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Occurrence of *Gasterophilus intestinalis* and some Parasitic Nematodes of Horses in Sweden

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[1]Department of Parasitology, National Veterinary Institute and Swedish University of Agrucultural Sciences, Uppsala, [2]Swedish Animal Health Service, Kristianstad, and [3]National Food Administration, Linköping, Sweden.

Höglund, J., B.-L. Ljungström, O. Nilsson, H. Lundquist, E. Osterman, and A. Uggla: Occurrence of *Gasterophilus intestinalis* and some parasitic nematodes of horses in Sweden. Acta vet. scand. 1997, 38, 157-166. – A survey was performed on the occurrence of some internal parasites in 461 horses (1-30 years old) slaughtered from October 1992 to September 1993 at the Linköping abattoir in central Sweden. Macroscopical examination was carried out specifically for parasites of the tear ducts and conjunctival sacs of the eyes, and of selected parts of the alimentary tract and cardio-vascular system. The following parasites were found in selected parts of the large intestine: encapsulated cyathostome larvae (in 35.6% of the horses), and mature strongyle worms (17.4%); in the stomach: *Gasterophilus intestinalis* (12.3% during October–June) and *Habronema muscae* (1.1%); and in the conjunctival sac: *Thelazia lacrymalis* (3.1%). Significantly more encapsulated cyathostome larvae were found during January to June than during other times of the year, and horses aged 1–5 years harboured significantly more larvae than older horses. Severe damage to the cranial mesenteric artery and its main branches was noticed in 16 (6.1%) out of 263 horses specifically examined. However, the 4th stage larva of *Strongylus vulgaris* was only recovered in 6 (2.3%) of the horses. Quantitative and qualitative faecal egg counts were done on 412 and 384 of the horses, respectively. Eggs of strongyles, *Parascaris equorum* and *Strongyloides westeri* were found in 78.1%, 1.9% and 0.2% of the faecal samples, respectively. Highest prevalence of strongyle eggs was found during July to September. Third stage larvae of the following nematodes were recovered from faecal cultures: subfamily *Cyathostomum sensu lato* (78.1%) *Triodontophorus* spp. (6.5%), *Strongylus vulgaris* (3.6%), *Trichostrongylus axei* (1.3%), while *Gyalocephalus* sp., *Oesophagodontus* sp., *Poteriostomum* sp. and *Strongylus edentatus* each comprised less than 0.5%.

equine; parasites; prevalence; relative density; mean intensity; Scandinavia.

Introduction

The horse is host to a diverse micro-community of internal metazoan parasites. Virtually all grazing horses harbour parasites and more than 80 helminth species have been described in equines (*Lichtenfels* 1975). In the domestic horse some parasites are responsible for potentially severe clinical disease. Nematodes of major importance are the non-migratory small strongyles (cyathostomes) and the migratory large strongyles (*Strongylus* spp.) (*Uhlinger* 1991, *Austin* 1994), while ascarids (*Parascaris equorum*) and threadworms (*Strongyloides westeri*) are considered as a problem mainly in foals (*Suderman et al.* 1979, *DiPietro* 1989). In addition, heavy tapeworm (*Anoplocephala perfoliata*) and exceptionally also botfly (*Gaste-*

rophilus intestinalis) larvae infections may cause clinical disease (*Price & Stromberg* 1987, *French & Chapman* 1992).

Knowledge of the species composition and abundance of parasites is essential to design rational control programmes against the clinically important parasites. This is especially important in view of the prevalent drug resistance among cyathostomes which is recognised also in Sweden (*Nilsson et al.* 1989).

Previous studies on parasites of horses in Sweden have mainly focused on the epidemiology and strategic treatment of strongyles. These studies were confined to horses in the southern and western part of Sweden and were almost exclusively based on faecal examinations (*Nilsson et al.* 1975, *Tolling* 1976, *Nilsson & Andersson* 1979). More recently a quantitative study of horses from central Sweden was performed with the primary aim to evaluate infection levels and the diagnosis of the equine tapeworm *A. perfoliata* (*Höglund et al.* 1995, *Nilsson et al.* 1995). The present survey comprises mainly the same horse material as in the tapeworm study and accordingly provides supplementary data.

