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INTERNAL PARASITES OF SHEEP AND THEIR EFFECTS ON PRODUCTION

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SUMMARY

Trials were undertaken to ascertain the effect of naturally-acquired trichostrongyle infestation on liveweight gain and wool production of sheep during their first year of life. Results show that what is probably regarded as the normal rate of growth of young sheep is not necessarily the same as the optimal rate.

Sheep in which infestation had been almost completely suppressed by fortnightly drenching with thiabendazole showed a mean liveweight-gain response of up to 31 lb over infected control animals grazing the same pasture. In the untreated control groups, mortalities of up to 11% could be directly attributed to worm infestation. Increases of up to 2.6 lb or 46% in greasy-fleece weight were recorded in favour of the treated groups. Monthly sampling showed that differential wool growth was greatest from April to August, wool production in the drenched group being almost twice that of the untreated animals.

Faecal egg counts of control animals showed a relatively constant pattern, from which it is seen that the highest levels of infestation usually occurred in the months of March, April and May.

A strategic drenching programme of three drenches at monthly intervals, commencing in March, resulted in a mean response of 15 lb liveweight together with an increase of 1.2 lb greasy wool.

The results demonstrate the possible major role of trichostrongyle infestation in the hogget ill-thrift problem, and provide evidence of greater economic loss in meat and wool production than has previously been considered.

INTERNAL PARASITES are insidious and seldom spectacular, but constitute a constant drain on the vitality and productivity of the host animal. Although, for a number of reasons, an accurate estimate of losses due to parasitic diseases is practically impossible, it is becoming increasingly appreciated that the presence of parasitic worms in sheep results in very considerable economic loss, even though infected animals may not die.

In this paper some host-parasite relationships, relevant to the control of trichostrongyle infestation in sheep, are outlined and an account is given of some recent trials conducted at the Wallaceville Animal Research Centre. These were designed to evaluate the cumulative effects of naturally-acquired infestation on the liveweight gain and

wool production of young sheep during their first year of life, and to ascertain the pattern of untreated infestation during this period. On the basis of the results of these trials, a strategic drenching programme is advocated and an estimate is given of the possible financial gains which could be derived from such a programme. However, before discussing these trials, some of the host-parasite relationships involved will be considered briefly.

PARASITIC GASTRO-ENTERITIS

Parasitic gastro-enteritis in sheep is principally caused by species of some six to eight genera of trichostrongylid nematode worms found in the alimentary tract. Studies on infestations of individual species have demonstrated distinct clinical differences among the effects of different species. However, mixed infestations are usually encountered in the field and it is customary to regard the disease as a single clinical entity although it would be more correctly described as a complex of diseases.

The way in which the parasites damage the sheep varies with the species, some of which cause anaemia by their blood-sucking activities while some feed on the tissues of the gut. The precise mechanisms involved are not fully understood but there is frequently depression of appetite and a decrease in the digestive economy caused by a reduction in both the digestibility and utilization of the food.

LIFE CYCLES AND HOST-PARASITE RELATIONSHIPS

The parasitic round-worms of sheep all have a broadly similar life history. The adult worms living in the bowels or lungs of the host animals lay eggs which pass out in the dung and must undergo a period of development on the pasture before they are capable of infecting another host which may swallow them. This means that the worms cannot multiply in the host animal alone; each worm in the host has been picked up from the pasture as an infective larva. In the same way, the number of free-living stages of worms on pasture cannot increase unless more are added in the dung of an infected host. Consequently, a worm infestation in the animal does not invariably run the same course. In contrast to bacterial and viral infections, the worms can increase in number only if new infection is picked up from the pasture, and the rate at which this occurs can be interrupted or otherwise affected by a variety of factors such as those involved in grazing management and drug treatment.

Space does not permit an elaboration of the many complexities involved in the dynamics of infection, and the effects of an established infestation will now be considered.

"DISEASE" AND "SUBCLINICAL INFESTATIONS"

The presence of infection does not necessarily imply the presence of disease; indeed, most of the common parasites are present in nearly all flocks and on the farms where these are kept, even where parasitic disease is rarely seen. However, one of the more recent advances in knowledge of worm disease concerns the fuller recognition of the existence of, and an awareness of, the losses from "subclinical infestations". The term "subclinical" has been applied to low levels of infestation generally characterized by the absence of marked or obvious clinical symptoms. Overseas, work on subclinical infestations has shown that even lightly-infested sheep on pasture, though appearing quite healthy and thriving, do not grow as fast as those with no worms. Results have shown that lambs carrying relatively light infestations, although appearing to thrive, were found on comparison with the corresponding uninfested twin lambs to be 20 to 30 lb lighter at the end of the first twelve months; furthermore, this loss of weight throughout the growth period is never regained. From studies such as these, it becomes obvious that normal sheep do not achieve their potential rate of growth at a given nutritional level.

