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## Gastrointestinal Nematode Infections on Sheep and Goats in West Java, Indonesia

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### ABSTRAK

BERIAJAYA. 2005. Infeksi cacing nematoda saluran pencernaan pada domba dan kambing di Jawa Barat, Indonesia. *JITV* 10(4): 293-304.

Penelitian ini dilakukan untuk mengetahui pengaruh musim, iklim, manajemen, pertumbuhan dan mortalitas terhadap infeksi cacing nematoda pada domba dan kambing di tiga lokasi yang mewakili dataran rendah, sedang dan tinggi di Jawa Barat, Indonesia. Hewan di tiap lokasi dibagi menjadi kelompok kontrol dan pengobatan dengan antelmintik. Hewan ditimbang dan sampel tinja diambil setiap 2-4 minggu. Jenis cacing yang dominan ditemukan dalam pupukan tinja adalah *Haemonchus contortus* dan *Trichostrongylus* spp. Di dataran rendah, jumlah telur cacing dan persentase larva *H. contortus* menurun sepanjang musim kemarau dan kemudian naik lagi bersamaan dengan tibanya musim hujan, tetapi kebalikan ini terjadi pada larva *Trichostrongylus* spp. Di dataran sedang, jumlah telur cacing tidak naik atau turun secara konsisten dihubungkan dengan fluktuasi curah hujan. Di dataran tinggi, jumlah telur cacing mempunyai kecenderungan untuk naik pada musim hujan, walaupun masih di bawah 1500 epg. Ternak yang sering digembalakan cenderung mempunyai jumlah telur cacing yang lebih banyak dibandingkan dengan ternak yang dikandangkan secara terus menerus. Setelah pengobatan dengan antelmintik, jumlah telur cacing turun menjadi sedikit dalam waktu 2 minggu dan kemudian naik lagi pada minggu ke-4, tetapi ternak yang diberi antelmintik phenothiazine, jumlah telur cacingnya tetap di bawah 500 epg. Setelah pengobatan jumlah telur cacing pada kelompok pengobatan tetap rendah sampai akhir penelitian. Fluktuasi kenaikan bobot hidup pada domba terlihat pada daerah rendah. Selain itu, kelompok pengobatan mempunyai angka mortalitas yang lebih rendah daripada kelompok yang tanpa pengobatan, tetapi kontribusi parasitisme belum dikonfirmasi. Penelitian ini menyimpulkan bahwa infeksi cacing nematoda menyebabkan turunnya produksi domba selama musim hujan di daerah dataran rendah dan di daerah dengan hujan yang terjadi sepanjang tahun.

**Kata Kunci:** Domba, Kambing, Nematode, Antelmintik

### ABSTRACT

BERIAJAYA. 2005. Gastrointestinal nematode infections in sheep and goats in West Java, Indonesia. *JITV* 10(4): 293-304.

These studies were carried out in three locations representing low, medium and high altitudes in West Java to determine the effects of season, climate, management, growth and mortality on nematode parasitism in sheep and goats. Basically, the animals in each location were divided into treated and untreated groups with anthelmintics. Animals were weighed and faecal samples were collected every 2 to 4 weeks. *Haemonchus contortus* and *Trichostrongylus* spp. were the predominant species of gastrointestinal nematodes recovered from faecal cultures. In low altitude areas, faecal egg counts dropped progressively throughout the dry season and rose again with the onset of the wet season. The proportion of *H. contortus* larvae decreased progressively throughout the dry season and increased with the onset of the wet season, however the opposite pattern occurred with proportions of larvae of *Trichostrongylus* spp. In medium altitude areas, there was no consistent pattern of rising or falling faecal egg counts associated with fluctuations in rainfall. In high altitude areas, there was a trend for egg counts to increase progressively after the onset of the wet season even faecal egg counts were below 1500 epg. After treated with anthelmintics, faecal egg counts were suppressed to only few eggs in two weeks and then rose again in four week later, however in animals received medicated phenothiazine, mean egg counts were maintained below 500 epg. Treated animals in medium areas maintained low egg counts until the end of the trial. Seasonal fluctuation in weight gain of sheep was observed in low areas. Treated animals had significantly lower mortality than untreated animals but the evidence that parasitism contributed to this mortality is persuasive. It was concluded that nematode parasites cause a significant loss of production in sheep during wet season in coastal regions and in areas of rainfall throughout the year.

**Key Words:** Sheep, Goat, Nematode, Anthelmintic

## INTRODUCTION

There are approximately 14.1 million goats and 7.5 million sheep in Indonesia (DITJEN PETERNAKAN, 2003), most of them are kept by small traditionally managed farms. Farmers keep the animals mainly for saving and to be sold when they need cash, beside that the animals are also used for production of manure and meat, and to create employment for family members. These factors and the high fecundity of sheep and goats make the animals have of high socio-economic value to farmers in the villages.

