TRACE ELEMENTS IN RELATION TO ANIMAL HEALTH IN SOUTHLAND

E. D. ANDREWS, Senior Principal Scientific Officer, Wallaceville Animal Research Station

In the "New Zealand Meat Producer" for May 1960 R. H. Bevin discusses the remarkable development of the sheep industry in Southland. As he puts it, "40 years ago there were roughly 1 ½ million sheep in the Southland Land District. Today there are 53 million". He goes on to trace the change from a farm economy which in 1920 depended largely on oat crops and dairying to one which is now predominantly concerned with the production of fat lambs for export. The Southland-Wallace Plain carries one of the greatest sheep concentrations in the world. Lambs killed at the four Southland freezing works each year now top the 3 million mark.

It is obvious that successful fat-lamb farming depends on ample supplies of nutritionally adequate feed. Other speakers have dealt with the means whereby adequate amounts of feed can be assured. This paper discusses feed factors which may cause trace element deficiencies in stock, outlines some results from trace element investigations in Southland, and considers the importance of these minerals with special reference to Southland's sheep industry. In our present state of knowledge the trace elements involved are iodine, copper, cobalt, and selenium.

Iodine

It is generally believed that goitre is associated with prolonged hypothyroidism, that is, to a deficient functional activity of the iodine-containing thyroid hormone. At present there is no acceptable evidence that hypothyroidism in farm animals is of significant practical importance except in new-born lambs or, more rarely, in new-born calves. In lambs severe outbreaks of goitre may result in the loss of more than half the flock at or near birth. Outbreaks tend to be sporadic. There may be no obvious goitre on a farm for many years, then dramatically a high percentage of deaths may occur.

Immediate causes of the disease are obscure. While there is some evidence that goitre can occur on feeds containing low con-

centrations of iodine, substances which interefere with iodine utilisation appear to be a more important cause. These so-called goitrogenic substances occur in white clover and the brassicas, but experimental evidence indicates that. the brassicas are much more goitrogenic than white clover. Although goitre is usually confined to alluvial river flats, there is no clear association with specific soil types. Rather, the disease tends to occur in more southern districts where brassica crops are widely grown for winter feeds. So far as I am aware severe goitre accompanied by high death rates has hitherto invariably been associated in New Zealand with the wintering of pregnant ewes on turnips, swedes, rape, kale, or chou moellier. Nevertheless, a serious outbreak of the disease on subterranean clover dominant pastures has recently been reported from Australia, and there is a distinct possibility that goitre might account for a proportion of neo-natal losses considered as normal over wide areas of New Zealand's ryegrass white clover pastures.

Although goitre is not generally believed to be one of our more important diseases, severe outbreaks have caused serious loss to individual farmers in some years. According to Wallaceviile records only a few such losses have occurred among lamb flocks in Southland. These cases were scattered throughout the province. In at least two instances the disease has been reported in calves in Southland.

Whatever its cause, goitrc in lambs is prevented by providing the ewes with extra iodine during the last two months of pregnancy. Licks containing potassium iodate have been used, but because adequate consumption of lick by all animals cannot be assured, a more certain method is to dose the ewes with an inorganic iodine compound at about three months after tupping and again one month later. Very recent work has shown that a single injection of iodinated poppysecd oil three months after tupping is also effective.

Copper

The symptoms, cause, and control of simple copper deficiency, and that complicated by an excess of sulphatc-potentiatcd molybdenum, have been described in Departmental bulletins and need not bc detailed hcrc. Copper deficiency occurs in Southland, but so far as is known it presents no problems peculiar to that province. Pasture analyses suggest that the deficiency is simple.

During the past 1 I years a considerable number of liver samples from widely distributed Southland sources have been analysed for copper content at Wallaceville. The results in Table 1 were for specimens which were accompanied by apparently adequate case

histories, many of them compiled from a survey carried out by C. E. Broad, formerly Livestock Instructor at Invercargill.