In this study we report on certain internal metazoan parasites, other than *A. perfoliata,* of Swedish horses. The study was carried out for a period of one year in order to collect information on parasite abundance with particular reference to seasonal occurrence in relation to last anthelmintic treatment and horse age, gender and breed. The aim of the study was to establish baseline data for horse parasites in Sweden.

Materials and methods

Abattoir survey

During one year, from October 1992 to September 1993, a total of 461 horses slaughtered at the Linköping abattoir in central Sweden were examined for certain internal parasites and parasitic lesions. 0.5 m of the distal ileum, caecum and 0.5 m of the proximal colon were examined according to the technique described by *Nilsson et al.* (1995). The stomach from 456 of the horses and the tear ducts and conjunctival sacs of the eyes from 196 of the horses were also examined. Parasites were identified and counted or their presence (i.e. encapsulated larvae of the cyathostomes) was assessed on a 3 graded scale (for definition see Table 2). No attempts were made to identify the species of cyathostomes found and to asses the numbers of adult small and large strongyles. The cranial mesenteric artery and its main branches were examined for lesions in 263 horses slaughtered from January to September 1993. The severity of the damage was graded as follows: 0 = no lesions; 1 = insignificant thickening of the endothelial lining of the arterial wall; 2 = slight dilation of the artery and thickening of its wall; 3 = severe thickening of the arterial wall accompanied by endothelial trombotic debris. Information about age, breed, gender, recent anthelmintic treatment, and relevant clinical data was, if possible, gathered from farm records.

Faecal examination

Rectal faecal samples were taken from 412 out of the 461 horses after slaughter. Nematode eggs were counted using a modified McMaster technique based on 3 g of faeces with a sensitivity of 50 helminth eggs per gram of faeces (EPG). Faecal cultures for nematode larvae were performed on 384 randomly selected samples by placing the faeces in a jar covered with a lid at 26 °C. After at least 10 days incubation infective larvae present were recovered by Baermann isolation, fixed in 70% etanol, stained with Lugol's iodine, and subsequently identified.

Statistical analyses

Excel 5.0 (Microsoft) for Macintosh (Apple

Computers) was used in data summary and descriptive analyses. In order to analyse the parasite burdens the horses were stratified into quarter of the year (4/92 = October-December 1992; 1/93 = January-March 1993; 2/93 = April-June 1993; 3/93 = July-September 1993), age group (1 = 1-5 years; 2 = 6-15 years; 3 = >15 years), gender (female, male and gelding), breed (Swedish warmblood, Standardbred trotter, Ponies and miscellanious breeds), and last anthelmintic treatment administered (1 = ivermectin; 2 = pyrantel pamoate; 3 = combined treatment including ivermectin; 4 = other drugs mainly including benzimidazoles and organophosphorous compounds; 5 = untreated over the last year before slaughter). Test of independence between observed frequencies of encapsulated cyathostomes and test of lesions of the cranial mesenteric artery were both analysed using contingency table analysis. Differences between observed prevalences of *G. intestinalis* and of EPG counts were both analysed with Chi-square test while relative densities or abundances and mean intensities of *G. intestinalis* were tested with Kruskal-Wallis non-parametric tests (for definitions see *Nilsson et al.* 1995). Statistical analyses were performed using StatView (Abacus Concepts) and considered significant at $p \leq 0.05$ level.

