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ACANTHOCEPHALA CYSTACANTH INFECTIONS IN SAND CRABS FROM BODEGA BAY, CALIFORNIA

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Three species of *Profilicollis: major, kenti,* and *altmani* (Phylum Acanthocephala, Family Polymorphidae) have been implicated in the cause of morbidity and mortality of the southern sea otter, *Enhydra lutris nereis*, population along the coast of California from Santa Cruz to Morro Bay. The usual definitive hosts in the life cycle of *Profilicollis* spp. are shore birds, and it has been suggested that the sand crab, *Emerita analoga*, is the intermediate host. Studies of the food habits of sea otters in California suggest that they acquire the infection by eating infected sand crabs. The purpose of this project was to determine if sand crabs from the Bodega Bay area might harbor these parasites and contribute to sea otter infections. The results of this study showed that there are at least three different species of acanthocephalans infecting sand crabs from Bodega Bay. Two of the species represent those found in sea otters from California, suggesting that the otters may be migrating to the Bodega Bay region and acquiring the infection there.

INTRODUCTION

According to surveys performed by the 1999 U.S. Geological Survey, Biological Resources Division, the population of sea otters, *Enhydra lutris nereis*, along the California coast from Santa Cruz to Morro Bay has declined over the last decade. A

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recent study of sea otter mortality conducted by the National Wildlife Health Center examined 195 sea otter carcasses over a 3-year period (Thomas and Cole 1996). A high percentage of deaths were attributed to infectious diseases (Thomas and Cole 1996); many of these deaths were due to peritonitis caused by acanthocephalan parasites belonging to the genus *Profilicollis* (= *Polymorphus*, Nickol et al. 1999).

Sea otters from central California have been reported to be infected with two genera of Acanthocephala: *Profilicollis* and *Corynosoma* (Hennessy and Morejohn 1977). The sea otter is the only reported host of *Corynosoma enhydri* and to date has not been implicated in the penetration of the intestinal wall (Margolis et al. 1997). *Profilicollis* spp. on the other hand, normally infect marine birds such as gulls and scoters (Reish 1950). In sea otters however, immature *Profilicollis* spp. penetrate the intestinal wall, resulting in necrotic ulceration, secondary bacterial infections, and peritonitis. Thomas and Cole (1996) suggested that these infections may contribute to sea otter mortality along the coast of California.

Recent studies by Thomas and Cole (1996) showed that the sand crab, *Emerita analoga,* from Monterey Bay is infected with the cystacanths of two species of *Profilicollis* (*P. kenti* and *P. altmani*) and are a food source of the otter. Hence, sand crabs represent a potential intermediate host of *Profilicollis* spp.

The purpose of this project was to determine if the sand crab from Bodega Bay might harbor *Profilicollis* spp., which can potentially infect sea otters.

METHODS

Sand crabs were collected from the intertidal (swash) zone along Salmon Creek in Bodega Bay during July 1999. A total of 14 crabs measuring in size from 2.5 - 5.0 cm was dissected using a dissecting scope to remove cystacanths from the hemocoel. Cystacanths were counted and placed in room temperature deionized water to encourage extension of the proboscis. Once excised, the cystacanths were cleaned and stored in 70% ethanol. Specimens were stained using Carmine stain, destained in acid alcohol, dehydrated to 100% ethanol, cleared in xylene, and mounted with Permount[3]. Additional worms were dehydrated as above, dried in hexamethyldisilazane, gold coated, and examined by scanning electron microscopy.

Parasites were identified according to Amin (1992) using number of proboscis hook rows and number of hooks/row. Cystacanths consisted of two identified species (*Profilicollis major* Lundstrom, 1942, 18-22 rows with 10-15 hooks/row; *P. altmani* Perry, 1942, 30-32 rows with 11-13 hooks/row) and one unidentified *Profilicollis* morphotype containing 23-28 rows with 12-17 hooks/row (Table 1).

To determine if larger crabs had more parasites, a simple linear regression analysis was performed comparing the total length of the crab and the intensity of infection (number of cystacanths per crab). Alpha was set at 0.05.

