

A STUDY OF DEPRAVED APPETITE IN DAIRY CATTLE

THESIS FOR DEGREE OF M. S.

GEORGE E. TAYLOR

1925

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A STUDY OF DERIVED SPATIAL IN DAIRY CATTLE

A STUDY OF DUTY AND RESPONSIBILITY IN DAILY CATTLE

THIS IS

Submitted to the faculty of the Michigan State College
in partial fulfillment of the requirements for the degree
of Master of Science.

by

George E. Taylor

1925

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INTRODUCTION

Appetite is not always a reliable guide to proper animal nutrition. Dairy cattle frequently show a marked appetite for things not ordinarily classed as food, such as dirt, rags, wood, bones, etc. Aside from interfering with the proper physiological functioning of the animal body, the consequences resulting from the eating of such foreign material are sometimes very serious.

The true economical importance of depraved appetite may be estimated when we stop to realize the financial loss resulting from such a practice. Cows in milk that are afflicted with the disease suffer a great reduction in milk flow, while young and growing animals undergo a marked cessation in growth and become emaciated to the extent that they are rendered practically valueless from the standpoint of future milk production.

This disease is common throughout the United States, and is found to quite an appreciable extent in the state of Michigan. Farmers are prone to minimize the importance of this ailment due to the fact that it does not have a well-defined morbid entity, and the symptoms are not manifested in the nature of an acute febrile, contagious or communicable disease.

Its importance may also be emphasized from an experimental standpoint. Animals on various experimental projects at the Iowa, Michigan and Pennsylvania Experiment Stations have been stricken with the ~~ailment~~ ~~to the~~

extent that it interferes with the proper interpretation of experimental data.

The cause and prevention of this condition is not definitely known, regardless of the fact that various remedies and theories regarding the nature of its onset are often expounded. This experimental work has been planned and conducted in an effort to throw more light on the underlying causes and to determine the value of preventative agents as a means of combating this disease.

GENERAL DISCUSSION AND REVIEW OF LITERATURE

Depraved appetite is a disease that is comparatively common among all classes of livestock including dairy cattle. This disease occurs in all parts of the world and is found to some extent in Michigan, being the most pronounced in the thumb region. Depraved appetite is also very marked among experimental animals at the Michigan Agricultural College, particularly animals raised on restricted rations; or animals on diets restricted in the amounts and kinds of roughage.

Definition and Discussion

Depraved, or perverted appetite is defined by Borland (1) in his medical dictionary as the longing for unnatural and indigestible things as articles of food. Depraved appetite is common in all classes of livestock and domesticated animals. This disturbance is manifested in different manners in the different classes of animals. Bone chewing, combined with wood chewing and dirt eating in cattle; pig eating in sows; feather eating in poultry and toe picking in chickens; wool eating in sheep and goats; wood chewing and cribbing in horses, and coprophagy (the eating of dung) of wild animals in captivity are some of the most noticeable outward manifestations of the disturbance. Mature animals suffering from depraved appetite, particularly cows in milk, suffer a reduction in milk flow, coats become rough; and if afflicted for considerable period of time develop a general run down and emaciated condition. Young and growing animals evidence the same general run

down condition and also suffer a cessation in growth. In addition to this general unthrifty condition the resistance of the animal is lowered and pathogenic organisms, which under ordinary conditions would not be able to gain foothold, are able to establish themselves and set up an infection, which may result in the death of the animal.

Depraved or Abnormal Appetite

Outbreaks of depraved appetite are characterized by regional and seasonal outbreaks as reported by Welch (2) of the University of Montana Experiment Station. Bone chewing by cattle has become much more common in Montana since the closure of the "Open" or "Free Range", thus restricting the grazing areas so that the cattle are now largely confined to certain special types of soil and forage. The areas where the depraved appetite are the more common are the regions of poorer soils. The condition as observed by Welch occurs only where the cattle are fed on "Wild Hay", grown largely on low lands, and consisting mainly of red top, wire grass, blue joint grass and various swamp grasses.

The time of year the disturbance is the most noticeable varies. In some localities the cattle seem to be all right in the fall but begin to chew bones in the late winter and spring. In other instances the bone eating habit is present throughout the entire year, but becomes more aggravated in the spring. However, some cattlemen report the bone chewing practice only in the fall months. Bone chewing by cattle in Montana is nothing new, and as long ago as 1910 numerous cases

were reported by breeders, and investigated by the Montana Experiment Station. In recent years the trouble is more prevalent, particularly where the better class of land is reserved for farming purposes, thus limiting the grazing land to areas of poorer soils. Bone chewing is also more common during some years than others. This may be partly explained by the fact that the chemical composition of forage plants is determined by the kind of plants and the composition of the soil upon which they grow; that is, if the soil is acid or sour, then it contains little or no lime, and crops grown upon it will be low in lime. On the other hand in a very dry year soils that contain plenty of lime may produce grasses with a very low mineral content, due to insufficient moisture to form a solution of the soil constituents.

The general symptoms of "bone chewing" cattle as described by Welch, are those of a general run down condition and emaciation. Animals in the herds chew bones just occasionally and only a few develop the habit, or a large number in the herd may become persistent bone chewers. Many "bone chewing" cattle become thin, stiff, apparently foot sore, lame, and disinclined to move about; and although they eat more than ordinary cattle they lose steadily in condition. The calves are light bones, often weak, and there are likely to be more abortions in the spring than can be accounted for by the usual causes. Until spring is well advanced the cattle are endlessly hunting for something to satisfy their craving, chewing rocks, boards, and bones. Many cattle are lost each

year from choking on bone fragments, and many cattlemen have found it necessary, at times, to catch a cow and forcibly remove a bone fragment that had been wedged between the jaws.

Welsh published the photographs of cross sections of the femur and fibia of a cow grazed on wild grass, that chewed bones occasionally, but otherwise was in fairly good condition. These were compared with the femur and fibia of a cow grazed on alfalfa pasture, that had evidenced no depravity of appetite. The bones of the cow suffering from depraved appetite showed a thin bony wall along the shaft of the bones. The bony wall did not extend around the ends of the bones, especially over the joint surfaces. The bones, taken as a whole, were frail compared to the bones of the cow grazed on alfalfa. This would tend to explain the reason for so much lameness, stiffness of gait, and etc., in bone chewing cattle, because there is no supporting wall over the joint surfaces, and hardly enough supporting strength in the necks of the bones to carry the body weight.

Depraved appetite does not occur under the same conditions in young and mature animals, according to Hansen and Bolter (3). In adults it often results from faulty feeding, or from some wasting disease which develops insidiously, or remains unrecognized. The animal has certain special body requirements to meet, which must be satisfied by food of suitable composition. If these alimentary and digestive requirements are not satisfied, depraved appetite may occur in animals which appear to be well nourished.

The symptoms of the disease are divided into two phases by Housen and Deller. In the first phase the animals still preserve their appetite, but whenever they have an opportunity they eat dirt, sand, manure, litter saturated with urine, plaster, etc. They lick the walls, the boarding, mangers, and trees, and also chew wood and trees; and may also eat sacks, articles of clothing, or anything to which they may have ready access. This phase may continue for a long time, three to four months or more, providing no acute complications result from the eating of such foreign material. There is no fever, but the appetite, although well preserved, is often capricious, and the ordinary food is eaten slowly.

In the second phase, which is frequently marked by the development of complications produced by the passage, contact, or prolonged sojourn of various material in the digestive tract, fever appears, usually little marked as a rule, but continuous in character. The normal appetite is also diminished. The animal starts wasting away; secretion of milk diminishes; signs of chronic gastro-enteritis may be noted; the perversion of appetite continues; and all manner of indigestible material is consumed. It is not surprising that such substances set up an inflammation of the mucous membranes of the digestive tract. The wasting process slowly leads to emaciation, and after an interval of from six months to a year, or even two years, the patients die in a state of complete exhaustion. The lesions found on post mortem examination are those of various diseases, capable of producing depressed appetite, or simply lesions of chronic gastro-enteritis.

In young animals it is usually the result of insufficient nutrition. Depraved appetite occurs most frequently in calves and lambs that are insufficiently nourished, or when the mothers are suffering from chronic debilitating diseases, and as a result are yielding milk poor in fat and mineral constituents. The calves eat and lick the hair from their own bodies and from the bodies of other calves in the herd. When this hair enters the stomach it is mixed with mucus, and then by the churning motion of the rumen is slowly formed into oegagrophiles or hair balls. These keep increasing in size as more hair is taken into the stomach, and finally reach a size sufficient to cause an obstruction of the pylorus. The young calves then refuse all nourishment, and die within a period of twenty-four to forty-eight hours in a state of complete exhaustion.

In lambs the complications due to depraved appetite develop in a similar manner. The wool swallowed by lambs, however, is usually obtained from the fleece of their mothers. The wool, unlike hair, is not easily formed into oegagrophiles; nevertheless, it soon accumulates in the pyloric region, thus causing an obstruction. Death then results from intestinal obstruction exactly as in the case of calves.

A. J. Murray (4) states that cattle suffering from depraved appetite have a capricious and variable appetite as regards their ordinary foods, but evidence a strong desire to lick and eat substances for which healthy cattle show no inclination. Alkaline and saline tasting substances are especially

attractive. They will lick lime, earth, coal, gravel, and even the faeces of other cattle. Cows in calf and young animals seem to be the most susceptible. Such animals develop a slow gait, and small vesicles containing yellowish fluid form under the tongue. The milk, given by mature animals, also becomes thin and watery. The animals become restless and uneasy as indicated by frequent bellowing. The disease may linger on and last for months, the animals finally dying after complete emaciation and exhaustion.

Many cases of depraved appetite are cited where all classes of animals as well as humans have devoured all manner of substances that can not be regarded as food. Rogers (5) reports instances of depraved appetite in horses, cattle, sheep, and dogs. Knives, forks, wire, pins, needles, nails, plaster, rod, sand, wood, hair and wool are mentioned as some of the substances eaten. He states that he has removed a pillow sham from the rumen of a calf, and a golf ball from the small intestine of a pointer dog. Also a large piece of overcoat from the rumen of a cow. Sheep also are said to develop such a taste for each other's wool that it leads to serious consequences.

Butler (6) reports cases of mules eating dirt and faeces, cows chewing and eating old rags, sheep and goats sucking and eating the wool from each other's bodies, and chickens picking and eating feathers from their own bodies and from the bodies of other members of the flock.

McIntosh (7) describes the condition of cribbiters and wind suckers in horses, which is primarily a depraved appetite.

Animals afflicted seize the manger or anything they can grasp between their teeth and make a sound as if sucking air.

Law (8) likewise mentions the usual symptoms of depraved appetite in horses and cows and cites instances where they have eaten wood, earth, manure and bones.

Lynch (9) brings out the fact that depraved appetite among swine is common. It is sometimes seen as a symptom in other diseases, such as gastritis, chronic indigestion, and even in hog cholera, especially in the chronic type. It is also commonly seen where hogs are fed inadequate rations, especially one that is deficient in alkaline and salty earths. Hogs suffering from this trouble will leave good wholesome food untouched in the trough, and eat indigestible substances as earth, dried feces, dirt and sand. In addition to losing flesh and becoming weak and unthrifty, the animals are frequently quite nervous, uneasy and quarrelsome, and may attack each other, occasionally killing and eating one of the members of the herd. Sows suffering from this disease also eat their own pigs. Lynch points out that depraved appetite is a danger signal, warning that the digestive track is out of order, and it is important to remember that this leaves the herd open to attacks of hog cholera and other diseases.

Baker (10) points out that depraved appetite is commonly seen in pregnant ewes. He regards wool eating in sheep more of a habit than a disease, that sheep acquire when they are penned up in close quarters.

According to Fox (11) coprophagy (eating of dung) is not

infrequent in our captive wild animals, and is especially noticeable in the chimpanzees. He states that the eating of feces is not healthful, and probably does not occur in nature.

It has been previously pointed out in this work that depraved appetite is common in humans. An editorial in the Lancet (12) states that a Frenchman, suffering from pathological gluttony, devoured one-fourth of a beef in twenty-four hours. At times he also ate serpents and cats, consuming them hair and all. This man was the descendant of a family that were earth eaters, wood eaters and insect eaters.

In another article in the Lancet (13) a French prisoner in England is reported as having the habit of eating rats, cats and dogs, at times devouring their entire bodies. Certain tribes of natives in South America are said to be earth eaters, and often fill their stomachs with large quantities of clay.

A case of depraved appetite is reported in the Lancet (14), of a girl employed as a sheep herder, who developed an abnormal craving for filthy and contaminated water.

Lichlenstein (15) in his article on rickets points out that often times rachitic children exhibit an abnormal sense of taste.

Schadler (16) calls attention to the fact that humans often have an abnormal craving for sweets and sugar. Cravings for sour or acid tasting foods, such as lemons and pickles, are also quite common.

Depraved appetite in humans is most common in cases of

hysteria, chlorosis and during pregnancy, according to Dorland (1).

More recent investigators have observed depraved appetites in ruminants fed on restricted rations. Devenport (17) found that calves fed on rations devoid of coarse feed evidenced a depraved appetite and would readily eat shavings and chew boards, rope, etc. whenever obtainable. The animals on whole milk and grain rations consumed large quantities of grain; nevertheless, the oat hulls in one-half bushel of whole oats a day, did not serve as sufficient bulk in the ration to satisfy the animals' craving for coarse feed.

Sanborn (18) while attempting to raise ruminants on milk and grain alone found that calves consumed large quantities of shavings. He attributed the death of the calves to the detrimental effects of the shavings. With older steers and sheep on similar rations, he did not mention any depraved appetite as being evident.

Jones (19) reported a form of depraved appetite in young ruminants fed on whole milk diet up to eight and twelve weeks of age. These animals were confined for the most part in a dry lot, where they were unable to obtain anything except the whole milk as food. The usual symptoms were gaunt appearance, weak, eyes staring, animal constantly grinds its teeth, and is more or less delirious.

McCandlish (20) working on the problem of milk as a sole diet for ruminants found that the calves on milk diet alone ate freely of shavings, gnawed the wood in the walls of the pen and ate hair from each other's bodies. On post mortem

examination of these calves considerable quantities of hair mixed with casein, or a cheesy like material, was found in the rumen.

In later work McCandlish (49) found that the lack of a factor carried in well cured alfalfa hay produced a depraved appetite in dairy calves. In this experiment McCandlish used twenty-four calves, which were divided into three groups of eight each. Group one calves were fed on whole milk diet alone. Group two calves were fed on whole milk diet supplemented with a mixed grain ration. Group three calves were fed on whole milk diet supplemented with alfalfa hay. These calves received these rations up to five months of age, at which time alfalfa hay was added to the rations of the group one and two animals.

Calves in group one developed a ravenous depraved appetite, and one calf in particular started eating the hair from the backs of other calves. At the end of four months this calf had eaten nearly all of the hair from the back of a group member. The depraved appetite gradually grew worse and after a time the animal was noticed to lie down considerable. The calf became weak in the knees and down in the front pasterns when led. Later in the period its gait became stilted and the legs were stiff at the knees and hocks. The calf also developed irritability and twitched considerable when touched, especially along the spinal column. At the end of the five months period alfalfa hay was added to the ration and the calf showed immediate improvement, all signs of depraved appetite disappeared and the calf continued to improve throughout the remainder of the experiment.

The calves in group two showed the same general symptoms as those in group one, and all of the calves developed an appetite for shavings and chewed the boards of the pens. The bulk contained in the mixed grain ration failed to carry the necessary factor needed in order to prevent the appearance of the depraved appetite. At the end of the five months period the bones of the front legs of one of the calves in this group were bowed into a rainbow shape. When alfalfa hay was introduced into the ration of these calves all signs of depraved appetite disappeared and the calves made a speedy recovery.

The calves in group three developed normally in every respect and did not show signs of depraved appetite.

Calves in groups one and two ate plenty of shavings to supply bulk, providing bulk was the factor needed to distend the digestive track, thus making proper digestion possible. But shavings failed to serve this purpose, and depraved appetite developed. This work suggests that there is a beneficial factor in alfalfa hay that prevents depraved appetite; however, the nature of this factor has not been determined.

H. J. Waters (21) found that animals placed on a maintenance ration developed a depraved appetite a short time after being placed on the ration. The animals resorted to eating considerable quantities of soil.

Pica (40) is the name given to a disease common among range animals in South Africa. Pica translated means depraved appetite. The disturbance has been a constant menace to the livestock industry for years in South Africa. In fact

depraved appetite is so common among cattle in some sections that the cattle breeders have come to regard it as a normal feature in their animals. In some sections the disease occurs in a very acute form, while in other sections it appears in a more mild form. The symptoms noticed are those of a general run down condition, emaciation, and a lack of thrift. The most noticeable outward manifestation of the disease is the abnormal craving for bones. When bones cannot be found the animals will gather around the homestead and consume washings, bags, cloths, reins, skins and all kinds of miscellaneous rubbish. When the animals are driven away from the homestead they will persistently return to the source of the supply of these materials.

Some authorities on the subject regard the disturbance as due to a nervous disorder, since animals in the best of condition are usually afflicted as they gradually loose in flesh their abnormal cravings abate. The Department of Agriculture of Union of South Africa have evidence that there is a relationship between the appearance of the disease and the phosphorous content of the soil. It would seem that the disturbance was primarily due to a deficiency of phosphorous in the pasture upon which the animals graze.

