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Transmission of Some Internal Parasites in Horses Born in 1989 on a Farm in Central Kentucky[1]

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ABSTRACT: The dynamics of acquisition of infections of internal parasites of equids in central Kentucky were observed. Aspects studied were the relationship of the life cycle of the parasites, seasonal occurrence, and age of the horses. Ten horses born in 1989 and kept on a pasture on a farm in central Kentucky were naturally infected with internal parasites and examined (1 a month) at necropsy at 64–222 days of age between 20 June 1989 and 14 March 1990. Antiparasitic compounds were never given to these horses and were not generally used in the breeding band for over 10 years.

Parasites found and the months of their recovery were: bots, *Gasterophilus intestinalis,* in the mouth from September to December and in the stomach September–March; stomach worms, *Trichostrongylus axei* in June–September, November, and March and *Habronema* sp. in August and January; ascarids, *Parascaris equorum,* in all months; intestinal threadworms, *Strongyloides westeri,* in all months but January and February; large strongyles, *Strongylus vulgaris* in the cranial mesenteric artery in all months and in the large intestine from September to March, and *Strongylus edentatus* in the ventral abdominal wall from August to March; small strongyles in all months; pinworms, *Oxyuris equi,* in all months; and eyeworms, *Thelazia lacrymalis,* in August, October, and November. Identification of small strongyles from 5 of the horses revealed 7 genera and 22 species present.

This research provided insight into the transmission pattern of several species of internal parasites of equids and should be useful in establishing more definite control measures.

KEY WORDS: horses, internal parasites, seasonal transmission, Kentucky.

Knowledge on transmission of internal parasites of equids is important; understanding this aspect of the biology of parasites is of special interest in providing a basis for control recommendations for these organisms. Specific research on ecology of internal parasites of equids is not extensive. Particularly lacking are studies on equids themselves regarding age when infections are acquired and the influence of life cycle of the parasites and season of transmission. In studying transmission of internal parasites, availability of adequate numbers of equids, born and raised under similar conditions, is usually a limitation.

Previous studies on parasite transmission in equids in Kentucky have generally included composite data. For example, investigations have been on horses born in 1982 on several farms (Lyons et al., 1985) and born over a 19-yr period on 1 farm (Lyons et al., 1990). While valuable information on seasonal transmission of internal parasites was found in these studies, it did not include monthly serial examination of horses born on the same pasture in the same year.

The purpose of the present research was to follow monthly the progressive acquisition of infections of endoparasites over a 10-mo period in horses born in 1989 on the same pasture (Field No. 10) in central Kentucky.

Materials and Methods

Ten foals were born on a pasture (Field No. 10) in central Kentucky between 17 April 1989 and 4 August 1989. Details on the birth date, month and age at necropsy, and sex of the horses are recorded (Table 1). History on size of the pasture, treatment of the breeding band, and other aspects of horses kept in Field No. 10 has been published recently (Lyons et al., 1990). Parasiticides have not been used in the breeding band in Field No. 10 since 1979, except for treatment of occasional replacement animals. However, beginning in 1987, parasite control was initiated in horses in surrounding fields and several antiparasitic compounds were routinely given.

None of the present foals examined was ever treated with an anthelmintic. Each foal was with its dam until necropsy.

Organs, tissues, or parts of the horses examined at necropsy were: eyes, mouth (tongue and gums), pharynx, brain, heart, mesenteric lymph nodes, ligamentum

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Table 1. Internal parasites recovered from 10 horses born on a farm in central Kentucky in 1989.

Horse					Parasites							
			Necropsy		Teeth and/or tongue		Stomach			Small intestine		
					G. intest.		*G. intest.*				*P. equor.*	
ID no.	Sex	Birth date	Mo.	Age (days)	1st	2nd	2nd	3rd	*T. axei*	*S. westeri*	Imm.	Mat.
		(1989)	(1989)									
1	♀	4/17	June	64	0	0	0	0	30	130	640	0
2	♀	5/2	July	78	0	0	0	0	30	1,760	1,770	0
3	♀	5/2	Aug.	107	0	0	0	0	10	1,850	390	17
4	♂	5/10	Sept.	125	4	2	4	0	180	2,270	110	168
5	♂	6/1	Oct.	139	27	21	70	9	0	4,420	230	223
6	♀	6/4	Nov.	164	2	1	21	21	30	2,610	510	68
7	♀	6/22	Dec.	174	3	3	25	73	0	6,850	1,890	5
			(1990)									
8	♀	6/25	Jan.	205	0	0	1	120	0	0	0	8
9	♀	7/25	Feb.	204	0	0	0	97	0	0	340	51
10	♂	8/4	Mar.	222	0	0	0	147	10	90	530	6

