Some Metazoan Parasites from Marine Mammals Stranded in California[1]

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Abstract: We used morphological and genetic identification to document metazoan parasites of cetaceans and pinnipeds from 28 carcasses salvaged in California between 1974 and 2002, including whales, dolphins, porpoises, sea lions, and seals. Nematodes found included *Anisakis simplex* (s.l.), *A. simplex* (s.s.), *Pseudoterranova decipiens* (s.l.), *Pseudoterranova* sp., *Contracaecum ogmorhini* (s.l.), *Contracaecum* sp., *Stenurus* cf. *minor*, *Pharurus* cf. *dalli*, and *Otostrongylus circumlitus*. Cestodes found included *Phyllobothrium delphini* and *Tetrabothrius* sp. The acanthocephalan *Bolbosoma capitatum*, and the arthropod *Halarachne miroungae*, also were documented. *Tetrabothrius* sp. in the pygmy beaked whale (*Mesoplodon peruvianus*) and *P. delphini* in the Eastern North Pacific long-beaked common dolphin (*Delphinus delphis bairdii*) constitute two new host records.

Keywords: parasitology, helminths, cetaceans, pinnipeds, California

Metazoan parasites infesting marine mammals, such as whales, dolphins, seals, and sea lions, include digeneans (flukes), cestodes (tapeworms), nematodes (roundworms), acanthocephalans (spiny headed worms), amphipods, hexapods, and acari. These parasites serve as markers of contemporary and historical ecological relationships. In addition, they provide useful information on host ecology, biogeography, and phylogeny (Gardner and Campbell 1992, Brooks and McLennan 1993, Hoberg 1996, 1997, Aznar et al. 2001). Nevertheless, parasitological studies on marine mammals tend to be opportunistic, a by-product of pathology assessment of protected species of marine mammals (Raga et al. 1997). When conducted, these studies have documented parasitic biodiversity in different geographical localities as well as tests of correspondence between parasite distributions in the zoogeographic distributions of their respective hosts.

In California, studies concerning marine mammal parasites were mostly published prior to 1990. A considerable number of comprehensive studies were reported for cetaceans from the area by Murray Dailey and colleagues, including Dailey (1969, 1970, 1971, 1975, 1978, 1985), Dailey and Hill (1970), Schmidt and Dailey (1971), Dailey and Brownell (1972), Margolis and Dailey (1972), Dailey and Perrin (1973), Dailey and Ridgway (1976), Dailey and Walker (1978), and Dailey and Nutting (1979). Sea lion acanthocephalans were studied by

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Lincicome (1943) and Van Cleave (1953). However, subsequent to the 1990s, only Dailey (2001), and Dailey et al. (2000, 2002) reported finding endoparasites of marine mammals from the area, and nematodes and acanthocephalan affecting California sea lions (*Zalophus californianus*) were documented by Lyons et al. (1997, 2000*a*, 2000*b*, 2011, 2016), Spraker et al. (2004), Kelly et al. (2005), Kuzmina and Kuzmin (2015), and Lisitsyna et al. (2018). A comprehensive review of California sea lion metazoan parasites was carried out by Kuzmina et al. (2018). We document the metazoan parasites of stranded cetaceans and pinnipeds from California between 1974 and 2002, using morphological and genetic identification.

