Journal of Wildlife Diseases, 25(2), 1989, pp. 291–293

Identification of Dorsal-spined Larvae from Free-ranging Wapiti (*Cervus elaphus*) in Southwestern Manitoba, Canada

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ABSTRACT: Dorsal-spined first-stage larvae recovered from feces of free-ranging wapiti (*Cervus elaphus*) were passaged through snails (*Triodopsis multilineata*) and two hand-raised white-tailed deer fawns (*Odocoileus virginianus*). A total of 74 adult *Parelaphostrongylus tenuis* were recovered from the fawns; no other protostrongylid nematodes were recovered. The study indicates that wapiti may be infected with natural infections of meningeal worm and pass larvae suitable for transmission to gastropod intermediate hosts. Wapiti from areas endemic with *P. tenuis* should not be translocated to areas currently free of the parasite.

Key words: *Parelaphostrongylus tenuis*, dorsal-spined larvae, wapiti, elk, *Cervus elaphus*, meningeal worm, transmission, experimental study.

A number of protostrongylid nematodes have first-stage larvae bearing a short spine on the dorsal surface of the posterior extremity. These include species of *Elaphostrongylus*, *Muellerius*, *Parelaphostrongylus*, and *Varestrongylus*, most of which may be pathogenic in certain ungulate hosts. Some of these species can be separated and identified by the length of their dorsal-spined larvae; however, others cannot (Pybus and Shave, 1984; Gray et al., 1985).

Meningeal worm, *Parelaphostrongylus tenuis*, which has a dorsal-spined first-stage larva, is found in white-tailed deer (*Odocoileus virginianus*) throughout eastern Canada and the United States (see Anderson and Prestwood, 1981 for review). It has the potential to be highly pathogenic in most other ruminants.

Anderson et al. (1966) report survival and a patent infection in one of two wapiti calves (*Cervus elaphus*) experimentally infected with *P. tenuis*. The second calf died as a result of the infection prior to the nematodes reaching patency. These authors concluded that the nematode could complete its life cycle in this host and could perhaps become established in wapiti populations. In addition, based on the presence of dorsal-spined larvae in feces, histologic lesions in the central nervous system (CNS), female nematodes recovered from the CNS, and/or clinical neurologic signs, *P. tenuis* is reported from free-ranging wapiti in Minnesota, Oklahoma and Pennsylvania (Karns, 1966; Carpenter et al., 1973; Olsen and Woolf, 1978, 1979). Unfortunately, none of these criteria is specific to meningeal worm. The current investigation confirms that dorsal-spined larvae from naturally infected free-ranging wapiti in southwestern Manitoba were *P. tenuis*.

Fecal pellets from wapiti in and adjacent to Spruce Woods Provincial Forest (49°25′N, 97°30′W) were collected and frozen. All pellets were collected fresh off snow by persons trained to distinguish pellets from different ungulate species. Pellets of wapiti were identified by size (only large pellets were collected), association with wapiti tracks, and/or association with the direct presence of wapiti at the location. Moose were not present in the area sampled.

Standard techniques for the recovery of larvae, experimental infection of snails (*Triodopsis multilineata*), and exposure of a hand-raised white-tailed deer fawn were used (Anderson, 1963; Platt and Samuel, 1978; Pybus and Samuel, 1984). Fecal samples from the experimental fawn were examined regularly before and after the fawn was exposed to 129 third-stage larvae of *P. tenuis*. The prepatent period was approximately 88 days and the number of larvae in feces increased slowly throughout

patency. Other fawns raised and held in the same facility at the same time did not produce dorsal-spined larvae.