G. intest. = *Gasterophilus intestinalis*; *T. axei* = *Trichostrongylus axei*; *S. westeri* = *Strongyloides westeri*; *P. equor.* = *Parascaris equorum*; *S. vulg.* = *Strongylus vulgaris*; *O. equi* = *Oxyuris equi*; SS or ss = small strongyles; *S. edent.* = *Strongylus edentatus*.
Mo. = month; Imm. = immature; Mat. = mature; VAW = ventral abdominal wall; CMA = cranial mesenteric artery.
ND = not determined.

nuchae, the cranial mesenteric artery, the ventral abdominal walls, lungs, esophagus (wash and mucosa), stomach (contents and mucosa), small intestine (contents and mucosa), ileocecal valve, contents and mucosa of the cecum, ventral colon, dorsal colon, small colon, and rectum.

Examination of the contents of the various portions of the gastrointestinal tract included inspections of aliquot samples to estimate numbers of smaller parasites and visual search of the remainder of the contents for the larger parasites.

Organs, tissues, and other areas were examined grossly, after which all (except for material artificially digested) were suspended in containers of water for about 16 hr. The material remaining after decanting or reducing the volume of liquid by pouring it into a 200-mesh sieve was fixed with 5% formalin. Later the preserved residue was washed over a 200-mesh sieve and examined under a stereoscopic microscope at about 10×.

Small strongyles, found in the contents of the large intestine, were identified to the species level for 5 of the horses. This was begun with the first horse (No. 1) examined, and done on every other horse thereafter.

Artificial digestive juice (1% pepsin and 1% HCl) was used for recovery of parasites from the esophageal mucosa, small intestine (anterior half), stomach (glandular mucosa), and cranial mesenteric artery.

The method for enumerating encysted small strongyles in the mucosa of the large intestines is given as follows: Separation of the large intestine was made into 3 portions—cecum, ventral colon, and dorsal colon. Following the removal of the contents, each portion was weighed and 10% was excised randomly with scissors. Thickened areas were trimmed from the serosal surface (e.g., lymph nodes and arteries) of these tissue samples, which were cut into smaller pieces, pressed between 2 petri dishes, and examined under a stereoscopic microscope at about 10×. The top, or smaller dish, turned upside down inside the bottom one, had a grid that aided in counting the larvae. High intensity light was used to illuminate the tissue (Reinemeyer and Herd, 1986a). Encysted small strongyles were enumerated for estimations of the total numbers present.

Feces were used for determining worm eggs per gram (epg) and larvae per gram (lpg) of feces. For the first 3 months of the study, lpg were not determined. More detailed descriptions on techniques for recovery of internal parasites and on methods for epg and lpg have been published (Drudge et al., 1963, 1975; Lyons and Drudge, 1975; Lyons et al., 1976b, 1981a, 1983).

Data on bots found in the mouth, eyeworms, and *Habronema* sp. from the stomach are not included in the tables. Comparisons are made of data for some of the internal parasites recovered from horses in Field No. 10 in the present study and from horses from this field and an adjacent field in a previous study (Lyons et al., 1990). Some parasites found in the present investigation were not sought in the earlier study. A major difference between the 2 studies is that the current investigation is on a group of horses born the same year and sampled monthly over a 10-mo period, whereas the earlier study was a random sampling of parasitic infections by month in foals born over a 19-yr period (Lyons et al., 1990).

Results

One species of bot and several species of nematodes were recovered at necropsy of the horses (Table 1).

In the mouth, *Gasterophilus intestinalis* first

Table 1. Continued.