PROBLEMS OF CONTROL OF PARASITE INFESTATIONS

With the present state of knowledge, it appears unlikely that eradication of worm infestations will be achieved. It is necessary, therefore, to strive for efficient control. To this end, a complete understanding of the biology of each species of parasite, its host-parasite relationships, and factors affecting control, is essential. Since the biology and host-parasite relationships of each of the fifteen or so species of worms occurring in sheep in this country differ in many important respects, such information becomes available only slowly. The possession of such information may eventually permit some prediction of the course of infections in the stock and on the pasture. It might then be possible to explain fully some of the limited or variable effects of some aspects of management involving such factors as length of herbage, density of stocking, rotational grazing, alternate grazing of sheep and cattle. In the absence of more detailed

knowledge of the epidemiology of parasite infections, it used to be assumed that an animal's worm burden was directly related to the total number of infective larvae that it had swallowed and that the infection on pasture depended in a similarly simple fashion on how many eggs had been passed on to it in the animal's droppings. In this way, it was thought that disease was the outcome of a process of increasing numbers of worms on the pasture and in the animals, involving several generations of worms, until a worm burden of harmful size was reached. However, the simple relationship between the number of larvae ingested, the worm burden resulting, and the subsequent rate at which worm eggs are voided in the dung usually obtains for only a short time after first exposure to infection; it is quickly modified by a variety of phenomena of acquired resistance. These affect the establishment, development, survival and egg production of worms in the host, and the different species of worms show marked differences in these phenomena.

Coupled with the present difficulties in evaluating various management procedures, newer possible control factors, such as the development of vaccines and of resistant host strains, have not yet shown great promise for practical and economic control of worms inhabiting the alimentary tract of sheep. Thus, the use of chemicals must still be accorded the major role in control programmes. The higher efficacy and also the higher cost of the newer drugs require that they be used wisely in well-integrated plans.

THE NEW ANTHELMINTIC DRUGS AS RESEARCH TOOLS

Much work has been carried out in New Zealand to ascertain the response in young sheep to drenching with anthelmintics but the results of past trials have been extremely variable. In some cases, no response has been observed; in others, considerable increases in weight gains have been achieved. Until recently, most of the published data have been from trials of short duration involving strategic drenching programmes, often employing drenches of uncertain efficiency, and few have been designed to cover the entire first year of young sheep. Furthermore, little attempt has hitherto been made to correlate the responses obtained with the changing degree and species composition of infection throughout the course of the trial.

The high efficacy of some of the newer drugs has shown them to be extremely useful as research tools in the study of the damage done by naturally-acquired infestations. With

the advent of these drugs, which are highly effective against both the adult and larval forms of all the common species of round-worms occurring in sheep, it has now become feasible to attempt to suppress almost completely worm infestation in sheep on pasture. This means it is now possible in field trials to obtain a true evaluation of the cumulative effects of an untreated infestation. This, in turn, should lead to a more accurate appraisal of strategic drenching programmes than was previously possible. With these points in view, three trials using thiabendazole were conducted at Wallaceville for three successive years from 1961-4.

WALLACEVILLE EXPERIMENTS AND RESULTS

EVALUATION OF THE EFFECTS OF INFESTATION

In the first two trials, half of the flock was subjected to a programme of fortnightly drenching with thiabendazole. The response obtained in these animals was measured in terms of liveweight gain and wool production by comparison with that of untreated control animals grazing the same pasture. In this way, a base-line of comparison was obtained which makes possible an evaluation of the effects of infestation during the first year of life. In the third trial, additional groups were incorporated to facilitate a comparison of drenching at more practical levels and to appraise what should be an acceptable strategic drenching programme.

The animals used in each of the trials were August-born Romney lambs. All three trials were conducted on the same experimental area, one with a past history of heavy infestations, the animals being grazed over a number of paddocks on a daily rotation at an initial stocking rate of approximately six ewes and eight lambs per acre. The lambs were weaned in the first week in December by removing the ewes. The lambs continued to graze the same area. In the first and third trials the number of animals per group was 20, and in the second trial, 28. In each of the trials the initial drenches were given in October when the lambs were between six and eight weeks old.