Results

Gasterophilus intestinalis

Botfly (*G. intestinalis*) larvae were found in 45 (9.9%) of the 456 horses and exclusively in the oesophageal region of the stomach. The relative density of 2nd and 3rd instars was 2.6 with a corresponding mean intensity of 26.3, whereas the maximum number was 203 (Table 1). Relative density refers to the total number of parasites in all horses divided by the number of horses examined, whereas the mean intensity is per infected host. There was a significant ($p = 0.0001$) seasonal variation in prevalence of bots. The highest prevalence (18.1%) was noted from October to December. Similarly, the numbers of bots varied significantly ($p = 0.0001$) during the year and both the relative density and intensity peaked from October to December with 5.4 and 31.7 bots, respectively. Bots were not found between June 10 to September 30. Significant differences were also noted both in prevalence ($p = 0.0141$) and in the number of bots ($p = 0.0058$) recovered from horses treated and not treated with antiparasitic drugs during the last year before slaughter. In horses treated with ivermectin the intensity of infection was 10.5, while horses that had received a combined treatment including ivermectin had 8.1 bots. Pyrantel treated and untreated horses harboured on average 35.0 and 73.6 bots, respectively. Although there was a significant ($p = 0.049$) difference in the number of bots among dissimilar breeds, the difference between prevalences was insignificant. Bots were found in all age categories (1-30 years) and there was no significant difference in bot prevalence between different age groups of horses. Similarly, there were no differences in infection levels between horses of different gender.

Macroscopically visible nematodes

Mature small and large strongyle worms were recovered from the contents of the selected parts of the alimentary tract of 80 (17.4%) of the 461 horses examined. The vector borne spirurids *Habronema muscae* and the eyeworm *Thelazia lacrymalis* were found only in 5 (1.1%) and 6 (3.1%) out of the 461 and 196 horses specifically examined, respectively.

Encapsulated cyathostomes

Mucosal stage cyathostome larvae were found in the caecum and the proximal 0.5 m of the colon in a total of 163 (35.6%) of the 458 horses examined. The majority (46.6%) of these in-

Table 1. Prevalence and numbers of *Gasterophilus intestinalis* in Swedish horses according to season, breed and last anthelmintic treatment.

	Prevalence (%)	Relative density	Intensity	Maximum number
Quarter of the year (n)				
4/92 (138)	18.1	5.4	31.7	203
1/93 (109)	11.0	2.4	21.9	150
2/93 (119)	6.7	1.1	16.0	50
3/93 (90)	0.0	0.0	0.0	0
All quarters (456)	9.9	2.6	26.3	
	p = 0.0001	p = 0.0001		
Breed				
Warmblood (181)	10.5	2.3	21.7	150
Standardbred (79)	2.5	0.2	6.5	10
Ponies (95)	14.7	7.4	50.3	203
Other (81)	12.3	0.7	5.4	12
	NS	p = 0.049		
Treatment[1]				
Ivermectin (115)	10.4	1.1	10.5	20
Combined[2] (212)	7.5	0.6	8.1	30
Pyrantel pamoate (33)	6.1	2.1	35.0	50
Other drugs (32)	6.3	0.8	13.0	20
Untreated (35)	25.7	18.9	73.6	203
	p = 0.0141	p = 0.0058		

[1] This study does not provide the theurapheutic efficacy of the drugs listed.
[2] Including ivermectin.

20.9% were scored as heavily infected. Analysis by quarter of the year showed significantly ($p = 0.038$) more encapsulated larvae as shown by lesion scores between January to June than at other times of the year (Table 2). A comparison by age group showed that horses aged 1-5 years harboured significantly ($p = 0.0001$) more larvae than older horses. The overall prevalence within this age group was 53.7%. No differences in infection levels were noted in relation to gender, breed and last drug treatment.

Nematode eggs in faecal samples

The prevalence of horses with positive strongyle faecal egg counts in the present material was 78.4%, i.e. 323 out of 412 horses examined. The highest number of strongyle eggs observed in a single horse was 5500 EPG. In 22.5% of the samples EPG were less than 50. The arithmetic mean EPG was 366 and the corresponding geometric mean was 45. The prevalence of egg positive horses varied significantly over the year ($p = 0.034$). The highest prevalence (85.9%) was observed from July to September with corresponding arithmetic and geometric means for the EPG values of 554 and 87, respectively (Table 3). There were no significant differences in strongyle faecal egg counts between horse age, gender, breed and last drug administered. Nine egg types were identified directly or subsequently by larval cultures from the faeces of 384 horses (Table 4). Most preva-

Table 2. Number of horses with encapsulated cyathostome larvae in the caecum and proximal 50 cm of the colon according to season and horse age.

