

## *P. tenuis* – The White-tailed Deer Parasite

“Brain worms” (meningeal worms) can affect sheep, goats, llamas, alpacas, moose and other exotic small ruminants

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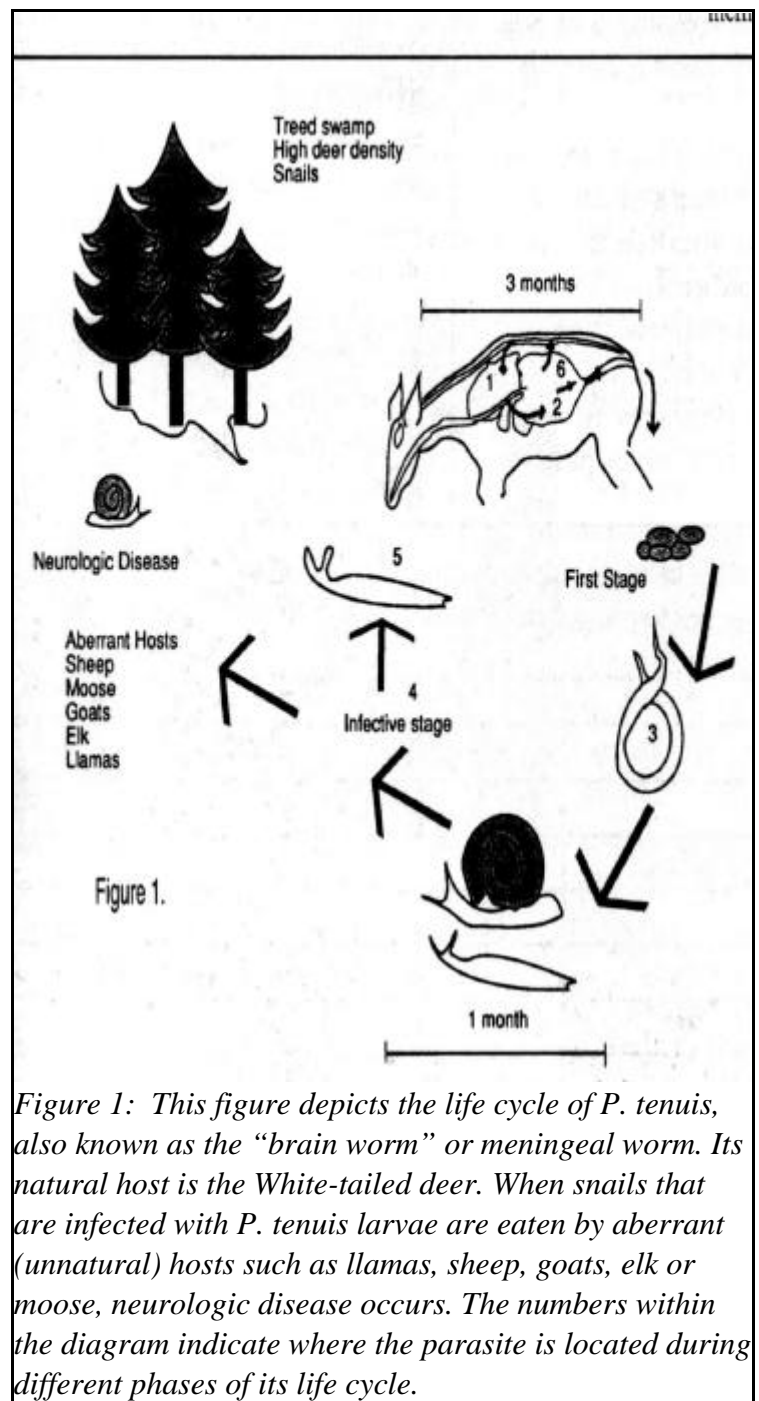
Many livestock producers are familiar with internal parasites that invade the digestive system (the abomasum, small or large intestines), liver, and lungs. An internal parasite which may not be so well-recognized is one that invades the central nervous system (brain and spinal cord). Commonly called the “brain worm” or meningeal worm (the meninges are a thin membrane that covers the brain and spinal column), the scientific name for this parasite is *Parelaphostrongylus tenuis* (*P. tenuis*), and its natural host is the White-tailed deer. Usually, *P. tenuis* completes its life cycle in the deer (*Figure 1*) without causing noticeable problems. However, when *P. tenuis* is ingested by unnatural, or aberrant hosts such as, llamas, sheep, goats, moose, elk, caribou, and other susceptible ruminants, the parasite moves into the brain and/or spinal cord, damaging delicate nervous tissue. Neurologic problems result.

