Onderstepoort J. Vet. Res. (1964), 31 (2), 143–150
Printed in the Republic of S. Afr. by the Government Printer, Pretoria

THE EPIZOOTIOLOGY OF NEMATODE PARASITES OF SHEEP IN THE COASTAL AREA OF THE EASTERN PROVINCE

L. W. ROSSITER, Principal State Veterinarian, Grahamstown, Cape Province

Introduction

A survey of the seasonal incidence of the nematode parasites of sheep and goats in the coastal areas of the Eastern Province, has been carried out. In a preliminary report Rossiter (1961) described the vegetation and farming practices in this region, as well as methods of carrying out this survey. His observations were made on three flocks; faecal samples were regularly collected and differential egg counts carried out.

The reliability of egg counts as an index of the worm burdens has been doubted (Roberts, 1957; Muller, 1961; Reinecke, 1963). This problem can be solved by comparing egg counts with worm burdens. Simultaneously, data from regular *post mortem* examinations can be used to study the epizootiology of the various species.

Materials and Methods

The experiment was carried out on the farm " Lincoln " in the frost-free area on the coastal peneplain, about 10 miles inland from Port Alfred. Fifty weaned lambs, 9 to 12 months of age, were introduced from the Karoo in April, 1962. Immediately on arrival they were drenched with thiabendazole to rid them of round worms; they were then grazed with the farm flock of the same age for two weeks. Thereafter they were run on their own in a small 20 morgen camp consisting of mixed sour veld. They gradually became infested as was confirmed by faecal egg counts and by August, 1962 they had acquired a moderate infestation.

The flock became heavily infested in summer; some died but were not examined. The entire flock was therefore treated with half doses (10 gm) of phenothiazine on 27 December, 21 February and 24 April.

Differential egg counts were carried out every two weeks on the entire experimental flock.

Two sheep were slaughtered every 14 days, but in four instances the periods varied from 12 to 21 days. These animals were randomly selected, but such animals as were severely affected by helminthiasis, were immediately included in the slaughter group. After starvation for 36 hours, faecal samples were collected for differential egg counts and the sheep slaughtered. Slaughter took place on the alternate week to the sampling of the entire flock for faecal egg counts.

Examination *post mortem* is described elsewhere (Reinecke, 1961).

The experiment ran from 17 September, 1962 to 3 September, 1963, and climatic data were recorded for this period.

