BOTS & BEYOND

Little-Known Parasite Enemies

PARASITE PRIMER—PART 5

BY KAREN BRIGGS, WITH
CRAIG REINEMEYER, DVM, PHD;
DENNIS FRENCH, DVM, MS, DIPL. ABVP;
AND RAY KAPLAN, DVM, PHD

When it comes to parasites, worms aren't your horse's only worry. Although nematodes and cestodes (or more colloquially, roundworms and tapeworms) make up the biggest demographic in the parasite "neighborhood" in your horse's insides, there's one other major class of internal pest you need to be concerned about—the larvae of the bot fly. Many other insects and arthropods feed from your horse's resources—lice, mites, and chiggers are three of the most common parasites—but only bots take up long-term residence deep in your horse's interior, sometimes clustering thickly all along his intestinal mucosa like particularly unappetizing gnocchi.

In addition to bots, there are other classes of internal parasites that while not as "high-profile" as strongyles or tapeworms, are important to recognize (and combat!). This month, we'll take a look at these lesser-known interlopers and make some recommendations on how to best limit their impact on your horse's health.

KIM AND KARI BAKER

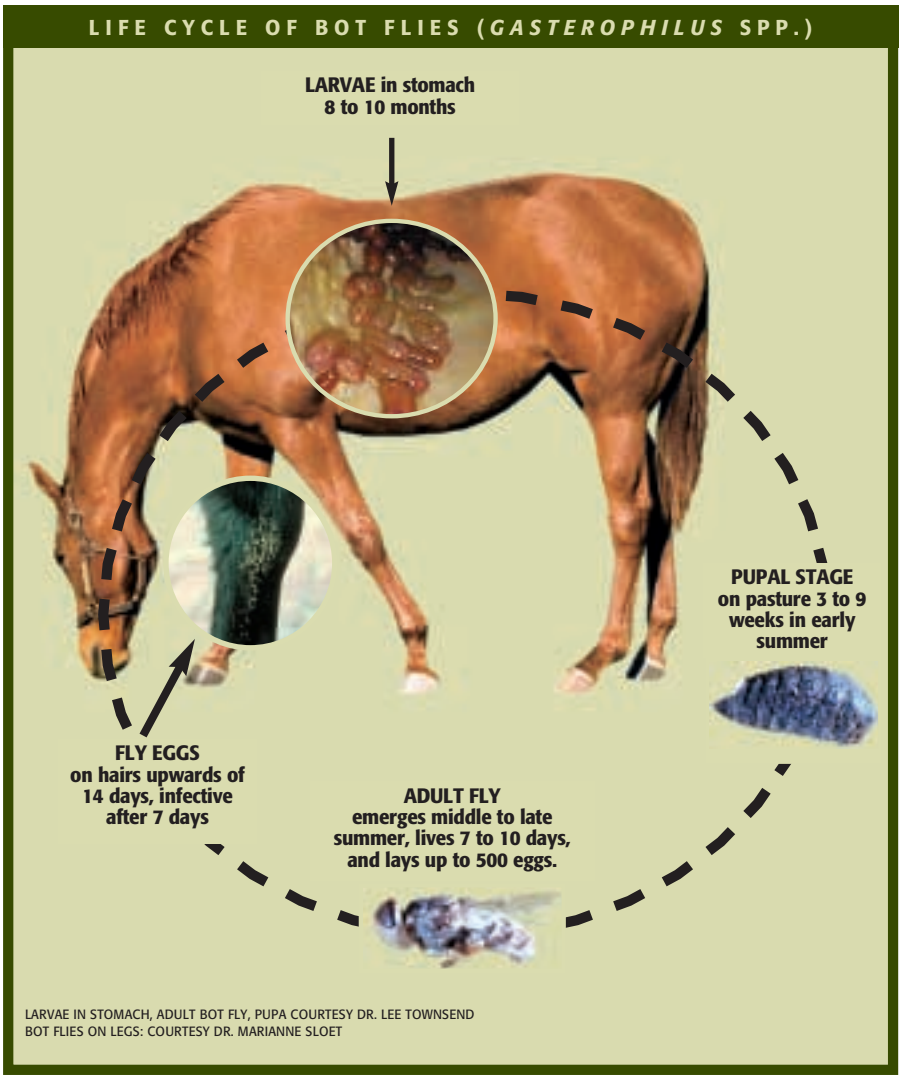
Those tiny yellow bot eggs glued onto your horse's legs, chest, shoulders, and maybe under his chin can hatch and cause health problems in your horse unless you remove them with a sharp blade or bot block.

