Rinderpest: its Pathology, Symptoms, Arthology and Treatment,

by

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Rinderpest

During the outbreak of Rinderpest in the Zulo district in 1897, I conducted the Kile Culture Camp for four months. During that time, 6,000 animals were killed for bile purposes in the camp, and I held a post-mortem examination in each case. When Rinderpest first broke out and had 90,000 head of cattle in the district, at one time or another I had the opportunity of examining the most of these. 40,000 head of cattle died from the disease, and in many instances I held a rough post-mortem examination, but those are not included in the 90,000 mentioned above.

From these facts it will be seen that I have had many opportunities of investigating, and making careful observations on, this disease. It is the results of these observations I intend giving in this paper.

Not only had I ample opportunity to investigate the nature of rinderpest, but when it was decided to make any experiment cattle were always at my disposal, having full charge of the culture camp if I could make any arrangement I might think necessary to carry out these experiments.

The results of these experiments are also given here.
Pathology

I. Mouth, Pharynx + Gullet.

The gums, lips, hard + soft palates, undersurface + upper surface of the root of the tongue, the superior surface of the epiglottis + the epiglottic folds of membrane, + the pharynx are studded with ulcers of minute size. These ulcers vary in size from pin heads to one eighth of an inch in diameter. On examination these ulcers are found to have well defined edges which are elevated, thickened + undermined. They generally extend to the submucous tissue but in many cases the underlying muscular tissue is exposed. The ulcers are found in varying stages of development + appear to originate at the orifices of the follicles which are more or less inflamed. The epithelium sloughs + thrown off, and leaves an ulcerated surface which ulcers gradually extends to the surrounding structures in the usual manner. That there are true ulcers + it can be no doubt for I have examined them carefully + in the more advanced cases have never failed to find the same condition of things. They are now regarded as one of the characteristic symptoms of the disease.

There are also numerous aphthous patches, new the whole surface, consisting of accumulations of epithelium.

The gullet shows no signs of disease.
The Stomachs.

The first second and third stomachs are generally loaded and distended with food & no abnormal signs are found in the first two.

The third stomach or omasum shows a certain amount of inflammation which is slight at the upper end but increases in intensity towards its lower end. This redness is due to congestion of the mucous & submucous bloodvessels. The mucous membrane at the lower end of the omasum is thickened and infiltrated with leucocytes, here & there small extravasations of blood are found.

The changes in the abomasum are always characteristic of this disease. The whole mucous membrane is reddened in the early stages of the disease but deepens as the disease advances till it finally becomes a dusky red. Looking more closely one observes numerous small bright red spots which are more numerous towards the pyloric end of the abomasum. These are numerous small ulcers all over the surface but towards the valve these ulcers become larger & are sometimes as large as the palm of the hand. These ulcers have bright red edges, thickened raised above the surrounding tissue. Sometimes a slough is found on the floor of the ulcer but more commonly it is quite clean and granulations can be seen growing up.

These ulcers are found in all stages of development. Their origin is as follows: - There is a
small extravasation of blood into the submucous tissue from the already highly distended vessels.
The epithelium over this small extravasation is thrown off and a minute ulcer results. These
extravasations are very numerous and are the bright red spots referred to above. The small ulcers
thus formed run together to larger ulcers are the result. The ulcers extend through the mucous
membrane to the submucous coat and exhibit all the destructive changes of ulceration.

The mucous membrane is considerably thickened
and infiltrated with leukocytes. Its attachment to the
muscular coat is loosened; the epithelium absent
in many places is much more fragile than usual.

III. The Intestines

1. The Small Intestines.

The whole of the mucous
membrane is congested, but, as in the case of
the abomasum, this congestion is more marked
towards the ileo-caecal valve. The crypts patches
and solitary glands can always be easily
distinguished at the lower end of the gut for
they have a deep red colour. Towards the lower
end of the gut it is by no means uncommon
to find ulcers over the glands, but this is not the
general rule. I found this condition present in
32.44 percent of the 1,600 cases examined. These
ulcers are typical typhoid ulcers in every respect.
when examined but their origin is different. The glands become injected & swollen & project above the surrounding surface. The distended mesentery ruptures in several places & new cells larger than leukocytes make their appearance infiltrating the tissues and multiplying by fission. The whole of the infiltrated & diseased tissue dies "in mass" from a soft slough which becomes detached and thrown off exposing the muscular walls as the floor of an ulcer with thin, soft rounded edges which are slightly undermined.

I have never found any ulceration of the ileo-caecal valve. Its membrane is always highly congested because function is never impaired.

2. The Large Intestines

The whole of the mucous membrane is congested. There is a characteristic condition of the mucous membrane of the caecum and rectum which is never absent - a peculiar striped appearance running in the long axis of the bowel. This striation is due to the congestion of the large blood-vessels. In addition petechiae are numerous & never absent. In advanced cases ulceration is never absent - indeed in the earlier stages it is very rare to find this condition wanting. These ulcers correspond in position to solitary glands and originate in the same manner as those already described in the small intestine. The petechiae are extravasation of blood into the submucous tissue. Ulceration is only found
in the Rectum + Cæcum + is diagnostic even although the abdomen may show no particular disease. Seldom does it occur, however, that this is marked ulceration in the Rectum + Cæcum without the same condition appearing in the abdomen.

The mucous membrane of all the intestines is swollen + as in the case of the abdomen.

3. The Mesenteric Glands.

There is no lesion of structure in the mesenteric glands. They are bloodless + shrunk + their basal vessels are generally empty.

In some few cases - thirty two in number - the glands were found to be enlarged. Their substance was pinkish with spots of haemorrhage here and there.

14 Liver, Gall-bladder + Spleen.

The liver is slightly enlarged and has a deeper colour than usual. These conditions are due to congestion. The substance is more friable than normal but its structure is unaltered.

The mucous membrane of the gall-bladder is healthy in the early stages. As the disease advances it becomes congested + then covered with petechiae which later on become ulcers with a yellow slough in the centre. This slough is thrown off + a true ulcer is left with their red edges.
The bile has at first a light green colour, later on becoming darker. As the disease progresses it becomes putrid and has a very offensive smell. In its early stages its constituents are normal, the water being increased. I did not analyse it at a later stage.

The spleen is invariably healthy in a true case of rinderpest.

V. Heart and Blood-vessels.

The muscular substance of the heart is relaxed and flabby, such as is found in many exhausting fevers. Usually there are ecchymosed patches on the exterior of the ventricles but this is often absent. It was found to be present in 72.8 per cent of the cases examined.

The blood vessels are healthy.

VI. The Trachea & Lungs.

The entire mucous membrane lining the respiratory passages is reddened and highly vascular. There is an abundance of frothy mucus in the tubes. The air-cells are healthy.

Serum, varying from a tea-cup full to a quart, is found in the pleural cavities. It appears to be of a trypical nature. Serum is also found in the abdominal cavity in varying quantities.
VII Kidneys, Bladder, Uterus etc.

The kidneys are enlarged by congestion which is most marked at the pyramids. There are no structural changes.

The mucous membrane of the bladder undergoes the same changes as that of the gall-bladder at corresponding periods. When there is ulceration in the one there is a similar condition in the other. The urine contains albumen, blood cells, bile pigment, bile acids, leucine and tyrosine. The urea is not diminished in quantity although the amount of urine passed is scanty.

The Uterus is healthy. Abortion or miscarriage are very common both during the progress of the disease and during convalescence. The calf in utero suffers in a corresponding degree to the mother. They do not so often recover as do the mother.