Liveweight Gain

The mean liveweight gains for the groups drenched fortnightly and the untreated control groups in the three successive years are shown in Figs. 1, 2 and 3. The mean trichostrongyle egg counts (excluding *Nematodirus*) for the control groups are also shown. On a few sampling dates during the trials, some animals in the treated groups were

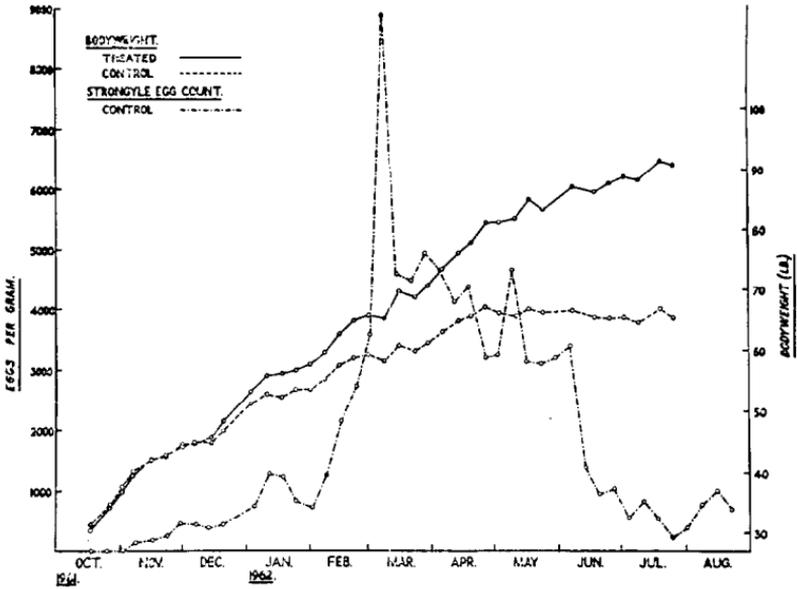


Fig. 1: 1961-2 trial. Mean body-weights of the treated and control groups and mean strongyle egg counts of the control group.

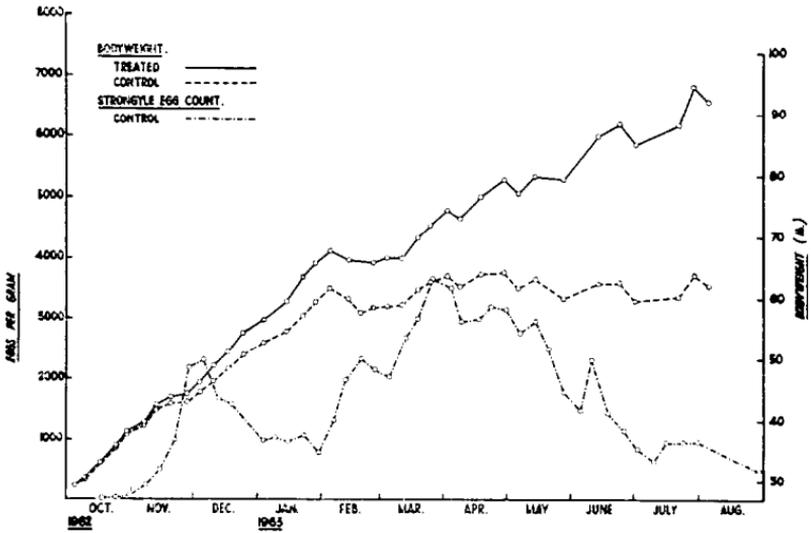


Fig. 2: 1962-3 trial. Mean body-weights of the treated and control groups, and mean strongyle egg counts of the control group.

