Cobalt Deficiency

in

New Hampshire Cattle, Sheep, and Goats

By

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G. P. Percival
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This is what a sheep did to the side of its pen in an attempt to make up for cobalt deficiency.

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Introduction

Cobalt deficiency appears to have affected New Hampshire livestock for over 125 years, but it was not recognized as such until 1944. Early in that year Mr. Ralph Littlefield, then County Agricultural Agent in Carroll County, New Hampshire, asked the staff of the Department of Dairy Husbandry of the New Hampshire Agricultural Experiment Station to find the cause of what appeared to be a nutritional deficiency which was affecting the cattle of his county.

The symptoms of the deficiency were found to be the same as had been reported for cobalt deficiency. This deficiency had been identified a few years previously in New Zealand and Australia, and in Florida and Michigan in this country. A small amount of cobalt solution and instructions for feeding it were left with owners of affected animals. When these farms were visited a few weeks later, the affected animals were found to have made marked improvement within a few days after the treatment started.

The symptoms observed in the deficient cattle were one or more of the following: a very poor appetite, gnawing of wood or eating sticks, weeds, or other things not normally eaten, constipation, rough hair coat, scaliness of skin, loss of hair in patches, gauntness, unsteady gait, decreased milk flow, retarded growth, and sometimes death. Similar cases soon were found in other parts of New Hampshire and the feeding of cobalt was likewise effective.

Historical

The condition identified as cobalt deficiency was found to have a very fascinating history in Carroll County. One of the best known legends is quoted from New Hampshire Agricultural Experiment Station Circular 68:

"The disease is called "Burton-ail" by the dairymen of that region because it was first observed in the township of Burton, know now as Albany. According to legends, it was in Burton that Chocorua, a prophet among the Indians of that section, lived. His son, a child of nine or ten years, often visited at the home of Cornelius Campbell, one of a band of hardy pioneers who inhabited Burton. One day the young Indian boy, out of his insatiable curiosity about the strange things he found at the home of his white friends, drank some fox poison. He returned home to his father, sickened, and died. Chocorua, believing that his son had been intentionally poisoned, cruelly

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killed the wife and children of Cornelius Campbell. The white man plotted revenge and knowing that Chocorua often climbed alone to the summit of the mountain which now bears his name laid a trap for him. He shot and fatally wounded the prophet. Chocorua, who uttered this curse just before he fell over the precipice. "A curse upon ye, whitemen! May the Great Spirit curse ye when he speaks in the clouds, and his words are fire! Chocorua had a son, and ye killed him while the sky looked bright! Lightning blast your crops! Winds and fire destroy your dwellings! The Evil Spirit breathe death upon your cattle! Your graves lie in the war-path of the Indian! Panthers howl and wolves fatten over your bones! Chocorua goes to the Great Spirit — his curse stays with the white man!"

"At one time (1821) it was believed that the disease was due to the natural occurrence of muriate of lime (calcium chloride) in the drinking water. Treatment of the drinking water with common soapsuds was recommended. The waters in this area, however, have since been found to be low in lime. Some farmers, as a preventive measure, feed their cattle clay from certain pits, one such pit being in the neighborhood of Whiteface school. In general the location of such pits was a closely guarded secret. The manner in which this clay might function has not been determined."

Another interesting sidelight on this situation was the rather profitable business carried on by a few shrewd cattle dealers. These men made it a practice to buy affected animals which were nearly ready to die. When placed on pasture in other parts of the state, these animals usually recovered rather quickly and were sold a few months later at almost a clear profit. One farmer told about having to go out of the dairy business on two different occasions because his animals were gradually starving to death because they would not eat normally. The blame was laid on the grain, but changing from one brand to another was of no benefit. This farmer was on the verge of quitting for the final time, when the condition was relieved by the feeding of cobalt. Other interesting situations were encounted, but a lack of space prevents their being recorded here.

Field Studies on New Hampshire Dairy Farms

THE FIRST REPORT on cobalt deficiency in New Hampshire was made during 1944 in New Hampshire Agricultural Experiment Station Circular 68. This publication, which reported on the first cases treated, was circulated rather widely throughout New Hampshire and it helped greatly in arousing the interest which was necessary for carrying out the second phase of the study.

