Tropical Biomedicine 22(2): 131–137 (2005)

Haemonchus contortus: Parasite problem No. 1 from Tropics - Polar Circle. Problems and prospects for control based on epidemiology

Peter J. Waller[a] and Chandrawathani P.[b]
[a] SWEPAR,National Veterinary Instutute, SE-751 89, Uppsala, Sweden
[b] Veterinary Research Institute, 59 Jalan Sultan Azlan Shah, 31400 Ipoh, Malaysia

Abstract. There is no doubt that on a global basis, *Haemonchus contortus* is by far the most important parasite of small ruminants (sheep and goats). This is particularly more so now, with the development of high levels of resistance to both the broad and narrow spectrum anthelmintic drugs in *H. contortus* throughout the world. Epidemiological studies describe the lower environmental limits for haemonchosis to occur in sheep, as being a mean monthly temperature of 18ºC and approximately 50mm rainfall. Thus it has been generally recognised that *H. contortus* is a problem parasite restricted to the warm, wet countries where sheep and goats are raised. However, recent evidence shows that this parasite is apparently common even in northern Europe. Thus the need for sustainable control strategies for *H. contortus* is becoming much more pressing. This report highlights two examples of sustainable and highly efficient control programmes for *H. contortus*, that can be implemented in regions at the extremes of its geographic range (Malaysia and Sweden), where the authors have had direct involvement.

INTRODUCTION

Among the diseases that constrain the survival and productivity of sheep and goats, gastrointestinal nematode infection ranks highest on a global index, with *Haemonchus contortus* being of overwhelming importance (Perry *et al.*, 2002). This blood-sucking parasite is infamous throughout the humid tropics/ subtropics. Annual treatment costs due to this parasite alone have been recently estimated to be $26m, $46m and $103m for Kenya (Anon., 1999), South Africa (Horak, pers. comm.) and India (McLeod, 2004), respectively.

Haemonchus contortus is probably the only nematode parasite of sheep and goats that can be accurately diagnosed without the aid of laboratory testing. Signs of acute anaemia are obvious. Past history and discounting other less common conditions causing anaemia, will strongly suggest clinical haemonchosis. On a worm-for-worm basis, *H. contortus* is considered to be the most pathogenic parasite of small ruminants. It has very high biotic potential and at times when transmission of this parasite is favoured, losses can occur in all classes of animals. Although it occurs in mixed infections with other nematode parasites, it invariably dominates the faecal worm egg contamination on pastures. *H. contortus* is also prominent amongst the reports of anthelmintic resistance that has emerged in all countries of the world that produce small ruminants.

Although the free-living stages of *H. contortus* are not as tolerant to unfavourable climatic (cold, but particularly dry) conditions as the other important nematode parasites of sheep (Donald, 1968; Waller & Donald, 1970), the very high biotic potential and pathogenicity of this parasite ensure that it is a major problem in the humid tropics and subtropics (Anon, 1991; Waller *et al.*, 1996; Chandrawathani *et al.*, 1999; Anon, 2001; Perry *et al.*, 2002). However, as Crofton *et al.* (1965) postulated several decades ago, *H. contortus*, in common with other nematode parasites of livestock, exhibits considerable ecological and biological plasticity to overcome unfavourable conditions either in the external, or host, environment. Obvious examples in the latter are the ability of parasites to overcome extreme selective pressures within the host imposed by the use of anthelmintics. *H. contortus* is notorious for the development of anthelmintic resistance, which certainly would have emerged independently in this parasite species in many countries, if not regions within countries, of the world (Waller, 1997; Sangster, 1999).

H. contortus in the Tropics – Management in Malaysia

Government-owned small ruminant breeding farms in Malaysia provide a source of sheep and goats to small holder farmers in the country. Despite the intensive use of anthelmintics on these farms, annual losses exceeding 25% of the total flock attributed primarily to *H. contortus*, are commonplace. Recent investigations into the drug resistance status on several of these farms, showed total anthelmintic failure to all drugs (Chandrawathani *et al.*, 2003; 2004a) – see Table 1.

Clearly this situation was unsustainable – not only in maintaining viability of the government farms – but also because it facilitated the distribution of highly, multiple resistant parasites together with the animals to small holder farmers. Changes in management were implemented, based on previous epidemiological studies that showed short-term rotational grazing (2-3 days only on each plot, returning to their original plot after 30 days), provided good level of control against *H. contortus* (Banks *et al.*, 1990; Barger *et al.*, 1994; Sani & Chandrawathani, 1996). However, control was further enhanced by daily supplementation of animals with the nematode destroying fungus, *Duddingtonia flagrans*. The level of *H. contortus* infection on pasture was consistently lower on the fungal supplemented pasture and this was reflected in significantly heavier weight gains of lambs that received the combination of rapid pasture rotation and fungal supplement (Chandrawathani *et al.*, 2004b) – see Figures 1 and 2.