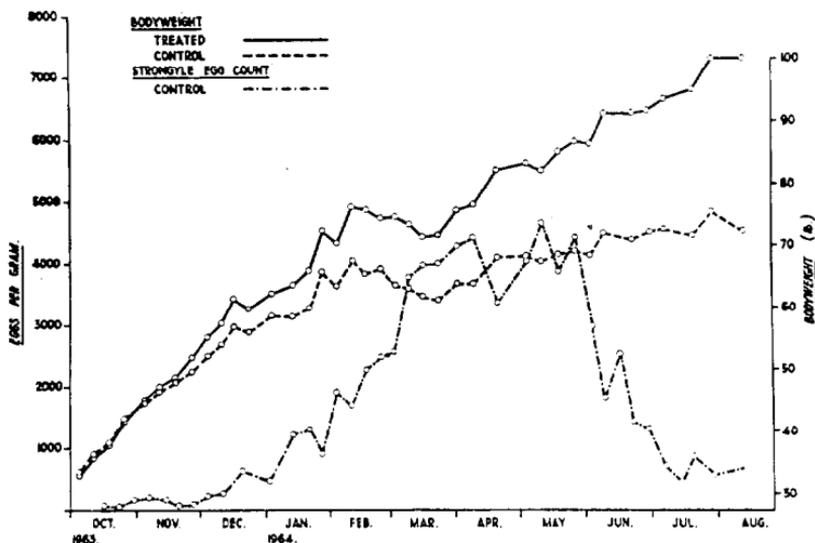


Fig. 3: 1963-4 trial. Mean body-weights of the treated and control groups, and mean strongyle egg counts of the control group.

found to be passing eggs but on no occasion did the mean egg count of these groups exceed 100 eggs per gram. *Nematodirus* egg counts of the control groups are not shown as only a low level of infestation was acquired by the lambs.

In the 1962-3 and 1963-4 trials, mortalities of 10% and 11% respectively occurred in the untreated groups and these were attributed to the effects of worm infestation. The mean weights shown in the graphs are those for animals surviving at each weighing.

Table 1 shows the cumulative monthly liveweight responses from weaning. (The responses in the additional groups included in the 1963-4 trial will be discussed separately.)

TABLE 1: CUMULATIVE LIVELWEIGHT GAIN RESPONSES (LB) OF ANIMALS DRENCHED FORTNIGHTLY FROM OCTOBER
(Responses shown for the beginning of each month)

		Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.
1961-2	.....	1	3	5	8	10	16	20	24	27
1962-3	.....	2	4	4	8	11	15	19	26	31
1963-4	.....	2	4	7	11	12	15	18	21	27

In the drenched groups, the mean weight responses at the termination of the trials in August, 1962, 1963 and 1964, were 27 lb, 31 lb and 27 lb respectively.

The consistent results of the three trials in successive years provide a basis for the evaluation of the cumulative effects of untreated trichostrongyle infestation. Thus, it is pertinent to summarize some of the more important features resulting from complete suppression of infestation, before considering other practical implications of the present results. The principal features common to the three trials are:

- (1) The suppression of worm infestation resulted in very marked liveweight gain responses, and these were similar at equivalent stages.
- (2) Throughout the course of the trials, the rate of weight gain of the treated animals remained comparatively constant except at times of apparent food shortage. In both the 1962-3 and 1963-4 trials, an acute feed shortage occurred from mid-January to mid-March. At this time, when the pasture was dried-up and eaten out, appreciable weight losses occurred in both treated and control animals. Apart from this period, in the latter two trials the good rate of weight gains made by the lambs during spring and summer was maintained throughout autumn and winter.
- (3) During the period April to July, the mean liveweight of the control groups tended either to decrease (the two earlier trials) or to increase only slightly (1963-4 trial). A reduction in the rate of gain over that period with or without actual loss in liveweight is characteristic of hogget ill-thrift.
- (4) The weight gains of the drenched and control groups tended to diverge at a relatively constant rate during the trials. The weight gains of the control groups showed no marked response to any sudden rise or fall in the level of infestation as indicated by the egg-count pattern. The liveweight of the control groups showed no response following the marked drop in egg count which occurred each year in May-June. It is usual for hoggets to lose the greater part of their worm burden at this time due, presumably, to the development of host resistance. This suggests that the cumulative effects of worm infestation had so debilitated the animals as to render them incapable of immediate response to the greatly lowered worm burden at that

time of year. Alternatively (or in addition), there may still have been sufficient worms present to affect their growth rate as compared with that of the treated animals.

- (5) Although, for a considerable part of the trials, the infestations acquired by the control animals would be classed, in terms of general diagnostic experience, as moderate to heavy, these were by no means exceptional. Also it must be remembered that from the commencement of the trials the pasture received only a fraction of the parasite contamination that would have been deposited by an entirely untreated flock.
- (6) With minor variations, owing principally to climatic factors, the pattern of worm infestation, as indicated by faecal egg count, was remarkably constant over the three years and is shown in Fig. 4. The pattern is one of relatively slow build-up during spring and early summer, becoming more rapid and reaching a peak in early autumn followed by a rapid decline in early winter. This pattern of infestation is emphasized by the egg counts recorded from untreated animals in a subsequent trial, 1964-5, shown in Fig. 5.

