Facts and Theories about Stijfziekte and Lamziekte

By Dr. A. Theiler, C.M.G., Director of Veterinary Research.

PART I.

HISTORICAL NOTES ON STIJFZIEKTE AND LAMZIEKTE.

Lamziekte is apparently not a new disease in South Africa, as in records of over a century ago reference is made to it.

Dr. G. M. Theal, the historiographer of this sub-continent, to whom I applied for information, referred me to Deel III of "Belangrijke Historische Dokumenten over Zuid-Afrika," collected in the Hague and in Berlin.

This collection of documents contains a diary of a commission appointed by the Government of the time of Commissioner Van der Mist to visit certain farmers and to induce them to improve their flocks by using woolled sheep rams, or, as they are called in the report, "Spanish Sheep."

The commission consisted of three members. They started on their travels on 25th September, 1805, from Koeberg, in the present District of Wellington, and travelled along the Vogel Valley (Paarl) to the Tulbagh District, and along the Witzenberg Mountains to the present District of Worcester. Then they went along the Hex River Valley to Touws River and along Verkeerde and Laken Valley to the Ceres District; they visited Karropoort and went across the Doorn, Dweyka, and Ongeluk Rivers into the present District of Sutherland (Aapenberg) and into Calvinia Districts; over Hantam's Berg to the Bokkenveld and Kobie Mountains; then across the Doorn River into the present District of Clanwilliam; along Oliphants and Twenty-four Rivers into Piquetberg and then to the present District of Malmesbury and back to the starting point.

On this journey, the presence of lamziekte was noted amongst the cattle of fifteen different owners; the first place mentioned was "Houd Constant." The names of the farms of the fourteen others are not given, but ten are situated in the territory of the Twenty-four Rivers.

That the disease is identical with our lamziekte can be recognized from notes by the famous naturalist, Dr. Lichtenstein, who lived in South Africa in the years 1803, 1804, 1805, and 1806. I am indebted to Dr. Gunning for these details.

Anent the disease he says as follows:—

"This place (in Goudinie District, Cape Colony) (which the commission also visited) is surrounded by mountains and rivers and cannot be reached in the winter time when the rivers are flooded. It is, therefore, called the "Eiland." Here we saw for the first time a cow which was suffering from lamziekte. For a week past she had been stretched out on the ground and could occasionally be brought on to her feet only with the help of men. The whole disease consists of a paralysis of the

nerves, principally of the loins and the hindquarters. The cause, however, as well as a certain cure, have not been found out. When the disease lasts for some time and the animal continues to feed, as in this case, then one is entitled to the hope that the animal will recover.

On another page of the same book he says:—

"From many a farmer we heard the remark that lamziekte at present is not so prevalent, because there was a succession of years with much rain and the disease appears more frequently after a prolonged drought."

The next information about the existence of this disease in the Cape Colony is contained in the Settler's Guide to the Cape of Good Hope and Natal, published by Edward Stanford, 6 Charing Cross, London, 1858. Mr. Parker, the hon. secretary of the Uitenhage and Port Elizabeth Farmers' Association, was good enough to draw my attention to it. On pages 164-165 a paper by a certain Mr. Reitz is published on the various cattle diseases, in which the following statement occurs:—

"Lam-sickness; no one knows the cause or seat of and yet it is one of the oldest and most destructive cattle diseases we have."

Perhaps the most valuable notes on lam-sickness and stiff-sickness in cattle are contained in the report of the late Dr. Hutcheon, Colonial Veterinary Surgeon, and I consider it worth while to republish them as fully as possible, as they show the actual position concerning these diseases during the last years of the past century and in the beginning of the new one.

In December, 1882, Hutcheon visited the neighbourhood of the farm Highlands, Lower Albany, and examined some cattle that were affected with a disease known as stiff-sickness. He could, however, not see any suitable cases, although he obtained the information that the disease prevails mostly in dry seasons. His conclusions were that it usually commenced in the winter, and on pastures that had lately been burned and were green, sick animals would improve.

In the course of his notes he says it is a well-known fact that cattle in that district have a great craving for chewing bones. He makes the statement:—"Why the disease should be on the increase of late years, unless it has been due to the dry season, I cannot offer an opinion."

According to this the disease must have been known in this part of the country for some time.

Much valuable information is obtained from his report for the year 1884.

In March, 1884, Hutcheon arrived in Barkly West in order to investigate lamziekte. He found it there on the farms Newlands, Donderboschfontein, and Wolvefontein. He subsequently spent some time in the neighbourhood of Cathcart West, visiting several farms. Here he met with the disease anthrax. Driving round a wide circle of farms, he only met with stijfziekte, but saw no cases of lamziekte.

In April he drove along that elevated plateau called the Kaap Range, calling at all the farms on his route where he heard of any sickness or where the disease had been very prevalent. He saw numbers of stijfziekte cases in various stages, but no lamziekte until he arrived at Daniel's Kuil. In the neighbourhood of this place he saw a few cases of lamziekte. All were in various stages of recovery. He also saw there a number of cases of stijfziekte. Leaving Daniel's Kuil he

travelled towards Griquatown, going round by that large shallow valley or vlei called White Pan, calling on several farms. There were no cases at that time, but previously cattle had been lost from the disease and the herd had been sent away. In the neighbourhood of Griquatown, at a place called Comma, he found a cow suffering from the typical form of the disease. He then made a post-mortem examination. Leaving Griquatown, he drove towards Douglas, calling at Spuitang, the owner of which informed him that he had lost two hundred cattle from lamziekte. On asking whether he considered the disease infectious or contagious, or whether he had observed any bad effects to follow when sheep or goats ate the contents of the stomach of a beast which had died of lamziekte, the owner replied in the negative, and took him to the place where the majority of the carcases had lain to show the doctor that every vestige of the carcases had been eaten by the remaining cattle, the contents of the stomachs being consumed principally by sheep and goats, and he had never observed any ill-effects to follow.

At Douglas Dr. Hutcheon was informed by a Mr. Wright that an old Griqua, whose age was estimated at nearly one hundred years, had said that lamziekte had prevailed as an epizootic over the whole territory of Griqualand West three times during his lifetime, each time carrying off nearly the whole of their cattle, and each visitation of the disease was during an exceptional drought.

In the District of Herbert there appeared to be but little of the disease—only upon exceptional farms.

From Douglas, Hutcheon travelled *via* Campbell, Schmidt's Drift, and returned by the Kaap Range, calling at various farms. On one of these he found a young ox suffering from stijfziekte.

