Experimental Ostertagia infection of sheep: worm populations resulting from single larval doses

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ABSTRACT

Sheep dosed Ostertagia larvae at rates of 2000, 8000, 32,000, or 128,000 each were killed 24 days later. Counts of adult worms from the abomasum showed a maximum in the 8000 group. A maximum for immatures at higher dose rates, although not confirmed statistically, appears likely. High between-animal variations were noted.

INTRODUCTION

The development of Ostertagia circumcincta in the abomasum of the sheep has been studied by Threlkeld (1934) and Denham (1969). The phenomenon of arrested development of this parasite is now well known (Sommerville 1953, 1954; Dunsmore 1960).

The present two trials were designed to compare Ostertagia populations resulting from single experimental infections of sheep with different numbers of larvae, the first with sheep on a high plane of nutrition and the second using sheep on high and low planes.

MATERIALS AND METHODS

Trial 1

Sixteen Romney sheep were maintained under worm-free conditions from birth and fed lucerne chaff and pelleted concentrates. At 6 months of age four animals were randomly allotted to each of four groups, a, b, c, and d. Single doses of infective Ostertagia larvae were given. Doses for each sheep for respective groups were 2000, 8000, 32,000, and 128,000. Animals were killed 24 days after infection, after 24 hours' starvation. Contents were washed from the abomasum and preserved in formalin. The abomasum was digested by Herlich's (1956) method to free worms embedded in the mucosa, and formalinised. Aliquots were examined under a dissecting microscope, and worms were removed and their length measured.

Trial 2

Twenty-four Romney sheep aged 7 months, raised as in trial 1, were randomly allotted to two levels of feeding. Lucerne chaff and concentrates were fed to one (high plane) group, and the other (low plane) group was fed poor quality meadow hay and intermittently starved. After 4 months, live weights were 39-53 kg and 24-36 kg respectively. Animals on each plane were randomly allotted to four groups of three each and infected at the same rates as in trial 1. Subsequent procedures were similar to those used in trial 1, but in an attempt to reduce the bulk of plant fibre in the abomasum, all animals were starved for 7 days before killing.

RESULTS

The results of both trials are considered together.

Length of worms

Worm-length distributions for individual sheep, shown in Figs 1, 2, and 3, suggest, in general, a bimodal type, with a trough at 5 mm, although considerable variation in pattern was evident within each mode. In this study, worms less than 5 mm long are designated "immatures" and those greater than 5 mm, "adults". In general, adult populations represent only fifth-stage worms, whereas immatures may include early fourth to early fifth.

Mean lengths of adults decreased as the size of the infecting dose increased but appeared unrelated to numbers of adults present in an animal.

Worms in abomasal digests

From the two trials, counts of immatures from groups a and b were less than 100 in 16
Fig. 1 — Worm-length distributions for individual animals — trial 1 sheep.

Fig. 2 — Worm-length distributions for individual animals — trial 2 sheep high-plane nutrition.
out of the 20 sheep, and all were less than 400. In groups c and d, 18 out of 20 were less than 900, the highest being 2900 (20% of the total immatures in the animal). Most immatures from digests were less than 2 mm long. No total count of adults from a digest exceeded 100 for any animal.

**Species composition**

*O. circumcincta* represented 96% and *O. trifurcata* 4% of male worms.

**Comparison of worm counts from different infection rates**

Counts are arrayed in Fig. 4.

Analysis of variance and orthogonal contrast were applied to investigate departures from linear effects. Data were transformed by log (1 + n/100). Because log linear dose rates were applied, log linear worm-count response would be the expected observation, and it is the departures from log linear response that are of interest.

For adults, no increases in counts beyond the b dose rate were noted in either trial. For the low-nutritional-plane animals in trial 2, 5% significant negative linear and 1% significant negative quadratic rates effects were attained, indicating a maximum in the b group and a decrease as dose rate increased. This was not noted for the high-plane animals, for trial 2 main effects, or for trial 1, although had the quadratic response in trial 1 been measured ignoring the highest dose rate, it would have been highly significant. Trial 2 showed highly significant linear and quadratic rates × nutrition interactions, but these results appear spurious because they suggest that as dose increases above the b rate, increased nutrition permits greater and decreased nutrition lesser establishment of adults. Nutritional main effects showed no significant differences.

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**Fig. 3** — Worm-length distributions for individual animals — trial 2 sheep low-plane nutrition.

- Row a — sheep dosed 2,000 larvae.
- Row b — sheep dosed 8,000 larvae.
- Row c — sheep dosed 32,000 larvae.
- Row d — sheep dosed 128,000 larvae.

Numbers in blocks show (A) counts of adults and (I) counts of immatures.
Immatures in both trials showed 1% significant linear effects, indicating the expected increase as dose level increased. Quadratic effects in trial 2, although negative, did not reach 5% significance, and, therefore attainment of or approach towards a maximum was not established.

Linear dose-rate effects for immatures and adults were significantly different, indicating a decrease in the proportion of adults as dose rate increased.

**DISCUSSION**

The developmental studies of Threlkeld (1934) and Denham (1969) on *Ostertagia* in sheep showed fifth stage worms at 8-9 days and fully developed females at 12-15 days after infection. Present results suggest a maximum for adult *Ostertagia* counts at a dose rate of 8000 or a little higher, and a possible reduction at higher rates. The highest adult count in the h group was 6500, and in the c and d groups only 9000. A maximum for immatures, although not confirmed statistically, appears likely. The highest count of immatures in trial 1 was 6600. Three of the six c-group counts in trial 2 were higher than could have resulted from a b-group larval dose, but the highest d-group count was less than a c-group dose.

The great range noted in counts of adult worms implies a wide between-animal variation in: (i), numbers establishing, (ii), numbers developing to the adult stage, (iii), the proportion eliminated before 24 days, or (iv), a combination of these factors.

The fact that no total count in the d group attained 32 000 indicates that at least 75% of the infecting dose in this group had either failed to establish or had been eliminated at some stage of development. Similar comments apply to variation in total counts in the lower-dose groups. Armour *et al.* (1966) infected sheep with 100 000 *O. circumcincta* larvae and reported that loss of adult worms occurred from day 16 onwards.

Worm-length distributions were similar in their general bimodal pattern to those noted by Dunsmore (1960), but differed in the much greater variation within either mode. The patterns demonstrate that arrested or delayed development may occur at any stage between early and late fourth. Distributions showing no pronounced trough between 4 and 6 mm suggest that, in these animals, development of worms to the adult stage may have been taking place, and as a “trickle”, rather than as a “wave”. Wave development implies that at least some populations would show a substantial mode between 4 and 6 mm, but no such mode was seen. No worms from 3–6 mm were recorded from some sheep, and some harboured no worms over 2 mm, which suggests that in these animals no development of any immatures was taking place. The absence of adults in some sheep implies that any such arrest in development could not be attributable to the presence of adult worms.

Trial 2 demonstrated no consistent worm-population differences between the two planes of nutrition.

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REFERENCES