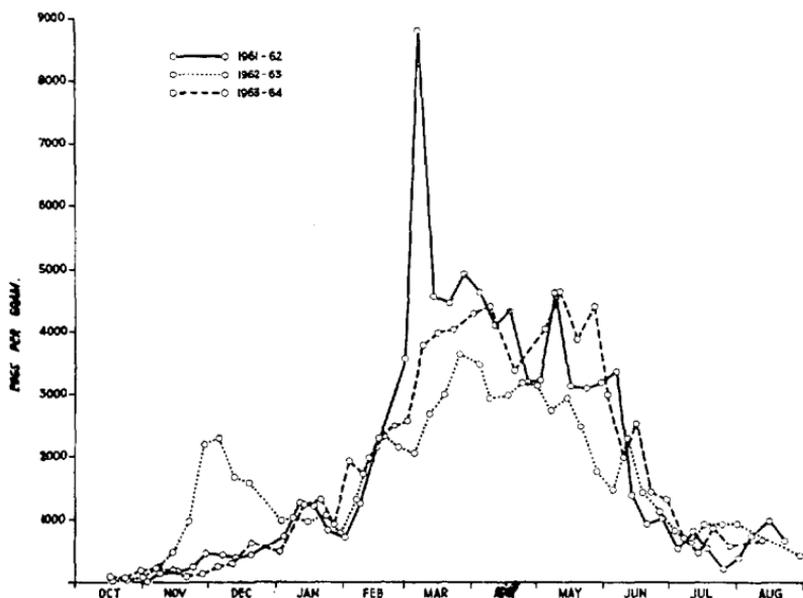


Fig. 4: Mean strongyle egg counts of the control groups in the three trials.

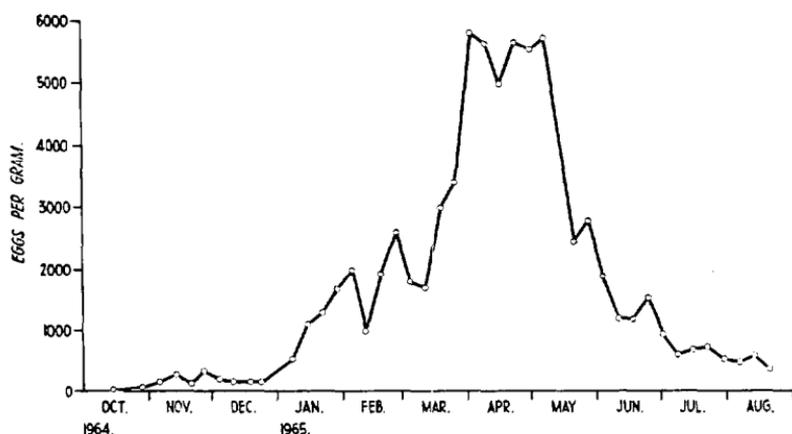


Fig. 5: Mean strongyle egg counts of an untreated flock 1964-5.

Wool Production

Immediately prior to the end of each trial in August, the animals were shorn. The wool growth response to drenching is shown in Table 2. It will be seen that this response closely follows that for liveweight gain. It was found that the wool response indicated in terms of greasy weight was further enhanced by an increase of approximately 3% in yield in the wool of the drenched animals.

TABLE 2: MEAN LIVELWEIGHT GAIN AND GREASY-WOOL WEIGHT RESPONSES OF DRENCHED ANIMALS

		Increase in Mean Live- weight over Controls (lb)	Difference %	Increase in Greasy- fleece Weight over Controls (lb)	Difference %
1961-2	.....	27	43	1.7	30
1962-3	.....	31	48	2.6	46
1963-4	.....	27	37	1.9	28

An analysis of fleece wools from the 1963-4 trial (Table 4), shows a considerable difference in the quality of the wool from the treated and control groups. In the animals treated fortnightly, there was a high proportion of good-styled fleeces and a complete absence of ill-thrift wools. In the control groups, there was a much lower proportion of

good-styled fleeces and approximately one quarter of the fleeces were of the ill-thrift type.

In order to obtain more detailed information on the effect of worm infestation on wool production, wool growth on half of the animals in the drenched and control groups of the 1962-3 trial was measured at 28-day intervals throughout the course of the trial. Wool measurements were obtained from clippings taken from a rectangular area 2 in. \times 3 in. tattooed in mid-flank position. The monthly clean, scoured wool production from the tattooed areas in the treated and control groups is shown in Fig. 6.

