LONG-TERM INFLUENCE OF LATE-WINTER USE OF IVERMECTIN ON THE NEMATODE OF SUBFAMILY CYATHOSTOMINAE

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Trials were conducted in the Czech Republic on 2 farms to determine the efficacy of the late-winter treatment with ivermectin against naturally acquired cyathostomes of horses. The group of 10 animals on each farm was treated with 0.2 $mg.kg^{-1}$ ivermectin in January (farm 1) or in February (farm 2). The intensity of faecal eggs output as well as cyathostome larval yield recovered from the litter of the stables were determined in the horses at monthly intervals. On the farm 1 the faecal egg output of the strongyles was completely suppressed during the first 3 months, in April and in May strongyle eggs were detected only in one horse. In the remaining year EPG has ranged from 1.8 to 23.5. Twenty animals on farm 2 were divided into 2 groups (ivermectin treatment, mebendazole treatment). The ivermectin treatment resulted in even more pronounced reduction in faecal egg output, the litter larval counts were considerably lower than in the mebendazole group. There was a statistically significant reduction in EPG as well as in litter larval counts of ivermectin treated horses compared with the other group ($P < 0.05$).

control of horse strongyles; ivermectin; Cyathostominae

INTRODUCTION

Cyathostomes have become the principal worm problem of horses (Duncan, 1985; Herd, 1986; Klei, 1996; Klei, French, 1998; Abbot, 1998; Lyons et al., 1999; Reinemeyer, 1999; Kaplan, Little, 2000). The control of these parasites is an important prerequisite for the breeding, rearing and maintenance of healthy stock. At the present time, this is often achieved by the use of a number of efficient modern anthelmintics under a variety of dosing regimes. Information on various aspects of the epidemiology of naturally-occurring cyathostome infection in the Czech Republic on which these control measures might be based is, however, lacking. Over the past several years various equine parasite control schemes had been proposed. However, many dewormers are only effective against adult cyathostomes and thereafter the effective control is achieved by the regular use of anthelmintics.

The spring/summer treatment strategy of Herd et al. (1986) was designed to prevent drug-related problems by giving a small number of strategic treatments to eliminate the spring/summer rise in faecal egg output in adult horses in northern latitudes. This approach has been used successfully for 10 years with adult horses under intensive grazing conditions. However, the frequent treatment, the likely it is that anthelmintic resistance will develop. A strong correlation has been reported between the frequency of the treatment of horses with benzimidazole drugs and the occurrence of resistance (Kelly et al., 1981). On the other hand, if the treatments are too widely or untimely spaced, pasture and stable contamination will not be controlled.

The purpose of this article is to propose an optimal time of late-winter treatment based upon current knowledge of the etiology and life cycles of the parasites. This experiment was designed to provide information on the following: first, to establish precise timing for larvicidal treatments of horses for the Czech Republic, secondly, to determine the duration of the faecal egg suppression treatment with ivermectin administered in January or February.

MATERIALS AND METHODS

Trials were conducted in the Czech Republic on 2 farms. The group of 10 animals on each farm was treated with 0.2 $mg.kg^{-1}$ ivermectin (Equalan paste, MSD, Agvet) on January 3 (farm 1) or on February 5 (farm 2). On the farm 1, the herd under investigation consisted of 10 Thoroughbred horses, pregnant or not pregnant mares. On farm 2, group of 20 adult cold-blooded horses, consisting of cycling or early pregnancy mares, was randomly assigned to either a ivermectin treated or mebendazole (8.8 $mg.kg^{-1}$ b.w., Telmin^{R} vet., Janssen Pharm.) treated subgroups.

The horses on both farms were run together daily in a corral or pastures for some hours and housed during the night. On pastures they stayed usually between 8–15 h.

The intensity of faecal egg output as well as strongyle larval yield recovered from the litter of the stables were determined in the horses in monthly intervals. Monthly faecal analyses for 1 year included a quantitative nematode egg count per gram of faeces (EPG) for each horse, according to McMaster's method. Larval cultures were carried out to differentiate the cythostome third-

stage larvae (L_3) from those of *Strongylus* and the identification of these larvae was based on morfological descriptions.

The litter samples consisted approximately of 500 g of the litter collected by hand from 5 places in every box stall. The larvae were isolated by means of a modified Baerman technique. Larval counts were expressed in the terms of L_3 per kilogram of matter for every box stall (LPKG). On the farm 2, the horses were transferred to another farms and so the litter samples from the stables were collected only up to August.