Related Diseases

Emaziente

A very closely related disease to Pica known as Emaziente, has been a far greater obstacle confronting the livestock

industry in South Africa. Lamziekte translated means "fallen sickness". The disease according to Viljoen (41) occurs under certain soil and pasture conditions, and is more prevalent during certain seasons of the year than others. Sandy soil, especially when shallow or when mixed with stone, particularly limestone, seems to be the most common formation upon which the disease occurs, and in all areas where Lamziekte is prevalent the soil is of a sandy nature. Lamziekte is unknown, or very rare on farms where the soil formation is a deep alluvial type. Climatic conditions at different seasons of the year play an important part in the development of the disease, and it may be said that Lamziekte appears most commonly on farms where the soil formation is such that very little moisture is retained, so that plants growing on such soils quickly respond to any change in rainfall. In regard to the nature of the vegetation of the infected areas Viljoen states that the disease occurs only on the grass pasture, and has never been seen on the Karoo pasture. The disease is reported not to occur on the game pasture where the plant "Brokgamma" will grow. He concludes that it is probably not so much the species or type of vegetation that is involved in the production of the disease, as the unfavorable climatic and soil conditions to which the plants are exposed. Lamziekte has always been recognized as a disease of growth and is very closely associated with the annual precipitation. The disease seems more common during the summer months. During this season of the year there will be an occasional shower of rain, followed by a period of growth and a very marked rise in temperature. Immediately following the shower of rain the grass responds with a young

succulent growth, and during the following period of drowth and hot weather, the young plants become wilted and practically burn up. It is then that the disease more often makes its appearance, while the cattle are grazing on the burnt pasture. The disease has been known to occur during the winter as the, but only under rare conditions.

Leuziente attacks all bovines, irrespective of breed or sex. However, young animals and cows in calf or in milk appear to be more susceptible. Farmers report Leuziente occurring in other species of animals as goats, sheep, mules and horses, but it is far more commonly seen in cattle. Under experimental conditions they have never been able to produce the disease in mules or horses. Animals brought from a Leuziente free area to an infected area do not develop the symptoms of the disease until after several months. The time required usually varies from four to ten months. This time is sometimes referred to as the incubation period, especially when viewing the cause of the disease from the standpoint of an accumulative toxin.

The general symptoms of the disease may be divided into three stages, namely: 1. Peracute, 2. Acute, 3. Sub-acute. In the cases of the peracute form, the duration of the disease is very short. The animal first exhibits marked muscular weakness and inability to rise almost immediately after the onset of the disease. Death usually follows within six hours after the first symptoms of the disease are noted.

With the acute form the muscular weakness comes on much more slowly. Lameness gradually develops, being more noticeable in the fore quarters. The animals become more sluggish and the muscular weakness slowly increases. The animal finally gets

down and is unable to rise alone, and when assisted onto it's legs is unable to maintain itself in a standing position. When the animal is permanently down it first maintains itself in a sternal position, but finally loses all control of it's body and is forced to lie stretched out full length on its side. Eating and rumination cease, due to partial paralysis of the throat and tongue. The temperature of the animal remains normal up to death. Animals afflicted with the acute form are able to withstand the attack of the disease from twelve hours to five or six days, with an average of approximately two to three days in the most of the cases.

The sub-acute form differs from the acute form in that the onset of the disease is not so sudden and the course of the disease is more prolonged. At first only slight signs of stiffness are noticed, and lameness increases very slowly. There is a loss of appetite and a gradual onset of a weakened condition. Animals go down and are unable to rise on about the fourteenth day. Death then follows in about seven days. Nearly all of the cases that finally get down and are unable to rise alone terminate fatally. Some animals never get down completely, and these cases frequently recover.

The post mortem findings in the three different forms of the disease do not differ a great deal, and the lesions found in most cases are as follows:

Liver.....Fatty degenerations

Gall Bladder.....Distended with bile

Spleen.....Hyperemia

Kidney.....Hyperemia

Abdomen and Intestines...Hyperemia

Rumen and Reticulum.....Bones, nails, etc., found in the contents
 Mesenteric glands.....Swollen and oedematous
 Genital organs.....Normal

Hedinger (42) made a study of the disease from the standpoint of Pathology, and reports on the characteristic pathological findings in typical cases as follows:

Hyperemia of the whole organs, especially the intestines
 Hemorrhage of the epicardium and endocardium
 Mucro-enteritis in the small intestines
 Fatty degeneration and brown pigmentation of the muscles
 Sarcosporidia isolated in all cases.

During the progress of the investigational work on this disease many different theories have been advanced regarding its probable cause. Hutcheon (43) in 1895 was the first man to work on this disease in an effort to determine its cause. He attributed the cause to a lack of phosphorus in the ration, and reported favorable results from the feeding of bone meal as a means of combating the disease. Bowlill (43) attributed the cause of the disease to be purely dietetic, the characteristic symptoms being ascribed to mechanical interference with the central nervous system from pressure due to a softening of the bones from a deficiency of phosphates in the ration.

Robertson (44) isolated an organism (polymorphic bacillus) as the causal factor. He demonstrated the presence of this organism in muddy pools and standing water, and pronounced the water supply as being the source of the infection.

Theiler (45) in 1912 advanced the grass toxin theory as being the cause of the disease. He suspected the grass of being

the causal factor because the disease occurred on certain types of pasture, under specific seasonal conditions. He was not sure whether the toxin was contained in the plant itself, or whether it was due to the products of a toxic fungus growing on the plants. Extensive experimental work carried out since that time in order to determine the toxicity of different plants has tended to disprove this theory.

Hedinger (42) was of the opinion that sarcosporidia were connected with the etiology of lamziekte. However, Viljoen (46) upon investigating carcasses in an effort to determine the roll that was played by sarcosporidia in the development of the disease came to the conclusion that sarcosporidia are harmless parasites in cattle. He advanced the idea that these organisms overrun the host only when the body has become debilitated and enaciated, due to some other cause. In cases of lamziekte the resistance of the animal is lowered, and the parasites are then able to gain a foot hold and to multiply rapidly. This tends to account for the exceedingly large numbers of sarcosporidia isolated in the majority of cases, but they are not, however, a primary cause of the disease.

Theiler (47) was the first investigator to definitely establish the true etiology of the disease lamziekte in cattle. According to Theiler lamziekte in itself may be loosely described as a form of ptomaine poisoning, caused by the ingestion of toxic carcass debris scattered about the pasture. The symptoms of the disease are simply those of a specific poisoning, and may appear among beasts in prime condition, within a few days after the ingestion of the poison; or even within thirty-six

hours if the concentrated toxin be injected straight into the blood stream.

The poison or toxin is produced by "toxicogenic saprophytes", an anaerobic bacterium, reminiscent of, but not identical with *Bacillus Botulinus*. Not all carcass debris is poisonous, but only such carrion as has become infected with the specific organism. It is thus possible for fragments of carrion, putrified flesh, or rotten bones to be poisonous in one district and not in another; or poisonous at one time or place, and not at others, even on the same farm. By removing all carcass debris *Lenziekte* is automatically excluded, and in practice it has been found possible, by thorough cleaning of a farm, to reduce the incidence of the disease almost to zero.

The second point of outstanding significance is that perfectly normal cattle will not touch poisonous carcass debris, no matter how much scattered about the pasture, but only those animals which show depraved appetite run any serious risk of ingesting the toxic debris, and so contracting *Lenziekte*. This depraved appetite is not in itself a disease with a mortality incidence of its own, but is merely an incidental precursor to dreaded *Lenziekte*.

Depraved appetites are common over wide areas in South Africa in which *Lenziekte* is unknown. Depraved appetite arises whenever the vegetation is deficient in phosphorus, and is apparently a manifestation of phosphorus hunger, and can be relieved by the feeding of practically any digestible phosphorus compound. By feeding phosphorus compounds the depraved appetite

is removed; the cattle leave the toxic carrion alone, and Lamziekte is therefore excluded. Bone meal is the cheapest and most palatable form of phosphorous on the market, and is therefore always recommended. It may be necessary to feed quite large quantities of bone meal, even three or more ounces per head per day, where depraved appetite is severe, the precise amount depending upon the district and the season of the year.

The first method of control outlined takes the debris away, the second leaves the debris where it is, but stops the cattle from eating it. If proper application of both methods of control are applied, the disease can easily be checked and obliterated.

Osteomalacia

Depraved appetite frequently precedes the condition in which the bones of cattle become soft and brittle and fracture easily, which is known as osteomalacia, according to Murray (4).

Osteomalacia is a disease marked by increasing softness of the bones, so that they become brittle and flexible, according to Dorland (1). There is a marked loss of mineral matter from the bones generally, according to Forbes and Keith (22), particularly calcium and a less marked loss of phosphorous. An increase in magnesium and sulphur is noted. The salts of the bones are absorbed and replaced by tissue not having the normal content of bone salts. The method by which these changes take place, as stated by Pommer (22) in 1885, is through a continuous building of new lime free bone tissue, a cessation of the

deposition of lime and a local removal of lime from the parts containing it.

Forbes and Keith (22) and McCradden and Folger (23) while studying bone metabolism in osteomalacia found a marked loss of inorganic matter of the dried bones. The relative amount of inorganic matter lost was twenty-eight per cent compared with forty-eight and one-half per cent in normal bone. The calcium content was reduced nearly one-half and the phosphorus content lowered about one third. The magnesium and sulphur content of the bones was found to be increased nearly four fold. The ratio of the P_2O_5 to CaO was found to be greater than normal.

Huston and Bryan (25) and Ingh (24) found on the analysis of bones of horses suffering from osteomalacia that there was a reduction of lime, phosphoric acid, soda, fats and nitrogen free organic matter.

As stated by Housen and Dellar (3), animals suffering from this disease first show a perversion of appetite and general loss of vitality; sluggishness appears and the animals have a tendency to remain lying in the stables. The weakness of the animals gradually becomes more marked, appetite becomes more irregular and lameness appears due to arthritis of the extremities. Animals in milk also suffer a diminution in milk flow. The next symptoms are characterized by fractures of the bones. The slightest blow, or even muscular effort, may cause a fracture in bones of the leg or the ribs. The fractures are seldom accompanied with excessive bleeding and show little tendency to repair. If the animals do not receive treatment in the early stages the bones finally become elastic, soft and

depressible. The bones of the head are usually the first to suffer, becoming greatly enlarged, and the osseous tissue slowly disappears.

Predisposing factors to the onset of the disease, according to Parker (26), Housen and Dellar (3), Forbes and Keith (22), are growth, pregnancy, starvation and lactation. This malady is due principally to deficiency of the food in bone forming constituents although perhaps due in part to a lack of the correct proportion between the mineral elements, bone forming or otherwise, contained in the food. It appears more probable that it is due to a lack of the correct proportion of mineral elements, rather than a deficiency of all of them; because Courrel (27) has found osteomalacia occurring in regions where there was plenty of lime in the soil and forage plants, as shown by chemical analysis.

Kellner (28) reports that in localities where the hay and roughage are low in calcium and phosphorus, that farm animals invariably evidence the usual symptoms of osteomalacia. Lewite (29) attributed the outbreak of osteomalacia in 1904 to a mineral deficiency of the food stuffs, particularly a deficiency of phosphorus and possibly calcium. During the year 1904 the absorption of calcium and phosphorus by the roots of the plants was hindered by drought.

Schewmert, Schettke and Loetsch (30) found that a ration of hay and oats fed to horses was followed by osteomalacia. Upon analysis the hay was found to be deficient in calcium, but no other deficiencies were noted.

Since the disease is most common on worn out soil, and on soils lacking in lime, according to Hawaii (71) and Liensaux (72), the cause of the disease must be looked upon as a deficiency of mineral constituents in the food stuffs; and treatment must consist of supplying the lacking minerals. The addition of lime and phosphorus to the ration in the form of bone meal, bone ash, or tri or di-basic calcium phosphate is recommended as a treatment by Hutcheon (33), Hagen (34), Forbes and Keith (22) and Moussu and Doller (3).

Osteous Cachexia

Another disease which is characterized by a depraved appetite is osteous cachexia. This malignant bone disease of sheep first made its appearance in New Zealand in 1909. Reid and Astor (35) state that this disease is identical with osteomalacia, therefore, further consideration of this disease will not be taken up in this work. They report the usual symptoms common to osteomalacia and state that the factor chiefly responsible for this abnormal condition appeared to be an excess of organic matter, and a deficiency of lime salts in the soils upon which the animals were pastured.

Bush Sickness

The first warning of an outbreak of Bush Sickness is the depraved appetite noticed among animals that are coming down with an attack of the disturbance. This disease is particularly common to certain parts of New Zealand. According to Astor (36) it is not a disease in the true sense of the term,

but rather a physiological condition resulting from a deficiency in the food of some essential nutrient. Astar assumed that the deficiency resulted either practically in starvation, or else the food contained some toxic compound, or a normal constituent, present in abnormal quantities, resulting in chronic poisoning. Animals suffering from the disease lose in flesh, gradually weaken, become emaciated, and finally get down and are unable to rise.

Gilruth (27) has described bush sickness as progressive anemia. Upon the analysis of the blood he found there was a diminution in the organic matter content. Blood from sick animals contained only one half the normal amounts of iron oxide, and greatly diminished amounts of phosphorus and potassium, the characteristic inorganic constituents of the blood cells. The results of the chemical analysis at this point definitely toward a decrease of the blood cells. Blood counts made by Reid (27) show conclusively that anemia is always present in animals suffering from bush sickness. Ruminants are affected with the disease while non-ruminants do not seem susceptible. Astar (26) suggested that the reason for this may be due to the difference in time required for the digestion of foods in ruminants and non-ruminants. The disease is not communicable to healthy cattle by direct contact, transfusion of blood or by direct inoculation. The trouble is confined to certain areas, outside of which it does not spread. Dislocated animals from an infected area gradually recover when moved to a non-infected area. The vegetation in these infected areas consists mainly of coon's foot and red and white clovers. Stock

may, however, apparently suffer and die from the sickness either in areas where there is nothing but red clover, or where there is little but cocks foot.

Since all conditions apparently pointed to a deficiency in the food supply, particularly iron and phosphorous; experiments were conducted by Reeses (37) in order to determine the beneficial effect of top dressing the soil, as a means of controlling and preventing the disease. Materials used as top dressing for the soil are as follows:

1. Hydrated Iron oxide
2. Blood, bone and guano
3. Basic slag and super-phosphate
4. Super-phosphate
5. Iron sulphate and super-phosphate
6. Iron sulphate

The best results were obtained with both ewes and heifers on the land dressed with super-phosphate. Animals on the top dressed paddocks did not develop the disease, and came from the lots in the fall in prime condition and good health. Control animals on the untreated paddocks developed bush sickness in a few months, although they had plenty of food, good shelter, and access to standing lush.

Trials were also conducted with the feeding of syrup or iron phosphate as a medicine. By this method they were able to entirely cure two bush sick animals by feeding daily allowances of syrup or iron phosphate over a period of several months. Reeses and Aston concluded that the medicinal treatment would give beneficial results in effecting a cure, but that the top

dressing of the soil would be a much more economical method of affecting a control of the disease.

Sweeney or Creeping Sickness

One of the first symptoms noted in outbreaks of sweeney or creeping sickness is the appearance of a depressed appetite in the animals. Creeping sickness is the name used by laymen to designate a deficiency disease that is prevalent in the wire grass region of southern Alabama.

Carry (73) reports that outbreaks of the disease are more prevalent during seasons of drouth, at which time the pastures become quite short, thus limiting the feed supply. At this time the cattle become poor, show emaciation, accompanied with atrophy of the muscles and fat. The animals also resort to the eating of house, slugs and even grasshoppers. In the later stages of the disease the bones become soft, flexible, and deformed. Reformaties in the spinal column, particularly in the region of the pelvis, produce pressure on nerves which ultimately result in the paralysis of certain parts of the body. Carry suggests that the disease is caused by a deficiency of calcium and phosphorus in the ration and that control measures should be in the direction of a correction of these deficiencies.

Cotton Seed Meal Poisoning

Upon the autopsy of animals that have died of cotton seed meal poisoning considerable quantities of sand, gravel, earth, etc., are always found, showing that the animals have had a depressed appetite. This disease is the most common in the

Southern States where cotton seed meal constitutes a large part of the concentrate ration. In an effort to determine the nature and symptoms of the disease the North Carolina Agricultural Experiment Station (29) conducted experiments with cattle and hogs on the heavy feeding of cotton seed meal.

Calves placed on this experiment failed to gain after being on the cottonseed meal ration for about four or five months. Acute symptoms of the disease however were not conspicuous until about ten days before the death of the animals. The animals gradually lost their appetite, became weak, debile and evidenced a very unthrifty and run down condition. Gritting of the teeth, labored and difficult breathing, and softened feces were also common symptoms. Upon the post mortem examination of these animals the usual characteristic findings were the presence of serous fluids in the thoracic and abdominal cavities, and general inflammation of the intestinal tract. The liver and kidneys showed some congestion, and the lungs likewise showed congestion along with hepatization, and some edema. The stomachs of these calves contained considerable sand and gravel.

Hogs on this same experiment showed about the same general symptoms that were evidenced in case of the calves. The more acute symptoms of the disease in the hogs, however, were in some cases not noted until four or five minutes before death.

Causes of Depraved Appetite

Calcium Deficiency

The cause of depraved appetite in cattle has been attributed to a deficiency of calcium in the ration by Rogers

(5), Butler (6) and Carry (53). Rogers points out that the disease is most common on worn out soils that are depleted of their lime, potash or soda salts.

Carry states that the depraved appetite evidenced by animals suffering from creeping sickness is due to lack of calcium in the ration.

Butler has observed that the cause of depraved appetite is usually a lack of mineral in the food. The animals that are not supplied with salt and lime are always the first to become afflicted.

Phosphorous Deficiency

Phosphorous deficiency in both the soil and the ration has been pointed out as a cause of depraved appetite by Carry (53), Green (50), Law (8) and Theiler (51). Carry has evidence to show that in some cases the depraved appetite prevalent in connection with creeping sickness is ceased by a phosphorous deficiency.

Green found that acute osteophagia (bone eating) is due to a phosphorous deficiency in the soil and vegetation. He has been able to bring about the condition experimentally by feeding low phosphorous rations, and was then able to relieve the condition by feeding phosphorous compounds.

Law suggests that a deficiency of phosphorous in both the soil and the ration is the cause of depraved appetite in cows.

Theiler has found that a phosphorous deficiency is the cause of the depraved appetite that occupies such an important place in the alimentary chain of ruminants.

