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Seasonal Changes and Hypobiosis in *Haemonchus contortus* Infection in the West African Dwarf Sheep and Goats in the Nigerian Derived Savanna

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ABSTRACT

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A survey was conducted in the Nigerian derived savanna (from August 1987 to July 1988) on the seasonal fluctuations in the composition of *Haemonchus contortus* burden of naturally infected West African Dwarf sheep and goats. During this period 117 abomasa collected from locally slaughtered animals were processed. Male, female as well as immature worms were enumerated.

The incidence of *Haemonchus* infection was high (77.8-100%) with no definite seasonal distinction. There was however, a clear seasonal trend in the worm burden of animals; higher burdens were evident during the rainy rather than the dry season. There was no significant hypobiosis; *Haemonchus contortus* survived in the host during the unfavourable dry season (November to March) as adults.

INTRODUCTION

The West African Dwarf (WAD) sheep and goats are indigenous to the Nigerian derived savanna. They have increasingly formed a significant source of meat in the rural areas contributing 11–35% of the meat supply (Adu and Ngere, 1979; Bayer, 1986).

Limited survey studies so far conducted in the rain forest, sahel and northern guinea savannas of Nigeria (Fabiyi, 1973; Okon and Enyenihi, 1975; Fagbemi and Dipeolu, 1982) have shown *Haemonchus contortus* to be the commonest gastrointestinal helminth in sheep and goats and the most incriminated

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for parasitic gastroenteritis (PGE) syndrome. This condition has been noted to contribute to gross economic losses (Akerejola et al., 1979; Chiejina, 1987).

The moisture and temperature requirements for the development of the infective larvae (L_3) of *H. contortus* are such that haemonchosis as well as other helminth infections and hence PGE in small ruminants in Nigeria are essentially a rainy season syndrome (Fabiyi, 1973; Okon and Enyenihi, 1975; Fagbemi and Dipeolu, 1982; ,Chiejina, 1987) since the dry season is unfavourable for the development of the extrahost stages. However, to explain how infections are carried over from one favourable season to another, it has been suggested that in cattle and small ruminants of northern Nigerian origin, *Haemonchus* spp. survive in the host as arrested early fourth stage larvae (EL_4) during the long dry season (Hart, 1964; Schillhorn van Veen, 1978; Ogunsusi and Eysker, 1979) with termination of the arrest at the beginning of the rainy season (Ogunsusi, 1979). In contrast, Chiejina et al. (1988) observed very limited arrested development of *H. contortus* in WAD goats and very recently Chiejina et al. (1989) found that the survival of extrahost stages of *H. contortus* was nil on pasture in the derived savanna. Thus, neither hypobiosis nor dry season survival of the infective larvae (L_3) on pasture, appear important in the initiation of infection in WAD sheep and goats at the onset of the rainy season in the Nigerian derived savanna.

This study was therefore initiated to examine the seasonal fluctuations in the composition of *Haemonchus* burdens in naturally infected WAD sheep and goats in the Nigerian derived savanna, to reappraise the issue of arrested development (hypobiosis) and to define the means of transmission and population expansion of this common stomach worm of small ruminants from one season to the next.

MATERIALS AND METHODS

Collection of samples

From August 1987 to July 1989 a monthly average of 10 abomasa was randomly collected from adult WAD sheep and goats slaughtered in markets and households in villages around Nsukka, a town in the Nigerian derived savanna whose location and weather conditions have been well described by Chiejina and Emehelu (1984). The abomasa were ligated at both ends and transferred to the laboratory in labelled plastic bags.

Parasitological techniques

Each abomasum was opened end to end with a pair of scissors and the contents were processed by repeated washing, sedimentation and decantation until the supernatant was clear enough to allow for easy worm counting. The sediments were made up to 400–800 ml (depending on the clarity) and at least 10% aliquots of well-mixed suspensions were examined for estimation of the total worm burden by dilution (MAFF, 1977); adult male and female worms as well as the immature stages were enumerated. In addition, mucosal scrapings of each abomasum were digested in acid-pepsin (Kingsley and Gerber, 1984) to retrieve additional immature stages (including arrested larvae) which were identified according to Blitz and Gibbs (1971) and counted.

Weather records

The total monthly rainfall, mean monthly maximum and minimum temperatures during the period of study were obtained from the Agrometeorological station of the University of Nigeria, Nsukka.