The second phase of the study was carried out to determine the extent of cobalt deficiency among the livestock population of New Hampshire. Much of the success of this undertaking was due to the cooperation of feedmen, veterinarians, county agricultural agents, and the owners of the affected livestock. The usual procedure in this phase was for a livestock owner to write to the Agricultural Experiment Station stating that one or two of his cattle were in very bad condition and would not eat normally but that the remainder of his animals appeared normal in every respect. When this letter was received, a small amount of cobalt sulfate and instructions for feeding it were sent to the livestock owner free of charge, but with the request that he report the results obtained from feeding it. Several of these farms were visited in order to get first-hand information on the deficiency.

Because of the prevalence of cobalt deficiency during the 1944-45 barn feeding season, it was natural that other conditions be called cobalt deficiency. Thus, when each letter was received, the condition described was classified as cobalt deficiency or not cobalt deficiency. During a period of about nine months cobalt was sent to over 200 livestock owners. Reports were not obtained from quite a few farmers, but the returns were as good as might be expected from this type of survey. It was found that the classification of cases into cobalt deficiency or not cobalt deficiency was almost perfect, indicating that cobalt deficiency has rather definite symptoms which make the deficiency rather easily identified in most cases.

The information obtained in the letters describing the condition and reporting on the use of cobalt did not furnish reliable data on the relative prevalence of the condition among different age groups, breeds, etc. To get such information a brief questionnaire was sent to each person who had used cobalt. Naturally, the returns also were not complete, but because of the relatively large number, the data obtained presented a rather accurate picture of the situation.

Table 1 — Summary of Cobalt Trials and the Result Obtained

County	No. Herds Furnished Cobalt	No. Herds Favorable Results	No. Herds Negative Results	No. Herds Unreported	Ave. Size Affected Herd	Percent Animals Affected
Belknap	20	16	0	4	22.2	15.4
Carroll	37	33	0	4	7.6	38.5
Cheshire	5	5	0	0	29.6	5.4
Coos	13	10	3	0	30.5	6.6
Grafton	16	16	0	0	25.7	10.0
Hillsboro	34	20	0	14	10.1	35.5
Merrimack	25	15	2	8	23.2	19.4
Rockingham	27	21	0	6	15.0	22.8
Strafford	14	11	1	2	11.6	21.0
Sullivan	13	6	2	5	18.5	20.3
State	204	153	8	43	17.2	17.8

Table 1 gives a summary of the use of cobalt and the results obtained in each county. It can be seen that both the number of herds treated and the percentage of animals affected per herd was highest in Carroll County, the apparent original location of the deficiency. Hillsboro and Rockingham counties also had a lot of the deficiency, apparently due in part to the intensive and extensive use of poultry manure on the land. Before the development of the poultry industry in this area, cobalt deficiency apparently was not a problem. The explanation for this situation appears to be this. There is a certain amount of available cobalt present in the soil for a crop. If it all goes into a small amount of hay, there is enough present on the percentage basis to prevent the deficiency. If the same amount is distributed through a much larger quantity of hay, the amount present on a percentage basis may be reduced to less than the amount required to prevent the deficiency. Poultry manure simply acted in stimulating the growth of the forage.

Figure 1 gives a better idea of the relative prevalence of the deficiency in various parts of the state. It can be seen that cobalt deficiency was much