The Vulva is characteristic. It is swollen, its membrane tense and has a very red and irritable aspect. When the mucous surface joins the integument ulcers are found, a glairy,ropy mucous, often tinged with blood, flows from the orifice and hangs in strips from the vulva.

VIII The Brain & Spinal Cord...

The cerebral membranes and membranes of the spinal cord are congested in advanced cases and small hemorrhages are also present. Then...
so cerebrum effusion in the majority of cases although this was not found in 613 or 38.3 per cent of the cases examined. There is no change in the cerebral substance or in the spinal cord.

IX. The Udder -

The udder undergoes no structural change but the secretion of milk stops after the first two or three days of parturition. I did not examine or analyze the milk.

X. The Blood.

The blood coagulates slowly if left in the body but, if caught in a jar from a dead which has been killed, it coagulates very rapidly. In deforming the blood I found there was much more fibrin in the blood than normal and on analyzing the blood this was confirmed. The blood corpuscles are also increased but the water and salts are greatly diminished. The specific gravity is greater by from 9° to 11° or a mean of 10°.

The red corpuscles are small and appear to be shrivelled and if allowed to stand assume a stellate configuration. The white corpuscles are much more numerous than normal and are distended and more granular than in health.
XI The Flesh.

In a freshly killed beast the colour of the meat and fat is perfectly normal but if allowed to stand for several hours it assumes the peculiar colour described by Dr. Andrew Smart (pages 778 of First Interim Report of 12th September 1866). The shrinking I have never been able to find.

The carcass of a beast dead from rinderpest gives off a peculiar disagreeable, penetrating smell which in itself is almost characteristic of the disease.

Symptoms

This peculiär disease can be divided into the four usual stages common to all eruptive fevers: incubation, invasion, advance, and resolution.

I Incubation.

This period is always difficult to fix. For the purpose of procuring bile it has been my lot to inject large numbers of cattle. I have injected under the skin and into circulents defibrinated rinderpest blood varying from one drop to 10 c. cm. in no case has symptoms appeared before the second day, while in many instances as much as ten days have elapsed.
before any symptoms have appeared. Taking
an average the duration of incubation may be
stated as four days from the reception of the
poison by the animal before symptoms of its
development in the body become apparent.

II Invasion.

The first symptom to appear is a
mucous discharge from the eyes of a peculiar vesicid
eosinone nature, which soon corrodes the tars in
the furrow it makes for itself as it runs down
the face. Secretion from the nostrils, running
from the mouth soon follow.

Skin follows loss of appetite; the animal
does not graze with its accustomed relish, only
picking tasty bits of grass here and there in a
languid manner. It looks depressed, stands
in the same posture with its head hanging
and ears drooped; the ears are colder than
normal. The breathing is now prolonged and
the pulse more rapid.

Next the muzzle becomes reddened. A
paint red line appears on the gums along the
roots of the teeth. The eyes are slightly
inflamed and look red and bloodless. The milk
by this time will have dried up.

During the two or three days this stage
ends the temperature will have risen two or
three degrees. Its course is not unlike that of
Typhoid in man, having a nightly rise and morning
fall. Unfortunately the animals under my observation were not stabled at night and the exposure to the night air may have had some effect on the temperature. The average temperature at night at the end of this stage is about 106° 4°F.

Advance.

All the symptoms become more marked: the animal no longer feeds; has a very dejected appearance; the discharge from the nose, eyes and mouth are increased; the ears droop in a characteristic manner; the eyes are much bloodshot and lustreless; the hair stands on end; the reddness of the vulva is increased and there is a mucous discharge from the vagina; diarrhea sets in and increases in intensity very rapidly.

The animal wanders about in an aimless manner bellowing mournfully from time to time and should it reach water that it will stand all day drinking incessantly; the mucous membrane of the mouth exhibits ulceration: on carefully examining the skin an eruption will be found more particularly on the skin over the abdominal paraceter. This eruption consists of small pin-head rose-coloured spots which on pressure vanish but quickly return when the pressure is removed. They last in two days: I have never found more than one crop of these spots. The pulse is increased in rapidity but is weaker. The
respirations are more rapid and now laboured. The temperature has risen to 107° F.

As the disease advances the diarrhoea becomes more marked the mucous blood and bile are pumped out as a reddish brown liquid; there is well marked ulceration of the vulva, mouth and fauces; the hair is standing on end; the animal no longer moves about but remains in the one position; the pulse is more rapid but weaker; the respirations quick, shallow and more laboured; the temperature will be higher even up to 108° F.

Collapse sets in, the animal can no longer stand up, it lies curled up with its head between its forelegs; the temperature falls suddenly to 94° F or even 92° F; the pulse is imperceptible, the breathing quick and shallow, the animal dies without a struggle.

IV. Resolution.

Should the animal recover without treatment after it has reached the more advanced stages of the disease the temperature will gradually become lower; the pulsations and respirations become stronger, fuller, and more regular; the animal will attempt to eat; the diarrhoea become less and less violent, the symptoms gradually subside in the course of nine or ten days.

Relapses however are common for should the animal eat too hearty a meal, a drink too
much water the symptoms will return with increased severity and death result in twenty-four hours.

From the appearance of the first symptoms to a fatal termination is usually ten days. In some cases twenty-four hours is the limit whilst in others it is as much as fourteen days before a fatal termination results. Taking an average of the cases I examined ten days would be the duration.

From careful observation the 7th, 14th and 21st days seem to be the critical periods in the progress and convalescence of this disease.

Diagnosis.

The only two diseases which could be mistaken for Rinderpest are Pleuro-pneumonia and Murray.

Pleuro-pneumonia is distinguished from Rinderpest by the absence of ulceration of mouth and fauces. Characteristic condition of melaena, peculiar droop of the ears, diarrhea and the presence of coughing. On post-mortem examination there is no resemblance of the two conditions.

The only resemblance between Murray and Rinderpest is in the condition of the Abomasum. In Murray the reddness is confined to the upper
part of the stomach, the colour is different, and ulceration is absent. The other mucous surfaces cannot in any way be said to bear any resemblance to Rinderpest.

Typhoid in Man.

It has often been remarked that Rinderpest in cattle is the same thing as Typhoid Fever in man. There is undoubtedly a good deal of truth in these statements, yet the two conditions are not by any means the same.

The stage of incubation is very much the same in both. The eruption looks the same in both diseases but there is only one crop of spots in Rinderpest whilst there are a number in Typhoid. The temperature charts might easily be mistaken one for the other. Diarrhoea is common to the two conditions. The ulceration of Rinderpest is very similar to that of Typhoid except that the seats of ulceration are different in each, yet in each the sympathetic glands are the parts affected. Of course the method of formation of the ulcers is very different but when once formed it is difficult to distinguish the one from the other. Ulceration in the mouth and throat is sometimes met with in Typhoid Fever & Tiomachal Caranah is by no means an unusual condition.

From a consideration of the symptoms & pathological lesions it will be seen that there is a great resemblance between the two conditions. That they are not one and the same condition is
evident but that they all of the same condition is
undoubted.

To prove that they were not the same
condition I procured a cultivation of Syphoid
bacillus & injected 5 c. cm. of that cultivation in
so a healthy beast & another 6 c. cm into a Monkey
The monkey died from Syphoid Fever. at the end of
twenty-one days the beast was still healthy that
showed no adverse symptoms. It was then injected
with Rinderpest & died from that disease fourteen
days later. This proves that Syphoid does
not produce Rinderpest.

I injected 1 c. cm. of Rinderpest blood
under the skin of my left arm & no ill-effects
followed except an abscess at the seat of injection.
Several animals were injected with the same blood
& these all contracted Rinderpest. I repeated this
experiment on a gentleman here & also on a
native boy with similar results. This
proves that Rinderpest does not produce Syphoid
in man.