Several studies have produced evidence that productivity of these animals is low (SABRANI *et al.*, 1982). Contributing factors involve inadequate quality and supply of feed and lack of health care (RANGKUTI *et al.*, 1984). Parasitic diseases have also been found to be an important constraint to production (PERRY and RANDOLPH, 1999). The parasites encountered in the greatest numbers and considered to be most important are *Haemonchus contortus*, *Trichostrongylus colubriformis* and *Oesophagostomum* spp. (*O. columbianum* and *O. asperum*) (BERIAJAYA and STEVENSON, 1985; REHANA *et al.*, 1985; 1986; DORNY *et al.*, 1995; 1996; RIDWAN *et al.*, 1996). Reduction of growth rate is up to 38% and mortality up to 40% have been attributed to parasitism (BERIAJAYA and STEVENSON, 1986; HANDAYANI and GATENBY, 1988; FAIZAL *et al.*, 1999). Previous studies also indicated that weight gains of sheep and goats were influenced by rainfall and management. Moreover, weight gains of sheep were higher in dry season as compared to wet season (BERIAJAYA and COPEMAN, 1996). Weight gain is also influenced by the quality of feed. Animals feed with high protein ration tend to grow faster and more resilience to helminth infection (KNOX and STEEL, 1996; COOP and KYRIAZAKIS, 1999). In low altitude areas, sheep and goats are grazed and quality of feed is usually poor, however in contrast in high altitude areas, most of the animals are kept in pens and feed may consist of high protein. These factors may influence the severity of infection. At present, little is known about factors which influence the severity of helminth infection of sheep and goats in Indonesia and there is insufficient epidemiological information on which to base rational strategies for control.

To help redress this deficiency a number of trials were undertaken with sheep and goats in West Java. The information gathered on the effects of season, climate and management on nematode parasitism, and the effect of parasitism on growth and mortality are reported.

## MATERIALS AND METHODS

### Location

Trials undertaken are listed in Table 1 according to their location, year, species, age and number of animals, and type of observation made. Observations were carried out in three locations in West Java; Cirebon, Bogor and Garut representing low (0-10 m), medium (300 m) and high (1400 m) altitudes and low (1100 mm), medium (2000 mm) and high (4500 mm) annual rainfall respectively.

### Animal

Sheep at Cirebon and Bogor are an indigenous Indonesian Thin-Tail breed. Garut sheep are also of this breed but are somewhat larger and have been selected over the years mainly on the fighting ability of the rams. Goats are the product of cross breeding between an indigenous Kacang breed and the Etawah breed introduced from India many generations ago. Typically each farmer owns about 5 animals which are housed each night in a roofed pen with a slatted floor about 1 m above the ground.

All studies were carried out in villages with animals maintained by their owner according to their usual method of husbandry. For experiments with anthelmintic, animals were allocated at random from strata based on body weight and faecal egg count so that treated and non-treated groups were similar in these respects at the commencement of treatment. Anthelmintics used for these trials were albendazole, levamisole, disophenol, closantel and phenothiazine (see Table 1). Date of treatment and number of animals were not similar in each location, however data resulted from each location were figured in similar season or month.

### Observation

Animals were weighed and faecal samples were collected every 2 to 4 weeks. Faecal egg counts were estimated using saturated sodium chloride for floatation and a 0.5 ml counting chamber to give a sensitivity of 40 eggs per gram of faeces (epg) (WHITLOCK, 1948). Strongyle larvae were cultured in a moist mixture of faeces and vermiculite for 7 days at room temperature (about 28°C) then up to 100 larvae per culture were identified to genus (MANUAL OF VETERINARY PARASITOLOGICAL LABORATORY TECHNIQUES, 1971).

**Table 1.** A description of trials undertaken to study nematode parasitism of sheep and goats in West Java with observations on weight gain and mortality

Location, year and species	No. of animals		Duration of trial (days)	Age at start (months)	Treatment	Mean weight gain	Mortality (%)
<b>Cirebon 1983-84</b>							
ITT	45	35	360	mixed	Untreated	Nr	10.0
KEG	45	35	360	mixed	Untreated	Nr	10.0
<b>Cirebon 1985</b>							
ITT	50	34	150	1.5-4	Untreated	31	6.0
ITT	50	39	150	1.5-4	Albendazole 3.8 mg/kg ea m	41	4.0
KEG	40	25	150	1.5-4.5	Untreated	39	12.5
KEG	40	23	150	1.5-4.5	Albendazole 3.8 mg/kg ea m	50	7.5
<b>Cirebon 1987-88</b>							
ITT	105	77	360	mixed	Untreated	8	17.5
ITT	108	68	150	mixed	Phenothiazine 69 mg/kg/d	17	0.0
<b>Bogor 1982</b>							
ITT	35	25	112	3-8	Untreated	42	17.1
ITT	35	29	112	3-8	Levamisole 8.9 mg/kg ea 4w	58	8.6
<b>Bogor 1983</b>							
ITT	45	29	126	1.5-6.5	Untreated	32	2.2
ITT	45	25	126	1.5-6.5	Closantel 7.5 mg/kg once	33	2.2
ITT	46	33	126	1.5-6.5	Closantel 7.5 mg/kg ea 6w	36	6.7
<b>Bogor 1985</b>							
ITT	50	26	168	1.5-6.5	Untreated	35	12.0
ITT	50	24	168	1.5-6.5	Disophenol 7.5 mg/kg once	35	6.0
ITT	50	25	168	1.5-6.5	Levamisole 7.5 mg/kg ea 3w	48	2.0
<b>Bogor 1984-1985</b>							
ITT	100	60	360	mixed	Untreated	nr	6.0
<b>Garut 1983-84</b>							
G	219	148	360	mixed	Untreated	Nr	5.4
<b>Garut 1985-86</b>							
G	50	32	126	1.5-5	Untreated	60	2.0
G	50	29	126	1.5-5	Albendazole 3.8 mg/kg ea 3w	61	0.0

