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The Atrium of the Fish Heart as a Site for *Contracaecum* spp. Larvae

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ABSTRACT: Ninety-five percent of the larvae of *Contracaecum* spp. were found in the atrium of the heart of fathead minnows (*Pimephales promelas*) and five- and nine-spined sticklebacks (*Culaea inconstans* and *Pungitius pungitius*). Atria containing nematodes were two to three times larger than an atria from uninfected fish, were thin walled and the muscular trabeculae were damaged. Atria with larvae were congested with blood that appeared to be organizing and extending as a thrombus into the ventricle, but there was no other evidence of a host response. Alternatively, there was an intense cellular response surrounding larvae in the body cavity of these and other host species. Apparently, this parasite which lacks host specificity has evolved an additional strategy to evade the host immune response in sticklebacks and fathead minnows.

Key words: *Contracaecum* spp., nematode larvae, pathology, fathead minnows, sticklebacks.

Larvae of *Contracaecum* spp. have been found in fish in the body cavity (Dartnall and Walkey, 1979), pericardial sac (Huizinga, 1967) and the intestine, viscera and musculature (Margolis and Arthur, 1979). Huizinga (1967) also noted "An occasional free larva . . ." in the ventricle of the heart. A recent study on the effects of *Contracaecum* spp. on a rainbow trout (*Salmo gairdneri*) stocking program at High Rock Lake (HRL), Manitoba found larvae in a number of minnow species such as fathead minnows (*Pimephales promelas*) and five- and nine-spined sticklebacks (*Culaea inconstans* and *Pungitius pungitius*) (Dick et al., 1987). The reasons for my identification as *Contracaecum* spp. are given in Dick et al. (1987). The ventral surface in the cardiac region was distended and dark in appearance in 75% of the five- and nine-spined sticklebacks from which larvae were recovered. Fathead minnows infected with *Contracaecum* spp. larvae did not show the same distension of the ventral surface in the area of the cardiac region. When the body cavity in the cardiac region of infected fish was opened, one or two worms and a large volume of blood were observed. It was difficult to determine if larvae were within the heart or in the pericardial cavity, although occasionally part of a worm was seen in the heart and the pericardial cavity. However, because the heart appeared enlarged with very fragile walls, it was possible that the wall had ruptured during dissection. To resolve the location of the larvae, whole fish were fixed in Bouin's fixative for 24 hr, washed five times in 70% ethanol over a period of 1 week, embedded in wax and serially sectioned at 10 μm. These sections were stained with haematoxylin and eosin (H&E).

Figure 1 shows larvae within the atrium of the heart of a nine-spined stickleback. The atrium was enlarged, had a thin wall and the usual muscular trabeculae were damaged. Larvae within the atrium of fathead minnows caused less distortion (Fig. 2). Measurements of the diameter of ventricle and atrium from infected and uninfected hearts were taken in mm and ex-

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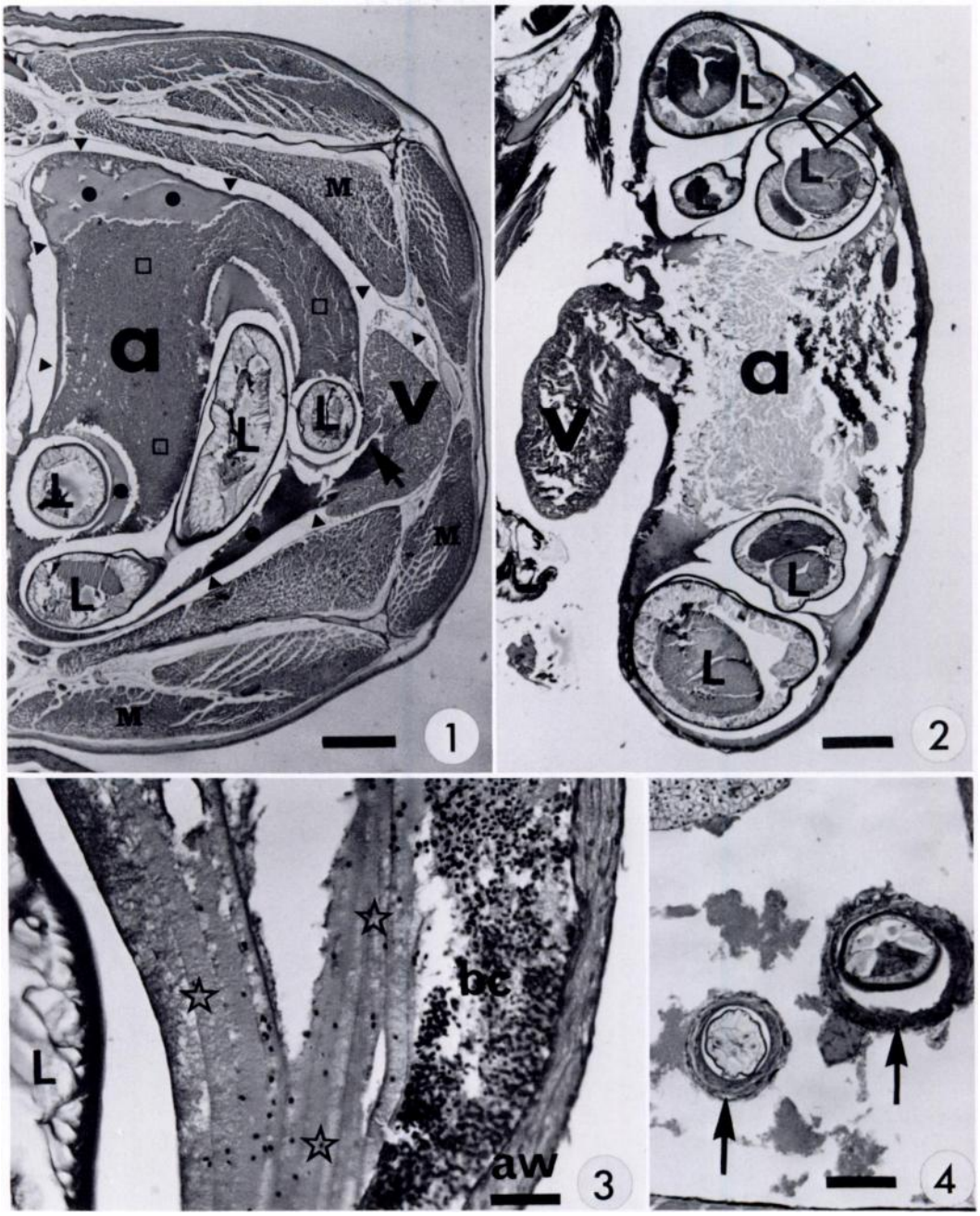
FIGURES 1–4. *Contracaecum* spp. larvae in sticklebacks and fathead minnows. 1. Cross-section of a nine-spined stickleback through the cardiac region; atrium (a) enlarged with a coiled larva of *Contracaecum* spp. (L); most erythrocytes (open black squares) intact but an amorphous material present (black circles); space



