasitized with *T. forsteri* was a 180 cm male (AGG-023), while the smallest dolphin examined measured 136 cm. This cestode was previously reported worldwide (Table 2).

1.3. Lungs (n= 27)

Nematoda: Pseudaliidae

Halocercus sp. (Baylis and Daubney, 1925)

Three *Halocercus* lungworms were extracted from the lung alveoli of a 180 cm, sexually immature male and from another male of 210.5 cm from a total of 27 dolphins examined (prevalence = 7.41%) (Table 1). Taxon could be determined only to genus level due to poor fixation of the specimens. As described in Dailey (1985), the anterior ending was typically embedded in a capsule, probably to protect the parasite from becoming dislodged during forceful expiration by the host. The smallest dolphin examined was a 153 cm juvenile male which was negative.

In addition, small cysts, mostly less than 5mm in diameter and partly consisting of necrotized tissue, were found in the lung tissue in low to high densities in 23.1% of examined dolphins (n= 26). However, these cysts were not found to correspond to any metazoan parasite.

1.4. Pancreatic duct (n=17), spleen, kidneys (n=8) and liver (n=3)

The pancreatic ducts of 17 long-beaked common dolphins (8 females and 9 males) were examined, but none presented helminth parasites. The smallest dolphin examined was a juvenile male of 189.5 cm (JCR-1851). No parasites were found in 8 (paired) kidneys (5 females, 3 males) and 3 livers.

1.5. Blubber (n= 7), mesenteries and mammary glands (n= 5)

Cestoda: Phyllobothriidae

Clistobothrium delphini (Bosc, 1802) Caira, Jensen, Pickering, Ruhnke and Gallagher, 2020 (previously known as *Phyllobothrium delphini*)

Two of seven dolphins studied, a mature female and a 197 cm male, showed small white cysts of merocercoids *of C. delphini* in the blubber, primarily concentrated in the anogenital area (Table 1). However, given the often large number of cysts and because we had no permission to make multiple sections in the blubber), the total number of merocercoids per dolphin could not be counted. The smallest infested and examined hosts consisted, respectively, of a 197 cm male (MFB-264) and a 161 cm male (AGG-371).

Cestoda: Phyllobothriidae

Clistobothrium grimaldii (Moniez, 1899) Caira, Jensen, Pickering, Ruhnke and Gallagher, 2020 (previously known as *Monorygma grimaldii*).

The lack of complete dissections of dolphin carcasses precluded a thorough examination and prevalence estimation for this parasite. However, only one 214.5 cm female long-beaked common dolphin (JCR-1069) was found to be parasitized by merocercoids of *C. grimaldii* cysts in the mesenteries, showing the occurrence of this species in Peruvian waters.

Crassicauda sp.

The mammary glands of 4 of 5 females examined (all of which were immature animals) were infested with *Crassicauda* sp. (Table 1). As was the case for the cranial sinuses, no complete nematode specimens could be extracted from the mammary glands in the field and thus species identification was not possible. Median intensity per positive host was 2 nematodes (range 1-7, n=5). The smallest infested dolphin, also the smallest one examined, a 173 cm female (AGG-488), presented *Crassicauda* worms firmly anchored in both the mammary glands and in the surrounding hypodermis and subcutaneous tissue.

1.6. Integument, orifices and appendages (n= 365)

Thoracica: Balanidae

Xenobalanus globicipitis (Steenstrup, 1851)

Pseudo-stalked barnacles were attached primarily to the trailing edge of the flukes, but also to the dorsal fin and flippers in 7.67% of 365 long-beaked common dolphin examined (Table 1). A slightly higher prevalence of females was infested (p= 0.0346) compared to males. Although the barnacle's calcareous base is incrusted into the skin, *X. globicipitis* did not cause inflammation or any other macroscopically detectable cutaneous pathology, as was also observed in other Peruvian odontocetes (*e.g*, Van Waerebeek *et al.*, 1993; Reyes and Van Waerebeek, 1995). The smallest infested and examined specimens were respectively a 149 cm male (KVW-1334) and a 136 cm female (JCR-1108).

Amphipoda: Cyamidae

No cyamids (whale-lice) were found on any of the 178 long-beaked common dolphins for which the integument, appendages and orifices were carefully examined. These included dolphins of both sexes and a full range of body lengths, proxy for age classes.

2. Host: Short-beaked Common Dolphin (n= 33)

Peru

Only limited data could be collected from 3 short-beaked common dolphins (KVW-568, KVW-569 and JSM-10). No helminths were found in the cranial sinuses of a 216 cm male (JSM-10). Stomachs (fore, main and pyloric) and livers of the three dolphins were found to be negative for helminths, with the exception of one main stomach (KVW-568, mature male) that contained the trematode *P. gastrophilus*. No barnacles, nor cyamids were detected.