ITT = Indonesian Thin-Tail sheep  
 KEG = Kacang cross Etawah goat  
 G = Garut sheep

w = week  
 d = day  
 ea=each

nr = not recorded  
 \* Animals sold or slaughtered  
 m = month are not included

**Statistical analysis**

During the course of the trials, a number of animals were lost from the study due to slaughter, sale or disease. Results were calculated from data of the surviving animals at the last sampling in each trial. Egg counts were logarithmically transformed ( $\log x + 1$ ) prior to multivariate analysis over time using analysis of variance.

**RESULTS**

**Seasonal pattern of egg counts**

**Cirebon**

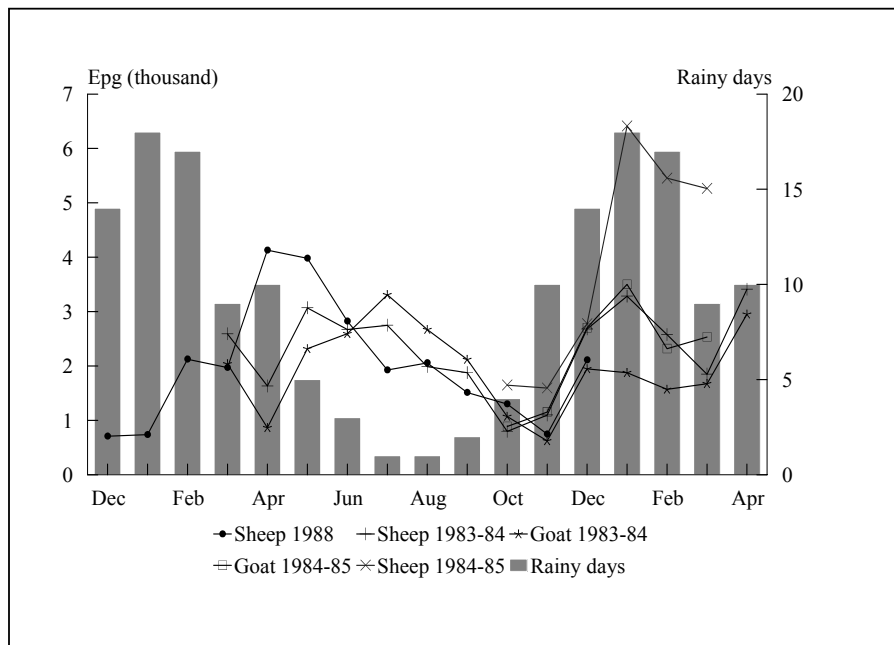
Mean faecal strongyle egg counts of sheep and goats monitored in 5 trials in Cirebon together with mean rainy days per month, are shown in Figure 1. The pattern of dry and rainy seasons is clearly shown. In general, the dry season extends from May to October or sometimes to November and the rainy season from November or December to April. The number of rainy days and rainfall each month were highly correlated ( $r=0.90$  and  $P=0.0001$ ). Faecal egg counts dropped progressively throughout the dry season but rose again

sharply with the onset of the wet season. Differential larval counts of faeces cultured monthly during 1988 revealed that the proportion of *H. contortus* larvae decreased progressively throughout the dry season and increased with the onset of the wet season. The opposite pattern occurred with proportions of larvae of *Trichostrongylus* spp. (Figure 2). Larvae of *Cooperia* spp., *Oesophagostomum* spp. and *Bunostomum* sp. were also found but they usually constituted less than 20 percent of the total.

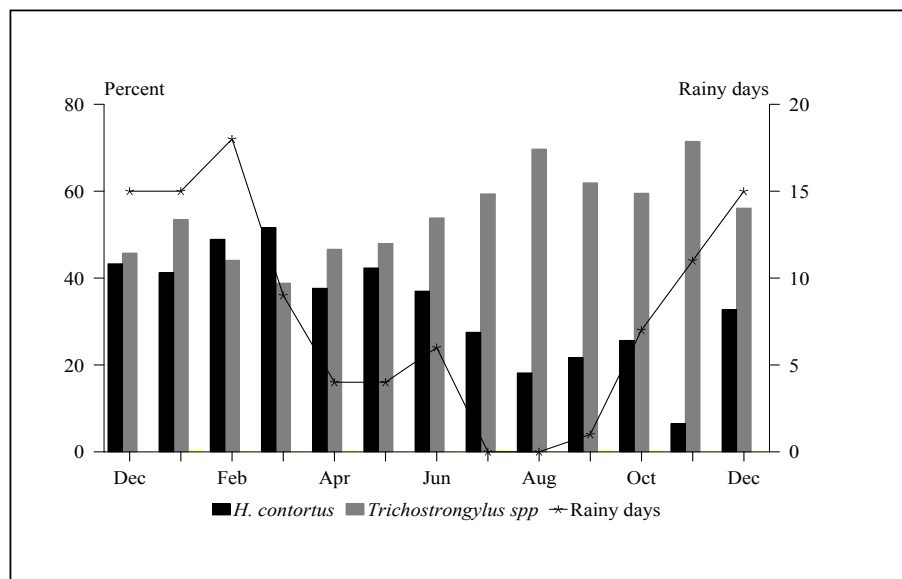
**Bogor**

Four studies on Javanese thin tail sheep were conducted in Bogor. In this area significant rain falls each month throughout the year. During the period of studies rain fell on 8 days even in the driest month.