MATERIALS AND METHODS

Parasites were collected from 28 dead cetaceans and pinnipeds salvaged in California between 1974 and 2002. Marine mammals examined included the false killer whale (*Pseudorca crassidens*), Pygmy beaked whale (*Mesoplodon peruvianus*), Cuvier's beaked whale (*Ziphius cavirostris*), Eastern North Pacific long-beaked common dolphin (*Delphinus delphis bairdii*), Eastern Pacific harbor porpoise (*Phocoena phocoena vomerina*), California sea lion, and Pacific harbor seal (*Phoca vitulina richardii*). Personnel from Moss Landing Marine Laboratories examined dead marine mammals during necropsy for metazoan endo- and ectoparasites including the entire gastro-intestinal tract, major organ systems, blubber and ear canals. Skin and teeth were examined for ectoparasites such as crustaceans and commensals. The collection of specimens was representative and did not attempt to collect all or ascertain parasite densities. Most of the parasites were initially fixed in the field in 10% formalin, and later stored in glass vials with 70% ethanol. Only very few specimens of anisakid nematodes, among those found, were stored in 70% ethanol, after their removal from the host's stomachs. Each vial was labeled with information from the stranding or mortality event, the date of collection and, in most cases, the site where the parasites was found in the host. Ectoparasites were not collected or were not present on the carcasses.

Helminths were identified morphologically with a phase-contrast or dissection stereomicroscope for external features and with a compound-light microscope for morphologic characters. For nematodes, we examined their cephalic and caudal end (i.e., spicules, postanal papillae, preanal papillae), postanal tail with typical mucron (for larvae identification), esophagus, lips, and body, at the level of intestinal ventricular junction, by mounting the helminth in lactophenol and comparing them to descriptions given in keys of Yamaguti (1959–1963), Anderson et al. (1974–1982), and Mattiucci et al. (2005, 2014, 2018). In addition, we used keys of Schmidt (1986) for cestodes.

A few specimens, among those collected from the Eastern Pacific harbor porpoise and the Eastern North Pacific long-beaked common dolphin, belonging to the genus *Anisakis* were identified genetically based on the sequence analysis of the mtDNA *cox2* gene locus. Total DNA was extracted from 2 mg of individual nematode tissue, using the Wizard® Genomic DNA Purification Kit (Promega, Madison, WI). Total DNAs from some specimens fixed in ethanol was extracted using cetyltriethylammonium bromide as described by Yang et al. (1997). The mt DNA *cox2* gene from those specimens of *Anisakis* was amplified using the primers 210 5′CACCAACTC TTAAAATTATC and 211 5′TTTTCT AGTTATATAGATTGRTTYAT from Nadler and Hudspeth (2000) and Nadler et al. (2005) spanning mtDNA nucleotide position 10639–11248 as defined in *Ascaris suum* (Accession #X54253). PCR amplification was carried out according to Mattiucci et al. (2014). The PCR product was purified using PEG precipitation, and automated DNA sequencing was performed by Macrogen (Seoul, Korea) using primers 210 and 211 (Valentini et al. 2006). The mtDNA *cox2* (629 bp) sequences obtained in the specimens of *Anisakis* were compared to those corresponding to the species of *Anisakis* and deposited in Genbank (Mattiucci et al. 2014). The *cox2* sequences were aligned using

ClustalW (Thompson et al. 1994) as implemented in BioEdit 7.0.1 (Hall 1999), using default parameters.

RESULTS

Nine species of endoparasitic helminths were found and morphologically identified, including six species of nematodes, two species of cestodes, one species of acanthocephalan; one species of arthropod was also found (Table 1).

Molecular identification allowed us to identify some nematodes as belonging to the species *Anisakis simplex sensu stricto* (in the narrow sense, s. s.) from the Eastern Pacific harbor porpoises and *Anisakis simplex sensu lato* (in the broad sense, s. l.) from Eastern North Pacific long-beaked common dolphins (Table 1); they matched at 99% the sequences of that *Anisakis* species available in GenBank. As for the other nematodes, they were *Anisakis* sp. (Fourth-stage larvae, L4) in Eastern Pacific harbor porpoises, *Pseudoterranova decipiens* (s. l.) and *Pseudoterranova* sp. (L4) in Pacific harbor seals, *Contracaecum ogmorhini* (s. l.) in California sea lions, *Contracaecum* sp. (L4) in a California sea lion and a Pacific harbor seal, *Stenurus* cf. *minor* in Eastern Pacific harbor porpoises, *Pharurus* cf. *dalli* in Eastern Pacific harbor porpoise, and *Otostrongylus* cf. *circumlitus* in a Pacific harbor seal (Table 1). Cestodes found included *Phyllobothrium delphini* in the blubber of an Eastern North Pacific long-beaked common dolphin and a Cuvier's beaked whale, and *Tetrabothrius* sp. in the intestine of a pygmy beaked whale. One species of acanthocephalan was found, *Bolbosoma capitatum*, in the intestine of a false killer whale and one arthropod, *Halarachne* cf. *miroungae*, was found in the nasal passages of a Pacific harbor seal (Table 1). Two new host records were found, *Tetrabothrius* sp. in the pygmy beaked whale, and *P. delphini* in the Eastern North Pacific long-beaked common dolphin.

