

A broad statement of the immediate policy in Southern Rhodesia to-day is that effort is being concentrated on reducing the game as much as possible all along the edge of the fly infested country in the hope of arresting or retarding the extension of the infested country. Such action is logical and inevitable in face of the very serious threat to the welfare of the colony created by the steady encroachment of the fly and lack of known practicable alternatives.

Control of Traffic.—Increased use of motor vehicles for prospecting and hunting purposes has rendered control of such traffic highly desirable in some localities and during the last Session of the Legislative Assembly at Salisbury an Act was passed giving the Government powers in this connection. This Act is to be utilized at once.

Research.—Definite action against the fly has been, and will, in all probability, continue to be unavoidable. It must, without doubt, have first call on the Treasury on considerations of urgency. It would seem, however, equally necessary that facilities for research into the bionomics of the fly should be provided and that the effect of such operations as are in progress should be followed on a more scientific basis than has been possible hitherto. Such research has not been altogether neglected in the colony and is in fact proceeding along several lines at the present time. It has, however, been a case of endeavouring to make the most of available opportunities and to fit this research work in with the other duties of the Division.

It appears highly desirable that a more or less permanent field station should be established in an undisturbed fly area, where pure bionomical research can be made the main feature of the work, whilst facilities for experimental and *ad hoc* research also exist in the neighbourhood. An increase in the technical establishment would, of course, be involved, and collaboration between veterinary officers, proto-zoologists, entomologists, etc., is indicated.

The vital menace to the colony created by the fly's continued spread certainly justifies a substantial effort in the direction of supplementing our present knowledge and finding more satisfactory methods of dealing with this complex problem than are known at the present time.

The question of establishing a suitable research station in the fly country is, I may say, receiving the very serious consideration of my Government at the present time.

Paper No. 4.

ESSAY ON THE ECONOMIC POSSIBILITIES OF THE TREATMENT OF TRYPANOSOMIASIS IN CATTLE (BOVINES) WORKING WITHIN AREAS AFFECTED BY GLOSSINA.

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ONE of the most serious problems confronting agricultural development in the northern part of the Portuguese Colony of Mozambique is, without doubt, the dissemination of the tsetse fly, whose ravages militate against the breeding of domesticated animals for employment in ploughing and tilling the land, and in the transport of its products.

In consequence thereof, most of the small and medium sized agricultural territories find themselves compelled, as is the case in all other inter-tropical colonies, to seek from the native the principal source of labour to till their lands; this kind of labour, however, on account of its comparatively high cost, together with atavic indolence, becomes too severe on the cost of production.

Overcoming the evil may lie in economically solving the problem of animal trypanosomiasis, since in the major part of this great area one finds exceptional conditions for cattle-breeding, provided the danger of trypanosomiasis could be eliminated, thus, human labour could be replaced, with great advantage in the way of economy, speed, and perfection, and the revenue from the land would increase with the subsidiary exploitation of cattle-breeding. But the complete solution of the problem of the tsetse fly and of the diseases transmitted by it is still a long way off, and it becomes necessary to seek a means of attenuating certain difficulties which, at the moment, burden the already created interests and investments, and thwart the initiative for fresh ventures.

The comparative study of the value of labour, as between native and cattle labour, for example, weighs, beyond dispute, in favour of the supremacy of the animal as against the native, both from the economic point of view as well as the most perfect tillage of the land.

Most accurate calculations, carried out in the Quelimane district, which is included in the area of the Colony, most affected by trypanosomiasis, and which is the region where the burden of difficulties mentioned is most felt, show that, by comparing the output from native labour as against its cost, with the output from cattle (bovine) labour, also as against its cost—the amount expended in the purchase (local price), feeding, etc., of the ox, will repay itself completely in less than 100 working days.

This economy will be further enhanced wherever the agriculturist is at the same time the breeder of the oxen required for his work; in fact, in the very areas affected by trypanosomiasis, the cost of the production of an ox, up to the time when it is old enough to work, is less than the commercial value of its hide.

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With the object of ascertaining the practical value of the employment of cattle (bovines) for agricultural labour in the glossina zones in the north of Mozambique, we have tried the following experiments in their treatment:—

1st.—In the treatment of the animals with any of the medicaments of an acknowledged trypanocide action, at intervals of not more than the medium period of incubation of the disease, granting as certain that the animals would be constantly reinfected by the glossinas from the locality, or subject to frequent relapses.