White-tailed deer may be parasitized by *P. tenuis* year-round. However, the neurologic disease seen in aberrant hosts has a seasonal occurrence that starts in the late summer and continues until a hard freeze occurs. A cool, moist summer and/or a mild winter may extend the period during which the disease occurs.

### How does it occur?

To understand this disease and how to prevent or minimize its occurrence, it is important to understand the life cycle of *P. tenuis* in the White-tailed deer and what happens when the parasite is ingested by susceptible ruminants. **The life cycle is as follows (*Figure 1*):** adult meningeal worms live in the deer's central nervous system (brain and spinal cord) and produce eggs which hatch into larvae. The larvae migrate from the deer's central nervous system to the lungs, where they are coughed into the mouth, swallowed and passed from the intestinal tract with the manure. This portion of the life cycle takes approximately three months (*Figure 1* - numbers 1 and 2). After excreted in the manure, larvae must continue their development in an intermediate host (certain land-dwelling snails and slugs) for another three to four weeks until they reach their infective stage (*Figure 1* - numbers 3 and 4).

White-tailed deer become infested with *P. tenuis* by eating these snails or slugs that contain the infective stage of the larvae (*Figure 1* - number 5). Once ingested, the larvae migrate through the deer's gut and eventually move into their central nervous system where they mature into adults, produce eggs,



*Figure 1: This figure depicts the life cycle of P. tenuis, also known as the “brain worm” or meningeal worm. Its natural host is the White-tailed deer. When snails that are infected with P. tenuis larvae are eaten by aberrant (unnatural) hosts such as llamas, sheep, goats, elk or moose, neurologic disease occurs. The numbers within the diagram indicate where the parasite is located during different phases of its life cycle.*

and the cycle begins again.

When *P. tenuis*-infected snails and slugs are ingested by aberrant hosts, the larvae migrate into the brain and/or spinal cord, but do not mature into adults. Instead, these immature larvae wander through the central nervous system causing inflammation and swelling which damages sensitive nervous tissue producing a variety of neurologic signs. Because these larvae do not mature into adults in aberrant hosts, they cannot produce eggs that would mature into larvae which would then pass outside the animal with the feces. This is why sheep, goats, llamas and other unnatural hosts are considered dead-end hosts for *P. tenuis*. ***Dead end hosts infected with *P. tenuis* larva cannot spread the disease to other aberrant hosts or back to deer - i.e. infected sheep or goats can not bring the disease to your flock or herd.***

The neurologic signs observed in infected llamas, sheep, goats and others depend upon the number of larvae present in the nervous tissue and the specific portion of the brain or spinal cord that has been affected. *For example* - a mild infestation in a very local area may produce a slight limp (*Figure 2*) or weakness in one or more legs (*Figure 3,4,5, & 6*). A more severe infestation may cause an animal to become partially or completely paralyzed. If the parasites are located only in the spinal cord, an affected animal will appear bright and alert, and have a normal appetite, despite the altered gait or paralysis. When larvae migrate through the brain, they may cause blindness, a head tilt, circling, disinterest in or inability to eat, or other signs that can mimic brain diseases caused by bacteria, viruses, nutritional deficiencies, trauma, or toxins. *Table I* lists some of the diseases that *P. tenuis* can mimic when the parasites migrate through nervous tissue.