The observations made on this journey *re* lamziekte and stijfziekte are then summarized,

Those referring to stijfziekte I have already quoted in my paper on stijfziekte in the first number of the *Union Agricultural Journal*, but in order to make this historical review as complete as possible I repeat them here:—

"Individual cases of the disease may appear at any time of the year, especially during a period of drought like that which was experienced in the territory of Griqualand West during the years 1882-83, but in ordinary seasons it is most prevalent during the early spring months after the grasses have shed their seeds and become withered and before fresh grasses have sprung up. It generally disappears after good rains. Animals of all ages and of either sex are subject to the disease, but young growing stock and cows—either in calf or giving milk—are by far the most liable to become affected. Full-grown oxen are seldom affected and oxen in work are still more rarely attacked. Young heifers are said to be more frequently attacked than bullocks of the same age, and cows immediately before and immediately after calving are more subject to the disease than the same animals at any other period.

"In ordinary seasons the mortality from stijfziekte is not very great. In cases which terminate fatally, the animals that die do not succumb to the direct effects of the disease so much as to the poverty which is induced by the pain which the affected animals suffer in walking; this prevents them from travelling far in search of food. The majority, therefore, die of debility and starvation."

It was found that in the western Cape the disease was associated with a peculiar condition of the soil, and with regard to this character Hutcheon says:—

"The disease manifests itself on different kinds of soil, but within the territory of Griqualand West it is most prevalent along that elevated plateau called the Kaap Range. On that tract of country the soil is principally calcareous—a sort of magnesian limestone, intermixed in some places with a red sandy loam. On many parts along the valleys of the Vaal and Harts Rivers, where the soil is more of a clay loam, the disease is rarely seen, and when animals which are affected with the disease are removed to such localities all symptoms of the disease disappear very rapidly. But on whatever character of soil the disease manifests itself, whether calcareous, silicious, or red sandy loam, there are clear indications that the vegetation which grows upon such soil during the prevalence of the disorder is deficient in one most essential ingredient of a complete food, viz., phosphates.

"This leads us to consider the nature of the disease. Stijfziekte is what is termed an enzootic disease, that is a form of disease which is confined to certain localities and is due to some special conditions which are peculiar to the soil—food or water of such localities. In this disease the enzootic influence is, in my opinion, a peculiarity of the soil which in dry seasons becomes incapable of supplying all the ingredients in their proper proportion which constitute a complete plant-food. The soil may, and does, contain all the necessary constituents of plant food. but they exist in an unavailable form. There is often a great quantity of fertilizing matter in the soil, but not in a condition immediately available for the growth of plants. Thus phosphates exist often potentially in a dormant state in the soil in great abundance, but it is not until they have been brought into a soluble form that they are of any use as food of plants. The phosphates are highly important in an agricultural point of view; unless they are present no albumen or other azotized matter can be formed. Azotized matter cannot exist without the presence of phosphates (Balfour's *Botany*).

"My experience of lamziekte and stijfziekte is far too limited as yet to enable me to give an authoritative opinion, but I have hitherto found these diseases to prevail mostly on dry porous soils such as the calcareous and silicious, which have little power of retaining moisture, and on such soils they are most prevalent during dry seasons.

"That these diseases are induced by a deficiency of phosphates in the food is indicated:—

"*First.*—By the intense craving for bones and all kinds of animal matter which the stock that are grazed on such pastures manifest. As already stated, on many farms along the Kaap Range cattle were reported to have eaten the complete carcasses of lambs, whilst at Spuitang not a vestige was left of the carcasses of about two hundred cattle. It is noticeable also that this craving for animal matter increases as the disease becomes more prevalent, and almost ceases when the disease disappears.

"*Second.*—By the nature of the disease, stijfziekte being a congested and inflamed condition of the bones and articular cartilages of the fore legs due, in my opinion, to the want of sufficient phosphate of

lime in their composition. In healthy bone this salt should form about 57 per cent. of its whole substance. It has also been shown by experiments conducted by Chossat, Roloff, and others that when animals are fed upon a diet deficient in phosphate of lime the bones lose more or less of their hardness and firmness and exhibit the lesions of osteomalacia and rachitis. Conversely, Roloff found that by administering phosphate of lime to a young rachitic dog it thoroughly recovered in three months. During my journey through the territory of Griqualand West I saw several cases of typical rachitis in young animals. Two very aggravated cases were shown to me at Daniel's Kuil—one of a young bullock belonging to Mr. Beadle, the other a young animal belonging to Mr. Ayton, Rotterdam. The fore legs of these animals were bent to such an extent that they could walk only with difficulty. In the one belonging to Mr. Ayton the knees overlapped one another to a considerable extent, yet the legs of both animals were perfectly normal at birth. It is worthy of remark that calves while suckling do not become affected with the disease.

"*Third.*—By the fact that young growing animals and cows which are either nourishing a full-grown *foetus in utero*, or secreting a full supply of milk immediately after calving, are the animals most liable to become affected with the disease. A good illustration of this fact was brought to my notice at Daniel's Kuil. On the farm belonging to Messrs. Wilmore, adjoining Daniel's Kuil, I was informed that one hundred full-grown oxen had been grazing there for eleven months, that they had not been inspanned nor once off the farm during the whole of that time, and that not one of them had become affected with either stijfziekte or lamziekte, whilst during the same period the Messrs. Wilmore lost seventy fine head of breeding stock, cows, and young growing cattle from this disease. I heard of numbers of exceptions to this rule, but this did not alter the generally acknowledged fact that young growing animals which require a greater proportion of phosphates in their food for 'cell formation' and nourishment for growing tissue, especially bones, and cows—the blood of which is being drained either to nourish the developing *fœtus in utero* or to supply that nourishing fluid, milk, which forms the food of the growing tissues of the calf after birth—are the animals most liable to become affected with these diseases.

"*Fourth.*—By one of the successful measures which are adopted for the cure of stijfziekte, viz., active exercise. When an animal, either a bullock or a cow, becomes affected with the disease, if you inspan the animal at once, either to a wagon or a plough, the symptoms of the disease invariably become very much ameliorated. How is this? During active exercise there is increased tissue change produced in the organs employed, and one of the substances formed during this process of the disintegration of tissue is phosphoric acid, which would be acted upon by the carbonate of lime which is present in these districts in great abundance, and thus form the phosphate of lime required. This is making the animal manufacture phosphates for its own consumption. The active exercise would of itself produce healthy nourishment in the affected bones by increasing the circulation of the blood within their textures and relieving the tendency to congestion which always exists in these diseases.