Statistical analyses were carried out using SAS (SAS Institute, 1989). The total mean EPG as well as strongyle larval yield recovered from the litter of the stables for subgroups within each group for 12 months, and subgroups for each month, were computed. The level of significance was set at $P < 0.05$.

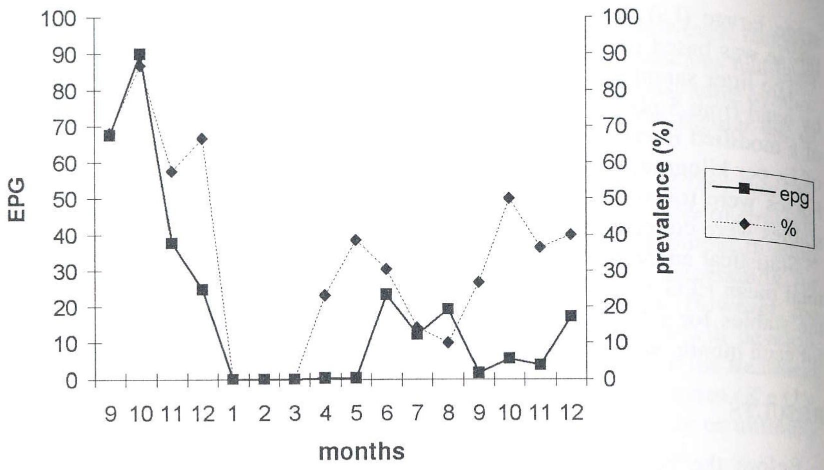
RESULTS

Before the beginning of the present trial, monthly faecal analyses for 4 months included a quantitative nematode egg counts and the larval cultures were determined in the horses of both farms. On farm 1 the infections observed coproscopically were due Cyathostominae, Strongylinae (*Strongylus edentatus*), *Parascaris equorum*, *Strongyloides westeri* and *Habronema* spp. The Cyathostominae demonstrated high prevalences (57.5–86.84%).

The composition of nematode parasite eggs recovered from the faeces of the horses of the farm 1 as well as the composition of infective larvae from litter of the stables are summarised in Table I. The faecal egg counts of the treated animals remained negative 3 months, evidence of patent infection occurred 4 months after treatment. On the farm 1 the faecal egg output of the strongyles was completely suppressed during the first 3 months, in April and in May strongyle eggs were detected only in one horse. In the remaining year EPG has ranged from 1.8 to 23.5. In the next months a constant low level of

I. Mean monthly strongyle faecal egg counts (EPG) and mean monthly litter larval counts (LPKG) for ivermectin treated horses of farm 1

	7.1.	10.2.	20.3.	14.4.	21.5.	19.6.	14.9.	17.10.	21.11.	12.12.
EPG	0	0	0	0.4	0.4	23.5	1.8	5.6	3.9	17.2
SD	0	0	0	1.1	6.1	46.0	1.8	6.1	5.3	27.4
Min–max	0	0	0	0–3.5	0–17.5	0–70	0–3.5	0–17.5	0–17.5	0–77
LPKG	978.1	300.0	7.1	194.6	381.1	54.0	71.3	519.9	1430.6	777.8
SD	2210.0	787.4	25.8	905.2	793.6	108.0	196.6	965.1	2768.9	1751.2
Min–max	0–8333	0–3000	0–100	0–750	0–2300	0–270	0–800	0–3000	0–8650	0–5700



1. The monthly prevalence of equine strongyles and intensity of faecal egg output on the ivermectin treated horses from September 1995 to December 1996

infection was observed (Table I, Fig. 1). The litter larval counts of the horses dropped to 7.1 ± 25.8 LPKG at the beginning of March, however, this rose sharply in November (1430.6 ± 2768.9).

On the farm 2, the parasites present were Cyathostominae, Strongylinae (*Triodontophorus* spp., *Strongylus vulgaris, Strongylus equinus, Strongylus edentatus*), *Parascaris equorum, Strongyloides westeri, Habronema* spp. The mean number of eggs per gram of faeces is shown in Tables II and III. The mean EPG for ivermectin treated subgroup varied from 1.3 ± 2.4 to 46.2 ± 63.4 and in mebendazole treated subgroup it rose from 4.9 ± 2.8 in the spring to a high of 191.3 ± 229.7 in October.