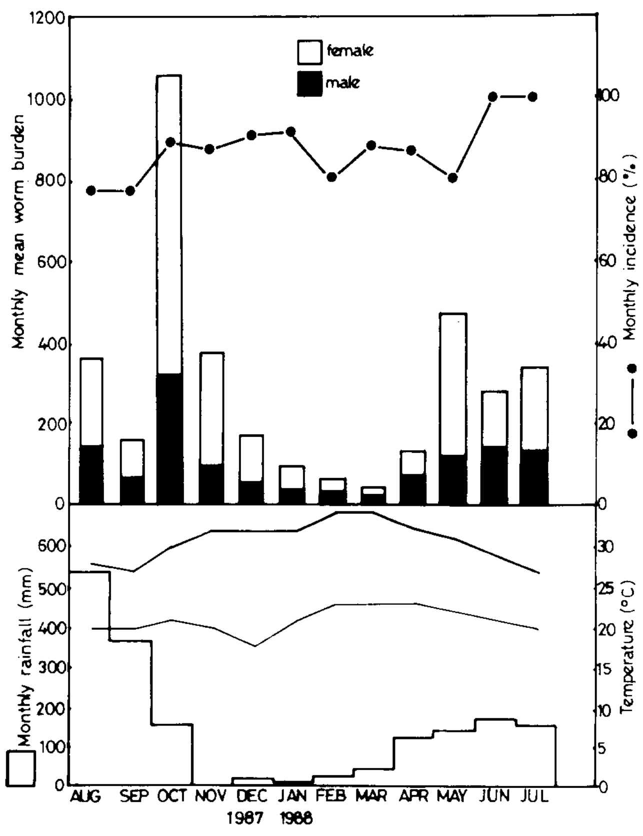

Fig. 1. Monthly incidence of haemonchosis and mean worm burden in WAD sheep and goats compared with the rainfall, maximum (—) and minimum (—) temperatures at Nsukka.

RESULTS

Environmental conditions

The weather records as indicated in Fig. 1 reveal a clear division of the months into rainy (April to October) and dry (November to March) seasons.

Worm burden

The monthly mean (male and female) worm burdens and the incidence of *H. contortus* infection are shown in Table 1 and Fig. 1. The monthly incidence of *Haemonchus* infection was generally high ranging from 77.8 to 100% with no seasonal distinction in the incidence.

There was, however, a clear seasonal pattern in the size of worm burden in the animals. The mean worm burden per animal rose from 132 at the start of the rains in April to a peak of 1060 at the end of the rainy season in October. With the onset of the dry season in November, the mean monthly adult worms per animal fell steadily to the lowest level of 40 at the end of the dry season in March (Fig. 1). For most of the dry months, the mean adult worms per animal did not exceed 100.

TABLE 1

Monthly changes in the composition of *Haemonchus contortus* burden in WAD sheep and goats in the derived savanna area of eastern Nigeria

Month	No. of animals	Range of worm burden per animal	EL_4[a]	Mean worm burden per animal		
				Male	Female	Total
1987						
Aug.	11	50- 960	0 (0)	138	230	368
Sept.	9	30- 500	0 (0)	60	100	160
Oct.	10	100-2400	60 (5.7)	318	742	1060
Nov.	9	40-1200	5 (1.3)	96	288	384
Dec.	11	20- 800	3 (1.8)	51	119	170
1988						
Jan.	12	5- 160	1 (1.1)	38	57	95
Feb.	10	10- 100	0 (0)	36	24	60
Mar.	9	10- 120	0 (0)	20	20	40
Apr.	8	10- 500	0 (0)	66	66	132
May	10	20-1800	0 (0)	119	357	476
Jun.	9	40-1080	0 (0)	141	141	282
Jul.	9	40- 840	0 (0)	136	204	340

[a]The percentage of EL_4 (early fourth stage larvae) to monthly mean worm burden are enclosed in brackets.

Except for the months of March, April and June when the mean numbers of male and female worms were equal, females were consistently more abundant than males (Table 1). Analysis of variance confirmed that there was a significant difference ($P<0.001$) between the sexes as a percentage of the total burden, with a preponderance of females over the year, but there was no significant difference ($P>0.05$) in sex ratio between the dry and rainy seasons.

Very small proportions of EL_4 were recovered in October, November, December 1987 and January 1988, contributing to 5.7, 1.3, 1.8 and 1.1% respectively of the total *Haemonchus* burden (Table 1). Although these showed the characteristic morphological features of arrested larvae described by Blitz and Gibbs (1971), their intestinal cells contained no crystals.