Ecuador

2.1. Gastrointestinal tract (n= 30)

Nematoda: Anisakidae

Anisakis spp. (Dujardin, 1845)

Anisakid roundworms were collected from 7 short-beaked common dolphins. Nematodes were predominantly encountered in the forestomach.

Cestoda: Tetrabothriidae

Tetrabothrium sp.

A single tetrabothrid tapeworm was collected at an unspecified location of the gastrointestinal tract, although most likely from the intestine, of a 186 cm male short-beaked common dolphin (Z2SR170). The poor state of preservation of the tapeworm precluded identification beyond genus level.

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Cestoda: unidentified tetraphyllidean larvae

Some 20 procercoid stage tetraphyllidean larvae, probably ingested and released from infested fish or squid, were found free in the digestive tract of a juvenile (144 cm) male dolphin (Z2SR080).

2.2. Lungs (n= 30)

Nematoda: Pseudaliidae

Halocercus sp.

The lungs of one short-beaked common dolphin, a 108 cm male calf (Z2SR002), contained the lungworm *Halocercus* sp.

2.3. Kidneys (n= 30)

Kidneys were sectioned and examined macroscopically, but no parasites were found.

2.4. Mesenteries and blubber (n= 30)

Cestoda: Phyllobothriidae

Clistobothrium delphini and *Clistobothrium grimaldii*

Merocercoids of *C. delphini,* which we called "cysts" in fieldnotes, were collected from the blubber around the anogenital area in 2 specimens, a 170 cm male (Z2SR186) and a 178 cm female (Z2SR171). A single *Cl. grimaldii* larva was recovered opportunistically from near the intercostal muscle of a male short-beaked common dolphin (Z2SR084).

2.5. Integument, orifices and appendages (n= 30)

Thoracica: Balanidae

Xenobalanus globicipitis

A 91 cm male calf (ZIPLO012) presented *X. globicipitis,* the only animal amongst 30 *D. delphis* examined (prevalence= 3.3%). Remarkably, the pseudo-stalked barnacles were present with high intensity, with *ca.* 50 specimens attached to flippers and flukes.

DISCUSSION

All species of helminth parasites documented in this study in long-beaked and short-beaked common dolphins from coastal waters of Peru and Ecuador were previously reported elsewhere for other *Delphinus* populations, however typically without distinction between common dolphin (sub)species or forms. Due to very small or indeterminate sample sizes for the short-beaked common dolphin, it is currently unfeasible to compare parasite loads between the two morphs of the SEP. Most helminths and the barnacles reported here for *Delphinus* spp. have also been encountered in other small odontocete species from the Southeast Pacific region.

Trematoda

The cranial sinus fluke *N. globicephalae* showed high prevalence in both inshore (80%) and offshore (94.1%) ecotypes of the common bottlenose dolphin (Reyes, 1989; Van Waerebeek *et al.*, 1990) and in Peruvian dusky dolphin (78.3%; Van Waerebeek, 1990; Van Waerebeek *et al.*, 1993), but only occasionally parasitized the Burmeister's porpoise (9.3%, Reyes and Van Waerebeek, 1995). The higher prevalence compared to the porpoises may be explained by significant differences in prey composition, related to the porpoises' more neritic distribution (Alfaro-Shigueto *et al.*, 2008) or to a dissimilar susceptibility to *Nasitrema* infection.

Nasitrema globicephalae was previously reported in common dolphins in the Northern Pacific (Table 2). In Peru, *N. globicephalae* is known to infest also the southern right whale dolphin *Lissodelphis peronii*, short-finned pilot whale *Globicephala macrorhynchus* and false

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killer whale *Pseudorca crassidens* (Alfaro-Shigueto, 1994; CEPEC, data archives). Another host record in Pacific South America includes the Chilean dolphin *Cephalorhynchus eutropia* (Brieva and Oporto, 1991). This trematode has been reported also in the long-finned pilot whale *Globicephala melas* from Argentina's Tierra del Fuego (Raga *et al.*, 1994). Trematodes of the genus *Nasitrema* and nematodes of the genus *Crassicauda* have been suggested as a cause for stranding and morbidity in small cetaceans (Dailey and Stroud, 1978; Dailey and Walker, 1978; Dailey, 1985; Morimitsu *et al.*, 1992). Comparable to what was found in Peruvian dusky dolphins (Van Waerebeek *et al.*, 1993), we did not detect any macroscopic lesions of mucosae in the cranial sinuses related to the presence of *Nasitrema* and identified no strandings of common dolphins other than fisheries related, but the question of serious morbidity remains unanswered. Other studies reported this trematode in free-ranging cetaceans obtained from fisheries and from strandings (Table 2).