DISCUSSION

Acanthocephala

Two genera of acanthocephalans in the family Polymorphidae (*Corynosoma* and *Bolbosoma*) have been reported in marine mammals (Lincicome 1943, Van Cleave 1953, Golvan 1959, Near et al. 1998, Mayer et al. 2003, Ionita et al. 2008, Kuzmina et al. 2012, 2018, Hernández-Orts et al. 2013, Lisitsyna et al. 2018). Species of *Bolbosoma* are characteristic parasites in the intestines of odontocetes and mysticete cetaceans (Delyamure 1955). In California, *Bolbosoma* sp. has been reported in the sei whale (*Balaenoptera borealis*), blue whale (*Balaenoptera musculus*) and humpback whale (*Megaptera novaeangliae*) (Margolis and Dailey 1972). Specimens of *Bolbosoma capitatum* have been found in the short-finned pilot whale (*Globicephala macrorhynchus*) from Puerto Rico (Mignucci-Gianonni et al. 1998, Colón-Llavina et al. 2009), and long-finned pilot whale (*Globicephala melas*) from Canadian and Mediterranean waters (Baylis 1932, Cowan 1967, Balbuena and Raga 1993). They also infect oceanic cetaceans, such as the sperm whale (*Physeter macrocephalus*) (Baylis 1932, Hoberg et al. 1993, Andrade et al. 1998), melon-headed whale (*Peponocepahala electra*) (Colón-Llavina et al. 2009), long-finned pilot whale, and false killer whale (Odell et al. 1980), as is the case of our specimen found in the latter delphinid. Of interest, no acanthocephalans were observed in the California sea lions studied, while in other studies they were found to be common (Kuzmina et al. 2018).

Nematoda

Anisakids and metastronglyoids were found in 24 individuals of four of the species examined (three odontocetes, one otariid) (Table 1). Species of *Anisakis* were the most prevalent nematodes. Morphological species identification was limited to adult male worms, although larvae (L4) and adult females were abundant in some collections (Table 1).

Anisakis simplex (s. l.) infects the California sea lion, common dolphin, Pacific white-sided dolphin (*Lagenorynchus obliquidens*), northern right-whale dolphin (*Lissodelphis borealis*), Baird's beaked whale (*Berardius bairdi*), killer whale (*Orcinus orca*), Dall's porpoise (*Phocoenoides dalli*), and sperm whale (Margolis and Dailey 1972, Dailey 1975, Dailey and Walker 1978, Kuzmina et al. 2018). In addition,

TABLE 1

Parasite Identification from Marine Mammals Examined for Endo and Ectoparasites in California

