

METAZOAN PARASITES AND OTHER SYMBIONTS OF CETACEANS IN THE CARIBBEAN

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ABSTRACT: The parasite fauna in cetaceans from Puerto Rico, the Virgin Islands, and the larger Caribbean region is poorly known. We provide the first records for parasite biodiversity among a diverse assemblage of cetaceans from the Caribbean Sea. Internal and external parasites and commensals were collected from stranded whales and dolphins salvaged in Puerto Rico, the United States and British Virgin Islands, Jamaica, and Venezuela between 1989 and 1997. A total of 47 individuals of 16 species of whales and dolphins (15 odontocetes and 1 mysticete) was examined. Overall, parasites and commensals were found in 34 (72.3%) animals, representing 13 species of odontocetes and 1 mysticete. Eighteen species of endoparasitic helminths were found, including 8 species of nematodes, 2 digeneans, 6 cestodes, and 2 acanthocephalans. Three species of whale-lice and 2 species of barnacles were also collected.

The parasite fauna in cetaceans from the region of Puerto Rico, the Virgin Islands, and the larger area of the Caribbean is poorly known. Adjacent to the Caribbean, Forrester (1992) summarized records of helminths and other parasites in 12 species of odontocetes from Florida, including dwarf sperm whales (*Kogia simus* Owen), densebeak whales (*Mesoplodon densirostris* (de Blainville)), pygmy killer whales (*Feresa attenuata* Gray), false killer whales (*Pseudorca crassidens* (Owen)), rough-tooth dolphins (*Steno bredanensis* (Lesson)), and bottle-nose dolphins (*Tursiops truncatus* (Montagu)). In the Caribbean, Arnold and Gaskin (1975) reported *Stenurus globicephala* Baylis and Daubney, 1925 in a shortfin pilot whale (*Globicephala macrorhynchus* Gray) landed at Castries in St. Lucia in October 1972. Morales-Vela and Olivera-Gómez (1993) reported nematodes (*S. globicephala* [USNPC 087445.01], *S. minor* (Kuhn, 1829) and *Crassicauda* sp. (Creplin, 1829) [USNPC 087445.03]) and diogeneans (*Nasitrema globicephalae* Neiland, Rice and Holden, 1970 [USNPC 087445.02]) in a shortfin pilot whale from Cozumel, Mexico. DeBrot and Barros (1994) reported the collection of 5 unidentified nematodes from a goose-beak whale (*Ziphius cavirostris* G. Cuvier) from Curaçao. In the current study, we provide the first records for helminth biodiversity among a diverse assemblage of cetaceans principally from Puerto Rico and the Virgin Islands and including other areas of the Caribbean Sea.

MATERIALS AND METHODS

Internal and external parasites and commensals were collected from dead whales and dolphins salvaged in Puerto Rico, the United States and British Virgin Islands, Jamaica, and Venezuela between 1989 and 1997 by the Caribbean Stranding Network (CSN). Additional parasites collected from 3 species of cetaceans in 1976, 1978, and 1986 were also included in the study. Stranded and dead cetaceans (Table I) were salvaged and examined at necropsy by the personnel of the CSN for endo- and ectoparasites. This entailed: (1) examination of the entire gastrointestinal tract, major organ systems, blubber, nares, ear canals, and cranial sinuses for helminth parasites, depending on the condition of individual animals; and (2) examination of the skin and teeth for

ectoparasitic crustacea and commensals such as barnacles and remoras. Specimens were initially fixed and preserved in 10% buffered formalin and later transferred to 70% ethanol for storage prior to identification. During routine histopathological examination of tissues from carcass recovered, signs of or actual segments of helminths were observed. Tissues for histopathology were preserved in 10% buffered formalin at a fluid to tissue ratio of 10:1, later transferred to 70% ethanol for storage, and prepared in 5- μ m paraffin sections stained in hematoxylin and eosin, Giemsa, Gram stain, and periodic acid-Schiff. Occurrence or prevalence is reported for all parasite and commensal collections; accurate estimates of intensity of infection were generally not possible. Following identification, representative voucher specimens of helminths were deposited in the U.S. National Parasite Collection, Biosystematics and National Parasite Collection Unit, Agricultural Research Service, USDA, Beltsville, Maryland 20705 (USNPC no. 087427–087471); specimens of crustaceans were deposited in the National Crustacean Collection of the U.S. Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

RESULTS

A total of 47 individuals of 16 species of whales and dolphins (15 odontocetes and 1 mysticete) was examined (Table I). Overall, parasites and commensals were found in 34 (72.3%) animals, representing 13 species of odontocetes and 1 mysticete (Table II). Species examined, but in which no parasites were found, included the rough-tooth dolphin and the densebeak whale.

