BÚVÍSINDI
ICEL. AGR. SCI. *11, 1997:* 131–139

Field efficacy of ivermectin (Ivomec®) injection on faecal strongyle egg output of Icelandic horses

Carl Oskar Paulrud

Rikke Engelbrecht Pedersen

Royal Veterinary and Agricultural University, Bülowsvej 13, DK-1870 Frederiksberg C, Copenhagen, Denmark

and

Matthías Eydal

Institute for Experimental Pathology, University of Iceland, Keldur, IS-112 Reykjavík, Iceland

SUMMARY

The main objective of this study was to evaluate the level and duration of suppression of faecal worm egg output and the effect on worm genera/species composition by a single ivermectin (Ivomec® (MSD)) injection in horses in Iceland.

A field study was carried out in Borgarfjörður, W-Iceland in 1995.

Thirty unbroken adult horses naturally infected with gastrointestinal nematodes were included in the study. The horses had not been treated with anthelmintics in the 6–24 months preceding the study. The animals were divided into six groups of five horses grazing from July to September in six experimental paddocks with varying stocking rates and grazing conditions. The horses were injected with the anthelmintic (Ivomec®) 9–10 days after entering the paddocks.

Faecal samples were collected from all horses once before treatment and on six occasions after treatment. Strongyle worm EPG (eggs per g faeces) counts were high before treatment. One week after treatment 98.9% reduction in egg output was observed. More than half of the samples had positive EPG counts after 7–8 weeks. Eggs found either first after treatment or reappearing a few weeks after treatment indicated that the injection neither completely eliminated the adult strongyles nor completely controlled the larval stages, at least of small strongyles.

In order to distinguish between the eggs of strongyle species/genera, third stage larval (L3) cultures were prepared from all the faecal samples before and 10–11 weeks after treatment. A variety of strongyle species was found before treatment but only small strongyles were found after treatment, *Cyathostomum, sensu latu* accounting for 99.9% of L3 found, with a prevalence of 97% in the faecal samples.

In order to determine pasture contamination, pasture larval counts were carried out on grass samples taken from July until October. No infective larvae (L3) were recovered from the paddocks until August and the density onwards varied greatly depending on both stocking rates and grazing conditions.

The study indicates that ivermectin injection (Ivomec®) produces a lower suppression on faecal strongyle egg output than treatment with oral ivermectin paste, as shown in previous studies in Iceland and abroad.

Key words: EPG, horse, Iceland, ivermectin, strongyles.

YFIRLIT

Áhrif ivermectin-inngjafar (Ivomec® stungulyf) á ormasýkingar í hrossum

Meginmarkmið verkefnisins var að athuga áhrif einnar inngjafar með ormalyfinu ivermectin (Ivomec® stungulyf) á ormaeggjafjölda í hrossataði.

Í rannsókninni voru 30 fullorðin hross sem voru í beitarhólfum, með mismunandi gróðurlendi og beitarálagi, á tveim stöðum í Borgarfirði sumarið 1995. Saursýni voru tekin einu sinni fyrir lyfjagjöf og í sex skipti eftir lyfjagjöf. Hrossin voru meðhöndluð með lyfinu (Ivomec®) 9–10 dögum eftir að þau voru sett á beitarhólfin. Fylgst var með áhrifum ormalyfsgjafarinnar á fjölda ormaeggja í hrossataðinu og tegundasamsetningu þeirra.

Fyrir lyfjagjöf fundust dreyraormaegg (Strongylidae) í saur allra hrossanna og var meðalfjöldi þeirra mikill, eða 2322 egg í grammi saurs (ígs). Margar tegundir stórra og lítilla dreyraorma fundust en mest var af eggjum lítilla dreyraorma, einkum *Cyathostomum, sensu lato* tegunda. Viku eftir lyfjagjöf var meðalfjöldi 25 ormaegg ígs, sem svaraði til 98,9% lækkunar í ormaeggjafjölda. Að tæpum átta vikum liðnum voru aftur komin ormaegg í 63% saursýnanna. Eftir lyfjagjöf fækkaði tegundum mikið í taði. Að tæpum 11 vikum liðnum fundust eingöngu litlir dreyraormar, hlutdeild *Cyathostomum, sensu lato* tegunda var 99,9% og þær fundust í 97% sýnanna. Þessar niðurstöður benda til að lyfið hafi ekki hreinsað út alla fullorðna orma úr meltingarvegi hrossanna. Ormaegg sem komu á ný fram í mörgum sýnum aðeins fáeinum vikum eftir lyfjagjöf bentu ennfremur til þess að lyfið hefði ekki verkað á allar ormalirfur í hrossunum, og sumar þeirra því náð fullum þroska.