Host Field number	Collection date	Sex	Length (cm)	Locality	Parasite type	Parasite species	Location in host
Eastern Pacific harbor porpoise (*Phocoena phocoena vomerina*)							
MLMLMM030	22 Aug 1990	M	130	Monterey	Nematoda	*Anisakis simplex* (s. s.)*	Esophagus
MLMLMM342	31 Oct 1996	M	–	Marina State Beach	Nematoda	*Stenurus* cf. *minor*	Tympanic bulla cavities
MLMLMM398	13 Aug 1996	F	129	Salinas River Mouth	Nematoda	*Pharurus* cf. *dalli*	Tympanic bulla cavities, lung
MLMLMM425	–	F	142	Monterey	Nematoda	*Stenurus* cf. *minor*	Lung
MLMLMM435	1 Apr 1997	F	173	Monterey	Nematoda	*Anisakis* spp. L4	Stomach
MLMLMM439	1 Apr 1997	F	155	Monterey	Nematoda	*Anisakis* spp. L4	Stomach/forestomach
MLMLMM446	12 Apr 1997	M	145	Monterey	Nematoda	*Stenurus* cf. *minor*	Connective tissue in reproductive tract
					Nematoda	*Stenurus* cf. *minor*	Left lung
					Nematoda	*Anisakis* spp. L4	Stomach
MLMLMM492	7 Oct 1998	F	168	Monterey	Nematoda	*Anisakis* spp. L4	Stomach
MLMLMM524	6 Nov 1998	F	165	Monterey	Nematoda	*Stenurus* cf. *minor*	Left lung
MLMLMM606	30 Sep 1998	M	118	California	Nematoda	*Anisakis* spp. L4	Forestomach
MLMLMM624	30 Oct 1998	M	143	Monterey	Nematoda	*Pharurus* cf. *dalli*	Left lung
MLMLMM719	27 Apr 2000	F	161	Monterey	Nematoda	*Anisakis simplex* (s. s.)*	Esophagus
MLMLMMC183	28 May 1975	M	–	California	Nematoda	*Anisakis simplex* (s. s.)*	Stomach
MLMLMMTRK109	–	M	–	California	Nematoda	*Anisakis* spp. L4	Stomach
Eastern North Pacific long-beaked common dolphin (*Delphinus delphis bairdii*)							
MLMLMM582	16 Jan 1998	M	207	Moss Landing Beach	Nematoda	*Anisakis simplex* (s. l.)*	Stomach
MLMLMM786	3 Mar 1999	M	239	Monterey, Pacific Grove	Nematoda	*Anisakis simplex* (s. l.)*	Stomach
					Euscestoda	*Phyllobothrium delphini*	Blubber
False killer whale (*Pseudorca crassidens*)							
MLMLMMC178	1 Sep 1974	F	–	California	Acanthocephala	*Bolbosoma capitatum*	Intestine
Cuvier's beaked whale (*Ziphius cavirostris*)							
MLMLMM499	11 Feb 1998	F	600	Monterey	Eucestoda	*Phyllobothrium delphini*	Blubber
Pygmy beaked whale (*Mesoplodon peruvianus*)							
MLMLMM858	31 Jan 2001	F	–	Monterey	Eucestoda	*Tetrabothrius* sp.	Intestine
Californiansea lion (*Zalophus californianus*)							
MLMLMM061	31 Aug 1990	M	197	Santa Cruz Harbor	Nematoda	*Contracaecum ogmorhini* (s. l.)	Stomach
MLMLMM360	2 Feb 1999	F	106	Monterey	Nematoda	*Contracaecum* spp. L4	Stomach
MLMLMM451	5 May 1997	M	162	Monterey	Nematoda	*Contracaecum ogmorhini* (s. l.)	Stomach

Pacific harbor seal (*Phoca vitulina richardii*)							
MLMLMM001	17 Oct 1989	M	114	Davenport	Nematoda	*Pseudoterranova decipiens* (s. l.)	Stomach
MLMLMM399	18 Aug 1996	F	80	Monterey	Nematoda	*Pseudoterranova* spp. L4	Stomach
MLMLMM691	4 Mar 2000	F	122	Marina State Beach	Nematoda	*Pseudoterranova decipiens* (s. l.)	Stomach
MLMLMM729	12 May 2000	M	87	Monterey	Arthropoda	*Halarachne* cf. *mirounga*e	Nose
MLMLMM785	2 Sep 2000	F	103	Santa Cruz	Nematoda	*Otostrogylus* cf. *circumlitus*	Lung
					Nematoda	*Otostrogylus* cf. *circumlitus*	Esophagus
					Nematoda	*Pseudoterranova decipiens* (s. l.)	Esophagus
MLMLMM P-35	9 Feb 2002	M	–	California	Nematoda	*Contracaecum* spp. L4	Pharynx

* = Species ID based on DNA sequence matches.
cf. = *Confero*, compare to.
s. s. = *sensu stricto*, in the narrow sense.
s. l. = *sensu lato*, in the broad sense.
L4 = Fourth-stage larvae.