The Bountiful Bot

Many of us have observed horses in the middle of summer zooming about the pasture in a vain attempt to escape swarms of annoying flies. If you see an insect that looks something like a honeybee buzzing industriously around your horse's legs, chances are it's not a bee but an adult bot fly, looking to deposit her yellow eggs on the horse's leg hairs with the long, curved ovipositor attached to her striped abdomen. Female bot flies are often observed on warm, sunny days hovering near horses and darting in rapidly in an attempt to attach eggs with a sticky "glue" that makes the eggs adhere tightly to the leg.

Bot flies are common virtually everywhere horses are kept, with two major species found in the United States. *Gasterophilus nasalis* lays its eggs on the hairs of the intermandibular space (under the jaw). The eggs hatch spontaneously five to six days after being deposited, and the larvae crawl downward to the chin until they pass between the lips.

In contrast, the females of *G. intestinalis* lay their eggs on the hairs of the forelegs and shoulders of the horse.



Far removed from their destination, the eggs depend on assistance from the horse to find their way into the mouth. Five days after the eggs are laid, they contain first-stage larvae that are ready to hatch rapidly in response to the sudden rise in temperature that occurs when the horse brings its muzzle in contact with them. When an itchy horse rubs and scratches himself with his muzzle and teeth, this allows the larvae to enter the horse's mouth and burrow into the epithelium (skin) on the top of the tongue.

First- and second-stage larvae of *G. intestinalis* spend about a month in the oral cavity. The white first-stage larvae drill burrows that can extend up to five inches (about 13 cm) into the mucosa of the horse's tongue, with air holes about every 0.16 inches (4 mm) through which they breathe. These burrows typically extend in a front-to-back direction along the tongue. The larvae will double in size while they live in the tongue, then will enter pockets in the interdental spaces of the upper molar teeth where they molt from first to second stage.

The second-stage larvae develop a red color due to the synthesis of their own hemoglobin (an oxygen-carrying protein), which is an adaptation necessary to compensate for the low-oxygen environment they will encounter in their migration to the stomach. When they finally leave the interdental spaces, they briefly attach to the root of the tongue before they proceed to the stomach, where they molt to the third larval stage or full-grown bot.

The oral migrations of the other species of bots have not been described in the detail of *G. intestinalis*. However, it is thought that first- and second-stage larvae of *G. nasalis* usually remain completely hidden well below the gum line in interdental pus pockets that extend into the root sockets of the molar teeth. Parasitologists believe that the tissue migration of these parasites helps protect them from the host's teeth, while putting them in a position where they can draw nourishment.

Inside your horse, the larvae of each type of bot have their preferences as to where they set up shop. The red *G. intestinalis* larvae attach in clusters to the non-glandular part of the stomach near the margo plicatus, which is the line of demarcation between the glandular and non-glandular portions of the equine stomach. *G. nasalis* larvae, which are yellowish, are usually found in a small dilatation in the first few inches of the duodenum.

Third-stage larvae attach by their mouth hooks to the wall of the stomach or duodenum for up to 12 months. Prime real estate for both *G. intestinalis* and *G. nasalis* is above the fluid level in the intestinal tract. In these locations, the bots are surrounded by gas pockets that supply them with sufficient oxygen.