There was no consistent pattern of rising or falling faecal egg counts associated with fluctuations in rainfall. The proportion of larvae of *H. contortus* in faecal cultures was mostly between 50 and 65 percent, whereas *Trichostrongylus* spp. larvae usually constituted 10 to 15 percent and larvae of *Oesophagostomum* spp. represented from 10 to 20%. Larvae of *Cooperia* spp. and *Bunostomum* sp. made up the remainder.



**Figure 1.** Mean strongyle eggs per gram (epg) of faeces of untreated Indonesian Thin Tail sheep and Kacang Etawah cross goats and mean number of rainy days per month in Cirebon



**Figure 2.** Mean proportion of larvae of *H. contortus* and *Trichostrongylus* spp. recovered from cultured faeces of untreated Indonesian Thin Tail sheep plotted with number of rainy days per month in Cirebon

### Garut

Two studies were carried out in Garut with Garut sheep. Mean monthly egg counts were below 1500 egg in both trials. Nevertheless, there was a trend for egg counts to increase progressively after the onset of the wet season in about October in both trials. Larvae of *H. contortus* constituted more than 70 percent of the larvae recovered from cultured faeces throughout the year and, together with larvae of *Oesophagostomum* spp., represented over 90 percent of all larvae present.

### Effects of anthelmintic treatment on egg count

The effect of anthelmintic treatment of sheep and goats in Cirebon was studied in three experiments (Table 1 and Figure 3). Two studies used monthly doses of albendazole (Valbazen) whereas in the third a palatable molasses-based block containing phenothiazine (Wormolas, Animeals Pty. Ltd., Australia) was made available to treated animals *ad libitum*. In animals medicated with phenothiazine, mean egg counts were maintained below 500 epg. Monthly repeated treatment with albendazole also suppressed faecal egg counts; to a greater extent in goats (300 to 1000) than sheep (500 to 2000), although the proportional suppression relative to egg counts of their respective control groups was similar.

Comparison of treatments with broad spectrum (levamisole) and narrow spectrum (closantel and disophenol) anthelmintics was studied in three

experiments with Javanese thin-tail sheep in Bogor (Figures 4, 5 and 6).

Few eggs were found in the faeces 2 weeks after each 4 weeks treatment with levamisole at 8.9 mg/kg. However, the egg counts rose again to between 1000 and 2000 egg by the fourth week after each treatment (Figure 4). When levamisole was administered each 3 weeks at 7.5 mg/kg, mean egg counts of between about 200 and 1000 egg were found 3 weeks after each treatment (Figure 6).

The proportion of larvae of each genus in faecal cultures was similar in animals 3 and 4 weeks after treatment with levamisole and their respective controls. Following treatment of sheep with a single dose of closantel or disophenol at 7.5 mg/kg, egg counts dropped to about 1000 epg. They remained at about this level for 6 weeks then rose to be similar to egg counts of control animals by 8 and 12 weeks after treatment with closantel and disophenol respectively (Figures 5 and 6). Egg counts of animals given closantel each 6 weeks at 7.5 mg/kg fluctuated between about 1000 and 2000 epg (Figure 5). The reduction in egg counts in animals treated with disophenol or closantel was due to reduction in the number of eggs of *H. contortus*. Egg counts of other genera, based on extrapolation from differential larval counts, were unaffected.

Faecal egg counts of sheep treated each 3 weeks with albendazole in Garut dropped from 550 to 180 epg 3 weeks later and remained less than 200 epg until the end of the trial (Figure 7).

**Live weight gain**

Mean daily live weight gain of all trial animals is shown in Table 1. Effects of anthelmintic treatment on weight gain were statistically significant ( $P < 0.05$ ) only in sheep treated monthly with albendazole in Cirebon and in sheep treated each 3 and 4 weeks with levamisole in Bogor. Although there was also a measured improvement in weight gain of goats treated with albendazole compared to untreated goats in Cirebon, this difference was only significance at  $P = 0.15$ .