Mignucci-Gianonni et al. (1998) reported this parasite in a common dolphin (*Delphinus delphis*) from Venezuela.

Molecular epidemiology studies on *Anisakis simplex* (s. l.) by Mattiucci et al. (1997, 2018) and Mattiucci and Nascetti (2008) documented the existence of three sibling species, hence becoming the *Anisakis simplex* complex and corresponding to (1) *Anisakis simplex* (s. s.), which was previously named *A. simplex* B and is widespread between 30° N and the Antartic polar circle, (2) *A. pegreffi*, which was previously named *A. simplex* A and occurs between 35° S and 55° S and in the Mediterranean Sea, and (3) *A. berlandi* which shows an undescribed marked genetic variation when compared with the two other sibling species, and its range includes Pacific Canada and the region south of 35° S (Mattiucci et al. 1997, 2014, 2018). Unfortunately, in this study, it was not possible to identify to the species level those nematodes because most of the samples were stored in formalin which destroys DNA. In our examination, only a few of the specimens of *A. simplex* (s. l.) collected from the stomach of an Eastern North Pacific long-beaked common dolphin, and from the esophagus and stomach of an Eastern Pacific harbor porpoise were identified as belonging to *A. simplex* (s. s.). Mixed infections of the three sibling species were not found. Larvae (L4) of *Anisakis* were consistently found in the stomach of respective cetacean hosts. Adults, however, were found in a variety of sites, including the main stomach, forestomach and esophagus.

Similarly, in the case of anisakid nematodes of the genus *Pseudoterranova*, because they were fixed in formalin, it was possible to refer to them only as adults of *P. decipiens* (s. l.) (Table 1) those occurring in the stomach and esophagus of Pacific harbor seals. *Pseudoterranova decipiens* (s. l.) was found in mixed infections with *Contracaecum* larvae (L4) in the Pacific harbor seal. Dailey (1975) suggested that this may be due to the lack of host specificity in their intermediate (crustacean and teleost) and definitive host for these helminths. For the western coast of North America, *P. decipiens* (s. s.), *P. azarasi*, and *P. bulbosa* have been reported for different

pinniped hosts (Delyamure 1955, Dailey 1975, Kuzmina et al. 2018).

Contracaecum ogmorhini (s. l.), which also represents a complex of sibling species (Mattiucci and Nascetti 2008), and *Contracaecum* larvae (L4) were consistently found in the stomach of Californian sea lions, although one *Contracaecum* larvae (L4) was found in the pharynx of a Pacific harbor seal. This nematode was first described from the leopard seal (*Hydrurga leptonyx*) but was later synonymized with *C. osculatum* by Johnston and Mawson (1945). Subsequently, Fagerholm and Gibson (1987) compared specimens of *C. ogmorhini* from leopard seals and *C. osculatum* from newly obtained parasites of different otariid pinnipeds and concluded that *C. ogmorhini* was a valid taxon. After species validation, genetic analysis of *C. ogmorhini* collected from boreal regions (i.e., the western coast of North America, and the austral regions of Argentina and South Africa), two gene pools were distinguished within a *C. ogmorhini* (s. l.), *C. ogmorhini* (s. s.) and a new sibling species for the boreal region, *Contracaecum margolisi*, was described by Mattiucci et al. (2003). From the western coast of North America, Johnston et al. (1966) reported *Contracaecum* (larva) from a ringed seal (*Pusa hispida*) and Martin et al. (1970) recorded *Contracaecum* sp. from the brain of a Pacific white-sided dolphin. Dailey (1975) summarized records of *C. osculatum*, recorded for a number of pinnipeds from New Zealand, Australia, South America and the west coast of North America including the Steller's sea lion (*Eumatopias jubatus*), South American sea lion (*Otaria byronia*), Australian sea lion (*Neophoca cinerea*), California sea lion, South American fur seal (*Arctocephalus australis*), Australian fur seal (*Arctocephalus pusillus doriferus*), Cape fur seal (*A. pusillus pusillus*), Subantarctic fur seal (*A. tropicalis*), harbor seal, Baikal seal (*Pusa sibirica*), bearded seal (*Erignathus barbatus*), gray seal (*Halichoerus grypus*), harp seal (*Pagophilus groenlandicus*), and ribbon seal (*Histriophoca fasciata*).