As maturity beckons in late spring, the larvae release their grip on the mucosa and pass out with the manure to pupate (mature into adult flies) in the soil. Adult bot flies emerge from the pupae in three to nine weeks depending on the ambient temperature and start the cycle anew. (There is generally only one generation a year.) Bot fly activity continues throughout the summer and fall, but ceases completely with the onset of cold weather.

The Damage Done

While most of us have seen photos of bot larvae lining the intestine or stomach, the oral lesions caused by migrating first- and second-stage larvae might come as a shock. They can be extensive, and they can have an impact on your horse's oral and dental health-to say nothing of the chronic lesions in your horse's gastric and intestinal mucosa.

Yet there is very little evidence associating *Gasterophilus* infections with clinical illness. Most horses can support substantial populations of these parasites without apparent disease. This is not to say that bots don't have an impact on the horse's health; their presence can cause disease too subtle for current detection methods. And particularly heavy *Gasterophilus* infections have been associated with subserosa (membranous) abscesses and gastric ulceration. Some researchers have implicated them in cases of stomach rupture and peritonitis (inflammation of the membrane lining of the abdomen), but others argue that the presence of bots might be coincidental, not causative, in such cases.

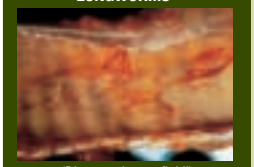
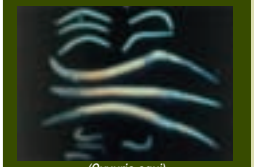
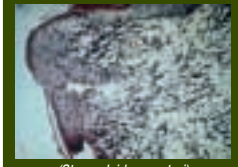
Other Invaders

Stomach worms—Like *G. intestinalis* bots, the spiral-shaped stomach worms

CHARLES MANN

Five days after *G. intestinalis* bot eggs are laid, they contain first-stage larvae that are ready to hatch rapidly in response to the sudden rise in temperature that occurs when the horse brings his muzzle in contact with them. When an itchy horse rubs and scratches himself with his muzzle and teeth, this allows the larvae to enter the horse's mouth and burrow into the epithelium (skin) on the top of the tongue.

LESS-KNOWN INTERNAL PARASITES OF EQUIDS

PARASITE	AGE AFFECTED	SIGNS	TREATMENT
LUNGWORMS  *(Dictyocaulus arnfieldi)*	Any age group (more common in donkeys)	Coughing, lung irritation	Ivermectin
STOMACH WORMS  *(Trichostrongylus axei; Habronema muscae; H. microstoma; Draschia megastoma)*	4 months and up	Loss of appetite, weight loss, poor growth, itchy, persistent sores	Ivermectin
PINWORMS  *(Oxyuris equi)*	6 months and up	Tail rubbing, rat-tailed appearance, weight loss	Broad-spectrum anthelmintics*
THREADWORMS  *(Strongyloides westeri)*	1 to 5 months	Diarrhea	Ivermectin Oxibendazole at 1.5 x label dose

* BROAD-SPECTRUM ANTHELMINTICS—ANY COMPOUND THAT DEMONSTRATES EFFICACY AGAINST FOUR DISTINCT GROUPS OF WORMS: SMALL STRONGYLES, LARGE STRONGYLES, ASCARIDS, AND PINWORMS.

PHOTOS COURTESY FARNAM; LUNGWORM COURTESY PARASITOLOGY SECTION, UNIVERSITY OF KENTUCKY

Habronema muscae, H. microstoma, and *Draschia megastoma* inhabit the glandular portion of the equine stomach, with a special predilection for the margo plicatus. There is also a stomach worm that is more common (and pathogenic) in sheep and cattle called *Trichostrongylus axei,* which horses sometimes contract when they're pastured with ruminants.

