

## **Meningeal Worms (Brain Worms) & Liver Flukes (Deer Flukes) Two Uncommon Internal Parasites**

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In Michigan, clinical disease resulting from the *deer fluke* or the *meningeal worm* is rare, sporadic, and very localized (geographically). Clinical disease generally occurs during the months of September through March - not times when producers typically associate parasites with clinical disease and death losses. Producers residing in endemic *deer fluke* or *meningeal worm* regions are well aware of these parasites and the clinical signs they produce. However, producers purchasing feeder lambs and replacement ewes from endemic areas are often not as well versed in the clinical signs, treatment, prevention and available control options.

The *deer fluke* and the *meningeal worm* are found in very limited areas of the Upper Great Lakes Region. Each parasite requires close contact with: 1) white-tailed deer (*definitive host*) and 2) specific species of swamp residing snails (*intermediate host*) for completion of the parasite's life cycle. Furthermore, sheep are considered *dead end hosts* for both *deer flukes* and *meningeal worms*. The fact that sheep are a *dead end host* means that neither parasite can reproduce and complete its life cycle within the infected sheep. Once either parasite is ingested by a sheep it may migrate through various parts of the body wrecking havoc with that individual sheep, but the parasite will ultimately fail to reproduce within the affected animal. Thus, only infected deer (not infected sheep) can harbor the parasites over winter and spread either parasite to your flock. Additionally, this can only occur if certain types of snails (*intermediate hosts*) are also found in your pastures. Due to the relationship of the snail (*intermediate host*) and the white-tailed deer (*definitive host*) to the life cycle of the *deer fluke* and the *meningeal worm*, both parasites will be discussed as a group.

### ***Meningeal worm* ( “*brain worm*”)**

The meningeal worm, scientifically known as *Parelaphostrongylus tenuis* and commonly referred to as the “*brain worm*”, is a unique parasite that behaves quite differently from other “more normal” sheep parasites. Due to the location of the “*brain worm*” within the central nervous system of clinically infected sheep, treatment of animals exhibiting clinical signs is usually unrewarding. Therefore, to avoid significant losses producers need to recognize the clinical signs of *meningeal worm* infection and to understand how to prevent initial exposure to the parasite.

## ***Deer fluke***

The “*deer fluke*” (*Fascioloides magna*) is also known as the “*giant liver fluke*”. It originates in the upper Great Lakes Region and is not the same liver fluke as the “*common liver fluke*” (*Fasciola hepatica*) that affects cattle and sheep in most other parts of the country. While treatment of infected animals is usually more rewarding than in *meningeal worm* infection, *deer flukes* often cause both acute and chronic losses in endemic areas and impact the grazing management of fall pastures. They are also a common reason for condemnation of livers at slaughter.

### ***Are your sheep at risk?***

If either meningeal worm or deer fluke infection is going to be a problem on your farm, a peculiar set of events must all fall into place. In order for either parasite to survive and thrive on your farm, the following scenario must occur:

1. There must be an abundance of infected white-tailed deer
2. You will usually have swampy pastures or small areas of swamp (pot holes etc.) that are grazed by sheep and goats during late summer and early fall
3. The appropriate species of snails and slugs also have to reside in that pasture. Generally, *deer fluke* snails are found in grassy type swampy pastures and *brain worm* snails are more common in swampy areas that also harbor trees.
4. You also need sufficient rainfall during the grazing season to maintain snail habitat. However, this statement can often be misleading because in dry years sheep often penetrate further into infected swampy areas than they normally would if more water were present. Flock pressure on available forage also forces deeper penetration into swampy areas. In years when little rainfall occurs producers with grass-based production systems also tend to utilize low lying wooded areas to provide several weeks of grazing during dry summer periods.

### ***How do deer contribute to the life cycle?:***

#### ***Common to both parasites***

White-tailed deer are the *definitive hosts* (the animal in which *meningeal worms* and *deer flukes* complete their life cycles) and can be carriers of both parasites. However, outside of endemic areas, white-tailed deer are rarely infected with either parasite. The deer is the animal that harbors and protects the parasite through the long cold winter months, allowing winter survival of flukes and brain worms. Each spring infected deer start the infection by depositing fluke or brain worm infected manure onto swampy, snail infested areas. As spring and summer progresses, snails eat the infective larva and

become *intermediate hosts* for *meningeal worms* or *deer flukes*. While the larva are inside their *intermediate hosts* (snails) they undergo changes that allow them to become infective to deer (*definitive hosts*) and sheep or other small ruminants (*dead end hosts*). These changes inside the *intermediate host* (snails) take about 3 to 4 weeks. When complete, the snail contains infective larva.