The mean litter larval counts for the horses of farm 2 are presented in Tables II and III. The mean LPKG and the number of box stalls with such larvae gradually increased and the mean LPKG was highest in July when it was 944.4 ± 1753.8. The mean EPG of the ivermectin treated animals as well as LPKG of the litter of their stables were significantly less than that of the mebendazole treated animals ($P < 0.05$).

DISCUSSION

Trials were conducted in the Czech Republic on 2 farms to determine the efficacy of the late-winter or early-spring treatment with ivermectin against

II. Mean monthly strongyle faecal egg counts (EPG) and mean monthly litter larval counts (LPKG) for ivermectin treated horses of farm 2

	20.1.	26.2.	27.3.	20.4.	21.5.	19.6.	20.9.	22.10.	19.11.	18.12.
EPG	164.9	2.6	1.7	1.3	2.6	44.2	36.8	46.2	44.1	32.2
SD	79.8	3.8	2.5	2.4	5.7	76.3	36.8	63.4	60.3	37.1
Min–max	7–206.5	0–10.5	0–7	0–7	0–17.5	0–224	0–73.5	0–168	0–161	0–98
LPKG	333.8	11.4	89.3	466.7	17.9	56.0	–	–	–	–
SD	752.9	30.1	126.8	1043.5	43.7	97.0	–	–	–	–
Min–max	0–2300	0–91	0–286	0–2800	0–125	0–224	–	–	–	–

III. Mean monthly strongyle faecal egg counts (EPG) and mean monthly litter larval counts (LPKG) for mebendazole treated horses of farm 2

	20.1.	26.2.	27.3.	20.4.	21.5.	19.6.	20.9.	22.10.	19.11.	18.12.
EPG	55.5	7.0	4.9	4.3	30.2	18.1	108.5	191.3	167.4	132.9
SD	61.5	3.3	2.8	1.5	52.9	13.6	93.8	229.7	173.9	89.2
Min–max	7–189	0–10.5	0–10.5	0–7	0–168	0–45.5	0–262.5	28–675	24.5–528	45.5–315
LPKG	260.9	38.5	941.9	111.6	186.9	944.4	–	–	–	–
SD	543.7	41.9	2166.9	217.1	277.8	1753.8	–	–	–	–
Min–max	0–2000	0–91	0–8856	0–666	0–1000	0–4447	–	–	–	–

naturally acquired cyathostomes of horses. The aim of the present study was to compare the strongyle faecal egg counts and litter larval counts as indicators of the levels of nematode parasites in groups of the horses treated by different schemes.

January applications of ivermectin markedly reduced the EPG of horses. On farm 1 the horses were dosed with ivermectin on January 3, 1996, positive egg count was recorded on April 14, 1996. The low faecal egg counts were observed during the remaining experimental period, only a few horses passed more than 50 EPG. On the farm 2 the mean total EPG of the ivermectin treated horses (1.3 ± 2.4 – 46.2 ± 63.4) as well as litter larval counts (11.4 ± 30.1 – 466.7 ± 1043.5) were significantly less than that of the mebendazole treated animals (EPG: 4.9 ± 2.8 – 191.3 ± 229.7; LPKG: 38.5 ± 41.9 – 944 ± 1753.8) ($P < 0.05$).

In cool climates, most transmission begins in the spring and continues throughout the warm months of the year, with peak transmission in the summer and autumn. By late autumn, a large percentage of newly ingested infective larvae become hypobiotic, arresting their development in the colonic mucosa as third-stage larvae (Ogbourne, 1975; Eysker et al., 1984). Peaks in faecal egg counts occur in the spring, and again in late summer/or early autumn (Herd, 1986), however, these seasonal rises are derived largely from worms developing from previously ingested larvae rather than from newly ingested ones (Herd et al., 1985).

The best strategy for control is to minimize infection rates by reducing environmental contamination with eggs and the subsequent accumulation of infective larvae on pasture or stables. Information on the pre-parasitic development and seasonal fluctuations strongyle faecal egg counts in the Czech Republic was provided by Nápravník et al. (1988) and Langrová (1998) which found that the highest number of strongyle eggs was passed in the early spring (February, March). Anthelmintic treatment should be therefore in January or February, before secretion of the eggs has been reach out for the highest level and when the larvae are not in hypobiotic state. The principal goal was the prevention of environmental contamination with nematode eggs and the precise timing of the treatment is reason the long-termed faecal egg suppression, the low pasture and stable contamination with eggs and the subsequent accumulation of infective larvae there and consequently lower nematode burdens of animals.