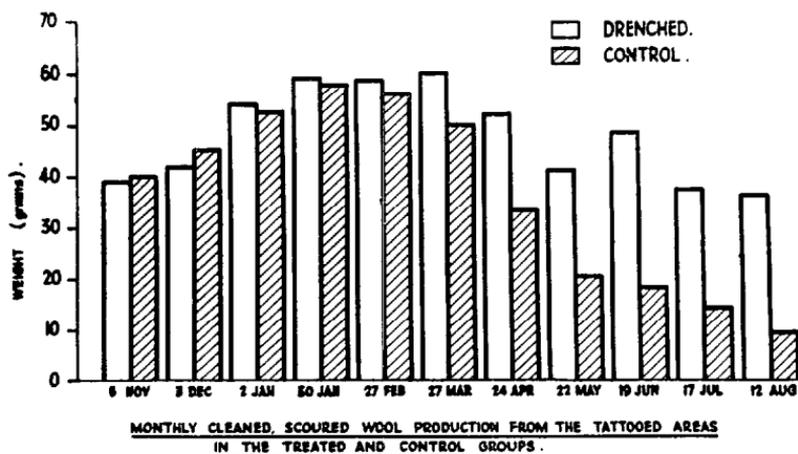


Fig. 6: Monthly clean, scoured wool production from the tattooed areas in the treated and control groups in the 1962-3 trial.

The data given in Fig. 6 show that by far the greatest difference in wool production between the groups occurred in the latter half of the trial from the beginning of March to the middle of August. During this period, the total weight of clean wool produced from the tattooed areas of the drenched group exceeded that produced in the control group by 90%. It will have been seen from Figs. 1, 2 and 3 that this was also the period of greatest difference between the groups in the rate of liveweight gain.

What can be Achieved by a Strategic Drenching Programme?

As the results of the 1961-2 and 1962-3 trials showed a consistent pattern of liveweight gain response to suppression of worm infestation, it was decided to include three additional drenching regimens in a further repeat of the trials in 1963-4. One of these could be considered as a feasible strategic drenching programme. ("Strategic" treatments are based on seasonal fluctuations in worm burdens and are part of a seasonal plan of control based on epidemiological findings and should be applied at more-or-less fixed periods in all but abnormal seasons.) It was considered that this might show to what extent the annual loss in production in young sheep could be curtailed by an economically practical plan of treatment.

The five treatment groups in the 1963-4 trial were as follows: Group 1 — drenched fortnightly throughout; Group 2 — drenched at 28-day intervals throughout; Group 3 — six drenches at 28-day intervals commencing in January; Group 4 — three drenches at 28-day intervals commencing in March; Group 5 — untreated controls. The mean liveweight gains of these groups are shown in Fig. 7. The terminal responses of the groups in liveweight gain and wool production are shown in Table 3.

TABLE 3: LIVELWEIGHT GAIN AND GREASY-WOOL WEIGHT RESPONSES OF THE TREATMENT GROUPS IN THE 1963-4 TRIAL

<i>Treatment</i>	<i>Liveweight</i>			<i>Greasy Fleece</i>		
	<i>Difference %</i>	<i>Increase in Mean Wt over Controls (lb)</i>	<i>Mean Wt (lb)</i>	<i>Difference %</i>	<i>Increase in Mean Wt over Controls (lb)</i>	<i>Mean Wt (lb)</i>
Drenched fortnightly throughout	100	27	37	8.8	1.9	28
Drenched 28-day intervals throughout	96	23	32	8.7	1.8	26
Six drenches	93	20	28	8.6	1.7	25
Three drenches	88	15	21	8.1	1.2	18
Untreated controls	73	—	—	6.9	—	—

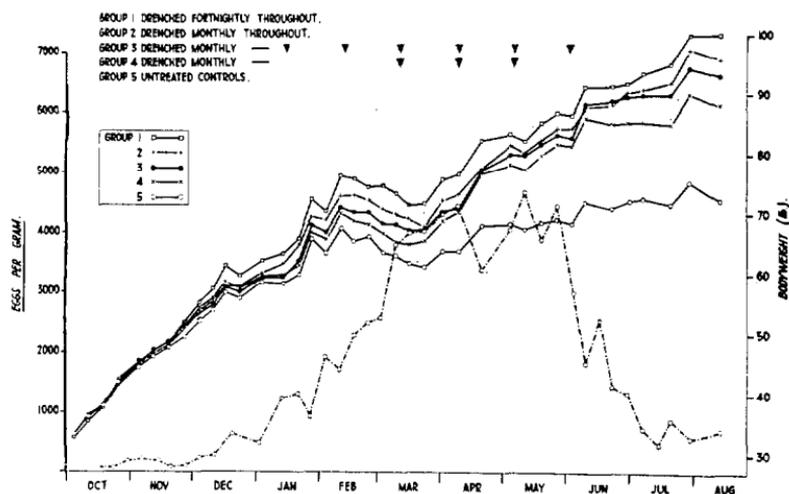


Fig. 7: 1963-4 trial. Mean body-weights of all the treated and control groups, and mean strongyle egg counts of the control group.