2nd.—In determining the sterilizing power of the medicament employed, and thus establishing and ascertaining by means of frequent blood analyses what is the minimum period of time taken by each medicament in avoiding the reappearance of the parasite in the circulation.

3rd.—In establishing the minimum period of resistance of the animals thus treated and of the controls (animals that were not treated).

4th.—In ascertaining whether the frequent infecting stings of the glossinas, and the repeated treatment, do grant any power of immunity after a certain period.

5th.—In carrying out the toxicological study of each medicament, and judging the advantage of medicamental associations.

6th.—In ascertaining the practicability of the treatment of a large number of animals, and judging its economical advantages.

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1st Experiment: This comprised a herd of 28 cattle (bovines) belonging to the Société du Madal, and which were working in the Zalala Plantation, at 36 miles distance from Quelimane, near the coast.

The Zalala Plantation lies near a dense forest, where the glossinas of the species *Brevipalpis* and *Austeni* are to be found in great numbers.

The contact of the animals with the forest is almost permanent, and often the glossinas are captured in the middle of the cocoon plantation, where the cattle kraal is situated. On several occasions, the owners sent to this plantation cattle for agricultural and transport purposes, but the trypanosomiasis soon completely decimated the animals.

In August, 1926, the company again experimented with 32 animals, nine of which died from this disease before April, 1927. On the 27th of that same month we initiated, with the permission of the company, an experiment with the remaining 23 bovines, treating 21, and reserving only 2 as controls.

The medicament preferred by us was tartar-emetic, which we had found, on previous occasions, to give us very encouraging results in the treatment of oxen infected with the trypanosoma *congolensis*, but in places from from tsetse.

The emetic, diluted in a physiological solution, was initially injected into the jugular vein, in a dose of 20 c.c. at 5 per cent., this corresponding, therefore, to 1 gram of the drug, per animal.

Microscopical examination of the blood revealed, in many of the animals, the existence of the trypanosoma *congolensis*, and almost every one of them showed the characteristic symptoms of the disease: Fever, melancholy, coat dry and without brilliancy, lachrymose eyes, pronounced thinness, and some of them in a complete state of organic misery.

In consequence of their depauperation, many hardly supported the injection of the emetic, the depressive action of which, on the circulation and breathing, is well known.

Cases of strong dyspnoea, with symptoms of pulmonary congestion, were not infrequent following on the injections and, for that reason, we started to inject, at the same time as the emetic, a dose of 20 c.c. of camphorated oil, at 10 per cent., also in the jugular vein. Thereafter, as we only possessed syringes with a capacity of 20 c.c., we mixed the two drugs in the same syringe, using 10 c.c. of camphorated oil at 20 per cent. and 10 c.c. of emetic solution at 10 per cent.

We preferred this process to the employment of the emetic in suspension in the camphorated oil, as, with the sterilization at boiling point, the emetic settles.

With the addition of camphorated oil, the shock caused by the emetic is very slight and soon disappears.

We next tried injecting the emetic-camphor mixture, by injections, into the muscles of the hindquarters (semi-tendinous), as it appeared to us of easier application, especially in bad-tempered animals and, in fact, we obtained good results. Only on two animals were observed small tumefactions at the seat of injection, which were soon reabsorbed, without causing inconvenience to the animal's movements.

Generally, the absorption of the emetic through the muscles is rapid, and the calmative action of the camphor avoids the irritation produced by the emetic, both on the cutaneous and subcutaneous tissue.

We frequently examined the blood of the animals on the day following the intermuscular treatment and we never found the parasite, even though it were found before the injection in the current of circulation, which proves the ease with which the emetic is absorbed, and the efficacy of its sterilizing action.

It was not possible for us to apply the treatment to this group of animals with such regularity as we would have desired. The intervals mediating as between every two treatments were, in the main, excessive and above 30 days (see Map No. 1), but other demands on our official time did not permit us to maintain a greater regularity. We think, however, that the best results will be obtained when the interval as between the two medications does not exceed 12 or 15 days.

On the 27th September, we interrupted the treatment, which had been carried on for five months. During that period, animals Nos. II, XIX, and XX died at the end of 32, 49, and 30 days respectively as calculating from the last treatment made.

We arrived at the conclusion that had we shortened the intervals as between the medications, these figures would have been further reduced.