In this district there was an outbreak of
Syphoid fever in eight houses who all got their water
from one spring. The fever was peculiar for in thirty
three cases which occurred in those houses not one
of them suffered from diarrhoea. On investigation
it was found that this water was contaminated
by putrid matter from a grave where 156 head of
cattle, which had died from Rinderpest, were buried.
Whether these had been Syphoid thus or no at some
previous date I was unable to discover. It is a
curious thing that not one of the patients developed diarrhoea. They all recovered so that I had no opportunity of holding a post-mortem examination to investigate the matter further. This is very possible of other cases of typhoid appearing at an early date in other parts of the district from similar causes: it will be interesting to note if this same curious condition is repeated.

It has been stated that in the Transvaal and some of the more northern parts of South Africa the natives are dying in hundreds from typhoid fever resulting from eating rinderpest meat. In this district where there are 10,000 natives no such disease has followed the eating of rinderpest meat. Mr. P. B. Payne, a gentleman residing in this town, and I both ate rinderpest meat to all our meals for a period of four months, partaking of the meat both when well cooked and when as much underdone as we could eat it, without suffering inconvenience in any way. We also drank the milk from sick cows without suffering any ill-effects. Nineteen native boys who lived in the Culture Camp with us also partook of the same food and during the four months none of them were sick or unfit for duty.

We found that the meat would putrefy if allowed to hang for twelve hours and therefore we had to cook and eat the meat as soon after killing as possible. From these facts it is evident that the meat is fit for human consumption if cooked within twelve hours after killing before putrefactive changes have
set in.

we proceed two turkeys + for a period of two weeks fed these birds on rinderpest blood + they were then killed and eaten by the whole camp. no one complained of illness as a consequence.

from these experiments it is abundantly proved to my mind that rinderpest + typhoid fever are two separate conditions of disease.

Aetiology:

The spread of this disease is peculiar, seeming from one place to another many miles apart. When once a centre is established all the country round about becomes infected but long before that can happen you hear of the disease appearing two hundred or even three hundred miles from the nearest infected area. how this is accomplished is a question which has been exercising the minds of south african people for the last three or four years + no satisfactory explanation has yet been given.

so try + solve this problem i tried a number of experiments which are recounted below.

when a herd becomes infected the spread in that herd is also peculiar. i have watched it in many herds + it was always the same, one a two animals take sick and die + four or five days afterwards the first animals
were noticed sick eight or nine more will be found showing symptoms of the disease & every four or five days another batch falls sick till the whole herd becomes infected. At the beginning if the sick animals are noticed very early, separated from the remainder of the herd & isolated it maybe weeks before the disease makes its appearance again or on the other hand this may have no effect. It all depends on whether the sick animals have infected the clean animals or no before they were isolated.

In this district the disease first appeared about three miles from the Township & two days later another outbreak was reported thirty five miles away from the first & within a week a third outbreak was reported twenty eight miles from the Township in another direction, thirty miles from the first case & over seventy miles from the second case. Very soon the whole district was infected from end to end. This district measures about forty-five miles in each of its boundaries & the whole of that area was infected in less than two months although the natives did their best to keep their herds free from infection.

Very many sources of infection were suggested some of those which appeared to me to have any grounds of truth about them I proceeded to test & dwell now give a summary of the work done in this direction & the results obtained.
Air.

Air was suggested as the medium. Dr. Koch ("Report to Government of Cape Colony," December 1896) had already experimented on this point. I repeated this experiment. A sick and healthy animal were placed together in a stable but separated from one another by a five-foot partition which prevented them touching one another. This was a trench of running water round the healthy animal which was also enclosed by a muslin tent to prevent flies from the sick animal reaching it. The ventilation was arranged so that the incoming air passed over the sick beast before reaching the healthy animal. The cattle remained together till the death of the sick animal which happened on the 10th day. The remaining animal was kept carefully isolated for a further ten days and was then infected with 1 c.c. of virulent reindeer blood. It died fourteen days afterwards.

This experiment is in itself sufficient to prove that air is not the medium for disseminating the disease but when taken along with a similar experiment by Dr. Koch any doubt is removed. Further, it is very improbable that, even in the medium, the disease should pass over large tracts of country remaining with cattle without spreading the disease broadcast.

Receptions

It was suggested that the disease was spread by a healthy animal absorbing the secretions of a sick
animal.

The secretions from the nose, eyes and mouth of sick animals were mixed and then smeared over the nostrils, mouth of two healthy animals which were then carefully isolated in wooden boxes. On the fourth, sixth and day symptoms of rinderpest appeared. Both animals died - one on the tenth and the other on the fourteenth day. Dr. Danyel and Boudet, two

French observers in the Transvaal, use this method for infecting healthy animals. Dr. Koch found it a somewhat uncertain method and adopted the injection of rinderpest blood as more constant.

The secretions from the mouths of sick animals were smeared over the nostrils, mouth of two healthy animals which both died from rinderpest on the eighth and the other on the ninth day.

The secretions from the nostrils and also of the eyes of sick cattle caused fatal in two cases each.

Two other healthy animals were given a mixture of milk, urine and dung from rinderpest animals with fatal results on the 13th and 16th days.

From these experiments it is evident that the secretions are capable of spreading the disease and this is probably the mode of spread in a herd when once it has got a hold. It however hardly explains the spread of the disease at distant places.

To explain this sudden jumps from one place to another by the secretions the following is given. A span of men containing one sick heifer is outspanned or a public outspan. The sick animal contaminates the stool. The stool from the next wagon which outspans
three feed on the contaminated grass & one or more of them contract the disease. The oxen are able to work for three or four days & in that time will travel a distance of eighty or a hundred miles before showing any symptoms. They will probably be able to continue working for another two days & during that time will leave the disease behind them to infect other cattle as they pass along.

This is certainly true & has been proved to be the case in a number of instances. In the three outbreaks in the Isole district this was not the case for none of the owners of cattle possessed wagons nor had their cattle been away from their usual feeding grounds for months previously. The people themselves had not been out of the district & in no way could it be proved that there was a possibility of the cattle having developed the disease in this manner.

### Contact of Animals

It has been maintained that the disease is conveyed by simple contact. Whether simple contact is sufficient to convey the disease is a difficult point to settle. I was unable to devise any means of testing this possibility which was not open to grave doubts for to keep clean & sick cattle in contact & exclude other means of infection is exceedingly difficult. My own opinion is that during incubation this is not the case. In many cases where a herd of cattle has been carefully watched for symptoms of the disease to appear that animal at once killed & buried no further outbreak has
occurred for weeks in some instances for months. Yet if blood be taken from an animal which has been infected with the disease by injection of virulent rinderpest blood under the skin, or the second, third, or fourth day after infection, such blood be injected into a healthy animal that animal will contract the disease in the usual manner.

This point has not yet been cleared up; for the present must be left an open question.

IV. Human Agency.

It has often been said, & correctly said, that the disease is carried from place to place by people handling sick animals & not disinfecting themselves afterwards.

That the natives have been the means of spreading the disease is certain. For instance, a case of rinderpest was reported in Umbata District & the animal was killed for post-mortem examination. The natives cooked & ate the meat, amongst those who took part in the cutting up, operations & disposing were two Pondsos. These two men, who had blood on their blankets & carried some of the diseased meat returned home the same night swimming the Umbata river & avoiding the guards who were stationed along the river banks. Ten days afterwards their cattle began to die from rinderpest & before they knew the disease was in all the weight-carrying kraals. I could quote numerous of similar cases which came under my observation in this district. It has been proved by many observers that several
Sunlight destroys the infective properties of blood, secretions, and ofrenderpest animals. As it is impossible for a man to ride very far in this country by day without being exposed to strong sunlight, the chances are that by the time he has gone forty or fifty miles all risk of infection is at an end.

