

1888.
NEW ZEALAND.

THE RABBIT NUISANCE.

INTERIM REPORT BY PROFESSOR A. P. W. THOMAS ON THE DISEASES AFFECTING RABBITS IN THE WAIRARAPA DISTRICT.

Presented to both Houses of the General Assembly by Command of His Excellency.

Professor A. P. W. THOMAS to the Hon. the MINISTER of LANDS.

SIR,—

University College, Auckland, 16th May, 1888.

I have the honour to forward herewith a report of the inquiry into the parasitic diseases affecting rabbits in the Wairarapa District, which was undertaken at your request. As some of the experiments are still in progress, I have termed it an interim report, but with respect to very many points I trust that it will be found sufficiently exhaustive.

In accordance with your instructions I have already forwarded to Mr. Bell a copy of the report for the use of the Rabbit Commission in Sydney.

I should be obliged if, after the report has been considered, you could inform me whether it is deemed advisable to propagate the diseases elsewhere. The general method of propagation of the diseases will be sufficiently clear from the report, but if it be decided to employ any one or more of the diseases I would draw up such specific instructions as could be used by unskilled persons.

The fact that stock feeding on the same ground as the diseased rabbits have remained healthy is probably sufficient in itself to demonstrate their harmlessness to stock, and this is confirmed by other evidence. Still, as an additional precaution, it might be desirable to prove the point experimentally, and, in this case, I will carry out such experiments on receiving your instructions. If the diseases are not to be employed the expense will be unnecessary. I may state that, so far, travelling-expenses, cost of animals, and general laboratory expenditure have not exceeded a total of £35.

If the report, or any part of it, is to be printed a few illustrations of the parasites, &c., would be a desirable addition, and could be readily added.

I have, &c.,

The Hon. the Minister of Lands.

A. P. W. THOMAS.

INTERIM REPORT ON THE DISEASES AFFECTING RABBITS IN THE WAIRARAPA DISTRICT.

I have the honour of submitting the following interim report of the result of the inquiry made at your request into the diseases prevalent amongst rabbits in the Wairarapa District, and the possibility of utilising them as a remedy for the rabbit-pest.

The subject will be considered under the following heads:—

- I. The causes which have led to the decrease of rabbits in the Wairarapa.
- II. Observations and experiments concerning the diseases of rabbits found in the Wairarapa.
- III. The applicability of the diseases as a remedy for the rabbit-pest.

I.—THE CAUSES WHICH HAVE LED TO THE DECREASE OF RABBITS IN THE WAIRARAPA.

The rabbits in the Wairarapa District, and particularly on the plain, have unquestionably been greatly diminishing in numbers during the last few years. This diminution has been attributed to the following causes: (1.) Poisoning—chiefly with phosphorised grain—in the winter-time. (2.) Trapping, and the use of dogs. (3.) The liberation of the natural enemies, as cats, ferrets, and, more recently, stoats and weasels. (4.) Parasitic disease, viz., that caused by the bladder-worm.

Mr. Bayley, the Superintending Inspector of Stock, has expressed the opinion that some factor outside the ordinary means of destruction by poisoning and rabbiting, is at work, either the natural enemy or disease. Mr. Orbell, the Inspector of Sheep and Rabbits in the Wairarapa District, has formed a similar opinion on this point. With reference to the last-named cause—parasitic disease—I may state that there is considerable diversity of opinion amongst those who have had opportunity for observation as to how far it has really been operative in the destruction of rabbits.

I spent ten days in the Wairarapa District, most of the time in the north, near Masterton, but was two or three days at Mr. Coleman Phillip's estate, at the Dry River, in the South Wairarapa. During this time, information was gathered as to how far means of destruction were

employed and the prevalence of the natural enemies, whilst several hundred rabbits were examined.

As the result of these inquiries, I arrived at the following conclusion: The most efficient cause of the decrease of the rabbits has been the careful use of phosphorised grain in the winter-time, followed up during the rest of the year by rabbiting. At the same time I was able to satisfy myself that the wild cats and ferrets are numerous in various places, and appear to be rendering good service.

