

PYROPLASMOSIS OF THE DONKEY.¹

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THE diseases of animals due to the presence of protozoa in the blood have recently assumed so much importance that a special class—pyroplasmosis—has been adopted for them by the French veterinarians. Nearly all the domesticated animals are now known to suffer from one or more diseases of this class. Up to the present, however, I am unaware that any writer has described a pyroplasmosis in the donkey.

My first acquaintance with the disease dates from the 2nd of March of this year, when I was sent to investigate an outbreak of disease among donkeys at Lydenburg, which was attended with heavy mortality. I made eight *post-mortem* examinations on the day of my arrival, and the appearances were so marked, so much alike in every case, and so different from anything I had seen before, that I came to the conclusion they were suffering from an unknown specific blood disease. Since then I have had outbreaks all along the Waterburg district, among isolated spans belonging to settlers and farmers, and also among a large mob up the Apies River.

The animals attacked do not appear to belong to any particular country, breed, age, or sex, but Colonial-bred donkeys in most cases pass easily through the first or acute stage, and then recover without passing on to the second or chronic form; in fact, in some cases, were it not for the extremely high temperature, coupled with the fact of other animals in the same mob or span being affected, no suspicion of disease would arise, although a careful observer might notice the animal a little dull and off-colour.

From this it will appear that native donkeys are more or less immune; for, although I have never seen one escape the disease if placed under the same conditions as imported donkeys, I have also never seen one die from it.

The disease does not appear to be congenitally transmissible. Foals of dams suffering from the disease in either of its stages appear to be quite healthy. Although the mother may be a mere bag of bones, the offspring thrives and does well, microscopic examination of blood smears revealing no pyroplasms, and intravenous injection of blood from an infected animal causing no reaction. This latter circumstance, however, must not be taken as conclusive evidence of immunity, as the intravenous injection of virulent blood into healthy adult donkeys, mules, a dog, and rabbits, caused no systemic disturbance whatever, thus by analogy leading us to the conclusion that there must be an intermediate host or carrier.

Symptoms.—The period of incubation is not known. The disease is usually ushered in by symptoms of a very trivial character; in fact, in the acute or first stage the disease is very difficult to diagnose, especially at the outset, when one has not had previous cases and *post-mortems* to give a clue.

The animal usually stands apart from the others, and seldom lies down during this stage of the disease. It appears dull, sleepy, and stumbles when walking; the skin is hot, and there is thirst and often

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slight loss of appetite. The visible mucous membranes are clean, pale, and blanched, but not yellow or dirty as in equine malaria. This also applies to the conjunctival membranes, but the membrana nictitans is often the seat of dark red patches of ecchymosis. A general or localised erythema usually makes its appearance during the first four or five days, with a vesicular eruption along each side of the spine, and occasionally on the muzzle, nose, and legs, below the knees and hocks; the vesicles afterwards become pustular, dry up, and desquamate. The pulse is usually full, quick, and intermittent, but varies a great deal. The temperature is always very high in the acute stage, ranging from 105° to 107° F., generally over 106° , and lasting usually five or six days, when it drops suddenly to sub-normal, where it remains until death or recovery. At the same time there is good reason to suppose that in some cases the period of fever is of longer duration; in one case, at least, the animal had a temperature until the ninth day, when it dropped suddenly, the patient dying a few hours later. In spite of this high temperature, it is remarkable that there are no rigors, that the extremities, legs, ears, etc., are always warm, and that the respirations are not increased; there is no swelling or œdema of the sheath or extremities, no pain or colic, and no loss of flesh, although a marked change comes over the patient as soon as the temperature drops.

In the second, or chronic form, the disease is characterised by progressive anæmia and rapid loss of flesh, especially in the muscles of the back and hind-quarters. The animal walks in a straight line, as though trying to balance himself on a tight-rope, and looks neither to the right nor to the left; he often appears to be in a state of semi-coma. In some cases a partial paralysis of the hind-quarters and sphincter ani, with consequent dilatation of the anus, is present, due, no doubt, to interference with the normal functions of the cord in the lower dorsal and lumbar regions, as the result of pressure caused by the exudate which is present in greater or lesser quantities within the spinal membranes.