"*Fifth.*—By the fact that the disease is most prevalent when the vegetation contains the least nourishment, such as a period of drought like what was experienced during 1882-83 and 1884, and in ordinary seasons during the winter and spring months after the grasses have ripened and shed their seeds, and thus parted with a great proportion of their nitrogenous and flesh-forming substances. When the grass grows up luxuriantly after good rains, such as they were favoured with in the territory of Griqualand West during the first months in 1884, the disease suddenly disappears. As already stated, I had to travel over the whole territory before I could find a sufficient number of typical cases to enable me to form an opinion upon the nature of the disease. Further, the disease manifested itself during the recent drought on farms upon which it had not been observed before, and as already mentioned, according to the old Griqua's statement it had carried off almost the whole of the cattle in the Griqualand West territory three times within the last hundred years, and each of these calamities occurred during a period of exceptional drought.

"*Sixth.*—By the fact that where stock were supplied with mealie stalks, chaff, etc., mixed with common salt, the disease did not manifest itself amongst them. Mr. Leischam, on the Kaap Range, supplied me with information confirmatory of this fact.

"The above facts appear to me to indicate that the diseased condition, termed 'stijfziekte,' is due to defective nutrition of the bones of the affected animal, and that this arises from the absence of a sufficiency of phosphates in the vegetation upon which the animal feeds. It may or may not be chemically deficient in the soil, but it is not available for plant food.

"*Symptoms of Stijfziekte.*—As the fore legs have to support the principal portion of the weight of the animal's body, they are the structures which are principally affected in this disease. The animal walks with back arched, hind legs brought well forward under the body: this is to relieve the fore legs from as much of the weight of the body as possible. There is no stiffness in the movement of the fore legs; the feeling of pain is evinced when the weight of the body comes upon the affected limb.

"To avoid this as much as possible the animal throws the weight as much as practicable on the heels of the fore feet to prevent jarring the bony column, while at the same time you will observe the shoulder-blades project up above the withers; this is done by a muscular effort in order to relieve the painful limb of the weight of the body. Although the back is arched, there is no disease or affection of the spine as some have supposed. It is merely a symptom and is produced, as already stated, by the effort which the animal makes to get the hind legs under the body to relieve the fore legs of their ordinary share of the weight.

"In all severe cases which have been ill for some time the hoofs grow out very long, especially the hoofs which cover the external digits. Elevated circular rings will be observed surrounding the parts of the affected limbs from the coronets downwards, and in some cases there is an enlargement similar to what is termed a ring-bone in a horse, immediately above the coronet. The animal lies a great

deal, and can scarcely be induced to walk in search of food; as a result it becomes very poor, eyes sunken, and has a generally starved appearance.

"*Post-mortem Appearances.*—As already stated, by the kindness of Mr. Leischam, who killed a young bullock which was suffering from an acute form of stijfziekte, I was enabled to make a careful examination of the carcase. I found the whole of the internal organs with their contents and secretions perfectly healthy to appearance, and the flesh normal in colour and feel. There were no indications of disease anywhere except in the bones of the fore legs, especially those from the knee to the foot. The articular extremities of these bones with the cartilage covering them were congested; this congestion visibly increased as you descended to the foot or pedal-bone, which was very much congested. This animal had been only a few days affected, so that there was no time for any effusion to have taken place or ulceration of the articular cartilage which I would expect to find in cases of long standing.

About lam-sickness the following notes are to the point:—

"In this diseased condition (lamziekte or paralysis) the animal appears to lose the power of its hindquarters, lies down, and, as a rule, seldom gets up again. While lying the animal manifests no particular pain, the pulse, breathing, and temperature appear very little disturbed: it will eat and drink up to within a short time of its death if food and water are brought to it. There must be exceptions to this rule because several correspondents have stated that the appetite fails. The average time that an animal lives after it has lain down is from four to eight days. Some few cases will die sooner and some will last very much longer, depending upon various circumstances, such as weather, etc. Animals were reported as having died of lamziekte within a few hours after they had been observed to be sick. I am convinced, however, that these cases of sudden death are not from the disease called 'lamziekte' at all, but from a much more virulent and dangerous disease, viz., 'gifziekte' or 'miltziekte.'

"My opportunities of investigating into the real nature of lamziekte were unfortunately very limited, but from the cases which I did examine I am of opinion that the disease is simply a modification of stijfziekte.

"Both diseases prevail upon the same farms at the same time, and are aggravated or ameliorated by the same modifying conditions which, I have already stated, exercise an influence on the developments or cessation of stijfziekte. The only difference appears to be that in stijfziekte the disease or defect is localised principally in the bones of the fore legs, while in lamziekte the disease or functional defect is more general, affecting the muscular as well as the osseous tissue.

"Lamziekte is, in my opinion, a more intense form of the disease than stijfziekte. You will see a number of cases of stijfziekte where there may be but individual cases of lamziekte, but when the latter disease becomes prevalent the former disease is generally very prevalent. On certain farms a number of cases of stijfziekte will occur every year, but it is only during exceptionally dry seasons that lamziekte becomes prevalent."

Dr. Hutcheon gives the symptoms of one case of lamziekte as follows:—

"The affected animal was a brown cow, five years of age, giving milk. . . . She was lying in a natural position on her left side; she had been lying there for three days; there was evidence, however, that during that time she had dragged herself about, for she had moved consecutively round a circle five yards in diameter. Whether she had been struggling to get up or only making an effort to reach some food it is difficult to determine, but it was most probably the latter, as she was chewing a mouthful of dry grass when we arrived. Her general appearance gave no indication of pain or even serious uneasiness, her pulse, breathing, and temperature were normal, her eyes were deeply sunk into their sockets. During the time that she had been lying she had discharged three separate quantities of faeces; these were very dry, hard, and in small pellets resembling the faeces of horses.

A post-mortem was then made and the following lesions noted: Impaction of the rectum, congested condition of small intestines, and the dry and caked condition of the outer leaf of the 'blaar pens.' The spinal cord throughout its whole length was examined, but except that there was a congested appearance about that portion situated between the loins and the tail (sacral) region, it looked perfectly healthy.

Dr. Hutcheon continues:—

"There is a very strong opinion amongst the farmers generally that lamziekte is caused by some poisonous herb or herbs which the cattle pick up in the veld, and in support of this opinion they will tell you that if they allow their cattle to feed on a certain portion of their veld some of the cattle will manifest the symptoms of the disease directly. Against this opinion, however, there is very strong evidence:—

"(*a*) There are no symptoms of sickness or fever about the animal when first observed. The first indication of the animal being affected is a certain peculiarity in its movements, and as already stated, the majority of those affected will continue to feed to within a short time of their death if food is brought to them.