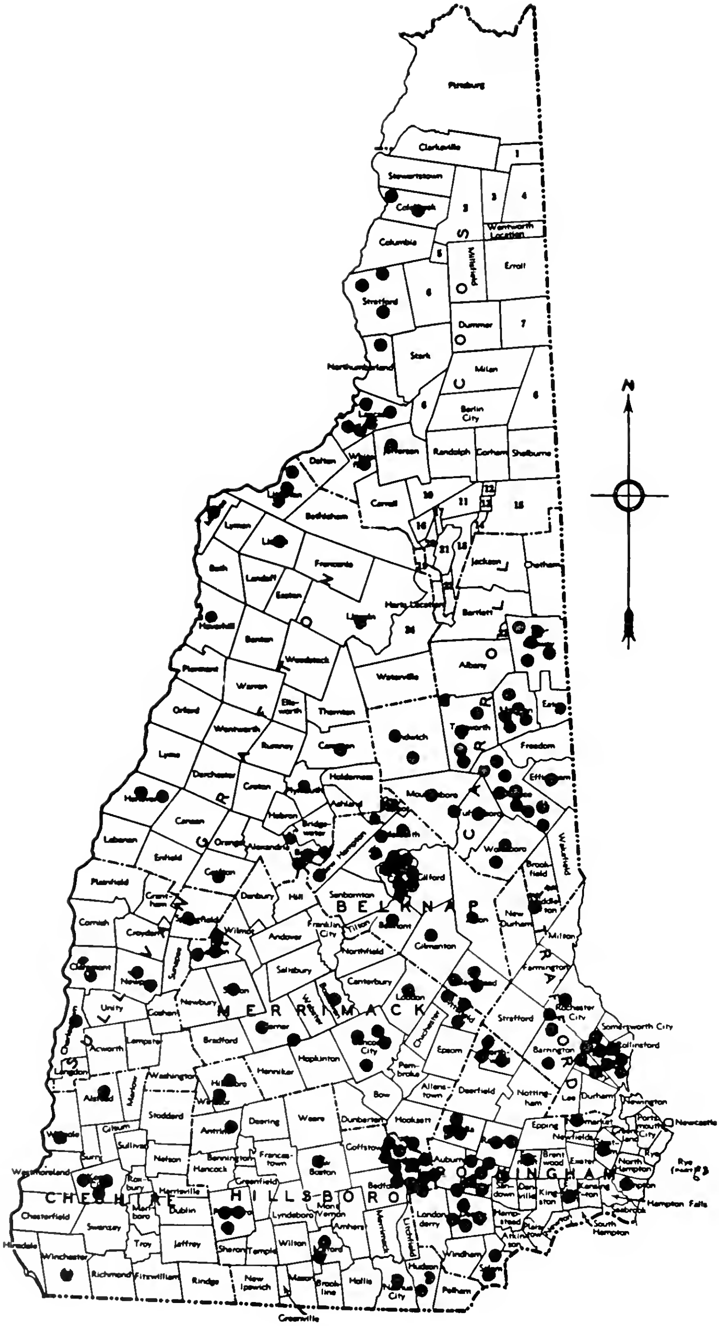


Figure 1. The location of farms in New Hampshire on which animals responded to the feeding of cobalt.

more troublesome in the eastern and southern parts of New Hampshire than in the northern and western parts. This cannot be accounted for entirely by the normal distribution of dairy cattle population in the state.

Table 2 — Percentage of Cobalt Deficient Animals in Affected Herds as Related to Breed and Age

Breed	Birth to 6 Mo.	6 Mo. to 2 Yrs.	Over 2 Yrs.	All of Breed
	Percent	Percent	Percent	Percent
Ayrshire	52.6	31.7	2.6	14.9
Brown Swiss	0.0	42.9	6.7	13.8
Guernsey	32.7	31.1	17.9	23.9
Holstein	13.8	25.3	8.8	13.9
Jersey	7.9	17.2	8.2	10.7
Other	42.9	41.2	33.3	37.9
All Breeds	23.1	26.7	12.1	17.8

Table 2 gives the distribution of cobalt deficiency among the various age groups and breeds. The deficiency was about twice as common among calves and heifers as milking cows. It would appear that cobalt deficiency might have been quite an important factor in causing hidden effects on calves which would lower their productive efficiency later as members of the milking herd.

Cobalt deficiency affected a higher percentage of Guernseys than of any of the other dairy breeds. A careful study of the situation, however, indicated that this breed was probably more popular in the deficient areas. Because of the fact that the herds in these areas were small, one or two affected animals represented a relatively high percentage of such herds. In those areas of the state which were troubled less by cobalt deficiency, Jersey and Holstein cattle were more popular and the herds were much larger. Thus it would appear that there was little if any difference in the susceptibility of the various breeds to cobalt deficiency.

