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MR. FITCH: We had rather a painful experience in connection with licks. We had groups of animals - 200 or 300 - on 800-acre paddocks, both of which had had reputations for bowie.

During the first year paddock "A" sheep had access to a simple bone-flour and salt lick, while paddock "B" sheep had no lick. There was no bowie in the former but a high incidence in the latter paddock. During the second season the lick position was reversed, but paddock "A" this time without licks, again produced no bowie while the lick failed to prevent a high incidence in paddock "B". We have since improved the palatability and distribution of licks in paddock "B" and are hoping for more successful results this season.

MR. GERRING asked if anything was known about the cause of deformity in the jaws of stock.

MR. FITCH: A few years ago a cystic condition in the lower jaw of sheep was reported to Wallaceville. We were unable to discover the cause, but it seems to be related to impaction of the primary incisors. The cause is obscure still, but it is interesting to note that Australian work on calcium deficiency in sheep fed on maize showed a tendency to impaction of temporary incisors. There was no cystic involvement of the permanent incisors, but the impaction in both cases is suggestive. In the case which occurred in New Zealand I discovered afterwards that the sheep had been fed on a poor crop of turnips. Whether faulty nutrition had any effect I do not know, but it is the only hypothesis I can offer.

DR. FILMER: Mr. Fitch's work is a good example of the necessity for following Dr. Hammond's advice on the solution of problems - to allow the scientist to find out the scientific principles involved. These bone conditions are not perfectly understood and do not respond to the administration of minerals in many cases. The only way we can get to the bottom of it is to allow a worker like Mr. Fitch to have his head. Let him study the whole pathology of the conditions and unravel the aetiology of them. Then the prevention and cure will follow in due course.

#### COPPER DEFICIENCY AFFECTING FARM STOCK IN NEW ZEALAND

Summary of paper by I.J. Cunningham, Animal Research Station, Department of Agriculture, Wallaceville.

The existence of a natural copper deficiency in certain parts of New Zealand was described.

The deficiency occurs on most reclaimed swamp areas where the soil is peaty, and on some areas where the soil is a mixture of peat and pumice.

The total area of peat deposits in New Zealand is approximately 400,000 acres and about 250,000 acres are occupied. Areas known to be deficient in copper are at Ruakaka, North Auckland, in the Waikato, Pongakawa, Reporoa, Opiki, Hawke's Bay, Christchurch and Southland districts, and on parts of the Rangitaiki Plains. These comprise the greater part of the peat land occupied for farming.

The evidence for copper deficiency is -

- (a) Subnormal copper content of herbage.
- (b) Subnormal copper contents of livers and blood of stock grazing on deficient areas.

(c) The improvement of stock health by supplying copper.

The health of stock on copper deficient country is seriously affected. Of cattle: Young stock are unthrifty and difficult or impossible to rear, adult stock scour badly and become anaemic, and production of milk or beef is greatly reduced. Of sheep: Lambs are affected by imperfection of the nervous system which causes inco-ordination of gait and sometimes paralysis, while wool production of adult animals is reduced.

The deficiency can be made good by annual applications of 5 pounds bluestone per acre alone or mixed with any of the usual fertilisers.

After top-dressing with copper there is no further occurrence of disease in cattle or sheep, and there is a marked increase in production of butter-fat, lamb crop or wool.

An illustration was given on one farm carrying 64 cows where production was 12,300lbs. butter-fat in 1943-44 before top-dressing and 17,200 lbs. butter-fat in 1944-45 after top-dressing. In this result some allowance had to be made for better season.

A full account of the work appeared in New Zealand Journal of Agriculture, December, 1944, Vol. 69, p. 559.

DISCUSSION ON MR. CUNNINGHAM'S PAPER:

MR. WARD: Does Dr. Cunningham associate the absence of copper, or a deficiency of it, with a general lowering of the tone? Has he any information on the fact that the Hauraki Plains had a high incidence of tuberculosis and does he associate that with a general lowering of resistance?

DR. CUNNINGHAM: I would not like to make a positive statement about increased susceptibility of copper deficient cows to tuberculosis. On the Hauraki Plains there are probably other factors influencing the occurrence of tuberculosis, such as dampness of soil favouring longevity of the organism. It is possible, on general grounds, that poor health and lowered resistance might make the animal more susceptible, but information on this point in respect to tuberculosis is by no means definite or complete.

MR. SWAN brought up the question of the possible risk of poisoning stock when bluestone is used as a topdressing.

DR. CUNNINGHAM said that if 5 lb. copper sulphate per acre were used on a paddock it was quite safe to put stock on to it after one rain had fallen and the bluestone had been washed into the soil. That had been practised by a number of farmers without any cases of copper poisoning occurring. That the copper should be thoroughly washed off the grass was more important for sheep than for cattle.

DR. HAMILTON: Apparently Dr. Cunningham dealt only with copper deficiencies on peat areas. Has he any information on the possibility of similar deficiencies occurring on other soils, for instance, the gum lands of North Auckland, which are very poor in mineral content? Secondly, is there any relation between the seasonal fluctuation shown in the copper content of pastures not normally deficient and the normal scouring of cattle in springtime?