Phosphorous deficiency has been shown to be a general characteristic of South African soils, the degree of deficiency varying some what in the different districts. In the phosphorous deficient areas, depraved appetite or osteomalacia develops in the animals pastured on this land. The degree or form of the depraved appetite, whether slight or marked, depends to a large extent upon the degree of phosphorous in the soil.

Emaziente is caused indirectly by a depraved appetite resulting from a phosphorous deficiency in the soil, the direct cause being a ptomaine poisoning brought about by the infection of the carcass debris with a specific toxogenic saprophyte. It is necessary for the organism to have a protein substrate before it can produce the toxin, hence if the causal organism is missing, or there is no decaying carcass, Emaziente cannot develop, regardless of the degree of depraved appetite in the animals. On the other hand, if the soil is not deficient in phosphorous depraved appetite does not develop, and the animals never ingest the poison carcasses, regardless of the amount to which they may have free access.

Theller has not only found that bone meal feeding relieves the depraved appetite, but he determined to some extent the amounts of bone meal necessary to feed animals in the different phosphorous deficient areas in order to prevent the occurrence of depraved appetite. The amount of bone meal required to prevent depraved appetite is dependent upon the degree of phosphorous deficiency in the soil. The same results can be obtained by the phosphate manuring of the soil, but this method of control was not recommended by Theller because it is prohibitive from an

economic standpoint.

Theiler also found that bone meal feeding produced very favorable results upon the growth and health of both mature and growing animals, particularly the latter.

Iron Deficiency

Beakes and Aston (37) believe that iron deficiency is the cause of depraved appetite, evidenced by sheep suffering from bush sickness; due to the fact that animals pastured on land top dressed with iron sulphate develop normally in every respect. Check animals on adjoining plots not top dressed with iron sulphate developed bush sickness and succumbed to the disease.

Protein Deficiency

Rogers (5) has suggested that in some cases a deficiency of protein seems to be the cause of depraved appetite. Lynch (9) stated that a deficiency of protein in the ration is often the cause of sows eating their pigs. It is recommended that sows be fed protein supplement previous to time of farrowing in order to keep them from eating their pigs.

Digestive Disturbances

Digestive disturbances and derangements have been cited as a cause of depraved appetite by Mousen and Dellar (3), McIntosh (7), Lynch (9), Hauber and Siedongretsky (53) and Fox (11). Mousen and Dellar state that in adult animals depraved appetite often occurs as a result of a well marked digestive disturbance. To support this theory they point out that well nourished animals in the best of condition often develop depraved appetite when

alimentary and digestive disturbances occur.

McIntosh asserts that crib-biting in horses is caused by a deranged condition of the digestive system and a lack of exercise.

Lynch found that with swine depraved appetite is sometimes seen as a symptom in gastritis, chronic indigestion and even in cases of hog cholera, particularly with the chronic type.

Haubner and Heidengrötsky attributed depraved appetite to nervous disorder. They state that permanent stalling, confinement and absence of sunlight help to bring on an attack.

Fox likewise suggests that coprophagy (eating of dung) in captive wild animals is due to a nervous disorder and discontentment brought about by permanent confinement.

It may be seen from a review of the literature that different authorities do not agree definitely upon any one factor as being the cause of depraved appetite. It is probably not the result of any one definite factor, but it can, and does occur under a variety of conditions. In a number of cases it seems to be the result of a deficiency in the soil of either calcium, phosphorus or iron, while in other cases it is caused by digestive disturbances and nervousness.

Prevention and Cure for Depraved Appetite

A number of preventative and curative agents have been suggested as a cure for depraved appetite by different authorities. Murray (4) recommends the feeding of approximately five grams,

three times daily, of the following mixture to animals suffering from depraved appetite:

Carbonate of iron.....4 ounces
 Bone flour.....1 pound
 Powdered gentian.....4 ounces
 Salt (common)3 ounces
 Powdered fennel-seed.....4 ounces

Pfeiffer and Lohrke (52) German investigators, report good results from the subcutaneous injections of apomorphine in doses of one and one-half to five grains daily for a period of three to four days, as a curative agent.

The treatment of depraved appetite in sheep by the subcutaneous injections of apomorphine is also recommended by Baker (10).

Reames and Eaton (37) conclude that syrup of iron phosphate in solution is a valuable cure for depraved appetite if given over a sufficiently long period.

Summary of Review of Literature

Depraved or perverted appetite is the abnormal craving for bones, wood, dirt, feces, hair, ropes, straps, articles of clothing, etc. It is synonymous with the terms Pica, osteophagia, polyphagia, pathological gluttony and coprophagy. Pica (translated means depraved appetite) is the term given to depraved appetite in South Africa. Osteophagia (bone eating) is also a form of depraved appetite. Polyphagia and pathological gluttony are terms applied to omnivorousness, or craving for all kinds of food in humans. Coprophagy means the

eating of dung, and is a practice that is common among captive wild animals.

Mature cattle and calves, as well as other classes of livestock, such as horses, sheep, goats, swine, and poultry suffer from attacks of depraved appetite.

Depraved appetite is characterized by a universal occurrence. Theiler reports that depraved appetite has existed in South Africa for such a long period of time that farmers have come to regard the condition as normal in their animals. Depraved appetite has been known in the United States for at least fifteen years. Welch reports cases of depraved appetite in Montana as far back as 1910. Numerous outbreaks have also been reported from time to time in different parts of the country by various authorities. Depraved appetite is very common in Michigan, particularly in the thumb region. In this section, during the spring and summer months, it is not uncommon for an entire herd to become afflicted. In some instances, however, only a few animals in the herd will develop the abnormal craving. The occurrence of the disease is apparently more universal in recent years than it has been in the past.

Lanzishte, cotton seed meal poisoning, creeping sickness, bush sickness and osteomalacia are all closely related diseases to depraved appetite. One of the most characteristic and pronounced symptoms of all of these diseases is the abnormal craving or depraved appetite. Lanzishte, a disease prevalent among cattle in South Africa, can be controlled by preventing the depraved appetite. A phosphorous deficiency in the soil

first serves as a means to aggravate an attack or depraved appetite. The affected animals then resort to the eating of poisoned cereals and debris, which is the direct cause of the disease. Cotton seed meal poisoning, as reported by the North Carolina Agricultural Experiment Station, and creeping sickness, common in the pine grass region of Alabama, according to Cary, are both diseases that are characterized by a depraved appetite. Animals suffering from both sickness in New Zealand, according to Leske and Aston, also show perverted appetite. Osteomalacia (softening of the bones so that they become brittle and easily broken) is a disease that is preceded by attacks of depraved appetite.

The causes of depraved appetite vary according to the conditions under which it occurs. Authorities do not agree upon any one factor as being the cause of depraved appetite in all cases. In regions where there is a deficiency of either calcium, phosphorus or iron in the ration, it has been shown that these deficiencies are the cause of depraved appetite according to Theiler, Leske and Aston, and Rogers. On the other hand there are numerous outbreaks reported, the cause of which can only be attributed to digestive derangements and nervousness, according to Housen and Dellar, Lynch, Baker and Fox.

The work of McCandlish suggests that depraved appetite produced under experimental conditions in calves may be due to a lack of a factor that is carried in well cured alfalfa hay.

The cure for depraved appetite depends entirely upon the underlying cause. In regions of calcium, phosphorus, or iron

deficiencies, the addition of these minerals to the ration will effect a cure. However, if it is caused by digestive disturbances or nervousness, the underlying cause must be sought out and corrected. It is very questionable whether syrup of iron, ferrous lactate, ascorbic acid, or various mineral mixtures are of much value for a treatment of depressed appetite. It is, therefore, the purpose of this work to make a study of depressed appetite, and determine, if possible, the cause and also the value of different treatments as cures or preventative agents for depressed appetites.

EXPERIMENTAL WORK

Object of Experiment

Depraved appetite, especially among dairy animals, has become more prevalent in recent years. This is probably due to a depletion of soil fertility, especially in mineral elements.

The general consensus of opinion has been that this abnormality was due to a mineral deficiency. According to Theiler and Green depraved appetite is due to a phosphorous deficiency, while Rogers and Carry attribute it to a deficiency of calcium.

Work conducted by Reed and Ruffman (57), while studying the effect of adding different minerals to a concentrate ration, has suggested the idea that all cases of depraved appetite may not be due to a lack of minerals in the ration. Calcium carbonate added to the ration of calves C-1 and C-12 failed to give beneficial results. Likewise, the feeding of raw rock phosphate to calf C-5, and sodium carbonate to calf C-6 failed to relieve the depraved appetite. The addition of magnesium phosphate to the ration of calf C-8 and tri-calcium phosphate to the ration of C-9 failed to stop an appetite for hair and shavings. Upon post mortem examination twelve hair balls were found in the rumen of calf C-8, and fifteen hair balls in the rumen of calf C-9.

Van't (48) has concluded that depraved appetite may be due to a lack of vitamins that aid in mineral retention. The vitamin theory is further substantiated by Reed and Ruffman

(57) who found that a factor carried in cod liver oil relieved the depraved appetite of calf C-10 for a period of approximately five weeks.

In light of the present knowledge of the subject it seems feasible to assume that factors, other than mineral deficiencies may be regarded as causes of depraved appetite. It is the object of this experiment to continue the work of Reed and Huffman, making a thorough study of depraved appetite in an endeavor to determine the position of minerals and mineral retention factors in the etiology of depraved appetite. The roll played by proteins, roughages, concentrates and cathartics will also be determined by feeding these as supplements to rations of animals suffering from depraved appetite.

A study will also be made of depraved appetite as it occurs under ordinary farm conditions whenever the opportunity presents itself. This work will be conducted in order to determine the relationship between depraved appetite that occurs in the field with that produced under experimental conditions.

Plan of Experiment

1. It is planned to feed restricted rations to calves in order to develop depraved appetite.

2. When the depraved appetite is exhibited the effect of supplementing the restricted rations with the following substances will be ascertained: (1) calcium carbonate, (2) calcium phosphate, (3) acid phosphate, (4) ground

limestone rock, (5) raw rock phosphate, (6) bone meal, (7) bone flour, (8) sodium carbonate, (9) magnesium phosphate, (10) wood ashes, (11) tankage, (12) blood meal, (13) wheat straw, (14) wheat bran, (15) alfalfa meal, (16) cod liver oil, (17) oxidized cod liver oil, (18) syrup of iron phosphate, (19) alfalfa mineral mix, (20) mineral plus cod liver oil, (21) flowers of sulphur, (22) starch.

3. The following feeds will be fed as supplements to a concentrate ration before the calves show signs of depraved appetite, in an attempt to prevent the development of this disease: (1) raw linseed oil, (2) paraffin oil, (3) alfalfa tea, (4) calcium carbonate plus cod liver oil.

4. An attempt will be made to produce depraved appetite in older calves by feeding concentrate rations in the form of mixed grains. The curative properties of a mineral mixture similar to the mineral combination found in alfalfa hay will then be studied. Other calves will be fed a concentrate ration supplemented with corn and oats until depraved appetite develops. Results obtained by replacing the corn and oats with wheat bran, oats and oat hulls, equal weights of each, will then be observed.

5. Blood counts are to be made from time to time in order to identify the presence of any secondary infection, or general systemic disturbance.

6. Metabolism experiments are to be conducted with animals suffering from depraved appetite to determine the calcium, phosphorous and nitrogen balances.

7. Observations are to be made from time to time regarding the general appearance and condition of animals suffering with depraved appetite.

8. Determinations will be made each week on the blood calcium, phosphorus, chlorine, carbon dioxide, non-protein nitrogen, protein nitrogen and hemoglobin of animals suffering from depraved appetite, in order that the blood picture of animals suffering from depraved appetite may be studied.

9. A study is to be made of depraved appetite under ordinary farm conditions, particular attention being given to the following: (1) animals affected, (2) soil analysis, (3) feed analysis, (4) curative and preventative agents.

Method of Procedure

Choice of Animals

Grade Holstein, Jersey and Guernsey calves were used in this experiment.

Choice of Feeds

The rations fed consisted of the following feed stuffs: (1) whole milk from Holsteins herd, (2) skim milk from mixed dairy herd, (3) powdered calcium carbonate, acid phosphate, sodium carbonate, calcium phosphate and magnesium phosphate, all chemically pure, (4) finely ground limestone rock, raw rock phosphate, bone meal, commercial grades, (5) precipitated bone meal, (6) syrup of iron phosphate U. S. P., (7) alfalfa meal, finely powdered green alfalfa leaves, (8) oat hulls, outer covering of oat grain, (9) wheat straw, (10) wheat bran, (11) Norwegian cod liver oil.

(12) oxidized Norwegian cod liver oil, (13) tankage, sixty per cent protein, (14) blood meal, eighty per cent protein, (15) pure flowers of sulphur, (16) pure corn starch, (17) alfalfa tea, the water extract of alfalfa hay, (18) alfalfa mineral mixture, composed of finely powdered, chemically pure minerals.

Preparation of Feeds

The oxidized cod liver oil was prepared by passing air through cod liver oil heated to a temperature of one hundred and forty degrees centigrade for a period of twelve hours.

The alfalfa tea used was the water extract of alfalfa hay prepared by leaching the dried green alfalfa hay with lukewarm water for twenty-four hours.

The alfalfa mineral mixture was prepared by mixing the tabulated amounts of finely powdered materials:

1,765.0 grams casein

55.0	"	Na_2HPO_4
26.6	"	NaCl
47.5	"	NaHCO_3
162.0	"	K_2SO_4
26.4	"	KCO_3
282.2	"	CaCO_3
140.0	"	MgCO_3

The syrup of iron phosphate was made by dissolving eight and six tenths grams of iron wire in sixty-two and five tenths cubic centimeters of phosphoric acid diluted

with sixty-two and five cubic centimeters of distilled water. The resulting solution was then filtered into seven hundred cubic centimeters of U. S. P. syrup, and made up to one thousand cubic centimeters by adding distilled water.

Care, Shelter and Feeding Methods

The animals were cared for and handled by a competent feeder under the supervision of the man in charge of the experiment. They were kept in individual stalls, sheltered in a small experimental barn, and were allowed to exercise in a lot which was free from edible material. Shavings were used for bedding in all except a few cases as noted in the experimental data. The animals had free access to water in the exercise lot.

The animals were fed regularly twice daily. Milk and concentrated were weighed on more delicate scales sensitive to a gram. The cod liver oil, oxidized cod liver oil, raw linseed oil, paraffin oil and syrup of iron phosphate were measured in a cylinder graduated to cubic centimeters. All feeds used to supplement the whole milk diet were stirred into the milk and fed with it. Materials used to supplement a grain ration were mixed directly into the grain mixture. During the metabolism period the feed and water was all weighed on gram scales.

Collection of Experimental Data

Weighing. The animals were weighed at the beginning of the experiment and afterwards at intervals of every ten

days. At the end of every thirty day period the animals were weighed three days in succession. The average of these weights being considered as the true weight of the animal. The weights were all taken early in the morning before feeding or watering. During the metabolism period the animals were weighed at the beginning, and each succeeding day thereafter during the period.

Measurements. The following measurements were taken the first of each month. Highest point at withers, and height at rump. Circumference of chest just behind the shoulders, and the greatest circumference of barrel. Also the depth of chest, width of chest, and width at hooks and thighs. The length of rump and length from point of shoulder to hook point.

Record of Feed. The feed consumed was recorded each day in a book provided for that purpose.

Health Observations. All symptoms of sickness and disease were recorded each day in a book provided for that purpose.

Photographs. Photographs of the animals were taken from time to time at a place especially designed for that purpose. The animals were placed on a level platform in front of a grey background that was marked off by black lines into ten centimeter squares.

Collection of Blood Samples. Blood samples were collected regularly each week for chemical analysis. The blood was drawn from the jugular vein, without stasis, into

large glass tubes, designed for that purpose. Precautionary measures were taken to prevent the occurrence of any chemical change, by collection the samples under paraffin oil.

Lithium citrate was used as an anti-coagulant. The chemical analysis of the blood was determined by the Experiment Station Chemistry Department who were working in cooperation with the Dairy Department on this problem.

The samples for blood counts were also taken from the jugular vein. The blood was allowed to flow freely into the palm of the hand, which had previously been washed in alcohol to facilitate drying. From the hand the blood was drawn into the Spenser blood counting pipette (1 to 100 dilution). Tissues fluid, which stains the white blood corpuscles a deep blue, leaving the red blood corpuscles unstained, was used as a diluting agent. It is permits the counting of both the red and white blood cells from the same sample. The Spenser Thoma-Blass haemocytometer, which is ruled into four hundred squares one-twentieth of a millimeter in length, was used in making the counts. The red blood cells in twenty-five squares in each of four corners were counted, making a total of one hundred squares. This sum multiplied by four thousand gives the total number of red blood cells per cubic millimeter of blood. The white blood cell count per cubic millimeter of blood is calculated by multiplying the total number of white blood cells in the entire ruled area by one thousand. Hemoglobin determinations were made on each sample of blood taken for blood counts, by the colorimetric method.

Metabolism. During the metabolism period the amount of feed and water was accurately determined on gram balances. The feces and urine were collected in suitable containers by competent attendants who remained on constant watch the entire period. The collections were weighed separately at the end of each twenty-four hour period and after thoroughly mixing a composite sample was taken for chemical analysis. A composite sample of feed and water was also taken at each time of feeding. The animals were weighed at the beginning of the metabolism period, and each consecutive morning thereafter. In order that the animals might be exposed to the ultra violet ray of the sunshine they were exercised each day in the open for a period of twenty minutes. Chemical determinations for calcium, phosphorus and nitrogen were made by the Experiment Station Chemistry Department on the feeds, water, urine and feces. From these determinations the average daily balances of calcium, phosphorus and nitrogen were calculated for each animal.

Autopsy of Animals. The Pathology Department of the Division of Veterinary Medicine performed the post mortem examination on the calves.