Pholeter gastrophilus is distributed in the North and South Atlantic Oceans, as well as in the Mediterranean, Black and North Seas. For the Pacific Ocean just a few reports exist for the Peruvian coast (Table 2) and South Australia and, for the Indian Ocean, *P. gastrophilus* samples are restricted to the Red Sea (Fraija-Fernandez *et al.*, 2017). The trematode species *P. gastrophilus* and *B. cordiformis* were previously reported for the common dolphin in the western South Atlantic and the Adriatic Sea (Table 2). They were also documented in Peru in both *T. truncatus* ecotypes (*Pholeter* only in the offshore form) (Reyes, 1989; Van Waerebeek *et al.*, 1990), in dusky dolphin (Van Waerebeek *et al.*, 1993) and in the Burmeister's porpoise (Reyes and Van Waerebeek, 1995).

Necropsies of *D. delphis* in Argentine's Patagonia showed the presence of *B. cordiformis* in the forestomach (Berón-Vera *et al.*, 2007), which expresses a different pathobiology than in Peruvian long-beaked common dolphin where none were collected from 70 forestomachs examined but present in 16.8% of pyloric stomachs (Table 1). Previous records of *P. gastrophilus* in *D. delphis* exist also for the Atlantic, west Pacific and Black Sea (see Table 2 for references).

Nematoda

The low prevalence (3.7%) of cranial crassicaudiasis, as estimated by infestation with *Crassicauda* sp. nematodes in the ventral cranial sinuses of long-beaked common dolphin in Peru mirrors their absence in the Peruvian dusky dolphin (n= 97; Van Waerebeek *et al.*, 1993), a sympatric species with a highly similar diet that often forms mixed schools (Van Waerebeek, 1994; García-Godos *et al.*, 2007). Cranial osteolysis, diagnostic for *Crassicauda* sp. infestation, was however encountered in museum specimens at a significantly higher prevalence (26.5%, n= 98) in Peru (Van Bressem *et al.*, 2006) suggesting that common dolphins that recovered from active infestation, however, did not resolve osteopathy. In Peru *Crassicauda* was also commonly found in offshore *T. truncatus* (Van Waerebeek *et al.*, 1990) but was absent in the inshore ecotype and in *P. spinipinnis*, both of which feed in neritic habitat (Alfaro-Shigueto *et al.*, 2008; Van Waerebeek *et al.*, 1990; Reyes and Van Waerebeek, 1995; Reyes, 2009). Other cases include those for *D. delphis* from the Eastern Tropical Pacific (Walker and Cowan, 1981) and from England and Wales (Gibson *et al.*, 1998).

Anisakis spp. are nematodes commonly present in hosts inhabiting temperate waters (Davey, 1971). They affect a large number of cetacean species (*e.g.*, Baylis, 1932; Delyamure, 1955; Dailey and Brownell, 1972), including also short-beaked common dolphins from the Northeast Atlantic, the Northeast Pacific and long-beaked common dolphin from South Africa, California and Venezuela's Caribbean coast (Mignucci-Giannoni *et al.*, 1998; Colom-Llavina, 2005) . Murga *et al.* (1986)[3] briefly commented on *Anisakis* sp. in '*D. delphis*' from Chimbote, Peru. However, the large majority of common dolphins landed at Peruvian ports, including Chimbote, have been the long-beaked form (Van Waerebeek *et al.*, 1994a). In Peru, *Anisakis* sp. was documented in both offshore (61.9%) and inshore (37.5%) ecotypes of the common bottlenose dolphin (Reyes, 1989; Van Waerebeek *et al.*, 1990) and in 28.1% of Burmeister's porpoises (Reyes and Van Waerebeek, 1995). Interestingly *Anisakis* sp. was encountered in 40% (n= 218) of Peruvian dusky dolphins (Van Waerebeek *et al.*, 1993), a significantly higher prevalence (two-tailed Fisher's, p<0.0001) than the 8.8% of common dolphins. Despite extensive group mixing, important differences exist in ecological niches.

Anisakis sp. is reported here for *D. delphis* from Ecuador and was found in a larval form, with a higher prevalence, in Atlantic *D. delphis* (Berón-Vera *et al.*, 2007) (Table 2). This stomach nematode affects also some other small odontocete hosts of the study region including Chilean dolphin *Cephalorhynchus eutropia* and Chilean Burmeister's porpoises (Torres *et al.*, 1992).