H. contortus at the Polar Circle – Management in Sweden

Although *H. contortus* is particularly adapted to the warm, wet conditions of the tropics / subtropics, there is an apparent

Table 1. Anthelmintic Resistance Status on Malaysian Government Farms
(adapted from Chandrawathani *et al.*, 2003; 2004a)

Farm	Percentage Reduction following drug treatment			
	Benzimidazole	Levamisole	Closantel	Ivermectin
Ranau	–122% (R*)	32% (R)	76% (R)	17% (R)
Purutan	17% (R)	22% (R)	–3% (R)	–54% (R)
Bongawan	2% (R)	82% (R)	35% (R)	41% (R)
Telupid	23% (R)	88% (R)	53% (R)	52% (R)
Lahad Datu	40% (R)	85% (R)	25% (R)	67% (R)
Gajah Mati	42% (R)	65% (R)	96% (SR)	73% (R)

R*: resistance based on Faecal Egg Count Reduction Test (FECRT) results.

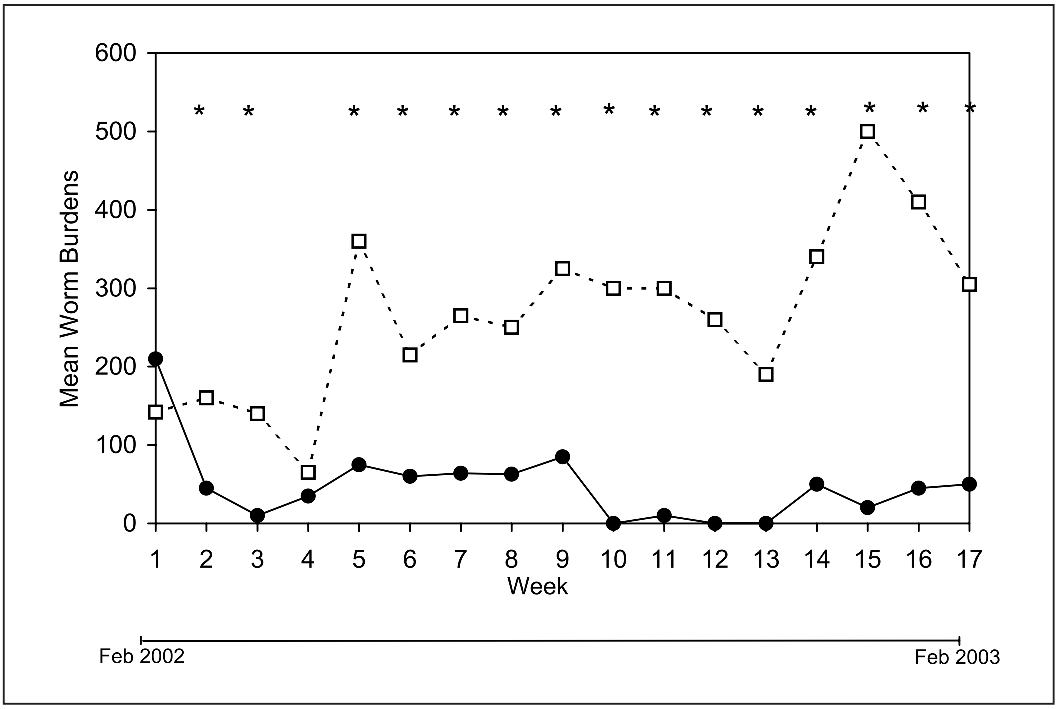

Figure 1. Mean tracer worm burdens from Control Group (broken line) and Fungus Treatment Group (solid line) in the field trial at Infoternak Farm, Malaysia. (from Chandrawathani et al. 2004b).