Einnig var fylgst með ormasmiti á beitilandi. Tekin voru grassýni af beitarhólfunum til að ákvarða fjölda smithæfra ormalirfa í þeim. Ekkert ormasmit fannst á beitilandi í byrjun beitartímabilsins. Ormasmit var talsvert mikið í ágúst og fram í október, en mjög breytilegt eftir gróðurlendi og beitarþunga.

Í fyrri athugunum hér á landi á áhrifum ormalyfjagjafa í hross hafa engin ormaegg fundist í saur fyrstu vikur eftir meðhöndlun (100% lækkun). Í athugunum hér á landi og erlendis á virkni ivermectin þykknis (sem gefið er í munn) komu ormaegg ekki fram í saur fyrr en allt að 10–12 vikum eftir inngjöf. Niðurstöðurnar benda því til að ivermectin gefið hrossum á formi ivermectin stungulyfs (Ivomec®) dragi ekki alveg eins mikið úr ormaeggjamagni í taði borið saman við inngjöf með ivermectin þykkni í munn.

INTRODUCTION

The control of parasite infections in the horse is an important prerequisite for the breeding, rearing and maintenance of a healthy stock. For the best result all horses should be included in a regular parasite control programme including adequate anthelmintics. In Iceland most farmers treat their riding and breeding horses once to three times a year, but many unbroken horses are not treated at all (Eydal and Gunnarsson, 1994).

Several earlier studies concerning the effect of anthelmintics on parasites in horses in Iceland have been made, including the effect of ivermectin paste (Eqvalan®) (Gestsson and Eydal, 1994). Ivermectin is a widely used drug, being predominant in veterinary medicine to control gastrointestinal nematodes (Gutteridge, 1993). All reports on its efficacy in horses seem to be confined to ivermectin in paste formulation, administered orally. Even though ivermectin (Ivomec®) is registered specifically for use on ruminants and pigs (Heilbrigðis- og tryggingamálaráðuneytið, 1996) ivermectin (Ivomec®) injection is however quite often used on horses in Iceland.

The main objective of this study was to evaluate the level and duration of suppression of faecal egg output by a single ivermectin (Ivomec® (MSD)) injection in mature horses in Iceland (Paulrud and Pedersen, 1995).

MATERIALS AND METHODS

Experimental design

Thirty horses with a different background of anthelmintic treatment, ranging in age from four to twenty years (mean 8 years) were obtained from five different farms in Borgarfjörður, W-Iceland. The horses had not been treated with anthelmintics for at least 6–24 months prior to the start of this study (see Table 1). The horses were divided into six groups of five horses and kept in separate experimental paddocks from the 3rd or 4th of

July to the 25th or 26th of September 1995. Three of the groups were kept on drained fen land at the farm Hestur, Andakílshreppur, while the remaining three groups were kept on old cultivated land at Litla-Drageyri in Skorradalur. Each of the two areas was divided into three different sized paddocks, one of 3.8 hectares, another of 5.0 ha, and the third of 7.1 ha which gives a stocking rate of 1.32, 1.0 and 0.71 per hectare respectively. The groups were almost identical with respect to sex, age, weight and anthelmintic treatment background. All males were geldings and none of the females were pregnant. At the beginning of the experimental period all groups were allowed to contaminate their respective paddocks (with strongyle eggs/larvae). Nine to ten days after entering the paddocks all horses were injected with the anthelmintic ivermectin (Ivomec® (MSD)), at the manufacturer's recommended dose per kg body weight. All paddocks had been grazed by horses in preceding years with the same stocking rates.

