

## Seasonal availability of gastrointestinal nematode larvae to cattle on pasture in the central highlands of Kenya

R.M. WARUIRU, E.H. WEDA, R.O. OTIENO and J.W. NGOTHO

Department of Veterinary Pathology, Microbiology and Parasitology, Faculty of Veterinary Medicine, University of Nairobi, P.O. Box 29053, Kabete, Kenya

### ABSTRACT

WARUIRU, R.M., WEDA, E.H., OTIENO, R.O. & NGOTHO, J.W. 2002. Seasonal availability of gastrointestinal nematode larvae to cattle on pasture in the central highlands of Kenya. *Onderstepoort Journal of Veterinary Research*, 69:141–146

The type and level of infective strongylid nematode larvae on pasture were monitored fortnightly from July 1995 to June 1996 in the central highlands of Kenya. The number of larvae on pasture was moderate, reaching  $> 1200 \text{ kg}^{-1}$  dry matter of grass during the period of, and soon after, the rains, and remained low in the dry seasons. The number of larvae on pasture was directly related to the rainfall pattern which was found to be the most important factor for the development of eggs and free-living stages. *Haemonchus* was the predominant genus, followed in decreasing order by *Trichostrongylus*, *Cooperia*, *Oesophagostomum* and *Bunostomum*. The mean total adult worm burdens of tracer calves released at monthly intervals were related to the levels of herbage larvae and there was a positive correlation between faecal worm egg counts and worm burdens ( $r = 0.58$ ) during the study period. These results indicate that a reduction in the contamination of pasture with nematode eggs before the rains could result in pastures carrying fewer larvae and thus form the basis of effective worm control programmes for cattle.

**Keywords:** Cattle, helminthosis, Kenya, larvae, nematodes, pasture, rainfall, season

### INTRODUCTION

Helminthosis in cattle is of considerable economic significance in a wide range of agro-climatic zones of Africa and affects production through losses due to mortalities and reduced weight gain (Fabiyyi 1987; Kaufmann & Pfister 1990; Waruiru, Ayuya, Weda & Kimoro 1993; Moyo, Bwangamoi, Henrikk & Eysker 1996). The rate of larval development and longevity of viable eggs on pasture are dependent on moisture and temperature, and vary between different geo-ecological regions (Dinnik & Dinnik 1961; Onyali, Onwuliri & Ajayi 1990; Wanyangu, Karimi, Mugambi & Bain 1997). Lee, Armour & Rose (1960), and Ndamukong & Ngone (1996) showed that rain-

fall is important in the preparasitic development of strongylid nematodes and that it promotes their emergence from the faecal pellets or pats (Rose 1962; Chiejina & Fakae 1984). The observation that the level of nematode egg output follows the pattern of rainfall (Agyei 1991; Pandey, Ndao & Kumar 1994) has also been reported in central Kenya (Waruiru, Thamsborg, Nansen, Kyvsgaard, Bogh, Munyua & Gathuma 2001).

Studies on seasonal differences in infective nematode larval availability are essential to the understanding of the epidemiology and control of strongylid nematode infections. Since the development of eggs to infective larvae ( $L_3$ ) and their survival on pasture are influenced by weather factors which vary from place to place, studies on the bionomics

of these larvae under local conditions are of great assistance in planning effective control measures (Okon & Enyenihi 1977). This study was therefore undertaken to determine the level and distribution of  $L_3$  on pasture in the central highlands of Kenya.

## MATERIALS AND METHODS

### Study site

The study was carried out from July 1995 to June 1996 in the Lari Division of Kiambu District (36°70'E; 0°75'S), in the central Kenyan highlands about 50 km north-west of Nairobi at an altitude of 1 800 m. The rainfall is bimodal, with the long rains occurring between March and May while the short rains fall from October to December (Sombroek, Vraun & Van Der Pouw 1982). The mean monthly minimum temperature varies from 10–15 °C and the mean maximum temperature from 20–34 °C (Anon. 1994). The natural vegetation is dominated by Kikuyu grass (*Pennisetum clandestinum*) with varying proportions of star grass (*Cynodon aethiopicus*). Daily records of minimum/maximum temperatures, relative humidity and rainfall were kept throughout the study period.