Specimens of the metastrongylid nematode *Stenurus* cf. *minor* were collected from the left and right tympanic bulla cavity, left and right lungs, and from connective tissue in the reproductive tract of Eastern Pacific harbor porpoises (Table 1). *Stenurus minor* has been reported previously from this cetacean (Bryden et al. 1977, Cannon 1977, Forrester et al. 1980) and from a short-finned pilot whale in Mexico (Morales-Vela and Olivera-Gómez 1993). Margolis and Dailey (1972) and Dailey and Walker (1978) reported *S. minor* to occur in the air sinus of a Dall's porpoise stranded in southern California. Dougherty (1943) and Johnston and Ridgway (1969) reported this parasite to occur in the lung and head sinuses of a harbor porpoise and a Dall's porpoise for the same area.

Pharurus cf. *convolutus*, another specimen of metastrongylid nematode, was collected from the left lung and the left and right tympanic bulla cavity of an Eastern Pacific harbor porpoise. Mignucci-Gianonni et al. (1998) reported lung lesions consistent with infections by either species of *Halocercus* sp. or *Pharurus* sp. during histopathological examination of the tissues from three pygmy killer whales (*Feresa attenuata*) involved in a herd stranding in the British Virgin Islands (Mignucci-Gianonni et al. 1999). Additionally, Dougherty (1943) reported this parasite in an Eastern Pacific harbor porpoise stranded in California and Scheffer and Slipp (1948) found this parasite in Eastern Pacific harbor porpoises stranded in Washington.

The metastrongylid nematode *Otostrongylus circumlitus* was found in the lungs and esophagus of a Pacific harbor seal. This parasite is known to inhabit the primary and secondary bronchi of harbor seals and northern elephant seals (*Mirounga angustirostris*), and seems to be unique to pinnipeds, along with *Parafilaroides* and *Skrjabinaria* nematodes (Dailey 1975). Möeller (1997) reported that this parasite causes prominent bronchiectasis, and as with most lungworms, a verminous pneumonia may develop as a result of secondary bacterial infection. Dailey (1975) reported this parasite to infect the harbor seal, ringed seal and harp seal, and Kelly et al. (2005) reported it as a new host-parasite association in California sea lions.

While extensive literature documents the ancylostomatid nematode *Uncinaria* spp. in northern fur seals (*Callorhinus ursinus*) and

California sea lions (Lyons et al. 1997, 2000*a*, 2000*b*, 2011, 2016, Spraker et al. 2004, Hernández-Orts et al. 2013, Kuzmina and Kuzmin 2015), we were not able to find any in the pinnipeds necropsied in this study.