The animal now becomes a sorry spectacle, for, in addition to the extreme emaciation, the hair falls out, and the skin peels off wherever there was rash. The action of the heart is irritable, irregular, and often tumultuous, the palpitations being heard some distance from the animal, and, in fact, sometimes so violent as to cause the whole frame of the animal to shake. The pulse may be full and quick, weak and thready, or intermittent, but is of no diagnostic value whatever, as it entirely depends on the extent of the heart lesions. The breathing is quickened, but each individual respiration is shallow, and the acceleration is probably due to heart disturbance, as it is very unusual to find the lungs in anything but a normal condition.

The appetite will, during this period, have increased if anything; in fact, in many cases the animal has a voracious appetite and will eat to the last. The evacuations are little changed in character. There is a copious excretion of urine, which is usually very pale and watery; but in a small percentage of cases the condition of hæmoglobinuria is present.

Unless treatment is prompt and energetic, the animal gradually wastes away; the anæmia becomes more marked, the animal appears half asleep, has to be helped on to its legs in the morning, ultimately

getting so weak that it lies prone for probably a couple of days, and dies without a struggle. In other cases complications may arise; and bowel troubles with colic occur occasionally, due to the animal being unable to digest the result of an appetite which he is always ready to satisfy.

The different kinds of pneumonia, but principally those of a septic infection, also hasten the end, and I have also found inflammation of the bowels to be the immediate cause of death; but these have nothing whatever to do with the disease, and are due to the conditions under which the animals are placed when in such a low and debilitated state.

From this it will be seen that no symptom or group of symptoms is really specific, and diagnosis in the first or acute stage is extremely difficult. At the same time, the fact of the symptoms being of a negative character, coupled with the high temperature, gives one a clue. Blood smears may confirm, or they may not, as the pyroplasma is not always present in the acute, and never in the second or chronic stage.

Post-mortem Appearances.—In the first or acute stage there is usually nothing to mark externally; internally, one cannot help noting the sort of parboiled appearance of the majority of the tissues. The liver is usually very much congested, with a yellow tinge, and its substance is also more or less broken down, but there is no jaundice or staining of the tissues.

The spleen is enlarged, but there is no breaking down of its structure; the kidneys are pale; all the other organs are more or less normal, and one is at a loss to explain death except by the action of a toxic poison.

The *post-mortem* appearances of the second or chronic stage are, however, more marked. Externally, extreme emaciation is noted, pallid visible mucous membranes, and a more or less bare condition of the skin along each side of the spine, and down each hind-quarter. On opening the animal it will be noted that there is marked anæmia, extreme pallidity of all the tissues, with sometimes an enormous serous effusion into the abdominal cavity—in fact, at times there appears to be an acute dropsy. This effusion is not confined to the peritoneal cavity; there *may* be a slight effusion into the pleural cavity, but there is *always* an abnormal quantity of fluid in the pericardial sac, the liquid being blood-tinged in a small percentage of cases.

In addition to petechiæ being found on the membrana nictitans, ecchymoses are occasionally found on the different mucous and serous surfaces, and D. V. Š. Conacher states that he found hæmorrhagic patches in the intestines; but, as I have come across very few cases out of a very large number of *post-mortems*, and as I have already stated that I consider inflammation of the bowels to be a concurrent accidental condition, I have not included it in either *ante-* or *post-mortem* symptoms. There is no jaundice. The changes in the heart are most marked; the pericardium invariably contains an amber-coloured fluid, which in some cases is a deep port-wine colour. The heart itself is very flabby and enlarged, and the fat at its base and along the auriculo-ventricular furrow is replaced by an almost transparent gelatinous exudate, but it may be amber or pale-green in

colour. Although this condition is not specific to the disease under notice, it is invariably found, and is therefore of considerable diagnostic value.

Subendocardial ecchymoses are also often found, and it is very rarely one makes a *post-mortem* examination without finding *ante-mortem* clots in the heart and extending along the course of the large blood vessels; and this clotting is so perfect that by gentle traction one may pull out the clot for a considerable distance, showing the branching of the various vessels which they occupied. I have also found extensive *ante-mortem* clots in the blood vessels of the hind limbs. The blood itself is noticeably pale in colour, and when the hand is dipped into it it runs off without leaving any stain. If placed upon a slide or a piece of writing paper, the red corpuscles immediately run together in nests or groups, so that they become visible with translucent liquor sanguinis between.