* Significant difference between Control and Fungus at P<0.05

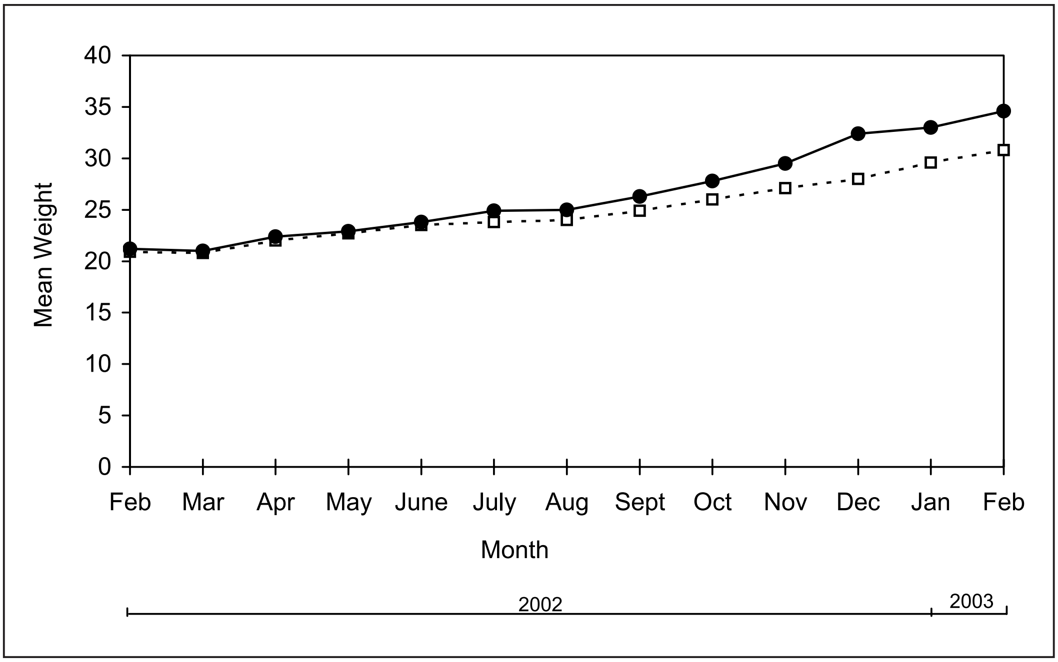

Figure 2. Mean weight gain of lambs from the Control Group (broken line) and Fungus Treatment Group (solid line) in the field trial at Infoternak Farm, Malaysia. (from Chandrawathani et al. 2004b).

increasing importance of this parasite in the temperate countries of Europe (U.K Jackson & Coop (2000); France: Hoste *et al.*, 2002; Netherlands: M. Eysker, pers. comm.; Denmark: Thamsborg, pers. comm.). This could well be as a consequence of the adaptation of this parasite not only to anthelmintic selection and the increasing development of resistance, but also to adaptation to unfavourable, non-chemical conditions experienced either by the free-living, or the parasitic stages. The parasites could have either become more cold tolerant for the development and survival of the free-living stages, and /or developed special survival mechanisms of the parasitic stages within the host, to ensure between-year survival.

Although anthelmintic resistance to the benzimidazole anthelmintics has been reported in *H. contortus* in Sweden (Nilsson *et al.*, 1993), it appears that this is the extent of the resistance problem. Thus the increased prevalence of this parasite is likely to be due to some other adaptive mechanism. A recent study in this country has shown that *H. contortus* has undergone some unique epidemiological adaptations (Waller *et al.*, 2004). Virtually complete inhibition of development occurs once infective larvae are acquired by sheep early in the grazing season. Almost no survival occurs over-winter on pasture. The peri-parturient ewes hold the key to between year transmission, as they often show high *H. contortus* faecal egg counts at the time of turn-out in early spring. This leads to early contamination of pastures and continuation of infection for a further year, with only one parasite generation/ year (see Table 2).

Winter housing of all small ruminants (sheep and goats) is virtually universally practised throughout Sweden, and generally for a period of 4 - 5 months (December – April/May). Thus animals are not exposed to infection, and importantly there is no faecal contamination, on pastures. These results suggested that eradication of *H. contortus*, on a farm-by-farm basis in the first instance, is a practical and realistic possibility for sheep (goat) flocks in Sweden. All ruminants on the farm (sheep, goats and cattle) would need to be properly treated with a highly effective anthelmintic during the winter housing period. This is because *H. contortus* is capable of infecting cattle, particularly young animals, and thus they could potentially act as a reservoir infection if not treated (Southcott & Barger, 1975). A 2-year pilot study on 2 farms was implemented, where such a programme was followed. Monitoring by faecal egg counts and infective larval differentials of ewes and lambs for the subsequent 2 grazing seasons, together with total abomasal worm counts of 10 lambs from each farm at the end of the first grazing year, showed that this objective was achieved (Waller *et al.*, 2005) – see Table 3.