TABLE I-COPPER CONTENTS (PARTS PEK MILLION DRY MATTER) OF LIVERS

Animals	copper status*	No. of farms	Copper Ranges	Means
Cattle	Normal	21	39-688	194
	Deficient	14	3-22	12
Lambs	Normal	127	1 O-684	294
	Deficient	8	8–20	12

* Based on clinical symptoms supported by analyses. Two lambs with low liver copper (IO and 18 ppm), but no history of ataxia classed as normal.

Of the 14 cases of apparent copper deficiency in cattle one was from Otautau, one from Winton, and four from farms around Gore. The soil types on which these six cases occurred are not available, but some at least were on low-lying country which may have been peaty. The remaining eight were from farms within a large peat and sandy peat area to the south and east of Invercargill known as the Seaward Moss (Otanomomo and Invercargill soils). All of the eight farms on which ataxia was found in lambs were within, or on the fringes of, the Seaward Moss area. Most of the lamb livers of normal copper content were from unthrifty animals. In the absence of ataxia no association between lack of thrift in lambs and copper levels in livers has ever been demonstrated, nor has it been possible in trials in Southland and elsewhere to improve significantly, growth rates of lambs by giving them extra copper.

Since lamb livers are more easily obtained than cattle livers, one possible inference from Table 1 is that despite the predominance of sheep farming copper deficiency in Southland is more important in cattle than in sheep. Although small peat areas are scattered throughout the province, the major area is that of the Seaward Moss. The Department of Lands and Survey estimates that over 70,000 acres of this are capable of being developed for farming. Copper will undoubtedly be needed as part of the development plan for the Seaward Moss, but elsewhere in Southland copper deficiency appears to be relatively of little importance. Despite this, my impression is that a' considerable amount of copperiscd superphosphate is used throughout the province, often with the mistaken idea that it will improve the thrift of lambs. On the credit side most of the Seaward Moss farms on which copper deficiency was diagnosed have recently been reinvestigated by

K. G. Gray, Livestock Instructor, Invercargill. He reports that control of scouring and unthriftiness in cattle and prevention of ataxia in lambs have followed the use of copper given in the form of injections or topdressing.

Cobalt

The Morton Mains district was once the granary of Southland, but with the change from oats to sheep during the 1920's it soon became apparent that marked unthriftiness was seriously limiting lamb production in that area. Features of "Morton Mains disease" were as follows:

(a) Weaned lambs were the main sufferers.
(b) Parasitism was sometimes involved, but was not the immediate cause.
(c) Surviving animals tended to recover during late autumn or winter.
(d) Affected and non-affected farms were sometimes located on the same kinds of soil, and in some years the disease did not occur at all.

By 1936 investigations, largely directed by the Cawthron Institute, had shown that the disease, which occurred also at **Otara**, Waipango, and Edendale, was completely controlled by cobalt.

With the completion of the Cawthron Institute's investigations about 1940 little further work was undertaken until 1950. At about that time it became evident that a number of pastures and

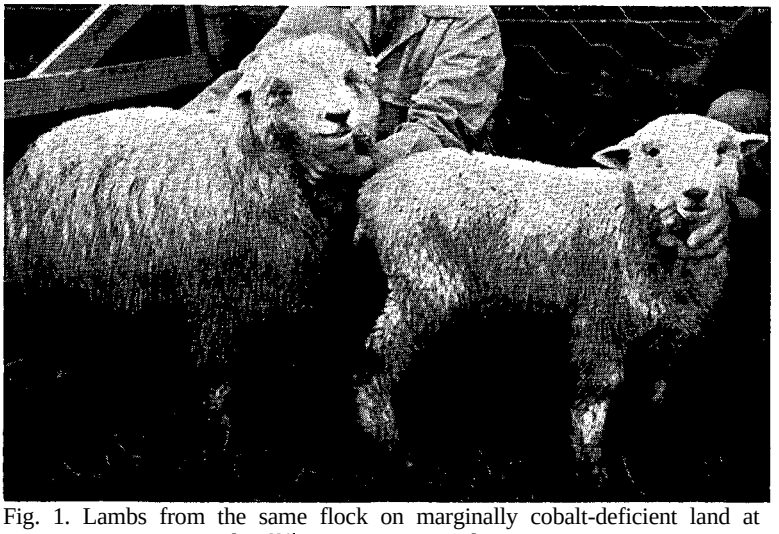

Fig. 1. Lambs from the same flock on marginally cobalt-deficient land at the Winton Experimental Farm.
Left--given cobalt. Right-untreated.

