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Parelaphostrongylus andersoni (Nematoda: Protostrongylidae) in White-tailed Deer from Michigan

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ABSTRACT: Dorsal-spined larvae in fecal samples from free-ranging white-tailed deer (*Odocoileus virginianus*) in Michigan and Pennsylvania were used as a source of larvae to infect a hand-raised white-tailed deer fawn. The fawn received 200 third-stage larvae and passed dorsal-spined larvae in feces 66 days later. Muscleworm (*Parelaphostrongylus andersoni*), and meningeal worm (*Parelaphostrongylus tenuis*) were recovered at necropsy. Two white-tailed deer and seven wapiti (*Cervus elaphus*) exposed to larvae of the source from Pennsylvania harbored only *P. tenuis*. This is the first report of *P. andersoni* in the midwestern United States and extends the known range of this muscleworm in free-ranging white-tailed deer. Concurrent infections of *P. andersoni* and *P. tenuis* have not been established previously in experimentally infected fawns.

Key words: Parelaphostrongylus andersoni, muscleworm, distribution, *Parelaphostrongylus tenuis*, meningeal worm, concurrent infections, white-tailed deer, *Odocoileus virginianus*.

In October 1988, fresh fecal samples from free-ranging white-tailed deer (*Odocoileus virginianus*) were collected in Marquette County, Michigan (USA; 46°30′N, 87°00′W) and Rachelwood Wildlife Research Preserve, Pennsylvania (USA; 40°25′N, 79°30′W). Dorsal-spined larvae were collected by the Baermann technique and used to expose laboratory-reared snails (*Triodopsis multilineata*). Previously described techniques for the recovery of larvae, experimental infection of snails, and subsequent exposure of a hand-reared white-tailed deer fawn were used (Anderson, 1963; Platt and Samuel, 1978; Pybus and Samuel, 1984).

In January 1989, 200 third-stage larvae from snails exposed to each of the two original fecal sources were pooled and used to expose a white-tailed deer fawn via stomach tube. Fecal samples were collected daily from 40 days postexposure (dPE) and examined for first-stage larvae using the Baermann technique.

Few clinical signs were observed. At 21 dPE, the fawn's right ear drooped and was withdrawn back along the neck. The right front leg was held off the ground and the fawn would use it only if forced to move. This behavior was short-lived, lasting less than 6 hr. Anderson (1965) noted a similar transient change in stance in a white-tailed deer fawn given 600 larvae of *Parelaphostrongylus tenuis*.

Dorsal-spined larvae were first noted in fecal samples at 66 dPE. Prior to 98 dPE, larval output fluctuated daily from 1 to 46 larvae/g ($\bar{x}$ = 8.9). After 98 dPE, daily output rose gradually to a peak of 317 larvae/g at 122 dPE ($\bar{x}$ = 76.6).

At 124 dPE, the fawn was killed with an overdose of sodium pentabarbital (Euthanyl®, M.T.C. Pharmaceuticals, Mississauga, Ontario, Canada L4W 2S5) administered intravenously. At necropsy, particular attention was given to skeletal muscles and the nervous system. Each longissimus dorsi and psoas muscle was removed intact, sliced thinly and examined at 6× magnification for evidence of muscleworms (Pybus and Samuel, 1984). Major thoracic, axillary, sciatic, and femoral nerves were examined grossly and at 6× magnification. The brain and spinal cord were removed intact, examined grossly, and teased apart at 6× magnification. The cranial cavity and vertebral canal were examined at 6× magnification. All intact females, intact males and male posterior ends were examined and measured. Representative specimens were deposited in the National Museum of Natural Sciences (Division of Invertebrate Zoology, Ottawa,

Ontario, Canada K1A 0M8; accession numbers CMN1990-0024 for *Parelaphostrongylus andersoni* and CMN1990-0025 for *P. tenuis*.

Seven adult *P. andersoni* were collected from the longissimus dorsi (one pair plus one female together in the left, two males plus one female together plus one adult of unknown sex in the right). Morphometrics of one intact female and three male posterior ends, as well as the gross haemorrhage and muscle damage in the carcass, were consistent with previous reports of *P. andersoni* (Prestwood, 1972; Pybus and Samuel, 1981). Nematodes were not found in the psoas.

Seventy-five adult *P. tenuis* were collected from the central nervous system: 39 (19 female, 18 male, two unknown) from the brain and cranial cavity, 36 (13 female, 17 male, six unknown) from the spinal cord and vertebral canal. Nematodes were distributed along the spinal cord from the anterior cervical region to the posterior sacral region.

Most meningeal worms were in the subdural space of the brain (n = 31, 41%) or spinal cord (n = 20, 27%). Other sites included cranial superior, transverse, and cavernous sinuses (n = 7, 9%) and spinal epidural regions, particularly regions adjacent to nerve roots (n = 17, 23%). The dura adhered strongly to much of the dorsal cerebrum and extensive accumulations of dark orange/yellow exudate were present on the subdural surface within the cranial cavity. Much exudate and frank haemorrhage also was associated with all cranial venous sinuses and the lining of the middle cranial fossae. Eggs and larvae of *P. tenuis* were seen histologically in the exudate and dura mater. Spinal nerve roots near worms in the epidural spaces were inflamed and thin yellow exudate often was nearby. Lesions were similar but more pronounced than those described by previous authors (see Anderson and Prestwood, 1981).

Fecal samples from Michigan were most likely the source of the *P. andersoni* larvae. In detailed examinations we failed to collect muscleworms from an additional two deer and seven wapiti exposed only to the Pennsylvania (Rachelwood) source but *P. tenuis* was collected from all of these animals (M. J. Pybus and W. M. Samuel, unpubl.).

This is the first report of *P. andersoni* in the midwestern United States; previous reports in white-tailed deer are restricted to the southeastern United States (Prestwood, 1972; Prestwood et al., 1974, 1975), New Jersey (Pursglove, 1977), and southeastern British Columbia (Pybus and Samuel, 1981). More recently, *P. andersoni* was reported from woodland and barrenground caribou (*Rangifer tarandus*) widely distributed in central and northeastern Canada (Lankester and Hauta, 1989).

Muscleworms are relatively inconspicuous nematodes easily overlooked using routine necropsy techniques. Verification of *P. andersoni* in Michigan supports previous suggestions that this parasite may be present in white-tailed deer throughout their range in eastern North America (Pybus and Samuel, 1981; Lankester and Fong, 1989). *P. andersoni* should be considered in differential diagnoses of any host passing dorsal-spined larvae in this area.

Natural concurrent infections of *P. andersoni* and *P. tenuis* have been reported once: in only two of 52 infected white-tailed deer (Prestwood et al., 1974) leading Lankester and Hauta (1989) to suggest that some mechanism of cross-immunity may exist between these two parasites. This implies that establishment of one species of *Parelaphostrongylus* in an individual deer may preclude establishment of another, perhaps, similar to the resistance against reinfection in *P. andersoni* infections as described by Prestwood and Nettles (1977). However, it is apparent from our study that if a fawn is exposed simultaneously to infective larvae of both species, concurrent infections can be established. Further information regarding cross-immunity between these species should be addressed in experimental studies. Interspecific inter-

actions could have important implications in the transmission and distribution of *Parelaphostrongylus* spp. and the management of free-ranging or captive ungulates.

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