Egg counts

Samples were collected from freshly voided faeces from all horses once before ivermectin injection and on six occasions after treatment (see Table 1). Faecal egg counts were carried out using a modified McMaster technique (Helle, 1971) which enables a minimum of 50 helminth eggs per g faeces (EPG) to be detected. A commercial flotation solution was used, Parasitosol (Meku®), density = 1.27 g/ml. No attempt was made to differentiate between eggs of different Strongylidae (strongyle) worm species. Calculations on the percentage reduction in egg output were based on arithmetic means and according to the formula:

$$\% \text{ reduction} = 100 - (\text{mean EPG after treatment} / \text{mean EPG before treatment}) \times 100$$

Larval cultures

In order to distinguish between different strongyle egg species/genera third stage larval (L3) cultures were set up from all the faecal samples collected before and 74–75 days after treatment. When sufficient numbers of larvae were present, one hundred infective third stage larvae (L3) recovered from each sample were examined microscopically for differentiation. For descriptions of procedures regarding culture, recovery and differentiation of L3's see Eydal (1983), Eydal and Gunnarsson (1994) and Henriksen (1965).

Pasture larval counts

Pasture larval counts were carried out on herbage samples collected from July 12th to October 17th taken at four sampling dates at Hestur and six at Litla-Drageyri (Table 4). A simplified Baermann apparatus was used for the recovery of infective third stage (L3) nematode larvae. The apparatus used for the study (Paulrud and Pedersen, 1995) was modified according to Prekehr and Conrad (1973), Persson (1974) and Henriksen (1982). A plastic funnel (∅ 20 cm with a 3 cm brim) was mounted on the top of a plastic tube (sealed with a Para-film), about 15 cm in length (∅ 3 cm) and with a conic tip. This funnel was filled with water (35–40°C) and 1–3 drops of detergent were added to the water.

The herbage samples (250 g) were taken from each of the six paddocks by walking from one corner to another in a W-shape course. At every tenth step, a small grass sample was cut to the soil by a pair of scissors. The entire sample was put into a double layer of gauze bandage and placed in the funnel together with a glass weight to keep the sample soaked in the water-detergent solution. The sample was kept inside the funnel for 20–24 hours at room temperature after which it was removed and all water-detergent solution, except 10 ml in the plastic tube, removed. The 10 ml, containing larvae (L3) in the sediment, were equal to a total of 336 drops. Eight homogenous drops (2×4) out of every single sample were

Table 1. Strongyle faecal egg counts (EPG) and the effect of ivermectin (Ivomec® (MSD)) injection.
1. tafla. Fjöldi dreyraormaeggja í grammi saurs og áhrif ivermectin (Ivomec® (MSD) stungulyf) inngjafar.