Unlike most of the common sheep internal parasites with which producers are familiar, these unique parasites require snails as part of their life cycle. While deer are the *definitive host*, snails are important as an *intermediate host* for the parasites. These parasites can not infect sheep without a 3 to 4 week infective stage that takes place in the snail. Deer that inhabit swampy areas ingest infected snails and the cycle continues. Remove any portion of the equation - deer, parasite or snails - and clinical disease can not occur.

In Michigan, sheep pastures are usually considered “clean” or “free” of *deer fluke* or *meningeal worm* contamination shortly after a hard killing freeze each fall (usually November). Each fall a hard freeze kills infective snails - thus eliminating the problem until infected deer re-initiate the cycle the following spring. Therefore, clinical signs and the progression of *deer fluke* and *meningeal worm* cases into the winter months are intimately linked to local fall weather conditions. While under certain unusual weather conditions clinical disease could occur at any time, the majority of cases of clinical disease occur from November through March. In most parts of Michigan, September and October pastures are most likely to be contaminated with snails containing infective larva.

### ***Brain worms only***

Once infective snails are ingested by deer the *meningeal worm* larva migrates through the intestinal wall of the deer and eventually moves to an area just outside of the deer's spinal cord. In white-tailed deer the meningeal worm never actually enters the spinal cord - this is why deer do not seem to be clinically affected by the parasite. Much as a hen would lay her eggs in a nest and hatch her brood, the *meningeal worm* matures in this area (adjacent to the spinal cord), produces eggs, and these eggs incubate and hatch into larvae. As these larvae mature, they migrate to the lung and are coughed up into the mouth of the deer and swallowed. The larva that enter the intestinal tract (swallowed) are excreted in the manure and ingested by snails. The entire process - from ingestion by the deer to ingestion by the snails - encompasses about 3 to 4 months. Therefore, contaminated pastures will usually not occur until 3 to 4 months into the grazing season. For this reason, transmission to sheep is generally thought to be sometime after September 1<sup>st</sup> each fall.

In contrast, when “*dead end*” or “*aberrant hosts*” (sheep, goats, moose, elk, llamas, and other exotic species) ingest infected snails the *meningeal worm* larva actually migrates to the inside of the spinal cord or brain. Once arrived, the larva mature and wander aimlessly through the nervous tissue until they are “walled-off” and killed by the body’s defenses or the animal dies. The final destination of the parasite often involves the area of the spinal cord controlling function of the rear legs. This is why loss of function to the rear limbs is a common clinical sign. The resulting swelling and damage to the

spinal cord produces the neurological deficits associated with *meningeal worm infection*. While reproduction does not occur in *dead-end hosts*, producers should remember that even individual worms migrating through the central nervous system can cause major damage to the spinal cord or brain!

### ***Deer flukes only***

The life cycle of the *deer fluke* is almost identical to that of the *meningeal worm*, except for the fact that the organ targeted by the parasite is the liver. When deer are infected, the larva migrate to the liver and reproduce, causing very little damage in that area. This is where the fluke winters. However, when sheep are infected, the flukes migrate to the liver and grow for 12 to 16 weeks, often becoming bigger than your thumb. All the while they are growing they continue to “swim” through the liver tissue causing tissue damage. Often they rupture blood vessels in the liver, causing sudden death (acute blood loss) or compromise liver function (chronic). Sheep often die from secondary clostridial disease initiated by the damaged tissue tracks from the migration. This disease, caused by *Clostridium novi*, is often referred to as Black Disease -- due to the black color of the liver. Producers in endemic areas often vaccinate against Black Disease.

The life cycle of the *deer fluke*, similar to the *meningeal worm*, requires the same 3 to 4 months of development time from the onset of grass and snails each spring - before infected snails are capable of infecting sheep. Again, sheep usually come in contact with infected snails after September 1st each year. Clinical signs of *deer fluke* disease usually do not develop until flukes grow to what is known as the 8 to 12 week stage (related to the time after ingestion by the sheep). Thus, clinical signs generally develop during November through March.

### ***When do clinical signs appear, and how do weather conditions and management practices affect onset?***

#### ***Brain worms and deer flukes***

In Michigan, it is unusual for clinical cases of *deer fluke* or *meningeal worm* infection to occur prior to September or after March. Normally, the majority of cases are concentrated in December, January and February. However, variations in weather conditions and grazing practices can greatly affect the onset, distribution and cessation of new infections.

As discussed earlier, it normally takes about 3 months for either the *meningeal worm* or *deer fluke* to complete one life cycle in the deer and another month to produce numerous infective larvae in a population of snails. Grazing season in Michigan rarely begins prior to May 1st, therefore, it is unlikely that pastured sheep or goats will ingest any quantity of infected snails prior to September 1<sup>st</sup> each year. Once ingested by the sheep, larva of the *meningeal worm* or *deer fluke* must migrate from the intestine to the central nervous system (long ways for a parasite) or from the intestine to the liver (short time) of the infected animal. *For the meningeal worm this migration can be as short as 10 days or*

as long as three months. Deer flukes generally reach the liver within several days after ingestion.