Farm Conditions of Depraved Appetite. Working in cooperation with Mr. J. W. Sims, county agent of Tuscola County, the men in charge of the experiment conducted investigations in regard to depraved appetite in the thumb region. A study was made of the farm conditions where depraved appetite occurs and different mineral supplements were recommended.

These supplements were fed by the farmers, following the directions given by the men in charge of the experiment. Samples of the soil and feed were also collected for chemical analysis. One outbreak of depraved appetite on a farm near the College was treated by increasing the mineral retention factor in the ration.

Experimental Data

A description of all calves used on this experiment will be found in Table Number I of the appendix. Graphs showing the blood pictures of calves suffering from depraved appetite will also be found on pages (109) to (113) inclusive. Other graphs showing the white blood corpuscles and red blood count of the blood of calves suffering from depraved appetite may be found on pages (105) to (108) inclusive in the appendix. Plates showing the pictures of hair balls collected from the rumen of calves and lambs may be found in the appendix, pages (114) to (116) inclusive.

Calf C-13

A grade Holstein bull calf born August 7, 1923 was placed on the experiment at the age of seven days. The animal was continued on the experiment until his death May 28, 1924. The ration consisted of whole milk supplemented with wheat straw. Shavings were used for bedding.

Notes and observations. This animal remained in apparently good health and continued to make good gains in weight up to January 21, 1924. About November 1, 1923

the animal developed a long coat of hair. On November 26 he was muzzled, but continued to remain in good spirits until February 10, 1924 when he developed a staggering gait and commenced chewing his tongue. Upon the removal of the muzzle the calf would eat shavings ravenously. On February 23, 1924, the calf had a convulsion of approximately five minutes duration.

February 27, 1924, wheat straw was added to the ration at the rate of one pound per day. After the addition of wheat straw all evidence of depraved appetite disappeared for the entire remainder of the time the calf was on the experiment.

The animal developed a severe case of scours about the middle of April. Blood counts and hemoglobin determinations made at this time pointed to the presence of anemia. The calf seemed to be growing weaker about May first, and was observed to lie down at every opportunity while in his stall or in the lot. The weakened condition gradually grew more pronounced and on May 19, 1924 the calf came down and was unable to rise, apparently paralyzed in the rear legs. Blood counts and hemoglobin determinations made at this time showed marked leucocytic infiltration of the blood stream along with a reduction of red blood corpuscles. In an effort to relieve the paralyzed condition and get the animal onto his feet, calcium carbonate and cod liver oil were given. Supplementing the ration with green grass also failed to relieve the paralysis. The animal became bloated and died in the late afternoon on May 23, 1924. Just before death

two cubic centimeters of iron citrate was injected intravenously into the jugular vein. This may have been the immediate cause of death.

Upon post mortem examination extensive degenerative changes were found in the kidneys, liver and heart. Also marked edema of the brisket and generalized anemia throughout the entire body. The blood was very pale in appearance and coagulated slowly.

The depraved appetite produced by feeding whole milk alone was cured by a factor carried in wheat straw. The wheat straw, however, did not prevent the development of anemia and run down condition which finally resulted in death. The red blood corpuscle count was decreased more than one-half, while the white blood corpuscle count was increased eleven times.

Calf C-14

This grade Holstein bull calf was born September 6, 1923, and placed on the experiment the following day. The animal was continued on the experiment until his death on February 27, 1924. The ration consisted of whole milk and cod liver oil. Shavings were used for bedding.

Notes and observations. Fifty cubic centimeters of cod liver oil per day was added to the ration on October 13, 1923, before signs of depraved appetite were ever manifested. The appetite remained normal and no evidence of any systemic disturbance was noticed until his gait became slow and sluggish about the latter part of December. On

January first, 1924, feed was refused for the first time. The general unthrifty condition gradually grew more marked, and the joints became swollen and very stiff. Death followed a very violent convulsion that occurred on February 27, 1924.

Post mortem examination revealed the presence of hyperemia of the kidneys, and multiple hemorrhages on the heart and lungs. Portions of the lungs were also in the stage of congestion preceding pneumonia. Small areas of necrosis were found on the liver and a small abscess on the rumen. The only digestive disturbance found was an area of inflammation in the small intestine and a small quantity of shavings in the rumen and the reticulum. The whole autopsy seemed to point to the presence of toxic substances in the blood stream, which were responsible for the formation of hemorrhages of different organs.

Outward signs of depraved appetite were never manifested by this calf, although he developed symptoms of irritability. A factor carried in cod liver oil apparently prevented the depraved appetite, but did not relieve the convulsions.

Calf C-15

Calf C-15 was a grade Holstein bull calf born September 7, 1923, and placed on the experiment when one week of age. He was continued on the experiment until death, March 9, 1924. The ration consisted of whole milk, cod liver oil, and a tri-calcium phosphate. Shavings were used for bedding.

Notes and observations. Manifestations of a depraved appetite along with symptoms of irritability developed about

the middle of January. The calf had a convulsion of about one and one-half minutes duration on January 31 while his picture was being taken. A second convulsion occurred on February 20 and a third on February 27, after cod liver oil had been added to the ration for six days. As the cod liver oil alone failed to relieve the depraved appetite, tri-calcium phosphate was given in addition in an effort to remedy the condition. The depraved appetite continued to grow worse until the animal died in a convulsion on March 9, 1924.

Upon post mortem examination edema of the kidneys, and multiple hemorrhages of the heart and lungs were found. The liver also showed extensive fatty degeneration, along with some congestion. The rumen contained five hair balls, and both the rumen and the reticulum contained a small quantity of shavings. There were two areas of gastritis in the abomasum and extensive areas of enteritis in the small intestine. In all probability the areas of enteritis were the immediate cause of death.

It will be noted that cod liver oil and tri-calcium phosphate did not cure the depraved appetite, and apparently had no effect on the prevention of irritability.

Calf C-16

This grade Holstein heifer calf was born October 13, 1923, and was placed on the experiment the following day. She has been continued on this experiment up to the time of writing this thesis. The ration was varied from time to time according to the behavior of the calf. Skim milk, cod liver oil, alfalfa

mineral mix, blood meal, syrup of iron phosphate and sodium chloride were fed during the experiment. Shavings were used for bedding.

Notes and observations. The first indication of a depraved appetite was observed about the first of January, 1934 when she commenced sucking her own tail. Since McCandlish found that alfalfa hay prevented depraved appetite it was thought advisable to add an alfalfa mineral mixture to the ration in order to determine if the mineral combination found in alfalfa hay was the beneficial factor. However, the alfalfa mineral (one hundred grams daily) was fed for a period of two months without results. The animal suffered a severe loss of weight during this period and developed a coarse coat of hair. Since the alfalfa mineral mixture did not relieve the depraved appetite, cod liver oil was added to the ration on March 1, 1934. The condition of the calf immediately improved, the coat became slick and growth was resumed. The animal, however, did not entirely recover from the practice of sucking her tail, and at times, particularly after feeding, would revert to this practice which may have been due to habit rather than a depraved appetite.

The latter part of May the animal started eating considerable quantities of manure while in the exercise lot. At this time the allowance of cod liver oil was increased to fifty cubic centimeters per day, which was followed by a gain of twenty-five pounds in weight in ten days. The craving for manure also abated to a marked degree for a time, but on June 11, the animal evidenced an appetite for shavings, and

by the latter part of June had reverted to eating manure with renewed vigor. On July 15, 1924, one hundred grams of blood meal per day were added to the ration, but the additional protein supplement did not improve the depraved appetite. Since one hundred grams of alfalfa mineral daily failed to relieve the abnormal craving, the alfalfa mineral was increased to one hundred and fifty grams per day the first day of August. It is of special interest to note that following this change the animal consumed a grain sack and a leather strap that had been accidentally thrown into the exercise lot. In order to prevent her eating foreign material the calf was muzzled, but nevertheless, she would work manure through the meshes of the muzzle, and consume large quantities at a time. The general condition and thrift of the calf, however, suffered a severe setback, due in all probability to a lack of water in the ration, because the animal would not drink through the muzzle. After the muzzle was removed her condition improved although the appetite for manure was still present.

After the blood meal and alfalfa mineral had been given a fair trial without results, five cubic centimeters of syrup of iron phosphate was added to the ration on August 1, 1924. The syrup of iron phosphate likewise failed to relieve the abnormal craving for manure. On October 8, 1924, the alfalfa mineral was increased to two hundred and sixteen grams per day, or the amount of mineral equivalent to the mineral contained in seven pounds of alfalfa hay in a further attempt to cure this depravity. Although the increase in alfalfa mineral was more than ample to meet the requirement for minerals the de-

praved appetite still persisted. Since the animal had developed an emaciated and run down condition it became necessary to make another change in her ration. On January 5, 1925, she was given equal parts of whole milk and skim milk, supplemented with twenty cubic centimeters of syrup of iron phosphate. Her condition however, was not readily improved and additional energy was supplied by feeding whole milk alone supplemented with the same amount of syrup of iron phosphate. The depraved appetite still persisted and on the morning of April 23, 1925, a picture was taken showing her eating manure. This picture appears in the appendix on page (117).

Blood counts taken from time to time failed to disclose any relationship between the depraved appetite and the blood cell counts.

This animal has had one of the most persistent depraved appetites of any of the calves on this experiment, and is the only one that has eaten manure in any quantity. The manure eaten, as well as all substances fed, with the possible exception of cod liver oil did not improve the depraved appetite. During the winter months while the animal was kept in the barn a considerable part of the time, an average of about four pounds of shavings were eaten per day. It is obvious that the depraved appetite in this case was due neither to absence of roughage, nor to a lack of minerals contained in alfalfa hay.

Calf C-17

Calf C-17 was a grade Guernsey heifer calf, born July 25, 1933, and placed on the experiment when two hundred days of age. The ration up to six months of age consisted of milk, grain and alfalfa hay. Her experimental ration consisted of grain mixture, alfalfa tea and wheat straw. The composition of the grain mixture is as follows:

200	pounds	ground corn
50	"	wheat bran
25	"	linseed oil meal
25	"	cottonseed meal
7 per cent alfalfa mineral mix		

Shavings were used for bedding.

Notes and observations. The animal made no permanent gains in weight after being placed on the grain ration alone. The first evidence of depraved appetite was recorded on March 8, 1934, when she was seen licking the building and eating dirt. The depraved appetite gradually became more severe, and on April 5, 1934 she was seen eating hair from another animal's back. Her normal appetite for food finally failed. Alfalfa tea was then added to the ration at the rate of four pounds per day on April 20 in an effort to tone up the appetite. However, the alfalfa tea was refused after eight days, and the depraved appetite still persisted. Wheat straw was added to the ration beginning April 29 by replacing the shavings used for bedding with wheat straw. The depraved appetite entirely disappeared within three weeks time after the animal started

eating straw. A temporary improvement in condition was also noted, however, this was followed by gritting of the teeth and frothing at the mouth, although the depraved appetite was not manifested. She gradually grew weaker, and was observed to lie down most of the time while in her stall. On June 7, 1934, cod liver oil was given as a medicine, but the animal died the following day.

Upon post mortem examination a generalized ischemic and edematous condition was found. There were necrotic and degenerative changes of the heart, liver and kidneys, and extensive necrotic pneumonia. An extensive area of catarrhal duodenitis was the only digestive disturbance evident.

Blood counts taken on this animal failed to show any relationship between the number of white and red blood cells and the depraved appetite.

These results indicate that depraved appetite may be produced as readily by feeding a grain mixture alone as on a whole milk diet. The same mineral mixture as found in alfalfa hay again failed to relieve the depraved appetite, indicating further that minerals are not always a cure for depraved appetite. It is interesting to note that the wheat straw cured the abnormal craving for things not classed as food, although it failed to ameliorate the associated condition.

Calves C-18, C-19, C-20 and C-21

These grade Holstein heifers were raised under approximately the same conditions until four months of age.

The ration of these animals during this period consisted of whole milk, skim milk, corn, oats and timothy hay (ad libitum). At the end of four months they were placed on a ration of timothy hay (one pound per day), potatoes and a grain mixture of the following composition:

180.0		pounds hominy
100.0	"	distillers grain
50.0	"	wheat bran
25.0	"	cotton seed meal
2.0	"	sodium chloride
1.0	"	sodium phosphate
1.0	"	d-sodium phosphate
0.5	"	magnesium carbonate
0.5	"	magnesium phosphate
0.25	"	potassium chloride
0.25	"	potassium carbonate
20.0		grams iron lactate

Heifers C-18 and C-20 received eight pounds of the above grain mixture in addition to five pounds of potatoes, and one pound of timothy hay per day. C-19 and C-21 received the same ration with the exception that three per cent of the grain ration consisted of calcium carbonate.

After the animals were restricted to the limited amount of roughage they all developed a craving for wood, shavings, dirt, etc. Calf C-21 developed a very marked appetite for hair, and ate considerable quantities from the backs of other animals. Calf C-18 also developed an appetite for wood and shavings, along with a slight degree of irritability evidenced by lolling the tongue. Both heifers

were placed on the metabolism experiment in order to determine the calcium, phosphorus and nitrogen balances of animals suffering from depraved appetite.

It is of special interest to note that these animals did not develop depraved appetite while they were receiving all of the timothy hay they would eat, but as soon as the allowance of hay was limited the depraved appetite became evident. This indicated further that depraved appetite may be due to the absence of a factor carried by hay, since the ration was adequate in every other respect.

Calf C-22

A grade Holstein calf was born December 15, 1923³ and was placed on the experiment the following day. She has been continued on this experiment up to the present time. The ration was varied from time to time according to the behavior of the calf and whole milk, skim milk, alfalfa tea, cod liver oil, wood ashes, tannage, syrup of iron phosphate and wheat bran. Shavings are being used for bedding.

Notes and observations. When first placed on the experiment this heifer suffered from a severe attack of scour that was caused by digestive disturbances. This condition was readily improved, however, by feeding cod liver oil for a period of two weeks.

Before any signs of depraved appetite were observed, the ration was supplemented with two pounds alfalfa tea per day, beginning March 3, 1924. The alfalfa tea was increased from time to time in an effort to maintain her normal appetite. A maximum amount of six pounds per day was finally

reached, and since an attempt to feed more than this amount resulted in scour, it was discontinued. The alfalfa tea was observed to prolong the latent period before the depraved appetite was outwardly manifested, but on June 6, 1934, the calf was seen eating hair from the back of one of the other animals. Since the depraved appetite for hair continued to grow more acute it became evident that the alfalfa tea was not a preventative against depraved appetite. Consequently the alfalfa tea was discontinued and the whole milk was supplemented with one hundred grams of wood ashes daily. The minerals in the wood ashes, however, failed to bring about any improvement in the depraved appetite. In fact this appetite for hair suggested that depraved appetite might be due to a deficiency of the amino acid cystine. Consequently tankage was added to the ration at the rate of one pound per day on June 15, 1934. The tankage had no beneficial effect on the depraved appetite. Cod liver oil was added to the ration, on July 15, 1934.

No further changes were made in the ration until August 25, 1934, when it became evident that the supplements in the ration were not ameliorating the depraved appetite. Syrup of iron chlorate was then added to the ration in an attempt to relieve the condition. Shortly after this change the appetite for hair became very acute resulting in large quantities being eaten each day. On one occasion in particular this animal devoured the entire switches from the tails of three calves. It was planned to place C-22 on the metabolism experiment, but on the morning of December 5, she

was down in her stall unable to rise. She quickly regained her strength, however, and was able to get onto her feet the following day without assistance, although she walked with a staggering gait. Since she was very slow in recovering her normal appetite the ration was changed to whole milk supplemented with wheat bran alone, since an organic form of phosphorus might prove beneficial. The addition of wheat bran had no effect on the craving for hair, and on April 25, 1925 a picture, page (118) appendix, was taken of this calf while eating hair.

Blood counts taken on this animal failed to show any relationship between the depressed appetite and the blood cell count.

Results with this heifer indicate that the factor in alfalfa hay that prevents depressed appetite is not soluble to any appreciable extent in lake warm water. The minerals contained in wood ashes and the cystine of tankage, as well as the organic and in-organic forms of phosphorus failed to relieve the perverted appetite for hair and shavings. It is also interesting to note that she regurgitated three hair balls during the month of May. A picture showing two of these hair balls appears on page (120) of the appendix.

Calf C-23

A pure bred Holstein bull calf born November 23, 1923, was placed on the experiment January 6, 1924. He was continued on this experiment until his death April 15, 1924. The ration of this calf before he was placed on the experiment consisted of whole milk, mixed grain and alfalfa hay. His

experimental ration consisted of whole milk, calcium carbonate, acid phosphate and corn starch. Shavings were used for bedding.

Notes and observations. Evidence of both a depraved appetite and irritability became noticeable about the middle of February, 1934. The animal had a convulsion on February 2, followed by two convulsions of short duration on February 27. One hundred grams daily of calcium carbonate daily added to the ration cured the convulsions, but did not stop the calf from eating shavings and gritting his teeth. After calcium carbonate had been fed one month it was replaced by acid phosphate. The acid phosphate responded in much the same manner as the calcium carbonate, and was therefore discontinued and corn starch was substituted in its place. The additional energy available from the corn starch seemed to improve the associated condition, but did not alleviate the depraved appetite. Its effect, however, was only temporary and the animal soon grew weaker and died on April 15, 1934.

Upon post mortem examination it was found that pneumonia was in all probability the immediate cause of death. The stages of acute lobar pneumonia were found in the right and middle lobes of the lungs, while the cephalic lobes were congested but not consolidated.

These results indicate that minerals are not a cure for depraved appetite in all cases. The fact is also emphasized that animals suffering from depraved appetite are in a very low state of resistance; otherwise the causal organisms of pneumonia would not have been able to establish themselves, in all probability.

Calf C-34

This grade Holstein heifer calf born March 15, 1924, was placed on the experiment when six days of age. She was continued on this experiment until her death June 19, 1924. The ration consisted of whole milk, supplemented with oxidized and later with unoxidized cod liver oil. Hayings were used for bedding.