[3]Use of trade names does not imply endorsement by the California Department of Fish and Game

Table 1. Key characteristics in grouping cystacanths found in sand crabs.

Group (# of cystacanths)	Row count	# of Hooks/row	Species
Group 1 (n = 14)	18-22	10-15	*Profilicollis major*
Group 2 (n = 5)	30	11-13	*Profilicollis altmani*
Group 3 (n = 24)	24-28	12-17	Undetermined

RESULTS

A total of 43 cystacanths was collected from 14 Bodega Bay sand crabs. Of the two identified species, a higher number of *P. major* (14/43, in 10/14 [71%] of the crabs) was found compared to *P. altmani* (5/43, in 2/14 [14%] of the crabs). The unidentified morphotype was the most numerous (24/43) cystacanth type recovered (Fig. 1) but was found in fewer crabs compared to *P. major* (8/14 [57%]).

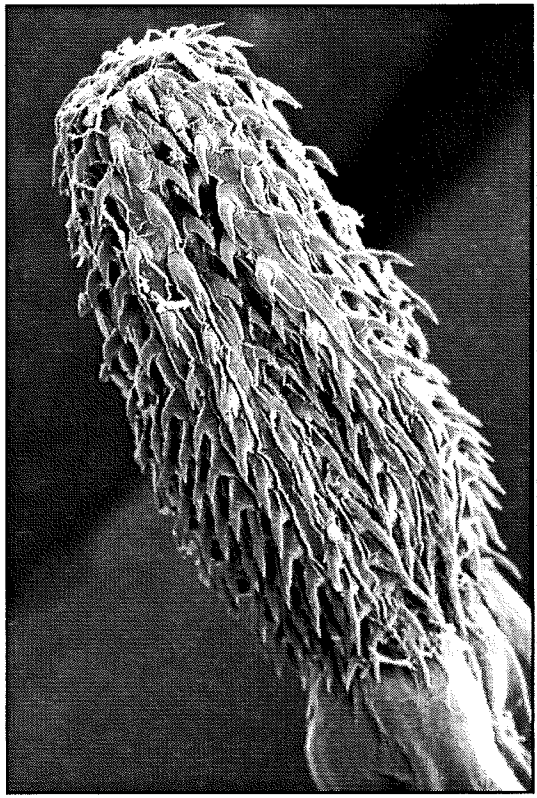

Figure 1. Scanning electron micrograph of the anterior end of one of the cystacanths assigned as an undetermined species.

Nine of the 14 crabs had single species infections: 6 with 1-3 *P. major* cystacanths per crab and 3 with 1-6 unidentified species of cystacanths per crab. Single infections were found in 4 of the 6 *P. major* and one of the unidentified species. No single infections of *P. altmani* was found.

Multiple *Profilicollis* spp. infections were observed in 5 of the 14 sand crabs (Fig. 2). Of the 5 cases of multiple parasite infections, 3 crabs were infected with *P. major* and the unidentified species in 1:1, 1:3, and 1:4 ratios; in the fourth crab, *P. altmani* and the unidentified species were found in a ratio of 1:3; in the fifth crab, the three species occurred in a 5:2:4 ratio, respectively.

The intensity (average number of parasites per host) of infection was 3.7 cystacanths per crab (range = 1-9). The size of crab (as measured by total length) was not significantly related to the intensity of infection ($r^2 = 0.291$; $p > 0.05$; $n = 14$ crabs).

Specimens of *P. major* and *P. altmani* have been deposited in the United States National Parasite Collection, United States Department of Agriculture, Beltsville, Maryland and given the accession numbers USNPC# 091998.00 and 091999.00, respectively.