I have several times exposed blood to the sun for three hours, redissolved it and injected large doses into healthy cattle without any symptoms of renderpest following. This has also been done by Dr. Koch and many eminent observers.

Again renderpest hides have been put to dry in the sun for six hours, then sprinkled with salt and healthy cattle have allowed to come and lick up the salt from the hides; no ill effects have resulted.

The secretions from the nostrils, eyes and mouth have been exposed to sunlight for four hours, redissolved, smeared over the nostrils, mouth, and eyes of healthy animals; no disease followed.

These facts all go to prove that it would be very difficult for human agency unconsciously to convey the disease any considerable distance.

V. Birds.

It has been said that the disease is carried by birds from one place to another and that this would account for the peculiar spread of the disease.

It has been said that the disease is carried by birds from one place to another and that this would account for the peculiar spread of the disease.
That this is in a great measure true has been proved over and over again. Many African birds, in particular the crow, are very fond of picking ticks from cattle. These ticks are very small animals before they begin sucking blood but as soon as they start doing that they expand and can go on expanding till they are from four to five times their original size. Several of these ticks were taken from a sick animal and the blood collected from them to the amount of 1 c.c. Each was injected under the skin of a healthy beast. The animal died from rinderpest twelve days later. The experiment was repeated several times with the same result.

It is quite possible that a crow or some other bird would pick ticks from a sick beast and fly away, or deserting those on it would pick ticks from a healthy beast and so spread the disease to that animal. To ascertain if this were possible, a number of crows were obtained and put on ticks taken from sick animals. These crows picked the ticks from the abdomen of each animal for about half-an-hour and were then allowed to escape. The cattle were carefully isolated in their muslin tents in their stables. In each case the animals developed rinderpest—one on the sixth, one on the seventh, the third on the tenth day after the crows had been at them. This experiment was repeated with the same result. Eight hours elapsed in each instance between the crows feeding on ticks from diseased
animals & from healthy animals.

Some in company with victuals fed on the bodies of dead animals. Thus they have every opportunity of carrying the disease away with them.

From these experiments it is, in my opinion, conclusively proved that some birds can carry the disease from place to place. In eight hours they can with ease fly a sufficient distance to account for the peculiar spread of the disease.

VI - Flies.

Flies, as is well known, are always around cattle in swarms & when an animal is sick they are more in evidence than ever. The possibility of their carrying the disease from one place to another was very evident & in all my experiments muslin curtains were used in the form of a tent. A boy was always left in the tent with the beast to attend to any flies which might manage to find their way inside.

To decide whether they had any connection with the disease I tried an experiment which, to me was sufficient evidence of their implication as carriers.

An assortment of various kinds of flies to the number of one hundred and ten were caught and placed in a cage. A sauce full of defibrinated undiluted blood was placed in the cage & allowed to remain for twenty four hours. The flies were allowed to remain in the cage for another twenty-four hours without food. They were then let loose inside a muslin tent in which was a healthy cow. They were allowed to remain worrying the cow for two hours and
were then either killed or driven out. The cow developed rinderpest on the 9th day and died on the 12th day.

This experiment was repeated several times, different things being used each time as food for the flies – meat, urine, secretion from the eyes, nostrils, mouth. A fatal termination followed on each occasion.

These are known to be able to travel long distances and in twenty-four hours they could cover a long number of miles. It is probable they are responsible to some extent for the jumping tendency of rinderpest.

VII. Inoculation

When properly carried out inoculation does not induce rinderpest in a herd. Unfortunately the cattle have to be caught, thrown, and then held down during the process of inoculation. Should the worms have been used previously for catching a sick beast there is a great risk of infection being introduced to the whole herd. One can never be sure of the boys used to catch the animals. There are many little ways in which the disease can be carried to a herd whilst inoculating that it is impossible to guard against that it is only right that the process of inoculation should be classed as one of the agents for spreading the disease even although it is impossible for the rule itself to be the agent.
From the above experiments the conclusions I draw are that Rinderpest is spread from one district to another wide distances apart by birds, often principally by a lesser extent by the movement of cattle which have become infected by the secretions of flies from diseased cattle. When once the disease has made its appearance in a place it is spread from one herd to another by birds, flies, movements of cattle, human agency, infection by drench inoculation, possibly by contact of diseased with healthy cattle.

Treatment

Many various methods have been tried both to cure and to prevent this disease. I will endeavour to give an outline of the work done that has been of a useful nature.

I. Attenuated Viruses.

In his report of the 5th January 1897 to the Cape Government Dr. Mack describes experiments on Cape sheep, merino sheep, anyora and Cape goats with a view to attenuating rinderpest virus. These animals are very little susceptible to the disease and it was hoped that by infecting successive generations an attenuated virus could be obtained. On the 14th December 1896 one Cape and one merino sheep, one anyora and one Cape goat were inoculated
with rinderpest by injection of defibrinated virulent rinderpest blood taken from a sick beast. Dr. Koch proved that this method of injection was constant and certain - the best method to employ (Report to Cape Government 3rd Jan, 1897). After a period of incubation extending over a period of two or three days he found a rise of temperature identical with that of rinderpest. A second generation was injected on the 24th December 1896 consisting of sheep and goats as before. Other live generations were injected in the same way.

A heifer was inoculated with the blood of an Angora goat of the second generation. This inoculation gave rinderpest to the heifer in a severe form but it recovered.

Four head of cattle were inoculated respectively from a goat, an Angora goat, a merino and a Cape sheep. After the series had passed five times through these animals, the four head of cattle became diseased after a short period of incubation and all of them died after an illness of seven and eight days. The course of the disease in the two cattle inoculated with the blood of the merino and Cape sheep was so violent that the pathological lesions of such a severe nature that Dr. Koch concluded that there was no attenuation of the disease as far as sheep are concerned but that it would be cultivated to a more virulent form through being continuously propagated within these animals systems. The experiments on sheep were therefore abandoned. Rather different was the
results with regard to the other two animals which were inoculated with blood from an angora and from a Cape goat, for the first one showed a high temperature only during five days scarcely any diarrhoeic evacuations and recovered. The other one into which blood from the Cape goat was injected was a weak animal and did not recover; on making a post-mortem examination it was found that the pathological changes in the stomach and in the intestines were less marked than those animals which were injected with sheep blood.

From these experiments Dr. Koch concludes that it is probable that the rinderpest virus, after a repeated passage through goats, becomes actually but slowly attenuated. These experiments were never carried any further so that it still remains a mute point. I have never had the opportunity of experimenting on sheep myself but I have seen flocks of sheep which have passed through the rinderpest twice and afterwards developed the disease in a severe form some months after rinderpest had disappeared from the large stock.

II I prose.

Mr. Stilington in his "Additional Report on Investigation made with the object of determining a safe and efficient method of Immunising cattle against Rinderpest" (to the Cape Government page 13) deals with this subject. Since he is the only expert who has tackled this subject I will quote his experiments, i.e.:-
"In my former reports I showed that virrius kept over seven days could not be used to infect healthy cattle. I did, however, find evidence that such inoculation gave rise to some slight degree of immunity, and it therefore seemed to me that this immunising power could only be exercised by, and obtained in virtue of, the toxin as present in the blood after the microbe itself had been destroyed.