### Pasture sampling and infective larvae recovery

The level of pasture contamination was determined using the method of Hansen & Perry (1994). Herbage samples were collected every 2 weeks between 08h00 and 09h00 from the paddocks where the animals grazed. After soaking the herbage in water overnight, the  $L_3$  were concentrated by centrifugation and separated using a zinc sulphate solution (density 1.35). Larvae were identified using the characteristics described in Anon. (1986). The dry matter content of the grass samples was determined and results were expressed as the number of  $L_3$  kg<sup>-1</sup> of herbage dry matter (DM).

### Experimental animals

During the study period a herd of cattle of different age groups was kept on 8 ha of pasture that was divided into paddocks. Each month, three tracer bullocks, aged 6–7 months, were introduced to the permanent herd to monitor larval availability on the pasture. Prior to their release they were drenched with albendazole (Valbazen® – Novartis East Africa Ltd, Nairobi, Kenya) at 10 mg kg<sup>-1</sup> body mass and were allowed to graze for 4 weeks with the permanent herd. They were then withdrawn for a 3-week period and slaughtered for worm recovery.

### Parasitological techniques

Faecal samples were taken from individual tracers at fortnightly intervals and faecal nematode egg counts were assessed using the modified McMaster technique (Anon. 1986). At necropsy, the gastrointestinal tract was removed, divided into the abomasum, and the small and large intestines, separately opened and washed in ten-litre buckets. An aliquot of 1:20 was removed from the washings of each and preserved in an equal volume of 10% formalin prior to examination. Adult worms were recovered and identified according to the descriptions of Anon. (1986) and Hansen & Perry (1994).

### Data analysis

The number of  $L_3$  kg<sup>-1</sup> of DM, egg counts and worm burden (WB) were transformed ( $\log_{10}(x + 10)$ ) to normalize their distribution and subjected to analyses of variance (ANOVA) using SAS® computer software. Correlation analysis was used to assess the relationship between rainfall and the number of raindays with the number of  $L_3$  on the pasture. The relationships between the level of  $L_3$ , faecal nematode egg counts and number of adult worms were also assessed.

## RESULTS

### Meteorological data

Information on relative humidity, temperature, rainfall and the number of raindays is shown in Fig. 1A and 1B, together with average rainfall figures over 20 years for the regional recording station. The lowest temperatures were experienced during July and August 1995 and the hottest months were January through March 1996. The area received 1 107 mm of rain during the study period, of which 31.2% fell during the short rains and 55.5% during the long rains, with more than 10 raindays in each month. During the other months, low to moderate falls of rain were recorded, with < 6 raindays per month. The recorded rainfall was slightly less than that of the 20-year average rainfall (Fig. 1B).

### Herbage larval counts

The mean total monthly number of infective herbage larvae is shown in Fig. 2. There were  $L_3$  on the pasture throughout the study period but the highest levels of 1 235 and 1 485  $L_3$  kg<sup>-1</sup> DM of herbage were recorded in December 1995 and May 1996 during the short and long rains, respectively.