livers from Southland were low in cobalt content. At the same time field reports indicated a lamb unthriftiness problem throughout much of the Southland-Wallace Plain. Frequently lambs were reported to be doing poorly as early as November. However, field trials on selected farms showed that pre-weaning unthriftiness failed to respond to cobalt.

In a few cases responses were obtained in weaned lambs, in particular, at the Winton Experimental Farm (Fig. 1). In conjunction with other evidence this led to the presumption that Otapiri soils, which comprise about 23,000 acres of the Southland Plain, were at least marginally cobalt-deficient, and this stimulated investigation of specific cobalt problems at the Winton Farm. The following summarises some of our findings, based on the work at Winton, during the past 10 years.

1. Cobalt deficiency in grazing lambs is due to a deficiency of vitamin B_{12}.

2. The vitamin B_{12} content of livers is a good laboratory aid to the diagnosis of cobalt deficiency.

3. As shown in Table 2, lucerne accumulates much more cobalt than do clover or grasses. Clover is richer than grasses in cobalt.

TABLE 2-COBALT CONTENTS (ppm D.M.) OF DIFFERENT FODDER PLANTS

Plants	Sampling Dates 17/9/52	13/12/52	27/1/53	Means
Lucerne	0.23	0.24	0.21	0.23
White clover	0.10	0.13	0.11	0.11
Mixed grasses	0.04	0.05	0.07	0.05

4. Long pastures favour cobalt deficiency; short pastures tend to prevent it. This may be related in part to yearly variations in the severity of the disease (Fig. 2).

5. Prior grazing of cobalt-topdressed pastures for three months protects lambs transferred to cobalt-deficient land for at least a further four months.

6. Cobalt bullets are useful for diagnostic tests in the field, but have certain disadvantages in practice. In some cases they result in small but significant depressions in growth rates when given to lambs not affected with cobalt deficiency. The reason for this is not yet known.

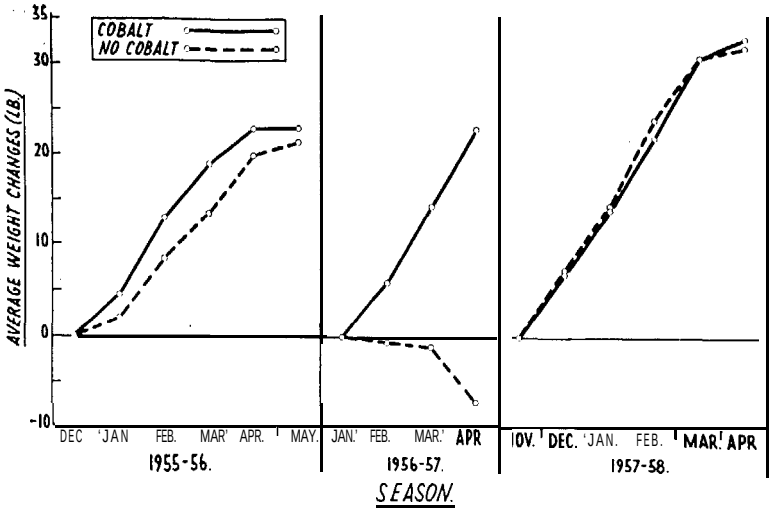

Fig. 2. Yearly variations in the thrift of lambs on marginally cobalt-deficient land. In the 1955-56 season untreated lambs were mildly cobalt-deficient. In 1957 cobalt deficiency was much more acute. In the 1957-58 season no cobalt deficiency occurred. Pasture production was relatively low in 1955–56 and 1957-58, but was much higher in 1956-57.