These results support the findings of the two earlier trials that by far the greater part of the losses in production occur after January and more particularly after March.

An analysis of fleece wools from the five treatment groups is shown in Table 4.

TABLE 4: ANALYSIS OF FLEECE WOOLS
 (Styles other than BB and B were not recorded)

Treatment	Mean Greasy-wool Weight (lb)	% of BB Style (Good/Super)	% of B Style (Good/Ave.)	% of Well-grown Sound	% of Break	% of Tender	% of Ill-thrift Wool
Drenched fortnightly throughout	8.8	50	44	88	6	6	Nil
Drenched 28-day intervals throughout	8.7	35	45	75	10	15	Nil
Six drenches	8.6	45	55	90	5	5	Nil
Three drenches	8.1	35	30	60	15	20	5
Untreated controls	6.9	33	28	33	17	26	24

The most important feature of the results is the response to a programme of three drenches commencing in March, which achieved more than 50% of the response recorded in animals in which infestation was completely suppressed during the first twelve months of life. The response of 15 lb liveweight together with more than 1 lb of wool per animal must make such a strategic drenching programme an economically attractive proposition. The financial rewards can be more readily appreciated from a statement of costs and returns presented in Table 5.

TABLE 5: INCOME AND EXPENDITURE ACCOUNT FOR A STRATEGIC DRENCHING PROGRAMME
(Per 100 lambs)

<i>Expenditure</i>	£	<i>Income</i>	£
300 drenches @ 8d.	10	100 lambs — Mortality prevention	
Cost of labour	5	(5% @ £3)	15
	15	100 lambs — Meat (15 lb live- weight response giving 7 lb carcass weight @ 12d. lb)	35
		100 lambs — Wool (1 lb wool re- sponse @ 48d. lb)	20
			<u>70</u>
Excess of income over expenditure = £55 = 11s. per head.			

While it is realized that a value measured in terms of meat is not strictly applicable to carry-over hoggets, it is considered that a price of 1s. per lb carcass meat is a not unreasonable index of the increased value of the animal be it only for replacement of breeding stock.

CONCLUSIONS

The present trials, although limited in extent and restricted to the same experimental area, clearly demonstrate the possible major role of trichostrongyle infestation in the hogget ill-thrift problem. Also, they provide evidence of the extent of the economic loss in meat and wool production caused by these parasites. The results show that what is probably regarded as the normal rate of growth of young sheep is not necessarily the same as the optimal rate. These conclusions are supported by the findings of Robertson (1963) who has summarized the results of part of an extensive series of country-wide post-weaning drenching trials conducted by the Department of Agriculture with thiabendazole.

zole. In those trials, consistent weight responses were recorded in favour of the drenched animals suggesting that parasites may be more important than previously considered.

The magnitude and pattern of the responses in the present trials make it obvious that worm infestation affects every aspect of the sheep industry whether wool production, the raising of fat lambs for slaughter, ewe lambs for replacement of breeding stock, or the fattening of store lambs.

While the use of drugs continues to be the principal means of control, cognizance is taken of the need for further studies to evaluate the effectiveness of various management procedures in reducing the level of available pasture infection. The absence of marked progress in the design of such control measures is partly because the lambs must run with the ewes, which are a major source of infection, and partly because the number of species of worms, which are of importance, is rather large. Moreover, there is not yet sufficient information available regarding the biology and epidemiology of each species.

It is unlikely that practical drenching and management programmes will produce weight-gain responses of the order of those obtained in the present trials by almost complete suppression of infestation. However, the results do provide a measure of the response which might be achieved by a strategic drenching programme of three drenches, a programme which is both practically and economically feasible.

REFERENCE

Robertson, T. G., 1963: *N.Z. J. Agric.*, 106: 127.

DISCUSSION

DR W. A. G. CHARLESTON (COMMENT): Dr Brunsdon has shown that the egg-count patterns of his sheep were remarkably consistent and generally reached their highest levels from about mid-March to mid-May. He has shown that dosing sheep with thiabendazole over this period prevents about 50% of the annual loss of production attributable to trichostrongyle infestations.