Eighteen species of endoparasitic helminths were found, including 8 species of nematodes, 2 digeneans, 6 cestodes, and 2 acanthocephalans (Table II). Four species of whale-lice (Crustacea: Amphipoda) and 2 species of barnacles (Crustacea: Cirripedia) were also collected. Specimens of larval nematodes and some other specimens in poor condition were only identified to the level of genus as specified. Additionally, data for host distribution along with new host and geographic records are included in Table II.

DISCUSSION

Acanthocephala

Species of *Bolbosoma* Porta, 1908 are characteristic parasites in the intestines of odontocete and mysticete cetaceans (see DeLiamure, 1955). Two species are reported from the Caribbean for the first time: *Bolbosoma capitatum* (von Linstow, 1880) and *Bolbosoma vasculosum* (Rudolphi, 1819) (Table II). Specimens of *Bolbosoma* sp. were also found in the intestines of a pygmy sperm whale (*Kogia breviceps* (de Blainville)). *Bolbosoma capitatum* has been reported widely among large odon-

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TABLE I. Biological data, geographic localities, and dates of collection for stranded and dead cetaceans examined for endo- and ectoparasites from the Caribbean.

Field number	Date of collection	Sex	Length (cm)	Locality	Parasites*
Humpback whale, <i>Megaptera novaeangliae</i> (Borowski)					
NEPST026	08 Apr 1986	M	~500	Mayagüez, Puerto Rico	Ci, Cy
NEPST497	04 Feb 1996	M	853	Rincón, Puerto Rico	Ci, Cy
Sperm whale, <i>Physeter macrocephalus</i> Linnaeus					
NEPST115	11 Feb 1990	M	577	Arecibo, Puerto Rico	Cy
NEPST161	09 May 1991	F	830	Maunabo, Puerto Rico	C, Cy
NEPST168	19 Jul 1991	F	277	Lajas, Puerto Rico	—
NEPST179	28 Dec 1991	M	1,000	Aguadilla, Puerto Rico	C, Ci
NEPST324	15 Jun 1994	F	1,006	Lajas, Puerto Rico	C
NEPST328	25 May 1994	F	293	Cabo Rojo, Puerto Rico	—
NEPST460	10 Sep 1995	F	914	Guayama, Puerto Rico	—
Pygmy sperm whale, <i>Kogia breviceps</i> (de Blainville)					
NEPST033	28 Jan 1976	M	315	Mayagüez, Puerto Rico	N
NEPST174	30 Oct 1991	M	250	St. Croix, U.S. Virgin Islands	N
NEPST527	06 May 1997	F	281	Barceloneta, Puerto Rico	A, C, N
Dwarf sperm whale, <i>Kogia simus</i> Owen					
NEPST288	25 Oct 1993	F	111	Fajardo, Puerto Rico	N
Goosebeak whale, <i>Ziphius cavirostris</i> G. Cuvier					
NEPST143	05 Feb 1991	F	529	St. Croix, U.S. Virgin Islands	C, N
NEPST144	05 Feb 1991	M	549	St. Croix, U.S. Virgin Islands	C, Cy, N
NEPST145	06 Feb 1991	M	579	St. Croix, U.S. Virgin Islands	C, Ci, N
NEPST190	13 Jun 1992	F	518	Humacao, Puerto Rico	—
NEPST195	08 Jul 1992	F	548	Isla de Vieques, Puerto Rico	N
Densebeak whale, <i>Mesoplodon densirostris</i> (de Blainville)					
NEPST167	22 Jun 1991	M	404	Rio Grande, Puerto Rico	—
Antillean beaked whale, <i>Mesoplodon europaeus</i> Gervais					
NEPST233	12 Sep 1993	M	~457	St. Croix, U.S. Virgin Islands	Ci
Shortfin pilot whale, <i>Globicephala macrorhynchus</i> Gray					
NEPST031	03 Apr 1978	M	274	Arecibo, Puerto Rico	A, N
NEPST170	26 Aug 1991	F	295	Trellis Bay, Jamaica	N
NEPST291	10 Nov 1993	M	455	Cabo Rojo, Puerto Rico	A, C, N
NEPST320	26 May 1994	M	480	Santa Isabel, Puerto Rico	N
Pygmy killer whale, <i>Feresa attenuata</i> Gray					
NEPST455	16 Sep 1995	F	204	Tortola, British Virgin Islands	A, C, N
NEPST456	16 Sep 1995	F	196	Tortola, British Virgin Islands	N
NEPST457	16 Sep 1995	F	165	Tortola, British Virgin Islands	N
NEPST526	27 Feb 1997	M	220	Aguada, Puerto Rico	C, Ci, Cy, N
Risso's dolphin, <i>Grampus griseus</i> (G. Cuvier)					
NEPST173	30 Oct 1991	M	273	Isla de Vieques, Puerto Rico	C, D
Melonhead whale, <i>Peponocephala electra</i> (Gray)					
NEPST223	17 Aug 1993	M	210	Fajardo, Puerto Rico	C, N
Rough-toothed dolphin, <i>Steno bredanensis</i> (Lesson)					
NEPST121	— Aug 1990	U	245	Lajas, Puerto Rico	—
Fraser's dolphin, <i>Lagenodelphis hosei</i> Fraser					
NEPST319	26 May 1994	M	227	Guánica, Puerto Rico	C
NEPST528	06 May 1997	F	121	Ponce, Puerto Rico	—
Longsnout common dolphin, <i>Delphinus capensis</i> (Gray)					
NEPST327	10 May 1994	M	210	Isla Margarita, Venezuela	N
NEPST331	10 May 1994	M	204	Isla Margarita, Venezuela	N