"(*b*) If lamziekte was caused by the animals eating some poisonous plant or plants, how can we account for the fact that full-grown oxen, and especially working oxen, so rarely become affected, as on Messrs. Wilmore's farm?

"(*c*) Although cattle that are grazing on a farm where the disease prevails will develop the symptoms of the disease very rapidly after being allowed to graze on a particular portion of the veld, healthy cattle brought fresh from another farm where the disease does not prevail, will not develop the symptoms of the disease so rapidly, although allowed to graze on such veld. . . . . There is another opinion respecting the nature of this disease upon which many farmers are very confident, viz., that it is contagious; that any healthy animal which eats the contents of the stomach of a beast which has died of lamziekte becomes affected with the disease and invariably dies within twenty-four hours.

"There are an equal number of farmers who are just as confident that the real lamziekte is not a contagious disease and bring equally strong evidence in support of their opinion."

Dr. Hutcheon then points out that anthrax is responsible for this discrepancy of opinion.

In June, 1884, Dr. Hutcheon wrote to the Civil Commissioners of Bathurst, Alexandria, and Uitenhage, inquiring whether the diseases termed lamziekte and stijfziekte affected cattle in their divisions, and if so, if they would kindly favour him with any information respecting the conditions and circumstances under which those diseases generally appeared.

The Civil Commissioner of Bathurst replied to the effect that the diseases known as lamziekte and stijfziekte did occur in that district, but are regarded in that locality as being merely symptoms of famine or low condition caused by drought and intensified by bad and stagnant water.

The answer from Uitenhage was to the effect that stijfziekte is more prevalent in the extremely "zuurveld," such as Tzekama, etc. A farmer in Afdak wrote to the effect that stijfziekte prevails in zuurveld and is not the least infective. He continues: "It comes on towards the winter months when the veld is dry. If the veld is short, green, and fine, cattle are not liable to it except delicate milk cows and young cattle. I had four of my oxen sick of stijfziekte in 1883. I could not work them; they could hardly move. I fed them two weeks on green barley when they became as well as ever. That is proof enough that it all depends on the pasturage.

"Lamziekte prevails more in sweet and bush veld; the cause of it is constant and long drought, bad pasturage, and bad water. If the veld is good and fine they are not liable to it. It is not a pest like 'lungziekte', 'redwater', 'rinderpest', etc.—in fact it all depends upon the weather."

In June, 1884, Dr. Hutcheon visited Mr. Hudson's farm near Coega (Alexandria District) where he had been informed that the previous season a great many cattle had died from lamziekte and stijfziekte. His principal object was to ascertain whether the nature of the soil and character of the veld corresponded with the soil and veld of Griqualand West, and whether the conditions generally were similar to those existing in the Griqualand territory.

On inquiry and examination he found that the general conditions associated with the appearance of lamziekte and stijfziekte in that district were almost identical with the general conditions existing on the Kaap Range.

On that elevated ridge, called the "Grass Ridge", where the disease was reported to be most prevalent, the soil is of a calcareous formation, light and porous, and very liable to be affected by a prolonged drought such as was experienced during the months when these diseases were most prevalent. The affected cattle manifested the same symptoms, the same craving for bones and animal matter of every description. The same class of cattle, viz., milch cows and young growing stock, were the animals most liable to become affected. In every particular the existing conditions tended to confirm the opinion which he had formed of the cause of these diseases during his visit to Griqualand West.

Further information about lamziekte is contained in the report of 1885. He then visited Alicedale, in the neighbourhood of which certain farms were affected. On 3rd July of the same year he investigated it in the neighbourhood of Coega.

In January, 1886, he revisited Coega, as lamziekte was reported to have made its appearance again at Hangham Park.

In the same report he states:—

"There is a form of gall-sickness associated with paralysis which occurs with great frequency in certain districts of the Colony where the disease termed lamziekte prevails and is generally confounded with it. This is not to be wondered at, considering that they both prevail at the same time, manifest similar symptoms, and are mainly due to the same cause. They may, however, be distinguished from one another by the fact that in lamziekte or adynamia there are no symptoms of pain or constitutional disturbance; the pulse, breathing, and temperature appear normal; the animal will eat and drink up to within a short period of its death if food and water are supplied to it.

"Further, if the animal is lying in a comfortable situation, and turned over daily, it may live for three weeks or more. Whereas, in the form of gall-sickness, which prevails concurrently with lamziekte, the appetite fails, the animal refuses food, and manifests by its dull, depressed appearance considerable fever and constitutional disturbance."

The same report contains the following statements:—

"The animals most subject to these diseases are cows in calf or giving a full supply of milk, and young growing cattle of both sexes. Full-grown oxen seldom become affected, and working oxen, I believe, do not manifest the disease at all. . . . There may be certain herbs, or certain other conditions of the vegetation in those parts which hasten the development of this form of paralysis, but the predisposing and primary cause is undoubtedly due to the absence of sufficient phosphates in the food. When phosphates are artificially supplied by any means cattle may then graze over such veld with perfect immunity from this disease . . . . Several farmers have written to me to the effect that after supplying their milch cows with bran, they ceased to lose any of them from lamziekte, while previous to adopting the plan they lost some every year."

He then continues as follows:—

"Most observers have recognized a severe and a simple form of this complaint, although they have not been careful to mark the distinction. It is easily discerned, however. In the biliary variety the attack is sudden, the symptoms are acute, and the course of the disease rapid. As already stated, the animal is sick, refuses food, manifests pain and general constitutional disturbance, and dies in two or three days in great pain.

"In the simple variety of lamziekte, on the other hand, the primary disease is the paralysis, the disturbance of the digestive organs is very trifling."

In the report of the year 1886, referring to stijfziekte, Hutcheon states:—

"This form of stijfziekte is generally associated with that other disease, due to the same cause, termed 'lamziekte'. They occur principally in districts in which the soil is light, sandy, or on porous limestone formations, such as over a great part of Bechuanaland, Griqualand West, and many districts along the coast divisions, both east and west."

In the report for the year 1894, he states:—

"*Stijfziekte, Lamziekte, and Paralysis.*—This is a class of disease which appears on a large number of farms throughout the Colony, but it is most prevalent in the districts on the east and west coasts, and in some of the northern districts, such as Griqualand West.

"The area over which these diseases occur is yearly extending, and on some farms the losses are so heavy that cattle farming can no longer be carried on upon such farms without frequent change of pasture."

He further says:—

"Although these diseases differ considerably in their symptoms and superficial characters. I am of opinion that they are closely related to one another in their origin, and that their principal predisposing cause is a deficiency of phosphates or bone-forming material in the vegetation where these diseases occur.