The only control animal that did not live died in December and, on that date, all the others were living and rendering labour. We considered these results quite satisfactory. Feeding was much improved, and that ought, to a great extent to have contributed thereto. The animals in that region are generally kept exclusively on grazing. If they work in the morning, they rest in the afternoon, and vice versa. During the night, they are enclosed in small kraals, which are used in rotation in order to avail the manures which are gradually employed in fertilizing the palm trees of the plantation, but it is not usual to supply the cattle with fodder.

However, the animals experimented upon were kept during the night in stables provided with mangers that were filled daily with mealie hay and green "massingel" (native name for elephant grass), which grows spontaneously in that region.

Careful feeding has an important influence in the benignant march of the trypanosomiasis.

We have on countless occasions observed that animals attacked by the trypanosomiasis will show a better resistance to the invasion of the virus if well fed.

Some of them, without any other treatment, succeed in an apparent cure, and will resist for several years, though subjected to an almost daily labour, without any manifestations of relapse. Of course reinfections are very improbable.

Therefore, we advise the continued greatest care with the feeding of the trypanosomated animals, in addition to any medication.

The death rate verified in this experiment was 14 per cent. as among the treated animals, whether we consider only the five months' period of treatment, or also the eight months period running up to 31st December.

Among the control animals, the mortality was nil during the treatment, and would have been 50 per cent. at the end of eight months, but on account of the number of controls being small, we cannot attach any important interpretation to this percentage.

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2nd Experiment: (Map No. 2).—This experiment was also carried out in the locality known as Zalala, during 1928, and was initiated on 21st March with 25 bovines (labour cattle), 13 of which had already gone through the first experiment (Nos. I, III, IV, V, VI, X, XI, XII, XXIII, XVI, VII, VIII, and XIII), the latter, therefore, having already been there for about eighteen months. The remaining 13 animals belonged to a primitive group of 20, 7 of which had succumbed to trypanosomiasis between the 1st January and the time when this experiment was started.

The total mortality at Zalala, as from 1st January to 21st March was 13 animals, as 6 out of those which underwent the first experiment died also of the sickness.

In less than three months, the death rate was 33.7 per cent.

Local conditions had not modified in any noticeable way, and the animals continued in permanent contact with the forest infested by the glossinas.

Besides the tsetse fly, the abundance of Tabanidae, *Haematopotes*, etc., was great and, even if there were no recurrences caused by the cyclic trypanomas held by the glossinas, the mechanical infection, by the various haematophagic flies, was evidently permanent because, this time, we reserved a greater number of animals for counter-proof, the blood of which was kept more or less virulent.

At Magurumene, at about 6 kilometres from Zalala, 32 labour bovines that had been sent from the clean areas were placed, but were not submitted to treatment and, therefore, were considered also as controls.

The animals from these two groups came frequently in contact with each other, doing the transport work between the two localities and working in the neighbouring plantations.

Out of the 26 oxen, 17 were submitted to treatment, and 9 were reserved as controls. The treatment was identical to the treatment employed the previous year: injections, with preference into the semi-tendinous muscles, with the mixture of emetic-camphorated oil, but, instead of 1 gram, we increased the dose of emetic to 1.5 in every injection.

The treatment carried out on 13th November (Map No. 1) consisted of a mixture of Bayer 205 (2 grams) and emetic (1 gram) in physiological solution, as it was only then that we were able to get hold of that medicament, which we wished to alternate with the emetic in future experiments.

The inter-muscular injections were always well supported by the animals, without any adverse effects worth mentioning. We con-

tinued to give preference to this method, as it obviates general accidents, which often cause the rapid death of the animals injected intravenously, and numerous cases of abscesses, phlebitis, etc., when the treatment is carried out by inexperienced persons.

From the beginning of the experiment up to the end of January of the current year, three of the treated animals died (Nos. III, VI, and XXVI. No. III was a very old animal and succeeded, notwithstanding, to resist about a year and a half in this infected region, rendering his labour to the plantation until very near death.

The death of No. VI could not be attributed to trypanosomiasis, but rather to an acute intestinal toxication or infection, as the European who was in charge informed us that the animal only on the day previous to its death became very run down and was expelling blood-stained mucus from the anus. This animal was also one of those undergoing the first experiment, and always appeared healthy, being daily kept at work. It had not been injected since June, because we had never found the parasite in its blood, and we desired to verify whether it was the treatment that caused the absence of trypanosomas, or whether a special state of immunity had been acquired. In fact, at the end of two months without treatment, the trypanosomas, though in small number, were noticed for the first time in that animal which, for about one and half years, had lived within an infected area and cohabited with other strongly infected animals.