TABLE I. Continued.

Field number	Date of collection	Sex	Length (cm)	Locality	Parasites*
Bottlenose dolphin, <i>Tursiops truncatus</i> (Montagu)					
NEPST191	27 Jun 1992	M	270	Fajardo, Puerto Rico	—
NEPST314	23 Jan 1994	F	135	Lajas, Puerto Rico	—
NEPST372	24 Nov 1994	F	233	Yauco, Puerto Rico	D
NEPST373	14 Feb 1995	M	262	Toa Baja, Puerto Rico	—
Atlantic spotted dolphin, <i>Stenella frontalis</i> (Cope)					
NEPST107	05 Sep 1989	M	162	Arroyo, Puerto Rico	N
NEPST111	16 Oct 1989	F	190	Fajardo, Puerto Rico	—
NEPST192	18 Jul 1992	F	143	Lajas, Puerto Rico	N
NEPST193	22 Jul 1992	F	—	Lajas, Puerto Rico	—
NEPST232	02 Sep 1993	U	—	Hatillo, Puerto Rico	—
NEPST365	22 Oct 1994	M	174	St. John, U.S. Virgin Islands	C, N
NEPST366	22 Oct 1994	M	176	St. John, U.S. Virgin islands	C, N
NEPST367	22 Oct 1994	M	183	St. John, U.S. Virgin Islands	A, N

* A = Acanthocephala, C = Eucestoda, Ci = Ciripectia, Cy = Cyamid, D = Digenea, N = Nematoda.

tocetes (reviewed by Hoberg et al., 1993) and has been found in longfin pilot whales (*Globicephala melas* (Traill)) in Canadian (Cowan, 1967) and Mediterranean waters (Balbuena and Raga, 1993). There are no previous records of *Bolbosoma* spp. in shortfin pilot whales. *Bolbosoma vasculosum* is known from the shortsnout common dolphin (*Delphinus delphis* Linnaeus), the pygmy sperm whale and Sowerby's beaked whale (*Mesoplodon bidens* (Sowerby)) (see Pendergraph, 1971; McAlpine et al., 1997) but has not been reported in pygmy killer whales (Ross and Leatherwood, 1994) or Atlantic spotted dolphins (*Stenella frontalis* (G. Cuvier)) (Perrin et al., 1994).

Nematoda

Ascaridoids, metastrongyloids, and spirurids were found among 24 individuals of 10 species of odontocetes (Table II). Species of *Anisakis* (Dujardin, 1845) were the most prevalent nematodes.