DR. CUNNINGHAM: Some indications have been obtained of the copper deficiency near Galatea on pumice soil. Unfortunately one herd in which symptoms appeared similar to copper deficiency, was dispersed before I was able to examine it properly. Other attempts to keep stock on the same farm have so far proved unsuccessful.

The Rangitaki Plains are not pure peat but peat deposits alternated with layers of water laid pumice. On these Plains there are many areas definitely copper deficient.

The position concerning pumice lands has therefore only been touched on at the present time.

The gum lands have been in my mind as possibly copper deficient and some conversations with farmers on those areas have further indicated this. So far I have not got round to studying these areas.

In reply to the second question concerning scouring in stock, I cannot say what causes the normal loosening in the spring. The type of scouring is different from that which occurs through copper deficiency. It is not so prolonged and damaging to the animal. During the ordinary spring scouring the cow fattens well and lives well, but, with scouring due to copper deficiency, animals lose condition rapidly. They may pick up condition in December and January, but when the autumn flush feed comes along they commence to scour and again lose condition very rapidly. I do not think that seasonal variation in copper content of "normal" pastures bears any relation to the usual spring looseness of cattle. Cattle on normal country have adequate supplies of copper stored in the liver and can draw on these to tide them over a period of temporary shortage - if such a period should occur.

MR. CANDY referred to pastures topdressed with a bluestone and super mixture and asked whether any difference had been noted in pastures where bluestone had been applied by itself instead of with phosphate.

DR. CUNNINGHAM said that the result depended on the state of the pasture before topdressing. Some pastures on less consolidated peat consisted of lotus major and Yorkshire fog. On these pastures the application of bluestone alone caused improvement by way of increasing clover and rye-grass content. Superphosphate in addition would cause further improvement along these lines.

Other copper deficient pastures are of very good composition, being mainly ryegrass and clover. Applications of superphosphate are not required but copper is necessary to increase the copper content.

MR. CLARE said he was surprised at the degree of variation shown in the seasonal copper content of deficient pastures as demonstrated by Dr. CUNNINGHAM. They varied from almost normal down to very low, and he wondered about the degree of variation in normal pastures.

DR. CUNNINGHAM: The variation we get at Wallaceville is between 7 and 11 p.p.m. copper in dry grass. The variation in deficient areas is, as you point out, very considerable. It raises the possibility as to whether copper deficiency alone is the cause of scouring in cattle on some areas. This possibility will be investigated but little work has so far been done because of lack of time.

The justification for stating at the present time that there is a copper deficiency is that copper content of pasture is low, liver copper is always low and by feeding or otherwise supplying copper the disease in stock is eliminated. There is no question then that a copper deficiency does exist but only further work will show whether other factors contribute to the precise nature of the disease which occurs on these deficient lands.

Referring to the copper uptake by pastures, MR. McINTOSH asked if it was taken up by the plant or remained in the soil. In such circumstances the increased copper content of pastures after topdressing might be due to soil contamination or to part of the topdressing mixture remaining on the plants.

DR. CUNNINGHAM: The copper is taken up by the pasture. Figures presented showed a considerable increase in copper content of pasture eleven weeks after it had been topdressed with  $2\frac{1}{2}$  or more pounds bluestone per acre. During that time the pasture had been eaten down hard twice by a mob of sheep and the regrowth was taken, without soil contamination, for analysis. The increased copper content could not have come from soil contamination or from copper which had adhered to the plant during topdressing.

In other parts of the world it has been shown that copper is essential for plant nutrition and that the proportion taken up into the plant bears a direct relationship to the supply either in liquid nutrient medium or in the soil.

MR. EASTRAM: Is there any evidence to show that sterility in dairy cattle is more prevalent on copper-deficient country than on other pastures?

DR. CUNNINGHAM: I have no evidence about that at all. I have one or two reports from farmers saying that they have been able to get their cows in calf more readily after topdressing. There is no evidence of more temporary sterility on the peat lands than in other parts of New Zealand.

MR. WARD said that if there was evidence of wastage from herds on land on which bluestone topdressing had been used, it could easily be followed up for the next two or three seasons in order to provide some factual data on which questions on tone conditions could be answered.

DR. CUNNINGHAM: It will now be difficult to get farmers on peat soils who do not supply copper in some form or other so that comparison of wastage between a sufficient number of herds with and without copper treatment may be impossible. I agree that stock health and production might well improve progressively with successive years in which normal copper supplies are available. The recommendation of 5 lbs. bluestone per acre was arrived at on this basis. It seemed better to reduce cost as much as possible and to suggest a treatment that could be applied each year as a routine but which at the same time would not incur any risk of over-dosage and copper poisoning. Bluestone at 5 lbs. per acre fulfills all these requirements but on some farms at least 5 lbs. per acre will satisfy all the needs of the animal only after the second year of topdressing.

DR. FILMER: Dr. Cunningham is an excellent example of the benefit of training a man for the job he is going to do. It is probably fortuitous in his case. He made his acquaintance with copper at the Rowett Institute and when copper deficiency was found in New Zealand, he quickly recognised an old friend, and I do not know how I am ever going to tear them apart again.