



Deer and elk, like other ruminants, are susceptible to internal parasite infection. For high-fence operations, economic losses caused by parasitism include decreased growth and production, cost of prevention, cost of treatment and death of infected animals. Jim Miller (2005) of Louisiana State University has pointed out that it is extremely difficult to determine precise figures on losses incurred due to parasitism by surveys or estimation. Parasitism interaction with nutrition and other environmental stresses may increase susceptibility to other diseases or disorders.

The effects of a parasitic infection can be influenced by the nutritional status of the deer or elk. It is well known that properly fed (well-fed) animals can better withstand parasitic infection than animals on an inadequate diet. Dr. Gil Myers (2008) stressed that an animal with a low protein intake has a compromised immune system, which lowers the animal's resistance to parasitic challenges, making it more susceptible to very serious consequences of parasitism, including death. It is also true that parasites interfere with the ability of the host to utilize nutrients efficiently. Consequently, it is important to realize that the better the deer or elk is fed the better able that animal can tolerate a higher internal parasite load. However, a point may be reached, depending on the type of internal parasites and conditions involved, where the parasites overwhelm the deer's ability to function properly (Miller, 2005). In high-fence deer operations, the problem of internal parasites is further complicated by the fact there are no "dewormers" (anthel-

mintics) approved for use in whitetail deer or elk.

Numerous species of internal parasites affect deer and elk. The effects of parasitism vary widely depending on species and degree of infestation. While many of these parasites are species specific, some parasites are known to infect other ruminants in addition to deer and/or elk.

Types of Internal Parasites Affecting Deer and Elk

Protozoa

Coccidia: Whitetail deer are infected by ingestion of oocysts (eggs). Infections may be subclinical (no apparent symptoms) or clinical, exhibited by diarrhea with varying degrees of severity. Coccidiosis is caused by protozoa in the intestinal tract. Specifically these are protozoa from the genus *Eimeria*. Species of coccidia are specific for different ruminants and even different cervids. Five species of *Eimeria* affect whitetail deer while elk and red deer are affected by 13 different species of *Eimeria* (Duszynski et al., 1999). These protozoa attack the small intestinal lining and destroy cells. While bloody diarrhea is a symptom of coccidiosis, blood does not have to be visible (McDonnell, 2008). Infected fawns often exhibit a fecal stained area below the tail. It is believed that mature, healthy adults can shed coccidia (mature oocysts) in manure that can infect younger, susceptible animals. Coccidiosis is associated with unsanitary conditions and excessive moisture and may be more prevalent during periods of depressed immunity such as at fawning, weaning or during transport.



Nematodes (roundworms) – Several types have varying degrees of impact

***Trichostrongylus* (small stomach worm, hairworm):** This worm feeds on nutrients in mucous and interferes with digestive function. Infection is characterized by profuse, watery diarrhea that is usually persistent (Miller, 2005). The animal may exhibit anemia (of varying degrees) and edema under the lower jaw (bottle jaw) that can sometimes extend along the abdomen. Left untreated, progressive weight loss, rough hair coat and anorexia may occur (Chislom, 2006). Heavy infections can result in death before symptoms appear.

***Nematodirus* (small intestine worm, thread-necked worm):** Symptoms of *Nematodirus* infection include diarrhea and anorexia that usually develop the third week of infection. Diagnosis can be difficult (Chislom, 2006).

***Haemonchus* (barberpole worm):** Many deer infected with this blood-sucking parasite do not develop any symptoms. However, young, non-immune deer are most susceptible to this parasite. Subclinical and clinical symptoms may include diarrhea, anemia, hypoproteinemia, reduced growth and death in severe cases. In domesticated ruminants, such as goats and sheep, the barberpole worm exerts the

greatest economic impact of any internal parasite.

***Trichuris* (whipworm):** Eggs can be found in fecal samples; however, diarrhea (infection) is rare and is associated with very heavy infections. The young animal is more susceptible to diarrhea caused by this parasite (The Merck Veterinary Manual, Fifth Edition).