In the rabbits examined I found four distinct kinds of parasitic diseases, which are widely spread in the district; and, from my own observations, together with the evidence of trustworthy witnesses, I believe that these diseases are capable of, and have, in the past, done good work in the destruction of rabbits.

II. OBSERVATIONS AND EXPERIMENTS CONCERNING THE DISEASES OF RABBITS IN THE WAIRARAPA.

Four different parasitic diseases were found amongst the rabbits in the district; these, however, are not all of equal importance, or equally injurious to rabbits. They are as follows: (1.) Disease due to bladder-worms. (2.) Parasitic disease of the liver, due to coccidia. (3.) Rabbit mange, itch or scab. (4.) Disease due to lice.

Of these, the first two are the most important.

1. *The Bladder-worm.*

The bladder-worms (incorrectly called "bladder-flukes") are well known to be the larval forms of tape-worms. Two distinct forms were found by me in rabbits in the Wairarapa, but one form only is of importance to us. This form is shown by my experiments to be the larva of a particular kind of tape-worm inhabiting the intestine of the dog.

A rabbit infested by this bladder-worm shows one or more swellings in connection with the muscles of the body; this may be on one of the limbs, on the outside of the trunk, on the head, or it may have a more internal position, and be found in the cavity of the abdomen or chest. When the rabbit is opened and examined, a bladder is found either within or attached to one of the muscles. The bladders vary in size according to the stage of development, but they reach the size of an orange, that is, a diameter of 3 in. or more. The bladder consists of two coats: the outer is a thick tough membrane of connective tissue formed by the rabbit, the inner is a more delicate, whiter membrane, which forms the bladder-worm itself. The cavity of the bladder is filled with a clear serous fluid, whilst on one side of the inner surface are attached a number of white oval bodies of about the size of a grain of wheat. Examination with the microscope shows that each consists of the head of a tape-worm, with its four suckers and crown of hooks, situated within a small pouch-like involution of the wall of the bladder. These heads are arranged close together in groups or sometimes in rows. It is clear that we have here an example of that particular kind of tape-worm larva to which the name of *Cœnurus* or many-headed bladder-worm has been given.

It is a well-established fact in the natural history of the tape-worms that the larval form is found in one animal, whilst the adult form is found in the intestine of some other animal, which preys upon the bearer of the adult form. It is, of course, usually the natural enemy of the animal harbouring the larval form, which serves as the bearer or host of the adult tape-worm. Thus the bladder-worm of the mouse (*Cysticercus fasciolaris*) develops into the tape-worm of the cat (*Tania cranicollis*), whilst the little bladder-worm of the ox, known as the "beef-measle," develops into the unarmed tape-worm of man, if the measled beef be eaten before it is sufficiently cooked.

The next question to be decided by my inquiries was which of the natural enemies of the rabbit served as the carriers of the adult form of the bladder-worm found in the rabbits of the district. The only carnivorous animals which fed on rabbits were dogs, cats, ferrets, and hawks. Stoats and weasels had been introduced into the district, but the bladder-worm was well known to exist there before their introduction. My experiments therefore took the direction of ascertaining whether any one or more of the above species of animals would serve as bearer of the adult tape-worms. I found on inquiry that the rabbit's dogs were infested with tape-worms. I therefore obtained a number of the mature tape-worm joints from the dogs and administered them to rabbits. The mature joints, it should be stated, contained great numbers of minute ova, in each of which an embryo, armed with six hooks, was already formed.

The first rabbit fed died thirteen days after infection, and was immediately examined. The muscles were marked with thick yellowish and reddish lines, and careful examination showed that these were due to the passage of young bladder-worms. The worms were found in great numbers, so that the rabbit must have contained at least five hundred of them. At this stage they were minute, transparent bladders of the size of a mustard-seed. The experiment, in fact, was too successful, for they must have led to the death of the rabbit. Another rabbit, fed with a smaller number of tape-worm eggs, died on the twenty-first day after infection. About a score of the bladder-worms were found in it, and corresponding to the longer interval allowed them for development, they had attained a greater size. They were found in the muscles of the legs, loins, chest, and neck; one was found in the tongue, one in the muscles of each cheek, and another in one of the muscles moving the eyeball. Considerable disturbance appeared to have been caused by the bladder-worms in their migration through the muscles, the bladder being generally found at the end of a track marked by the destruction of the substance of the muscle-fibre and the accumulation of pus. The favourite place for the bladder-worm would seem to be in the muscles of the loins, but all the other muscles of the body seem to be affected, even the diaphragm and the muscles of the heart and eyeball. None, however, were found away from the muscles, with a single exception, when what was possibly the track of one was found in the kidney; none were found in the digestive track, liver, lungs, brain, or spinal-cord.

