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Research Note

Cardicola forsteri (Digenea: Sanguinicolidae) from the Heart of a Northern Bluefin Tuna, *Thunnus thynnus* (Scombridae), in the Northwest Atlantic Ocean

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ABSTRACT: We report a specimen of *Cardicola forsteri* Cribb, Daintith, and Munday, 2000 (Digenea: Sanguinicolidae) from the lumen of the heart of a northern bluefin tuna, *Thunnus thynnus* (Linnaeus, 1758) (Scombridae), that was 218 cm in total length (TL) and caught in the northwest Atlantic Ocean 12 km south of Cape Lookout, North Carolina. The hearts of 12 similarly sized northern bluefin tuna (127–262 cm TL) from George's Bank, northwest Atlantic Ocean, were not infected. This is the first report of *C. forsteri* from a wild host and of a sanguinicolid from any scombrid in the northwest Atlantic Ocean. Bluefin tuna is cultured in sea cages because of its highly prized flesh, and the fact that a blood fluke infects this host is significant because some blood flukes have been identified as serious pathogens of cage-cultured fish.

KEY WORDS: *Cardicola forsteri*, Sanguinicolidae, Digenea, blood fluke, *Thunnus thynnus*, northern bluefin tuna, Scombridae, heart, northwest Atlantic Ocean, cage, aquaculture, disease.

The northern bluefin tuna, *Thunnus thynnus* (Linnaeus, 1758) (Scombridae), is one of the largest and most sought after teleosts, with individuals reaching 3.2 m in total length (TL) and 680 kg in weight and being purchased for as much as US$80,000 in the Japanese sushi and sashimi market (Kantor, 1996). The capture fishery for northern bluefin tuna is commercially lucrative and provides most of the bluefin tuna purchased. However, cage culture operations that maintain tunas in the southwest Pacific Ocean and Mediterranean Sea supplement the high demand. For cage systems, small wild tuna in schools are purse-seined and transferred to a floating net cage that is towed to a farm site where the fish are fattened before harvest and sale (Fish Farming International, February 2003; Apeitos, personal communication).

Tuna aquaculture is presently in its early stages of development and will likely continue to expand, but with this expansion, parasitic disease will become increasingly important. Blood flukes (Sanguinicolidae) infect the vascular system and body cavity of marine and freshwater fish throughout the world (Smith, 1997a, b), and under appropriate conditions, some are serious pathogens of cage-cultured fish (Hoffman et al., 1985; Ogawa et al., 1989; Ogawa and Fukudome, 1994; Munday and Hallegraeff, 1998; Bullard and Overstreet, 2002). The disease caused by some blood flukes, sanguinicoliasis, primarily results from a large number of fluke eggs sequestered in the afferent brachial arteries and may asphyxiate the host. Information on the host range and geographic distribution of tuna blood flukes is relevant to the tuna aquaculture industry because it could help aquaculture managers identify infections or prevent sanguinicoliasis (Bullard and Overstreet, 2002). In this study, we extend the host and geographic range of a potentially pathogenic blood fluke that infects 2 commercially valuable tunas.

Specimens of the northern bluefin tuna were captured by hook and line and killed by severing the spinal cord. In the field, the heart was excised, placed in a sample bag, bisected, doused with near-boiling water, and fixed in 70% ethanol (EtOH) or 5–10% neutral buffered formalin. In the laboratory, the contents of the bag were examined with the aid of a dissecting microscope. The worm was stained in Van Cleave hematoxylin with several additional drops of Ehrlich hematoxylin, made basic in 70% EtOH with lithium carbonate and butylamine, dehydrated, cleared in clove oil, and mounted in Canada balsam (Bullard and Overstreet, 2003). The specimen was deposited in the United States National Parasite Collection (USNPC),

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United States Department of Agriculture, Beltsville, Maryland (USNPC 94131).

A single specimen of *Cardicola forsteri* Cribb, Daintith, and Munday, 2000, was collected from the lumen of the heart of a northern bluefin tuna, *T. thynnus*, that was 218 cm in TL and captured in the northwest Atlantic Ocean 12 km south of Cape Lookout, North Carolina. The hearts of 12 similarly sized northern bluefin tuna (127–262 cm TL) from George's Bank, northwest Atlantic Ocean, were also examined, but none were infected. Previously, this fluke only has been reported from the heart of caged southern bluefin tuna, *Thynnus maccoyii* (Castelnau, 1872), from south Australia (Cribb et al., 2000; Colquitt et al., 2001). This is the first report of *C. forsteri* from a wild host and from the northern hemisphere and constitutes the only known sanguinicolid from any scombrid in the northwest Atlantic Ocean. Two other sanguinicolids have been described from scombrids: *Cardicola congruenta* Lebedev and Mamaev, 1968, from the branchial vessels of the kawakawa, *Euthynnus affinis* (Cantor, 1849), in the Gulf of Tonkin, South China Sea, and *Cardicola ahi* Yamaguti, 1970, from the gills of both the yellowfin tuna, *Thunnus albacares* (Bonnaterre, 1788) (as *Euthynnus macropterus*), and the bigeye tuna, *Thunnus obesus* (Lowe, 1839) (as *Parathunnus sibi*), in the North Pacific Ocean off Hawaii (Smith, 1997b).

The seemingly disjunct distribution of *C. forsteri* is noteworthy. The life cycle of *C. forsteri* is unknown, but if it follows that of all studied sanguinicolids, then it would include a single snail, bivalve, or polychaete intermediate host species (Køie, 1982; Smith, 1997a). If so, the unidentified intermediate host may be widespread, occurring within the range of each of the fish hosts. On the other hand, the infected individual bluefin tuna could have migrated from southern oceans.

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