Stomach worms are transmitted by house and stable flies, which transfer the larvae when they land on your horse's muzzle, eyes, sheath, or an open wound. Those larvae that enter wounds reach something of an impasse in their life cycles, because they can't access the interior of the horse from there, but they do create granulomas on the wound surface (more on these in a minute). Larvae that are swallowed by the horse eventually make their way to the stomach; *Draschia* are associated with the formation of fibrous nodules riddled with pus-filled cysts, but with the advent of modern dewormers these have become rare in horses.

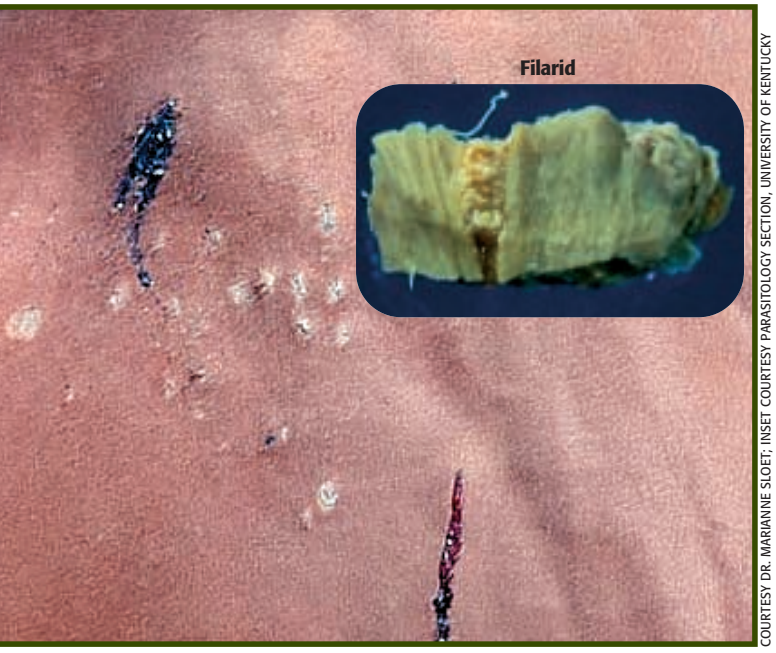
Trichostrongylus species overwinter on pasture, so horses are exposed to them as soon as they are turned out on grass in the spring. The infective larvae die off as the weather warms, and by summer the generation that survived the winter will be gone. But egg production from the new infections rapidly re-contaminates the pasture and continues well into the fall to produce the next season's over-wintering *Trichostrongylus* population.

How significant is the damage done by *Draschia* and *Habronema* stomach worms? Not much, at least not in the stomach. However, their larvae are responsible for a skin condition known as cutaneous habronemiasis, a.k.a. summer sores or swamp cancer. These granulomas develop when the parasites infect minor wounds and moist areas of skin, such as the conjunctiva of the eye, which in pastured horses is often drenched in tears due to stimulation and irritation by flies. Characterized by very rapid production of granulation tissue that refuses to heal during the fly season, the granulomas are also extremely itchy, and secondary trauma often occurs as the horse attempts everything possible to find relief. Granulomas, especially those around the eye, might end up severely ulcerated.

Trichostrongylus axei infection in the horse is most often asymptomatic, but in large numbers it is possible for them to trigger a protracted and debilitating watery diarrhea, especially in stressed individuals.

Lungworms—If your horses share space with donkeys, they might be at risk for contracting lungworms. *Dictyocaulus arnfieldi* is a primary parasite of donkeys that has also found horses to be a passable host, and they can be very pathogenic.

As the common name suggests, this long, white worm hangs out in the respiratory tract. Adults can be up to three inches (about eight centimeters) long. The eggs already contain first-stage larvae when laid, which hatch *before* they're passed out in the donkey's manure. (It is rare for lungworms to successfully reproduce in horses.) The larvae become infective in pasture in about five days, and when they're ingested they migrate by way of the lymphatic system to arrive in the lungs in another five days. Egg laying begins about 28 days after initial infection in the lungs, and the larvae travel up the trachea via coughing. Once in the throat, they're swallowed and make their exit via the intestinal tract.



