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Haematozoa of Fishes in Humboldt Bay, California

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ABSTRACT: Five hundred seven fish representing 45 species from Humboldt Bay, California (USA) were examined for blood parasites. Four fish (<1%) from two species were infected. *Haemogregarina leptocotti* sp. n. is described from one of 33 staghorn sculpin (*Leptocottus armatus*). *Haemogregarina roelofsi* sp. n. is described from three of 15 black rockfish (*Sebastes melanops*). Gametocytes of *H. leptocotti* sp. n. averaged 6.1 × 2.1 μm with a 2.7 × 1.7 μm oval nucleus; those of *H. roelofsi* sp. n. averaged 5.5 × 2.7 μm with a 2.5 × 2.2 μm rectangular nucleus. Neither species of parasite had distinct chromatin granules, a polar cap, or more than one gametocyte in an infected cell. Haematozoa are relatively rare in fishes of the northeastern Pacific Ocean.

Key words: *Haemogregarina roelofsi* sp. n., *Haemogregarina leptocotti* sp. n., haematozoa, marine fish, parasite, survey.

Little is known about the occurrence and distribution of haematozoa in marine fish off of the western coast of North America. Laird (1961) examined 10 padded sculpins (*Artedius fenestralis*) collected off of Vancouver Island, British Columbia (Canada). Two fish were infected with *Haemogregarina bigemina*. Burreson and Pratt (1972) surveyed 498 fish of 11 species from Oregon coastal waters. They found 67 of 392 (17%) English sole (*Parophrys vetulus*) infected with *Trypanosoma pacifica* (Burreson and Pratt, 1972). Burreson (1979) described *Cryptobia* (*Trypanoplasma*) *beckeri* from cabezon (*Scorpaenichthys marmoratus*) collected from Oregon coastal waters. The present study describes two new species of the genus *Haemogregarina* from marine fish from Humboldt Bay, Humboldt County, California (USA).

Fish were collected from Humboldt Bay monthly from September 1983 through August 1984. Collections were made with a semi-balloon otter trawl, with 19-mm square nylon mesh in the body and a 6-mm mesh liner in the cod end. Trawls (15 min to 1 hr) were made at low tide when fish were concentrated in bay channels.

Fish were kept alive in seawater and transported back to the laboratory (Humboldt State University, Arcata, California 95521, USA). They were killed by a sharp blow to the head and the tail was severed. At least one drop of free flowing blood was discarded before making blood smears. Blood smears were air dried, methanol fixed, and stained with Wright-giemsa stain for 10 min and then moved to a phosphate buffer for 10 min. Slides then were rinsed in tap water and air dried.

Each of two slides from each fish was examined under oil immersion (1,000×) for 20 min. Haematozoa were identified and the total number of parasites observed was recorded. Relative intensity of infection of infected hosts was rated using the method of Becker and Katz (1966): 0, no parasites observed; +1, one to five parasites observed; +2, six to 20 parasites observed; +3, five to 10 parasites observed in the first minute; +4, one or more parasites observed in each of the first five fields.

Blood from 507 fish representing 45 species was examined (Table 1). Only four fish (<1%) were infected. One of 33 (3%) staghorn sculpin (*Leptocottus armatus*) was infected with *Haemogregarina leptocotti* sp. n. The infected fish was 20.8 cm in standard length, and had a +2 infection. Three of 13 (23%) black rock fish (*Sebastes melanops*) were infected with *Haemogregarina roelofsi* sp. n. Infected rock fish ranged from 17 to 23 cm in standard length and all fish had +1 infections. These parasites are described herein, based on morphology of gametocytes in host erythrocytes.