It is not possible to estimate the total number of animals that have been affected or the financial loss that cobalt deficiency has caused New Hampshire livestock owners over the years. There is no question, however, but that the loss has been considerable. Person after person has told of animals that had died or that had been sold for practically nothing. It raises the question as to what effect the deficiency has had on bringing about the abandonment of farms which appear to have been prosperous at one time.

Cobalt Deficiency in Sheep and Goats

Soon after cobalt deficiency was found to be affecting cattle in the state, cases of the deficiency also were found in sheep and in goats. The effects on these animals were about the same as with cattle. In general, however, they tended to be more severe. The response to cobalt feeding was just as spectacular as it was with cattle. It was found that a relatively large number of goats were affected in various parts of the state. The effect on sheep was quite troublesome in certain areas in southern New Hampshire.

The sheep on the left received supp'emental cobalt. The one on the right received none. Notice the difference in size of the sheep and the condition of the fleece.

Cobalt Added to Dairy and Livestock Rations

SHORTLY AFTER it became evident that cobalt deficiency was having a marked effect on the health of cattle, sheep, and goats throughout New Hampshire, most feed manufacturers operating in this part of the country started to add cobalt to their mixed feeds for ruminants. The amount used was approximately two grams of cobalt sulphate per ton of feed. The cost to the feeder ranged from nothing to five or six cents per ton of feed. This practice practically eliminated cobalt deficiency from New Hampshire within a period of a few months. Since that time a few cases of the deficiency have been observed when concentrates were not being fed or when the concentrate mixture did not contain added cobalt. A few cases also have been observed in which animals have benefitted from receiving more cobalt than is included in the grain ration, but such cases have been very rare. It appears that the benefit of cobalt in such cases may come from a stimulating effect on rumen activity.

Laboratory Studies with Livestock

Cobalt Tolerance Studies with Young Dairy Cattle

When it became apparent that cobalt might be used rather widely to correct or prevent cobalt deficiency, the question of just how much cobalt an animal could consume without harmful effects was raised. Because very little information on this subject was available, studies on this problem were started in September, 1944.

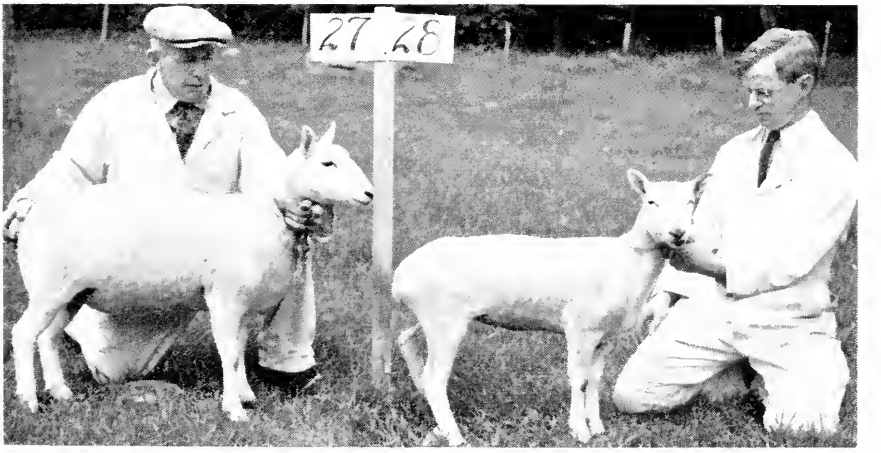
The experimental animals used were Holstein calves. Some animals received relatively large amounts of cobalt every day for periods of over a year in length. In general cobalt was fed in proportion to body weight in order to allow for growth. The effects of feeding large amounts of cobalt were determined by means of the effect on growth, appetite, and the hemoglobin and packed red-cell volume of the blood. Many of the animals were slaughtered at the end of the experiment and the amount of cobalt stored in certain body tissues was determined.