"There can be very little doubt, however, that in the case of the acute form of lamziekte there must be some other immediate and exciting agent which causes the sudden development of this form of the complaint, and which induces the nervous prostration and effusion into the cranial cavity of the medulla oblongata which so quickly follows."

On the 18th October, 1895, the first experiments were carried out in connection with lamziekte, which experiments should prove or disprove that the supply of bonemeal is a preventive for the disease.

The experiment was carried out under the supervision of Mr. Borthwick on a farm Witte Clay Berg, which was renowned for lamziekte. The farmers who were interested nominated a committee to assist, and a number of cattle were supplied for the purpose. There were thirty-seven head received and valued; these were divided into two lots of twenty-three and fourteen respectively. The twenty-three were placed in a kraal and received an allowance of three ounces of bonemeal daily, while the fourteen were kept in another kraal and received nothing. Both lots grazed together by day, and were in every respect treated alike. The reason why the cattle were not more evenly divided was because this farm had such a bad reputation for lamziekte that they were led to anticipate that a great many of the lot not receiving bonemeal would take the disease, and as it was not intended to make the experiment more costly than was absolutely necessary, only a small proportion was risked. Within a month no mortality took place, and then some more and younger cattle were added to the lot, viz., thirteen heifers, one young cow, and three young oxen. Of these, seven had to receive bonemeal and nine not. The experiment was concluded in February, 1896, and the results were as follows:—None of the animals which received bonemeal manifested the slightest indication either of stijfziekte or lamziekte, while out of

twenty-three which did not get any, ten became affected, four of which terminated fatally, and two of which were killed for experimental purposes.

The experiment was considered to be a complete success, and to have clearly established the fact that a liberal allowance of bonemeal given to cattle where lamziekte prevails acts as an effective preventive of the most common form of that disease.

Mr. Borthwick at that time also undertook some feeding experiments with a leguminous plant with negative results; he further inoculated blood of a sick beast to a healthy beast with negative results, and dosed an animal with fluid contents of an affected animal with the same result.

In the report for the year 1898 I find the following interesting notes by Mr. J. A. Robinson, then Government Veterinary Surgeon:

"*Lamziekte or Stijfziekte.*—The disease known by these names appears in several forms in the south-western districts, the most common being a general unthrifty condition of the animal, malnutrition, and increasing stiffness of the articulations. It is most prevalent in the sour veld portions of the Mossel Bay, George, and Knysna divisions. This form of the disease is quite distinct from that seen in the Southern Karroo, which is manifested by the rickety condition of the system in young animals, and an inordinate craving for lime, salt, and bones in adults, and on post-mortem examination a generally softened condition of the osseous skeleton. This form is again different from the acute lamziekte which I have seen affecting both cattle and goats in Griqualand West, and which is probably a disease of a specific character. The rachitic form of the disease sometimes prevails very extensively, but it has not done so during the past year, and the first-mentioned type of the ailment is the one to which my attention has been chiefly directed. The chief symptoms of this form, in addition to those already noted, are gradual loss of appetite, irregular action of the bowels, and an increasing disinclination to rise, the animal usually remaining recumbent for a few days before death. The temperature is sub-normal throughout the disease.

"Post-mortem examination reveals a wasted state of the muscles and tissues, the liver is nearly always small, softened, and light in colour, and the kidneys are often congested. I have not been able to test the character of the urine. Some of the joints always show signs of chronic inflammation, and there is frequently adhesion of some of the bones of the spinal column. In one case which I examined, five of the lumbar vertebrae were inseparable, and it is usual to find fusion of two or three of the posterior dorsal bones. As most of the animals examined were trek oxen, this may in some degree be due to the rough usage they had met with during their unenviable existence. The bones are not at all softened, and I have never noticed any increase in the meningeal fluids. I am of opinion that this disease is a chronic rheumatism due to the extremely acid material on which the cattle in these districts subsist. If the animal in the early stages can be removed to sweet veld or salt vlei, the symptoms soon become modified."

The last notes by Dr. Hutcheon on stijfziekte and lamziekte in cattle are continued in the September number of the *Agricultural*

Journal of the Cape of Good Hope, 1903; they are in reply to a controversy, and may be considered to represent Dr. Hutcheon's latest view. The description of both stijfziekte and lamziekte is given, to which I will in a future part of my paper have to refer to again.

"STIJFZIEKTE.

"It is a highly congested, sometimes even inflamed, condition of the ends of the long bones which form the joints of the limbs, principally of the fore legs, because they have the greatest portion of the weight of the body to bear.

"This congested condition of the ends of the bones is accompanied by acute pain and lameness.

"The animal walks with its back arched, and its fore legs extended so that the heels come to the ground first, while the hind legs are brought well forward under the body, to take as much of the weight of the body as possible and thus relieve the inflamed and tender joints of the fore legs.

"In some cases of long standing there is enlargement of the joints, especially the fetlock and pastern, and the outer digit of the hoof is invariably larger than the inner one. In other cases there is an enlargement round above the coronet, similar to what is termed ring-bone in the horse. The pain in walking is often very acute, the beast puts the heel of the fore foot down carefully, and when the weight of the body comes on the limbs the shoulder blade will be observed suddenly to rise up above the withers. This is done by a muscular effort to lift up, as it were, the weight of the quarter from resting on the tender bones of the limb as much as possible.

"In an acute case, if the bones of the fore legs are sawn longitudinally down the centre, the cancellous or lattice-like tissue which forms the joint ends of the long bones will be observed to be of a dark red colour, and highly congested with blood-coloured exudation. The bone marrow may also present the same appearances. There is, therefore, no doubt that stijfziekte is due to a soft and vascular condition of the bones of the limbs, and that this condition is due to a deficiency of bone earth in their substance."

"LAMZIEKTE.

"Lamziekte is a form of paralysis due to an effusion of a clear serous fluid into the membranes covering the brain and spinal cord, associated with a highly congested condition of the bones of the vertebrae, and of the articular extremities or joint ends of the long bones of the limbs, principally of the larger ones, with softening of their cancellated tissue.

'In lamziekte it will be observed that some cases are very acute and rapid in their course, the patient becoming comatose within from ten to twenty hours, and death in some instances occurring within twenty-four hours. In other cases the patients may last for days, and even weeks, during which they may eat, drink, and ruminate, and die merely from exposure or exhaustion.

"There is no essential difference, however, between the acute and the more protracted cases.