Thus a three-fold line of action was suggested to me:

1. To attempt immunisation by means of the toxin alone.
2. To attempt to obtain an attenuated derivative of a constant virus of an attenuated character.
3. To attempt immunisation by serial inoculation, beginning with a virus which could not give rise to kindness, and proceeding gradually to one of the more virulent type.

In order to obtain material containing the toxin, three methods were devised:

(a) Blood taken in citrate solution oxygenated and kept for such a time as ensured the destruction of the microbe, when it was then glycerinated, and formed a dark-coloured fluid, which could not undergo any chemical or proteolytic change.

(b) Instead of glycerinating the blood, recourse was had to drying it in thin layers and subsequently reducing it to powder.

(c) The citrated blood was made to deposit its corpuscles, and the clear supernatant fluid was subsequently cleansed, and then filtered through a Pasteur filter, when it then presented itself as a clear
In order to attempt immunisation (or more properly speaking, vaccination) with an attenuated virus, I oxygenated the blood up to the period which has been shown to have an attenuating but not absolutely destructive action on the virus in the blood. The blood was now dried at a low temperature & powdered.

By the use of either (a) or (b) followed by the latter taken at a stage of maximum attenuation, I considered that serial inoculations might be made, whereby the highest immunity might be granted without incurring great risk of fatal issue.

The following experiments will show clearly how much is to be hoped for from experiments made in this direction.

Experiment 24.

In this experiment, diluted blood was made in the following manner:

Bottles of diluted blood, oxygenated during two days, were glycinated, and then labelled 'Two-day glycinated blood.' Similarly, blood was taken at the respective periods of 4, 6, 8 days, and labelled accordingly. Inoculations were begun with the most oxygenated, and proceeded after intervals to those less oxygenated. Meanwhile a control experiment was made with immediate inoculation of two-day glycinated blood, which had been kept for a week in the glycinated state, in order to determine whether such blood could produce reinfection. The animal was inoculated on the 10th March, and has remained perfectly healthy, thus showing that glycine, although it does not destroy the virus, is
Unable to definitely arrest its declension and death.

Thus animals and one control were made use of. Nos. 49, 50, 52, 81 (control).

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In the above experiment, it will be observed that, subsequent to the first inoculation with 84th day blood, an elevation of temperature occurred. In 820
4.9 and 5.0 on the afternoon or evening of the following, which was continued until the third day. A similar result followed the second inoculation, but the rise in the case of No. 5.0 was finished on the second day. After the fourth inoculation, the rise was delayed for one day (in the case of No. 4.9 the former rise had extended into this period of inoculation). When the temperatures of Nos 4.9 and 5.3 are observed it is most noticeable that this animal never reached until the fourth inoculation. No. 5.0 however reacted strongly.

Another experiment (No. 28) is similar to the above with the exception that three days intervened between the inoculations as compared with two in experiment 24. Nos. 4.2, 4.5, 4.6 were the animals used. In this experiment the reaction to inoculation is not so manifest as the doses and material used were identical with those in the former experiment, it might be assumed that the difference was due either to the longer periods of time which was permitted between the inoculations, or that the animals were more refractory to the toxin.

These six animals were all afterwards inoculated with virulent blood. Nos 4.9, 5.3, and 4.2 died of Panderpest. Nos 4.5 and 4.6 recovered after an illness. No. 5.0 was almost absolutely immune. In this case the febrile symptoms were the only evidence of illness, no other symptoms having appeared. This experiment seems therefore to show that (as in No. 5.0) a real immunity can be conferred by a non-virulent material, but that such immunity can be conferred
more quickly and easily on certain animals than on others. (Page 17 of Dr. Bodington's Report).

In cattle the temperature is always a very variable thing depending on some extent on the weather. It is higher at night than in the morning. People who know had much to do with cattle in this country say the temperature is normal if it is anywhere between 100 °F to 102 °F in the morning and 102 °F to 103 °F in the evening, but the variation should never be more than 2 °F. This I have found to be true for I have taken the temperature of a herd of 98 animals night and morning for six weeks and that is the result obtained. Now in Dr. Bodington's experiment No. 241 from examination of the chart No. 249 never showed any variation in temperature indicating reaction till the 13th March, and this rise of temperature lasted till the morning of the 21st. In the case of No. 58 the rise did not take place till the 20th and only lasted one day. In both cases death resulted when the beasts were inoculated with virulent blood. No. 42 reached very slightly after the first inoculation but died after inoculation with virulent blood. No. 58 reached on two occasions - 10th and 21st March. Nos. 145 and 146 also reached on two occasions. These three animals recovered after an illness.

From these experiments I take it that the action of serial doses of glycerinated blood is very uncertain and that unless by repeated injections you can get a reaction on more than one occasion the animal, if exposed to injection, will die. The time
required to carry on these various inoculations is so long and the rate of the animal becoming infected in the meantime so great that this method is absolutely unreliable and trustworthy.

From Post 16 of Dr. Langley's Reports I take the following experiment numbered 29.

"In this case the plasma of citrated blood kept for a few days was decanted and filtered through a Pasteur filter. Three animals were selected, one was inoculated with thirty cubic centimeters, another with ten, the third with twenty cubic centimeters.

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It is to be noted that a rise of temperature occurred in each of these animals on the fourth day after inoculation. Each of these animals were afterwards inoculated with 2½ c.c. of virulent blood. Nos. 55 and 57 died. Nos. 56 recovered after severe illness. This is therefore evidence that a measure of
immunity had been conferred although not enough to protect. It is to be noted also that the one which recovered was not the one which had received the greatest amount of immunizing poison, since it is probable that the amount of toxin given in one single dose is not the most necessary factor in the induction of immunity. (Page 16 of Dr. Siddington Report).

From an examination of the charts that appear to me to have been no reaction to the plasma. When infected with virulent blood two died the other had a prolonged serious illness. I should say the latter had recovered in spite of being inoculated with plasma. This experiment proves nothing beyond the sufficiency of the method adopted.

III. Kindred's Gall.

Dr. Koch was induced to try inoculation with bile because a mixture of bile with blood or other liquids was said to be used by the Chinese farmers and also the circumstance that in the bile of most of the cattle examined I have found in pure cultivation a bacterium which, according to the description published, is conformable with the microbe discovered by Dr. Simpson in Calcutta, and declared to be the cause of kinderpest. (Page 7 of Reports to Cape Government).

These inoculations gave good results and Dr. Koch found that he was able to render healthy cattle immune with the bile of such cattle as have
succeeded to be underpest. An hypodermic injection of 10 c.c. is a sufficient dose.

In page 13 of his "Report to Cape Government," Dr. Koch says:

"This immunity sets in on the 10th day at latest, and is of such an extent that even four weeks afterwards 40 c.c. of underpest blood could be injected without any injurious result. I therefore conclude that the immunity produced in such manner is of an "active" nature."

"The local result of an injection is merely a hard somewhat painful swelling of the size of a man's fist, and which gradually disappears in the course of a few weeks, provided, however, that the bite is not in a state of decomposition, as is not uncommon when an animal suffers from underpest. Under such circumstances an abscess may form, which, however, does not seem to be detrimental to the process of immunisation."

The first practical test of protective inoculation with gall of underpest animals was made on the busana farm in the Orange Free State: (page 16 of "Report to Cape Government").