***Dictyocaulus* (lungworms):** Adults of this nematode live in the lungs and bronchi of cattle, deer, elk and bison. Eggs hatch in the lungs, and larvae migrate up the respiratory tract, cross over to the digestive tract and are eliminated in the feces. In the soil the larvae become infective and are then ingested by the animal. Moderate to heavy infections often result in impaired respiratory function and may lead to death. Infections in wild deer appear to be associated with cross-contamination with infected domestic species (Kocan). This parasite is an important pathogen of red deer, elk and fallow deer in captivity (high-fence operations).

***Parelaphostrongylus tenuis* (brain worm, meningeal worm):** This parasite invades the central nervous system (brain and spinal cord). Its natural host is the whitetail deer. Usually *P. tenuis* completes its life cycle in the deer without causing noticeable problems. However, when *P. tenuis* is ingested by other hosts such as elk, caribou, moose, goats, sheep or llamas, it moves into the brain and/or spinal cord, damaging delicate nervous tissue, resulting in neurologic problems. After being expelled by deer, *P. tenuis* larvae live in an intermediate host (snails and slugs). When *P. tenuis* infected snails and slugs are ingested by an aberrant host (elk, for example), the larvae migrate into the brain or spinal cord, but do not mature into adults. The immature larvae wander throughout the body causing inflammation and swelling which damages sensitive nervous tissue (Kopcha et al.).

***Monezia* spp (tapeworm):** Adult tapeworms are restricted to the small intestine of deer. They can reach 20 feet long. Non-parasitic mites that live

in the soil are intermediate hosts, allowing the animal to be infected while grazing. Most infections are considered non-pathogenic.

***Fascioloides* spp (liver fluke):** This parasite is frequently found in the liver of deer. *F. magna* is the most common species. In fact, wild whitetail deer are the reservoir hosts for this parasite. Whitetail deer, bison and cattle will encapsulate mature flukes in the liver, restricting their migration and subsequent damage. However, mule deer fawns and elk calves have died from fluke infection. There is no indication that a whole herd of whitetail deer suffer any ill effects due to infection with liver flukes; however, individual animals could develop liver damage with a heavy infection (Michigan Department of Natural Resources, 2000).

Dewormers (Anthelmintics) and Anticoccidials

Dewormers and anticoccidials are chemicals (drugs) that have been evaluated and tested (effectiveness and safety) for use in animals to remove internal parasites. Within the US, only FDA-approved dewormers can be used in animals. There are no FDA-approved drugs for internal parasites (including coccidia) for whitetail deer or elk. Under current FDA Compliance Policy Guide 615.115, certain drugs can be used for a minor species (under the direction of a qualified veterinarian) if rules are strictly followed under the Minor Use and Minor Species Animal Health Act of 2004 (and amendments):

1. A veterinarian has to recommend to the producer, in writing, that a certain drug (dewormer, etc.) needs to be used in a deer or elk herd for a specified time period. This recommendation is based on a recent diagnosis of an active disease (or worm infection). The veterinarian has to make this recommendation, not the drug rep or feed sales personnel.
2. To make the recommendation

noted above (1.), there must be a valid veterinarian-client-patient relationship.

3. The veterinarian has to have contact with the animals and make a diagnosis that the parasite situation (or disease situation) is potentially life threatening.
4. The drug (dewormer) recommended has to be used at the treatment level (not at a production level).
5. Procedures must be established to ensure that the identity of treated animals is carefully maintained.
6. The veterinarian must establish a withdrawal period for the use of the drug prior to the marketing of meat or other edible products derived from treated animals.
7. The veterinarian's written recommendation must include the medical rationale (e.g., diagnosis, drug selection, dose and duration, and the required withdrawal period) and be dated within six months prior to use.