"In the acute cases the effusion of the fluid takes place into the membranes surrounding the brain, and the upper portion of the spinal cord—the medulla oblongata—which is rapidly followed by complete paralysis, coma, and death. The quantity of the fluid surrounding the medulla is sometimes so great that when the membrane is pierced the serous fluid rises up like a spring. In the protracted cases the fluid is found principally in the membranes surrounding the spinal cord in the dorsal and lumbar regions, producing paralysis of the hind extremities only, and rarely producing any disturbance of the brain.

"With respect to the cause of this serous effusion into the membranes surrounding the brain and spinal cord, I think there can be little doubt that it is intimately connected with the softened and highly congested condition of the bones of the vertebrae, which is invariably present.

"The long bones of the limbs are affected in the same manner as in stijfziekte, the only difference being that in stijfziekte it is the lower bones of the limb which are most severely affected, whereas in lamziekte it is the higher and larger bones, such as the humerus and radius of the fore leg and the femur and tibia of the hind leg which are most severely affected.

"So much for the nature of the disease." Dr. Hutcheon continues:—

"From what I have written it will be evident that I regard lamziekte and stijfziekte as simply different phases of the same disease, arising from the same primary cause, a deficiency of phosphates in the vegetation of the particular farm or district. It may be difficult to explain satisfactorily why in certain animals and in certain localities the lower bones of the fore limbs should be the principal bones of the skeleton affected, while, in other instances, the bones of the vertebrae and the upper and larger bones of the limbs are most seriously involved. It is very probable that although the vegetation of the different districts, where this disease prevails, agrees in this one particular, that it is more or less deficient in phosphates, the vegetation of each district may differ considerably in other respects, the one from the other. In our experience we have found that a beast which is growing and improving in condition appears to be much more liable to contract lamziekte than one which is simply maintaining the same uniform condition. The latter are more subject to stijfziekte.

"Further, the most acute and rapidly fatal cases of lamziekte are generally met with in young animals in good condition. From these and other observations I arrive at the opinion that when food is deficient in one essential constituent, the balance of the system would be the more readily upset the more abundant the other constituents are. Acute lamziekte would therefore be most prevalent where the vegetation was luxuriant, and chronic lamziekte and stijfziekte most prevalent when the vegetation was dry and not so abundant. This may account for the fact that the disease is more prevalent on certain portions of the same farm than on others.

"It is quite possible also that there are certain plants which when eaten largely by cattle may have a tendency to act as an exciting cause in hastening the development of the disease, just as certain

poisonous plants, when eaten by a perfectly healthy animal, have a tendency to cause an effusion of serous fluid into the membranes of the brain and spinal cord, producing rapid coma and sudden death. But the main cause of the prevalence of this disease is undoubtedly due to a deficiency of phosphates in the food, and it disappears when that deficiency is supplied."

Summary of Conclusions.

From the foregoing extracts the following conclusions are drawn by the writer:—

(1) Lamziekte of cattle is a disease which was known in the western part of the Cape over a hundred years ago.

(2) As long as human memory can serve it was known in Bechuanaland.

(3) Even in the olden times the prevalence of the disease was associated with dry years and dry seasons.

(4) Hutcheon describes a disease, "stijfziekte," in cattle which he found prevalent in the same areas where lamziekte existed.

(5) It was well known that where stijfziekte and lamziekte occurred cattle had a craving for chewing bones..

(6) The increasing prevalence of the disease stijfziekte in 1882 was considered to be due to the dry season.

(7) Anthrax and lamziekte occurred on certain farms together and led to mistakes in the diagnosis.

(8) Sheep and goats that eat the ingesta of cattle that succumbed to true lamziekte, or cattle which fed on the remains of lamziekte cattle, did not contract the disease as a result of this.

(9) During dry years individual cases appeared at any time of the year, but lamziekte was principally noted in the early spring and after the grasses had gone to seed.

(10) All class of stock are susceptible, but more particularly growing stock and cows in calf or giving milk.

(11) Full grown oxen were seldom affected.

(12) Young heifers seemed to be more frequently attacked than bullocks of the same age.

(13) Cows before and immediately after calving are more subject than the same animals at other times.

(14) The disease was found on different kinds of soils and all these soils showed clear indications of lack of phosphates.

(15) Animals affected by stijfziekte improved when they were inspanned in a wagon or plough.

(16) When stock were supplied with mealie stalks, chaff, bran, etc., the disease did not maintain itself amongst them.

(17) Two forms of lamziekte may be distinguished: an acute form when the animal showed alarming symptoms and a slower one with a paralysis as the dominant symptom.

(18) Farmers had a strong opinion that a poisonous herb is the cause of the disease.

(19) Cattle contracted the disease more in certain parts of a farm than on others.

(20) Healthy cattle freshly introduced from a farm where the disease did not prevail did not contract the disease as quickly.

(21) In later reports Hutcheon says that in cases of acute lamziekte some other immediate and exciting agent must be responsible.

(22) In an experiment it was shown that cattle which were supplied with bonemeal did not contract the disease.

(23) All experiments to transmit the disease by the injection of blood or drenching with the contents of the stomach failed.

(24) In the south-western district of the Cape, according to Robinson, a disease exists, not identical with lam- and stijfziekte, but known under the same names.

Dr. Hutcheon's Conclusions.

The deductions Dr. Hutcheon made were to the effect that lamziekte and stijfziekte are two different forms of one and the same disease, and he considered the cause to be a want of phosphates in the food.

In his later reports, however, notwithstanding the experiment which was to the effect that bonemeal-fed animals did not contract the disease, he suspects some other immediate and exciting agent which causes the sudden devolpment of the disease, and he even admits that certain poisonous plants may be responsible.

His last views might therefore be summarized as follows: —

Stijfziekte and lamziekte are two different forms of one and the same disease; the common factor in both, as the primary cause, is a want of phosphates in the system; this want may tend to produce stijfziekte, but when another exciting cause, possibly a plant, is present, lamziekte may occur.

The practical outcome of this view was Hutcheon's recommendation of feeding bonemeal as a preventive for both stijfziekte and lamziekte: at the present time, however, there is not a consensus of opinion amongst the farmers that this precaution is efficacious.

PART II.

DISEASES RESEMBLING OR RELATING TO STIJFZIEKTE AND LAMZIEKTE. COMPARATIVE NOTES.

In various diseases it is accepted or has actually been proved that there is an absence of lime and particularly phosphate of lime in the skeletal system of affected animals, and this fact has been the reason for the formation of speculative theories adducing the lack of phosphates in foodstuffs to be the cause of the diseases themselves. This being so, and similar deductions having been made with regard to South African Stijfziekte and Lamziekte, I consider it advisable to review our knowledge of the diseases mentioned in the sub-title, in which the absence of phosphates is considered to be established.