Score	None no. (%)	Few no. (%)	Moderate no. (%)	Numerous no. (%)
Quarter of the year				
4/92	105 (35.6)	15 (19.7)	13 (24.5)	7 (20.6)
1/93	61 (20.7)	24 (31.6)	13 (24.5)	10 (29.4)
2/93	69 (23.4)	19 (25.0)	19 (35.9)	13 (38.2)
3/93	60 (20.3)	18 (23.7)	8 (15.1)	4 (11.8)
All quarters	295 (64.4)	76 (16.6)	53 (11.6)	34 (7.4)
				p = 0.0382
Age				
1-5 years	31 (46.3)	6 (9.0)	13 (19.4)	17 (25.4)
6-15 years	132 (67.3)	35 ((17.9)	19 (9.7)	10 (5.1)
>15 years	112 (68.3)	32 (19.5)	16 (9.8)	4 (2.4)
				p = 0.0001

Table 3. Prevalence and abundance of strongyle eggs (EPG) in faeces of Swedish horses according to season.

	Prevalence (%)	Arithmetic mean (EPG)	Geometric mean (EPG)	Maximum (EPG)
Quarter of the year				
4/92 (132)	81.1	289	48	2600
1/93 (99)	68.7	314	31	2000
2/93 (103)	78.6	373	37	5500
3/93 (78)	85.9	554	87	5500
All quarters (412)	78.4	366	45	5500
	p = 0.0342	NS		

Table 4. Prevalence of different nematodes in the faeces of Swedish horses.

Species	No. examined	No. infected	Prevalence (%)
Cyathostomum, sensu lato	384	300	78.1
Strongylus vulgaris	384	14	3.6
Strongylus edentatus	384	3	0.8
Strongyloides westeri	412	1	0.2
Triodontophorus sp.	384	25	6.5
Trichostrongylus axei	384	5	1.3
Parascascaris equorum	412	8	1.9
*Other species**	384	5	1.3

* *Gyalocephalus* sp., *Oesophagodontus* sp., *Poteriostomum* sp.

lent were eggs of the cyathostomes (*i.e. Cyathostomum, sensu lato*) that were found in 78.1% of the cultured faecal samples. The prevalences of other eggs, i.e. *Gyalocephalus* sp., *Oesophagodontus* sp., *Poteriostomum* sp., *Strongylus vulgaris, S. edentatus, Tridontophorus* sp. and *Trichostrongylus axei,* were low and ranged from 0.8% and 6.5%. Eggs of *S. vulgaris* were recovered from 3.6% of the horses and the proportional abundance of larvae in *S. vulgaris* positive cultures ranged from 2% and 40%. Eggs of *Parascaris equorum* were demonstrated only in 8 (1.9%) of the horses. All except 2 of the infected horses were 2 years old or less and of the horses in this category 24% were infected. The *P. equorum* EPG counts were generally low (≤50 EPG) although as many as 3000 EPG was recorded in a yearling. Eggs of *Strongyloides westeri* were found in the faeces from only one yearling.

Lesions of the cranial mesenteric artery

Slight to severe pathological changes to the intima of the cranial mesenteric artery and its main branches were found in 165 (62.7%) of the 263 horses examined. Severe lesions were noted in 16 (6.1%) of the horses, but the 4th stage larva of *S. vulgaris* was recovered in only 6 (2.3%) of the horses. Three out of these 6 horses were yearlings and comprised 1 Standardbred, 1 pony and 1 cold-blood. The remaining 3 horses were all cold-bloods and between 16 and 20 years old. Like the cold-blooded yearling they were all left untreated during the last year. There were significantly ($p = 0.036$) more horses affected from April until September than in other quarters (Table 5). No specific examinations were done between October to December. Significant ($p = 0.0019$) differences were also noticed between the different age groups. Severe lesions were seen in 7.1% of horses >15 years whereas only in 4.9% of those ≤5 years old.