The results of this study showed that there was some variation in the tolerance level of different animals. When a slight excess of cobalt was consumed, there was an increase in hemoglobin and packed red-cell volume of the blood. When a greater excess was consumed there was a loss of appetite, a decrease in water consumption, a roughening of the hair coat, an unsteadiness when standing as well as an increase in hemoglobin and packed red-cell volume. High levels of cobalt feeding increased the cobalt content of kidney and liver tissues to several times that of similar animals which did not receive cobalt, but in light of the amounts fed and the duration of the feeding, these accumulations were considered to be small. Growing dairy animals were found to be able to consume approximately 50 mg. of cobalt per 100 lbs. body weight per day from cobalt sulfate for many weeks without definite harmful effects. It was concluded that over 100 times the amount of cobalt fed in the ordinary cobalt-supplemented, manufactured feeds can be consumed by growing dairy cattle without harmful effects.

The Development of Cobalt Deficiency under Controlled Conditions

After getting a response from feeding cobalt to deficient animals out in the state, the next step was to try to develop cobalt deficiency under controlled conditions. This was undertaken in an experiment using sheep as experimental subjects. Sheep are susceptible to cobalt deficiency because they have the same type of digestive tract as the cow and the goat. Their relatively small size permits the use of a considerable number of them at a relatively low cost. This experiment was started in January, 1946, and continued for a period of 27 weeks.

This experiment was started with 10 pairs of yearling lambs. The members of each pair were similar with respect to breed, sex, size, and origin. One member of each pair was given 7 mg. of cobalt twice per week as a drench, the other received none. Corn meal was fed as the sole concentrate. The roughage fed was a low-cobalt grass hay from a farm in southeastern



The difference in the size of these sheared sheep is striking. The one at the left was fed supplemental cobalt; the one at the right received none.

New Hampshire on which cobalt deficiency had been troublesome in cattle the previous winter.

Only one of the low-cobalt animals developed severe cobalt deficiency symptoms, but the others were borderline cases. In spite of a lack of severe cases of the deficiency, those animals which received cobalt gained on the average two and a half times as much in weight as those which did not receive supplemental cobalt. Feed and water consumption were found to be depressed by the deficiency just as they were in the field studies. It was concluded that cobalt deficiency can be produced by feeding low cobalt hay, such as found in New Hampshire, and that the effects of even a borderline deficiency are of considerable importance.

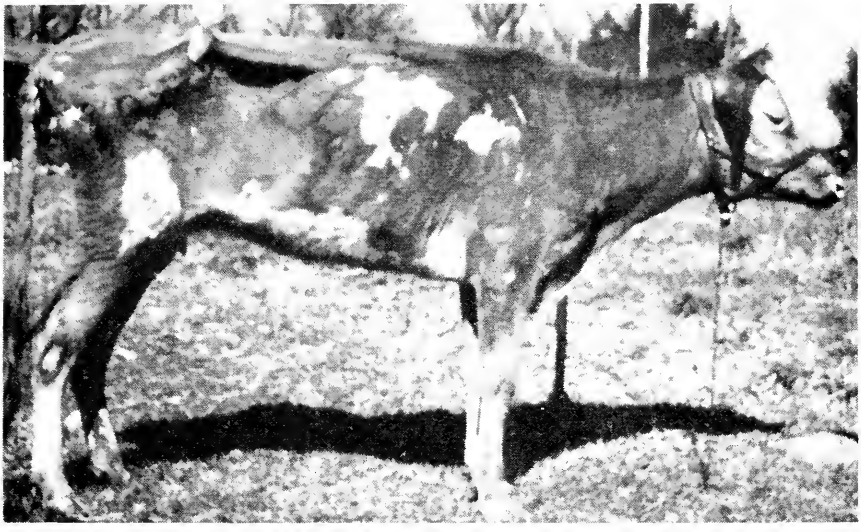
A Study of the Function of Cobalt in Ruminant Nutrition

Having established the existence of cobalt deficiency in New Hampshire, the next step was to determine just how cobalt functions in the nutrition of the ruminant. It had been observed for several years that cobalt deficiency did not appear to affect non-ruminants. It also had been reported that cobalt fed to a deficient animal was much more effective in correcting the deficiency than that injected into the blood stream. From those two observations it was deduced that cobalt is essential for the synthesis of some sort of nutritional factor by the flora of the rumen.