Although the bladder-worms were still small there can be no doubt that they were of the same kind as those found, in a more advanced stage, in the rabbits of the neighbourhood. This is shown by the general agreement of structure, so far as it was developed, and by the identical distribution in the organs of the body. The dogs, moreover, had been bred on the spot, and had never left it save to go rabbiting; they had been fed chiefly on rabbit (often uncooked), and only occasionally on mutton, if a sheep got weakly. There was therefore a strong probability that the tape-worm had been derived from the rabbit.

The above experiments sufficiently demonstrate the genetic relation of the bladder-worm of the rabbit to the tape-worm of the dog. I say a tape-worm of the dog, for it should be remembered in this connection that at least eleven different kinds of tape-worm are known to occur in the dog.

Further observations were made with the view of ascertaining whether any of the other carnivorous animals in the district were also capable of acting as host or bearer of the adult tape-worm. In the first place, a wild-ferret and two wild-cats were obtained from a paddock in which the rabbits with bladder-worm were procured, and these were examined for tape-worm. Both cats and rabbits were free from tape-worm. In the next place, two ferrets and a cat were fed with fresh bladder-worms and kept under observation. Up to the present date the animals had given no indication of being infected with tape-worms. The evidence at present points to the dog alone as being the bearer of the adult tape-worm.

It has been mentioned above that a second form of bladder-worm was found in rabbits from the Wairarapa. Only a single specimen was obtained in that district, but in rabbits procured for the purpose of experiments from the Waikato, considerable numbers have been found. This second kind is the *Cysticercus pisiformis*, well known to all students of cestoid parasites. It is a small bladder-worm of round or pear-like form, a little larger than a pea. It differs from the *Cœnurus* described above, not only in its much smaller size, but also in containing only a single head. It is not found in the muscles, but during its early stages in the liver, and subsequently in the abdominal cavity attached to the liver or mesentery, or sometimes free. It has been shown by several zoologists that it is the larval form of a tape-worm (*Tænia serrata*) inhabiting the dog. Owing to its smaller size it causes no serious injury to the rabbit unless present in very large numbers.

Duration and Fatality of the Disease.

Let us first consider the conditions necessary for the propagation and development of the bladder-worm disease. This disease is due to a parasite which, in the larval condition, lives in the rabbit, whilst at a later period it attains the adult stage in the dog.

The adult tape-worm in the dog is a flattened tape-like animal which has the length of about 16in. It lives attached by the four suckers and crown of hooks of the head to the wall of the intestine of the dog. Just behind the head is the neck, the narrowest part of the body. The remainder of the body is composed of joints, which become wider and longer as the distance from the head increases. New joints are constantly being formed at the neck, whilst at the opposite end, as the joints mature, they drop off, and leaving the dog with the excrement, they are distributed wherever the dog goes. The joints possess a limited power of locomotion, and leaving the droppings of the dog, they hide themselves amongst the roots of the grass. Now, each joint contains some thousand ripe ova in each of which is a mature embryo. This embryo is a minute oval body armed with six hooks or spines. If the joint remains long on the ground it dies, and the eggs may be distributed over the grass by rain, &c., or may be washed down into marshy spots, puddles, or pools of stagnant water. The ova retain their vitality for several days, exactly how long I am not able to say, but I have infected a rabbit with ova which had been kept in water for eight days.