Halocercus sp. has previously been reported to infest lungs of common dolphins *D. delphis* s.l. in the Atlantic and Pacific Oceans, and the Mediterranean and Black Seas (Table 2). In the present study only two long-beaked (prevalence = 7.4%) and one short-beaked common dolphin had a low-intensity *Halocercus* sp. lungworm infestation. For the SEP only one other case is reported in dusky dolphin (Van Waerebeek *et al.*, 1993) and three cases in Burmeister's porpoise (Reyes and Van Waerebeek, 1995). *Halocercus* lungworms may cause verminous pneumonia and possibly death (Dailey, 1985). Dailey *et al.* (1991) found evidence of prenatal infection of *Halocercus lagenorhynchi* in *T. truncatus*, which begs the question whether this is an exceptional or a frequent form of transmission. Though *H. delphini* and *H. kleinenbergi* were reported in common dolphins from various oceanic regions (Table 2), they were absent in *D. delphis* from Argentine's Patagonian coast (Berón-Vera *et al.*, 2007).

Cestoda

Tetrabothrium forsteri was present in both forms of common dolphin (Table 1). Three other final hosts for this cestode have been reported for the SEP, *i.e.* southern right whale dolphin *Lissodelphis peronii* in central Chile (Fernández, 1987) and inshore (16.7%) and offshore (70.6%) forms of *T. truncatus* in Peru (Van Waerebeek *et al.*, 1990). In both short-beaked common dolphins from Ecuador and long-beaked common dolphins from Peru we found the merocercoids *Cl. grimaldii* and *Cl. delphinii*, previously known as *Monorygma grimaldii* and *Phyllobothrium delphinii*, respectively. The taxonomic identity of these species has been in dispute for years (Aznar *et al.*, 1994, Agusti *et al.*, 2005a, b, Aznar *et al.*, 2007). Recently, *Caira et al.* (2020) using broad phylogenetic data have shed light on their nomenclature. These larval cestodes showed molecular affinities with *Clistobothrium* species, whose adults commonly occur in sharks (Caira *et al.*, 2020). The cestodes *Cl. delphini* and *Cl. monorygma* from either stranded or captured cetaceans have been reported mostly in the Atlantic and North Pacific Oceans. Both species may serve as bio-indicators in *T. truncatus*, as they are present only in the offshore population (Reyes, 1989; Van Waerebeek *et al.*, 1990), presumably because the latter often feeds on squid, a likely intermediate host (Walker, 1981). *Clistobothrium delphini* (reported as *Phyllobothrium delphini*) parasitized also 70.0 % of Peruvian dusky dolphins (Van Waerebeek *et al.*, 1993).

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[3] Murga G., S, Moreno R., B. and Escalante A., H. (1986) Helmintos parásitos de *Delphinus delphis* procedentes de la zona norte del Mar Peruano. Abstracts, VIII Congreso Nacional de Biología y III Simposio de Educación en Ciencias Biológicas, 25-31 de mayo 1986, Arequipa, Perú.

Acanthocephala

No Acanthocephala were found in SEP *Delphinus*, analogous to checklists of helminth faunas in Peruvian dusky dolphin, Burmeister's porpoise and common bottlenose dolphin (Reyes, 1989; Van Waerebeek, 1992; Van Waerebeek *et al.*, 1990, 1993; Reyes and Van Waerebeek, 1995). This suggests acanthocephalans are rare in small cetaceans of this region. Recent reviews of the diversity of marine acanthocephalans in Peru identified the South American sealion (*Otaria byronia*) as only known marine mammal host, namely for *Corynosoma obtuscens* (Tantalean *et al.*, 2005; Morales *et al.*, 2005). However, studies in the Atlantic, Mediterranean and Australia reported acanthocephalans such as *Bolbosoma vasculosum*, *Corynosoma cetaceum* and *Corynosoma* sp. in common dolphins (Delyamure, 1955, Abollo *et al.*, 1998; Costa *et al.*, 2000; Berón-Vera *et al.*, 2007), most of which are thought to be short-beaked common dolphin.

In several organs subjected to gross examination, no metazoan parasites were encountered, including the spleen (n=3), kidneys (n=8 paired) and liver (n=3). This finding is consistent with the study by Ross (1984), which neither found helminths in the kidneys (n=10), liver (n=6), lungs (n=8) and hearts (n=4) of long-beaked common dolphin from the SE coast of South Africa (Samaai *et al.*, 2005). A 185 cm female was the smallest dolphin for which spleen, kidneys and liver were examined in Peru.