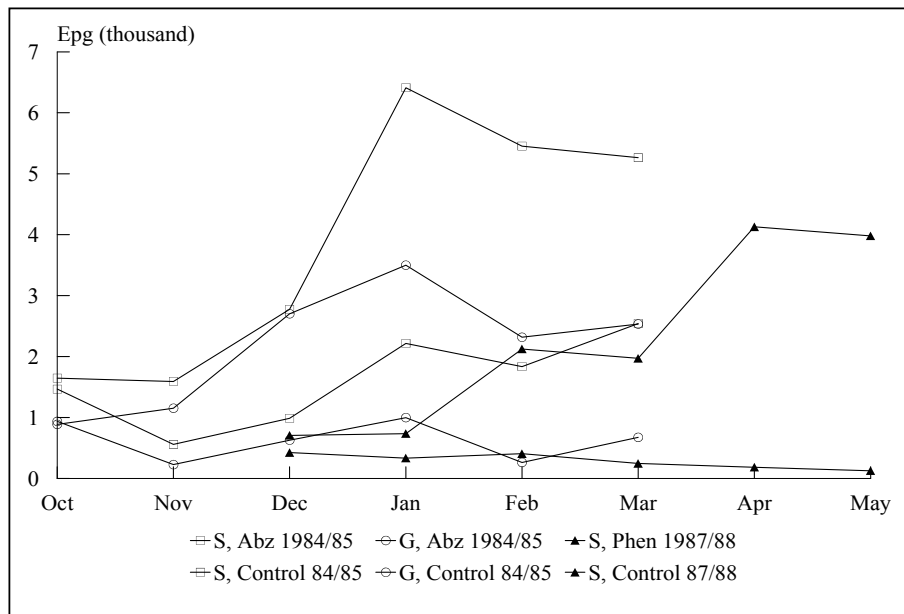
Differences between weight gains and differences in the effect of anthelmintic on weight gain of sheep and goats between locations, of trials carried out at the same time of the year, were seen in these studies. Garut sheep had a significantly higher weight gain ( $P < 0.05$ ) than sheep or goats at other sites. The effect of treatment on weight gain of sheep at Bogor and Cirebon was similar, however, there was a significant difference in weight gain of sheep between trials carried out at different times of the year.

Significant seasonal fluctuation in weight gain of sheep within sites was observed only at Cirebon ( $P < 0.05$ ). In goats at Cirebon there was a significant

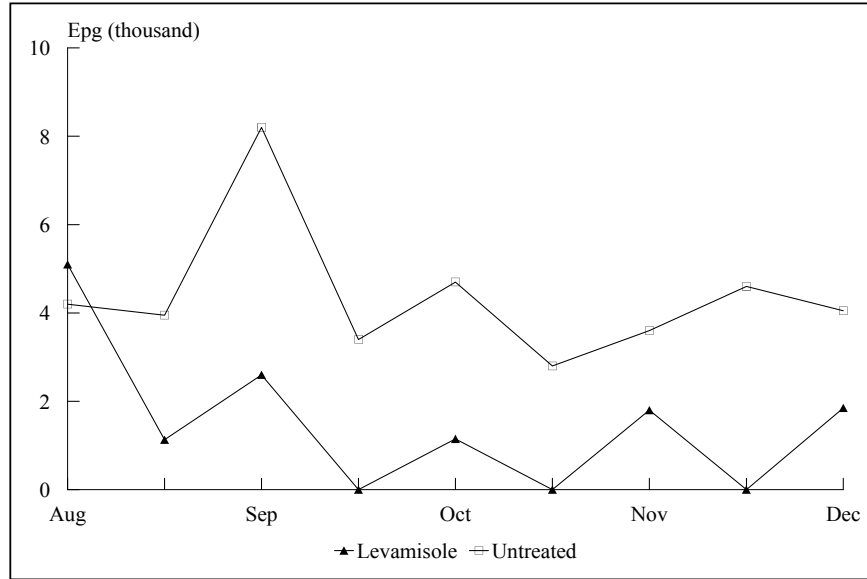
decrease in mean monthly weight gain recorded over the period between November and March ( $P < 0.05$ ).

**Mortality**

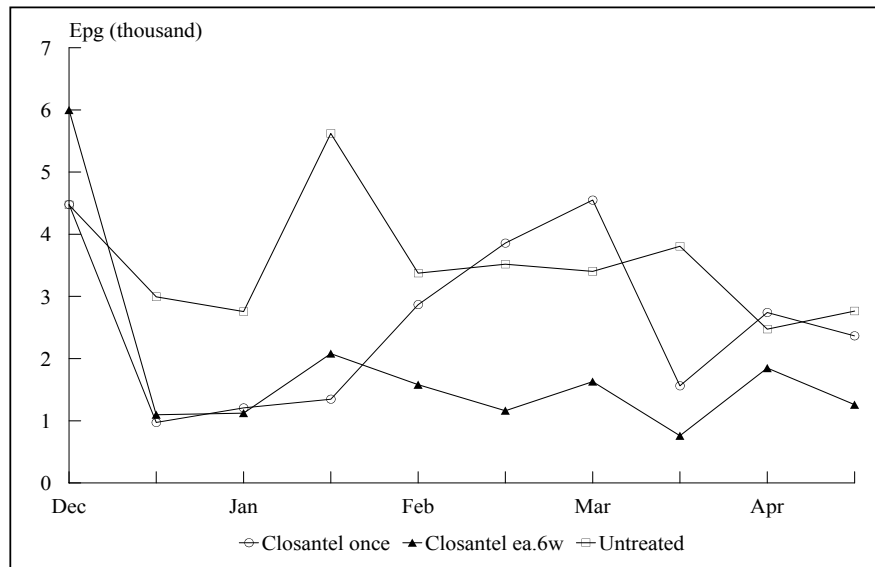
Mortality rate of sheep and goats which died during these studies are shown in Table 1. When analysed together treated animals had significantly lower mortality than their untreated controls ( $P < 0.05$ ). This trend was particularly apparent in groups where a significant increase in weight gain occurred due to anthelmintic treatment. Faecal egg counts of untreated animals which died were also significantly higher ( $P < 0.05$ ) than the mean of other untreated animals in their group at the time they died. The higher slaughter rate in untreated than in treated animals might also be attributable to parasitism as slaughtered control animals had a significantly higher epg ( $P < 0.05$ ) than the mean of other controls at the time of slaughter, and it is common practice in Indonesia to slaughter moribund animals for food as animals which die naturally are generally unacceptable for use as food. Mortality in treated animals was thought by farmers to have been caused by herbicides and pesticides which may have contaminated the herbage fed to them, bloat and other undiagnosed causes.