**Figure 2** The Angora goat in the center of the picture had a mild lameness in its left forelimb (arrow). The presumptive diagnosis was meningeal worm infestation. Mild cases such as this one may recover spontaneously.



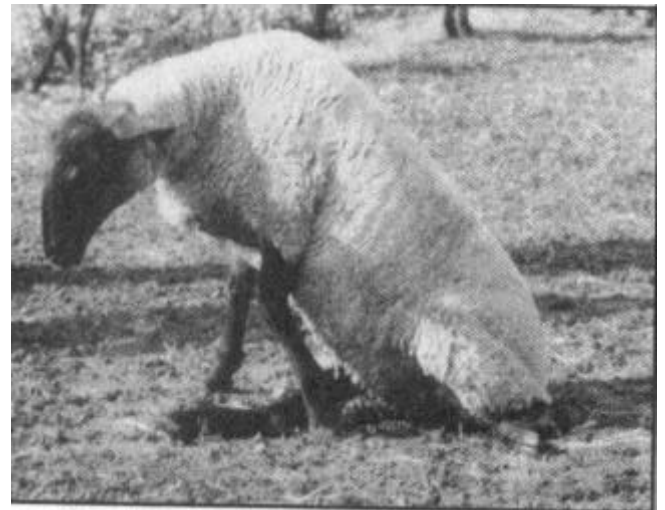
**Figure 3** This Angora goat was probably affected with meningeal worms and was able to use its hindlimbs, but was unable to rise onto its forelimbs.



**Figure 4** This alpaca had been paralyzed by meningeal worms. Notice that despite the paralysis, the animal appears alert. This is typical for a brain worm infestation that affects the spinal cord and not the brain.



**Figure 5:** This alpaca displayed weakness in both hindlimbs and was unable to stand without assistance. The presumptive diagnosis was brain worm infestation. This animal eventually recovered.



**Figure 6:** This Suffolk sheep was one of several sheep from a flock that were affected with *Parelaphostrongylus tenuis*. The posture that this animal is displaying is referred to as a "dogsitting" position.

## Could it happen on my farm?

Animals pastured in lowland areas frequented by infected White-tailed deer are prime candidates for exposure to snails containing *P. tenuis* larvae. When such animals develop neurological problems during the late summer through early winter in the Upper Midwest (the season for exposure may be longer in other parts of the country), “brain worms” are a likely possibility.

Presently there is no definitive test that can be performed on a live animal to confirm *P. tenuis* infestation. Since the larvae do not mature to adulthood in aberrant hosts, and therefore, cannot produce eggs or pass larvae in the feces, a fecal examination is not useful. Also, these parasites cannot be detected by blood testing.

A test that can help support suspicions of brain worm infestation is evaluation of cerebrospinal fluid (CSF), which is the fluid that bathes the brain and spinal cord. Disease that occurs in these areas may cause changes in the CSF detectable by various tests.

Normal CSF contains very few cells and little protein. An animal that has parasites migrating in the brain or spinal cord, often will have a larger number of cells, especially a certain type of cell called an eosinophil. Also, the protein concentration may be increased. Therefore, finding eosinophils in a CSF tap taken from an animal with

neurologic abnormalities is very supportive evidence for “brain worm” infestation. If eosinophils are not found, this does not rule out the possibility of a “brain worm” problem. Currently, the only way to confirm this diagnosis is by finding the parasite in the nervous system, which requires a necropsy examination.

Obtaining CSF from sheep, goats, and llamas is somewhat more involved than obtaining a blood sample. Two areas used most often for CSF collection are just behind the poll or over the hips, in the area called the lumbosacral junction. We prefer the lumbosacral site because the test can be performed using local anesthetic only (rarely would a tranquilizer be required), and the animal can be standing or lying down, whichever is most comfortable. The head site usually requires that the animal be heavily tranquilized or anesthetized.