Crustacea

This study documented the epizoite *X. globicipitis* on both SEP common dolphin forms. Previous reports of *Xenobalanus* in *D. delphis* exist from the North Atlantic, western Mediterranean (4%) and North Pacific (Dollfus, 1968; Pilleri, 1970; Dailey and Walker, 1978). This pseudo-stalked barnacle is very common in Peruvian waters and has been found in the dusky dolphin with prevalence = 38.9%, CI 35.4-42.5 (Van Waerebeek, 1990; Van Waerebeek *et al.*, 1993), Burmeister's porpoise with prevalence = 23.8%, CI 13.3-38.7 (Huamán and Reyes, 1986; Reyes and Van Waerebeek, 1995), in common bottlenose dolphins with prevalence = 6.8% (Van Waerebeek *et al.*, 1990). However, in Ecuador, 42.3% of offshore bottlenose dolphins were infested with this phoront (Félix and Castro, *In press*). From photographs of free-ranging animals, the prevalence of *X. globicipitis* in the short-beaked and long-beaked common dolphin in the eastern tropical Pacific Ocean was estimated as 2.9% and 1%, respectively (Kane *et al.*, 2008). These are considerably lower values compared to the samples from coastal Peru. The high productivity linked to year-round upwelling in the Humboldt Current Large Marine Ecosystem (Gutiérrez *et al.*, 2016), we suggest, creates a particularly favourable environment for a sessile filter-feeder like *Xenobalanus*, alongside providing a high intensity of phoretic hosts. Prevalence derived from at-surface photographs of free-ranging dolphins (Kane *et al.*, 2008) will inevitably underestimate true values considering that a number of barnacles will not be detected on largely submerged caudal and pectoral fins.

As was the case in Peruvian dusky dolphins (Van Waerebeek *et al.*, 1993), this study found no associated cyamids despite the close inspection of hundreds of carcasses of long-beaked common dolphin. This shared absence is consistent with these dolphin species frequently forming mixed schools in coastal Peru (Van Waerebeek, 1994) which hypothetically would facilitate cyamid transmission. In contrast, *Isocyamus* sp. was occasionally encountered on Burmeister's porpoises in Peru (Reyes and Van Waerebeek, 1995; CEPEC, unpublished data) and also on a few common bottlenose dolphins (Van Waerebeek *et al.*, 1990). In the Atlantic, Leung (1967) reported *Isocyamus delphini* in *D. delphis* while Ross (1984) mentioned cyamids for South African long-beaked common dolphin (Table 2).

CONCLUSION

The presence of most gastrointestinal helminth parasites in marine mammals is directly related to their diet habits, as both fish and squid act as intermediate hosts (Dans *et al.*, 1999; Berón-Vera *et al.*, 2007). While there is a paucity of information on helminth fauna in prey species, we know more on the feeding ecology of the principal odontocetes of the study region. By far the main prey item of long-beaked common dolphin is the Peruvian anchovy *Engraulis ringens* (García-Godos *et al.*, 2007). Other species include silverside *Odontesthes regia*, Peruvian pilchard *Sardinops sagax*, mackerel *Trachurus picturatus*, hake *Merluccius gayi* and various squids (Garcia-Godos *et al.*, 2007). A study of the metazoan parasites of *E. ringens* in Chilean waters revealed the occurrence of *Anisakis* sp. (Valdivia *et al.*, 2007) which may plausibly explain why common dolphins are infested.

In order to improve sample sizes, establish time series and help reveal helminth life cycles and hosting, we recommend systematic, standardized parasite sampling from dolphin bycatch in the study region, and most especially from short-beaked common dolphins as to allow a comparative analysis between both common dolphin forms. Surveys of marine mammal helminth fauna in the SEP region linked to detailed, laboratory-based necropsies, unfeasible under the field conditions of the present study, should yield better information on pathological processes and contribute to the understanding of verminous morbidity and mortality and impact on general health of cetaceans. Conceivably, cetacean helminths may have some relevance also for human health, considering that dolphins and porpoises are still occasionally consumed in Peru, at least until recently (Alfaro-Shigueto *et al.*, 2008; Tzika *et al.*, 2010). Other studies with a zoonotic focus (*e.g.* Miyazaki, 1999; Tantalean, 1994; McCarthy and Moore, 2000; Goldsmid, 2005) have discussed precautions to prevent the accidental transmission of helminth parasites to humans through the consumption of insufficiently cooked cetacean meat and organs, so-called aquatic bushmeat or 'wild meat' prevalent in many regions of the world (*e.g.*, Ofori-Danson *et al.*, 2003; Clapham and Van Waerebeek, 2007).

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