**Figure 3.** Mean strongyle eggs per gram (epg) of faeces of Indonesian Thin-Tail sheep (S) and Kacang Etawah cross goats (G) treated monthly with albendazole (Abz)\* at 3.8 mg/kg or consuming daily molasses-based block containing a mean of 1.7 g per animal (69 mg/kg) of phenothiazine (Phen)\*\*, and their non treated controls at Cirebon  
 \* Valbazen, Smith-Kline  
 \*\* Wormolas, Animeals Pty. Ltd., Australia



**Figure 4.** Mean strongyle eggs per gram (epg) of faeces of untreated Indonesian Thin-Tail sheep and sheep treated every 4 weeks with levamisole\* at 8.9 mg/kg in Bogor  
\* Nilverm, ICI

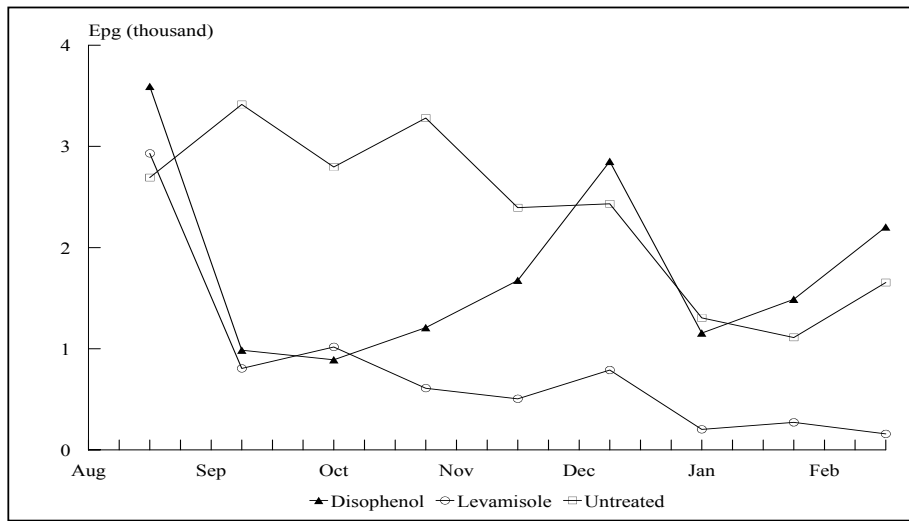


**Figure 5.** Mean strongyle eggs per gram (epg) of faeces of untreated Indonesian Thin-Tail sheep and sheep treated either once or each 6 weeks with closantel\* at 7.5 mg/kg in Bogor  
\* Seponver, Smith-Kline

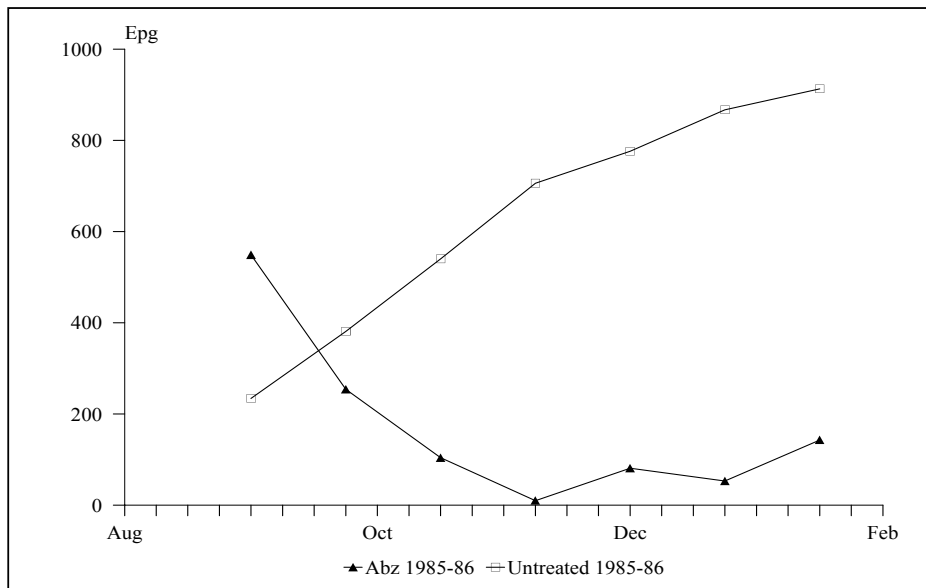
### DISCUSSION

The three areas chosen for these studies were selected because they represent the range of environments found in most of West Java (SABRANI *et al.*, 1982). The area around Cirebon is typical of the coastal lowland of North West Java. The region has

distinct wet and dry seasons. Rice, much of it rain-fed, is the predominant crop. Sheep are allowed to graze throughout the day in harvested rice fields and along irrigation channels and road verges. In contrast Garut has a high altitude with medium rainfall and the land is intensively and continuously cropped.