DISCUSSION

The consistently high monthly incidence (77.8–100%) of *H. contortus* infection seen in these WAD sheep and goats is similar to that reported by Okon and Enyenihi (1975) for rain forest and sahel savanna goats. This confirms that, as in other parts of Nigeria (Fabiyi, 1973; Fagbemi and Dipeolu, 1982; Chiejina, 1986) *H. contortus* is ubiquitous in small ruminants and is of great economic importance.

Experimental studies involving the contamination of pastures with sheep and goat faeces in southern Nigeria have been carried out by Okon and Enyenihi (1977) and Chiejina et al. (1989). These studies indicated that the dry season is unfavourable for the development and survival of extrahost stages of *H. contortus*. Chiejina et al. (1989) attributed this to the rapid drying out of the faecal pellets during the hot dry weather. At such times, therefore the availability of infection to animals is nil. In contrast, during the rainy season (April to October) the minimal requirements with respect to temperature and moisture for development are continuously met; hence the expected rise in worm burden due to the availability of infection.

This study indicates a clear seasonal pattern in *H. contortus* infection under field conditions in the derived savanna. The observed gradual rise in worm burden from the onset of the rainy season is similar to the observations of Fabiyi (1973) and Okon and Enyenihi (1975). Given the absence of EL_4, this rise could only be as a result of an accumulation of adult worms following the availability of new infections during the rains.

The observed mean maximum worm burden which occurred in October coincided with the end of the rains but this was followed by a sudden drop in the worm count until the lowest level was obtained in March, which marked the end of the dry season. Results of controlled experiments suggest that in animals experiencing repeated infection, *H. contortus* burden is regulated by constant turnover of adult worm burden (Courtney et al., 1983). Barger et al. (1985) concluded that the regulation is through the development of the host's resistance and loss of established worms, which is controlled by the rate of larval intake and the host's previous experience of infection. But in the complete absence of any larval challenge, as is the case during the dry season, decline in worm burden could be due to sheer mortality of ageing worms.

In spite of the low adult worm burden (40–170) present during the dry season, there was no significant arrested larval development which has been suggested to serve as a means of survival of the nematode during unfavourable environmental conditions (Michel, 1974; Schad, 1977). There are conflicting reports on the actual stimuli for hypobiosis in the field. For example some studies have indicated that where conditions are favourable for the development of the extrahost stages, as in Haryana (India), the faculty of hypobiosis is discarded by parasites (Gupta et al., 1987). By contrast, Ikeme et al. (1987) observed that in spite of the year-round tropical rainfall in Serdang (Malaysia) there were still significant numbers of hypobiotic larvae of *H. contortus* in goats. Again, although Ogunsusi and Eysker (1979) did not observe any significant hypobiosis with *Trichostrongylus colubriformis*, Hart (1964) obtained large numbers of hypobiotic larvae of *T. axei* in northern Nigeria. It seems therefore that the degree of environmental adversity and probably other suggested stimuli for hypobiosis may not be important in certain strains of nematode that are not hypobiosis-prone because, judging from the observations of Chiejina et al. (1988) and that of the present study at Nsukka (Nigeria) where the environmental conditions during the dry season are comparatively harsh enough to disallow successful development and survival of L_3 in caprine and ovine faeces (Chiejina et al., 1989), there was yet no corresponding level of arrested EL_4. It could be concluded that the strain of *H. contortus* prevalent in WAD sheep and goats in the derived savanna area of eastern Nigeria is not hypobiosis-prone. Hypobiosis therefore, does not seem to play any important role in the epidemiology of haemonchosis in the study area.

In the absence of significant hypobiosis during the dry season, the only alternative strategy for survival of *H. contortus* is to exist as adults in the host. Owing to the high fecundity of *H. contortus*, residual proportions of female worms in the total population as seen during the dry season could be advantageous for the transmission of the parasite from one rainy season to the other, and for the successful repopulation of the environment during the favourable season.

The persistence of adults in the host as the only means of surviving the dry season has an important implication for the design of measures for control and prophylaxis of ovine and caprine haemonchosis in this part of the country. If WAD sheep and goats within the same holding in the village are given a single November (early dry season) anthelmintic treatment such as suggested by Fabiyi (1973), the already declining dry season adult worm burden will be totally eliminated and since there will be no recrudescence of the worm population due to resumed development of hypobiotic larvae nor new infections during the dry season (Chiejina et al., 1989), such animals will remain worm free until very late in the rainy season.

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