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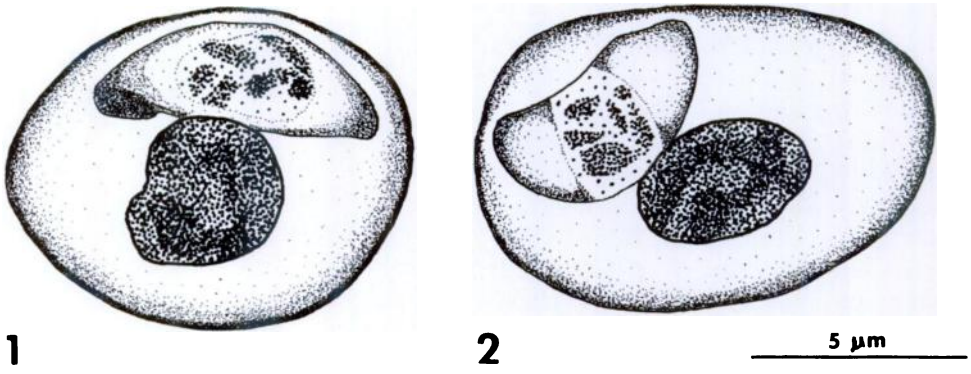
TABLE 1. Fish from Humboldt Bay, California (USA) examined for haematozoa.

Fish	Number sampled	Fish	Number sampled
Carcharhinidae		Hexagrammidae	
Mustelus henlei	17	*Hexagrammos decagrammus*	11
Triakis semifasciata	4	*Hexagrammos lagocephalus*	2
Myliobatididae		*Ophiodon elongatus*	5
Myliobatis californica	40	Cottidae	
Clupeidae		*Artedius notospilotus*	5
Alosa sapidissima	6	*Enophrys bison*	12
Clupea harengus	28	*Hemilepidotus hemilepidotus*	10
Dorosoma petenense	2	*Leptocottus armatus*[a]	33
Engraulidae		*Oligocottus snyderi*	1
Engraulis mordax	7	*Scorpaenichthys marmoratus*	1
Osmeridae		Embiotocidae	
Hypomesus pretiosus	3	*Amphistichus rhodoterus*	12
Spirinchus starksi	9	*Cymatogaster aggregata*	19
Spirinchus thaleichthys	14	*Rhacochilus vacca*	4
Gadidae		*Embiotoca lateralis*	1
Microgadus proximus	30	*Hyperprosopon argenteum*	22
Atherinidae		*Hyperprosopon ellipticum*	3
Atherinops affinis	2	*Phanerodon furcatus*	35
Atherinopsis californiensis	4	Pholidae	
Syngnathidae		*Pholis ornata*	8
Syngnathus leptorhynchus	24	Ammodytidae	
Gasterosteidae		*Ammodytes hexapterus*	1
Aulorhynchus flavidus	15	Gobiidae	
Gasterosteus aculeatus	31	*Lepidogobius lepidus*	10
Scorpaenidae		Bothidae	
Sebastes sp.	1	*Citharichthys stigmaeus*	2
Sebastes auriculatus	13	*Paralichthys californicus*	3
Sebastes flavidus	1	Pleuronectidae	
Sebastes melanops[b]	13	*Parophrys vetulus*	21
Sebastes mystinus	5	*Platichthys stellatus*	15
Sebastes rastrelliger	1	Cynoglossidae	
		Symphurus atricauda	1

[a] One fish infected with *Haemogregarina leptocotti*.
[b] Three fish infected with *Haemogregarina roelofsi*.



FIGURES 1, 2. 1. *Haemogregarina leptocotti* sp. n. in an erythrocyte of *Leptocottus armatus*. Wright-giemsa stain. 2. *Haemogregarina roelofsi* sp. n. in an erythrocyte of *Sebastes melanops*. Wright-giemsa stain.

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Haemogregarina leptocotti sp. n. (Figure 1)