**Considering these pertinent facts, the following assumptions can be made:**

1. Large numbers of infective snail populations for either parasite species are unlikely to develop prior to September 1<sup>st</sup>.
2. Clinical signs of *meningeal worm* disease are unlikely to develop until at least 10 days after September 1<sup>st</sup>. Clinical signs of *deer fluke* disease are unlikely to develop until at least 6 to 8 weeks after ingestion of infected snails.
3. After a hard freeze infective snails disappear from pasture. In some years this freeze may occur as early as November 1<sup>st</sup>.
4. If clinical disease generally occurs 10 days to 3 to 4 months after ingestion of infective larva, new cases of clinical disease are unlikely (not impossible) after March.
5. Yearly cycles of infection often occur. Clinical cases appear to be more common when an extremely wet summer is followed by a long, warm fall.

### ***How can I protect my sheep and goats from meningeal worm or deer fluke infection?:***

We have briefly discussed the life cycle of the *meningeal worm* and the *deer fluke* in the deer, snails and aberrant hosts such as sheep. Utilizing this information, we should be able to determine what management practices will help to prevent infection in Michigan sheep.

***Key prevention practices would be as follows:***

#### ***Grazing management and strategic treatments***

Grazing management and strategic treatments are the keys to preventing infection in Michigan. If swampy areas are to be pastured, if possible they should not be pastured by sheep after September 1<sup>st</sup> (August 15<sup>th</sup> might be a more conservative date). Many farms contain combination pastures of mixed high ground and swampy swales. If the pasture contains small areas where snails, slugs, swamp and deer coexist, then sheep should be fenced out of these areas. This practice is often the most sensible and economical preventative approach. Remember, a small finger-like projection of swamp may be the only source of infection in a 40 to 50 acre pasture. Fencing sheep out of this area is usually a more sensible alternative than repeatedly administering preventive medications.

Sheep and goats that are removed from infected pastures should be strategically dewormed with ivermectin or fenbendazole (for *meningeal worms*) or albendazole (for *deer flukes*). If treatment (discussed later in the article) is to target preventing *meningeal worm* infections then sheep can be medicated when they are removed from suspect pastures. If *deer flukes* are the issue, then treatment with albendazole should occur twice: 1) at removal and 2) again at six weeks after the first treatment. Albendazole is not effective against immature flukes (flukes less than 4 to 6 weeks old). Therefore, the second dose is needed 6 weeks later to treat immature flukes that were unaffected by the first dose. Farms that raise both cattle and sheep should also try to utilize cattle to graze swampy pastures after August 15<sup>th</sup> or during the entire grazing season. Cattle do not appear to be affected by either species.

### ***Deer control?***

Deer control is another not-so-practical method of reducing problems. The amount of deer needed to induce an infective population of snails is not known. Therefore, hunting pressure will unlikely influence infection. Fencing deer out of the area is usually cost prohibitive and swamp water and snails do not respect boundary fences.

### ***Snail***

Snail control could, theoretically, reduce the likelihood infection in sheep. While snail control products are available in Europe they are not currently approved for use in the United States. The environmental impact of these products makes their future approval unlikely.

### ***How will I know if my sheep are infected with meningeal worms, and what can be done to treat them?***

Animals infected with *meningeal worms* may exhibit a number of varying neurological signs. The severity of these signs will be dependent upon the number and location of parasites in the spinal cord. Larvae moving through the spinal cord can cause mild lameness in one or more legs, or total paralysis. If only the spinal cord is involved the affected animal will usually appear bright, alert, and have a normal appetite. Only the gait may be altered. A weakness or dragging of the rear legs is often noted. This often progresses to paralysis of the rear limbs with a classical "dog sitting" posture. If meningeal worms enter the brain, blindness and circling can develop - but this is unusual. Other diseases such as polioencephalomalacia, listeriosis and white-muscle disease need to be considered as alternative causes of similar clinical signs.

### ***Diagnosis of meningeal worms***

Diagnosis of meningeal worm infection is usually based upon clinical signs, seasonality and environmental and geographic conditions conducive to the life cycle of the parasite. *Confirmation of the disease*, however, is difficult. Currently, there is no safe, convenient and economical antemortem test for *meningeal worm* infection in sheep. Flock confirmation is based upon histopathological (fixed

sections of spinal cord are viewed under a microscope) identification of: 1) the actual parasite in the tissue or 2) parasite migration tracts in the spinal cord of affected individuals. **Confirmation involves a postmortem examination which includes removal and sectioning of the spinal cord.**

### ***What can I use to treat animals infected with meningeal worms?***

*Meningeal worms* are already present in the spinal cord when clinical signs are apparent. For this reason, treatment is usually unrewarding and "after the fact". ***Sheep producers should view diagnosis and confirmation as a warning to prevent further losses in the remainder of the flock.*** Flock treatment of affected and non-affected animals should involve the following:

1. Removal of exposed animals from affected pastures
- and*
2. Immediate deworming of the entire flock with either fenbendazole (5 cc of a 10% solution/100 lbs of body weight, orally, non-approved use) or ivermectin (1 cc of cattle strength injectable/110 lbs of body weight, injected subcutaneously, non-approved usage), or ivermectin sheep drench as labeled on the approved product.