The procedure can be performed in a hospital setting or on the farm, and must be done in a sterile manner. This includes removal of the hair or wool from a small area where the puncture will be made, scrubbing the site with surgical disinfectant and rinsing with alcohol. Sterile gloves and equipment are used.

**Table 1** Included in this table are various diseases that can look similar to “brain worm” infestation. Also listed are the target species that are susceptible to each of the diseases.

Disease	Species		
	Llamas and Alpacas	Sheep	Goats
Listeriosis	X	X	X
Caprine Arthritis-Encephalitis			X
Scrapie		X	Rare*
Rabies	X	X	X
Trauma	X	X	X
Copper Deficiency	X	X	X
Vitamin E/Selenium Deficiency	X	X	X
Spinal Cord or Brain Abscess	X	X	X
Polioencephalomalacia	X	X	X

After the site has been scrubbed, an injection of a local anesthetic is placed under the skin and into the deeper tissues where the spinal needle will be placed. The needle is inserted through the anesthetized area. The animal may notice slight discomfort when the needle enters the spinal canal. However, having a quiet person at the animal's head (in some cases the best person is the owner or handler) will provide a calming effect. The needle does not penetrate the spinal cord. In many animals, the cord ends just ahead of where the needle is placed. Once fluid has been obtained, the needle is withdrawn. The amount of fluid collected depends on the animal's size. Usually, 5 to 8 cc's are withdrawn and submitted to a clinical laboratory for analysis. This is a very safe procedure if performed properly.

### **What about treatment?**

Many different drugs including thiabendazole, levamisole, fenbendazole, albendazole, and ivermectin have been used in an attempt to treat "brain worm" infestation. However, to date, no controlled studies have confirmed or refuted the efficacy of various treatment recommendations. Some anthelmintics can kill *P. tenuis* larvae while they migrate from the stomach to the brain or spinal cord, but are unable to enter the central nervous system because of a structure called the blood-brain barrier. Therefore, they do not have an effect on parasitic larvae once the parasite has migrated across the blood-brain barrier and is in the central nervous system. Other anthelmintics may be able to kill the larvae regardless of their location in the body. An important point to remember is that once the parasite begins to migrate within the nervous tissue, damage occurs that is usually irreversible. Although some drugs may kill the worms, thus preventing further damage, treatment does not repair nervous tissue. Some animals with mild clinical signs may recover without treatment. At this time, the best recommendation for treatment is "do no harm." Perhaps some medications are helpful, however, remember that drugs used at higher-than-usual levels or more frequently than usual may cause toxicity problems.

The best approach to "brain worm" infestation is prevention. This is achieved by keeping the life cycle in mind. Animals kept in pastures that have wetlands and White-tailed deer should be removed from these pastures in the late summer and until the first hard freeze. If this is not possible, strategic deworming is the second best approach. This would involve either continuously providing an anthelmintic in feed or mineral mix throughout the "brain worm" season, or deworming with an oral or injectable product every 10 to 14 days - starting in late summer and continuing through early to mid-winter, depending on the severity of the freezing temperatures.

The 10- to 14-day schedule recommendation is based on experimental evidence that demonstrated the parasites' ability to reach the brain and/or spinal cord in this amount of time after an animal eats the snails containing *P. tenuis* larvae. Thus, this is a "window of opportunity" to kill the worms before they enter the central nervous system where they may be "safe" or protected from the killing effect of drugs that cannot cross the blood-brain barrier.

While clinical cases of meningeal worm infestation are rare, "brain worms" could affect your animals if they have access to wetlands harboring *P. tenuis*-infected White-tailed deer. Wetlands contain a population of snails and slugs needed to complete the parasite's life cycle if it is the season when *P. tenuis* infestation occurs. Remember: the success of treatment is variable - prevention is the best means of control.