Notes and observations. The oxidized cod liver oil proved to be of no benefit as a curative agent for depressed appetite. After the oxidized cod liver oil was fed for nearly a month, it was replaced by the unoxidized form. Immediately following this change the calf was stricken with a case of acute indigestion and died June 19, 1924, before the effect of the unoxidized cod liver oil could be determined.

Upon post mortem examination the lesions characteristic of acute indigestion were found. Extensive area of gastritis in the abomasum, and a small area of enteritis were probably the immediate cause of death.

Calf C-35

A grade Jersey heifer born April 1, 1924, was placed on the experiment the following day. This heifer has been continued on this experiment up to the time of writing this thesis. The ration was varied from time to time according to the behavior of the calf and whole milk, oxidized cod liver oil, unoxidized cod liver oil, bone flour, bone meal, syrup of iron phosphate, alfalfa meal and wheat bran were fed during the experiment. Hayings were used for bedding.

Notes and observations. Calf C-25 started cribbing the manger about two months after she was placed on the experiment. Neither oxidized nor the unoxidized form of cod liver oil lessened her desire for wood. Hence, according to Theiler, depraved appetite is caused by a deficiency of phosphorous bone meal was fed in the form of special steamed bone meal and later as bone flour, but neither relieved the depraved appetite. Consequently cod liver oil was added to the ration in addition to bone meal without relieving the disease. Bone meal and cod liver oil was replaced by phosphate on August 23, 1924.

Shortly after this change she evidenced symptoms of irritability by lolling her tongue. Since the depraved appetite became more aggravated the ration was changed to whole milk and alfalfa meal on September 8. Following this change the general appearance and condition of the animal showed improvement, but the depraved appetite continued to grow more acute. Therefore, syrup of iron phosphate was again added to the ration on October 7, 1924. While on this ration she was placed on the metabolism experiment for seven days, beginning December 8. During the metabolism period the depraved appetite became so pronounced that it was necessary to keep her muzzled to prevent the eating of wood and shavings. As soon as the metabolism period was finished her ration was changed to whole milk and one pound of wheat bran daily. The condition and appearance at once showed marked improvement and all signs of depraved appetite were reduced to zero until about the middle of March. At this time the bran was increased to two pounds

daily, and up to the present time no further evidence of a depravity has been observed. At times she has been seen lolling her tongue, which in all probability is a manifestation of irritability. This condition is shown by a picture which appears on page (121) of the appendix.

Contradictory results were obtained from feeding cod liver oil. Both the oxidized and the unoxidized forms of cod liver oil proved to be of no benefit as a relief for the perversion of appetite. The failure of bone meal, syrup of iron phosphate and alfalfa meal to cure the depraved appetite may indicate that the disease is caused by different underlying factors. The results obtained from the feeding of the alfalfa meal were surprising and difficult to explain, since the factor carried in alfalfa hay should also be found in alfalfa meal, which was simply the powdered green alfalfa leaves. Very favorable results were obtained from the feeding of wheat bran, and points to the presence of a factor in wheat bran that may serve as a cure for depraved appetite.

Calf C-37

This grade Holstein bull calf born May 8, 1934, was placed on the experiment May 10, 1934. He has been continued on this experiment up to the present time. The ration has consisted of whole milk, supplemented with syrup of iron phosphate. Shavings were used for bedding.

Notes and observations. When the depraved appetite was first evidenced syrup of iron phosphate was added to the ration. Constipation resulted from the feeding of syrup of iron phosphate, and it became necessary to feed neutral

paraffin oil as a purgative for nearly two months. Since that time the calf has not been bothered to any great extent from constipation, although the feces are always slightly more firm than normal.

Marked symptoms of depraved appetite have never been evidenced by this animal, although occasionally after feeding he will eat a few shavings. The syrup of iron phosphate has unquestionably been a factor in preventing depraved appetite.

Calf C-28

A grade Holstein bull calf born May 11, 1934, was placed on the experiment at nineteen days of age. He was continued on this experiment until his death December 25, 1934. The ration consisted of whole milk, flowers of sulphur and sodium chloride. Shavings were used for bedding.

Notes and observations. Both flowers of sulphur and sodium chloride failed to decrease the depraved appetite and the animal resorted to eating shavings, cribbing his manger, chewing his tail, gritting his teeth and sucking his navel. On December 10, 1934, he was placed on a metabolism experiment for a period of seven days in order to determine the calcium, phosphorus and nitrogen balances.

Two days after the completion of the metabolism experiment the calf had a slight convulsion at feeding time, followed by a second convulsion of short duration on December 22, 1934. He was observed to be very irritable and nervous on December 23, and died in a convulsion on December 25, 1934.

Upon post mortem examination multiple hemorrhages were found under the epicardium and endocardium, along with extreme fatty degeneration of the liver.

The sulphur was not a cure for depraved appetite in this animal, and did not prevent the occurrence of convulsions.

Calf C-50

A pure bred Holstein bull calf born June 15, 1934 was placed on the experiment July 19, 1934. He has been continued on this experiment up to the present time. Before he was placed on the experiment his ration consisted of whole milk, mixed grain and alfalfa hay. The experimental ration consisted of whole milk supplemented with raw linseed oil from the beginning of the experiment. Shavings were used for bedding.

Notes and observations. The raw linseed oil has not prevented a depraved appetite for shavings, wood, hair and manure. The animal has always been in good flesh and his coat has remained fairly slick and glossy. He refused his feed for the first time on April 13, 1935, and was observed to be very stiff in gait and swollen in the joints. One hundred cubic centimeters of raw linseed oil, given as a drench, brought about recovery. The oil was again fed in the milk as a part of the ration. No signs of depraved appetite were manifested during this breakdown. It is interesting to note that just before this disturbance the calf was showing sexual desire, which bordered closely onto nymphomania.

The results with this calf indicate that raw linseed oil has no effect upon depraved appetite.

Calf C-54

This grade Holstein heifer calf born August 11, 1924, was placed on the experiment August 16, 1924. She was continued on this experiment until her death November 27, 1924. The ration consisted of whole milk, supplemented with neutral paraffin oil. Shavings were used for bedding.

Notes and observations. She remained normal throughout the experiment, with the exception of a few hard breathing attacks, caused in all probability by the presence of a goiter. The animal manifested no signs of depraved appetite while on the experiment. On November 26, 1924 the calf was scouring and refused to eat. She died the following day in a convulsion.

Upon post mortem examination numerous adhesions of the pericardium, along with adhesions of the rumen and the diaphragm to the walls of the thoracic cavity were found. Diffuse hemorrhages were found on the rumen and in the thoracic cavity, and along the entire length of the spinal column. A partial pyloric obstruction caused by excessive growth of connective tissue may have been the immediate cause of death.

The neutral paraffin oil may have prevented the appearance of the depraved appetite, but in all probability the calf died of convulsions before the depraved appetite had time to develop.

Calf C-56

A grade Holstein bull calf born September 2, 1924, was placed on the experiment at nine days of age. He was continued

on this experiment until his death February 14, 1925. The ration was varied from time to time according to the behavior of the calf. Whole milk, skim milk, corn, oats, oat hulls, bone flour and cod liver oil were fed during the experiment. Shavings were used for bedding.

Notes and observations. The calf was fed on whole milk alone until September 20, 1924, when he was changed to skim milk, corn and oats. The first indications of a depraved appetite became evident about the middle of November. Since the animal showed a preference for oats the corn was removed from the ration and skim milk supplemented with oats alone constituted the diet until January 15, 1925. The depraved appetite continued to increase in intensity and oat hulls were added to the ration on January 16, 1925. The additional roughage in the oat hulls, however, had no effect upon the depraved appetite. After the calf had a slight convulsion on January 21, 1925, the oats and oat hulls were removed from the ration, and one pound of wheat bran was substituted in their place. The calf became paralyzed in the rear quarters following a very violent convulsion which occurred on January 26, 1925. During the convulsion the animal became bloated and ten cubic centimeters of formaldehyde was given as a drench to relieve the bloat. An attempt was made to relieve the paralyzed condition by feeding cod liver oil and bone meal. The animal gradually grew weaker, however, and died February 14, 1925.

Upon post mortem examination hemorrhages were found in the mucosa of the urinary bladder, along with numerous

areas of ruffening. The lungs showed a small amount of red hepatization in the right cardiac lobe, and considerable congestion in the entire lung, along with some congestion of the brain. The interesting part of the autopsy was a malformation of the first lumbar vertebrae, which projected into the spinal canal, exerting considerable pressure upon the spinal cord, which was almost obliterated at this point. The atrophied condition of the spinal cord no doubt accounts for the paralyzed condition of the rear quarters.

These results at least indicate that depraved appetite may be produced as readily in an animal on skim milk, corn and oats as on whole milk alone. The roughage in the oat hulls did not prevent or relieve the depraved appetite, again eliminating roughage as the important factor that cures depraved appetite. The brain in this case was not fed for a sufficient length of time to enable any conclusions to be drawn. It is not surprising that the cod liver oil and bone meal did not relieve the paralyzed condition, which was caused by the atrophy of the spinal cord.

Calves C-75, C-77, C-78, C-79

These grade Holstein heifer calves were raised exactly the same up to four months of age. The animals were fed whole milk supplemented with calcium carbonate and cod liver oil during the first six weeks. At this time the ration was changed to skim milk, calcium carbonate, cod liver oil, corn, oats and alfalfa hay which was continued until the calves were four months of age. C-77 and C-79 were then placed on skim milk, corn, oats and magnesium phosphate, while C-75 and C-78 were

fed only shlg milk corn and oats. At six months of age all four animals were placed on a basal ration of corn silage and a grain mixture consisting of three parts corn, one part oats and one part cotton seed meal. In addition to the basal ration C-57 and C-59 were given three percent magnesium phosphate. Wheat straw was used for bedding.

Notes and observations. These animals remained normal in every respect, and showed no perversion of appetite until the alfalfa hay was removed from the ration. Shortly after this change was made the animals developed an appetite for wood and shavings. The craving for wood in C-55 is illustrated by a picture, which may be found on page (122) of the appendix.

Neither the magnesium phosphate nor the roughage carried in the silage and wheat straw relieved the depraved appetite. These animals were receiving an adequate ration with the exception of the right quality of roughage, which again emphasizes the importance of the factors carried in well cured hay.

Field calves 1, 2, 3 and 4

These calves were all pure bred Jersey calves raised on a farm near East Lansing. Calves 1 and 3 were approximately one month and ten days of age and calves 2 and 4 were four and one-half months of age. They all developed a depraved appetite on a ration of whole milk, alfalfa hay and a grain mixture composed of equal parts of linseed oil meal, ground barley and wheat bran. They all had an appetite for wood and had been chewing the boards of the pen and manger. The owner also

stated that they had been eating sacks, rags and straps from time to time. Cod liver oil was fed to these animals at the rate of twenty-five cubic centimeters per day. Within fifteen days the depraved appetite had entirely disappeared in all four calves.

The alfalfa hay was a very poor quality which may explain why the depraved appetite developed. Blood pictures of these animals showed that the cod liver oil produced no appreciable change in the blood calcium and phosphorus, although it served to relieve the depraved appetite.

Depraved Appetite Under Farm Condition

Depraved appetite was reported among dairy cattle in Tuscola County, Michigan, by the county agricultural agent. Mr. Haffman visited this section on July 12, 1924 and studied the conditions under which depraved appetite occurred on farms A, B and C. Most of the cows at these farms exhibited a craving for rags, woods, bones, and etc, and would leave good pasture in order to chew these materials. The depraved appetite seemed to prevail only in the prairie land region and not in sections where the land was formerly covered by timber. It was reported that most of the affected cattle had developed the depraved appetite in the early spring after being turned on pasture. Cows in milk seemed to be the more susceptible while dry cows were not affected.

A mixture consisting of finely ground limestone rock, tannage, salt and cod liver oil was left on farm A and B. A mixture of bone meal, acid phosphate, salt and cod liver oil was left on farm C. The owners of these cattle promised to

feed these mixtures, according to the directions given by Mr. Huffman.

A pasture sample was taken from the pasture, which consisted mostly of Canadian Blue grass. A similar sample was also taken from lot number eleven of the Michigan State College pasture. These samples were analyzed by the Experiment Station Chemistry for calcium, phosphorus and iron.

Results

M.S.C. Pasture (No depraved appetite)	Farm B Pasture (Depraved appetite)
Calcium oxide.....1.01%	0.67%
Iron.....0.04%	0.06%
Phosphorus.....0.16%	0.07%

A second trip was made to Tuscola County on September 12, 1934, and farms A, B, C, D and E were visited. It was found that depraved appetite had prevailed among dairy animals on these farms during the spring and early summer, but about August first the abnormal craving gradually abated. The farmers reported that they had observed these same conditions in previous years.

Farm B where the cows had received cod liver oil, tankage, salt and limestone rock, showed no evidence of depraved appetite, and had not done so since the first of August.

A cow on farm C had exhibited a severe craving for abnormal things was entirely cured, and had not exhibited the symptoms since about the first of August at which time oats had been added to her ration.

Animals in herd A that had been receiving limestone rock, tankage, salt and cod liver oil had ceased to chew wood,

but still had a craving for bones. These animals were still on good pasture but were not receiving a grain supplement. The mangers in the barn where these cows had been stabled during the early part of summer, had been chewed to the extent that one of the six inch boards was nearly devoured for a distance of two to three feet. Numerous specimens of sticks and boards which had been chewed earlier in the spring were collected from the pastures on this farm. Unmistakable evidence was found which showed that the cows had been eating grass and chewing boards interchangeably.

A Holstein herd on Farm B were in good flesh at the time of this visit, and according to the owner and county agent these animals had not exhibited a depraved appetite for nearly six weeks. These animals had developed a marked depraved appetite on sweet clover pasture in the spring and early summer, when the pasture constituted the entire ration. About August first the sweet clover pasture was supplemented with a grain ration. Samples of the sweet clover pasture were taken in the succulent bloom and seed stages. The succulent stage represented the pasture that these animals received at the time the depraved appetite developed, while the bloom and seed stages represented the pasture the animals received at the time the depraved appetite disappeared. The following table shows the percent calcium and phosphorus of these three stages, along with the pounds of such pasture needed to meet the calcium and phosphorus requirements of a nine hundred and thirty-five pound cow producing thirty-six pounds of average milk daily.

**Table Showing Calcium and Phosphorous Content of Succulent
Bloom and Seed Stages of**

Sweet Clover Pasture

Pasture	Analysis of Grass		Lbs. of pasture needed to meet Ca & P requirements of 335 lb. cow producing 36 lbs. milk daily	Remarks
	% Ca	% P		
			CA P	
Succulent	0.6437	0.5333	26 190	Depraved appetite
Bloom	0.4556	0.7354	36 138	Depraved appetite ceased
Seed	0.3704	0.8955	44 119	No depraved appetite

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On October 1st, 1934, a Holstein Herd on farm F that had been suffering from depraved appetite during the summer months, was visited. Pasture consisted of mixed clover and blue grass. These animals were producing forty to sixty pounds of milk a day in May and those afflicted with the depraved appetite dropped in a very short time to twelve to twenty pounds of milk daily, while still on good pasture. Before being turned on pasture in the spring these animals had received a ration high in calcium, but comparatively low in phosphorous. The depraved appetite ceased about August first, at which time the pasture was supplemented with grain.

Pasture and soil samples were taken on farms A, B, D, E and F where depraved appetite prevailed. Similar pasture samples were also collected on M. S. C. farm and on Farms F and G where depraved appetite was not prevalent. The results of the analysis of these samples for calcium and phosphorous along with the pounds of such pasture needed to meet the calcium and phosphorous requirements of a nine hundred and thirty-five pound cow producing thirty six pounds of average milk daily appears in the following tables.

Table Showing Ca & P Content of Soil and Pasture Samples Where Depressed Appetite Prevailed.

Pasture	Analysis of Grass			Analysis of Soil		Lbs. of pasture needed to meet Ca & P requirements of 935 lb. cow producing 36 lbs. milk daily	Remarks
						Ca P	
B	0.3449	0.04216	-	-	-	48 254	No change in pasture during summer
A	0.3347	0.4552	4.30	.0393	-	50 224	Depressed Appetite all pastures period
D	0.3557	0.5229	-	-	-	47 195	Clover-blue Grass pasture
E	0.6437	0.5333	2.60	.0651	-	26 190	Sweet Clover pasture, succulent stage
F	-----	-----	1.25	.0351	-	- -	No samples taken while animals had depressed appetite

Continued.

Pastures where there was no Depraved Appetite

Pasture	Analysis of Grass Analysis of Soil				Lbs. of pasture needed to meet Ca & P requirement of 935 lb. cow producing 36 lbs. milk daily		Remarks
	% Ca	% P	% Ca	% P	Ca	P	
M.S.O.	0.3608	0.0800			50	126	Pasture sample taken early part of July
Y	0.2683	0.08955			62	113	No depraved appetite when sample was taken
Z	0.3704	0.849			45	120	No depraved appetite when sample was taken

Results of Metabolism Experiment

Four calves suffering from depraved appetite were placed on a metabolism experiment in order to determine the calcium, phosphorous, and nitrogen balances.

Calf C-18 did not exhibit a marked depraved appetite during the metabolism period and C-21, an animal whose depraved appetite was more marked during the metabolism experiment, were both in positive nitrogen, calcium and phosphorous balances. Previous to the metabolism period the latter had exhibited a depraved appetite for hair.

The depraved appetite of Calf C-25 during the metabolism experiment was very marked and it was necessary to keep the calf muzzled in order to prevent the eating of wood and shavings. Nevertheless she was also in a positive calcium, phosphorous and nitrogen balance.

Calf C-18 who showed a marked depraved appetite for wood throughout the entire seven days was in a positive nitrogen, calcium and phosphorous balances the entire period.

The daily calcium, phosphorous and nitrogen balances along with the average balance for the metabolism period for each calf appears separately for each calf in the following tables.