Hestur (H) Age *Aldur*	Sex[a] *Kyn*[a]	Origin[b] *Uppruni*[b]	Last treatment[c] *Síðasta lyfjagjöf*[c]	4 July Day 1	13 July Day 10	20 July Day 17	9 Aug. Day 37	5 Sep. Day 64	15 Sep. Day 74	21 Sep. Day 80	26 Sep. Day 85
7.1 ha paddock—*7,1 ha beitarhólf*											
14	M	1	>24	4000	Ivomec	0	0	150	50	50	0
8	F	4	12	100	injec-	0	0	50	0	50	0
6	M	1	12	4900	tion	0	0	50	0	0	50
4	M	1	24	4400		0	0	100	100	100	0
4	F	3	9	2350		0	0	0	0	0	0
5.0 ha paddock—*5,0 ha beitarhólf*											
12	M	3	9	1450	*Ivomec*	0	0	0	50	100	0
10	F	4	12	1000	*ormalyf*	100	50	50	0	50	0
4	F	3	9	1750	*gefið*	0	50	200	200	350	100
4	M	3	9	1900		0	100	50	0	0	50
5	M	4	12	2200		0	0	0	0	0	0
3.8 ha paddock—*3,8 ha beitarhólf*											
20	M	3	9	3500		0	150	250	100	200	200
7	F	5	6	250		0	0	0	100	0	50
7	M	2	>24	1000		0	0	350	300	100	200
4	M	3	9	300		300	400	1000	1050	1100	800
4	M	2	24	1450		0	50	50	0	0	0
Litla-Drageyri (L) Age *Aldur*	Sex[a] *Kyn*[a]	Origin[b] *Uppruni*[b]	Last treatment[c] *Síðasta lyfjagjöf*[c]	3 July Day 1	13 July Day 11	20 July Day 18	9 Aug. Day 38	4 Sep. Day 64	14 Sep. Day 74	21 Sep. Day 81	25 Sep. Day 85
7.1 ha paddock—*7,1 ha beitarhólf*											
14	F	1	12	1850	Ivomec	100	50	0	150	0	100
10	M	4	12	1400	injec-	0	100	0	0	0	0
5	M	1	24	1100	tion	0	0	0	0	0	0
4	F	3	9	3350		50	50	150	150	200	200
4	M	3	9	2450		100	0	100	100	0	50
5.0 ha paddock—*5,0 ha beitarhólf*											
18	M	2	12	5350	*Ivomec*	0	0	0	100	100	0
8	F	4	12	1100	*ormalyf*	50	100	50	0	250	0
6	M	4	12	1900	*gefið*	0	0	0	0	50	50
4	M	3	9	5450		0	0	0	0	0	50
4	M	2	24	2750		0	0	50	50	50	100
3.8 ha paddock—*3,8 ha beitarhólf*											
17	M	1	12	1100		0	0	0	0	100	0
7	M	2	>24	2200		50	50	150	100	50	0
4	F	3	9	5150		0	0	50	0	0	50
4	F	2	24	2050		0	100	150	200	100	200
4	M	3	9	2000		0	50	50	50	100	50
Mean (H+L)—*Meðaltal (H+L)*											
8			≥14	2322		25	43	102	95	103	77

a) M=Male—*Geldingur*, F=Female—*Hryssa*.
b) Different numbers, 1–5, represent different farms—*Bæir 1–5*.
c) Months from last anthelmintic treatment—*Mánuðir frá síðustu ormalyfsgjöf*.

Table 2. The suppression effect of ivermectin (Ivomec® (MSD)) on mean faecal egg output; n=30 (n=29[a)]).

2. tafla. Áhrif ivermectin (Ivomec® (MSD) stungulyf) meðhöndlunar til minnkunar á ormaeggjamagni í saur, n=30 (n=29[a)]).

	Mean EPG *Meðalormaeggja fjöldi ígs*	No. of positive EPG counts *Fjöldi „jákvæðra" saursýna*	% reduction *% minnkun*
Before treatment—*Fyrir lyfjagjöf*	2322 (2391)	30	
7 days after treatment—*7 dögum eftir lyfjagjöf*	25 (16)	7	98.9 (99.3)
27 days after treatment—*27 dögum eftir lyfjagjöf*	43 (31)	13	98.1 (98.7)
53–54 days after treatment—*53–54 dögum eftir lyfjagjöf*	102 (71)	19	95.6 (97.0)
63–64 days after treatment—*63–64 dögum eftir lyfjagjöf*	95 (62)	16	95.9 (97.4)
70 days after treatment—*70 dögum eftir lyfjagjöf*	103 (69)	18	95.6 (97.1)
74–75 days after treatment—*74–75 dögum eftir lyfjagjöf*	77 (52)	16	96.7 (97.8)

a) Figures in parenthesis: Excluding the horse that did apparently not receive the injection—*Tölur í svigum: Eitt hross, þar sem meðhöndlun með lyfinu virtist hafa misfarist, ekki tekið með í útreikningum.*

examined microscopically. The number of L3 found was multiplied by 42 (336/(2×4)=42) to get the number of larvae in the whole sample. The soaked herbage sample was then dried and weighed and the total number of L3 presented as larvae per kg of dry herbage.