Discussion

In the present study statistical analyses were performed on infection levels of some internal parasites recovered from Swedish horses at slaughter. In addition, the abundance of eggs in appurtenant faecal samples was investigated. It was observed that 78.4% of the horses were shedding strongyle eggs and that 35.6% harboured macroscopically visible encapsulated cyathostomes. Moreover, 6.1% of the horses exhibited severe lesions of the cranial mesenteric artery suggestive to have been caused by *Strongylus vulgaris* activity. However, eggs and intravasal larvae of *S. vulgaris* were only recovered from 3.6% and 2.1% of the horses examined, respectively. *Gasterophilus intestinalis* was found in 9.9% of the horses while the spirurids *Habronema* sp. and *Thelazia lacrymalis* were found in less than 4% of the horses examined.

One explanation for the absence or possible underestimation of some helminth species in this study is that the examinations were limited to selected parts of the gastrointestinal tract. For example, eggs of *Parascaris equorum* were recovered from 8 horses whereas the adult stage was only found in a single horse. This discrepancy is certainly due to the fact that the small intestine except the posterior 0.5 m was not examined. Some parasites may also have been overlooked or missed because only cursory examinations were made. This will at least partly explain the recorded difference between the number of confirmed cases of *S. vulgaris* infection and the occurrence of horses with arterial lesions of presumed parasitic origin, as also observed in investigations in other countries (*Reinmeyer et al.* 1984, *Dunsmore et al.* 1985, *Lyons et al.* 1987). Another explanation could be that intravasal stages may have been lost following treatment whereas the damage inflicted to the vessels still remained. Although the current control of *S. vulgaris* in Sweden seems to

Table 5. Number of horses with lesions of the cranial mesenteric artery according to season and horse age.

Score*	None[0] no. (%)	Insignificant[1] no. (%)	Slight[2] no. (%)	Severe[3] no. (%)
Quarter of the year				
4/92		No observations		
1/93	33 (51.6)	20 (31.3)	7 (10.9)	4 (6.3)
2/93	35 (31.5)	63 (56.8)	9 (8.1)	4 (3.6)
3/93	30 (34.1)	44 (50.0)	6 (6.8)	8 (9.1)
All quarters	98 (37.3)	127 (48.3)	22 (8.4)	16 (6.1)
				p = 0.0360
Age				
1-5 years	25 (61.0)	11 (26.8)	3 (7.3)	2 (4.9)
6-15 years	40 (35.4)	63 (55.8)	5 (4.4)	5 (4.4)
>15 years	27 (27.3)	51 (51.5)	14 (14.1)	7 (7.1)
				p = 0.0019

* score 0 = no lesions; 1 = insignificant thickening of the endothelial lining of the arterial wall; 2 = slight dilation of the artery and thickening of its wall; 3 = severe thickening of the arterial wall accompanied by endothelial thrombotic debris.

be satisfactory, the infection obviously still exists in some horse enterprises.

It is evident that the parasites and their lesions recorded in this study were not equally distributed within the horse population. For example, the prevalence of encapsulated cyathostomes, *G. intestinalis* and arteritic lesions were highly influenced by horse age, the time of the year the horses were slaughtered, and/or previous treatment routines. Consequently, the influence of both host-related and other factors such as the date of slaughter and management practices has to be considered when the present results are compared with those of similar surveys performed elsewhere. Still, the infection levels recorded were in general lower in comparision with those found in other surveys. For instance, in this study, 9.9% of the horses and 12.3% when the data for July to September were excluded, were infected with bots of *G. intestinalis,* whereas some previous European studies showed infection levels of 53% for horses in northern England and Wales (*Edwards* 1982), 43% in Germany (*Bauer* 1986), 33% in Normandy in France (*Bernard et al.* 1994) , 43% in Ireland (*Sweeney* 1990) and 94% in Italy (*Princato* 1989).