Since, over the summer months in New Zealand, the climate in most areas seems unlikely to exert a limiting effect on the development of nematode larvae on the pasture, it would seem reasonable to suppose that the availability of infective larvae of different species of trichostrongyle reflects the rate of contamination of the pasture with eggs. At least for a time, the availability of larvae is reflected in the general egg-count level of the sheep. This may not apply to individual sheep at any one time but should represent the overall picture.

In a previous publication, Dr Brunson (1963: *N.Z. vet J.*, 11: 86) reported the seasonal availability of trichostrongyle larvae. The time during the year when each species reaches its peak of population size varies; the peak depends on the biotic potential and generation time of each species as originally suggested by H. D. Crofton in 1957 (*Parasitology*, 47: 304). It was shown that from March to May species of *Trichostrongylus* and *Cooperia* dominate the pasture population.

Would it be correct to assume from this that the 50% loss prevented by dosing at this time of the year is principally due to these two genera? If this is the case, it seems that a more direct approach to the control of these genera through a better understanding of their larval bionomics or perhaps through selecting animals resistant to them might be profitable.

The assumption could be quite wrong, however, since it is well known that one of the most common phenomenon associated with acquired resistance to trichostrongyles is larval inhibition. This is known to occur in *Ostertagia* (R. I. Sommerville, 1954: *Aust. J. agric. Res.*, 5: 130) and in *Haemonchus contortus* (M. G. Christie, M. R. Brambell and W. A. G. Charleston, 1964: *J. comp. Path. Therap.*, 74: 435).

These two genera peak before March and I wonder how much of the March-May loss is attributable to inhibited larval stages of these parasites, since the stages are pathogenic in their own right. Even the newest anthelmintics are less effective against the larval stages than against adults, though much better than the older ones, so this could be important.

It does seem possible too that the persistence of failure to gain weight in hoggets which have been infected but whose egg counts have declined may be due to the continued presence of the inhibited larval forms whose presence is not reflected in egg counts.

Another question is that of the applicability of Dr Brunson's findings and proposals throughout the country. It is quite likely that the rate of build-up of parasite populations will be slower in some areas than others owing to lower mean temperatures and it may prove necessary to modify the dosing times, to delay them to some extent. From a study of meteorological data of the country, one can expect *Haemonchus contortus* to be a potential nuisance in areas such as Hawke's Bay, Gisborne, Auckland and Northland, while being more secondary in the Hutt Valley. Since *Haemonchus* peaks earlier than March it may be necessary to modify the dosing regime appropriately.

Dr Brunson has stated that the growth pattern of his undosed sheep was typical of hogget ill-thrift. A great deal hangs on whether these are typical.

It is quite clear that the term "hogget ill-thrift" covers a multitude of sins and at various times in various places selenium deficiencies, cobalt deficiencies, type of pasture and so on have been blamed for the condition. Occasionally, responses have been claimed for anthelmintics.

However, Clarke and Filmer (1954: *Proc. N.Z. Soc. Anim. Prod.*, 14: 91) reported that, although a consistent feature of ill-thrift is a high parasite burden and circumstantial evidence suggests that parasites cause the ill-thrift, the data from trials which they carried out using phenothiazine as an anthelmintic indicated "that in the light of present knowledge intensive efforts aimed at eliminating or reducing parasitism cannot be relied upon to prevent the

development of ill-thrift in hoggets nor to alleviate it once it has developed."

In 1958, the same workers reported an extensive series of trials involving various management procedures, with and without the use of phenothiazine. They came to the same conclusion. In one trial in which lambs were reared and maintained virtually worm free, ill-thrift still developed in the presence of abundant feed.

A report from Manutuke in 1961 stated that on ryegrass no response to anthelmintics, including thiabendazole, Néguvon and methyridine occurred and ill-thrift developed. A response was obtained, though not an economically significant one on clover pasture. In 1962, fortnightly dosing with thiabendazole or phenothiazine failed to prevent ill-thrift at Manutuke.

In spite of the fact that Clarke and Filmer were using phenothiazine, which they admit was not particularly effective against *Trichostrongylus*, and there is nothing in their papers to indicate whether or not they looked for histotrophic stages in the gut mucosa, their results taken with some others I have mentioned are in direct contradiction to those of Dr Brunson.

However, the present results are so consistent and convincing and so clearly economically feasible that this must again open up the question of the role of helminths in the aetiology of hogget ill-thrift, and in turn of the general applicability of the findings. In any event, it is important to find out whether these results in terms of growth rate are due to the larvicidal activity of the drug. If this is the case, this limits the choice of drug which is likely to be of use in this connection.