Parasites									
Lungs	Large intestine					VAW		CMA	
P. equor. Imm.	*S. vulg.*	*O. equi* Imm.	*O. equi* Mat.	SS	Encysted ss	*S. edent.* 4th	*S. edent.* 5th	*S. vulg.* 4th	*S. vulg.* 5th
0	0	20	1	20,970	8,610	0	0	55	0
25	0	30	74	15,260	3,030	ND	ND	126	2
4	0	750	64	34,650	2,750	77	1	236	43
1	5	50	0	42,575	2,050	261	122	206	111
1	62	2,200	275	30,700	4,240	41	89	147	95
2	146	1,650	87	82,550	9,270	47	161	284	82
11	66	1,100	465	105,050	16,450	98	28	250	46
0	248	3,050	85	102,200	1,420	32	90	273	108
0	129	7,050	162	49,250	3,590	59	87	110	49
2	173	8,050	485	3,770	1,360	39	155	23	12

instars (2–27/horse) and second instars (1–21/horse) were found from September through December. *Gasterophilus intestinalis* second instars were found in the stomach from September through January. Third instars of this species were present from October through March.

The stomach collections also included species of 2 genera of nematodes. *Trichostrongylus axei* were present in low numbers from June to September and in November and March. A second species of nematode in the stomach was *Habronema* sp. (immature) in 2 horses (August [N = 36] and January [N = 20]).

In the small intestine 2 species of nematodes were found. *Strongyloides westeri* were recovered in all months except January and February. Immature *Parascaris equorum* were represented in all months but January, and mature specimens in every month except the initial months of June and July when the foals were only 64 and 78 days old, respectively. From July to December, and in March, immature *P. equorum* were also found in the lungs.

Examination of the large intestine revealed 1 species of large strongyle, 22 species of small strongyles, and 1 species of pinworm. *Strongylus vulgaris* were first seen in September and observed each month through March. Small strongyles were found in the mucosa and contents for all months. The month with the highest number of small strongyles was December in both the mucosa and contents. Regarding the mucosa of the dorsal colon, encysted small strongyle larvae were found in much lower numbers than from the mucosae of the cecum and ventral colon; there was none present in the dorsal colon mucosa in November, December, February, and March.

A total of 7 genera and 22 species of small strongyles was present in the contents of the large intestine of 5 horses (Table 2). The most prevalent were *Cyathostomum catinatum* and *Cylicostephanus longibursatus*. Those 2 species, plus *Cyathostomum coronatum* and *Cylicostephanus goldi*, were the only small strongyles found in horse No. 1, examined in June at 64 days of age. Also, about 80% of the small strongyles in horse No. 1 were immature; whereas in the subsequent horses, the majority were mature.

Oxyuris equi immatures were found in all months and matures in all months except September.

Strongylus vulgaris were found in the cranial mesenteric arteries for all months and *Strongylus edentatus* were found in the ventral abdominal walls from August (no examination in July) to March.

The eyeworm, *Thelazia lacrymalis* (1–2/horse) was found in only 3 horses (33%) in August, October, and November.

Table 2. Numbers of small strongyles recovered from 5 horses born on a farm in central Kentucky in 1989.

Genus and species	Counts for individual horses*					All horses: Counts: Total	All horses: Counts: Aggregate average	All horses: % of total†
	1	3	5	7	9			
Cyathostomum								
C. catinatum	50	6,500	3,700	28,100	14,650	53,000	10,600	26
C. coronatum	20	200	750	1,100	250	2,320	464	1
C. labiatum	0	200	100	600	200	1,100	220	1
C. labratum	0	800	300	650	700	2,450	490	1
Cylicocyclus								
C. elongatus	0	100	0	0	0	100	20	<1
C. insigne	0	100	600	750	1,350	2,800	560	1
C. leptostomus	0	900	600	2,300	1,350	5,150	1,030	2
C. nassatus	0	2,500	900	8,750	4,900	17,050	3,410	8
C. radiatus	0	0	0	150	200	350	70	<1
Cylicodontophorus								
C. bicoronatus	0	300	100	300	200	900	180	<1
C. mettami	0	0	200	0	0	200	40	<1
Cylicostephanus								
C. asymetricus	0	100	200	0	0	300	60	<1
C. calicatus	0	500	750	1,450	650	3,350	670	2
C. goldi	950	3,300	3,300	8,400	1,700	17,650	3,530	9
C. longibursatus	2,870	12,000	12,500	36,400	17,300	81,070	16,214	39
C. minutus	0	2,500	2,300	6,100	3,050	13,950	2,790	7
C. poculatus§	0	0	100	100	0	200	40	<1
Poteriostomum								
P. imparidentatum	0	100	0	450	500	1,050	210	1
Craterostomum								
C. acuticaudatum	0	0	400	150	0	550	110	<1
Triodontophorus								
T. brevicauda	0	200	200	1,050	200	1,650	330	1
T. serratus	0	100	300	650	400	1,450	290	1
T. tenuicollis	0	0	200	150	0	350	70	<1
Total mature	3,890	30,400	27,500	97,600	47,600	206,990	41,398	86‡
Total immature	17,080	4,250	3,200	7,450	1,650	33,630	6,726	14‡
Total small strongyles	20,970	34,650	30,700	105,050	49,250	240,620	48,124	100