When the joints or eggs are accidentally taken up by the rabbit whilst feeding or drinking, the embryos are hatched out of the eggs within the stomach, and perforating its wall by means of the six hooks, pass into a blood-vessel, and so are conveyed by the blood-stream to some part or other of the body and take up their abode in the muscles. The embryo grows and develops into a bladder which is very small at first, but gradually assumes a larger size, and then develops the tape-worm heads. The bladder may ultimately reach the diameter of 3in. or more; growth appears from my experiments to be slow, so that the development of the bladder-worm probably occupies two or three months.

If a rabbit is so unfortunate as to swallow a whole joint, with its thousand of contained eggs, the result is disastrous to the rabbit, for the local inflammation of the muscles and destruction of their tissue must lead to the death of the rabbit either at once or as soon as the young bladder-worms grow to a somewhat larger size. In the bladdery rabbits I obtained in the Wairarapa, I never found more than two bladders in the same rabbit, and usually there was only one. This circumstance points to the infection of the rabbits, not by the consumption of whole joints with great numbers of eggs, but by the accidental swallowing of isolated ova. It is, however, probable that rabbits do sometimes swallow a larger number of eggs, but that the greater number of bladder-worms kill the rabbit. How often this occurs it is, of course, difficult to estimate.

If a rabbit contain but a single bladder-worm the latter will, in most cases, be able to develop to maturity without causing serious injury to its host; but as the bladder increases in size it must become a greater source of inconvenience to the rabbit; it must be a drain on the resources of its host. The weight of the included fluid will amount to several ounces; and, as the bladder is often found on the limbs, it must interfere with the locomotion; and so in various ways it renders the rabbit an easier prey to its natural enemies, and, amongst these, to the dog.

If the rabbit and bladder-worm, with its contained heads, be eaten by a dog (and dogs, cats, and ferrets eat the bladders greedily) these heads attach themselves to the walls of the dog's intestine, and by elongation of the neck, accompanied by the marking-off of joints, they develop into tape-worms, and the circle of parasitism is completed.

It will be seen, therefore, that the bladder-worm disease in the rabbit is closely analagous to the hydatid disease, which is so common in man, particularly in the Colony of Victoria, and frequently proves fatal. In both cases the ova are derived from a tape-worm of the dog, and in both instances the ova give rise to large bladder-worms (or hydatids), in the one case in the rabbit, in the other case in man, or in the sheep, ox, pig, &c. The two kinds of bladder-worms, however, are distinct, and so, too, are the tape-worms, to which they respectively give rise.

In some cases the presence of only a single bladder-worm may cause the death of a rabbit, for the worms are found in places where they must interfere with the vital functions; for instance, in the heart or in the thorax, where the pressure on the lungs cannot be but injurious. I have found a worm in one of the muscles of the eyeball, causing displacement of the eye; and in one of my experimental rabbits I found one had settled in the tongue, and if the growth of this had been allowed to progress it must ultimately have caused the starvation of the rabbit by preventing it from swallowing.

Although two are the largest number of bladder-worms found by me in any one rabbit under natural conditions, yet it is highly probable that rabbits do sometimes swallow a large number of eggs, and that the greater number of bladder-worms developed therefrom kill the rabbit. I may cite here, as an example which illustrates the point, the smaller bladder-worm (*Cysticercus pisiformis*) found in rabbits as mentioned above. In this case the conditions for infection are precisely similar, and yet it is seldom that a single bladder-worm only is found. More frequently from five to ten are present, and sometimes a still larger number. The larval form of the common tape-worm of a man (*Tenia mediocanellata*) occurs as a very small bladder-worm in the flesh of the ox, beef containing these larvæ being turned measley. Here many hundreds, or even thousands, of bladder-worms or measles may be found in the same animal.

It may be said that if the bladder-worms kill any considerable number of rabbits such dead rabbits ought to be found lying about on the ground; but many of them would doubtless die in the burrows, and so escape notice. The rabbiters in the Wairarapa informed me that they sometimes found dead rabbits lying about, but that the hawks had always been at them, so that it was impossible to discover what the rabbits might have died from.

The disease has certainly been known in the district for over five years, and there is some evidence that it was present ten or twelve years ago. More than five years ago Dr. Hosking, of Masterton, procured a specimen, which he gave to Sir James Hector.