RESULTS

Faecal egg counts

The EPG counts before and after Ivomec® (MSD) treatment are shown in Table 1. The suppression effect of Ivomec® on mean faecal egg output is expressed as % reduction after treatment in Table 2. One horse (at 3.8 ha paddock, Hestur) had the same EPG count before and after treatment (300 EPG) which indicates that it probably did not receive the injection properly. Strongyle eggs were found in all faecal samples before treatment with a mean count of 2322 EPG (range 100 to 5450 EPG). One week after treatment the mean strongyle egg count was 25 EPG, representing a 98.9% reduction, and 23% (7) of the horses had positive egg counts. Eight weeks (53–54 days) after treatment the reduction in EPG counts was 95.6% and as many as 63% (19) of the horses had positive EPG counts. At the end of the experimental period the mean count was 77 EPG representing a 96.7% reduction, and none of the counts, except the one mentioned above, exceeded the pre-treatment values. Only three out of 30 horses had negative (zero) EPG counts throughout the experimental period after treatment.

Larval cultures

The following genera/species of infective strongyle larvae (L3) were identified before treatment: *Cyathostomum, sensu lato* (100% prevalence), *Gyalocephalus capitatus* (19%), *Poteriostomum* spp. (27%), *Strongylus vulgaris* (54%), *Strongylus equinus* (31%), *Strongylus edentatus* (15%) and *Triodontophorus* spp. (19%).

Only the small strongyles *Cyathostomum, sensu lato* (97% prevalence) and *Poteriostomum* spp. (3%) were recovered 74–75 days after the anthelmintic treatment. Although L3 were recovered from 97% of the samples, less than 100 larvae were recovered from many of them, but they were all included in the calculations.

The total proportional abundance (in percentage) of the L3 genera/species is presented in Table 3.

Table 3. L3 species/genera recovered from faecal cultures before and after treatment and their proportional abundance (in percentage).
3. tafla. Þriðja stigs lirfur fundnar í saur eftir ræktun og hlutfallslegt magn þeirra (í %).

Before treatment—*Fyrir lyfjagjöf*
Family Strongylidae
Subfamily Cyathostominae[a)]
Cyathostomum, sensu lato (94.1%)
Gyalocephalus capitatus (0.4%)
Poteriostomum spp. (0.7%)
Subfamily Strongylinae[b)]
Strongylus vulgaris (1.8%)
Strongylus equinus (2.2%)
Strongylus edentatus (0.2%)
Triodontophorus spp. (0.6%)
74–75 d after treatment—*74–75 dögum eftir lyfjagjöf*
Family Strongylidae
Subfamily Cyathostominae[a)]
Cyathostomum, sensu lato (99.9%)
Poteriostomum spp. (0.1%)

a) Small strongyles—*Litlir dreyraormar.*
b) Large strongyles—*Stórir dreyraormar.*

Pasture larval counts

Results from pasture larval counts from different paddocks are shown in Table 4. The numbers of larvae recovered ranged from 0–10 578 L3/kg dried herbage. L3 were not recovered from any of the paddocks at the beginning of the grazing period (July 12th). Positive larval counts were recorded in samples from August onwards. During October the levels of infective larvae recovered from the paddocks at Litla-Drageyri fell to a low or even a zero value. The last positive larval count at Hestur was made at end of September (Table 4).

The results from Litla-Drageyri show the highest density of infective larvae on the paddock with the highest stocking rate (3.8 ha paddock) and the lowest density on the paddock with the lowest stocking rate (7.1 ha paddock). The results from Hestur show the opposite, the highest density of infective larvae on the paddock with the lowest stocking rate.

DISCUSSION

In general, pre-treatment faecal egg counts and composition and abundance of the recovered third stage larvae from faecal cultures are consistent with earlier studies made in Iceland (for review see Eydal and Gunnarsson, 1994).