Hydrogen in Glass

Shoring Nitrogen, Phosphorous and Calcium Balance of C.I.F. C-13

Action 1 was showing slight Derived Appetite on a ration

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TABLE NO. I Continued

CaO in Grams

Date	Grain	Potatoes	Timothy	Water	Total Intake	Feces	Urine	Total Outgo	Balance
12/15/24	7.6188	.6795	3.0351	.6322	11.9656	5.5795	.14808	5.71258	6.25302
12/16/24	7.6188	.6795	3.0351	1.0358	12.3692	6.8550	.18216	7.01716	5.35200
12/17/24	7.6188	.6795	3.0351	1.41266	12.7451	6.7760	.22722	7.10308	5.64200
12/18/24	7.6188	.6795	3.0351	.079388	12.4227	6.5960	.07472	6.67072	4.74200
12/19/24	6.6696	.6795	3.0351	.845672	11.2299	6.0950	.14510	6.24010	4.98980
12/20/24	7.6188	.6795	3.0351	.833240	12.1666	6.2556	.17146	6.52506	5.64150
12/21/24	7.6188	.6795	3.0351	.922240	12.2554	10.1122	.10218	10.23318	1.02222
Average Balance									4.949

TABLE NO. II

Nitrogen in Grass

Showing Nitrogen, Cellulose and Phenolic Balance of Calf C-31

Animal was showing marked decreased appetite for hay on a
ration high in lime.

Date	Grain	Potatoes	Timothy	Total Intake	Food	Urine	Total Output	Balance
12/8/24	105.212	6.804	4.575	116.591	38.7079	55.1170	93.6249	22.9661
12/9/24	105.212	6.804	4.575	116.591	26.7870	49.8970	76.6840	39.9070
12/10/24	105.212	6.804	4.575	116.591	37.1168	57.6330	94.7328	21.7922
12/11/24	105.212	6.804	4.575	116.591	37.3870	53.9115	91.2985	25.2925
12/12/24	105.212	6.804	4.575	116.591	40.636	61.6320	102.2680	14.3230
12/13/24	105.212	6.804	4.575	116.591	38.8678	53.8528	92.7206	23.8704
12/14/24	105.212	6.804	4.575	116.591	32.8616	50.0080	82.8696	33.7214
Average Balance 25.9749								

TABLE NO. II
Continued

P₂O₅ in Gravel

Date	Grain	Potatoes	Ferment	Total Intake	Feces	Urine	Total Outgo	Balance
12/8/24	64.5784	3.1752	1.1778	68.9314	37.8769	15.18168	53.01858	15.91282
12/9/24	64.5784	3.1752	1.1778	68.9314	24.0736	13.96022	38.03382	30.8976
12/10/24	64.5784	3.1752	1.1778	68.9314	33.1290	19.25604	52.38504	15.94636
12/11/24	64.5784	3.1752	1.1778	68.9314	30.5950	11.26985	41.86485	27.06715
12/12/24	64.5784	3.1752	1.1778	68.9314	35.7167	22.69046	58.40716	10.56424
12/13/24	64.5784	3.1752	1.1778	68.9314	38.8673	20.76256	59.62986	9.30144
12/14/24	64.5784	3.1752	1.1778	68.9314	34.9339	16.27400	51.20790	17.12950
								Average Balance 18.1192

TABLE NO. II Continued

C₁O in Grain

Grain	Grain	Potatoes	Timothy	Water	Total Intake	Feces	Urine	Total Outgo Balance
12/8/24	84.1696	.6824	2.718	1.121	88.739	68.255	.55184	68.58684 80.17416
12/9/24	84.1696	.6824	2.718	1.123	88.766	47.729	.27644	47.22544 40.73056
12/10/24	84.1696	.6824	2.718	.641	88.209	66.872	.41244	67.28444 20.925
12/11/24	84.1696	.6824	2.718	.674	88.192	70.369	.25470	70.62370 17.5686
12/12/24	84.1696	.6824	2.718	1.114	88.682	39.026	.54268	39.57968 49.1727
12/13/24	84.1696	.6824	2.718	1.152	88.716	43.256	.55514	43.21214 44.914
12/14/24	84.1696	.6824	2.718	1.200	88.563	40.855	.50000	41.27550 47.233
Average Balance 34.406								

TABLE NO. III

Nitrogen in Cows

Showing Nitrogen, Calcium and Phosphorus Balance of C 11 C-25

Animal had a hard derived appetite for wood and shavings

on a ration comparatively high in cellulose and phosphorus.

Date	Milk	Alfalfa Leaves	Total Intake	Feces	Urine	Total Output	Balance
12/5/24	44.023	26.775	70.824	20.380	43.011	63.391	7.433
12/9/24	49.794	24.285	74.081	19.253	42.105	61.978	12.103
12/10/24	42.4476	22.2150	65.2626	22.231	42.745	64.976	2.286
12/11/24	44.725	25.721	70.5131	19.5396	40.116	59.6756	10.8375
12/12/24	43.2958	26.1765	70.0753	22.8910	44.5998	67.4908	2.5845
12/13/24	45.2590	26.1135	71.3725	18.9700	41.9930	60.5550	11.8175
12/14/24	43.2080	31.0396	74.8976	17.3510	47.1960	64.5470	10.3486
Average Balance 7.7729							

TABLE NO. III Continued

P₂O₅ in Grass

Date	Milk	Alfalfa Leaves	Iron	Salt	Total Intake Paces	Urine Total	Output Balance
12/8/24	18.4518	6.323	.643	.038	26.0178	14.617	10.617 25.493 .5048
12/9/24	20.2168	6.245	.643	.038	27.2428	10.674	8.022 18.736 8.4458
12/10/24	18.2556	5.678	.643	.038	25.2246	13.799	9.294 23.633 1.0216
12/11/24	19.8633	6.634	.643	.038	27.1783	15.125	10.593 25.713 1.4503
12/12/24	20.3168	6.731	.643	.038	27.7288	16.043	11.074 27.117 .6118
12/13/24	19.6819	6.715	.643	.038	27.0779	11.591	11.639 22.961 4.1169
12/14/24	18.6942	6.532	.643	.038	25.2912	16.371	16.146 33.017 - 7.1158
						Average Balance 1.3775	

TABLE NO. XII Continued

CRO IN GRASS

Date	Milk	Alfalfa Leaves	Iron	Salt	Water	Total Intake	Feces	Urine	Total Output	Balance
12/2/24	13.477	40.035	.0043	.045	.3537	53.915	47.603	.1168	47.7191	6.02332
12/9/24	13.914	36.314	.0043	.045	.6097	50.487	41.934	.1166	42.1986	6.00244
12/10/24	13.679	33.017	.0043	.045	.0570	46.003	42.4997	.19668	42.69638	-3.64
12/11/24	14.331	35.575	.0043	.045	.0274	53.177	47.0018	.00005	47.0018	5.763
12/12/24	14.693	39.180	.0043	.045	.1779	54.0602	53.173	.30140	53.4764	-1.4162
12/13/24	13.605	39.046	.0043	.045	.3731	53.0734	48.120	.00200	48.369	4.7044
12/14/24	13.661	20.955	.0043	.045	.3028	34.3761	40.4378	.11070	40.7483	-6.3742
Average Balance 1.9179										

TABLE NO. 17

Nitrogen in Grass

Showing Nitrogen, Calcium and Phosphorus Balances of Calf C-78

Animal had a mixed derivative waste formed, hair and feces

on a ration comparatively high in phosphorus

Date	Milk	Feces	Urine	Total Outgo	Balance
12/8/34	43.7	3.8768	21.258	28.875	20.43
12/9/34	54.9	3.5376	25.970	27.490	27.41
12/10/34	46.8	4.4269	23.275	27.772	19.03
12/11/34	49.3	5.2559	26.479	31.735	17.56
12/12/34	48.4	4.5110	26.751	31.262	17.14
12/13/34	49.9	4.6595	24.353	29.012	20.59
12/14/34	43.3	7.5040	24.046	31.550	16.75
Average Balance				19.425	

TABLE NO. IV Continued

U.S. GOVT

[illegible]

TABLE NO. IV Continued

C.O. in Grams

Date	Milk	Salt	Water	Total Intake	Feces	Urine	Total Outgo	Balance
12/8/24	16.9	.045	.0358	14.9608	3.6018	.4975	4.0993	10.8615
12/9/24	16.9	.045	.0327	14.9777	3.7350	.14982	3.8848	11.0929
12/10/24	16.0	.045	-----	14.9450	3.7152	.13736	3.8526	11.0924
12/11/24	16.8	.045	-----	15.4450	3.6698	.20950	3.8793	11.5657
12/12/24	16.2	.045	-----	16.2450	3.3828	.17954	3.5623	12.6827
12/13/24	15.0	.045	.0704	15.1154	6.7417	.20750	6.9492	8.1662
12/14/24	14.4	.045	.0167	14.4617	5.1165	.14544	5.2619	9.1997
Average Balance 10.674								

TABLE NO. IV Continued

C.O. in Grams

Date	Milk	Sub	Water	Total Intake	Recess	Urine	Total Output	Balance
12/2/24	14.9	.045	.0758	14.9808	3.6016	.4918	4.0936	10.8862
12/9/24	14.9	.045	.0727	14.9777	3.7350	.14982	3.8848	11.1129
17/10/24	14.9	.045	-----	14.9450	3.7152	.13796	3.8531	10.9718
12/11/24	15.8	.045	-----	15.8450	3.6698	.20950	3.8793	11.9657
12/12/24	16.2	.045	-----	16.2050	3.3328	.17974	3.5127	12.7122
12/13/24	15.0	.045	.0724	15.1154	6.7417	.20380	6.9455	8.5224
12/14/24	16.4	.045	.0167	16.4517	5.1165	.14544	5.2619	9.1897
Average Balance								10.674

DISCUSSION OF THE MINERAL DEFICIENCIES

Experimental Depraved Appetite

Depraved appetite may be produced experimentally by feeding dairy calves on concentrated rations in the form of either whole milk, or grain mixture containing ample protein, energy, minerals and vitamins for normal growth.

In an attempt to cure this type of depraved appetite, contradictory results have been obtained from feeding cod liver oil, syrup of iron phosphate and wheat bran. The cod liver oil relieved the depraved appetite in calves C-14 and C-16, but failed to relieve the condition in calves C-15, C-22, C-24, C-25 and C-26. Likewise oxidized cod liver oil did not cure the depraved appetite in animals C-24 and C-25. Syrup of iron phosphate relieved the depraved appetite in calf C-27 but had no beneficial effect upon animals C-16, C-22 and C-25. Wheat bran relieved the depraved appetite in calf C-25, but it had no effect when fed to calf C-22. These results indicate that the depraved appetite in the cases mentioned are not caused by any one specific factor.

Negative results have been obtained in every instance where mineral supplements have been given in order to cure the depraved appetite, as the following table shows:

Mineral supplement fed	Animals number	Results
Calcium carbonate	C-23	No cure
Tri-calcium phosphate	C-15	No cure
Sodium chloride	C-16, C-22, C-25	No cure
Ground limestone rock	C-13	No cure
Acid phosphate	C-23	No cure
Bone meal	C-25, C-26	No cure
Bone flour	C-25	No cure
Magnesium phosphate	C-37, C-39	No cure
Wood ashes	C-22	No cure
Alfalfa mineral mixture	C-16, C-17	No cure
Raw rock phosphate	C-5	No cure
Sodium carbonate	C-6	No cure
Flowers of sulphur	C-28	No cure

The results of the metabolism experiment conducted on calves C-18, C-21, C-25 and C-28 while they were suffering from depraved appetite shows that these animals had positive calcium and phosphorous balances. These results seem to indicate that a lack of minerals or the lack of the mineral retention factor is not the cause of depraved appetite occurring on rations restricted as to the quantity and quality of roughage.

Where depraved appetite and irritability were both produced by feeding a concentrate ration, the addition of different mineral supplements mentioned relieved the irritability, but had no effect upon the depraved appetite. This indicates that irritability and depraved appetite are two separate diseases, although they may both be produced under identical conditions.

Rogers (5) and Lynch (9) believe that a deficiency of protein is the cause of depraved appetite in some classes of livestock. However, the feeding of tankage to C-22, blood meal to C-16 and alfalfa meal to C-25 as protein supplements failed to relieve the depraved appetite. This indicated that the depraved appetite was not due to amino acid deficiency.

The depraved appetite was just as marked during the winter months as during the summer, indicating that the ultra violet ray from sunshine has no beneficial effect on this disease. This is further demonstrated by the picture found on page (125) of the appendix, showing five animals chewing the fence while in the direct sunlight. Three weeks previous

to the time this picture was taken the animals had been in the sunlight seven hours each day.

In all cases where the experimental animals were receiving good quality roughage in the form of timothy or alfalfa hay depraved appetite did not develop. As soon as the timothy hay was limited to one pound per day the depraved appetite was manifested in calves C-18, C-19, C-20 and C-21. The depraved appetite in calves C-35, C-37, C-38 and C-39 made its appearance as soon as alfalfa hay was removed from the ration, although the animals had all of the roughage they would eat in the form of corn silage and wheat straw. In all probability the two calves C-13 and C-17 whose depraved appetite was relieved by adding wheat straw to the ration, died of weakness and emaciation before the depraved appetite had time to reappear. There seems to be a factor in good quality roughage which prevents the depraved appetite. The failure of alfalfa tea to relieve the depraved appetite in calves C-22 and C-17 indicate that this factor is not soluble to any appreciable extent in lukewarm water. This factor is probably not a mineral since a mineral mixture similar to the mineral combination found to relieve the depraved appetite. Likewise the question of bulk cannot be the factor, because the shavings, oat hulls and wheat straw supplied plenty of bulk to stimulate proper physiological functioning of the digestive track. These results agree with those of McCandlish (49) who found that the feeding of alfalfa hay prevented depraved appetite in experimental animals.

A study of the blood pictures of calves C-13, C-16, C-22, C-25 and C-75 that were suffering from depraved appetite, showed no relationship between the blood calcium, phosphorus, chlorine, carbon dioxide, protein nitrogen, non-protein nitrogen and hemoglobin and the depraved appetite.

Likewise a study of the red blood and white blood corpuscle count of calves C-16, C-22, C-25 and C-75 suggested no relationship between the blood cell count and depraved appetite.

Depraved Appetite in the Field

The addition of cod liver oil to the ration of field calves 1, 2, 7, and 4 cured the depraved appetite. This indicates that a lack of a factor carried in cod liver oil may be the cause of the depraved appetite that occurs under ordinary farm conditions, where the animals are receiving a poor quality of hay.

The investigational work conducted with depraved appetite as it occurs under farm conditions in the thumb region, points to a phosphorus deficiency as being the cause of the depraved appetite. Cows in milk, and young growing animals seem to be the more susceptible, while older non-lactating animals are not affected to as marked a degree. These results agree with the work of Theiler (11) who concludes that the depraved appetite in South Africa is caused by a phosphorus deficiency.

Analysis of the pasture samples from farms A, B, D, E and F, where depraved appetite occurred, showed only one-

half the amount of phosphorus found in the pasture samples from the H. S. C. farm and from farms F and L where depraved appetite was not found. Also the analysis of samples of sweet clover pasture collected from farm L shows that the succulent stage contains only 0.0553 per cent phosphorus, while the seed stage contains 0.0895 per cent phosphorus. The succulent stage is representative of the pasture when depraved appetite developed, while the seed stage is representative of the pasture when the depraved appetite disappeared. This may explain why the depraved appetite occurs more often in the spring, while the grass is young and tender, and then disappears when phosphorus is being stored during the bloom and seed stages. The addition of grain to the ration about the middle of the summer may also account for the disappearance of depraved appetite at that time, since these grains are fairly high in phosphorus.

CONCLUSIONS

1 Depraved appetite may be produced by feeding calves on a concentrate ration containing adequate energy, protein, minerals and vitamins for normal growth.

2 Depraved appetite may also be produced in dairy calves receiving an adequate ration by substituting wheat straw and corn silage for alfalfa hay. This indicates that a factor in good quality hay prevents depraved appetite.

3 The results indicate that depraved appetite as it occurs on rations limited as to the quantity and quality of roughage, is neither due to a mineral deficiency, particularly calcium and phosphorous, nor to a lack of the mineral retention factor.

4 The ultra violet ray of the sunshine has no effect on depraved appetite.

5 There is no relationship between the calcium, phosphorous, caloric, carbon dioxide, protein nitrogen, non-protein nitrogen and hemoglobin content of the blood and depraved appetite.