Description: Measurements are in micrometers and based on 20 specimens (ranges given followed by means in parentheses). One gametocyte per infected host cell. Gametocytes 5.3–7.8 (6.1) long by 1.2–2.9 (2.1) wide, attenuated towards the end closest to their nucleus. Gametocytes reniform, depth of cell curvature 0.0–1.0 (0.4). Nucleus not centered in cell, oval, 2.4–3.4 (2.7) along long axis of parasite cell by 1.0–1.9 (1.7) along short axis of parasite cell. Longer cytoplasmic extremity from the nucleus 1.7–2.7 (2.2) long. Shorter cytoplasmic extremity from nucleus 1.0–2.4 (1.5) long. Nucleus stained deep purple and lacked distinct chromatin granules. Cytoplasm stained pale blue. No basophilic granulation or polar cap observed. Parasitized erythrocytes [7.3–10.7 (8.9) long by 5.1–8.3 (6.6) wide] not significantly longer ($t = 0.25$, $P > 0.50$) or wider ($t = 0.43$, $P > 0.50$) than non-parasitized cells [7.3–10.6 (8.9) long by 4.8–8.2 (6.5) wide]. No difference in nucleus length ($t = 0.43$, $P > 0.50$) or width ($t = 0.28$, $P > 0.50$) between parasitized [3.8–4.9 (4.3) by 3.2–4.3 (3.6)] and non-parasitized [3.9–4.8 (4.2) by 3.4–4.4 (3.6)] erythrocytes.

Type host: *Leptocottus armatus* (Cottidae).

Location in host: Erythrocytes.

Type locality: Humboldt Bay, California, USA (40° 48′N, 124°10′W).

Type specimens: Syntype deposited in U.S. National Museum, Beltsville, Maryland 20705, as USNM 81941.

Etymology: This species is named after the genus of its type host.

Remarks: Two other haemogregarine gametocytes are similar to those of *H. leptocotti*. *Haemogregarina coelorhynchi* (Laird, 1952) has been reported from *Coelorhynchus australis* (Macrouridae) and *Physiculus bachus* (Moridae) collected off the coast of New Zealand (Laird, 1952). *Haemogregarina coelorhynchi* is 5.0–5.9 μm long × 2.5–3.1 μm wide and is distinguished by its polar cap. *Haemogregarina mavori* (Laird and Bullock, 1969) has only been reported from *Macrozoarces americanus* (Zoarcidae) collected from coastal waters of eastern Canada (Laird and Bullock, 1969). *Haemogregarina mavori* is 5.5–8.6 μm long × 2.2–3.5 μm wide and is distinguished by a nucleus which contains 8 to 18 discrete chromatin granules.

Four haemogregarines have been described from other marine cottids: *H. bigemina*, *H. cotti*, *H. cotti scorpi* and *H. myoxocephali*. *Haemogregarina bigemina* from padded sculpin is the only marine haemogregarine described from the western coast of North America. Gametocytes of *H. bigemina* are much larger (10.1–14.1 μm long × 1.0–1.9 μm wide) (Laird, 1961) than those of *H. leptocotti*. Henry (1910) did not adequately describe *H. cotti scorpii* and it may be synonymous with *H. cotti*. *Haemogregarina cotti* has been reported from *Cottus bubalis* and *C. scorpius* collected from European coastal waters. It is also much larger (12 μm long × 2.5 μm wide) than *H. leptocotti* (Laird and Bullock, 1969). *Haemogregarina myoxocephali* has only been described from *Myoxocephalus octodecemspinosus* collected in coastal waters of eastern Canada and the United States. *Haemogregarina myoxocephali* is 4.9–9.6 μm long × 1.6–3.7 μm wide and is distinguished from the parasite in this study by the occurrence of 8 to 14 discrete chromatin granules in its nucleus (Laird and Bullock, 1969).

Haemogregarina roelofsi sp. n. (Figure 2)

Description: Measurements are in micrometers and based on 16 specimens (ranges given followed by means in parentheses). One gametocyte per infected host cell. Most gametocytes oval 4.3–6.4 (5.5) long by 1.9–3.7 (2.7) wide. Some gametocytes are slightly reniform, depth of cell curvature 0.0–1.0 (0.4). Nucleus usually near center of cell, somewhat trapezoidal, 1.6–3.4 (2.2) along long axis of parasite cell by 1.4–3.7 (2.5) along short axis of parasite cell. Longer cytoplasmic ex-