In all previous studies in Iceland on the effect of different anthelmintic treatments, including the drug ivermectin in oral paste formulation (Eqvalan® paste), 100% reductions in strongyle egg output were obtained after treatment (for review see Gestsson and Eydal, 1994). After ivermectin (Eqvalan® paste) treatment strongyle eggs were first detected in faeces 10–12 weeks after treatment (Gestsson and Eydal, 1994). These results (100% reduction) are consistent with comparable studies with ivermectin paste in other countries (f.ex. Boersema *et al.*, 1996; Lumsden *et al.*, 1989; Parry *et al.*, 1993; Piché *et al.*, 1991; Yadav *et al.*, 1993). As mentioned in the introduction, no information is available on the effect of ivermecin given as hypodermic injection in horses. The results demonstrated in the present study showed less than 100% reduction in faecal egg output after ivermecin (Ivomec®) injection and eggs reappeared sooner than in the studies mentioned above. We have no single explanation for this "incomplete efficacy". One horse did, though, apparently not receive the injection properly.

Eggs found in the faecal samples either first after treatment or reappearing a few weeks after treatment indicated that the injection neither completely eliminated the adult strongyles nor controlled the larval stages of at least small strongyles. As a consequence, some strongyle eggs were deposited on the pastures during the whole study period, although the faecal strongyle egg output was considerably reduced compared to the high EPG level before treatment. Incomplete effectiveness of ivermectin paste against larval stages of small strongyles has been confirmed in other studies (Eysker *et al.*, 1992;

Table 4. Pasture larval counts from the experimental paddocks (L3/kg dried herbage).
4. tafla. Fjöldi smithæfra lirfa á beitarhólfum (þriðja stigs lirfur/kg þurrkaðs grassýnis).

Hestur				Date			
	12 July	13 July	31 Aug.	16 Sept.	25 Sept.	5 Oct.	17 Oct.
Paddock				Day no.			
Beitarhólf	9	10	59	75	84	94	106
7.1 ha	0	a)	762	1830	1049	b)	b)
5.0 ha	0	a)	624	504	832	b)	b)
3.8 ha	0	a)	641	163	387	b)	b)
Litla-Drageyri				Date			
	12 July	13 July	31 Aug.	18 Sept.	25 Sept.	5 Oct.	17 Oct.
Paddock				Day no.			
Beitarhólf	10	11	60	78	85	95	107
7.1 ha	0	a)	638	758	237	393	0
5.0 ha	0	a)	5400	2362	1068	1742	116
3.8 ha	0	a)	10578	3905	2967	3226	423

a) Anthelmintic treatment—*Ormalyfsgjöf.*
b) Due to lack of herbage no samples were taken—*Ekki náðist nægilegt grasmagn til rannsóknar.*

Love *et al.*, 1995). In faecal egg count reduction tests (FECRT), as commonly performed in other countries, 90% reduction or less is considered indicative of anthelmintic resistance of small strongyles to the drug given (Bauer *et al.*, 1986). However, it is well known that resistance to ivermectin has never been confirmed, resistance being confined to benzimidazole and probenzimidazole compounds (for review see Borgsteede *et al.*, 1997). In the present study the reduction was well over the 90% level.

The horses harboured a variety of strongyle species before treatment as shown by faecal cultures (Table 3). After treatment only small strongyles were found. Thus, the treatment completely suppressed the build up of pasture contamination of large strongyles, which is consistent with earlier studies in Iceland (Eydal, 1981, 1983; Gestsson and Eydal, 1994). The prevalence of *Cyathostomum, sensu lato* was 97% 74–75 days after treatment whereas only 53% of the same samples had positive EPG counts. This difference can be explained by the fact that much bigger samples are used for larval cultures than for egg counts, and thus lower parasite density can be detected. Recoveries from faecal cultures after treatment may further imply that Ivomec® (MSD) injection was only partially effective against larval stages of small strongyles.

The actual parasite community within the host can hardly be predicted from faecal egg counts and faecal cultures alone (Eydal and Gunnarsson, 1994). Ogbourne and Duncan (1977), among others, concluded that faecal egg counts and faecal cultures can provide an alternative to post-mortem examinations and give positive evidence for the presence of the mature worms. Faecal egg counts and faecal cultures can also be used as an indicator and a fairly rough assessment of the parasite burden, although seasonal variations, due to f.ex. hypobiosis and climatic factors, should always be taken into account (Poynter, 1954; Chiejina and Mason, 1977; Eydal, 1983; Jacobs, 1986). However, knowledge of the faecal egg output is a great advantage when planning anthelmintic treatment in order to reduce environmental contamination (Lumsden *et al.*, 1989; Piché *et al.*, 1991). The treatment intervals which are intended to keep pasture contamination as low as possible are determined by the length of time it takes for eggs to reappear in faeces after each treatment.