Received on 20 July, 1964, for publication—Editor

TABLE 1.—*Worms recovered* post mortem

Date	Sheep No.	*HAEMONCHUS*			*OSTERTAGIA*				*TRICHOSTRONGYLUS*						*OESOPHAGOSTOMUM*		*NEMATODIRUS*		*TRICHURIS*
		3rd	4th	*contortus*	*3rd	*4th	*circumcincta*	*trifurcata*	3rd	4th	*axei*	*rugatus*	*colubriformis*	*pietersei*	4th	*columbianum*	4th	*spathiger*	*globulosa*
17 Sept..... 1962	67 25	0 0	6 0	1,006 730	20 0	0 0	320 232	65 18	0 0	0 0	40 120	658 423	282 282	0 0	0 0	24 43	0 0	0 220	4 13
8 Oct.....	146 169	0 10	20 228	1,150 3,240	20 0	6 42	380 2,380	62 577	0 0	20 0	180 800	141 1,622	68 811	276 1,622	0 0	14 71	0 0	0 0	4 20
22 Oct.....	17 260	30 20	140 82	1,860 510	38 30	82 32	1,030 508	0 27	0 0	0 0	118 242	499 411	182 242	454 767	0 0	71 32	0 0	0 0	4 2
5 Nov.....	128 26	0 30	740 95	2,416 499	143 10	121 20	741 494	141 0	76 0	288 345	682 85	704 359	384 265	128 156	0 0	30 50	0 0	0 0	4 12
19 Nov.....	87 186	10 0	75 2,957	920 843	52 0	95 196	252 350	22 10	438 0	829 0	375 133	1,102 57	375 0	1,028 69	0 3	46 22	10 313	50 0	15 3
3 Dec.....	188 210	0 0	999 233	7,650 883	0 0	143 36	1,080 260	272 0	0 0	50 0	213 290	144 153	144 41	72 396	0 0	38 61	260 270	1,006 10	17 7
14 Dec.....	18 36	0 0	3,536 1,206	5,416 4,054	0 0	300 190	984 1,576	329 277	0 0	0 50	516 666	912 540	357 135	714 451	4 3	41 88	406 763	0 0	2 10
2 Jan..... 1963	106 167	0 0	292 163	1,553 4,347	0 0	58 100	1,277 671	319 92	0 0	0 0	130 296	691 273	221 55	321 218	0 0	80 24	187 20	503 433	30 2
14 Jan.....	132 140	0 0	216 0	1,040 150	0 0	0 0	636 0	0 0	0 0	0 0	180 0	597 601	104 64	165 408	233 37	31 7	510 36	140 340	21 10
28 Jan.....	110 47	0 0	283 600	337 1,676	0 0	0 80	60 502	0 158	0 0	0 0	80 20	225 608	199 401	99 207	0 5	4 25	745 140	0 0	0 17
11 Feb.....	164 256	0 0	190 0	2,390 470	0 0	0 0	306 0	0 0	0 0	0 0	43 20	697 280	0 70	196 0	160 92	24 12	570 40	0 0	0 0
25 Feb.....	207 203	0 0	0 0	0 0	0 0	0 0	0 20	0 0	0 0	0 0	40 143	216 207	118 74	26 15	2 0	2 0	193 78	0 80	0 0
11 Mar.....	49 309	0 0	120 343	1,050 973	0 0	0 20	190 200	0 18	0 0	0 0	20 126	16 920	0 285	0 381	22 80	0 0	100 276	10 176	0 3
1 Apr.....	166 9	0 0	216 631	170 810	0 0	8 18	56 275	0 38	0 0	0 0	90 106	789 315	116 210	255 131	50 0	0 2	160 0	10 0	0 0

TABLE 1 (*contd.*)

Date	Sheep No.	*HAEMONCHUS* 3rd	*HAEMONCHUS* 4th	*HAEMONCHUS* *contortus*	*OSTERTAGIA* *3rd	*OSTERTAGIA* *4th	*OSTERTAGIA* *circumcincta*	*OSTERTAGIA* *trifurcata*	*TRICHOSTRONGYLUS* 3rd	*TRICHOSTRONGYLUS* 4th	*TRICHOSTRONGYLUS* *axei*	*TRICHOSTRONGYLUS* *rugatus*	*TRICHOSTRONGYLUS* *colubriformis*	*TRICHOSTRONGYLUS* *pieterser*	*OESOPHAGOSTOMUM* 4th	*OESOPHAGOSTOMUM* *columbianum*	*NEMATODIRUS* 4th	*NEMATODIRUS* *spathiger*	*TRICHURIS* *globulosa*
16 Apr.....	250 194	0 0	1,711 110	2,690 526	0 0	50 10	135 30	19 0	0 0	0 0	110 164	545 426	425 284	120 0	306 190	114 3	0 0	0 0	21 20
29 Apr.....	98 83	0 0	30 640	0 633	0 0	0 10	0 191	0 0	0 0	0 0	20 116	519 706	91 132	0 45	86 40	2 0	380 190	4 168	0 2
13 May....	57 149	0 0	40 88	0 90	0 0	0 0	0 32	0 0	0 0	0 0	0 355	346 795	186 292	0 238	2 22	0 1	66 238	0 0	1 4
27 May....	122 60	0 0	73 210	1,149 110	0 0	5 0	233 0	0 0	0 0	0 0	0 245	1,653 337	713 145	177 0	93 100	19 0	0 10	951 0	7 3
10 Jun.....	70 28	0 0	530 115	480 10	0 0	30 0	82 0	0 0	0 0	0 0	220 518	1,686 740	813 345	407 148	85 84	9 0	35 0	0 0	0 1
24 Jun.....	120 82	0 0	850 340	20 820	0 0	0 40	0 130	0 0	0 0	0 0	482 120	732 452	282 219	111 109	8 17	4 0	0 20	0 0	0 0
9 Jul......	187 180	0 0	805 646	305 2,787	0 0	10 10	42 240	0 0	0 0	0 0	215 326	707 767	385 319	193 94	4 4	2 19	0 33	0 100	0 0
22 Jul......	104 291	0 0	253 483	1,443 2,265	0 0	14 0	151 0	0 0	0 0	0 0	141 206	626 1,193	179 410	90 261	30 45	20 70	0 231	0 0	0 0
5 Aug.....	72 22	0 0	1,666 683	670 1,058	0 0	5 0	26 0	0 0	0 0	0 0	126 111	122 2,111	53 559	0 435	24 4	67 4	0 127	20 27	5 0
19 Aug.....	231 111	0 0	1,900 133	4,476 593	0 0	28 0	300 53	0 0	0 0	0 0	74 10	924 1,265	261 502	0 93	12 4	60 23	0 120	0 0	0 0
13 Sep.....	209 121	0 0	245 776	610 1,246	0 0	0 0	0 0	0 0	0 0	0 0	50 118	499 221	218 102	63 17	0 0	54 4	0 0	0 0	0 0