Lately many authors consider the larvicidal treatment as the keystone of the optimal worm control program (Abbot, 1998; Paul, 1999; Kaplan, Little, 2000). All available anthelmintics have excellent efficacy against adult cyathostomes (if they have not developed resistance), however, most drugs do not kill the pathogenic mucosal larval stages. Only double dose of fenbendazole (10 mg/kg) for 5 consecutive days and single dose of moxidectin have label claims for efficacy against mucosal larvae. A double dose of oxibendazole (20 mg/kg) for 5 consecutive days has also been used successfully. Ivermectin has lower efficacy against mucosal larvae in hypobiotic stage, however, ivermectin was shown to be effective anthelmintic for the cyathostomes emerging from the gut wall in the late-winter (Drudge et al., 1984). Therefore the parasites can be controlled by strategically timed ivermectin treatment in the time, when the cyathostomes are in the preadult (not egg-laying) stage of development (in the Czech Republic in January and February).

Lately several studies have been reported in the literature on this matter. However, the proposed control programs usually include specific larvicidal treatment (double dose of fenbendazole for 5 consecutive days), intensive standard deworming schedule with (the best) moxidectin in suppressive intervals during the grazing season (Paul, 1999; Kaplan, Little, 2000)

or during autumn (Abbot, 1998). This control constitutes a considerable expenditure for the Czech owners and can be hardly accepted for conditions of the Czech Republic.

The main purpose of this investigation was to obtain information on the efficacy of the ivermectin administered in January or February. The proposed optimal worm control program for the horses of the Czech Republic is to administer a larvicidal ivermectin (moxidectin) treatment in January or February, the other treat at the end of grazing, with an arbitrary anthelmintic. The aim should be to prevent the disease by combination of the correct prophylactic use of anthelmintics together with the adoption of non-chemical methods of reducing pasture infectivity such as regular removal of faeces from pasture. Rotation of pastures also has been recommended as a means of prevention.

Maintaining that for all horses incurred a marked financial saving in antiparasiticide costs. The added advantages of such system is the reduced selection pressure for the development of chemotherapy resistance. Another significant finding of the present study was the prevalence of cyathostome L_3 and the absence of *Strongylus* L_3. This is in contrast to findings during 1989–1991 in the farm 1 where quantitative nematode recovery studies revealed the presence of *Strongylus edentatus* in 1.88% of a group of horses and *Strongylus vulgaris* and *S. equinus* in 3.54 and 0.05% of the horses, respectively (Langrová, 1998). The absence of *Strongylus* larvae at present may be attributed to the regular use of effective antiparasitic products in the farm.

Few studies exist on the epidemiology or the effect of management schemes, or control of nematode parasites in horses in the Czech Republic. The studies are needed on the basic epidemiology of horse helminths and the extent of anthelmintic resistance in the Czech Republic, so that guidelines for the treatment of horses maintained under various management schemes may be refined. Such information could be useful for effective parasite control in horses

The proposal treatments based upon the larvicidal treatment in late winter could lead to all animals being treated less frequently. This technique could save the owners financial cost and reduce the frequency of drug usage.

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Dlouhodobý účinek odčervení koní ivermektinem v pozdně zimním období na hlístice podčeledi Cyathostominae.

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Účinek strategického odčervení koní ivermektinem v zimním až časně jarním období byl v období 1996–1997 testován v chovu anglického plnokrevníka a v chovu lánského norika. V každém chovu byla ivermektinem (0,2 mg.kg^{-1}) odčervena vždy skupina 10 koní – v lednu v chovu anglického plnokrevníka, počátkem února v chovu lánského norika. U těchto koní bylo v měsíčních intervalech sledováno EPG a kontaminace jejich podestýlek. V chovu anglického plnokrevníka bylo EPG odčervených koní nulové až do března, v dubnu a v květnu byly hodnoty EPG minimální (0,4) a po zbytek roku se průměrné hodnoty EPG pohybovaly od 1,8 do 23,5. V chovu lánského norika bylo kromě koní odčervených ivermektinem dalších deset koní odčerveno mebendazolem. Průměrné EPG stejně jako množství infekčních larev strongylidů v podestýlce bylo u koní odčervených ivermektinem významně nižší než u koní odčervených mebendazolem ($P < 0,05$).

systém prevence strongylidů koní; ivermektin; Cyathostominae

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