Table 2. Monthly Worm Burdens of Tracer Lambs in Sweden (adapted from Waller et al. 2004)

Test No. (date)	*H. contortus*	*T. circumcincta*
1 (13/5 – 2/6)	0	100
2 (2/6 – 23/6)	0	725 (22%)*
3 (23/6 – 8/7)	163 (60%)*	713 (54%)
4 (19/8 – 4/9)	850 (100%)	4300 (73%)
5 (4/9 – 23/9)	3213 (97%)	5563 (46%)
6 (23/9 – 9/10)	28800 (100%)	37838 (88%)
7 (9/10 – 28/10)	55450 (100%)	78938 (91%)
Year 2		
9 (13/5 – 10/6)	625 (100%)	157873 (64%)
10 (6/7 – 31/7)	13 (100%)	7263 (38%)

* Numbers in parenthesis represent the percentage of the population arrested in development at the early fourth larval stage in the mucosa of the abomasums.

Table 3. Faecal egg counts of ewes and lambs and worm burdens of lambs on 2 farms in Sweden where eradication of *Haemonchus contortus* was achieved (from Waller et al. 2005)

Farm 1

Sampling Date		Mean Egg count (epg)	Infective Larval Differentiation				
			H. contortus	*T.circ.*	*Trich. spp.*	*Ch. ovina*	*Oesoph.*
2003							
Ewes	30 April	670	***36%***	*32%*	*8%*	*24%*	*0*
	21 Aug.	25	***0***	*0*	*0*	*0*	*0*
	25 Sept.	0	***0***	*0*	0	0	0
Lambs	21 Aug.	60	***0***	*0*	*0*	*0*	*0*
	25 Sept.	240	***0***	*33%*	24%	17%	26%
2004							
Ewes	15 April	0	***0***	*0*	*0*	*0*	*0*
	1 June	20	***0***	*23%*	*73%*	*4%*	*0*
Lambs	8 July	260	***0***	*63%*	*26%*	*11%*	*0*
	31 Aug.	380	***0***	*7%*	*64%*	*16%*	*8%*
2005							
Ewes	19 April	200	***0***	25%	23%	50%	2%
Lambs	9 Aug	580	***0***	13%	8%	79%	0
Mean Worm Burdens (10) Lambs - October 2004							
			Nil	*1855*	*75*	*Nil*	*Nil*

Farm 2

			H. contortus	*T.circ.*	*Trich. spp.*	*Ch. ovina*	*Oesoph.*
2003							
Ewes	9 May	1650	***44%***	*16%*	*32%*	*8%*	*0*
	19 Aug.	165	**+**	+	+	-	-
	29 Sept.	10	**-**	+	+	+	-
Lambs	19 Aug.	80	***20%***	*25%*	*20%*	*35%*	*0*
	29 Sept.	390	***20%***	*29%*	*33%*	*18%*	-
2004							
Ewes	15 April	0	***0***	*0*	*0*	*0*	*0*
	18 May	10	***0***	*0*	*0*	*0*	*0*
Lambs	13 July	425	***0***	*28%*	*23%*	*42%*	*9%*
	16 Aug.	440	***0***	*25%*	*45%*	*30%*	*0%*
2005							
Ewes	12 April	215	***0***	*15%*	*50%*	*15%*	*20%*
Lambs	29 June	620	***0***	*45%*	*55%*	*0*	*0*
Mean Worm Burdens (10) Lambs – October 2004							
			Nil	*6183*	*600*	*Nil*	*Nil*

REFERENCES

Anonymous. (1991). Report of the FAO Expert Consultation of the Helminth Infections of Livestock in Developing Countries. Rome Italy 23-27 September 1991. Food and Agriculture Organisation of the United Nations Rome 1991 AGA – 815. pp 32.

Anonymous. (1999). Integrated Sustainable Parasite Control of Ruminants in Mixed Farming Systems in Kenya FAO, pp. 55.

Anonymous. (2001). Sustainable approaches for managing haemonchosis in sheep and goats. Final Report of FAO Technical Co-operation Project in South Africa 2001. FAO Animal Production and Health Paper. pp 90.

Banks, D.J.D., Singh, R., Barger, I.A., Pratap, B. & Le Jambre, L.F. (1990). Development and survival of infective larvae of *Haemonchus contortus* and *Trichostrongylus colubriformis* in a tropical environment. International *Journal of Parasitology* **20:** 155-160.

Barger, I.A., Siale, K., Banks, D.J.D., & LeJambre, L.F. (1994). Rotational grazing for control of gastrointestinal nematodes of goats in a wet tropical environment. *Veterinary Parasitology* **53:** 109-116.