* 3rd = Third stage　　　*4th = Fourth stage.

Results

Species Recovered post mortem

This is summarized in Table 1.

Parasites of the abomasum

Haemonchus contortus: This species rapidly built up to a peak in December when treatment became necessary to prevent mortality. It was the dominant species except during those periods immediately following treatment with half doses of phenothiazine; during these periods more *Trichostrongylus* spp., and on rare occasions more *Nematodirus spathiger*, were present. This was to be expected as at these dosage rates only *H. contortus* is affected.

It is of interest that immature stages were present in all but five animals, and also that these were present in winter and spring, which were comparatively dry. Only two animals did not have either larval or adult *H. contortus.*

Ostertagia spp.: Numerically *O. circumcincta* dominated *O. trifurcata.* Worm burdens reached their peak from October to January. Third and fourth stage larvae were recorded neither in such numbers nor as consistently as those of *H. contortus.* Immature worms were recovered from October to January, coincidental with the higher adult worm burdens.

The worm counts rose steeply in October, while those of *H. contortus* only showed a marked rise two months later. This appears to indicate that *Ostertagia* spp. respond more readily to rain in the cooler spring months, but that once *H. contortus* increases, *Ostertagia* spp. tend to disappear.

Trichostrongylus axei: This parasite was present in moderate numbers in all but three sheep. Larval stages were recovered from the abomasum in five autopsies only, in October and November. The adult worm burden rose from October to December, fell to a low level in the summer months, rose again in June and fell steadily until September.

Parasites of the small intestine

Trichostrongylus spp.: Most of the parasites in the small intestine belonged to this genus. The increase in worm burdens in October is due to 4,055 worms recovered from sheep 169; this was far in excess of the number of worms in other sheep slaughtered at the time. Worm counts fell sharply during the summer months, but rose steadily in autumn to reach a peak in August. Larval stages were recovered in small numbers in October, larger numbers in November and then disappeared.

The order of prevalence of the species was *T. rugatus*, *T. colubriformis* and *T. pietersei.* During October, however, *T. pietersei* was dominant.

Phenothiazine at half dosage levels had no effect on this genus; worm burdens were already falling prior to treatment, but rose sharply after the second and third treatment.

Nematodirus spathiger: This species was recovered from 32 autopsies. A striking feature was the recovery of only fourth stage larvae in 15 of these sheep.

