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It was found to be completely non-injurious to them. It is supposed to be a very active poison but there is doubt about that.

MR. DOCKER: I have often found pieces of glass in the gizzard of a fowl. They did not seem to have done any harm.

DR. FILMER: This has been another interesting paper. It shows the sort of thing that goes on behind the scenes. Unless something special like mangold poisoning in pigs in the Canterbury district comes along all that is recorded is a couple of lines in the annual report of the Department to say that 7,000 samples were sent to Wallaceville for diagnosis. The samples from suspected poisoning cases passed through the hands of Mr. McIntosh. The question of "red water" being caused by turnips and other brassicas is one which quite frankly we have not yet tackled. We would in the first instance like the field men to supply whatever data they have collected about it. If any of the field men are experiencing trouble in that or any other problem we would be glad to have careful records of their observations, and as staff and opportunity become available we will do what we can towards the solution of the problems.

RICKETS IN SHEEP IN NEW ZEALAND.

L.W.N. FITCH, WALLACEVILLE ANIMAL RESEARCH STATION.

1. DEFINITION: Rickets is best defined on a pathological basis as a disease of highly characteristic morbid anatomy. Used in this manner the term has definite aetiological implications which point the way to logical prophylactic or curative measures.

2. INCIDENCE: The incidence of rickets in sheep elsewhere than in New Zealand appears to be rare in unhoused animals. In New Zealand it is confined to the South Island, principally Canterbury and Otago. It occurs only during the winter months and abates spontaneously with the advent of spring. Although it sometimes affects sheep grazing root crops and grass, it is mainly associated with winter grazing on green oats. Hoggets only develop clinical symptoms, probably on account of their growth being faster than that of maturer animals.

3. DESCRIPTION:

(a) Clinical: Mildly affected animals may show no symptoms but diminished growth during the winter. Severer cases exhibit lameness, and winter growth may be completely arrested. Deformity is not gross, but there is moderate swelling of certain joints - notably the radio-carpal, and the distal ends of the ribs are enlarged.

(b) Pathological: Rickets owes its characteristic pathology to the failure of provisional calcification of epiphyseal and other cartilage, and defective calcification of newly deposited osteoid. The result is an accumulation of uncalcified cartilage and osteoid. The former is strikingly manifested as a thickening of the epiphyseal cartilages, and this feature affords the simplest means of diagnosis, either ante-mortem by radiography, or by post-mortem inspection. Other deformities seen in rickets result from the inability of ricketic bone to withstand the stress and strain of normal physical activity.

(c) Biochemical: Blood calcium is usually depressed and may drop to 4-5 mgm. per cent. In recent experimental work, however, the blood calcium of sheep on green oats was depressed in a protected control group (calci-ferol) to the same extent as in an unprotected group which developed a high incidence of rickets.

Hence depression of blood calcium does not seem to be an important factor in the genesis of rickets in sheep.

Blood phosphorus of hoggets grazing green oats during the winter is fairly consistently depressed, and in rickets values between 2-4 mgm. per cent are common. This is in contrast to the blood phosphorus of similar sheep grazing grass or chou moellier at the same time, which uncommonly drops below 5 mgm. per cent. When vitamin D. supplements are used prophylactically blood phosphorus is elevated and maintained at a normal or high level. Similar treatment of sheep on grass or chou moellier does not affect their blood phosphorus content.

4. AETIOLOGY:

(a) General: Rickets is due to an insufficiency of either calcium or phosphorus or both for the normal calcification of cartilage or bone. In theory limitation of either dietary phosphorus or calcium alone should, if sufficiently intense, produce rickets, but in practice this does not appear to be the case. Rickets is commonly due to a deficiency of dietary phosphorus or to inefficient phosphorus utilisation resulting from a lack of vitamin D. Experimentally the low phosphorus type of rickets is often produced by the incorporation in the diet of excessive amounts of calcium, which, it is presumed, forms a relatively stable form of calcium phosphate, or other phosphorus-immobilising substance such as beryllium or strontium. There is no evidence that it can be caused by an uncomplicated deficiency of dietary calcium, however intense, but on diets very low in calcium a degree of hypovit.-D., in itself not ricketogenic, will precipitate rickets through its adverse effect on calcium assimilation alone. Thus lack of vitamin D. may cause rickets by its effect on either calcium or phosphorus; but on a diet containing normal amounts of these minerals its ricketogenic effect appears to depend on the depression of blood phosphorus alone.

(b) In New Zealand: The diagnosis of rickets virtually eliminates the possibility of uncomplicated calcium deficiency and although, in the present case, it can be prevented by D. supplements there is evidence that it is not due to the combined effects of low dietary calcium and vitamin D. For example, the lime content of green oats is adequate by acceptable standard, and successful prophylaxis is not accompanied by a significant alteration in the blood calcium level. The phosphorus requirements of sheep of 6-12 months is known to be about 1.5 grams and rickets has not been produced in sheep receiving more than one gram daily. The P_2O_5 content of green oats is usually about 0.8% or better. Even if it drops to 0.5% an animal which eats a kilo of dry matter daily will obtain approximately two grams of phosphorus, so that there is little chance of a simple aphosphorosis developing.