6 There is no relationship between the leucocytic count of the erythrocytic count of the blood and depraved appetite.

7 Depraved appetite among dairy cattle in certain sections may be due to a phosphorous deficiency.

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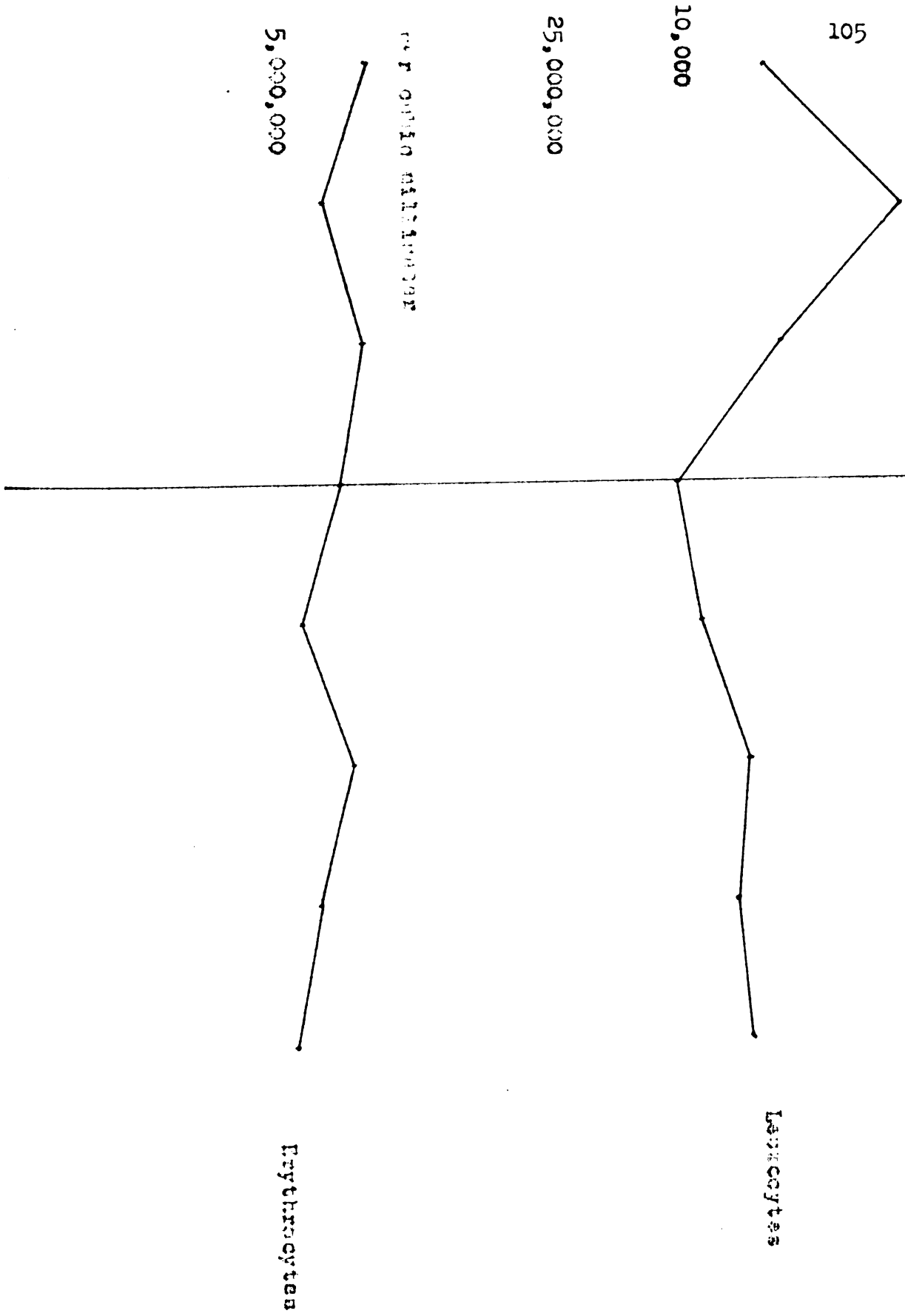
Unpublished data from work conducted Michigan exp.
Station, East Lansing, Michigan.

APPENDIX

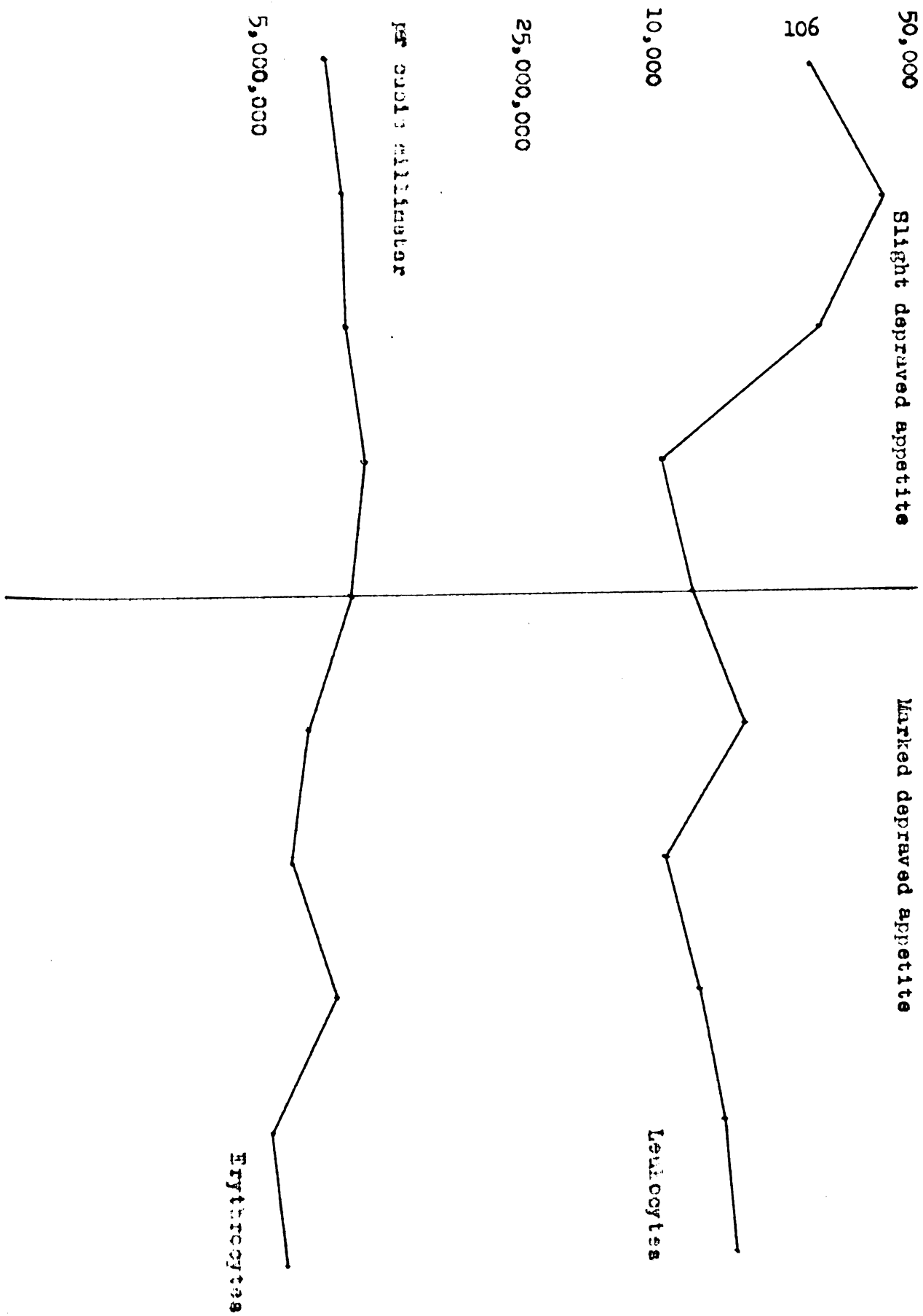
Table giving description of calves used on the experiment.

Calf No.	Sex	Age in days when		
		Placed on Experiment	Developed Depraved appetite	Developed irritability
C-13	Male	7	183	None
C-14	Male	1	None	171
C-15	Male	7	128	128
C-16	Female	1	67	None
C-17	Female	200	223	None
C-18	Female	3	200	180
C-19	Female	3	300	270
C-20	Female	3	210	400
C-21	Female	2	180	360
C-22	Female	1	171	None
C-24	Female	6	60	None
C-25	Female	1	61	120
C-27	Male	2	None	None
C-28	Male	19	60	218
C-30	Male	36	120	None
C-34	Female	5	None	106
C-35	Female	1	159	None
C-36	Male	9	70	134
C-37	Female	1	137	None
C-38	Female	1	162	None
C-39	Female	1	161	None

C-16
 Calf C-16. Graph showing relation of leucocytes and erythrocytes to deprived appetite.
 50,000 slight deprived appetite marked deprived appetite



Calf C-22. ² Graph showing relation of leukocytes and erythrocytes to deprived appetite.



C-25

50,000 Calf C-25. Graph showing relation of leukocytes and erythrocytes to depraved appetite.

107

No depraved
appetite

Marked depraved appetite

No depraved appetite

10,000

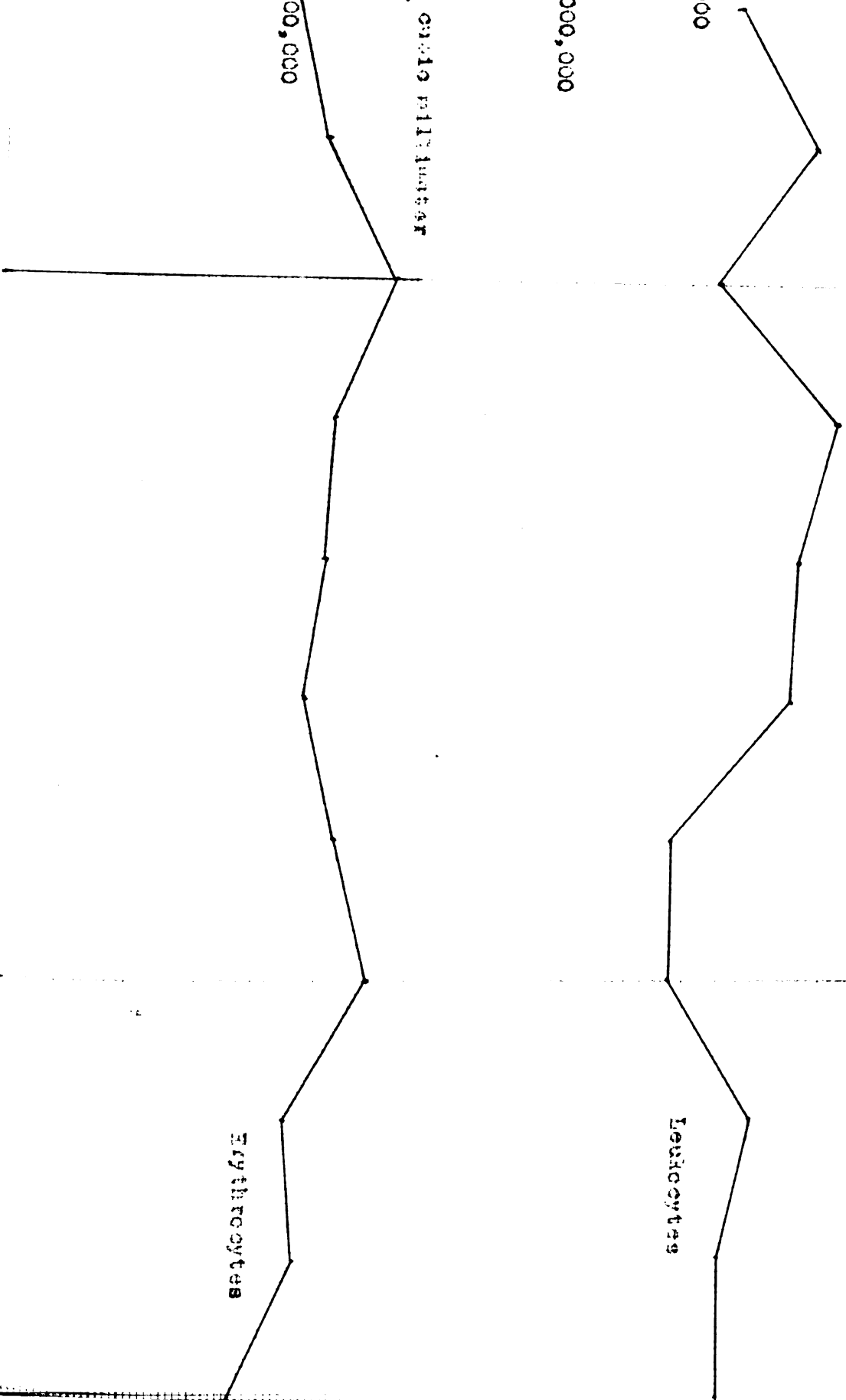
25,000,000

per cubic millimeter

5,000,000

Leukocytes

Erythrocytes



50,000 Calf C-35. Graph showing relation of leukocytes and erythrocytes to depraved appetite.

101

No depraved
appetite

Marked depraved appetite

10,000

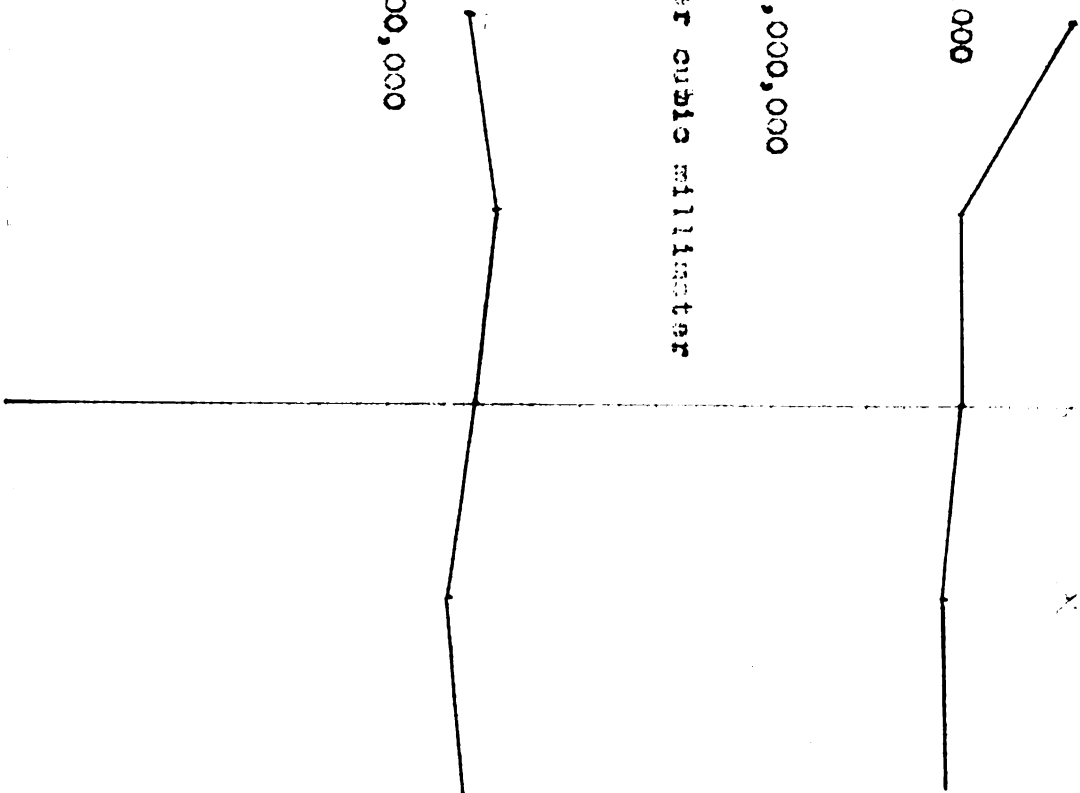
25,000,000

per cubic millimeter

Leukocytes

Erythrocytes

5,000,000



5

No depraved appetite

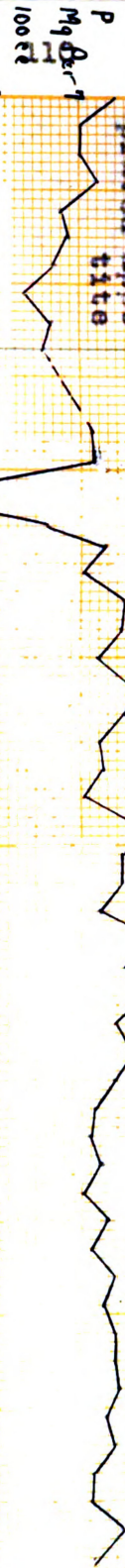
Year	Number of people (millions)
1970	55
1975	65
1980	63
1985	75
1990	85

△

DEPARTMENT OF MATHEMATICS

Calf O-16. Graph showing relationship between the blood picture and depraved appetite.