In the subsequent notes I have consulted the publication of Hutyra and Marek, "Spezielle Pathologie und Therapie der Haustiere", a work published in the German language by two eminent professors of the Veterinary College in Budapest, and which is considered to be the most up-to-date and complete record of our knowledge of animal diseases. I have also taken into consideration the diseases of man, known under the same name, in order to record

our knowledge of their causes, and have for this purpose consulted Abderhalden's " Physioligical Chemistry ", which book may be considered the most modern one on the subject.

Finally I have given careful attention to a publication of Ostertag and Zuntz, on a disease called " Pica ", or *abnormal craving in cattle*, which has been investigated experimentally, and the results leave but little doubt as to the cause of this disease. These results may help to throw some light on our own diseases.

Rickets.—Rickets is a disease of young animals due to a disturbance of the metabolism, by which the newly formed bone tissue remains in the osteoid stage, and a proliferation of the cartilagenous tissue takes place; the ossification process proceeds along irregular lines, and as a result of this various deformities of the skeleton occur.

The animals are usually attacked in *their first year*, more often when they are a few months old or *after they have been weaned.*

The animals most frequently affected are young pigs, puppies, lambs and kids; foals and calves are not so often affected; birds may also suffer from this disease.

As the animal grows most quickly after weaning it is thought that any shortcoming of lime during this period would manifest itself.

Symptoms.—Deformations of the bones are the prominent features. The epiphyses (viz., the ends of the long bones) are enlarged, giving the affected joint the appearance of being swollen, but on probing with the fingers the true character of these enlargements can easily be ascertained. Similar enlargements are also met with on the cartilagenous ends of the ribs; two rows of bony knobs can be recognized to run parallel to the breast-bone. This symptom is more particularly found in canines.

The weight of the body and the tension of the muscles cause the bones to bend. This is principally seen in the fore legs. The bones may be bent in any direction, and accordingly all possible shaped legs are noticeable.

Through the weight of the shoulder and the elbows the ribs are compressed, their middle portion bends inwards, and the diameter across the chest is thus shortened; the distance between the vertebrae and breast-bone widens, and the two margins of the latter bone draw together, forming an acute angle, so that the sternum becomes " keel-shaped."

In animals which frequently lie down, e.g. cattle, the diameter from the vertebrae to the breast-bone becomes on the contrary shortened.

On the pelvis both acetabulae are pushed upwards and inwards by the articular extremities of the femurs, the symphsis is pushed forward and downwards, and accordingly the pelvis becomes narrower; the inward deviation of the upper part of the hind legs is indicative of this deformation.

The vertebral column shows various deformities; it may be bent to one or the other side, upwards or downwards, and even combinations of these irregularities may be noticeable.

Deformation of the skull also occurs, the thickening and bending of the lower jaw and the thickening of the bones of the face gives the head a swollen appearance. This impairs breathing and feeding.

The course of the disease is a slow one. The animals lose in condition, do not thrive well, and remain stunted in growth. Occasionally it is noted that the bones break suddenly without apparent cause. The symptoms which are so marked in the bones and which leave traces behind even in cases of recovery are sometimes preceded by general symptoms of a passing nature. To these belong disturbances of the nutritive functions. The young animals do not feed well, the abdomen becomes distended, and occasionally diarrhoea is seen; they show a depraved appetite and *an abnormal craving which causes them to gnaw stones and woodwork.* Most of these symptoms are overlooked at the commencement, and only peculiarities in the movement of the animal attract attention; these symptoms are caused by pain in the bones before they have actually started to deform.

Post-mortem Lesions.—The apiphyses of the bones are enlarged and thickened. The diaphyses are shortened. The bone tissue appears porous and is softer than normal, sometimes so soft that it can be cut with a knife. If a bone is cut in its longitudinal direction one notices between the periosteum and the bone substance a soft spongy layer with congested blood vessels, which, on removing the periosteum remains partially attached to the bone. This layer is particularly noticeable on such places where sinews and muscles are attached, where occasionally exostoses are noted. The limit between the cartilage of the epiphysis and the diaphyses (which in normal bones is characterized by a bluish-white or yellowish double stripe) is broadened, forming a much wider, spongy, soft, and red tissue without definite borders. Occasionally the connection between the epiphyses and diaphysis is loose, and it is sometimes possible to tear these portions of the bone asunder. The yellow marrow of the bone appears more or less reddened and gelatinous, particularly when the animal is in a poor condition. The spongy substance of the bone also shows a reddish tint, and a rarification of the cancellated tissue becomes noticeable. Occasionally an inflammatory condition of the same joints is present, the cartilage showing ulcerative defects.

The Cause of Rickets.—It is important to know whether Rickets, as described, can be produced in an experimental way, and more than 60 years ago the first attempt was made to prove that the want of lime salts was the cause of Rickets. The experiments were made with young pigs and puppies by feeding them with foodstuffs deprived of lime, and lesions were produced which, from *inspection with the naked eye*, corresponded to Rickets, viz., swelling of the epiphyses, softening of the bones, and subsequent deformation. On the other hand a number of experiments did not succeed in producing any lesions in the way indicated, but it was thought that this result was either due to carrying out experiments for too short a period or that the experiment was frustrated by a complete withdrawal of all nutritive salts in the food supplied.

Since these experiments were undertaken, it has repeatedly been pointed out that they do not by any means prove that the disease produced by the withdrawal of the lime-salts was not identical with Rickets, and when the bones of the experimental animals were examined microscopically, it was found that the pathological process was quite of a different nature. Thus the

correct interpretation of this experiment would be that in young growing animals a disease of the skeletal system can be produced when the lime-salts are withheld, accordingly the necessity of such salts for the proper development of the bones has experimentally been demonstrated. But this fact was not astonishing. We should very likely produce a disease if we withheld other salts, such as sodium chloride, iron, etc. *Nevertheless we may accept that, under the conditions of the practice, when foodstuffs poor in lime-salts represent the main food, a coincidence of conditions may occur, and then diseases similar to Rickets in young animals may follow.*

It is a noteworthy fact, borne out by experiments, that the supply of phosphoric acid to animals, when extended over a long period coincidental with the withdrawal of lime-salts, produced a disease resembling Rickets in young animals, and, finally, it was shown that it was not even necessary to withdraw the lime-salts at all; an increased amount of phosphoric acid had the same effect.

Thus here we would have the paradoxical effect that material required for the growth of bone may form the cause of the disease when apparently given in an overdose.