In spite of all precautions, underpest appeared on the farm, first among the cattle belonging to the servants. This outbreak occurred in the 26th of January, and on visiting the place on the 2nd of February, I found the stock already so badly infected that of 180 head of cattle, twenty-seven died, and at least thirty more manifested more or less pronounced symptoms of underpest. A hook of forty-four head which
appeared still healthy and were kept isolated, had been inoculated the day before my arrival by a farmer with material taken from the brain and urinary bladder of an animal suffering from rinderpest. We selected eighteen diseased animals and inoculated the majority with virulent blood, which was prepared with formalin, and the other with bile. Ten more animals, which to all appearances were healthy, received likewise virulent blood, and twenty seven others which had been carefully isolated, were injected with bile. The bile was taken from a beast which had died on the previous day of rinderpest at the experimental station, after an illness of about six days. It was of a dark green colour, almost clear, and had the smell of a healthy recently slaughtered animal.

"All the animals inoculated with gall had a more or less extensive swelling at the seat of injection, as a consequence a few of them showed a somewhat painful gait. This swelling decreased considerably during the second week, and soon afterwards disappeared. In no instance was the formation of an abscess noticed. Six days after this inoculation four animals showed symptoms of rinderpest, and three of them succumbed to the disease. The other one, which had it in a mild form, recovered."

"Taking the period of incubation into consideration, it is most likely that these animals had been infected before inoculation. But even on the day of inoculation the infection might have taken place, however for the purpose of being exact and
passaged the animals were brought into a kraal in which, as I learned afterwards, the diseased beast had been kept during the nights. The floor was covered with rinderpest feces, moistened by recent rains, so that the animals were unavoidably much soiled with dung when operated upon.

"One animal belonging to this herd refused to eat on the 20th February, and an examination showed a rise of temperature. It had, however, no diarrhea, nor did it manifest any other symptoms of rinderpest. Already on the next morning the owner found the beast dead in the kraal, and it is, therefore, improbable that it had been suffering from the pest. I regarded much that the intestines had been devoured by vultures and could not be examined. No other cases of disease occurred amongst these animals, though from the eighth day after the inoculation they had been allowed to graze with the injected herd on the farm. As all times they have been eating well and remained in good condition. The result of this experiment, supposing even that the last case was also one of rinderpest, may, therefore, be summed up as follows — one injection of bile saved twenty-four animals out of twenty-nine, and this under conditions which, as above described, were exceedingly unfavourable."

"To prove beyond doubt that these animals were undoubtedly immune, I inoculated with rinderpest blood on the 16th February four animals belonging to this herd, selected indiscriminately. This injection, however, had not the slightest
ill-effect upon any of these animals, whereas two healthy beasts, which had not previously been treated with bile, nor inoculated with the same virulent blood, thus serving as controls, animals, became so severely ill that they succumbed to the disease.

"Of the ten animals inoculated with phenol-blood these died seven, whereas the other three remained alive without manifesting any symptoms of the disease. Of the eighteen head which, although sick, were inoculated with phenol-blood or bile, six recovered.

"Of the forty-four animals which the farmer had inoculated with material from the heart and urinary bladder, seven were contracted the disease, and two of them recovered. Of eighty animals, which were neither inoculated nor treated in any way, seven became killed, a number which is the usual percentage of recoveries on a rinderpest farm.

"The results obtained by me in this instance with the injection of bile, cannot be designated otherwise than as most satisfactory. It clearly demonstrates that this operation, even when carried out on a rinderpest farm, where the natural infection has to be taken into consideration, produces the same good effect as on the experimental station, where the immunized animals have to be treated artificially by means of injection with virulent rinderpest blood.

"gall having the properties described as possessed by that employed on the farm Susanna, gave in all cases the best results. For theoretical reasons I have mixed rinderpest gall with virulent blood in
different proportion, and this experiment showed that bile is able to render innocuous a considerable amount of underpest blood, provided that both are well mixed. Even a mixture of 5 c.c. of bile with 5 c.c. of blood produced in one instance no disease, and the animal used for this experiment became immunised.

It seems that this addition of bile even increases the immunising strength of the bile. I do not think it impossible that the less efficacious bile, for instance, bile taken during the early stages of the disease, or, perhaps, even from quite healthy animals, may be transformed in this manner into a useful and more powerful vaccine.

Another experiment served to define more exactly the time of time when, after an injection of gall, the immunity was really established. I inoculated four animals, each with 10 c.c. of bile taken from a horse that had succumbed to underpest on the farm owned by me. Two days afterwards the first of these animals was inoculated with blood, and the second, third, and fourth were injected on the fourth, sixth, and eighth day respectively. No one died from underpest, as if it had never been subjected to any preventive inoculation, and no one contracted the disease in such a mild form that he rapidly recovered. No symptoms of the pest were seen in the other two, and that immunity appeared so considerable that they withstood without the slightest reaction an injection of 20 c.c. of fresh underpest blood. Thus the conclusion is forced upon me that the immunity was established as latent on the
and day after inoculation with the bile. In order to find also if smaller doses than 10 c.c. of bile are able to produce immunity, I injected three animals respectively with 1, 2, and 3 c.c. of bile. After a period of ten days each received simultaneously subcutaneously 0.2 c.c. of virulent blood, and as a consequence three of all these animals became very severely ill; thus whilst the first two died No. 3 recovered. This experiment reaches us that a quantity of rinderpest gall smaller than 10 c.c. is not sufficient to immunise an animal against rinderpest.

Mr. Holbock in his "Report to the Cape Government" 17th May 1887, after many experiments gives his opinion on the kinds of gall to be used as follows:

"Animals which were injected either with brownish green gall, containing the Simpson Bacillus in pure cultivation culture, or gall of a brown colour, containing both bacteria streptococci, became immune without the occurrence of any accident, such as abscess etc."

"Thick green gall, free from small organisms has often been taken from dead cattle; on one occasion I injected an animal immune with such a fluid, which had previously been mixed with normal salt solution to render it thin enough to go through the needle by injecting 20 c.c. of the mixture. This is the only experiment of the kind made.

"A yellow brown gall with yellow plaits, free from small, taken from an animal which had been suffering three weeks from Rinderpest, and cured of secondary infection, caused sickness in an animal on the second day, and it died on the fifth day."
"I am unable to assert that this gall was the cause of the animals' death, on account of the injected blood of the station, but it is certainly not less immune.

It has been frequently stated that gall used while still warm was capable of infecting the animal injected therewith. I have tested the statement by injecting an animal with 10 c.c. of fresh warm brown gall, which gave a yellow gangrene. The heart became infarcted and resulted the morulae, first with 0.2 c.c., then with 0.1 c.c. of virulent blood.

Eighteen animals became sick between the first and seventh day after injection with gall; these cases all occurred while the hearts were as situated as to be liable to infection before or soon after injection, and were not infected by the gall itself, because I succeeded in immunizing animals with the same gall upon repetition of the experiment. The days after injection with gall on which the temperature began to rise is further evidence of this statement. Thus, eleven were ill between twelve and twenty-four hours, three between the second and third days, and four between the third and seventh days.

The animals injected with 9 c.c. of normal gall from an ox killed at the slaughterhouse, mixed with 1 c.c. of virulent blood, and allowed to stand twenty-four hours at the temperature of the room, did not raise the disease, but when injected ten days later with 10 c.c. virulent blood,
the heads then died of Rinderpest."

"To ascertain the period of the disease at which the gall should be taken to give the highest protection, a series of animals were injected and killed on the fifth, sixth, seventh days of the period. Those killed on the sixth day gave the best results." (Pages 44 & 5 of "Reports" by Sir. Kohler to the Cape Government).

It has been asserted over and over again that the gall itself or the animals subjected to the influence might impart the disease to others. This, I have myself proved to be false. On ten different occasions I have had the opportunity of inoculating clean tents to the number of 300 heads of cattle and in no case did rinderpest follow. Not a single animal was lost out of this number. I had my own boys to catch the cattle and precautions were taken to ensure a minimum of possibility of the cattle being infected during the process of inoculation. These cattle were carefully guarded against infection during the next ten days and in no single instance did rinderpest follow. The gall used by me on those occasions was also used to inoculate cattle belonging to natives who are by no means careful to guard against infection. In most cases some cattle died from rinderpest.