With the exception of the animals slaughtered on 16 April, this species was consistently recovered from mid-November to May; at other times it made an erratic appearance.

Parasites of the caecum and colon

Oesophagostomum columbianum: This species was always present in moderate numbers. A marked feature was the predominance of fourth stage larvae from January to June inclusive; adults were more numerous during the rest of the survey period. The larval predominance coincided with the phenothiazine treatment. This drug is known to be more effective against adults than larval stages, thus accounting for the reversed ratio.

Trichuris globulosa: This species was consistently recovered from September to mid-January and again in May.

A comparison between differential egg counts and worm burdens

The results of four autopsies as well as the average egg counts for that period, have been grouped together in an attempt to indicate general trends rather than individual fluctuations. The data are illustrated graphically in Figure 1.

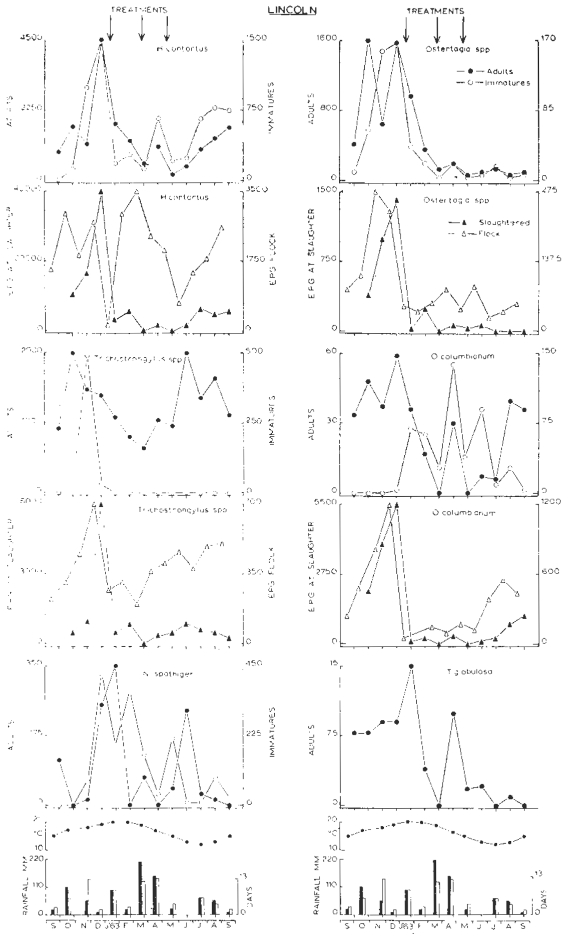

FIG. I.—Comparison of average worm burdens *post mortem*, eggs per gram (e.p.g.) of faeces counts at slaughter and of flock intervals of four weeks.

·—· = Mean monthly temperatures.

▌ = Total monthly rainfall.

▯ = Number of days rain fell.

(*a*) *Haemonchus contortus*

There appears to be a fairly close correlation between egg counts performed before slaughter and worms recovered *post mortem*. The average egg count of the flock did not always agree with the autopsy results.

Worm burdens increased rapidly after the rains in November and half doses of phenothiazine controlled this infestation. There was not the same increase in worm burdens, however, after heavy rains in March and April.

The graph in Figure 1 does not give a true reflection of the effects of the second and third anthelmintic treatments, as the results were grouped irrespective of the time of treatment. Autopsy results summarized in Table 1 show the effects of treatment.

(*b*) *Ostertagia* spp.

There is little or no correlation between egg counts and number of worms recovered *post mortem*. Heavy worm burdens did not cause a corresponding increase in egg counts of slaughtered sheep. Worm counts rose suddenly in October and were falling steadily before treatment was initiated in December. Phenothiazine did not suppress the worm burdens to the same extent as it did the egg counts.

(*c*) *Trichostrongylus* spp.