Failing the demonstration of calcium or phosphorus deficiency the possibility of D. deficiency received consideration, and found support in the efficiency of D. in raising the blood phosphorus to a normal level and preventing the occurrence of rickets, and also in the strict seasonal and geographic incidence of the condition. More recent observations at Wallaceville have confirmed the suggestion that solar irradiation of growing sheep is insufficient to guarantee adequate vitamin D. during the winter. However, there is an objection to the unqualified acceptance of a simple hypo-vitaminosis D. since, under experimental conditions at Kirwee, sheep grazing grass and chou moellier remain almost or completely free of rickets when a high percentage of similar animals on oats become affected. If it were simply a question of insufficient solar irradiation of the animal, rickets should develop on grass or chou moellier as readily as on green oats, and the fact that this does not happen suggests the presence of a

ricketogenic factor in oats, which probably requires the seasonal borderline state of vitamin D. sufficiency to find expression in clinical rickets. What this ricketogenic factor might be is at present quite inapparent.

5. PREVENTION: During 1942, in experiments at Kirwee, the incidence and severity of rickets in wethers was greatly reduced by the weekly administration of 30 cc. of cod liver oil throughout the winter. Weekly drenching with one ounce of bone flour had no prophylactic effect.

During 1943 and 1944 the single massive dose method of administering calciferol was tested. A million International Units of vitamin D. as calciferol, given in a single dose per os. or subcutaneously protected hoggets grazed through the winter on green oats.

6. OTHER OSTEODYSTROPHIC DISEASES OF SHEEP IN NEW ZEALAND:

(a) Acute Osteoporosis of lambs associated with copper deficiency. Has a very limited distribution, occurring only on parts of the Hauraki Plains very deficient in copper.

(b) Bowie: A condition of suckling lambs affecting chiefly Merinos, in the Wairau Valley, Marlborough, but seen also in parts of Canterbury and Otago.

(c) Atrophy: A very common condition associated with malnutrition from any cause, e.g. parasitism, cobalt deficiency.

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DISCUSSION ON MR. FITCH'S PAPER:

MR. HOW: Mr. Fitch mentioned that rickets in sheep occurred naturally only in the South Island, and I took it that why he said "naturally" is that a large number of sheep in that island are fed on green oats. Could Mr. Fitch give me any idea of the length of time sheep would have to be feeding on green oats before rickets appeared?

MR. FITCH: It is only in the South Island that the practise of feeding sheep on green oats is common. It is difficult to say just how long would be required before rickets appeared. I know one instance of a man grazing sheep on grass through most of the winter and then on turning them on to green oats in August, and within a fortnight they were all lame. I think they must have been on the borderline when they went on to the oats. Dr. Cunningham has carried out experimental work at Wallaceville when the solar radiation was found, in the winter to be inadequate for the prevention of rickets in hoggets.

Thus there is a tendency for grazing animals to be in a state bordering on vitamin D. deficiency, and if you expose such sheep to some other ricketogenic factor you precipitate rickets.

MR. LESLIE, after congratulating Mr. Fitch on his paper, said that his work would lead to bigger things. Among other points, he raised the question of the health of sheep's teeth. There seemed to be a connection, he said, between rickets and the condition of the teeth. "By investigating the factors of nutrition which affect the teeth - as distinct from rickets - we may be able to solve one of the major problems of the industry".

MR. FITCH: There is a problem of dental attrition. In many parts of New Zealand the farmers are concerned because sheep's teeth wear more rapidly than they should and they have to cull their ewes on account of age a year or two sooner than they would like to. We have not had a chance of investigating that problem yet, but it is an important one.

MR. DODSON: In the Waikato, we have noted a condition in which cows go lame for no apparent reason. Their feet are perfectly healthy but they walk in a bumble-footed way. It is noticeable when the soil dries up and the mud hardens a bit. Is there some calcium or bone deficiency causing this? We have also noted a condition of osteoarthritis in elderly cows. Is that a calcium or phosphorus deficiency or what might it be?

MR. FITCH: I have no knowledge of the bumble-footed condition of bovines. You often get one or two cases of chronic osteoarthritis in a herd. It is the older cows which have suffered heavy and continued lactation without much opportunity for recuperation which are affected. One can only assume that the arthritis may be due to the effect of heavy lactation on the skeleton and bone condition.

MR. CAMPBELL asked if the parathyroid gland in any of these animals had been examined. The mineral metabolism was affected by certain glands, he said. From the point of view of animal husbandry we are interested in whether these glands affect the mineral metabolism in our live-stock in the same way as they affect it in experimental animals such as rats, mice and guinea pigs. There is an opportunity here to throw some light upon that. We know that in rats, for example, the size of the parathyroid glands can be altered by varying calcium, phosphorus and vitamin D. in the diet. If such alteration occurs in the size and activity of the parathyroid in sheep under the conditions mentioned we may have a line on the importance and function of the parathyroid glands in one of our important species of live-stock.

MR. FITCH: I have examined them, but I find it difficult to decide whether there is an enlargement or not. Measurement is difficult, because the parathyroid is embedded in the thyroid and, moreover, we have no data on which to base comparisons. I have not recognised any definite abnormality in the parathyroids of sheep suffering from bowie or rickets. The parathyroid is very sensitive to any change in calcium or phosphorus. Even in pregnancy it is affected.

COLONEL WATSON said that studies he had made abroad had led him to the conclusion that certain ratios of magnesium in relation to calcium in the diet created an abnormal bone condition.

MR. FITCH replied that magnesium did not play a part in the production of rickets.

MR. CRAWFORD: I understood Mr. Fitch to say that they do not know the cause of bow-leg in sheep as it occurred in Marlborough, but that they were attempting treatment with licks.