Chandrawathani, P., Adnan, M. & Waller, P.J. (1999). Anthelmintic resistance in sheep and goat farms on Peninsula Malaysia. *Veterinary Parasitology* **82**: 305-310.

Chandrawathani, P., Waller, P.J., Adnan, M. & Höglund, J. (2003). Evolution of high level, multiple anthelmintic resistance on a sheep farm in Malaysia. *Tropical Animal Health and Production* **35**: 17-25.

Chandrawathani, P., Yussof, N. & Waller, P.J. (2004a). Total anthelmintic failure to control nematode parasites of small ruminants on government breeding farms in Sabah, east Malaysia. *Veterinary Research Communications* **28**: 479- 489.

Chandrawathani, P., Jamnah, O., Adnan, M., Waller, P.J., Larsen, M. & Gillespie, A.T. (2004b). Field studies on the biological control of nematode parasites of sheep in the Tropics, using the microfungus *Duddingtonia flagrans*. *Veterinary Parasitology* **120**: 177-187.

Crofton, H.D., Whitlock, J.H. & Glazier, R.A. (1965). Ecological and biological plasticity of sheep nematodes. II. Genetic and environmental plasticity in *Haemonchus contortus* (Rud. 1803). *Cornell Veterinarian* **55**: 251 –258.

Donald, A.D. (1968). Ecology of the free-living stages of nematode parasites of sheep. *Australian Veterinary Journal* **44**: 139-144.

Hoste, H., Chartier, C. & Le Frileux, Y. (2002). Control of gastrointestinal parasitism with nematodes by treating the host category at risk. *Veterinary Research* **33**: 531-545.

Jackson, F. & Coop, R.L. (2000). The development of anthelmintic resistance in sheep nematodes. *Parasitology* **120**: S 95 – S107.

Nilsson, O., Rudby-Martin, L. & Schwan O. (1993). Bensimidazol-resistenta *Haemonchus contortus* påvisade hos får i Sverige (Benzimidazole resistance demonstrated in *Haemonchus contortus* infections of sheep in Sweden). *Svensk Veterinair Tidning* **45**: 303-307.

McLeod, R.S. (2004). Economic impact of worm infections in small ruminants in South East Asia, India and Australia. In: *Worm Control of Small Ruminants in Tropical Asia* (Sani R.A., Gray G.D and Baker R.L. eds), ACIAR Monograph **113:** 23-33.

Perry, B.D., Randolph, R.F., McDermott, J.J., Sones, K.R. & Thornton, P.K. (2002). Investing in animal health research to alleviate poverty. International Livestock Research Institute (ILRI), Nairobi, Kenya, 148 pp.

Sani, R.A. & Chandrawathani, P. (1996). Gastrointestinal parasitism in small ruminants in Malaysia . In: Le Jambre, L.F., Knox, M.R., Sustainable Parasite Control in Small Ruminants. Australian Centre for International Agricultural Research (ACIAR) Proceedings No.74, pp.98-100

Sangster, N.C. (1999). Anthelmintic resistance: past, present and future. *International Journal for Parasitology* **29**: 115-124.

Southcott, W.H. & Barger, I.A. (1975). Control of nematode parasites by grazing management. 2. Decontamination of sheep and cattle pastures by varying periods of grazing with the alternative host. *International Journal of Parasitology* **15,** 645-649.

Waller, P.J. (1997). Anthelmintic resistance. *Veterinary Parasitology* **72**: 391-412.

Waller, P.J. & Donald, A.D. (1970). The response to desiccation of eggs of *Trichostrongylus colubriformis* and *Haemonchus contortus* (Nematoda: Trichostrongylidae). *Parasitology* **61**: 195-204.

Waller, P.J., Echevarria, F., Eddi, C., Maciel, S., Nari, A. & Hansen, J.W. (1996). The prevalence of anthelmintic resistance in nematode parasites of sheep in Southern Latin America: general overview. *Veterinary Parasitology* **62**: 181-187.

Waller, P.J., Rudby-Martin, L., Ljungström, B.L. & Rydzik, A. (2004). The epidemiology of abomasal nematodes of sheep in Sweden, with particular reference to overwinter survival strategies. *Veterinary Parasitology* **122**: 207-220.

Waller, P.J., Rydzik, A., Ljungström, B.L. & Törnquist, M. (2005). Towards the eradication of *Haemonchus contortus* from sheep flocks in Sweden. *Veterinary Parasitology* (in press).