Species-level identifications for *Anisakis* have been limited to adult male worms, although larvae (L3 and L4) and adult females were abundant in some collections (Table II). Consistent with the taxonomy of Davey (1971), 3 species of *Anisakis* were collected: *Anisakis typica* (Diesing, 1860), *Anisakis physeteris* Baylis, 1923, and *Anisakis simplex* (Rudolphi, 1809). Mixed infections of these species were not apparent. Adults were found consistently in the stomach of respective cetacean hosts. Larvae (L3 and L4), however, were found in a variety of sites: (1) in the esophagus, liver, stomach, and intestine of 4 Atlantic spotted dolphins; (2) the trachea of a dwarf sperm whale; (3) from the stomachs and liver of 2 pygmy sperm whales; (4) and from the stomachs of 3 goosebeak whales and 3 pygmy killer whales.

All cetaceans recorded (Table II), except the pygmy killer whales, are documented hosts for species of *Anisakis* (Baylis, 1932; Kenyon, 1961; Zam et al., 1971; Davey, 1971; Gunter and Overstreet, 1974; Fordyce et al., 1979; Perrin et al., 1994; Zerbini and Santos, 1997). Perrin et al. (1994) had previously reported specimens of *Anisakis alexandri* Hsü and Hoeppli, 1933 from Atlantic spotted dolphins. This species, originally described from *Sotalia sinensis* True (now a synonym of the

Indopacific humpback dolphin, *Sousa chinensis* (Osbeck)), was considered as species inquirendae by Davey (1971). Kagel et al. (1967) and Dailey and Brownell (1972) reported *Anisakis* sp. for the shortfin pilot whale, but no reference was found for *A. typica* in this toothed whale. Atlantic spotted dolphins and shortfin pilot whale are new host records for *A. typica*.

Other anisakinae included larvae (L3 and L4) and adults of *Terranova* and adults of *Terranova ceticola* Deardorff and Overstreet, 1981 (Table II). *Terranova* sp. or *T. ceticola* occurred in mixed infections with *Anisakis* sp. and *A. physeteris* in pygmy and dwarf sperm whales and pygmy killer whales (Table II). Species of *Terranova* have been reported from both pygmy and dwarf sperm whales (see Dollfus, 1966; Gunter and Overstreet, 1974; Deardorff and Overstreet, 1981; McAlpine et al., 1997) but not from the pygmy killer whale; thus our report is a new host record.

Spirurids were represented by species of *Crassicauda* Leiper and Atkinson, 1914. *Crassicauda anthonyi* Chabaud, 1962 was found in the kidney of a goosebeak whale (Table II). The infection appeared to be severe, resulting in destruction of the kidney, similar to 1 case reported from Australia (Robson, 1984). Specimens of *Crassicauda* cf. *duguyi* Dollfus, 1966, were collected from the neck musculature of a pygmy sperm whale, the typical site for this helminth (Dollfus, 1966). A decomposed specimen of *Crassicauda* sp. also was collected from the pelvic girdle of a shortfin pilot whale. Previous records of *Crassicauda* spp. from goosebeak whales include *C. anthonyi*, *Crassicauda boopis* Baylis, 1920, and *Crassicauda crassicauda* (Creplin, 1829) (see Baylis 1932; Deliamure, 1955; Heyning, 1989; Raga, 1994), although some of these records have been questioned by Dollfus (1966) and Raga and Balbuena (1990). *Crassicauda* sp. was reported from a shortfin pilot whale by Morales-Vela and Olivera-Gómez (1993).

Specimens of the metastrongyloid nematode *Stenurus globicephalae* Baylis and Daubney, 1925 were collected from the cranial sinuses and stomach of a shortfin pilot whale and a pygmy killer whale, respectively (Table II). Adult female specimens found in the ear of a melonhead whale (*Peponocephala electra* (Gray)) were also assigned to this species. *Stenurus*

TABLE II. Parasites and commensals associated with cetaceans from the Caribbean. Numbers refer to the number of specimens of a given cetacean species that were infected with the particular parasite or commensal.