Sheep that are exhibiting clinical signs of *meningeal worm* infection may occasionally respond to treatment. This is the exception rather than the rule and generally follows prolonged nursing care. In most cases, nursing care is impractical. Practitioners also often use 2X to 5X doses of ivermectin for treatment.

### ***What if I can't remove my sheep or goats from infected pastures?***

For some producers, removal of animals from infected pastures may be impractical. If removal can not occur, the following treatment regimen may help control losses.

1. Strategic de-worming with ivermectin injectable every 20 days until a hard freeze and sheep are removed from pasture.
- Or**
2. Daily strategic deworming with a medicated salt mix or salt block containing fenbendazole. Although not approved for sheep, commercial cattle salt blocks containing fenbendazole ("Safeguard") can be used in a free-choice feeding program.

It is very important to remember to continue these medicated routines until animals have been off the contaminated pasture for 10 days.

## ***How will I know if my sheep are infected with deer flukes and what can be done to treat them?***

Animals infected with *deer flukes* generally present the owner with sudden unexplained deaths during the late fall and early winter. These deaths generally result from blood loss following migration of a fluke through a liver blood vessel. A certain portion of the flock may also exhibit as “poor doers”. The liver functions as a filter for many of the toxins and by-products produced in the body. When compromised, infected sheep often become more susceptible to other diseases. In feedlot lambs that arrive in the early fall, the sudden losses usually occur after the major losses from shipping fever have subsided and lambs are well on feed. Furthermore, lamb deaths are limited to groups of lambs from fluke infected areas. Postmortem exam generally reveals an abdomen full of thin, blood colored fluid and dark black tracks in the liver. Large, flat, flukes are also commonly observed and a generalized peritonitis is present.

## ***What can I use to treat animals infected with deer flukes and how do I prevent losses?***

### ***Active cases i.e. dead animals with confirmed deer fluke infection***

Currently, there are no approved products for treatment of *deer fluke* infections in sheep. Only albendazole (Valbazen), fenbendazole (Panacur & Safeguard) and clorsulon (Curatrem) are known to have some affect on mid-aged to mature flukes (>6 week old flukes). Clorsulon is not believed to be as effective as albendazole, so currently albendazole (at the bottle dose 4cc/100lbs) is considered the drug of choice. Neither drug is 100% effective, so some residual cases will remain - even after treatment.

***Breeding flock:*** When confronted with midwinter deaths due to *deer fluke* infection, affected animals are generally 8 to 12 weeks away from infected pastures and harboring 8 to 12 week stage flukes. Single Valbazen treatments will be reasonably effective on these mature flukes. However, when breeding replacements are involved ewes should be treated twice - about 4 weeks apart. In severely infected flocks it also may prove useful to vaccinate ewes for Black Disease and treat prophylactically with long acting penicillin. ***Valbazen is also not labeled for use during the first 30 days of pregnancy.***

***Feedlot lambs:*** Valbazen (albendazole) is a good choice of medication for all lambs arriving at the feedlot. This alleviates the risk of missing some fluke infected lambs with an ineffective dewormer. However, some lambs from infected areas will be arriving fresh from infected pasture. Treatment upon arrival may treat resident 6 to 8 week old flukes, but will likely prove ineffective on less mature flukes. If lambs arrive from fluke areas, they should be treated upon arrival and again in about 6 weeks with albendazole. If it is known that lambs have been off of pasture for at least 6 weeks, one treatment may suffice.

***Pastured animals:*** Treatment of pastured animals will be dependent upon the time of year and level of exposure. Most endemic fluke areas have early snows that run lambs off pasture by October or November. As mentioned earlier, deworming once with albendazole - upon removal from pasture -

does not address the immature flukes missed by the treatment. Generally 2 treatments with albendazole is better - once at removal from pasture and again in 6 to 8 weeks is a good practice.

***Prevention of deer fluke infection:*** Prevention of fluke infection generally centers around preventing contact on pasture. In endemic areas this is often impractical - unless contaminated areas can be fenced or grazed by other species. Prevention generally has to involve a 2X serial fluke treatment with albendazole at removal from pasture and 6 to 8 weeks later.