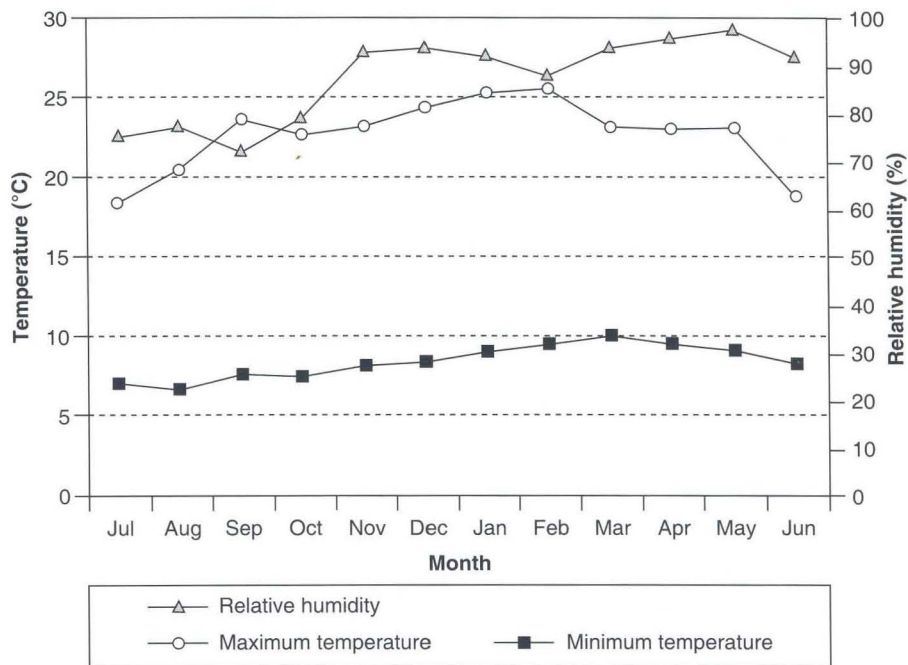


FIG. 1A Mean minimum and maximum temperatures and relative humidity (values taken at 14.00) for the study area

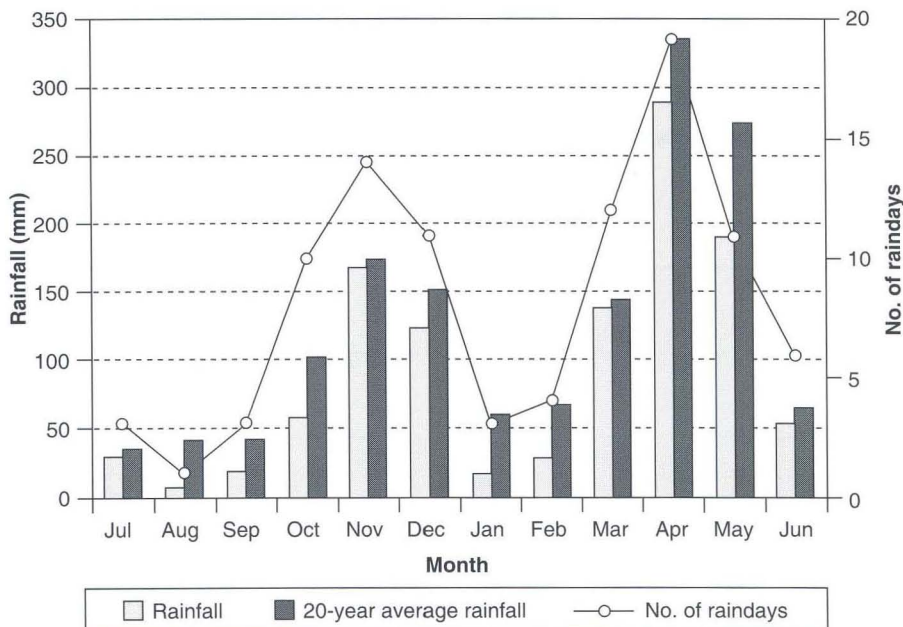


FIG. 1B Monthly pattern of rainfall and number of raindays during the study period

Of these, *Haemonchus* (54.3%) was the most common, followed by *Trichostrongylus* (21.6%), *Cooperia* (13.7%), *Oesophagostomum* (8.1%) and *Bunostomum* (2.3%). The relationship between the L<sub>3</sub> on the pasture and the rainfall was statistically significant ( $P < 0.05$ ), with a correlation coefficient of 0.89.

### Tracer worm burdens

Adult helminth worm burdens (WB) obtained after slaughter of the tracer calves and their epg counts are shown in Fig. 3. The number of worms from individual calves ranged from 186–4842 with the highest counts being recorded in November 1995 and