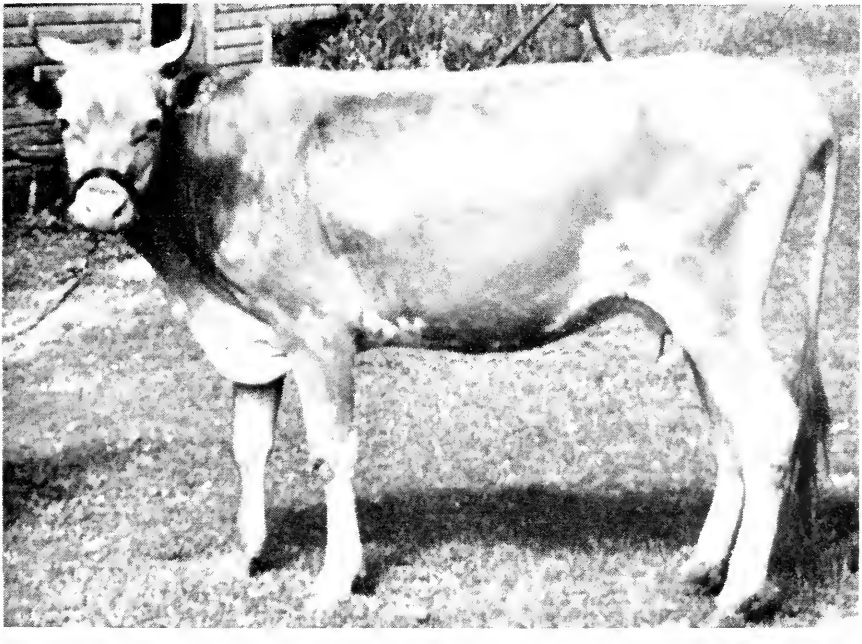
In order to learn more about the role of cobalt in the nutrition of ruminants, a second experiment was carried out with sheep. This experiment started with 10 pairs of yearling lambs and 10 unpaired animals. One member of each pair was given 3½ mg. of cobalt twice a week as a drench. The remainder did not receive any supplemental cobalt until after cobalt deficiency symptoms had developed. The sheep were fed a concentrate mixture composed of nine parts of a low-cobalt corn obtained from North Carolina and one part of skim milk powder and a low-cobalt grass hay which was purchased several miles west of Durham. This experiment started in March, 1948, and continued for 64 weeks.

Every animal fed the deficient ration without supplemental cobalt developed marked cobalt deficiency symptoms before the experiment was terminated. Every one of the 10 animals which were given cobalt remained healthy in every respect. At the time the first treatment was given to the deficient animals, the cobalt supplemented animals had gained nearly 7 times as much in body weight, were eating 5 times as much concentrates, 6 times as much hay, and were drinking twice as much water as the deficient animals. Wool production of the deficient sheep was approximately 62 percent that of those which were given cobalt.

Cobalt sulfate when fed to the deficient sheep corrected the deficiency in every case. When injected intravenously cobalt sulfate brought about a response, if large enough amounts were given over a long enough period. The first indications of response, however, were slow in coming. Cobalt carbonate, a compound which is relatively insoluble in water, also was found to be effective in relieving the deficiency. It was not possible to correct the deficiency by the use of vitamins, other trace elements, certain amino acids, liver extract, fresh rumen liquid from a cow, or fresh raw milk. This work indicated that cobalt was essential for the production of some unidentified nutritional factor in the rumen.



The cow abave, found on a New Hampshire farm, is typical of cabalt deficiency. The picture belaw shows the same cow a few weeks loter after she had been fed a cobalt supplement.



Studies with Radioactive Cobalt

To obtain further information on the way in which cobalt functions in the ruminant, an experiment was carried out using radioactive cobalt. When radioactive cobalt sulfate was injected intravenously into cobalt deficient sheep, it was found that a small amount of the cobalt reached the rumen. This explained why injected cobalt could bring about a slow recovery from the deficiency even if it was required only in the rumen.