Parasites and commensals†	Cetacean species*															
	Dc	Fa	Gg	Gm	Kb	Ks	Lh	Md	Me	Mn	Pe	Pm	Sb	Sf	Tt	Zc
Phylum Acanthocephala																
Family Polymorphidae																
<i>Bolbosoma capitatum</i> ‡	—	—	—	2§	—	—	—	—	—	—	—	—	—	—	—	—
<i>Bolbosoma vasculosum</i> ‡	—	1§	—	—	—	—	—	—	—	—	—	—	—	1§	—	—
<i>Bolbosoma</i> sp.‡	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Phylum Nemathelminthes																
Family Anisakidae																
<i>Anisakis physeteris</i> ‡	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
<i>Anisakis simplex</i> ‡	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Anisakis typica</i> ‡	—	—	—	1§	—	—	—	—	—	—	—	—	—	2§	—	—
<i>Anisakis</i> sp.‡	—	3§	—	1	2	1	—	—	—	—	—	—	—	5	—	3
<i>Terranova ceticola</i> ‡	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
<i>Terranova</i> sp.‡	—	2§	—	—	2	1	—	—	—	—	—	—	—	—	—	—
Family tetrameridae																
<i>Crassicauda anthonyi</i> ‡	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
<i>Crassicauda duguyi</i> ‡	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
<i>Crassicauda</i> sp.	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Family Pseudaliidae																
<i>Stenurus globicephalae</i>	—	1	—	1	—	—	—	—	—	—	1	—	—	—	—	—
<i>Halocercus</i> spp. or <i>Pharurus</i> spp.‡	—	3§	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Phylum Platyhelminthes																
Family Campulidae																
<i>Synthesium tursionis</i> ‡	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Family Diphylobothriidae																
<i>Diphylobothrium</i> sp.‡	—	—	—	—	—	—	—	—	—	—	1§	—	—	—	—	—
Family Tetrabothriidae																
<i>Tetrabothrius forsteri</i> ‡	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
<i>Trigonocotyle sexitesticulae</i> ‡	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Trigonocotyle</i> sp.‡	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Family Phyllobothriidae																
<i>Monorygma grimaldii</i> ‡	—	2§	—	1	—	—	1	—	—	—	—	—	—	—	—	—
<i>Phyllobothrium delphini</i> ‡	—	—	1	—	1	—	1	—	—	—	—	3	—	2§	—	3
Phylum Arthropoda																
Family Coronulidae																
<i>Coronula</i> sp.‡	—	—	—	—	—	—	—	—	—	2§	—	—	—	—	—	—
Family Lepadidae																
<i>Conchoderma auritum</i> ‡	—	1§	—	—	—	—	—	—	1	—	—	1	—	—	—	1
Family Cyamidae																
<i>Cyamus boopis</i> ‡	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—
<i>Cyamus monodontis</i> ‡	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1§
<i>Neocyamus physeteris</i> ‡	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—
<i>Cyamus</i> sp.‡	—	1§	—	—	—	—	—	—	—	—	—	—	—	—	—	—

* Abbreviations for host as follows: Dc = *Delphinus capensis*, Fa = *Feresa attenuata*, Gg = *Grampus griseus*, Gm = *Goblicephala macrorhynchus*, Kb = *Kogia breviceps*, Ks = *Kogia simus*, Lh = *Lagenodelphis hosei*, Md = *Mesoplodon densirostris*, Me = *Mesoplodon europaeus*, Mn = *Megaptera novaeangliae*, Pe = *Peponocephala electra*, Pm = *Physeter macrocephalus*, Sb = *Steno bredanensis*, Sf = *Stenella frontalis*, Tt = *Tursiops truncatus*, Zc = *Ziphius cavirostris*.

† New records.

‡ New geographical record.

§ New host record.

globicephalae has been reported previously from these cetaceans (Bryden et al., 1977; Cannon, 1977; Forrester et al., 1980; Morales-Vela and Olivera-Gómez, 1993).

Lung lesions consistent with infection by either species of *Halocercus* Baylis and Daubney, 1925 or *Pharurus* Leukart, 1848 were observed during histopathological examination of tissues from 3 pygmy killer whales involved in a herd stranding in the British Virgin Islands. Whereas no adult nematodes were found, signs of active and chronic multifocal granulomata and granulomatous bronchopneumonia were observed in the tissues of the bronchi and alveoli that were studied. Such inflammatory lesions (pneumonia/congestion and hemorrhage) noted in the lung were significant and associated with the mortality of these animals. These appear to be consistent with secondary involvement following a primary lungworm infection. Neither of these nematodes has been reported previously for the pygmy killer whale.