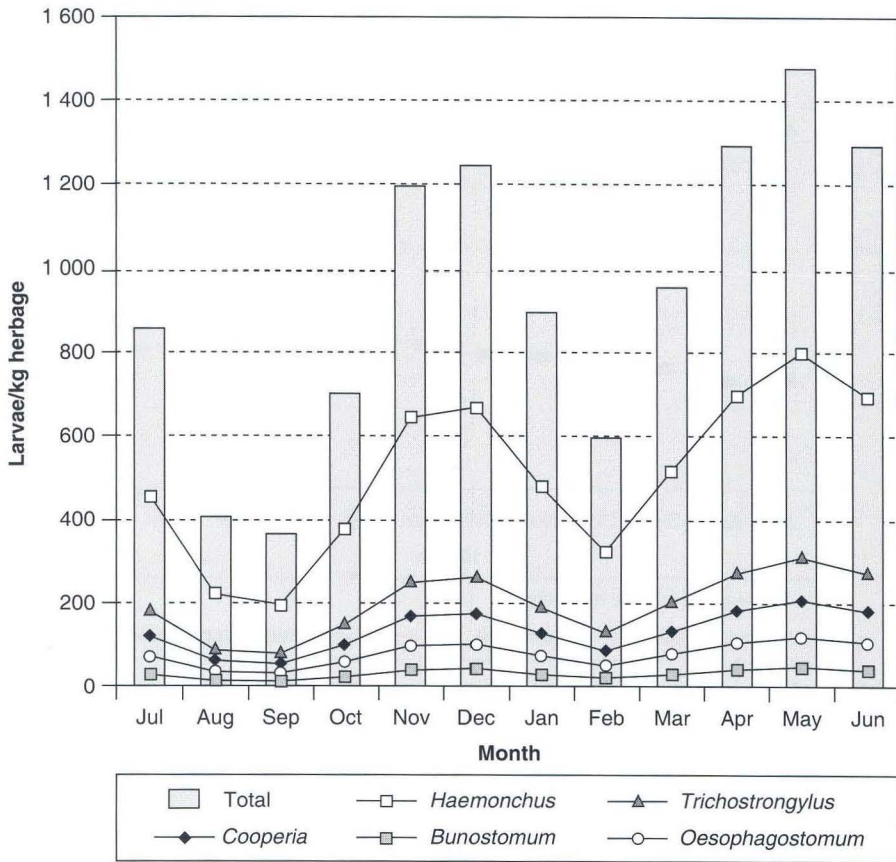


FIG. 2 Number and types of infective strongylid nematode larvae recovered from pasture

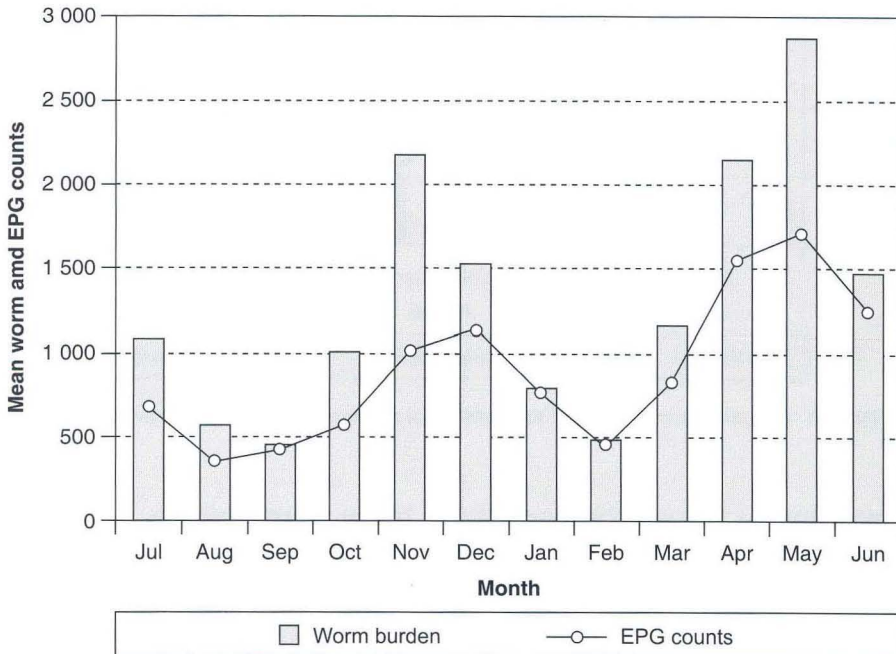


FIG. 3 Mean monthly number of adult worms and faecal egg output from tracer calves

May 1996. The composition of the WB broadly reflected the composition of the pasture infestation. *Haemonchus placei*, *Trichostrongylus axei*, *Cooperia pectinata* and *Cooperia punctata* were the most common species, followed by *Oesophagostomum radiatum*, *Bunostomum phlebotomum*, *Nematodirus helvetianus* and *Trichuris globulosa*. *Moniezia benedeni* was found occasionally.

