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Gnathostomiasis in a Wild-caught Nine-banded Armadillo (*Dasypus novemcinctus*)

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Gnathostoma belongs to one of the largest groups of roundworms, the Spirurida. The genus *Gnathostoma* has 10 to 12 species, 3 of which have been reported in humans: *G. spinigerum*, *G. hispidum*, and *G. doloresi*. The most is known about *G. spinigerum*, which is the cause of the greatest number of cases of gnathostomiasis reported in humans. The life cycle of *G. spinigerum* involves two intermediate and one final host. In addition, many paratenic hosts aid in transmission through predation. Adult worms live in the the stomach wall of wild and domestic cats and dogs. Eggs, passed in the feces into water, embryonate and hatch. The larvae are eaten by *Cyclops* spp. and develop in the body cavity of the crustacean. When the infected cyclops are eaten by fish, frogs, or snakes, the larvae develop in the flesh of these animals. The life cycle is completed when an appropriate definitive host ingests larvae encapsulated in muscle from any of these species (1). *Gnathostoma procyonis* of raccoons and *G. didelphis* of opossums are found in the United States. *Gnathostoma* sp. has not previously been reported in armadillos.

The most important endemic areas for human gnathostomiasis are southeast Asia and India, with major foci in Thailand and Japan. Humans acquire the infection by eating parasitized raw, marinated, or inadequately cooked fish or frogs. Since a human is not a natural host, the parasite fails to mature. After ingestion of the larva by a human, the parasite reaches the intestine, then the liver, and from there, almost any place in the body. The parasite frequently migrates under the skin but also migrates to the mucous membranes, the eye, and the brain, where it causes eosinophilic meningitis (2). The behavior of *Gnathostoma* larvae in humans is similar to the behavior in other paratenic hosts, that is, it is a form of visceral larva migrans.

Twenty wild-caught armadillos were purchased for a leprosy study. The armadillos were collected by trappers in Iberia Parish, La. At receipt, the animals were examined by a veterinarian, found to be healthy, and placed on a 30-day quarantine. The armadillos were individually housed in portable polyethylene kennels, which contained sawdust bedding. The room was maintained at 74 to 80°F (23 to 27°C) and 30 to 70% relative humidity. Lighting was set on a 12-h light/dark cycle with the dark cycle beginning at 1100 h. Each armadillo was maintained on a standard commercial diet for cats (Cat Chow 4524®, Purina Mills, Inc., St. Louis, Mo.) supplemented with fresh fruit and vegetables. Water was available ad libitum.

On day 21 of the quarantine period, an animal caretaker noticed an armadillo in lateral recumbency with all four limbs in rigid extension. Physical examination revealed the animal was comatose and nonresponsive to all external stimuli. Body temperature, pulse, and respiration were below normal limits. Peripheral circulation was poor. When the animal failed to respond to intramuscular administration of 5 mg of diazepam (Lyphomed, Rosemont, Ill.), it was euthanatized with 0.3 ml of T-61 euthanasia solution/kg (Hoechst-Roussel, Somerville, N.J.) given by intracardiac injection. The remaining 19 animals remained clinically normal.

Necropsy revealed the animal was in good nutritional condition, but it had bilateral epistaxis, possibly secondary to seizures, and marked subcutaneous emphysema, in the axillary region, presumed secondary to agonal breathing. Multifocal raised nodules were on the capsule of the kidneys and liver and in the omentum. The trachea contained abundant frothy serosanguinous fluid, and the lungs were moderately congested. There were multifocal areas of hemorrhage within the cerebellum, brain stem, and overlying meninges (Figure 1). A live nematode larva was on the meninges of the ventral aspect of the pons.

Histologic examination revealed multifocal areas of hemorrhage, rarefaction, and loss of neuropil in the white and gray matter of the cerebellum, cerebrum, and brain stem (Figure 2) and increased numbers of glial cells within adjacent neuropil. The meninges were expanded by aggregates of neutrophils, lymphocytes, eosinophils, macrophages, and plasma cells admixed with fibrin, edema, and hemorrhage. Meningeal vessels were dilated and contained transmigrating leukocytes. Nodules on the capsule of multiple organs were calcareous granulomas and contained degenerate metazoan parasites.

The larva had a maximum diameter of 660 µm. The cuticle was spinose and a large bulb with cuticularized hooks surrounded the mouth (Figure 3). Musculature was coelomyarian. Lateral cords were large and extended into the pseudocoelom. The digestive tract was composed of a glandular esophagus and a large-diameter intestine containing numerous uninucleate cells and a distinctive brush border (Figure 4). Histologic features were consistent with the genus *Gnathostoma*. Species identification was not possible.

Three spiruroid larvae have been previously reported from the nine-banded armadillo, with the armadillo serving as a

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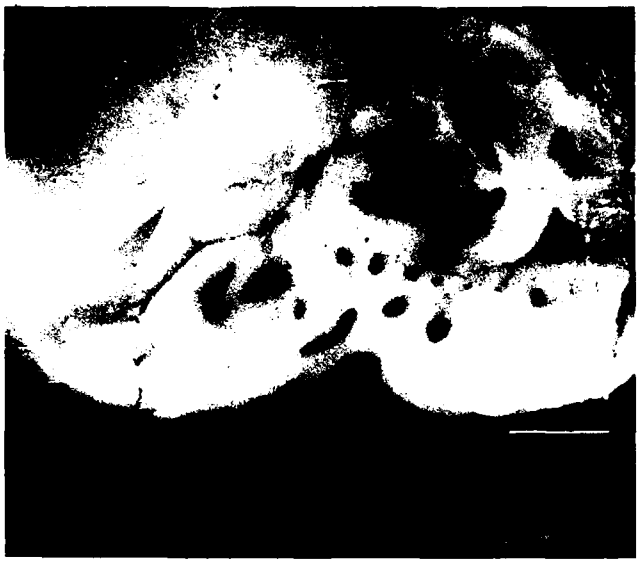

Figure 1. Gross formalin-fixed specimen showing multifocal areas of hemorrhage in the cerebellar folia, brain stem, and midbrain of an armadillo with gnathostomiasis. Bar = 5 mm.

Figure 2. Photomicrograph of cerebellum with multifocal areas of hemorrhage and rarefaction. These areas are interpreted as nematode migratory tracts (arrow). H&E stain, 99x.

paratenic host. These include larvae of *Physaloptera, Physocephalus,* and *Ascarops* species (3). This is the first report of gnathostomiasis in the nine-banded armadillo, with the armadillo serving as a paratenic host. Meningoencephalitis caused by the aberrant migration of a larval form of this

Figure 3. Photomicrograph of sagittal section of *Gnathostoma* larva depicting large bulb (solid black arrow) and spinose cuticle (open arrow). The digestive tract is composed of a large-diameter intestine (white arrowhead). H&E stain, 25x.

Figure 4. Photomicrograph of section of *Gnathostoma* larva showing large-diameter intestine (arrow) with numerous uninucleate cells. The lumen contains blood and cellular debris. H&E stain, 120x.

spirurid nematode was the cause for the clinical signs, which necessitated euthanasia of this animal.

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