

THE PATHOLOGICAL PHYSIOLOGY OF HELMINTH INFESTATIONS. I. *OSTERTAGIA CIRCUMCINCTA*

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INTRODUCTION

Threlkeld & Johnson (1948) recorded a decrease in erythrocyte counts and haemoglobin concentration in calves experimentally infested with *Ostertagia ostertagi*. Similar results as well as a marked decrease in circulating red blood cell volume, were reported in sheep artificially infested with *O. circumcincta* by Horak & Clark (1964).

The present study was undertaken in an attempt to elucidate the cause of this anaemia in sheep.

METHODS

Three Dorper sheep, bred and reared worm-free, were used in this experiment.

Plastic abomasal fistulae were inserted in these sheep. After allowing for healing of the wounds, red cells of all three animals were labelled by adding 50 μC ^{51}Cr to 30 ml of whole blood with A.C.D. as anticoagulant. After incubation for 90 minutes at room temperature, 50 mg of ascorbic acid were added to prevent further uptake of ^{51}Cr by the cells. The plasma was replaced by fresh autogenous plasma and the blood reinjected into the animals. Two of the sheep were then infested and radioactivity counts done on blood and abomasal contents of all three sheep twice weekly for the following five weeks. Haematocrit values and haemoglobin concentrations were determined from the blood samples, pepsin concentration (Grosskopf, 1959), larval development and pH from the abomasal samples.

Infestation, food intake, blood analyses, faecal egg counts and recovery and counting of worms have been described (Horak & Clark, 1964).

EXPERIMENTAL ANIMALS

Sheep 1: Uninfested control.

Sheep 2: Infested with 270,000 larvae. Died 143 days later.

Sheep 3: Infested with 270,000 larvae. Died 32 days later.

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RESULTS

Clinical Observations

Food intake.—The diet consisted of lucerne hay *ad lib.* Sheep 2 and 3 showed a marked decrease in food intake during the second and third weeks of infestation followed by a slight increase (Sheep 2) or a further decline (Sheep 3). The food intake of Sheep 1 was maintained at a constant level (Fig. 1).

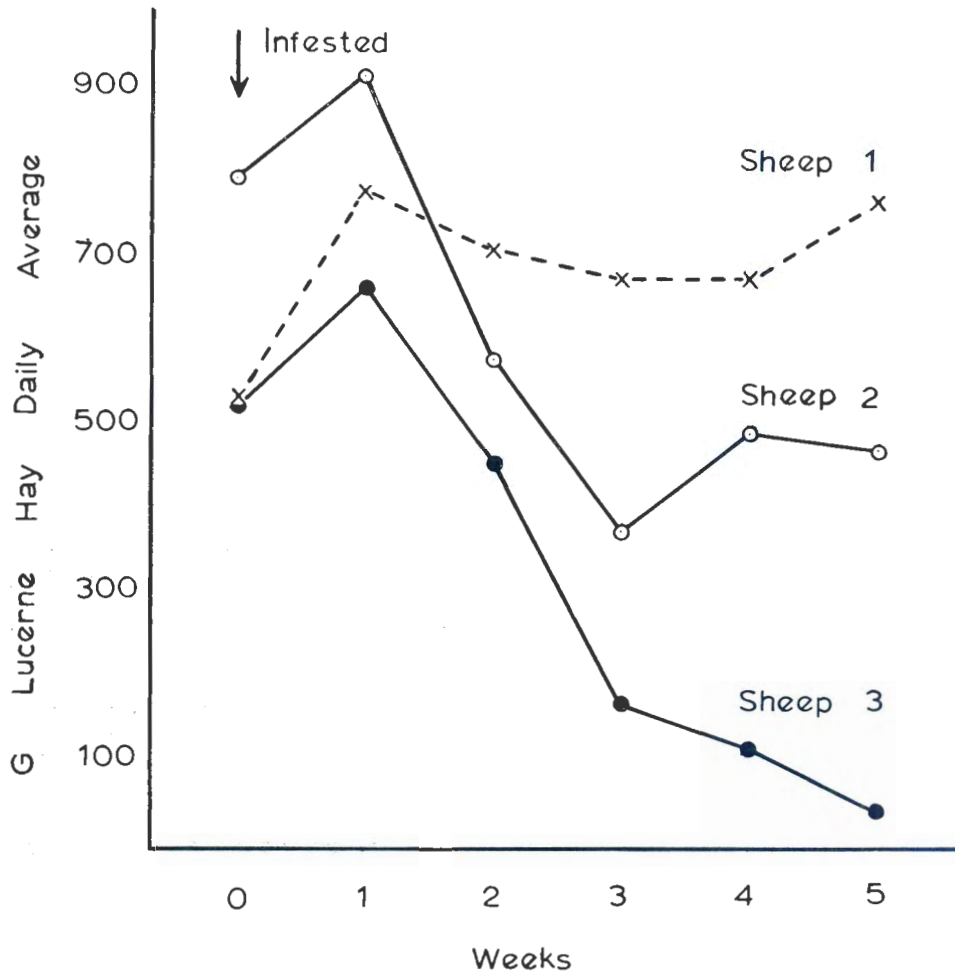


FIG. 1.—Lucerne hay intake.