The relative abundance of *H. placei*, *T. axei*, *Cooperia* spp., *O. radiatum* and *B. phlebotomum* followed the same trend as that of the WB during the different seasons and accounted, on average, for 57.6%, 18.5%, 15.3%, 4.3% and 2.7% of the total WB, respectively. *Nematodirus helvetianus* and *T. globulosa* occurred in very small numbers, and their populations were apparently not affected by seasonal environmental fluctuations. Faecal egg output showed a seasonal pattern with monthly mean peaks of 1 200 and 1 800 epg being recorded for December 1995 and May 1996, respectively. A moderate positive correlation was found between the epg and total WB (0.58) and was associated with the presence of *H. placei* (i.e. the overall correlation between *Haemonchus* WB and total WB was 0.74).

## DISCUSSION

The results of this study indicate a distinct seasonal availability of L<sub>3</sub> on pasture in response to weather changes. Acquisition of L<sub>3</sub> was highest during the short and long rains even though L<sub>3</sub> were recovered from pasture throughout the year. Levels of faecal nematode eggs and WB in tracer calves were also mostly dependent on the period of the year. The correspondence between the pasture larval counts and the number of adult worms recovered for a given period supports the use of tracer animals for monitoring L<sub>3</sub> on pasture (Waller, Dobson, Donald & Thomas 1981; Cabaret, Raynaud & Le Stang 1982; Uriarte & Valderrabano 1989). The positive correlation between the faecal nematode egg counts and total WB was probably related to the high fecundity of *H. placei* which represented 45.7–69.8% of the total population at any given period of the year. The results show that faecal egg counts could be used to estimate WB in cattle in the study area as has also been reported previously (Maingi, Gichohi, Munyua, Gathuma & Thamsborg 1997; Phiri & Mungomba 1998). The predominance of *Haemonchus* spp. on pasture is in agreement with the finding of Waruiru *et al.* (2001) that these helminths constituted the largest proportion of lar-

vae obtained in faecal cultures. Although contamination of pasture with *Oesophagostomum* spp. (mainly *O. radiatum*) occurred, the short interval between possible ingestion of L<sub>3</sub> and slaughter meant that few if any L<sub>3</sub> would have reached maturity and, in the absence of special techniques for recovery of immature stages, only a few worms of this species were recovered.

The present study shows that the strongylid nematodes encountered were capable of development throughout the year (Waruiru, Munyua, Thamsborg, Nansen, Bogh & Gathuma 1998). In the central Kenyan highlands, the environmental temperature did not appear to be a limiting factor in the development, and survival of the eggs and larvae of strongylid nematodes of the cattle. However, rainfall seemed to have the most important effect on the development of eggs and free-living stages (Lee *et al.* 1960; Ndamukong & Ngone 1996; Agyei 1997).

The present findings suggest that strongylid nematodes survive the dry seasons as adult worms rather than hypobiotic larvae in the abomasum and the intestinal mucosae of cattle, since the cold and dry (July to September), and hot and dry (January to February) seasons, with occasional rainfall, are short in comparison to the severe dry seasons in west and central Africa (Kaufmann & Pfister 1990; Pandey, Chitate & Nyanzunda 1993). In a study on the dynamics of helminth infections in small ruminants conducted in a high rainfall area of Kenya, Gatongi, Murira, Mukasa & Nyanjom (1998) recorded only a low level of larval inhibition throughout the period of study indicating that the phenomenon of hypobiosis is of no consequence in determining control strategies.

In conclusion, this study shows a well-defined seasonal pattern of strongylid infections in calves in the central highlands of Kenya. This information, together with data on larval ecology (Waruiru *et al.* 1998) should provide a basis for the development of sustainable nematode control strategies. Rotational grazing schemes (Chandrawathani 1997), the use of sustained-release devices (Munyua, Ng'ang'a & Ngotho 1998), supplementary feeding with urea- and molasses-containing supplementary blocks (P.M. Gatongi, personal communication 2001), the "Farmacha system" (Van Wyk, Malan & Bath 1997) and targeted application of anthelmintics to control strongylosis in domestic ruminants are possibilities being explored in on-going studies in Kenya.

## ACKNOWLEDGEMENTS

This study was supported by the Livestock Helminth Research Project under the auspices of the Danish International Development Agency (DANIDA).

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