**Figure 6.** Mean strongyle eggs per gram (epg) of faeces of untreated Indonesian Thin-Tail sheep and sheep treated either once with disophenol\* at 7.5 mg/kg or each 3 weeks with levamisole\*\* at 7.5 mg/kg in Bogor.  
 \* Ancyolol, Cyanamid  
 \*\* Strommisole, Vetoquinol



**Figure 7.** Mean strongyle eggs per gram of faeces (epg) of untreated sheep and sheep treated each 3 week with albendazole \* (Abz) at 3.8 mg/kg in Garut  
 \* Valbazen, Smith Kline

Garut sheep are popular there but goats are not commonly reared. Due to the limited uncultivated land and the abundance of crop residues, sheep in Garut are kept and fed in pens most of the time. Around Bogor, which has medium altitude and high rainfall, rice and other crops, and rubber or coconut plantations are common. In this area sheep and goats receive a combination of pen-feeding and daily grazing for a few

hours, except during wet weather when they are kept housed.

Since West Java lies within 8 degrees of the equator it might be anticipated that the small seasonal fluctuations in temperature that occur would contribute little to seasonal differences in faecal egg counts observed in Cirebon and Garut and, furthermore, that such differences are likely to be influenced mainly by



seasonal differences in rainfall. Results obtained in these trials support this conclusion.

Faecal egg counts from sheep and goats in Cirebon were highest at the end of the wet season, decreased progressively over the dry season and rose again with the onset of the next wet season. This pattern is consistent with reduced translation of infective larvae from dung to the pasture and perhaps inhibition of egg hatching and larval development by high temperatures during the long dry season (CROFTON, 1963; IKEME *et al.*, 1986; BANK *et al.*, 1990). Sheep at Garut, too, experienced an increase in faecal egg count with the onset of the wet season so it seems that even the relatively short dry season at Garut may adversely affect translation of larvae to pasture. In Bogor, on the other hand, where the driest month still averages 6 wet days and over 300 mm of rain falls, uptake of parasites was apparently not limited by availability of moisture at any time as faecal egg counts remained constant throughout the year. This conclusion was also confirmed by RIDWAN *et al.* (1996) who demonstrated that faecal egg counts of sheep remained high during dry season.

Another factor which probably influenced faecal egg counts was the extent to which animals were kept in pens and fed using a cut and carry system. Forage fed usually comprises crop residues, foliage from edible trees and shrubs, and herbage from areas to which stock may have limited access. It is thus likely to be less contaminated with infective nematode larvae than pasture regularly grazed by free-ranging stock. This is the probable explanation for the lower egg counts in sheep at Garut than at other sites and for lower egg counts in goats than sheep in Cirebon, as both Garut sheep and Cirebon goats were kept in pens most of the time. Sheep at Cirebon and Bogor, on the other hand, were allowed to graze from about mid morning to dusk each day except during wet weather.

It is likely that seasonal differences in rainfall and differences between locations in the mean temperature both contributed to the seasonal and site variations observed in composition of nematode genera in larval faecal cultures (BERIAJAYA and COPEMAN, 1997). The intolerance of *H. contortus* (WALLER and DONALD, 1970) and relative tolerance of *Trichostrongylus* spp. to desiccation (ROSE, 1963) were the likely cause of dominance of the latter in faecal cultures from Cirebon during the dry season and increase in the proportion of larvae of *H. contortus* during the wet season. In contrast, studies in Rengasdengklok where is a similar condition as Cirebon demonstrated that faecal egg counts increased during dry season and faecal cultures were dominated with *T. colubriformis* (RIDWAN *et al.*, 1996).

In the comparatively high rainfall areas of Bogor and Garut, on the other hand, larvae of *H. contortus*

were by far the dominant genus throughout the year, demonstrating that moisture is not a limiting factor for this species in these areas at any time of the year. Furthermore, in Bogor and Garut, *Oesophagostomum* spp. replaced *Trichostrongylus* spp. as the second most common species in faecal cultures, possibly because it was more suited than the latter to the cooler temperatures and higher rainfall of these elevated areas, relative to Cirebon.

The low prevalence of *Bunostomum* sp larvae in cultures from all areas may reflect the use of goat and sheep housing with an elevated slatted floor throughout West Java, thus reducing the opportunity for transmission of this species. In contrast, *Bunostomum phlebotomum* is regarded as a serious pathogen in goats and sheep in Central and East Java where the animals are housed in pens on the ground (STEVENSON, personal communication).

This is the most comprehensive study reported to date on weight gain of sheep and goats in West Java, both regionally and seasonally, and of the effects on weight gain achieved with repeated anthelmintic treatment.

Significant seasonal fluctuations in weight gain occurred in sheep and goats in Cirebon and in sheep in Bogor, being lowest during the wet season. It is thought that reduced grazing time during wet weather (because animals are kept housed) and increased reliance on cut food provided by farmer results in reduced intake of lower quality food than animals would select from the pasture and consequently reduced weight gain. This effect was most apparent in Cirebon where animals usually get their food from grazing and where, presumably, the routine of gathering food is less well established than in areas where rain falls more often such as Bogor and Garut. Nevertheless, weight gain was also lower in Bogor from about November to March than at other times, corresponding to months of highest rainfall and suggesting that quality of food available at this time may also be lower than during drier periods of the year.