The larynx, trachea, bronchi, pleura, and lungs present a perfectly normal appearance, but occasionally symptoms of bronchitis are present, and I have found several cases of septic pneumonia, either running concurrently with the disease under notice, or induced by the lowered state of the general health and the more or less insanitary conditions.

Nodules are also found occasionally in the lungs, due no doubt to some nematode which has undergone calcareous degeneration, but this has nothing to do with the disease.

The lymphatic glands throughout the body are more or less swollen, and often show a hæmorrhagic infiltration. The mouth, pharynx, and œsophagus present no abnormal appearance.

Although there is usually an enormous serous effusion into the peritoneal cavity, there is no inflammation, either circumscribed or general; it is purely a transudate.

Out of the enormous number of *post-mortems* that I have made, I have never found any abnormality of the stomach, but in one case examined by D. V. S. Conacher he found inflammation of this organ, which may have been an accidental occurrence.

The intestines are as a rule more or less normal, but pale in colour; they often contain enormous quantities of nematode worms (*Sclerostoma equinum* and *Sclerostoma tetracanthum*), so numerous, in fact, that one might easily jump to the conclusion that the presence of the worms was the cause of the disease, but it is not so. All parasites, whether internal or external, thrive and multiply when the body juices of their host lose their protective action from disease or debility, and the worms in question simply revel in the catarrhal condition of the mucosa which is nearly always present.

In the earlier stages of the disease the liver is always enlarged, and often presents yellowish-white patches on its surface, which appear to be due to thickening of the capsule; but, as the disease assumes a chronic form, cirrhosis takes place, with consequent contraction in at least 75 per cent. of cases.

In several cases I have found liver flukes in great numbers, and in a few cases the liver was simply studded with calcareous degenerations of cestode larvæ.

The spleen is always enlarged and pulpy, often broken down, and

may weigh anything up to 7 lbs. ; in fact, its naked eye appearance is that of an anthrax spleen.

The kidneys are always pale, and present a parboiled appearance.

The bladder on *post-mortem* is always enormously distended, usually with pale watery urine, but occasionally with blood-coloured contents, the organ itself presenting no abnormality.

The brain, as a rule, presents a perfectly normal appearance, except that there is usually fluid in the lateral ventricles, which is colourless or slightly tinged. There is nearly always an increase of fluid within the spinal membranes, and occasionally a gelatinous deposit in the lower dorsal and lumbar regions. These conditions probably account for the semi-coma and partial paralysis so often seen in this disease.

Cause of the Disease.—The cause of the disease was discovered by Dr Theiler in blood smears made from donkeys during the first outbreak, and I quote his report in his own words :—

“The cause of the disease is the presence of an endoglobular parasite invading the red blood corpuscles. It belongs to the class of pyroplasma, and is very closely related to, if not identical with, the pyroplasma found in the malarial or biliary fever of the horse and mule.

“The pyrosoma, as it was originally called in cattle, belongs to the same group, as also does the pyroplasma of biliary fever in the dog. The pyroplasma of the donkey is round in shape, and varies somewhat in size, from about one sixth to one third of the red corpuscle in which it is found ; pear-shaped or oval forms are exceptional.

“In staining with ordinary aniline dyes—methylene-blue, for instance,—the pyroplasma is recognised as a blue disc, on the green-tinted corpuscle.

“In staining with eosin-methylene-blue mixture, specially known as Laveran's stain, and in mixtures of Azur II. with eosin, the finer structure of the pyroplasma is recognised. When stained, a nucleus is seen which takes a red tinge. Around the nucleus (karyosoma) the faintly-bluish protoplasm of the parasite cell is recognised. Sometimes a clear zone encircles the nucleus. The karyosoma may be recognised in all forms of the pyroplasma, and varies according to the size of the latter.

“The largest forms which we recognise are apparently those which multiply by fission.

“Thus we recognise in one protoplasma four karyosomas, and in a later stage we find each four karyosomas separated, and surrounded by a small zone of bluish-tinged protoplasma.