I found only a small proportion of the rabbits affected with the disease in the places I visited, but the rabbiters state that it is no uncommon thing for them to find 20 per cent. of the rabbits with bladders. The men would only notice the advanced stages of the disease, so that a much larger percentage of the rabbits may really be affected. There is, however, a great deal of difference in this respect in neighbouring localities, and in the same locality the disease may be common at one time and scarce at another. In one instance, four out of six rabbits shot on one occasion were affected with bladder-worm. At the Dry River run only one bladdery rabbit was obtained, but here, and again near Masterton, I found that the rabbiters were unconsciously doing their best to prevent the spread of the disease. Noticing that their dogs were infested with tape-worms, they periodically gave them medicine to expel the worms. This may, in part, account for the much smaller percentage observed by me. Parasitic diseases are eminently liable to variation, and although my own observations show that in the rabbits which came under my notice only some 5 per cent. were infested with bladder-worm, yet the large percentage said to occur by others is by no means improbable.

The bladder-worm disease is doubtless one introduced from Europe, either with the rabbit, or more probably brought by the importation of a dog infested with the tape-worm. New Zealand was originally a country devoid of all mammals except bats until the Maoris brought the native dog and the native rat. Since then the colonists have introduced various animals, and at the same time many of the numerous parasites which infest those animals in European countries. Whilst engaged in investigating the parasitic diseases affecting sheep in New Zealand I found in one lamb no less than eight different kinds of parasitic worms, all of them forms known in Europe, and doubtless brought thence. We may, therefore, appropriately inquire whether any similar form of bladder-worm has been observed in Europe, and whether it has been noticed as the cause of any considerable epizootic amongst rabbits. Species of *Cœnurus*, or many-headed bladder-worms, have been found in the rabbit in various countries; amongst these there is a form occurring in the rabbits in the eastern counties of England, and first described by Rose in 1833. By the Norfolk Warreners rabbits affected by this bladder-worm are termed "bladdery." A specimen of a similar form is preserved in the Oxford University Museum under the name of *Cœnurus cuniculi*. Dr. Cobbald states that he obtained a specimen of the same form from Ayrshire. In France similar bladder-worms have been found in rabbits by various observers. M. Baillet found in a rabbit a *Cœnurus* which had the size of a fowl's egg; the heads attached were very numerous, and arranged, not in groups, but in rows, and hence he termed the worm *Cœnurus cerialis*. Given to two dogs, the heads developed into tape-worms. I have pointed out above that the heads in the bladder-worms from the Wairarapa rabbits are sometimes arranged in groups and sometimes in rows; the arrangement in rows may therefore be looked upon as an inconstant character. It appears to me highly improbable that the *Cœnuri* of the English and French rabbit-warrens and of the Wairarapa District belong to one and the same form. *Cœnuri* of similar characters have also been found in the muscles of the rabbit in Germany and Italy.

Reference will be expected here to the disease which is said to appear from time to time among the Canadian rabbits (not the same species as the English rabbit), and to sweep them off in such numbers that, for the time, they seem to be exterminated. Sir James Hector, in a letter which has been published by Mr. Coleman Phillips, states that the disease is due to a bladder-worm. Whilst I desire to show all due respect for Sir James Hector's opinion, I think it right to say that from what

I have heard of the disease, and more particularly from the description of it given by Mr. C. N. Bell of Winnipeg, I conclude that the Canadian disease is quite distinct from that caused by the bladder-worm in the Wairarapa.