There is little correlation between the egg counts of the slaughtered sheep and their respective worm burdens. Both worm burdens and egg counts fell prior to treatment, but rose steadily even after the third dose of phenothiazine. The heavy rains in March and April were followed by a rise in worm burdens in late autumn and winter; this was also reflected in the egg counts of the flock, but not in those of the slaughtered animals.

(*d*) *Oesophagostomum columbianum*

There is little correlation between egg counts and worm burdens.

(*e*) *Nematodirus spathiger*

No comparison can be made between egg counts and worm burdens, as eggs were only recovered twice from individual sheep.

(*f*) *Trichuris globulosa*

Similar remarks apply as to the preceding species.

Discussion

It is undesirable to treat an experimental flock during the survey period. As, however, some died in December from heavy *H. contortus* infestations treatment was essential to prevent further mortalities.

Treatment could be aimed either at the complete elimination or the partial control of the nematodes. The elimination of the worms by a highly effective anthelmintic with a wide range of efficacy, e.g. thiabendazole, would have created an almost worm-free flock and jeopardized the main object of the experiment. The other alternative was the partial control of the worms, particularly those responsible for the mortalities. This was the method chosen. The entire flock was treated with half doses of phenothiazine. This solved the immediate problem, but had little effect on other genera except adult *O. columbianum*. The survey could continue, but further treatment was again necessitated by abnormally heavy rains.

The treatments depresssed egg laying in all worms and therefore faecal egg counts were lower and did not give a true reflection of the worm burdens.

An important observation was, that in spite of treatment, there was a very close relationship between egg counts of slaughtered sheep and the adult worm burdens of *H. contortus*. The flock egg count averages did not correspond to the same extent and flock averages should accordingly be treated with reserve. In the other species, neither egg count data of slaughtered sheep nor the average egg count of the flock, was a reliable index of infestation.

This experiment emphasizes the importance of third and fourth stage larvae in a study of this nature; this was particularly noticeable in *O. columbianum* and *N. spathiger*. To establish the presence of immature worms, slaughter and critical examination of the worms present is essential.

It is interesting to note so many fourth stage larvae of *O. columbianum* from mid-summer to autumn and so few adults later in the year. In experimental infestations there is an inverse ratio between the number of *O. columbianum* larvae dosed and the number that eventually develop into adults (Sarles, 1944). These experiments confirm Sarles' observations, under field conditions. At various times the experimental sheep showed moderate to severe diarrhoea; this possibly resulted in the expulsion of the larvae as demonstrated by Sarles. This has also been observed in calves, experimentally infested with *Oesophagostomum radiatum* (Roberts, Elek & Keith, 1962).

It has been shown by Kates & Turner (1953) that lambs rapidly develop a resistance to *N. spathiger*. In many of the sheep slaughtered fourth stage larvae were recovered while adults were absent. It is suggested that this is part of immune-mechanism, as is the case with other worms, e.g. *Haemonchus placei* (Roberts, 1957) and *Ostertagia* spp. (Sommerville, 1954).

Peak *H. contortus* infestation appears to be from December or January to April. Summer rains stimulated outbreaks of haemonchosis, thus confirming Gordon's (1948) observations.

Ostertagia spp. make their appearance earlier; they reach a peak from October to December and taper off from January onwards. Whilst the development of *H. contortus* is adversely affected by temperatures below 18·3°C (Gordon, 1948), this is not the case with *Ostertagia* spp. No doubt this accounts for its earlier appearance and peak.

Strategic dosing

Gordon (1948) defined strategic drenching as preventive dosing to control potential outbreaks of worm infestation; this is based on the epizootiology of the various genera. In the coastal areas of the Eastern Province the following strategic drenches are recommended:—

1. October to control *Ostertagia* spp.
2. December to control *H. contortus* and *O. columbianum*.
3. April to control *Trichostrongylus* spp.