COURTESY DR. MARIANNE SLOET; INSET COURTESY PARASITOLOGY SECTION, UNIVERSITY OF KENTUCKY

When *Onchocerca cervicalis* larvae (called microfilariae) migrate to the skin, they produce an intense itchy skin reaction (shown above) that horses respond to by scratching and rolling, subsequently leading to redness and hair loss.

Larval lungworms live in the lumen (cavity) of the bronchial tree (the larger air passages of the lungs), where in horses they can cause chronic bronchitis, coughing, and atelectasis—a collapse of the alveoli (air sacs), which can compromise the ability of that part of the lung to exchange oxygen-all while remaining practically undetectable. The lung damage can have a serious impact on any high-performance horse. Interestingly, donkeys can harbor lungworms without any outward sign of disease, but it's in donkeys that the worms can successfully complete their life cycles.

A minor infection of lungworms imposes only a mild burden on the horse. Heavier infections, however, can lead to partial or complete obstruction of the air passages, with clinical disease developing in proportion to the degree of obstruction. These horses might be difficult to distinguish from those with other types of respiratory problems, such as chronic obstructive pulmonary disease (COPD, also known as heaves). The easiest way to distinguish a lungworm infection is to consider the horse's history; if he has been housed with donkeys, lungworms are a real possibility.

Threadworms—The genus *Strongyloides* (commonly called the threadworm) is mostly of concern in foals. The species that infects horses, *S. westeri*, is commonly transmitted from mare to foal through nursing, a mode of transmission with important implications for disease induction and control. Larvae in the tissues of mature mares are induced to migrate to the mammary glands by the hormones of pregnancy and lactation, so they're present in colostrum and in the first few days of milking.

Mares infected with *S. westeri* are asymptomatic, but once the larvae find a home in a foal, they mature rapidly in the small intestine. Within 10 to 14 days after birth, foals begin to shed eggs from the parasite. Diarrhea is a possible sign at this time. These "foal scours" can be coincident with the mare's first return to estrus, and numerous investigators have questioned the correlation between infection with *S. westeri* and foal heat diarrhea, although no definitive connection has been established. Heavy infections in foals can persist for 10 weeks, while lighter infections can last two to three times as long. Fortunately, horses develop immunity to these worms by about six months of age, and egg-shedding is never seen in mature animals.

Pinworms—Most horse people have heard about *Oxyuris equi*, the pinworm, a common and fairly large parasite with a long, tapering tail (hence the name).

Pinworms lurk in the large intestine. Instead of simply discharging their eggs with the horse's manure, the females migrate through the rectum and cement their eggs in masses to the skin around the anus. Each mass consists of a thick yellow or gray fluid, containing up to 60,000 eggs. The eggs develop into the infective stage in four to five days, during which the cementing fluid dries and cracks, allowing for detachment from the skin. The flakes that fall away from the skin adhere to mangers, water buckets, and walls, effectively contaminating the environment of the stable. If a sponge or towel is used to wipe down the horse's perineum following work or grooming and that sponge is used again to clean a bit, transmission has been accomplished for the pinworm. The entire life cycle for these parasites takes up to five months to complete.

Severe infections with third and fourth stage larvae of *O. equi* can produce inflammation of the cecal and colonic mucosa, resulting in mild colic signs. The most common problem associated with pinworms in horses is the intense itchiness caused by the adhesive egg masses. In an effort to relieve the itching, horses will rub their tail heads against any surface they can find. Numerous horses have lost beautiful tails thanks to pinworm eggs. Cleansing the perineum with paper towels and warm water will give an affected horse some relief.