2. Parasitic Disease of the Liver, due to Coccidia.

A comparatively large proportion of the rabbits examined by me in the Wairarapa were more or less affected with a form of parasitic disease attacking the liver. This disease is due to the presence of minute animal parasites belonging to the lowly organized group of Gregarinidæ. The livers containing the parasites show a number of irregular knots, or string-like masses of a lighter colour. When one of the masses is cut across, a quantity of yellowish- or pale-coloured ooze flows from the interior. Microscopic examination of the ooze shows that it contains, besides the remains of cells from the epithelium of the bile-ducts, vast numbers of extremely minute bodies of a regular egg-like shape, and about $\frac{1}{120}$ in. in length. These are the Coccidia, and from the regularity of their form, which has more than once caused them to be mistaken for the ova of flukes, they have received the name of *Coccidium oviforme*. The parasites really live in the epithelial cells of the bile-ducts of the rabbit, but cause extensive alterations in the neighbouring parts of the liver, the liver-cells undergoing degeneration, and the connective tissue increasing greatly, so as to form a thick wall round the affected part. The bile-ducts frequently coalesce, owing to the destruction of the tissue, whilst their interior becomes distended with the accumulated Coccidia, &c. The Coccidia are the encysted form of the parasites, and are destined to pass out of the liver and spread the disease elsewhere. They may be found in quantities in the gall-bladder of infested rabbits, and ultimately pass into the intestine, and are distributed everywhere with the droppings of the rabbits.

So long as the Coccidia remain in the rabbit no further development occurs, but when they are kept in water the contents of each Coccidium may be seen to break up into four rounded masses. These assume an oval form, one end being distinctly pointed; these are the spores. Each spore has a delicate membrane, and contains a curved rod-like body with thickened ends, whilst against the concavity of the curve rests a rounded granular mass. The rod-like body is the true reproducing germ. Development up to this point occupies from four to five weeks.

So far as I am aware, no feeding experiments have been conducted with the liver-coccidia of the rabbit, and my own experiments are still in progress, but experiments performed with somewhat similar Coccidia of the intestine indicate that, in this state, the germs are ready for further development with a rabbit. With reference to the injury done to the rabbit by the parasites, I may mention that some six or seven years ago the rabbits in the neighbourhood of Oxford (England) were dying of some epidemic disease, and were found lying dead on the ground near their burrows. At my request one of these rabbits was brought to the University Museum; examination showed its liver to be extensively invaded by the Coccidia which had been the cause of death.

Professor Lockhart states that in many warrens the disease is endemic, so that scarcely a single sound animal is to be found, whilst it produces a sickly condition from which the animals not infrequently perish. If the disease reaches any considerable development the animals die off without fail. They become very thin, and, after a few weeks' illness, they lose all desire to eat or move, begin to breathe quickly and heavily, and at length die in convulsions.

I may state that I found this disease more prevalent in the rabbits examined by me than was the bladder-worm. Near Masterton, out of nineteen rabbits examined in one morning, eleven were more or less attacked by the disease, five of them severely.

3. Rabbit-itch, Mange, or Scab. 4. Disease due to Lice.

These two diseases being due to external parasites, which are readily distributed by the contact of the rabbits in the burrows, are commonly found together in the same animal. The rabbit-mange, itch, or scab is due to a minute species of mite (*Dermatodectes cuniculi*) allied to, but quite distinct from the mite (*Dermatodectes ovis*) which causes the scab in sheep. The rabbit-louse is a larger animal, being readily recognisable with the naked eye. It may be found in considerable numbers on rabbits; frequently it is seen with its beak buried in the skin, whilst the abdomen becomes distended and round from the quantity of blood sucked up. Rabbits infested with the mites generally show scabby spots and chafing of the skin due to the scratches which the rabbits inflict on themselves in their endeavours to obtain ease from the itching produced by the mites.

I found the rabbits in the Wairarapa, with few exceptions, had a larger or smaller number of either lice or mites, or both. As a rule, the number of the parasites was small, and they seem to cause the rabbits comparatively little injury. A few of the rabbits, however, carried greater numbers, and these were marked by scabby patches, and were in rather poor condition. It must be remembered, however, that I saw the rabbits at the time of the year when they should be in the best condition. Mr. Orbell states that he has found rabbits showing scabby symptoms of a similar kind, but in a much higher degree, with the hair falling off over large areas of the skin. Some of the rabbiters, too, state that they have found rabbits largely denuded of hair and marked with scabby patches, and so thin as not to be able to run more than a few yards at a time. Still, I am of opinion that the combined effects of the scab, mite, and lice are seldom so serious as to lead to the death of the rabbit.

Chicken-cholera in the Wairarapa.