integration of laboratory and field results with Soil Bureau data has given us a reasonably clear picture of areas liable to bc cobalt-deficient in Southland (Fig. 3). Affected soils consist mostly of grcywacke loess and alluvium. Those classed as moderately deficient (for example, Waikiwi and Tisbury soils) total some 200,000 acres, nearly all of which are farmed. The area of those classed as marginally or suspected deficient is about the same, although it is possiblc that only relatively few farms on these soils need more cobalt than the pastures supply. No precise information on the amount of cobaltised superphosphate used in Southland is available, but a very approximate estimate suggests that more than enough is sold to cover those areas likely to need it. Finally, last season in Southland was one which should have favoured cobalt deficiency, yet Departmental results showed that on only one out of 20 trial farms was there a significant positive responsc to cobalt. Thus, although cobalt has a continuing and important role to play in Southland's sheep industry, these facts encourage the belief that control of the disease has largely been achieved.

Selenium

During the past two years numerous trials have shown that selenium will control white muscle disease in young lambs,

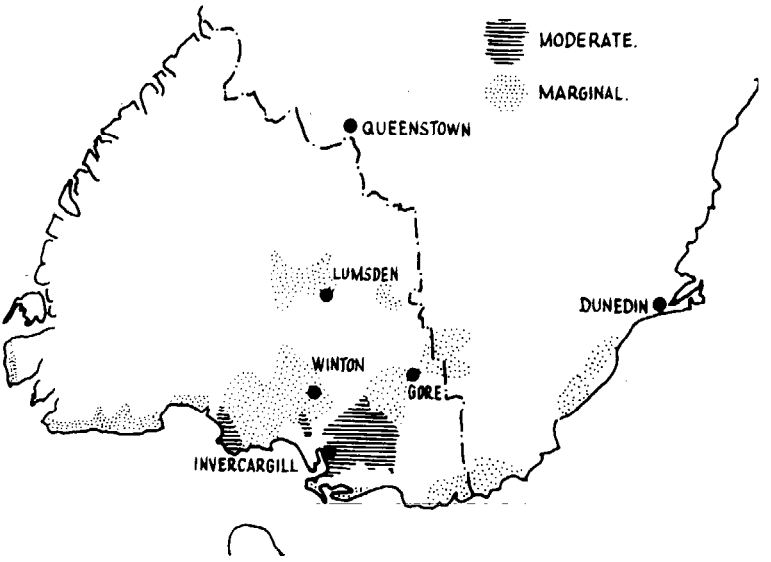

Fig. 3. Cobalt-deficient and suspected deficient areas in Southland.

although so far as I am aware it is not yet known whether the element is effective against that form of the disease sometimes found in hoggets wintered on turnips. More importantly, selenium will prevent one form of unthriftiness in lambs and calves. It will also result in striking improvement of lambing percentages in areas where a barren ewe problem sometimes accompanies white muscle disease or unthriftiness in lambs.

During the past season the Animal Industry and Farm Advisory Divisions of the Department of Agriculture carried out more than 250 lamb growth rate trials with selenium throughout the country. Results from these trials are not yet fully assessed. It is, however, clear that while impressive responses were obtained in both Islands, a considerably higher proportion of these occurred in the South Island during this particular season. Growth rates were significantly increased in 12 out of 20 Southland trials. Responses were widely distributed throughout the province, from farms near Invercargill in the south through Edendale, Wyndham, and Winton in mid-Southland, to Gore, Riversdale, and Lumsden in the north.

It is not yet certain to what extent selenium responses can be related to soil types. Some responses occurred on soil types, notably Edendale, Otapiri, and Waikoikoi, with which cobalt deficiency is also associated. Also, we do not yet know whether the presence or absence of responses is related to the selenium

content of pastures. Pasture samples from trial paddocks are awaiting analysis and should provide an answer to this question.