11
Straight De-
praved appe-
tite



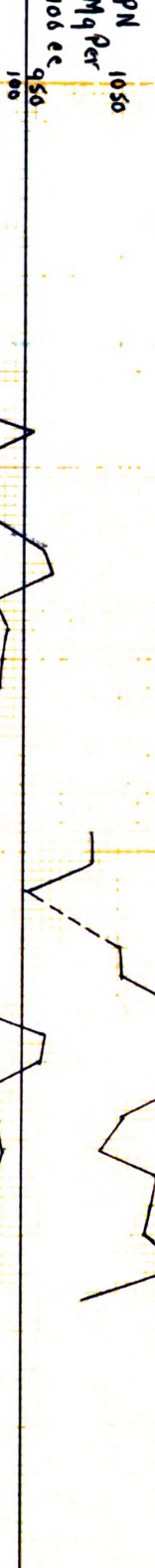
380



1000
800
600
400
200



1150



100



Calf C-22. Graph showing relationship between the blood picture and deprived appetite.
 No deprived appetite



Month 0-25. Graph showing relationship between the food picture and deprived appetite.
No deprivation Marked deprivation Very marked deprivation No deprivation appetite

Depr 1

100cc 30

Cl 300

Mg Per

100cc 30

CO₂ 60

Vol 90

100cc 30

Ca 70

Mg Per

100cc 30

NDN 50

Mg Per

100cc 30

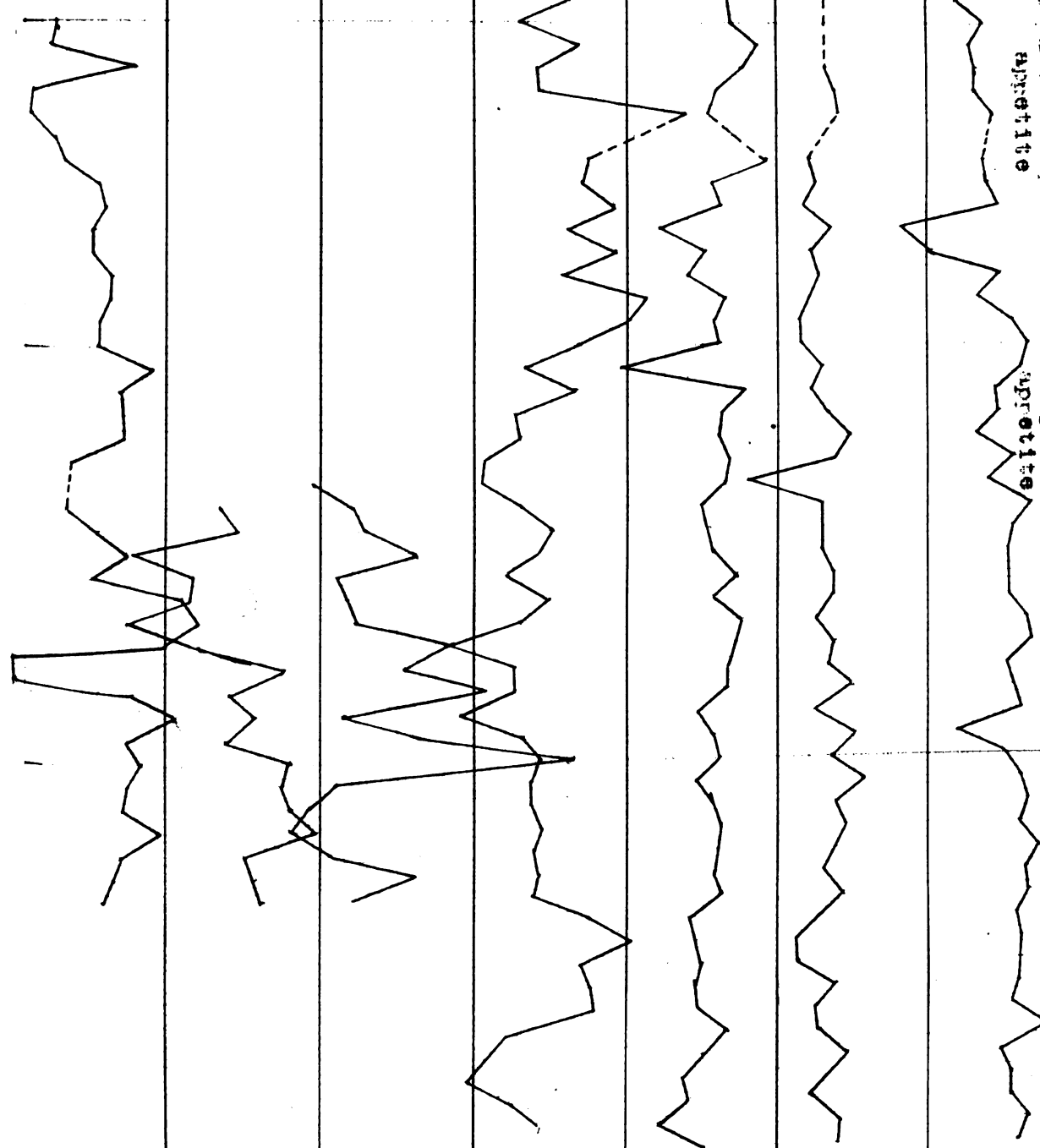
PN 950

Mg Per

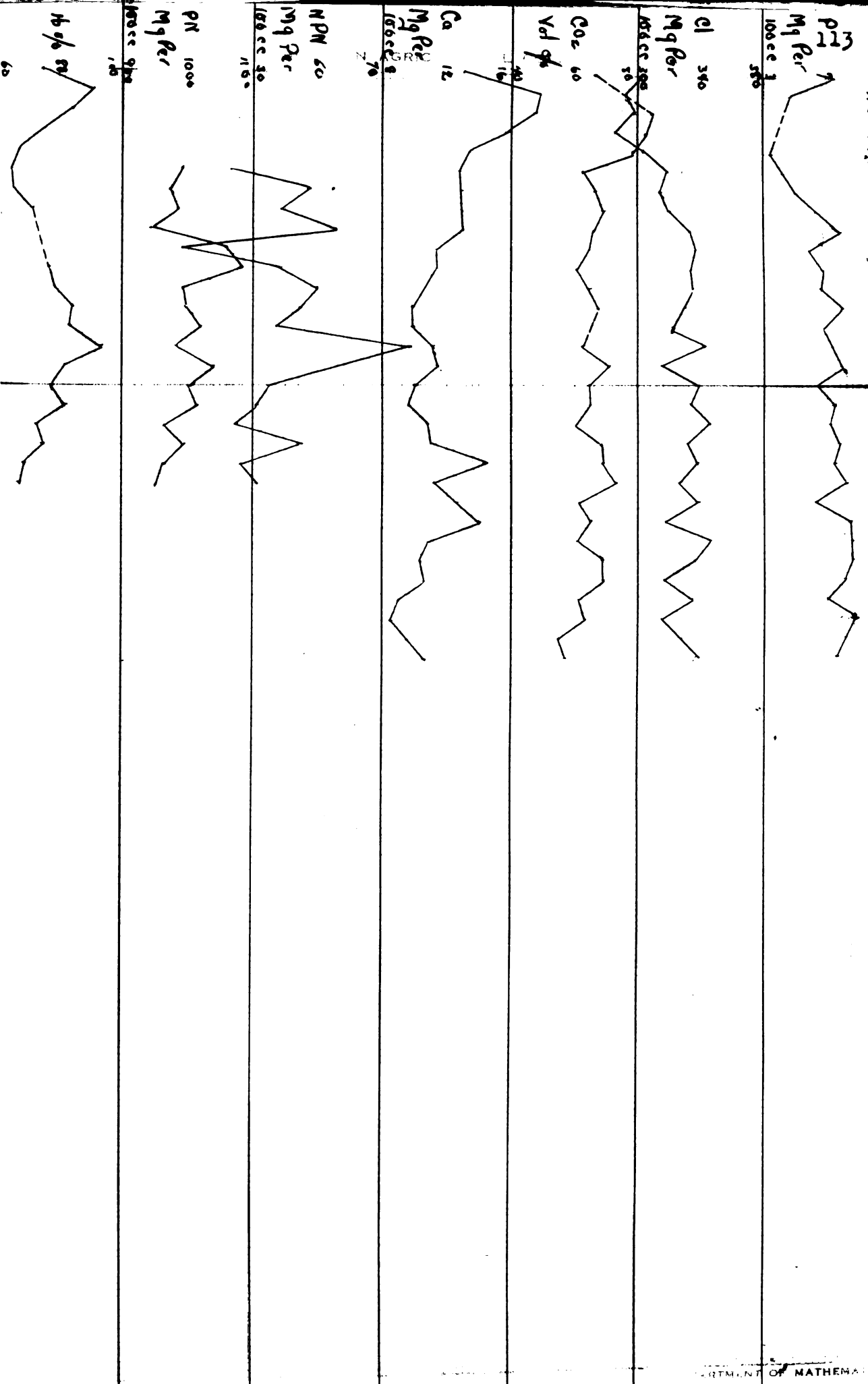
100cc 30

Ab o/o 50

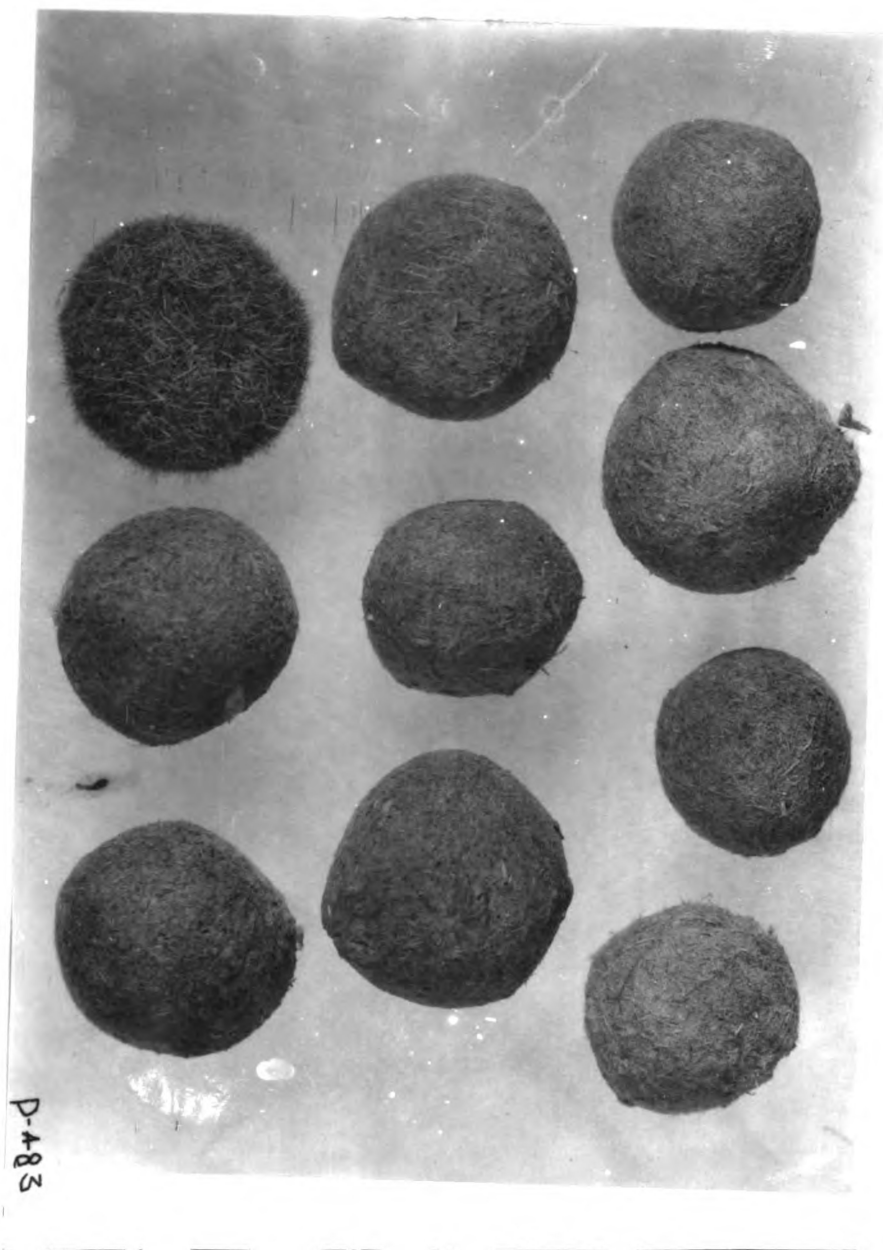
60



"Calf C-25. Growth and retention of nutrients and deprivation of appetite."
 "No deprived appetite" "Mixed deprived appetite"



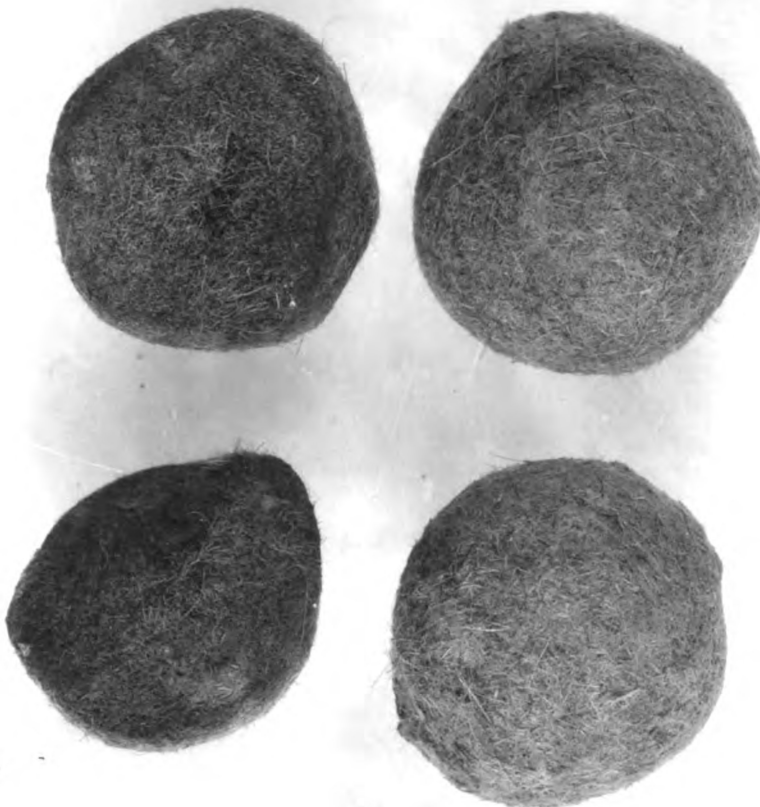
P L A T E 1



Pictures of hair balls collected
from the rumens of calves.

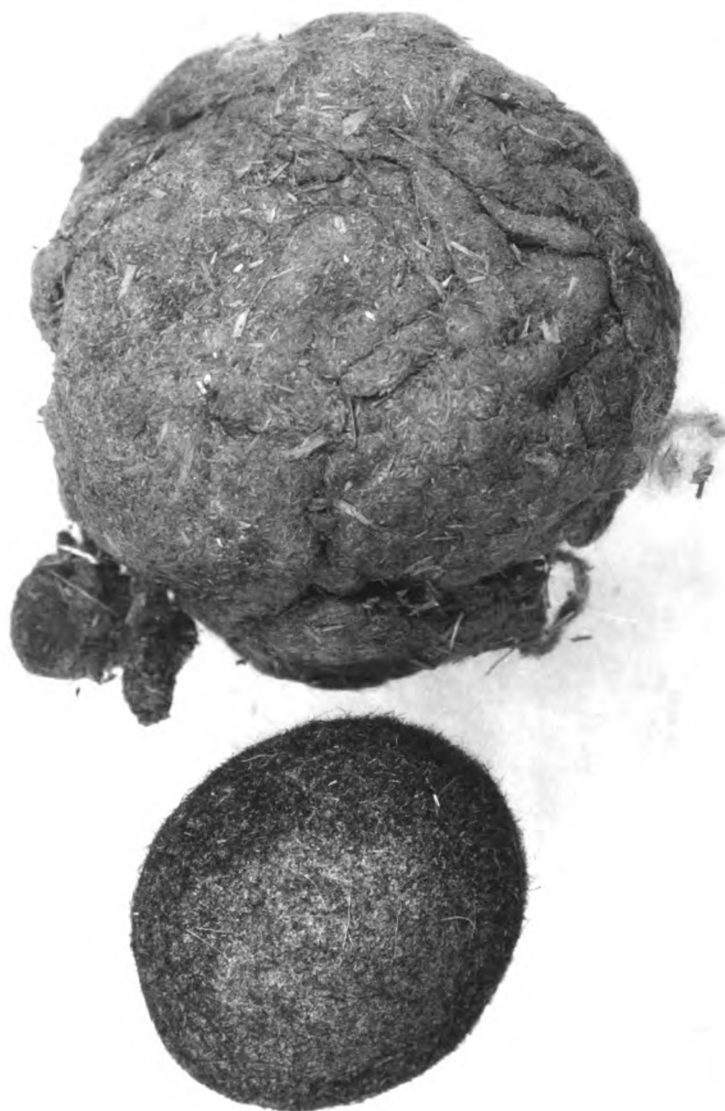
P L A T E 2

D-484



Picture showing cross section of hair
balls collected from the rumens of
calves.

P L A T E 3



D-482

Picture of large hair ball collected
from the rumen of a calf and a
wool ball collected from the
rumen of a lamb.

P L A T E 4



Picture of calf C-16 eating manure.

P L A T E 5



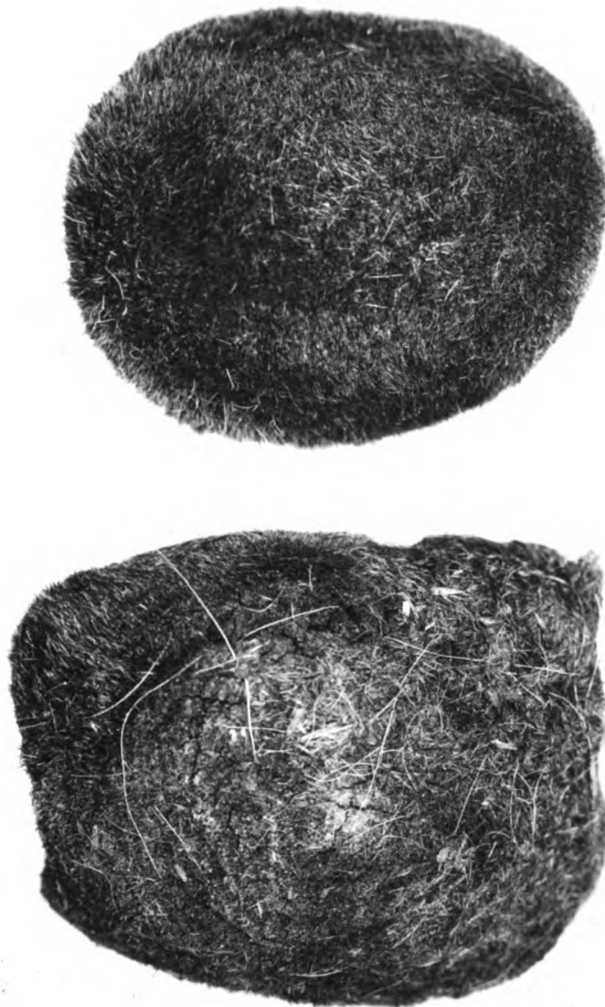
Picture of Calf C-22 eating hair.

P L A T E 6



Picture of a calf that has a patchy coat of hair. This condition is the result of the ravenous appetite for hair exhibited by calf C-22.

P L A T E 7



D-664

Picture of hair balls regurgitated
by calf C-22 during the month of
May.

P L A T E 8



Picture of Calf C-25 lolling her
tongue. This condition often
accompanied depraved appetite.

P L A T E 9



Picture of Calf C-35 chewing a board fence.

P L A T E 10



619-4

Pictures of boards collected from
pastures where depraved appetite
prevailed, showing chewed areas.



P L A T E 11



D-611

Sticks of wood collected from pasture
where depraved appetite prevailed,
showing chewed ends.

P L A T E 12



Picture showing five calves chewing a board
fence. These calves had received seven
hours of sunshine daily from April 1
to April 25.



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