The experimental fawn was killed with an intravenous injection of Euthanyl (M.T.C. Pharmaceuticals, Mississauga, Ontario, Canada L4W 2S5) 163 days after exposure. The skeletal muscles, lungs and central nervous system were searched for nematodes as per Pybus and Samuel (1984). Nine adult nematodes were recovered; seven in the cerebral subdural space, two in blood vessels in the cerebral pia mater. Specimens collected included three complete females, one complete male, and three male posterior ends. These specimens were deposited in the National Museum of Natural Sciences (Division of Invertebrate Zoology, Ottawa, Ontario, Canada K1A 0M8; accession number NMCP1988-0896). Morphological measurements indicated the specimens were *P. tenuis*; however, slight aberrations were noted. The base of all bursal rays of the caudal extremity of three males were distinctly bulbous and one specimen (the complete male specimen) had three separate and complete spicules.

In order to further confirm the identity of the original infection, larvae from the experimentally infected fawn were passaged again through snails and then to a second hand-raised white-tail deer fawn. The second fawn was exposed to 300 third-stage larvae. A rapid loss of all guard hairs from the hair coat was noted between 154 and 156 days postexposure; however, the fawn remained active and showed no other clinical signs of infection. At 157 days postexposure, 65 adult *P. tenuis* (NMCP1988-0897) were found in the brain and spinal cord of the second fawn. An accumulation of thick yellow/brown fibrinous exudate was noted surrounding the pituitary and pineal glands. Other necropsy results were consistent with published reports of meningeal worm in white-tailed deer. Aberrations were not observed in any of the specimens recovered from this fawn. Nematodes were not found in the lungs or skeletal muscles of either fawn.

This study confirms that dorsal-spined larvae from wapiti pellets collected in the Spruce Woods forest (Manitoba game hunting area 30) were *P. tenuis*. Meningeal worm is known to occur in white-tailed deer in the area (Bindernagel and Anderson, 1972) and apparently infects some wapiti sympatric with these deer. Wapiti feces collected in Manitoba's Interlakes region also contained dorsal-spined larvae similar to those of *P. tenuis* (V. Crichton, unpubl. data).

There are no reports of neurologic disease in wapiti in southwestern Manitoba; however, Anderson et al. (1966) showed that clinical neurologic signs in wapiti infected with meningeal worm may be short-term. Similarly, based on histological evidence in the central nervous system, Woolf et al. (1977) concluded that many wapiti in Rachelwood Game Preserve (Pennsylvania, USA) harboured subclinical infections of *P. tenuis*. Successful infection in wapiti could be attributed to individual animals resistant to neurologic insult or, more likely, development of the parasite without significant damage to the CNS. Other nematode species known to have dorsal-spined larvae have not been reported from free-ranging wapiti.

Certain morphological characteristics of the male nematodes from the first fawn we infected were not typical of *P. tenuis*. The presence of three spicules in one individual may be a host-induced anomaly resulting from an abnormal host-parasite relationship (using first-stage larvae from a wapiti as a source of third-stage larvae to infect a white-tailed deer). Similar teratological changes have been reported in other host-parasite relationships. The peculiar bursal rays in the male specimens also may be host-induced and are similar to anomalies seen when *Parelaphostrongylus odocoilei* from mule deer (*Odocoileus hemionus hemionus*) was used to infect moose (*Alces alces*) or black-tailed deer

(*O. hemionus columbianus*) (M. J. Pybus, pers. obs.).

Confirmation that some free-ranging wapiti pass larvae of meningeal worm has important implications for wildlife management as well as game farming activities throughout North America. In general, meningeal worm has been reported in an area from western Manitoba south to eastern Oklahoma and Texas and east to the Atlantic coast. To prevent the spread of the infection into western regions of Canada and the United States, white-tailed deer traditionally have not been translocated across this line. It is apparent that wapiti also should not be moved from areas enzootic with *P. tenuis* to those currently free of the parasite. It is not possible to directly identify subclinical infections, and infected wapiti rarely pass enough dorsal-spined larvae to make fecal examination reliable as a diagnostic test for infection. In addition, although ivermectin (Merck, Sharp and Dohme, Rahway, New Jersey 07065, USA) temporarily removes larvae of meningeal worm from feces (Kocan, 1985), there is no known treatment to prevent, remove or kill the adult worms.

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Received for publication 7 October 1988.