We were unable to post-mortem this animal, as we were at the time staying too far off from the place where it died, but as the aforesaid symptoms have nothing in common with the trypanosomiasis, we do not attach the probable cause of its death to this sickness; even if that were the case, we should bear in mind the fact that the animal had received no treatment during the previous four months.

Ox No. XXVI was the only one of the treated animals among the most recently introduced in Zalala that died. Nevertheless, it worked for eight months, which well compensated for the loss sustained by its death. It must be observed that it died thirty days after its last treatment.

Ox No. XXV was felled for consumption of the labourers, as it was unfit for work.

Actually, only two oxen succumbed to trypanosomiasis proper which gives an average death rate of 11.7 per cent., being a small average if we consider that half the oxen were animals which had been kept at the place for many months previously, and that even now a part of their number are still rendering their useful labour.

Among the nine controls that cohabited with the treated animals, there were only two deaths, being No. XVI, one of the oldest animals in the region, and No. XXXVI, one of the oxen introduced to Zalala in January, 1928. The death rate of these two controls was only 22.2 per cent., which may lead us to conclude, on superficial analysis, that the influence of the treatment was practically of no value.

But one must not come to that conclusion. Oxen Nos. VII and XII appeared, when the treatment was started, in a complete state of organic misery. Their leanness was extreme, and we almost supposed that they would hardly resist a few days more. But the emetic treatment and some four week's rest were sufficient for their recovery, their feeding being considerably improved. They took to work again and, up to the end of January of this year, maintained an apparent state of regular health, although now and then a few trypanosomas had been noticed in their blood samples.

These two examples do constitute an undoubted proof of the efficacy of the emetic treatment.

The heavy death rate suffered by the animals in the Magurumane kraal is also a confirmation of the therapeutic value of the emetic.

In this kraal, in which, as already stated, there were 34 oxen in January, 1928, there remained only 13 one year later. The remainder had succumbed to the trypanosomiasis, giving a death rate of 61.7 per cent.

If we add the controls from Zalala to the number of oxen for this kraal, which may be reckoned also as controls, we conclude that the figure for the average death rate in that zone was 53.4 per cent., that is, out of a total of 43 animals, 23 died.

The difference in the death rates, as between the treated animals (11.7 per cent.) and the non-treated (53.4 per cent.), is, therefore, very striking; more so if we bear in mind that, as in the first experiment, the intervals between the treatments were considerably long, but we were unable to maintain weekly intervals, although we tried at the beginning.

In this experiment, the animals of both kraals were made to undergo a system of feeding similar to the one adopted in the first experiment, and, besides, ground bones and salt were placed before them in the proportion of 2 to 1, which they had *ad libitum*.

We were desirous of observing whether there was any relation between the symptom "pica"—very frequently noticed in the animals with the trypanosomiasis in the advanced stage of the sickness, and the deficiency in phosphates attributed to certain pathological stages in which "pica" is also a dominant symptom.

We are of opinion that the rapid thinning of the tripanosomated animals, at the second and third period of the disease, accompanied by perversion of appetite which leads them to swallow earth (geophagia), is the consequence of an intensive dissimilation of phosphated elements, or of other salts, from the organism, the equilibrium of which the instinct of the animal tries to re-establish in such aberrant way. And the exacerbated appetite which the sick animals show up to the last moments of life is a further argument to reinforce our opinion, which leads us to the conclusion, until otherwise demonstrated, that a feed rich in desirable elements does exercise a beneficial influence, and often decisive, to the benign evolution of the trypanosomiasis. And the rich elements contain, almost always, a high percentage of phosphate salts.

Now, we have observed that the animals which are most vigorously attacked by this sickness are exactly those which show the greatest appetite for the bonemeal.

The Zalala oxen which, in their great majority, were subjected to the emetic treatment, always showed a lesser appetite for bonemeal than the oxen from Magurumane, which devoured it with actual greed, and as between the two places there is no difference in the pasturages, which are abundant and composed of the same botanical species.

We are also of opinion that the fact of the oxen from the Magurumane kraal showing an exaggerated appetite for bonemeal had its cause in the more intensive necessity of replenishing the losses