It is probable that the comparatively scarce occurrence of *G. intestinalis* in Sweden is a reflection of the rational usage of potent insecticidal drugs during autumn, although an influence of possibly unfavourable climatic conditions for parasite survival and transmission must also be taken into consideration. This suggestion is supported by the observed difference between applied treatment routines. Of the horses included in this study 91.8% had been treated at some time over the last year before slaughter, and within this group 83.4% were medicated with ivermectin which exhibits a nearly 100% efficacy against 1st, 2nd and 3rd stage *Gasterophilus* instars (*Campbell et al.* 1989). The time elapsed from treatment to slaughter most probably explains why a few of the ivermectin treated horses harboured a few bots. A peak prevalence and intensity was found in the 4th

quarter of the year and bots were absent between early June and late September. This is slightly different from what was observed in England and Italy where *Gasterophilus* was absent only during August (*Edwards* 1982, *Princato* 1989). Evidently, climatic factors influence the appearance of this parasite in the horse. The reason why standardbreds were less infected with bots than other breeds was most probably a result of the more intense management of trotters as compared to other types of horses. In contrast to the findings of *Edwards* (1982) infection levels in the present study were the same irrespective of age of the horse. The routine application of an insecticidal drug following the grazing season, which is commonly practised in Sweden, seems to be effective.

Although all of the colon was not examined, the cyathostomes were the most prevalent parasites recorded in this study. There were significantly more encapsulated cyathostome larvae in younger horses than in older ones and in the 1st and 2nd than in the 3rd and 4th quarter of the year. These results thus provide support for the current opinion that outbreaks of larval cyathostomosis are most likely to occur during the first half of the year in young horses (*Uhlinger* 1991). Inhibited or encapsulated larvae are insusceptible to the anthelmintics on the Swedish market at standard dose rates (Anon. 1995). Until compounds with very high larvicidal activity are available, the parasite control has to rely upon strategies designed to minimise the faecal egg output and thereby the number of infective larvae in the grazing environment. To make future epidemiological and clinical studies more informative, it is particularly important to identify the different species of Cyathostominae involved in clinical disease in Sweden.

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Sammanfattning

Förekomst av Gasterophilus intestinalis samt vissa nematoder hos svenska hästar.

Förekomst och intensitet av styngflugelarver (*Gasterophilus intestinalis*), samt förekomst av vissa nematoder hos hästar i åldrarna 1-30 år undersökta vid slakteriet i Linköping redovisas. Undersökningen som var begränsad till att omfatta makroskopiskt synliga parasiter och parasitära skador i magsäcken (n = 456), distala ileum, caecum och 0.5 m av proximala colon (n = 461), ögats konjuktivalsäck och tårkanal (n = 196), och krösroten (n = 263) pågick under tiden oktober 1992–september 1993. Hos de slaktade hästarna påträffades larver av *Gasterophilus intestinalis* (9,9%) och *Habronema muscae* (1,1%) i magsäcken medan inkapslade larver av små strongylida maskar (35,6%) och vuxna strongylida maskar (17,4%) noterades i grovtarmen. *Thelazia lacrymalis* påträffades i ögonhålan hos 6 (3,1%) av hästarna. Omfattande krösrotförändringar observerades hos 16 (6,1%) hästar medan intravasala larver av *Strongylus vulgaris* däremot endast återfanns hos 6 (2,3%) av de undersökta hästarna. Hos merparten av de slaktade hästarna genomfördes även kvantitativ och kvalitativ träckprovsundersökning avseende nematodägg. I den kvantitativa delen av undersökningen, som baserades på träckprover från 412 hästar, påträffades ägg av strongylider (78,1%), *Parascaris equorum* (1,9%) och *Strongyloides westeri* (0,2%). Efter kvantitativ undersökning inkuberades 384 träckprover för att möjliggöra artbestämning av tredje stadiets larver. Följande arter identifierades: gruppen *Cyathostomum, sensu lato* (78,1%), *Triodontophorus* spp. (6,5%), *Strongylus vulgaris* (3,6%), *Trichostrongylus axei* (1,3%), medan *Gyalocephalus* sp., *Oesophagodontus* sp., *Poteriostomum* sp. och *Strongylus edentatus* utgjorde var och en mindre än 0,5%. Det visade sig att *Gasterophilus intestinalis* och *Strongylus vulgaris* numera är förhållandevis ovanliga parasiter hos svenska hästar sannolikt till följd av framgångsrika behandlingsprogram. Angrepp av små strongylida maskar utgör däremot fortfarande ett påtagligt problem.

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