Thus, both failure of owners to provide sufficient feed to housed animals and a lower quality of feed available during the wet than the dry season may contribute to seasonal variations in growth rate in Cirebon and Bogor (BERIAJAYA and COPEMAN, 1996; COOP and SYKES, 2002). On the other hand, the absence of seasonal differences in the high growth rate achieved by sheep in Garut, where animals are housed most of the time, suggest that farmers are skilled at providing feed of high quality and sufficient quantity throughout the year (SYKES and COOP, 2001; KAHN *et al.*, 2003).

Regionally, growth rate of sheep in Garut was significantly higher than achieved by sheep or goats in Bogor or Cirebon. Superior quality of feed and lower burden of nematode parasites in Garut relative to these

factors in Bogor and Cirebon probably contributed most to this result, but Garut sheep may also have a higher genetic potential for rapid growth than the sheep and goats in other areas as they are bred for fighting and large size is an important attribute. However, such a genetically superior propensity for growth in Garut sheep seems unlikely as a similar weight gain was achieved by Javanese thin-tail sheep treated each 4 weeks with levamisole in Bogor in 1982.

Use of the broad-spectrum anthelmintics levamisole and albendazole at intervals of 3 or 4 weeks in this study was not intended to demonstrate a practical regimen for control of nematode parasites, but rather to suppress parasites in treated animals in order to provide an estimate of the effects of parasitism by comparison of weight gain in otherwise similarly treated and untreated groups. Use of closantel each 6 weeks had a similar role but with estimates of the effect of *H. contortus* on weight gain as the objective due to the selective action of closantel against this species (HALL *et al.*, 1981; GUERRERO, 1984; DASH, 1986; BARGER *et al.*, 1991). However, such estimates of the effects of parasitism on weight gain are likely to be conservative as infection was not completely suppressed by the protocols used, and larval contamination of the trial area would have been reduced by treating a proportion of the flock, thus reducing the level of challenge in untreated animals.

In spite of this limitation the effect of anthelmintic treatment on weight gain was significant in sheep treated monthly with albendazole in Cirebon and each 3 or 4 weeks with levamisole in Bogor; increases of 32 to 38 percent being recorded in weight gain in treated over untreated animals. On the other hand, differences between weight gain of similarly treated and untreated groups of goats in Cirebon and of treated and untreated sheep in Garut were not significant. This result is consistent with a conclusion supported by data on egg counts that goats had lower worm burdens than sheep in Cirebon and that the level of parasitism in sheep in Garut was low; both cases probably resulting from low exposure to parasites due to extensive confinement of the animals in pens. Grazing goats may also have been less exposed than sheep due to their habit of browsing on herbage well above ground level which is unlikely to be infested with nematode larvae, whereas sheep prefer herbage close to the ground within the zone infested by infective larvae.

An unexpected result was the lack of weight gain response to treatment of sheep each 6 weeks with closantel in Bogor, since closantel is reported to be effective against *H. contortus* (GUERRERO, 1984; DASH, 1986) the dominant parasite in larval culture from sheep at this site. This suggests that either a regimen of treatment each 6 weeks does not provide a measurable level of suppression of *H. contortus*; or that the other

parasites present, particularly *Trichostrongylus* spp and *Oesophagostomum* spp, which are unaffected by closantel, contribute more to the pathogenic effects of parasitism than is suggested by the proportion of their larvae in faecal cultures. This result and the lack of weight gain response in sheep given a single dose of closantel or disophenol (which also has a narrow spectrum of activity, mainly against *H. contortus* (HALL *et al.*, 1981) support a conclusion that anthelmintics used in the control of nematode parasitism of sheep and goats in West Java should have a broad spectrum of activity.

Molasses-based blocks containing phenothiazine have been recommended for control of nematode parasites of sheep, cattle and horses; daily low-level intake of phenothiazine does not eliminate nematode parasites but suppresses their fecundity, resulting in control through a lowering of pasture contamination with infective larvae and a consequent progressive lowering of the worm burden of grazing animals (KELLY *et al.*, 1981a; 1981b). Use of such medicated blocks at Cirebon successfully reduced faecal egg counts of treated animals to low levels in comparison with un-medicated controls, thus confirming the published claims for this approach to control (BERIAJAYA *et al.*, 1995).

Post mortem examination of animals which died or were slaughtered was not possible in these trials due to the remoteness of trial areas from the laboratory and to lack of facilities for communicating such deaths quickly. Nevertheless, it was possible to determine from retrospective faecal egg counts that animals that died had higher egg counts than those of survivors and, furthermore, that there was significantly higher mortality in untreated animals than in those given anthelmintic. Thus, although the role of parasitism in the increased mortality observed in untreated animals is speculative, the evidence that parasitism contributed to this mortality is persuasive.

## CONCLUSION

Results of this study thus indicate that nematode parasites cause a significant loss of production in Javanese thin tail sheep in West Java during the wet season in coastal regions, and in areas of high rainfall, throughout the year. Control measures to minimize this loss in sheep are therefore justified. On the other hand, measures to control nematode parasites in Garut sheep and in Kacang cross Etawah goats are not warranted on the basis of these observations.

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