Filarial parasites—*Onchocerca cervicalis* adults are found in the nuchal ligament of the horse, a very strong, elastic ligament originating at the withers and extending to insert at the poll. *O. cervicalis* adults are large parasites, intricately woven into the deep connective tissues of the nuchal ligament, so it is very difficult to isolate them.

Deep in the ligament, the adults cause little damage. But the larvae (called microfilariae) migrate to the skin, where they produce an intense reaction that horses respond to by scratching and rolling, subsequently leading to redness and hair loss. A skin biopsy is sometimes needed to confirm the diagnosis—but some horses can harbor large numbers of microfilariae with no evidence of skin disease, while in other animals a relatively minor infection can produce dramatic clinical signs.

The distribution of microfilariae within the skin is not random. The highest densities are found along the ventral (lower)

midline, but can also be found in the forelegs, chest, eyelids, and withers. Eventually, they are ingested by insect vectors, most notably *Culicoides* gnats, where they complete their larval development.

COURTESY DR. MARIANNE SLOET

***Draschia* and *Habronema* larvae are responsible for a skin condition known as cutaneous habronemiasis, a.k.a. summer sores or swamp cancer, in which infected minor wounds quickly develop large amounts of granulation tissue and itchiness.**

Dealing With Multiple Enemies

The parasites discussed in this month's article might not be associated with the severe clinical disease that some of the other internal parasites of the horse cause, but they still represent a threat to the overall health of the horse.

Fortunately for horses and horse owners, all of the parasites discussed this month are fairly easy to treat. Most will be killed by treatment with macrocyclic lactones (moxidectin or ivermectin) given at the correct dosage, based upon the weight of the horse.

Ivermectin is highly effective in removing bots from the equine stomach. Bot larvae are the "rate-limiting parasite" for moxidectin, but efficacy against *G. intestinalis* usually exceeds 95% and moxidectin is nearly 100% effective against *G. nasalis*. A dose-limiting parasite defines the dosage necessary to be effective in removal of the parasite. This is the targeted parasite that needs the highest dose for control. If the horse is underdosed by underestimating his body weight, the parasite might not be completely eliminated.

The dermatitis caused by *Onchocerca* microfilariae is 100% responsive to ivermectin at the regular dose. Disappearance of the skin lesions also validates the diagnosis, although complete resolution of the lesions might take up to a month. Midline edema within the first 48 hours after treatment was a common problem when ivermectin was first introduced. This was thought to be due to the acute death of the microfilariae. Relapses might occur within two to eight months because adult *O. cervicalis* continue to live happily in the nuchal ligament. They are not killed by any of the anthelmintics that are available and can continue to produce filariae, making repeat treatments necessary at appropriate intervals (although ivermectin might disrupt their reproductive success).

Summer sores can be frustrating to treat. Ivermectin and moxidectin effectively kill these parasites if they can get into the lesion from the bloodstream, but the amount of fibrous tissue generated around some of these ulcerated areas can preclude good drug penetration. It might be necessary in some cases to prepare a topical concoction of organophosphates, steroid cream, and anti-inflammatory agents as an adjunct to oral administration of either ivermectin or moxidectin. These topical preparations are difficult to keep on the wound and may involve multiple applications to be effective.

Treatment of *Dictyocaulus* (lungworms) and *Strongyloides* is best accomplished with macrocyclic lactones. Attempts to block transmission of *Strongyloides* by treating mares on the day of parturition with ivermectin have not been successful. However, the number of *S. westeri* eggs passed in the feces of foals from treated mares was significantly lower than those of foals from control mares. (Moxidectin is currently not labeled for use in foals younger than six months.)

Numerous anthelmintics are effective against pinworms. Remember that the adults are really not the problem with these parasites; it is the sticky egg mass laid by the female in the perineal area that produces the most visible clinical signs. Benzimidazoles, pyrantel salts, and macrocyclic lactones all have demonstrable activity against *Oxyuris equi*.