An encysted nematode was collected from the skeletal muscle of a pygmy sperm whale. The cyst, approximately 1.5 cm in diameter, contained a small amount of clear fluid and the knotted mass of the parasite. The cyst was studied histologically and was found to consist of a thick fibrous connective tissue capsule infiltrated by abundant numbers of macrophages, multinucleated giant cells, lymphocytes and plasma cells, and lesser numbers of neutrophils and eosinophils. The capsule was found to be well vascularized and there were small foci of hemorrhage. Given the locality of the encysted parasite, it is probably a case of aberrant migration.

Digenea

Two species of digeneans were found in odontocetes (Table II). *Synthesium tursionis* Marchi, 1873 is a widely reported and typical fluke that infects the intestines of bottlenose dolphins (see Deliamure, 1955). Fernández et al. (1994) recently transferred this species to the genus *Hadwenius* Price, 1932, a conclusion that requires confirmation. An unidentified digenean was found in the bile duct of a Risso's dolphin (*Grampus griseus* (G. Cuvier)), following histopathological examination. This would be consistent with a number of campulid digeneans that are characteristic parasites in cetaceans (see Deliamure, 1955; Margolis and Pike, 1955; Margolis and Arai, 1989).

Eucestoda

Strobilate tetrabothriids and diphyllbothriids, and metacestodes of phyllobothriids were collected (Table II). Six species were found in 15 individuals from 9 species of odontocetes.

Tetraphyllidean metacestodes were represented by *Phyllobothrium delphini* (Bosc, 1802) and *Monorygma grimaldi* (Moniez, 1889). Specimens of *P. delphini* occurred in the blubber of 6 species and were among the most abundant parasites encountered (Table II). Morphological types of *Phyllobothrium* larvae have been described from cetaceans throughout the world's oceans and in some cases may represent discrete species (Deliamure, 1955; Skrjabin, 1972; Testa and Dailey, 1976), but these were not characterized in the present study. Previous reports have been documented for goosebeak whales (Tomilin, 1957), sperm whales (*Physeter macrocephalus* Linnaeus) (Sokolov, 1955; Testa and Dailey, 1976; Rice, 1989; McAlpine et al., 1997), Risso's dolphin (Baylis, 1932), and Fraser's dolphin

(*Lagenodelphis hosei* Fraser) (McColl and Obendorf, 1982). There are no previous records in Atlantic spotted dolphins according to Perrin et al. (1994). Specimens of *M. grimaldi* were found in the abdominal cavity of a shortfin pilot whale, in the abdominal wall adjacent to the testes in a Fraser's dolphin, and in the blubber of 2 pygmy killer whales (Table II). The typical site of infection of these cestodes is the abdominal cavity, and they have been reported from a striped dolphin (*Stenella coeruleoalba* (Meyen)) in the Atlantic Ocean (Forrester, 1992) but not previously from the Caribbean Sea. For these tetraphyllideans, sharks are considered to be the definitive host (Testa and Dailey, 1976), although their life cycles are unknown. *Monorygma grimaldi* has been reported previously in both the shortfin pilot whale (Dailey and Brownell, 1972) and Fraser's dolphin (McColl and Obendorf, 1982) but not for the pygmy killer whale (Ross and Leatherwood, 1994).

A specimen of an unidentified *Diphyllbothrium* Cobbold, 1858 was found in the intestine of a melonhead whale. Although species of this genus are known from cetaceans (see Deliamure, 1955), there are no apparent records from the melonhead whale (Perryman et al., 1994).

Tetrabothriids were represented by species of *Trigonocotyle* Baer, 1932 and *Tetrabothrius* Rudolphi, 1809 (Table II). Strobilate specimens designated as *Tetrabothrius forsteri* (Kreft, 1871) were found in the intestine of a Fraser's dolphin. Although *T. forsteri* has received considerable attention, there is substantial confusion over diagnostic characters for the species that remain to be resolved (see Baer, 1954; Deliamure, 1955; Temirova and Skrjabin, 1978). The species is considered a typical parasite in odontocetes and is known in Fraser's dolphin (McColl and Obendorf, 1982) and pygmy killer whales, the latter from waters off Florida (Forrester et al., 1980). Specimens of *Trigonocotyle sextesticulae* Hoberg, 1990 and an apparently undescribed species of *Trigonocotyle*, to be dealt with elsewhere, were found in a pygmy killer whale. *Feresa attenuata* is the type host for *T. sextesticulae*, but this species has previously only been found in waters off Florida (Hoberg, 1990).