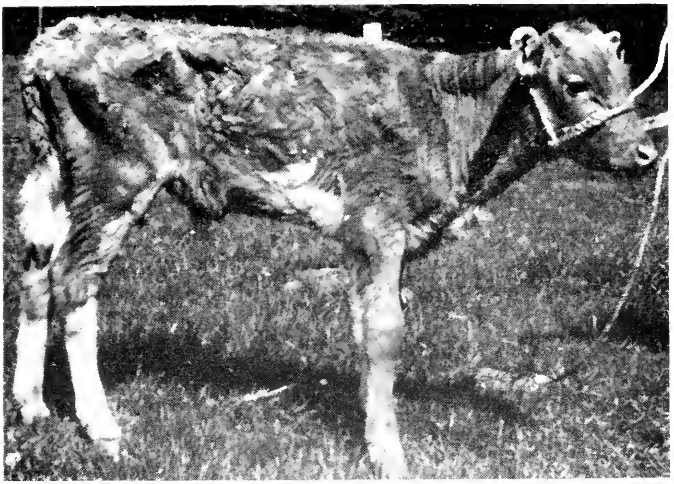
When radioactive cobalt carbonate, a compound which is relatively insoluble in water, was fed to normal sheep, it was found to be soluble enough in the digestive tract to be absorbed in appreciable quantities. This was shown by the presence of radioactive cobalt in the blood stream and in the urine.

Present Status

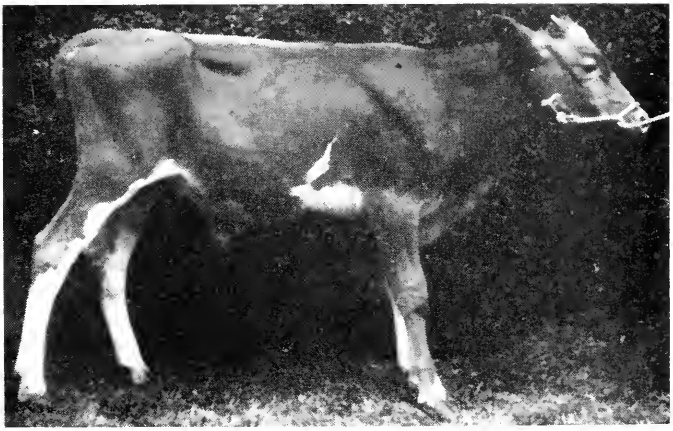
COBALT DEFICIENCY was found to affect the health of cattle, sheep, and goats generally throughout the state of New Hampshire. The effects of the deficiency have been practically eliminated by the use of cobalt-supplemented, manufactured feeds, salt, and mineral mixtures. The need for supplemental cobalt is very small: one pound of cobalt sulfate being enough to treat 225 tons of manufactured feed. The cost is negligible.

Studies now in progress at the New Hampshire Agricultural Experiment Station show that the cobalt content of forage may be reduced to the deficiency level in heavy yields resulting from the use of chemical fertilizers as well as from poultry manure. One surprising result of this study was the finding that the presence of a considerable percentage of ladino clover in a mixture is no guarantee against cobalt deficiency as is generally believed. In fact, the cobalt content of the ladino clover plant itself has been below the deficiency level in several cases. These studies emphasize the continued need for supplemental cobalt by cattle, sheep, and goats which may be fed forage produced under heavy fertilization.

The most recent information indicates that cobalt deficiency symptoms in ruminants are due to a lowered production of vitamin B_{12} by the flora of the rumen. The principal symptom is a lack of appetite. The other symptoms appear to result largely from an inadequate feed intake. In addition to the feeding of cobalt, the deficiency can be cured by the injection or feeding of adequate amounts of vitamin B_{12}, which contains cobalt in its molecule. According to Cornell University workers, the deficiency also can be corrected by the injection of a special liver extract containing a high potency of vitamin B_{12}.



The picture above shows a Guernsey calf affected by cobalt deficiency. After it was fed cobalt for a few weeks, the calf looked like this (below).



List of Publication on Various Phases of the Study

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