In Freiberg, Germany, it was noted that metallurgical factories emitted smoke containing arsenic, lead, and sulphurous acids, and the cattle grazing in the neighbourhood contracted *Rickets* and *Osteomalacia*, but these diseases disappeared when the smoke nuisance abated.

The disease, Rickets in children, has been observed under the best of conditions *notwithstanding the administration of lime-salts.* It can, therefore, be concluded that the want of these salts is not responsible for the disease, and our present knowledge permits us to draw the conclusion that the disease cannot be attributed to a lack of lime in the diet of the child.

Milk, which is invariably the basis of infant diet, contains more lime than almost any other articles of food, so that the individual receives relatively more lime when an infant than at any subsequent period of his life.

Osteomalacia.—This is a disease resulting from disturbances of the nutritive system leading to an increased resorption of lime-salts in the bones and accompanied with deformation and fractures of the skeletal system.

It principally attacks cattle and of these cows in calf. It is less frequent in goats and pigs and still more rare in horses and mules. Sheep also show it, whereas dogs and birds are only attacked in quite exceptional circumstances.

Symptoms.—Those which point to an affection of the bones are the result of pain in these parts. The animals frequently lie down, do not like to rise, and only move when forced to do so. When standing the back is arched, the legs are spread, and are lifted alternately. The pains occur intermittently and suggest rheumatism. The movement is somewhat stiff, lameness is occasionally noticed on one or the other or on all four legs. Frequently, on rising or moving, a crackling noise is noticed. In the lower parts of the feet

(hock and coronary pedal joint), as well as in the sheath of the flexor tendons, swellings are frequently noticed accompanied by inflammatory processes.

Meanwhile a decrease of the firmness of the bones becomes noticeable, and they may bend or break without any apparent cause. Fractures are most frequently met with in the pelvis, ribs, and in the bones of the upper part of the limbs. This is more particularly the case with horses. The bending of the bones are less frequently found, and, if present, are met with in the bone of the ribs, limbs, or vertebral column.

In the later stages of the affection, swellings of the bones of the head are noticed; this is, however, a symptom only exceptionally met with in cattle; it is more frequent in horses, pigs, and goats.

The course of the disease is very slow, lasting months, and if this change takes place in outside conditions it leads to poverty, inability to rise and feed, and, finally, exhaustion.

A characteristic symptom which precedes all others, but which is only typical for cattle, is the *abnormal craving which persists, so to say, throughout the length of the disease.* The animals will lick anything and everything they can get access to; they will pick up any material, chew it, and swallow it. In a later stage they will eat repulsive material, such as dung, etc. The appetite may become so altered that, finally, they refuse the good food and go for any repulsive matter that they can find. As a result of this, a loss in condition, naturally, takes place; they become hide-bound, there are disturbances in the digestion, and constipation and diarrhœa become noticeable.

Post-mortem Lesions.—In far-advanced cases the spaces occupied by the marrow of the bones become enlarged and widened, the cortex of the bone is thinner and spongy, friable or soft, and can easily be cut with a knife. In very severe cases the cortex is only a few millimeters thick, the marrow is vividly reddened and occupies blood points; if cachexia has developed then it is gelatinous and watery. The wide, flat and short bones are also friable and soft. Deformation of the pelvis, the vertebral column and of the ribs, a narrowing of the chest, and a protrusion of the breast bone are noticeable. Frequently the formation of a new callus is met with on the ribs and bones or on the places of fresh fractures. Separation of the sinew from the bones and defects of the cartilages of the joint may be noticeable

In later stages the lesions of anaemia and hydraemia with oedematous infiltrations develop.

Cause of the Disease.—Similar to Rickets, experiments were made to produce Osteomalacia. Pigeons which were exclusively fed on wheat developed it; further, it was produced in a dog, goat, and a sheep. A bitch, which from the beginning of pregnancy was fed with food poor in lime-salts, developed softness of the vertebral column and of the pelvis.

The indirect proofs are to the effect that the disease is met with in regions with unfavourable tellurical conditions, where the soil is poor in minerals, principally in phosphoric acid and lime. Certain

seasons, distinguished by dryness, seem to foster the disease, and this is explained that, through want of rains, the minerals of the soil are not dissolved and cannot be resorbed.

Also sour grasses in moors and marshes are considered to be the cause, and they are said to contain less salts and proteids than the good grasses. This must be regarded as a concidence, and it has yet to be proved that the minerals in question are wanting.

The moment of predisposition for Osteomalacia seems to be during the periods of pregnancy and milk production.

No definite deduction can be made from these statements, but Osteomalacia in cattle will appear in quite a new light when we have consulted the notes of Ostertag and Zuntz on "Pica".

Osteomalacia of women is a disease which occurrs occasionally during pregnancy. It would seem probable that this disease bears some relation to the increased requirement of lime-salts on the part of the organism of the mother. The child develops at the expense of the mother's tissue. All that we know concerning the disease, however, is contrary to this assumption. Its appearance is not restricted to the period of pregnancy. It is at such time, however, that the symptoms are most pronounced, and usually the disease then progresses more rapidly.

Considering all these facts together, we are led to the conclusion that the disease is not caused by the lime being given up to the organism of the child, but there is evidently a severe metabolic disturbance of the bony tissue.

But, just as in the disease of Rickets, the lime plays a more or less passive part, it is indeed highly probable that here, again, the absence of lime is not directly responsible for the trouble, *but that the loss of lime takes place secondarily as a result of the disease.* The lime is loosened from its state of combination in the bones, and is eliminated as refuse out of the system. The primary trouble is a disturbance in the economy of the bony tissue.

As to the nature of the disease, the following notes are important: Fehling's observations that removal of the ovaries serves to check the disease has shed a peculiar light upon the nature of the disease. After this operation lime is once more retained by the system, and the newly-formed osteoid tissue calcifies. At present we can merely assume that the loss of the ovaries brings back the metabolism to normal paths. We may suspect that the ovaries have previously produced something which has caused the metabolic disturbance. Such a hypothesis, however, had not up to the present time been established experimentally. We must for the present be content with the knowledge of the observed facts and await a fuller explanation of the peculiar or mutual action between the ovaries and the bony tissue as a result of further investigation.

Thus it is evident that the cause of osteomalacia in women has no relation to the want of lime-salt in the foodstuffs at all; it is a disturbance of the metabolism, the cause of which has not yet been established. Inasmuch as Osteomalacia is found in women, and principally amongst pregnant women, a certain relationship exists etween this disease and that of the same name in cattle, the cause apparently being connected with the sex.