Because small amounts of selenium are poisonous the devising of practicable topdressing procedures is likely to be difficult. Topdressing experiments arc proceeding, but the probability that small doses of selenium need to be given perhaps only once every few months makes this problem less urgent than was at first expected:

Hitherto Departmental trials have been largely confined to weaned lambs. On the other hand much of the present-day ill-thrift in Southland (and elsewhere) occurs while lambs are still on the mothers. Wallaceville investigations and results from a trial carried out by C. E. Isaacs, Government Veterinarian, Invercargill, suggest that the parasite *Nematodirus* may in part be responsible. Lamb trials with selenium will also be needed to discover whether this element will assist in controlling pre-weaning unthriftiness, and so increase fat lamb production in Southland.

Conclusion

Iodine, copper, and cobalt supplements are needed in Southland. On the other hand it seems probable that goitre is of minor importance, and deficiencies of copper and cobalt are probably now reasonably well controlled. Within the next few years the importance of selenium in animal production will become clearer. Last season some 25 per cent of Departmental lamb trials throughout the country gave significant liveweight responses to selenium, averaging about 5 lb per head. If a small amount of selenium at negligible cost can add an equivalent weight to one fourth of Southland's lamb carcasses, the investment in terms of the province's fat lamb industry alone could be worth more than £100,000 each year.

ACKNOWLEDGMENTS

I am greatly indebted to officers of the Department of Lands and Survey and to various colleagues in the Soil Bureau and Department of Agriculture for much of the information contained in this paper.

DISCUSSION

Q. Is there any difference in cobalt content between white clover and red clover?

A. Yes. In our experiments red clover contained slightly more cobalt than white clover.

Q. In the Winton trials where yearly variations in pasture production and severity of cobalt deficiency occurred, were there any rainfall differences between years?

A. We were unable to relate pasture production to rainfall.

Q. If 1 mg of selenium is given at docking, how long before another dose should be given?

A. Possibly not until weaning. Present indications are that 1 mg will last 2 to 3 months.

Q. What is the tie up between lime and trace elements?

A. This will depend upon the initial soil pH. Generally lime depresses uptake of cobalt and copper by plants and increases molybdenum uptake. However in Southland trials we were unable to significantly depress cobalt uptake by heavy lime applications to soils already approaching pH7.

Comment (Dr J. K. Dixon): The pH of Southland soils is not abnormally high and in our experience lime has not caused trace element trouble. In fact Southland lime contains some cobalt which has proved beneficial.

Q. (A. J. Harris) : Are the areas of cobalt deficiency increasing?

A. Possibly. Management may play some part. On the other hand some areas of deficiency revealed by recent work may have always been deficient.

Q. How often should cobalt be applied?

A. In the North Island one application each year during autumn is sufficient if sheep are continuously on cobalt-topdressed pasture. In Southland if ewes are wintered on crops not receiving cobalt, it is best to topdress for their lambs in spring or early summer.

Q. Would two applications, one in spring and one in autumn, not be better?

A. In the North Island on severely deficient land under high rainfall, one autumn application of 5 oz proved satisfactory. In Southland where the problem is essentially confined to lambs the spring application should suffice.

Q. (T. E. Ludecke): Is there any danger of selenium building up to dangerous levels in pasture?

A. Topdressing trials have shown that 2 oz per acre is dangerous. One oz applications did not cause deaths but long term effects are not yet known. Topdressing is definitely in the experimental stage only, and under no circumstances should be used in practice.

Q. What is the relationship between sulphur and selenium uptake in plants?

A. (1. L. Elliott) : This is not yet known. Factors which may effect selenium uptake by plants are being investigated at Rukuhia.

Q. Is there any relationship between lime application and selenium deficiency?

A. Not yet known. The effect of fertilisers is being investigated.

Q. Can cobalt be dosed with phenothiazine or with selenium'?

A. Yes.

Q. Would you expect more copper deficiency on higher producing country?

A. I don't know.

Q. Is there any danger of selenium levels in meat affecting our export trade?

A. The use of selenium is carefully controlled. The recommended levels of dosing are very low and could constitute no hazard in meat.