Cyamidae (Crustacea: Amphipoda)

Cyamidae were represented by 3 species, including *Cyamus boopis* Lütken, 1870, *Cyamus monodontis* Lütken, 1873, and *Neocyamus physteris* (Pouchet, 1888) (Table II). In addition, an apparently unidentified species of cyamid, to be dealt with elsewhere, was found in a pygmy killer whale. *Cyamus boopis* and *N. physteris* have been reported as host specific for the humpback whale (*Megaptera novaeangliae* (Borowski)) (Winn and Reichley, 1985) and sperm whale (Rice, 1989), respectively. The *N. physteris* retrieved from the beached sperm whale in 1990 were 2 gravid and 3 nonbreeding females and 2 male adults, while in the 1991 whale there were 4 gravid females and 4 adult males. The *C. boopis* retrieved from the humpback whale in 1996 included 6 gravid females, 16 nonbreeding females, 70 males, and 23 juveniles. New host records are represented by a single female specimen of *C. monodontis* in the goosebeak whale and the unidentified cyamids (3 nongravid females and 3 adult males) found on the pygmy killer whale. Previous to this study, there are no records of any cyamid infesting pygmy killer whales.

Cirripedia (Crustacea: Maxillopoda)

Commensal cirripedians were represented by a species of acorn barnacle *Coronula* sp. Linnaeus, 1758, and the stalked barnacle *Conchoderma auritum* (Linnaeus, 1758) (Table II). Acorn barnacles were collected from the skin of 2 humpback whales. *Coronula* spp. apparently have not been reported from the Atlantic Ocean, although they are considered widespread in the north Pacific from right whales (*Eubalaena glacialis* (Müller)) and other cetaceans (Scarff, 1986). Specimens of stalked barnacles were found attached to teeth in the lower mandibles of a pygmy killer whale, a sperm whale, a goosebeak whale and an Antillean beaked whale (*Mesoplodon europaeus* Gervais), all which have been reported previously as hosts (Clarke, 1966; Fordyce et al., 1979; Ross and Leatherwood, 1994), as well as other cetaceans (Gittings et al., 1986).

Ecological summary

The presence of parasites in marine mammals is relatively common (Williams and Jones, 1976) and is often considered inconsequential, causing no observable clinical signs or pathological condition (Dierauf, 1990). Parasites have also been implicated in disease processes and as one of the prominent causes of strandings of whales and dolphins (Deliamure, 1955; Ridgway and Dailey, 1972; Geraci, 1979; Ridgway, 1979; Robson, 1984; Dierauf, 1990). Additionally, Dailey (1979) recommended that parasites could be used as biological tags of marine mammal populations, as indicators of migration and feeding, as a means of separating intraspecific variation of inshore and offshore populations, as indicators of general state of health, and as an aid in assessing mortality. Thus, information on parasites, may serve as an essential tool to better understand cetacean populations in a given area, therefore enhancing the effective management of these protected species.

Twenty-seven species of cetaceans have been reported from the Caribbean (Mignucci-Giannoni, 1998; Mignucci-Giannoni et al., 1998). Among these are species considered endangered or vulnerable given low population numbers and thus are protected by local, national, and international law. The distribution of the cetaceans in the area has been described zoogeographically as coastal, shelf, shelf-edge, or offshore (Mignucci-Giannoni, 1998). The humpback whale and sperm whale are the only cetaceans reported to engage in long-distance migrations between summer feeding grounds in the northern latitudes and winter breeding grounds in the tropical waters of the Caribbean. Other species, especially the delphinids, are thought to be resident animals, only exhibiting offshore-nearshore seasonal movements probably following prey species. Dailey (1979) used parasites as biological indicators for cetacean populations, and they have been applied effectively to differentiate between coastal and offshore populations (see Mead and Potter, 1990; van Waerebeek et al., 1990; Balbuena et al., 1995). The present work has served as an initial step in documenting biodiversity for the parasitic fauna of a number of cetaceans encountered in the Caribbean; their utility as biogeographic indicators remains to be evaluated.

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