“This form resembles a rosette and is very typical. In still later stages we find these rosettes completely separated ; the newly formed pyroplasms leave the red corpuscle, and thus it happens that we find two parasites in one cell. We may, however, find three individual pyroplasms, which are either completely separated from each other, or still hanging together. I have not been able to trace the pyroplasma outside the red corpuscle, but there is no doubt that it exists in the plasma, as it does in biliary fever of the horse.

“The pyroplasma is usually found in acute cases. It may be in the blood, the heart muscle, or the liver, but it is found most abundantly in the spleen, where the forms of multiplication—the rosettes—are most frequently met with. So much does the pyroplasma resemble

in its form and in its reproduction the pyroplasma found in horses and mules suffering from biliary fever, that one is struck with the idea that probably they are the same species, or varieties of the same species of endoglobular parasite."

Experiments.—Very little experimental work has been carried out, as those of us who have come in contact with the disease have had our hands too full to devote the necessary time and close observation demanded in research of this nature, and what little has been done is of a negative character.

I.—A fairly young large Kaffir hound was inoculated at Lydenburg by D. V. S. Conacher and myself, with blood from a donkey owned by the P. W. Department, suffering from the disease in the acute stage, with a temperature of $106\cdot4^{\circ}$ F., pyroplasms being afterwards found by Dr Theiler in blood smears obtained at the time of injection. The dog was forwarded to Dr Theiler for observation. No reaction and no systemic disturbance took place; in fact, the dog improved in condition, and no pyroplasms were found, although the blood was examined daily for an extended period. The donkey from which the blood was taken ultimately died, and D. V. S. Conacher, who made a *post-mortem*, found the usual appearances.

II.—Two rabbits inoculated with blood by Veterinary-Surgeon Pye at Lydenburg were sent to Dr Theiler for observation; no reaction took place.

III.—Three mules inoculated by myself with 50 cc. of blood from donkeys in the second or chronic stage of the disease, and suffering from its sequelæ, caused no elevation of temperature, and no systemic or local reaction.

IV.—A healthy donkey was injected by myself with 20 cc. of blood from a donkey in the second stage of the disease, the injection being made into the jugular; and no reaction whatever took place.

V.—Two healthy donkey foals, whose dams had suffered from the disease and recovered, were inoculated by me with 20 cc. of blood from a donkey in the chronic stage of the disease; no reaction whatever took place. No blood containing pyroplasms was available at this time, as all the mob were in the second stage.

VI.—Struck by the similarity of many of the *post-mortem* appearances of this disease and tick fever in cattle, allowing for difference in species, D. V. S. Conacher was induced to inoculate a healthy donkey with 50 cc. of virulent blood from a certified case of Rhodesian tick fever. The second day the temperature rose to 103° F., then fell to $100\cdot3^{\circ}$ F., and ranged between that and $101\cdot4^{\circ}$ F. until the sixth day, when he was unable to continue his observations through stress of work.

I am afraid these experiments tell us very little, except that the disease is not contagious in the ordinary way; but, by analogy, we can assume that the hæmatozoon undergoes some metamorphosis, probably in the body of a tick by which it is carried and the disease transmitted, as has been proved to be the case in red-water and the malarial biliary fever of dogs.

At one time I was of opinion that this disease was quite different from anything found in the horse or mule, but I have lately had occasion to modify my views, for not only have I seen something very similar, if not identical, in mules, and which I have not had time so

far to investigate, but it will be seen that in many things the disease resembles equine malaria. The hæmatozoon is of the same type, the disease runs a very similar course, and although the clinical symptoms, especially in the acute form, vary considerably, this may be accounted for by difference of species. At the same time, although they are so very similar, I am of opinion that they are different and distinct diseases, caused by blood parasites that are possibly as nearly related to each other as the horse is to the ass. One reason for coming to this conclusion, and a very important one I think, is that I have inspected mobs of donkeys that were either healthy or suffering from worms, or some other complaint, and been called in to attend cases of biliary fever among the conductors' horses used for herding the donkeys. These were invariably imported horses, but so were the donkeys.