Body Weight.—The decrease in body weight of Sheep 2 and 3 closely followed the reduced food intake of these sheep. Sheep 1, however, gained 1.6 Kg during the course of the experiment (Fig. 2).

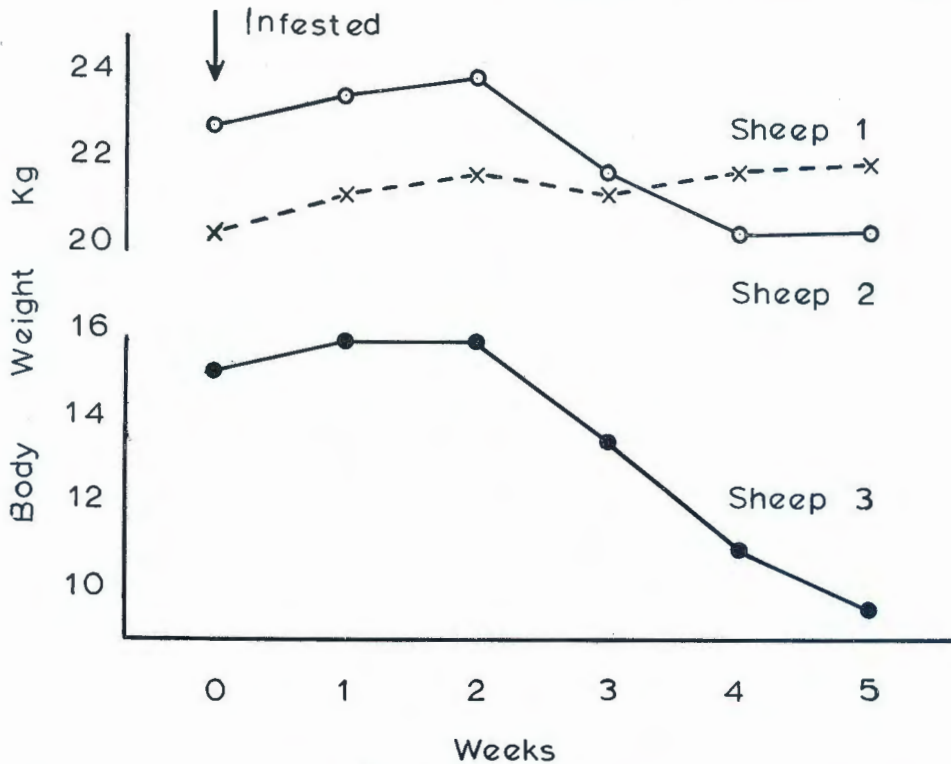


FIG. 2.—Body weights.

At no stage during the infestation was diarrhoea, sub-mandibular oedema or clinical anaemia observed.

Clinical Chemistry

The clinical chemistry findings are presented in Table 1.

TABLE 1.—*Clinical Chemistry Findings*

Week of Infestation.	0	1	2	3	4	5	6	7	8
Packed cell volume percentage..	30	30	30	28	27	28	33	—	—
	30	31	33	33	32	33	32	—	28
	27	29	29	29	30	32	—	—	—
Haemoglobin gm percentage...	11.1	10.8	12.4	11.1	10.8	10.8	—	—	—
	10.3	11.4	13.8	13.5	11.6	12.1	—	—	9.7
	9.5	10.8	11.3	11.4	11.4	11.3	—	—	—
Abomasal pH.....	—	—	2.4	2.3	2.6	2.3	2.7	2.5	—
	—	—	6.8	6.4	5.7	6.1	5.2	2.9	—
	—	—	7.5	6.8	5.8	3.1	—	—	—
Pepsin concentration in Units*	—	—	13	25	16	20	15	20	—
	—	—	6	9	13	15	13	15	—
	—	—	9	0	18	>30	—	—	—

The figures for Sheep 1, 2 and 3 are given, respectively, under each heading

*One unit of pepsin = Enzyme which produces 0.00015 milli-equivalents of tyrosin per 5 ml from 100 mgm of Hb in an acid medium during 5 minutes at 37° C (Grosskopf, 1959)

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Red blood cells: No marked decrease in packed red cell volume or haemoglobin concentration was noted. Sheep 2, however, showed a slight decrease 54 days after infestation.

Abomasal pH: The first recording of abomasal pH was made two weeks after infestation and was markedly higher in the infested sheep than in Sheep 1. At the time of death the pH of Sheep 3 had decreased, while that of Sheep 2 only returned to normal during the seventh week of infestation.

Pepsin concentration: As in the case of abomasal pH the first recording of pepsin concentration was made two weeks after infestation. Pepsin concentration was reduced in the infested sheep when compared with the control, although Sheep 3 did show an increase in concentration during the two weeks preceding death.