A copy of the written recommendation must be kept by both the veterinarian and the producer and made available to the FDA upon request.

8. No reformulation or relabeling is allowed. Once manufactured and labeled as approved for use in a major species, the feed cannot be either reformulated to meet nutritional needs of the intended minor species or relabeled as such.

For coccidiosis, several anticoccidials are commonly used in ruminants. For treatment, both water-soluble amprolium and amprolium mixed in feed are used. In addition, decoquinate (Deccox[®] mixed in feed), and the ionophores - monensin (Rumensin[®] mixed in feed) and lasalocid (Bovatec[®] mixed in feed) are all utilized. An up-to-date drug compendium should be used to determine mixing and use rates

Three general classes of anthelmin-

tics are used in ruminants for treatment and control of roundworms – benzimidazoles, imidazothiazoles and macrolides.

Benzimidazoles include fenbendazole (Safe-Guard[®], Panacur[®]) and albendazole (Valbazen[®]). Safe-Guard (mixed in feed) is used as an anthelmintic product for the removal and control of small stomach worms (*Trichostrongylus spp*), thread-necked intestinal worms (*Nematodirus spp*), barberpole worms (*Haemonchus spp*) and whipworms (*Trichuris spp*). Where meningeal worms (*Parelaphostrongylus t.*) are a problem, Dr. Gil Myers (2011) recommends preventive deworming during the summer with Safe-Guard or Panacur at a 30-45 day interval. This procedure during the summer may kill the migrating larvae of the meningeal worm. Valbazen (an oral suspension) is approved for liver flukes, tapeworms, lungworms and some intestinal worms.

Imidazothiazoles include levamisole (Levisol[®], Tramisol[®]) and morantel tartrate (Rumatel[®]). Rumatel (mixed in feed) is used for the removal and control of *Haemonchus contortus* (barberpole worm) and *Trichostrongylus spp* (small stomach worm) (Feed Drug Compendium, 2011).

Macrolides include ivermectin (Ivomec[®]) and moxidectin (Cydectin[®]). Ivomec (injected and pour-on) is used for the treatment and control of lungworms (*Dictyocaulus spp*) and certain gastrointestinal roundworms (Drugs.com). It is also effective against many external parasites. A very closely related product to Ivomec is doramectin (Dectomax[®] – injected and pour-on). It is used to control gastrointestinal roundworms along with *Trichuris spp* (whipworms) and *Trichostrongylus spp* (Pfizer Animal Health). It also controls lungworms. Like Ivomec, it is effective against several external parasites.

Summary

Although it is difficult to estimate exact cost of losses in deer and elk high-fence operations, even a moder-

ate load of internal parasites can decrease growth, adversely impact health status, raise costs of production and increase both costs of prevention and treatment. The impact of parasitic infection can be heavily influenced by the level of nutrition of the animal; conversely, a load of internal parasites can negatively affect nutrient utilization by the animal.

The vast majority of internal parasitic infections are caused by protozoa (coccidia) and nematodes (roundworms). The exception to this is liver flukes and tapeworms. Nematode species that have very adverse impacts on domestic animals such as goats, sheep and cattle may not be as big of a concern with whitetail deer or elk. An example of this is the barberpole worm that has huge implications with the domestic ruminant species, but is mostly a concern in fawns and elk calves, but not in adult deer and elk.

There are no dewormers or anticoccidials approved in the US for use in whitetail deer or elk. However, under certain rules established by FDA, veterinarians in a valid client-patient relationship can prescribe anthelmintics or anticoccidials for use in deer and elk at treatment levels for a specified period of time.

Mike Strobush, DVM, (2011) has suggested a strategic deworming program for adult deer that includes deworming deer after the first killing frost to eliminate all parasites during winter months, deworming deer three weeks after spring green up, then another deworming three to six weeks later to kill new parasites picked up on pasture before they mature into adults and produce eggs. This strategy prevents recontamination of pasture.

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