During the last two summers an epidemic disease has visited the poultry-yards in Masterton and the neighbourhood. This disease has been supposed to be chicken-cholera. Mr. W. Beetham lost sixty out of seventy fowls, and others have suffered as severely. During my visit to Masterton I endeavoured to obtain some of the infested fowls, but no cases were available at the time, so that I was unable to cultivate and identify the bacterial organism to which the disease is due. The symptoms, as described to me by various observers, agree closely with those commonly found in

cases of chicken-cholera. The disease is stated to have occurred in Canterbury one year earlier, and, as exchanges of poultry frequently occur between that district and Masterton, it is possible that it was brought thence. In the first instance, however, the disease has probably been introduced from the United States, where it is prevalent, for importation of poultry from San Francisco have been numerous during the past few years.

III. APPLICABILITY OF THE DISEASES AS A REMEDY FOR THE RABBIT-PEST.

Any disease to be suitable for this purpose must satisfy the following conditions: (1.) It must be sufficiently fatal to rabbits. (2.) It must not be injurious to man or any of the animals useful to man, and least of all, of course, to stock.

With reference to the first condition, it will be seen that, although the diseases in question have proved useful in keeping down the rabbits in the Wairarapa, yet they have not the power of suddenly and swiftly sweeping off or exterminating all the rabbits in a district. But it is only an infective disease which has the power of wholesale destruction, and it is doubtful whether there is any infective or parasitic disease in nature which possess the power of absolutely exterminating any species of animal. Any truly parasitic organism which should mercilessly cause the death of a whole species would, in the end, defeat its own object; for, with the extinction of all suitable victims, the life of that species of parasite must itself come to an end. But where animals of the same kind are densely crowded together on the same ground, as is the case with rabbits in the infested districts, there one of the conditions for the propagation of any parasitic disease is best fulfilled. It is for this reason, probably, that the parasitic diseases mentioned have spread so widely in the Wairarapa. When the number of animals is reduced the danger of infection becomes less. The colonial farmer, however, would be well pleased to see the rabbits reduced within such limits. Surprise is often expressed at the excessive rate of multiplication of rabbits in Australasia. This excessive rate may, in some measure, be due to a favourable climate; but, in a large measure, it is due to the absence of natural enemies and parasitic diseases. So, too, the lower death-rate amongst human beings in the colonies is, to a certain extent, due to the absence or comparative rarity of many infective or parasitic diseases. Even in England, where population is denser and the natural enemies of the rabbit exist in numbers, the rabbit occasionally increases to such an extent as to become a nuisance. But there are a great number of parasitic diseases established in European countries, and, from time to time, epidemics thin down the rabbits to numbers which are more satisfactory to the farmer. Some of the parasitic diseases of the rabbit have been introduced with it into the Wairarapa, and are as serviceable there as is in other countries in reducing its excessive numbers.

But, although these diseases are distinctly useful as an aid against the rabbit-pest, it would not be safe to trust wholly to them. The spread of parasitic diseases under natural conditions is always somewhat capricious, and subject to numerous accidents. It would therefore still be necessary to resort to poisoning in the winter, the use of the natural enemy, and rabbiting; but the presence of the parasitic diseases would render this work less heavy and the reduction of the rabbits more effectual.

I have been asked whether it would not be possible to render the disease more virulent. In the case of the present diseases it is not possible to modify the constitutional powers of the parasites, as can be done with some of the bacterial organisms that cause disease. The virulence or fatality in the present instances depends mainly on the number of parasites with which an animal is infected, and this again is dependent upon the number of germs scattered upon the ground upon which the animal feeds. To increase the destructive effect of the bladder-worm disease, it would be necessary to increase the number of tape-worms in the neighbourhood, that is, to make sure that each dog carries its suitable compliment, and, in case of need, to increase the number of dogs. Furthermore, the dogs must pass frequently over the ground infested with rabbits. Unless dogs infested with tape-worm are present in a given locality, the bladder-worm disease must die out there. It would of course be quite impracticable to turn out dogs to run wild in the same way that cats and ferrets have been liberated for the purpose of keeping down the rabbits, for wild dogs would learn to attack the sheep. The dogs, therefore, would require to be kept under supervision, and the rabbit's pack of dogs would best serve the purpose in view.