Eucestoda

Strobilate tetrabthriids, diphyllobothrids, and phyllobothriid metacestodes were collected (Table 1). Tetraphyllidean metacestodes were represented by *P. delphini*. Specimens of *P. delphini* were found in the blubber of the Eastern North Pacific long-beaked common dolphin and the Cuvier's beaked whale. Although morphological types of *Phyllobothrium* larvae have been described from cetaceans throughout the oceans, and in some cases may represent discrete species (Delyamure 1955, Skrjabin 1972, Testa and Dailey 1976), these were not characterized for this study due to their poor morphological condition. In the west coast of North America, *P. delphini* has been reported from the fin whale (*Balaenoptera physalus*), Baird's beaked whale, sperm whale, pygmy sperm whale (*Kogia breviceps*), dwarf sperm whale (*Kogia sima*), Cuvier's beaked whale, rough-toothed dolphin (*Steno bredanensis*), common bottlenose dolphin (*Tursiops truncatus*), Fraser's dolphin (*Lagenodelphis hosei*), Atlantic spotted dolphin (*Stenella frontalis*), Risso's dolphin (*Grampus griseus*), Eastern North Pacific common dolphin, and Pacific white-sided dolphin (Margolis and Dailey 1972, Colón-Llavina et al. 2009).

Margolis and Pike (1955), Rice (1963), Ridgway and Johnston (1965) and Johnston and Ridgway (1969), have reported this parasite for the common dolphin without specifying which subspecies of *Delphinus delphis*. Previous reports of *P. delphini* have been documented for the Cuvier's beaked whale (Tomilin 1957), sperm whale (Sokolov 1955, Testa and Dailey 1976, Rice 1989, McAlpine et al. 1997), Risso's dolphin (Baylis 1932), and Fraser's dolphin (McColl and Obendorf 1982). Dailey and Walker (1978) reported *P. delphini* to occur in the blubber of the common dolphin, Pacific white-sided dolphin, Northern right-whale dolphin, and striped dolphin (*Stenella coeruleoalba*) stranded in southern California. The typical sites of infection reported for these cestodes were the skin and blubber.

Tetrabothrius sp. was found in the intestine of a pygmy beaked whale. Reyes et al. (1991) reported trematodes of the genus *Nasitrema*, and one single unidentified anisakid nematode from the pygmy beaked whale, but no *Tetrabothrius*. Our record constitutes a new host record and may represent a new species. The specimens were in poor condition and more specimens are needed for an accurate description.

Hernández-Orts et al. (2013, 2015) found *Diphyllobothrium* tapeworms in South American sea lions in Argentina and northern fur seals in Alaska, as did Kuzmina et al. (2015). Kuzmina et al. (2018) reported both *Diphyllobothrium* and *Anophryocephalus* tapeworms in California sea lions. However, no cestodes were found in the pinnipeds studied.

Arthropoda: Mites

Halarachne cf. *miroungae* was found in the nasal passages of a Pacific harbor seal. This mite has been observed in sea otters (Möeller 1997), the northern elephant seal, and the Pacific harbor seal (Margolis and Dailey 1972). Lung mites are common parasites of the nasal passages, trachea, bronchi, and bronchioles in amphibious marine mammals (Möeller 1997). The most common mites observed in seals and sea lions are *Orthohalarachne diminuata* and *Orthohalarachne attenuata* (Dailey 2001, Kuzmina et al. 2018).

CONCLUSIONS

This study provides an updated report of the parasite fauna encountered in marine mammals stranded along the central Californian coast in the years 1974–2002. We add new records and diversity to the knowledge of parasites of Californian marine mammals, thus providing valuable information on parasite records and diversity. Morphological species-level identification was limited to adult male worms, although larvae (L4) and adult females where usually more abundant in

some collections in which genetic species-level identification was effective. Unfortunately, the molecular identification was possible on only very few specimens of anisakid nematodes, due to the fact that most of those historically collected parasites were fixed in formalin according to routine parasite storage protocols at the time of collection; therefore, DNA extraction was not possible. More data on parasite biodiversity acquired by the genetic/molecular identification of anisakid nematodes from those marine mammals throughout the North Pacific, as well as a host population genetic study would be valuable in order to give a more detailed analysis.

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