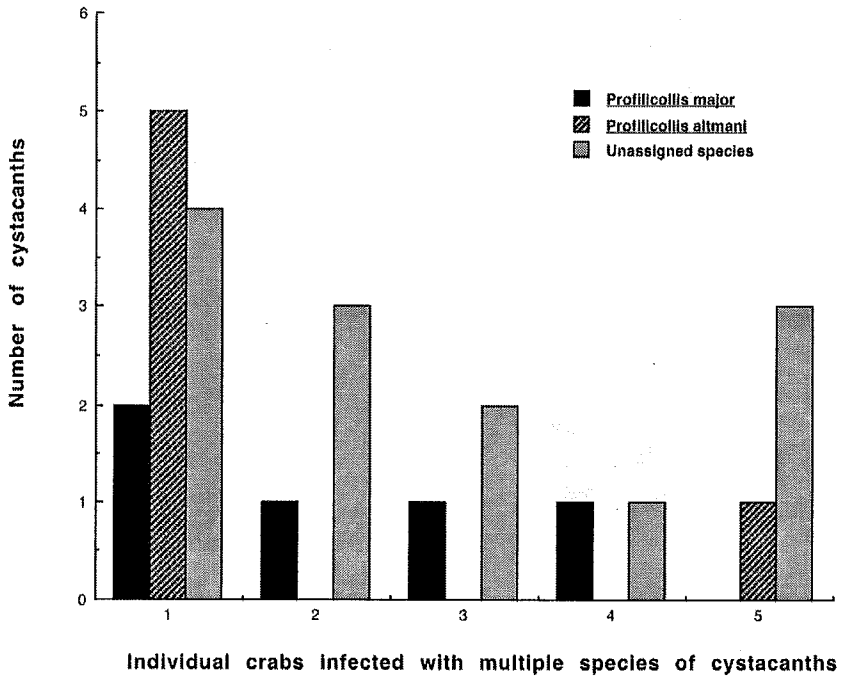

Figure 2. Number of cystacanth infections in five individual sand crabs collected in July 1999 from Bodega Bay, California.

DISCUSSION

Several studies have been undertaken to compare the California and Alaska sea otter populations to understand the factors which may contribute to the declining California sea otter populations. In a study of more than 1,000 Alaskan sea otters, Margolis et al. (1997) found that unlike California sea otters, which were infected by both *Profilicollis* spp. and *C. enhydri*, the Alaskan otter population was infected by three species of acanthocephala in the genus *Corynosoma (C. enhydri, C. stromosum,* and *C. villosum).* They also found that the Alaskan sea otter population was relatively free of the disease in contrast to California sea otters, which react pathologically to infection by various *Profilicollis* spp.

The difference in pathology observed between these two populations may be the result of host specificity and the mode of transmission of the different acanthocephalan species. The Alaskan sea otters are infected with several types of parasites transmitted mostly by fish and shorebirds. California sea otters, on the other hand, are not infected by parasites that are typically transmitted by fish, and forage primarily on invertebrates including sand crabs, an intermediate host of *Profilicollis.*

In this study, we found that sand crabs from Bodega Bay were infected with cystacanths of *P. major* and *P. altmani*, as well as an undetermined species of acanthocephalan. Mayer et al. (2003) found that California sea otters from the Monterey Bay area were infected with three species of *Profilicollis*: *P. major*, *P. kenti*, and *P. altmani.* Cystacanths of *P. major* however, were not found in the sand crabs collected from the Monterey Bay area (K. Mayer, Monterey Bay Aquarium, personal communication) which may suggest that California sea otters might acquire *P. major* infections from another site in northern California.

Fourteen sand crabs from Bodega Bay had an intensity of infection of 4, with one crab having 9 cystacanths contained within its hemocoel. No *P. kenti* were recovered from any of the crabs. Multiple infections of *P. major*, *P. altmani,* and the undetermined species occurred in 5 of the 14 sand crabs sampled, a finding that has not yet been reported. Multiple infections of *Profilicollis* spp. in California sea otters is not surprising because they may be foraging on sand crabs harboring multiple infections.

In summary, this study showed that sand crabs from Bodega Bay, California are infected with cystacanths of *Profilicollis major*, *P. altmani*, and an unidentified species. These infections may be contributing to the infections acquired by sea otters in California as the sea otters migrate along the coastal waters between Monterey and the northern waters of San Francisco Bay area.

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