Some interesting statistics are furnished by Mr. Turner & Rolle in their "Reports on the Progress of Research Work at the Rinderpest Experimental Station, Kimberley. 11th Sept. 1897."
"Kotch operated on 138 animals on March 12th at Talpan, only one animal died, a beast which was infected at the time of inoculation; none of the others showed any signs of the disease."

"Dr. Turner & Kotharope operated on 83 animals at Kleeprin-dam on April 8th, and though three samples of bile were used, none of the animals showed any symptoms indicative of the disease."

"Dr. Turner operated on 160 animals at Badaun on July 13th but not one showed any symptoms of the disease in consequence."

"That the animal undergoing immunization by means of gall is no source of danger has been proved over and over again by leaving animals unprotected by bile inoculation to graze with numbers of others undergoing that process, and also by injecting into healthy cattle blood drawn from beasts in course of immunization at various stages. Feeding with rinderpest gall and smearing the nostrils with the fluid are equally devoid of danger. Indeed the introduction of large quantities of gall into the alimentary canal appears to excite a certain protective action."

"Perhaps the best evidence which can be brought forward to show that rinderpest gall is harmless is to be gathered from the reports of those inoculators who attest that it has actually caused the disease and who attempt to bring forward facts in evidence of that assertion. Take for example the following return of a Veterinary Surgeon on May 3rd, the names and surnames only being omitted:"
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<td></td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Beetfontein</td>
<td>15.0</td>
<td>0</td>
<td>10</td>
<td>7</td>
<td>15th</td>
</tr>
<tr>
<td></td>
<td>42</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>92</td>
<td>0</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Beetfontein</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>16th</td>
</tr>
</tbody>
</table>

| Total         | 1056                     | 8                            | 138                                       | 110                           |                               |

This return shows that out of 1056 cattle inoculated with live or 21 strains in this neighbourhood, 138 are reported to have subsequently suffered from the disease and 110 died, consequently 88.7 per cent.
of the animals escaped.

"The two first farms are admittedly infected if we omit them. Thus we have 918 animals operated upon of which 19 became sick and 9 died. That is to say that 98 per cent of the animals were immunized."

"It will be observed moreover that while on the 9th and 10th of May operating on undoubtedly infected herds the loss was 73 per cent; during the 11th, 12th, 13th and 14th no less than 6.877% were infected by the same operation without any case of underestimation occurring and it was not until the 15th that disease was supposed to have followed the inoculation. It was stated that there were no animals visibly affected on the day of inoculation and this, by no means implies, as it is always assumed to do, that the herds were free from infection. An animal may be infected and not show any sign of the disease for a week or ten days or even more. You mentioned that the first herd in the list, that at Charlottenhald, been inoculated on the 1st of May instead of on the 9th, it is absolutely certain that the fact that the cow which died on the eighth which was already infected would have escaped observation. The herd would have been returned as consisting of 184 animals, none of which were affected, and the result, which would undoubtedly have been very bad, would have with equal certainty been attributed to the bile."
Further than this I injected 10 c.c. of blood, taken from a beast which had been inoculated with bile six days, into a healthy beast without any result. When injected with rinderpest blood it contracted the disease and died. On three occasions I smeared the nostrils & mouth of a healthy beast with guck, also gave it 20 g. internally, and after fourteen days' no reaction had appeared. It was afterwards injected with rinderpest blood but recovered after a serious illness.

I also repeated Dr. Koch's experiments to ascertain the case of establishment of immunity: my results were practically the same. In no case did an animal recover which was injected with virulent blood on the fourth or fifth day after inoculation with rinderpest bile.

I tried many experiments with virulent blood and bile mixed in varying proportions and found that blood could be mixed with bile till that was equal quantities of each and no harm result. More blood than that proved fatal.

To test the immunity conferred by bile thirteen cattle were inoculated with bile on the 27th August 1897. On the 6th September each received 0.2 c.c. of virulent blood; on the 16th September 10 c.c. each; on the 27th September 20 c.c. each; on the 10th October 100 c.c. each; and on the 21st October 200 c.c. each. No sign of rinderpest appeared in any of the cattle at any time. These cattle were allowed to run in the camp and with the nine cattle till the closing of the camp on the 31st December and at that date were fit and well.
At the end of August an order was issued by government that all inoculated cattle must be reinoculated with 0.2 e.c. of virulent blood ten days after inoculation. This was followed in many districts with disastrous results. In the next district - Limuru - the mortality was dreadful, whole herds being swept away. Out of a total number treated of 12,000 only about 1,500 were left. In this, Isiolo, district the committee decided to reinoculate all cattle ten days after the first inoculation and then ten days later with 0.2 e.c. of rinderpest blood. Unfortunately we were instructed to discontinue the blood inoculation before very much had been done. Some 1,768 head of cattle were treated in this manner without a single death falling sick.

To procure live cattle were always killed about the sixth day when diarrhea had just started. Only green bile of either a light or dark shade was selected and this had to have a fresh smell, sweet taste, no sediment, no shaking a white froth with a greenish tinge. The gall bladder was always examined and if either bile or gall stone was present that sample was rejected. A postmortem was held on each animal. We killed 1613 head of cattle which provided bile to inoculate 110,800 head of cattle or an average of 250 e.c. per beast killed. Bile which was more than two days old was never used.

In this district we inoculated 24,011 head of cattle and inoculated 12,210 head. There
... include both clean and infected herds. In many instances a herd was killed to procure bile with which to inoculate the remainder of the herd. The... and it will readily be understood that this gives rise to serious danger of infection before immunity is established, for it must be remembered that by the middle of August Rinderpest was prevalent over the whole of the Isolo district. Notwithstanding these adverse circumstances only 3,500 head died after inoculation whilst over 40,000 un inoculated cattle perished. The statistics are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Head of cattle</th>
<th>No. dead</th>
<th>Death Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inoculated</td>
<td>241</td>
<td>3,500</td>
<td>14.6%</td>
</tr>
<tr>
<td>Re inoculated</td>
<td>12,210</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Un inoculated</td>
<td>41,925</td>
<td>40,101</td>
<td>96.5%</td>
</tr>
</tbody>
</table>

These results are very much better than those of surrounding districts which vary from 20% to 60% per cent of deaths. Taking the colony over these results are a fair average of the success of inoculation when properly carried out.

There are present four cows which were inoculated on the 25th July which I send to run with sick herds whenever a year of an outbreak within reasonable distance. These cattle have never shown any symptoms of the disease.

I think I have said enough to prove beyond a doubt that gall injected into a healthy animal will confer immunity against rinderpest without producing the disease.
Glycerinated bile.

"Dr. Dodgson has advocated the addition of glycerin to the gall in the proportion of one of that liquid to two of gall. Dr. Dodgson claims for this mixture three great advantages:

1. That the disease cannot be spread by the use of glycerinated bile.
2. That a great economy is effected by the use of glycerin; all gall is then available.
3. That the mixture will keep."

"We agree that glycerinated bile is incapable of spreading the disease, the bile itself being free from this objection. If the gall spreads the disease it can only do so by the presence of the tenderpest organism, which in a modified form appears in gall. But Dr. Koch showed that glycerin kills this organism, and we have shown that it practically deprives the gall of all active immunising power."