This is the first study on pasture larval contamination with emphasis on horse parasites performed in Iceland. The study may be of value to comparative parasite studies, especially in relation to epidemiological studies, in Iceland or abroad.

Probably most of the L3 found in the paddocks (Table 4) developed from the high output of strongyle eggs in the faeces of the horses during the short period (9–10 days) before the anthelmintic injection. However, some of the contamination certainly might have originated after treatment of the horses. Highest pasture larval counts were demonstrated in August and September. These results indicate that pasture larval contamination of horse strongyles reaches a peak in late summer in Iceland.

Compared to the old cultivated land (Litla-Drageyri) the drained fen land (Hestur) showed inverse correlation of pasture larval counts with stocking rate. The density of infective larvae was highest in paddock with the lowest stocking rate (Table 4). This unexpected result could be explained by unfavourable conditions for development or migration of strongyle larvae on the drained fen land, although it could to some extent be explained by different strongyle egg output on different paddocks at the beginning of the grazing period (Table 1). Intact horse faeces on pasture were rare on the drained fen paddock with the highest stocking rate. The grass, even close to scattered faeces, was grazed to the same extent as elsewhere. There were few or no signs of "roughs" (faecal-fouled areas) and "lawns" (grazable areas) as mentioned by Ödberg and Francis-Smith (1977). The surface of the land was characterised by large tufts that caused the faeces to slide downwards and be scattered even further by the horses. It then dried out or was stepped down into the soil.

The study indicates that ivermectin injection (Ivomec®) produces a lower suppression on faecal strongyle egg output than treatment with oral ivermectin paste, as shown in previous studies in Iceland and abroad.

It is therefore concluded, that for maximum efficacy, oral ivermectin paste should be recommended instead of ivermectin (Ivomec®) injection in horses.

REFERENCES

Bauer, C, J.C. **Merkt**, G. **Janke-Grimm** & H.-J. **Bürger**, 1986. Prevalence and control of benzimidazole-resistant small strongyles on German thoroughbred studs. *Veterinary Parasitology* **21**: 189–203.

Boersema, J.H, M. **Eysker**, J. **Maas** & W.M. **van der Aar**, 1996. Comparison of the reappearance of strongyle eggs in foals, yearlings, and adult horses after treatment with ivermectin or pyrantel. *Veterinary Quarterly* **18(1)**: 7–9.

Borgsteede, F.H.M., G.M. **Dvojnos** & V.A. **Kharchenko**, 1997. Benzimidazole resistance in cyathostomes in horses in the Ukraine. *Veterinary Parasitology* **68**: 113–117.

Chiejina, S.N. & J.A. **Mason**, 1977. Immature stages of *Trichonema* spp. as a cause of diarrhoea in adult horses in spring. *Veterinary Record* **100**: 360–361.

Eydal, Matthías, 1981. Sníkjudýr í hrossum í landnýtingartilraun í Kálfholti. In: *Ráðunautafundur 1981*. Agricultural Research Institute & Agricultural Society of Iceland: 101–105.

Eydal, Matthías, 1983. Gastrointestinal parasites in horses in Iceland. *Journal of Agricultural Research in Iceland* **15(1–2)**: 3–28.

Eydal, Matthías & Eggert **Gunnarson**, 1994. Helminth infections in a group of Icelandic horses with little exposure to anthelmintics. *Icelandic Agricultural Sciences* **8**: 85–91.

Eysker M., J.H. **Boersema** & F.N.J. **Kooyman**, 1992. The effect of ivermectin treatment against inhibited early third stage, late third stage and fourth stage larvae and adult stages of the cyathostomes in Shetland ponies and spontaneous expulsion of these parasites. *Veterinary Parasitology* **42**: 295–302.