2. *The Second Condition is that the Disease must not be Injurious to Man or any of the Animals useful to Man.*—With regard to this condition, the best answer which can be given is that stock of all kinds feeding on the same ground with the diseased rabbits remain healthy and in good condition.

With reference to the bladder-worm disease, it will be asked whether the dogs do not suffer from the presence of the tape-worm within them. I do not think that, as a rule, they suffer to an appreciable extent, though, of course, the tape-worm requires nourishment, and so the dog consumes rather more food. The rabbit's pack of dogs at the Dry River were all infested with tape-worms, but all seemed in a good state of health. If, after any length of time, the dogs should begin to show signs that the parasites are proving injurious it would of course be an easy matter to expel them. The Abyssinian Natives are, almost without exception, infested by the human unarmed tape-worm, and they regard their parasite as necessary for the maintenance of health, asserting that in many ways it has a beneficial influence.

The bladder-worm of the rabbit has a certain resemblance to the bladder-worm (*Cœnurus cerebralis*) which is found in the brain of the sheep, and gives rise to the disease known as "gid" or "sturdy." The fact that it is confined to the muscles of the rabbit, whereas that of the sheep is confined to the brain, is probably sufficient evidence to indicate its distinct nature, and this is confirmed by other evidence, including the freedom of sheep from the disease, although they feed on the same ground as the rabbits.

It must be mentioned here, with reference to the liver disease produced by the presence of *Coccidia*, that a very similar, and possibly the same, kind of *Coccidium* has been discovered in the

liver of man on four different occasions. In one of these cases these parasites were the cause of death. As a rule, however, men are seldom exposed to infection with *Coccidia* spores, for it is only under exceptional circumstances that the excrement of rabbits can contaminate what is afterwards used as food for human beings, and even if this be the case, cooking will destroy the vitality of the germs. Moreover, the *Coccidia*, as they occur in the liver, are incapable of giving rise to the disease, so that no danger arises from the eating or handling of rabbits affected by the disease. The *Coccidia* only becomes dangerous when they have undergone development in a moist place outside of the rabbit, *i.e.*, in stagnant water, marshy spots, or even on damp soil. There is evidence to show that the disease is only serious or fatal when the infection takes place repeatedly; to this repeated infection rabbits are particularly liable, but not human beings.

If there were any real danger of the disease spreading to man from wild rabbits it would be most unsuitable to even contemplate the employment of the disease. In the few cases recorded the germs were probably derived from tame rabbits, and the infection must have been the result of uncleanly habits. The keeping of tame rabbits is illegal in New Zealand, whilst rabbits are only numerous in places where the population is scanty. There is therefore no real danger of the disease spreading to human beings, and even if, where uncleanly habits prevail, a single infection should occur it would probably produce little disturbance of health. I leave it to others, however, to say how far it is right to employ the disease. It is my duty to state the nature of the disease, the conditions of its distribution, and the fact that it has been effective in assisting to reduce the rabbits in the Wairarapa.

SUMMARY.

The decrease of the rabbits in the Wairarapa has, in the first place, been due to the measures adopted by man, especially the winter poisoning. Certain parasitic diseases, however, have appeared in the district, have been largely prevalent, and have been useful in keeping down the rabbits. Of the diseases, those due to the bladder-worm and a liver-parasite have been the most effective, whilst the rabbit-itch, or scab and lice, though widely distributed, have been operative in a minor degree only.

If it were thought desirable to employ the diseases elsewhere there would be very little difficulty in propagating them. Whilst the diseases have been distinctly useful in the Wairarapa they are nevertheless not of such a character as to render unnecessary all other methods of the destruction of rabbits; they must be looked upon simply as auxiliary means of destruction.

A. P. W. THOMAS.

[Approximate Cost of Paper.—Preparation, nil; printing (1,475 copies), £4 16s. 6d.]

By Authority: GEORGE DIDSBURY, Government Printer, Wellington.—1888.