At the present time I am treating a mob of 1000 donkeys suffering from pyroplasmiasis, but the horses, to the number of a dozen or more, that herd them, mix with them, eat the same grass, drink the same water, and get bitten by the same tick, are not only quite healthy but are in the pink of condition. This also applies to the mules used for transport on the same dépôt.

On a farm at Hartingsburg, near Warm Baths, I had twenty donkeys affected with this disease, eight being Argentines and twelve South African bred. One, an Argentine, died in the acute stage before I arrived; another was very bad in the acute stage, with a temperature over 107° F. My prognosis was that he would die, but he recovered with very little evidence of sequelæ. The other six had passed on to the second stage and had sub-normal temperatures; they all recovered and are now at work. The twelve country-bred donkeys had all either been sick, or had high temperatures when I examined them; and, as is usually the case with native donkeys, passed through the acute form, recovered, and were the first to be at work. The only horse on the farm was never ailing for an hour; but though it was country bred so were twelve of the donkeys, and, if the diseases are caused by identical pyroplasms, one would expect the horse to show it more than the donkeys, seeing that the symptoms of biliary fever of the horse are so much more marked during the acute stage.

From this it will be seen that it is possible to have horses affected with equine malaria in contact with a herd of donkeys, and the donkeys not to be affected with the pyroplasma equi. It will also be seen that it is possible to have 1000 donkeys suffering and dying with heavy mortality, and the horses which herd them apparently possessing immunity.

Treatment.—The one redeeming feature of this disease is that it is amenable to treatment; prognosis, except where the animal has suffered from the disease for some time and where organic changes have taken place, is always favourable. It is essential, however, that the animal be treated as an invalid; he must have generous fare, food that he can easily digest, mash made with boiled oats and maize, with bran added until it is crumbly moist, and green food if it is obtainable.

In the first or acute stage, until the temperature drops, I have found the administration of 2 drachms of either ammonia carbonate or chloride, combined with 2 drachms of sodæ hyposulphite, to be most

effective ; and if the heart is irritable, irregular, or tumultuous, as it often is, I have found a drachm of belladonnæ extract, given as an electuary, or combined with the ammonia and hyposulphite of soda, to have a markedly beneficial effect.

Immediately the fever abates, change the medicine to 3 grains of arsenic in a drachm of sulphur, given dry on the tongue once a day for ten days ; then do nothing for two days, after which start the administration of tonics. I have found a drachm of finely pulverised ferri sulph. placed on the tongue in the same manner as the arsenic mixture to act very well. I do not advise the administration of purgatives, even at the commencement of the attack ; but, if the animal is stall-fed, a couple of ounces of mag. sulph. in a bucket of water, left before the patient so that he can drink whenever he wishes, is a great help in keeping the bowels in order, and also acts as a febrifuge.

Other drugs have been experimented with, and with success, especially carbolic acid, quinine, and salicylate of soda ; but these drugs are not so convenient to use, especially if one has a large mob to dose. They are more expensive, and their exhibition has not proved so effective in my hands as those recommended.

In conclusion I have to thank D. V. S. Conacher for much assistance, and I am also under the greatest obligation to Dr Theiler for his generous help and advice, for which I am grateful.

REPORT ON EXPERIMENTS WITH ANTI-RINDERPEST SERUM.

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IN accordance with instructions, I requested Dr Lingard to inform me regarding his plan of experiments which were to be carried out in the Madras Presidency with a view to ascertaining the correct dose of anti-rinderpest serum.

On the 15th December 1902, in obedience to orders, I proceeded from Khandwa to Madras, to consult with Vet.-Major Gunn, Supt. C. V. D., about the arrangements.

Major Gunn had arranged that the Taheildars of the Taluga in which experiments were to be performed should get farmers to lend the requisite number of cattle on condition that they would be compensated for any loss. We decided, however, to purchase all animals to be used as controls and for the upkeep of virulent blood, as it was thought possible that the death rate amongst these animals might be high. This arrangement led to a very considerable saving, and made it possible to undertake test experiments on a much larger scale than was originally intended. I had been given to understand that my service in India should not cease until the experiments were finished, but unfortunately it was impossible to complete the whole series, as I was informed later that my departure for the Transvaal should not be unnecessarily delayed.

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