* Month of necropsy was June (No. 1), August (No. 3), October (No. 5), December (No. 7), and February (No. 9).
† % for each species is based on the total no. of mature small strongyles.
‡ % based on combined total No. of mature and immature small strongyles.
§ Lichtenfels and Klei (1988) cite and accept the placing of *C. poculatus* in the genus *Petrovinema* by Hartwich.

Epg and lpg data are recorded (Table 3). Ascarid eggs were found first in August and also in all succeeding months except December and March. Eggs of strongyles were present for all months and of *Strongyloides* for all but the last 3 months of the study. Larvae of *S. vulgaris* appeared first in December, but also in the months of January, February, and March. *Strongyloides westeri* larvae were found in the same months as were worm specimens. *Eimeria leuckarti*-type oocysts were found in July.

Discussion

Finding that *G. intestinalis* were not present until September was of interest because, in the earlier observations in the 19-yr study on horses in Field No. 10 (Lyons et al., 1990), second instars were found in all months of the year except June and third instars in all months. The numbers of both instars were much fewer in the present than previous study. Possibly, this is related to the recent use of boticides in horses in sur-

Table 3. Worm eggs per gram (epg) and larvae per gram (lpg) of feces of 10 horses born on a farm in central Kentucky in 1989.

ID No.	Epg			Lpg		
	Ascarids	Strongyles	Strongyloides	*Strongylus vulgaris*	Small strongyles	*Strongyloides westeri*
1	0	20	10	ND	ND	ND
2*	Neg	Pos	Pos	ND	ND	ND
3	10	1,690	2,190	ND	ND	ND
4	180	590	170	0	770	Pos
5	150	830	180	0	135	Pos
6	100	290	130	0	310	Pos
7	0	650	250	10	860	Pos
8	20	600	0	10	440	Neg
9	70	750	0	30	950	Neg
10	0	780	0	15	355	Pos

* No epg, but float was positive for strongyles, *Strongyloides*, and *Eimeria* oocysts.
ND = no data; Pos = positive; Neg = negative.

rounding fields and the consequent reduction of the pool of botflies.

Comparison of data on stomach worms reveals that in the present study only *T. axei* and immature *Habronema* sp. were found, whereas in the previous study *T. axei* were not found, but prevalence of *Habronema muscae* was 79% and *Draschia megastoma*, 37% (Lyons et al., 1990).

The high rate of occurrence of *Strongyloides westeri* in the horses born in 1989 was not unexpected because usually there is a high prevalence in young horses. But, infections are self-limiting and tend to disappear after foals are a few months of age (Drudge and Lyons, 1986). Examination was not made in the previous study for this parasite.

Regarding *Parascaris equorum*, results were similar to the previous observation (Lyons et al., 1990) where immatures were found in all months but June and August; matures were present in all months. Recovery of immature *P. equorum* in the lungs in the present study from July to December, and in March, provided an index of the ongoing acquisition of ascarid infections, because invasive ascarid larvae reach the lungs by about 14 days after ingestion (Lyons et al., 1976a).

While intestinal stages of *Strongylus vulgaris* were first found in September, patency was not indicated until December when larvae were first present in fecal cultures. In the 19-yr study, *S. vulgaris* were present in all months except August.