around heart and within pericardial cavity indicated with black triangles and juncture of ventricle and atrium with a black arrowhead, space around the worms an artifact of fixation and dehydration procedures; (M) body wall musculature; H&E, horizontal bar = 55 μm. 2. Cross-section through cardiac region of a fathead minnow; atrium enlarged and there is amorphous material around the larvae (insert enlarged in Fig. 3); H&E, horizontal bar = 41 μm. 3. Section through wall of atrium of a fathead minnow with *Contracaecum* spp. larvae; leucocytes and erythrocytes dispersed through the congested blood which appears as concentric layers of amorphous material (stars) around the larva; (aw) atrium wall; (bc) blood cells; H&E, horizontal bar = 5 μm. 4. Cross-section of a larval *Contracaecum* spp. in body cavity of a fathead minnow; host reaction forms a sleeve of connective tissue around larva (arrows); H&E, horizontal bar = 10 μm.

pressed as a ratio. The ratio in size of atrium/ventricle in infected and uninfected sticklebacks was 1.6 and 5.2, respectively, and for fathead minnows was 2.1 and 5.1, respectively. The diameter of the atrium was related to the size and number of worms and varied in size from 1.0 mm (uninfected) to 5.9 mm (two larvae present). The atrium was congested with blood that appeared to be organizing and extending as a thrombus into the ventricle. The latter event could result in the formation of emboli which would subsequently compromise blood flow into the gills. The congested blood often appeared as concentric rings of amorphous material with a few intact erythrocytes, leucocytes and macrophages (Fig. 3). In several specimens a thrombus (up to one-third the volume of the atrium) was noted, but whether it was a result of parasitism or an artifact of the fixation procedure is unknown. There was no evidence that cells were adhering to the cuticle of nematode larvae within the atrium. There was a strong cellular reaction in the form of a sleeve of connective tissue when larvae (<5% of larvae recovered) were found in the body cavity (Fig. 4).

It is clear that the atrium of the heart of fathead minnows and sticklebacks is a preferred site for larvae of *Contracaecum* spp. since >95% of all larvae recovered were within the atrium of the heart. Furthermore, it is evident that these minnows can live for some time with the parasite within the atrium. Minnows transported from HRL to Winnipeg and maintained in the laboratory for 6–8 mo prior to necropsy had the same prevalence values for *Contracaecum* spp. larvae as a subsample of these minnows examined upon arrival in the laboratory. Alternatively, rainbow trout (*Salmo gairdneri*) and central mudminnows (*Umbria limi*) from the same lake had larvae located only in the body cavity and, in the case of rainbow trout, also in the body musculature. There was an intense and typical cellular reaction to the parasite in these sites in both these species of fish. It seems that this parasite which lacks host-specificity, has evolved an additional strategy to evade the host cellular immune response.

Nematodes are deposited in the National Museum of Natural Science, Ottawa K1A 0M8, Canada as unmounted specimens from a stickleback, NMCP 1986-0078 (two larvae).

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