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tremity from the nucleus 1.4–2.5 (1.9) long. Shorter cytoplasmic extremity from nucleus 0.9–2.0 (1.5) long. Nucleus stained red violet and lacked distinct chromatin granules. Cytoplasm did not stain. No basophilic granulation or polar cap observed. Parasitized erythrocytes [8.9–11.7 (10.1) long by 5.8–8.3 (7.2) wide] not significantly longer ($t = 1.39, 0.10 < P < 0.20$) or wider ($t = 1.12, 0.30 < P < 0.40$) than non-parasitized cells [8.7–10.5 (9.7) long by 5.8–7.8 (6.9) wide]. No difference in nucleus length ($t = 0.78, 0.40 < P < 0.50$) or width ($t = 1.02, 0.30 < P < 0.40$) between parasitized [3.3–5.1 (4.2) by 2.4–3.4 (2.9)] and non-parasitized [3.6–4.9 (4.4) by 2.4–3.9 (3.1)] erythrocytes.

Type host: *Sebastes melanops* (Scorpaenidae).

Location in host: Erythrocytes.

Type locality: Humboldt Bay, California, USA (40°48′N, 124°10′W).

Type specimens: Syntype deposited in U.S. National Museum, Beltsville, Maryland 20705, as USNM 81940.

Etymology: Named in honor of Dr. Terry Roelofs, Professor of Fisheries, Humboldt State University, for his contributions to fisheries biology and education.

Remarks: Two other haemogregarine gametocytes are similar to those of *H. roelofsi*. *Haemogregarina coelorhynchi* (Laird, 1952) has been reported from *Coelorhynchus australis* (Macrouridae) and *Physiculus bachus* (Moridae) collected off the coast of New Zealand (Laird, 1952). *Haemogregarina coelorhynchi* is 5.0–5.9 μm long × 2.5–3.1 μm wide and is distinguished by its polar cap. *Haemogregarina mavori* (Laird and Bullock, 1969) has only been reported from *Macrozoarces americanus* (Zoarcidae) collected from coastal waters of eastern Canada (Laird and Bullock, 1969). *Haemogregarina mavori* is 5.5–8.6 μm long × 2.2–3.5 μm wide and is distinguished by a nucleus which contains 8 to 18 discrete chromatin granules.

One haemogregarine has been previously described from marine scorpaenids. Neumann (1909) briefly described *H. scorpaenae* from *Scorpaena scrofa* collected off the coast of Italy. Neumann (1909) encountered only a few parasites and suggested that his description of the parasite may be inadequate. Gametocytes occurred singly in red blood cells and were oval, 6 μm long × 1.2 μm wide. Gametocytes not in blood cells occurred in groups of four and were 17 μm long × 1.5 μm wide. Neumann's (1909) description of *H. scorpaenae* is inadequate and it is difficult to make comparisons. However, *H. roelofsi* is much wider than *H. scorpaenae* and occurs in a different host and in a substantially different geographic location.

Burreson and Pratt (1972) surveyed 67 staghorn sculpins from Oregon (USA) and detected no haemogregarines, but found 17% of the English sole (*Parophrys vetulus*) to be infected with a trypanosome. We surveyed 21 English sole and detected no haematozoa. Burreson (1979) reported a new cryptobiid from cabezon collected off of Oregon. We examined one cabezon and detected no haematozoa.

The prevalence of haematozoan infections in a given species of marine fish from the western coast of North America has been low: 3 to 23% (present study), 17% (Burreson and Pratt, 1972), and 20% (Laird, 1961). The percentage of species infected also has been low: 4% (present study) and 9% (Burreson and Pratt, 1972). Haematozoan surveys of marine fish from eastern North America often have found parasites to be more prevalent. In fact, Laird and Bullock (1969) and Khan (1986) found more than 50% of the individuals of some species infected. In addition, eastern surveys have regularly found over 30% of the fish species examined infected with haematozoa (Laird and Bullock, 1969; Daily, 1978; Khan, 1986).

The apparent difference in prevalence of haematozoa between eastern and western North America may be an artifact and a result of the small number of surveys conducted on the western coast. However, Khan (1986) suggested that the abundance

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of leech vectors controls the incidence and prevalence of haematozoan infections. Leeches known to transmit haematozoa occur along the Pacific coast (Burreson, 1977, 1979), but little is known about their distribution or abundance.

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