A recent publication listing 9 genera and 33 species of small strongyles found in equids in Kentucky by the present authors over about a 30-yr period (Tolliver et al., 1985) includes the 7 genera and 22 species found in the present study. Another investigation in this geographical area (Ohio) revealed 6 genera and 21 species of small strongyles present in horses (Reinemeyer et al., 1984). The finding of very few encysted small strongyles in the mucosa of the dorsal colon has been reported previously (Reinemeyer and Herd, 1986b).

A comparison of findings on parenteral stages of large strongyles reveals that, in the other study (Lyons et al., 1990), *S. vulgaris* were found in the cranial mesenteric artery in every month but July and *S. edentatus* were found in the ventral abdominal wall in all months except February, July, and August.

Presence of mature *Oxyuris equi* was similar to the previous study in which they were found in all months except February, July, August, and November (Lyons et al., 1990).

For the previous data on prevalence, *Thelazia lacrymalis* were found from January through May and in September and December (Lyons et al., 1990). Also in that survey, the prevalence (75%) and the mean number of eyeworms (6) were much higher than in the present study. A possible reason for the differences is that the availability of the intermediate host, the face fly (*Musca autumnalis*) (Lyons et al., 1980), was probably less in 1989 because of recent removal of grazing cattle from a farm in close proximity to Field No. 10. Therefore, suitable breeding material, mainly cattle feces (Drudge and Lyons, 1986), for the face flies was less available. Also, possible

effect of 1 compound (ivermectin), used several times in horses in surrounding fields, on reducing *T. lacrymalis* infections available for face fly transmission to the present horses is unknown. Single treatments with ivermectin appear to be ineffective on *T. lacrymalis* (Lyons et al., 1981b; Drudge et al., 1984), but data are not available for multi-treatments.

A relationship between the prepatent periods (Drudge and Lyons, 1986) of some of the parasites and ages of the horses when infected was evident. That is, there was evidence that some foals became infected soon after birth. For *P. equorum,* the prepatent period is approximately 10–12 wk. Eggs of this parasite were not found in the 78-day-old foal, but were present in the 107-day-old. Larvae of *S. vulgaris* were first observed in a fecal culture from the foal 174 days old, although adult specimens were present in 3 younger foals (125, 139, and 164 days old). For this large strongyle, the prepatent period is approximately 6 mo. The foals were not examined at a young enough age to record first occurrence of patent infections for some parasites, e.g., *S. westeri* and small strongyles. The prepatent period for *S. westeri* is about 2 wk and small strongyles approximately 6–10 wk; the youngest foal examined was 64 days old. Classic field research by Russell (1948) and Todd et al. (1949) has established the typical acquisition and development profile of several species of internal parasites in young equids.

Several species of parasites, previously found in horses born in Field No. 10, were not recovered from horses born there in 1989. They were *Gasterophilus nasalis, Anoplocephala perfoliata, Habronema muscae* (adult), *Draschia megastoma,* and *Strongylus edentatus* (in the large intestine). The reason for absence of *G. nasalis, H. muscae* (a few immature specimens of *Habronema* sp. were found), and *D. megastoma* is probably because horses in surrounding fields had been treated with parasiticides, therefore reducing the pool of these parasites. The absence of *A. perfoliata* is not readily explainable, but it is cyclic (Drudge and Lyons, 1986). This species of tapeworm was found in 33% of of horses born in Field No. 10 over a 19-yr period (Lyons et al., 1990). Absence of *S. edentatus* in the large intestine is accounted for by the young age of the horses. The prepatent period for *S. edentatus* is about 11 mo and the oldest horse was less than 8 mo old.

In the present study, the serial examination at monthly intervals of horses born the same year in the same field provided insights on the transmission dynamics of several species of endoparasites. Although not investigated previously in this manner in central Kentucky, several essentially predictable findings were verified. These included seasonal presence of some parasites and their stage of development according to established life cycle features. Several other observations on seasonal transmission of parasites were not anticipated because previous data were limited or lacking, e.g., numbers of encysted small strongyles, pinworm infectivity and development, and actual numerical values on migrating large strongyles. Probable effects of factors outside the pasture under research were found, causing lessening of available dipterid parasites and dipterid intermediate hosts themselves, or parasites they transmit. This research, besides filling at least some of the void in the biology of these parasites under natural conditions, may be a contributing factor in improving control recommendations.

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