"The second claim is that the use of glycerine effects an economy. The mixture of gall and glycerine has a slight immunising power, due to the presence in the gall of a small amount of a peculiar chemical immunising substance. Dr. Dodgson's great experiments were made with 16 c.c. of the mixture. When the animals were injected with 0.2 c.c. of really active tenderpest blood after ten days, the animals without exception suffered severely, and 70 per cent. died. In consequence, the dose was then increased to 24 c.c. followed by 0.2 c.c. of tenderpest blood ten days later. The results were good. This dose represents 16 c.c. of bile which is an increase of 60 per cent. over the quantity required by Dr. Koch's method. If gall
is prepared properly this is no occasion to reject
from samples out of ten, which would be necessary to
put the close examination used by Dr. Delington on a test with
the 10 c.c. presented by both.

The third advantage claimed, viz. that the mixture
will keep is undoubtedly true, i.e. the mixture will
retain its extremely feeble immunising powers for a
considerable time.” “Reports to Cape Government”
by Dr. Turner & Kelle in the Government Gazette of
October 1st 1897.

My own experience of this method is very similar.
I inoculated two heifers – one of 56 and the other of 76 c.c.
with glycerinated bile, the dose given being 15 c.c. on the
day later inoculated with 0.1 c.c. of virulent blood.
In consequence 89% in the first heid + 63% in the second
heird died whereas the rest were all severely ill. I
afterwards inoculated 1000 head of cattle by this
method, using c. 1.2 of 25 c.c. of the mixture followed
by 0.2 c.c. of virulent blood, with good results only
6 per cent. dying.

I cannot see any advantage to be gained by
using this method.

V Serum.

Professor Koch discovered that by using serum from
a salted beast immunity could be produced for a short
period. By further experiments he perfected this process
and rendered it practicable.

To prepare the vaccine I used blood taken
from animals that have entirely recovered from the pest
after I had convinced myself by means of an injection of 20 c.c. of fresh rinderpest blood that they are actually immune. The blood which is drawn from the vein by incision, is caught in a well cleaned and well covered large glass vessel, and placed during the next twenty-four hours in a cool room. Provided that during this time it had been standing undisturbed a blood clot is formed which is swimming in the enclosed serum. By means of a pipette this liquid is removed and as once mixed with fresh rinderpest blood in the proportion of 1:100. The mixture is kept for at least twelve hours in a cool place, but must be shaken from time to time. After the expiration of this time 20 c.c. of the mixture are to be injected for immunisation. In this manner a certain foundation for the immunity is established which is considered lower than that produced by bile, but may be rapidly increased by means of further blood injections. To do so I have seven days after the first inoculation injected 1 c.c. of rinderpest blood, and have repeated the operation with a quantity of 20 c.c. one week afterwards.

("Report to Cape Government" page 20, by Dr. Koch).

I tried this process on twenty animals with serum obtained from the salted castle. The serum of each was used separately. No. 1 immunised the seven animals treated. No. 2 immunised four animals whilst two died. No. 3 immunised one animal whilst six died. This was a very variable result. I repeated the experiment but this time mixed the serum beforehand and the result was much better. All serum is not of the same strength and hence the variation. This method
should only be used when serum from fortifid cattle cannot be obtained. The Sanguy and Bodzie desinfectated salted blood method is practically the same process as this.

**VI. Serum and Desinfectated Blood from Fortifid Cattle.**

This method of both immunising cattle against rinderpest & curing the disease was first published by Dr. Turner & Noble in the Government Gazette of 12th October 1894.

"The animals which provide the serum are prepared in the following manner:

"A salted animal is obtained, either one naturally salted or one which has been given the rinderpest after having been slightly immunized. As soon as the animal has recovered, it is injected with 100 c.c. of virulent blood. This generally produces a petrid reaction: as soon as the reaction is over 200 c.c. are injected, and the dose is thereafter increased to 500, 1,000, 2,000, 3,000 + 4,000 c.c. as one always waiting for the reaction from the last inoculation to subside before administering the blood."

"From such a salted animal 80 c.c. of desinfectated blood in its equivalent 200 c.c. of serum is an effective dose. For instance, at the experimental station we have treated 24 animals suffering from rinderpest in the earlier stages, and all have recovered. To show the strength of the serum, two animals already suffering from rinderpest were injected with 100 + 500 c.c. of virulent blood respectively. Next day they each received 200 c.c. of serum; both have recovered."
"In a test consisting of 92 animals 16 were side. The whole subject received, subcutaneously, 20 c.c. of defibrinated pasteurized blood. The next morning another animal was sick, but this head of the sixteen others, which were all previous to inoculation, recovered, and the rest of the herd are well at the present time."

The results of this treatment are given on 94 6 injected animals with a mortality of 74 head or about 10 percent. The report then goes on to deal with producing immunity in animals not already injected with rabbit sera.

"The object is to ensure infection of as definitely and severe a character as possible, and at the same time to administer the serum in such a dose as to ensure the safety of the animal. It will then have suffered from the disease, and will enjoy as high and durable a degree of immunity as it is possible to confer. This object may be easily obtained by injecting the virulent blood, i.e., on one side of the animal, and immediately after 1, 10, 20 c.c. of the serum on the other side. We direct the blood and serum to be injected on different sides, not because this is of importance, if they are injected away from one another this is sufficient, but if they were introduced together or in close proximity the serum would ineffectually destroy the tenderest tissue and the animal would not become ill."

"Used in this way the virulent blood injects the animal before the serum has time to take effect, the tenderest organisms enter the blood immediately and immediately begin to multiply. The serum does not produce its effects before some hours have
passed. Thus the presence of the organism in the blood containing a chemical immunising substance of a definite strength is ensured. The organism is not actually destroyed, but it is attenuated. The animal suffers from a modified form of the disease showing all the usual symptoms, and is salted. Our experiments have been made upon 29 animals. These have been treated as follows:

<table>
<thead>
<tr>
<th>No. of animals</th>
<th>Dose of serum</th>
<th>No. which died</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>20 c.c.</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>10 c.c.</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>5 c.c.</td>
<td>6</td>
</tr>
</tbody>
</table>

These animals were not treated in any way; we have not even administered a second dose of serum, which in case of necessity, the farmer would be in a position to do with good effect.” ("Report on the Progress of Research Work at the Kimberley Experimental Station, Kimberley" by Sir James and Holle, published in the "Cape Government Gazette", October 23, 1897).

I had 21 salted cattle and these 9 were killed. I could inject 6,000 c.c. of virulent blood into each without any serious reaction following. Serum was taken from each of these animals, mixed and used on a small herd of cattle numbering 11, which were in varying stages of recovery from the pest in the eighth day of fever. Each animal received 20 c.c. of serum & each succeeding morning 10 c.c. till they were over the disease. Two heads of cattle died & there were very sick before treatment was started, the remainder of the herd salved.
another herd of 61 head were treated in the same way. These cattle were all men or less sick and seven had died previously to treatment. 6 head died and the remainder salted.

I next obtained 72 head of clean cattle and these received 1 c.c. of virulent blood on one side of the neck and 20 c.c. of serum on the other. These cattle received no further treatment, all salted after suffering very mild attacks of rinderpest.

These facts speak for themselves and I have no hesitation in saying that properly carried out the mortality after this treatment should not be greater than 10 per cent.

To sum up, the treatment of rinderpest I should advise that where fortified salted cattle can be obtained clean heads should be treated by Yuner and Kolli's serum and blood method, where salted fortified cattle cannot be obtained Koch's gall method should be used in clean heads; in infected heads Yuner and Kolli's serum should be used or if this cannot be obtained then defibrinated salted blood in large doses should be used.

David M'Carthy MB + C. M.
District Surgeon of Tsolo
District in Griqualand West,
Cape Colony