Gestsson, Einar & Matthías **Eydal**, 1994. Áhrif ivermectin-ormalyfsgjafar á ormasýkingar í hrossum (The effect of ivermectin treatment on faecal Strongyle egg output of horses in Iceland). *Icelandic Agricultural Sciences* **8**: 107–114.

Gutteridge, W.E., 1993. Chemotherapy. In: *Modern Parasitology* (ed. F.E.G. Cox). 2nd edn. Blackwell Scientific Publications, Oxford: 219–242.

Heilbrigðis- og tryggingamálaráðuneytið, 1996. *Sérlyfjaskrá 1996*. Ministry of Health and Social Security, Reykjavík: 983 pp.

Helle, O., 1971. The effect on sheep parasites of grazing in alternate years by sheep and cattle. A comparison with set-stocking and the use of anthelmintics with these grazing managements. *Acta Veterinaria Scandinavica* **Supplementum 33**: 59 pp.

Henriksen, S.A., 1965. En forbedret teknik ved undersøgelser for lungeormelarver i faeces (An improved technique for the examination of faeces for larvae of lungworms). *Nordisk veterinærmedicin* **17**: 446–454.

Henriksen, S.A., 1982. Makro-Baermann – en metode til parasitologisk undersøgelse af græsprøver. *Nordisk veterinærmedicin* **34**: 101–102.

Jacobs, D.E., 1986. *A Colour Atlas of Equine Parasites*. Bailliére Tindall, London.

Love, S., J.L. **Duncan**, J.M. **Parry** & W.T.R **Grimshaw**, 1995. Efficacy of oral ivermectin paste against mucosal stages of cyathostomes. *Veterinary Record* **136(1)**: 18–19.

Lumsden, G.G., R. **Quan-Taylor**, S.M. **Smith** & I.M. **Washbrooke**, 1989. Field efficacy of ivermectin, fenbendazole and pyrantel embonate paste anthelmintics in horses. *Veterinary Record* **125**: 497–499.

Ogbourne, C.P. & J.L. **Duncan**, 1977. *Strongylus vulgaris* in the horse: Its biology and veterinary importance. *Miscellaneous Publication No.* **4**. Commonwealth Institute of Helminthology, Farnham Royal, UK; Commonwealth Agricultural Bureaux: 40 pp.

Parry, J.M., M.A. **Fisher**, W.T.R. **Grimshaw** & D.E. **Jacobs**, 1993. Anthelmintic dosing intervals for horses: comparison of three chemical groups. *Veterinary Record* **133**: 346–347.

Paulrud, C.O. & R.E. **Pedersen**, 1995. *Mavetarmparasitter hos heste i Island – et studie af effekten af Ivomec® (MSD). 3. semesters projekt.* Royal Veterinary and Agricultural University, Cophenhagen: 32 pp.

Persson, L., 1974. A modified Baermann apparatus for the recovery of infective nematode larvae from herbage and manure. *Zentralblatt Veterinärmedizin* **2**: 483–488.

Piché, C.A., M.J. **Cennedy**, H.A. **Herbers** & K.M. **Newcomb**, 1991. Comparison of ivermectin, oxibendazole and pyrantel pamoate in suppresing fecal egg output in horses. *Canadian Veterinary Journal* **32**: 104–107.

Poynter, D., 1954. Seasonal fluctuations in the number of strongyle eggs passed by horses. *Veterinary Record* **66**: 74–78.

Prekehr, S. & G.H. **Conrad**, 1973. *Methode zur Gewinnung von III. Strongylidenlarven aus dem Weidegras*. Dissertation, Veterinary University of Hannover, Germany: 58 pp.

Yadav, C.L., J.P. **Varshney**, R.P. **Uppal** & P.K. **Uppal**, 1993. Efficacy of ivermectin, thiophanate and levamisole against strongyle infections in equines. *Indian Veterinary Journal* **70(6)**: 554–556.

Ödberg, F.O. & K. **Francis-Smith**, 1977. Studies on the formation of ungrazed eliminative areas in fields used by horses. *Applied Animal Ethology* **3(1)**: 27–34.

Manuscript received 12 August 1997,
accepted 11 September 1997.