At the time of sampling the colour of the abomasal ingesta was noted and whereas the ingesta of Sheep 1 was a constant brown colour that of Sheep 2 and 3 was green and appeared undigested during the first five weeks of the experiment.

Radio-activity counts

The counts obtained from the abomasal contents of all three animals were extremely low throughout the experiment and there was no difference between those from the infested sheep and the control. The decrement of activity in the blood of all three sheep was entirely normal and here again no effect of the infestation could be detected.

Larval development

Larvae in the abomasal ingesta withdrawn through the fistulae were examined to determine the stage of development (Table 2).

TABLE 2.—*Larval development and egg counts per gm of faeces*

Age of infestation in days	4	11	14-21	25	32
Stage of Development	3rd	4th, 4th Moults 5th	5th	5th, Adult	5th, Adult
Egg Count { Sheep 1.....	0	0	0	0	0
Sheep 2.....	0	0	0	100	300
Sheep 3.....	0	0	0	Positive	500

Faecal examinations

The results are summarized in Table 2. Eggs were recovered in the faeces of Sheep 2, 24 days and Sheep 3, 25 days after infestation.

Autopsy

No gross macroscopic changes were observed in Sheep 2. Sheep 3 exhibited slight serous atrophy of the mesenteric fat along the abomasum. Numerous nodules and shallow erosions containing worms were observed at the omasal-abomasal juncture while fewer nodules were found in the pyloric portion of the abomasum. The fistula had been inserted into the fundic portion of the abomasum and few lesions attributable to helminths were found here.

Worms recovered post mortem

Sheep 2 died after the conclusion of the experiment while Sheep 3 died of oster-tagiasis during the experiment. The total number of worms recovered from these sheep is shown in Table 3.

TABLE 3.—*Ostertagia circumcincta* recovered at autopsy

Sheep No.	Age of Infestation at Death	Stage of Development			Total
		4th	5th	Adult	
2.....	143	0	0	180	180
3.....	32	651	13,994	11,315	25,960

No cross-infestation with other nematode parasites was present in either of the sheep.

DISCUSSION

Clinical observations

As previously reported (Horak & Clark, 1964) anorexia was one of the first responses to infestation. The decreased food intake was closely followed by a loss in body weight. That the anorexia and weight loss were not due to the fistulae is shown by the fact that the uninfested control ate normally and gained weight during the experimental period.

Clinical chemistry

Ross, Todd & Dow (1963) found an increase in abomasal pH and decrease in pepsin concentration in cattle infested with *O. ostertagi*. The present results in sheep confirm their findings. These lesions are probably due to the effect of the parasite on the various cells lining the gastric glands (Sommerville, 1954). Sheep 3 was moribund for some time before death; the terminal decrease in pH and increase in pepsin concentration was probably due to decreased gastric motility and food intake, resulting in a retention and concentration of abomasal contents.

Radio-activity counts

The results indicate that the infestation did not cause haemorrhage into the abomasum. Unfortunately, the animals in the present trial did not show the decrease in haematocrit and haemoglobin values reported previously (Horak & Clark, 1964), but they did react similarly in all other respects and they were undoubtedly heavily infested. It would, therefore, appear unlikely that anaemia associated with *O. circumcincta* infestation is due to abomasal haemorrhage or blood-sucking by the worms.

Further confirmation of this result was obtained during Trial 2 of the previous experiment reported by Horak & Clark (1964). The sheep in that experiment were injected with ⁵¹Cr labelled erythrocytes and counts were made on the blood and faeces

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at regular intervals. Neither an abnormal decrement in blood counts nor an increase in faecal counts was observed even though the sheep exhibited a marked anaemia. These results were inconclusive, however, as the anorexia resulted in a very small faecal output complicating interpretation.

Helminthology

The parasitic development of this worm closely followed that of *O. ostertagi* described by Douvres (1956). On the fourth day of infestation, however, only third stage worms were present in the ingesta, the fourth stage probably lying in the gastric glands (Sommerville, 1954).

The 25,960 worms recovered from Sheep 3 was similar to the total of 29,586 which produced death in one sheep (Horak & Clark, 1964), while Sheep 2, which died 143 days after infestation, had lost most of its worm burden (Table 3).

Autopsy

The distribution of abomasal lesions in Sheep 3 is interesting in that they were concentrated at the omasal-abomasal juncture with fewer lesions in the pylorus. The virtual absence of lesions in the fundus was possibly due to the position of the fistula.

SUMMARY

An experiment is described in which two sheep were artificially infested with *O. circumcincta* and a third kept as an uninfested control. Plastic abomasal fistulae were inserted in these sheep and their erythrocytes were labelled with ^{51}Cr . Radioactivity counts on blood and abomasal contents were done at regular intervals as well as other reactions being noted.

The main findings were:—

- (i) No abnormal decrement in blood counts or increase in abomasal counts.
- (ii) An increase in abomasal pH and decrease in pepsin concentration.
- (iii) Anorexia and weight loss.

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