Tactical dosing, i.e. dosing according to the rainfall, should be practised when rain, in excess of 15 mm, is recorded in a period of seven to ten days, particularly from spring to autumn.

Anthelmintics effective against both larvae and adults (e.g. thiabendazole and methyridine) may be given at any time after such rains. On the other hand, if other anthelmintics, only effective against adults, are used, at least three weeks should elapse before treatment so that the larvae may develop to adults.

Conclusions

Seasonal incidence trends of the nematode parasites of sheep can best be determined by slaughtering sheep at regular intervals and carrying out total and differential worm counts *post mortem*. Differential egg count data are reliable with *Haemonchus contortus* only.

Summary

An experiment comparing critical slaughter results with egg count data collected *ante mortem* is described.

Haemonchus contortus was prevalent from December to April; *Ostertagia* spp. from October to December; *Trichostrongylus* spp. from July to August.

No obvious trends were discernible either with *Oesophagostumum columbianum* or *Nematodirus spathiger*, although larval stages of both species were plentiful from mid-summer to autumn.

Strategic dosing is recommended in October, December and April.

Acknowledgements

A very real debt of gratitude is due to Dr. R. K. Reinecke, Head of the Department of Parasitology, Onderstepoort for his guidance and support during the course of the experiment and for invaluable assistance in the preparation of this paper and Miss M. Collins for drawing the graph.

Thanks are also due to Mr. R. R. Dalbock for technical assistance and to Messrs. E. N. S. Warren and Sons of " Lincoln " without whose co-operation this experiment would not have been possible.

The author expresses his thanks to the Chief, Veterinary Field Services for his asistance and permission to publish this paper.

References

GORDON, H. McL., 1948. The epidemiology of parasitic diseases with special reference to studies with nematode parasites of sheep. *Aust. Vet. J.* 24, 17–44.

KATES, K. C. & TURNER, J. H., 1953. Experimental studies on the pathogenicity of *Nematodirus spathiger*, a trichostrongylid parasite of sheep. *Am. J. Vet. Res.* 14, 72–81.

MULLER, G. L., 1961. Cited by Hobbs, W. B.; Rossiter, L. W.; Reinecke, R. K.; Muller, G. L.; Verster, Anna; van der Walt, K.; and Tustin, R. C. Symposium: Helminth Research in South Africa. *J.S. Afr. Vet. Med. Ass.*, 32, 477–479.

REINECKE, R. K., 1961. Helminth Research in South Africa. III. The diagnosis of nematode parasites in ruminants for worm survey purposes. *J.S. Afr. Vet. Med. Ass.*, 32, 167–173.

REINECKE, R. K., 1963. Methods of testing anthelmintics in sheep. *J.S. Afr. Vet. Med. Ass.*, 34, 233–246.

ROBERTS, F. H. S., 1957. Reactions of calves to infestation with the stomach worm, *Haemonchus placei* (Place, 1893) Ransom, 1911. *Aust. J. Agric. Res.*, 8, 740–767.

ROBERTS, F. H. S., ELEK, P. & KEITH, R. K., 1962. Studies on resistance in calves to experimental infections with the nodular worm, *Oesophagostomum radiatum* (Rudolphi, 1803) Railliet, 1898. *Aust. J. Agric. Res.*, 13, 551–573.

ROSSITER, L. W., 1961. Helminth research in South Africa. II. Seasonal incidence of nematode parasites of small stock in the Grahamstown area. *J.S. Afr. Vet. Med. Ass.*, 32, 157–162.

SARLES, M. P., 1944. Effects of experimental nodular worm (*Oesophagostomum columbianum*) infection in sheep. *U.S. Dept. Agric. Tech. Bull.* 875, pp. 19.

SOMMERVILLE, R. I., 1954. Histiotrophic Phase of the Nematode Parasite, *Ostertagia circumcincta*. *Aust. J. Agric. Res.*, 5, 130–140.