

animals under the conditions realisable in experiments may be immediately applied to explain the method of infection in cases of natural tuberculosis in man. That is why the word "probably" has been introduced into the fourth of the conclusions. The whole of the experimental evidence on which the theory of the intestinal origin of pulmonary tuberculosis in man was built up has been swept away, and valuable new support has been provided for the older inhalation theory; but one ought to avoid the mistake of denying any importance to infection by ingestion either in man or in cattle, or of asserting that tubercle bacilli which enter the body by way of the alimentary canal are never the cause of tuberculosis with lesions apparently primary in the lungs.

SOME POINTS IN THE EPIZOOTIOLOGY OF SHEEP SCAB IN RELATION TO ERADICATION.

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NOTWITHSTANDING the fact that sheep scab is one of the oldest diseases known, its epizootiology still presents unsolved problems which are of considerable importance in State medicine. The policy followed during the last three years in dealing with sheep scab in Great Britain has been of a tentative character, and the plan of campaign, which has been to reduce gradually the prevalence of the disease before resorting to more heroic measures for its final eradication, has been largely dictated by the exigencies of the business of sheep farmers. In the Reports of the Chief Veterinary Officer, Board of Agriculture, for 1906, 1907, and 1908, references were made to what appeared to be defects in the tentative methods adopted, and a continued study of the circumstances connected with the various outbreaks has since tended to confirm opinions which formerly might have been considered to have been based upon insufficient evidence from the field.

The Report of 1906 pointed out that "one must not hastily conclude that the recognised and confirmed outbreaks represent the sum total of sheep scab in the country, as indications are not wanting that quite a number of cases in an early or comparatively quiescent stage are not diagnosed until a later date, when more marked clinical symptoms supervene. These remarks especially apply to flocks of sheep which have been dipped under one or other of the compulsory dipping Orders, and at the time of dipping were not noticed to be amiss. In some instances, however, after an interval of two or three months' time, these sheep, although they have not been in contact with others, have nevertheless developed clinical and unmistakable appearances of sheep scab, and an outbreak has been declared. That such cases are not altogether exceptional there is good reason to believe, and a method of combating them is deserving of careful consideration."

It was stated in the Report of 1907 that "in not a few instances only one animal out of a large flock was returned as affected after

¹ From the Annual Reports, 1906-7-8-9.

examination by the veterinary surgeon employed to conduct the inquiry. This state of affairs seems, in some instances, almost inexplicable, unless one is prepared either to question the reliability of the diagnosis or to admit that sheep scab is not so contagious as is generally believed. One has also to admit that a considerable number of outbreaks are reported amongst sheep which have been dipped under the Compulsory Dipping Order. That is to say, the affected sheep had been dipped at least twice, with a long interval, during the year."

One cannot hope to eradicate a disease like sheep scab without closely studying its epizootiology, and one is seldom in a position completely to study the epizootiology of any contagious disease of animals until a campaign of eradication has been undertaken; it is then, of course, that one is most likely to come face to face with what seem to be errors or insufficiencies in the classical conceptions concerning the life-history of the causal parasite, the development of the disease, and the effect of remedies.

The study of the life-history of a parasite by entomologists is often limited to the cycle of its development, with the result that the classical conception of the life-history may be somewhat academic, whereas for purposes of eradication the study of the various habits of a parasite under actual conditions may be of equal importance to that of its cycle of development.

It is not to be understood from the above remarks that the observations made by entomologists on the life-cycle of the sheep scab acarus are not correct, or that they are not valuable, but rather that they do not complete our knowledge, and they certainly do not furnish the explanation of some of the epizootiological problems in connection with sheep scab.

The accepted life-cycle of the sheep acarus is, shortly, as follows: (a) The eggs hatch in from two to five days, four days being the average time, but, according to some observers, hatching may take as long as eleven days. (b) The larvæ moult into nymphæ—time occupied, four days. (c) The nymphæ moult into adults—time occupied, four days. (d) The female adults moult, and lay eggs; the time occupied by this stage does not appear to have been accurately determined, but the duration of the whole cycle is stated at twelve to sixteen days, twenty-three days being the longest by calculation. The acari have been found to remain alive off the sheep for a month to six weeks at the longest, but most of them die before this time. Most of the eggs are said to hatch out in a few days, but they have been observed to hatch two and even four weeks after removal from the sheep.

As the result of a continued study of the reports on outbreaks up to the end of 1909, and from experimental observations at the laboratory during the last two years, it appears that, although a sheep experimentally infected with a fair number of acari may show visible symptoms of scab in about twenty-five days, it often happens in practice that scab does not show itself in a flock for two, three, or four months, and even longer, after contact with infection. It has also been further noted that scab in a visible form has appeared amongst sheep which have been dipped once in the year, or twice with a long interval, although they had never been observed to be

affected before, and had not been in contact with other flocks since being dipped. Indeed, one might say that the majority of the outbreaks have occurred amongst sheep which have been dipped at least once in the year. The interval between dipping and the appearance of scab in such cases seems to vary from one to two, three, or four months, and even longer, as in the case of the interval between contact and the advent of symptoms mentioned above. A complete cycle of development occupying at most twenty-three days cannot account for these long periods of quiescence.

It does not appear, however, that sheep are bound to show visible symptoms of sheep scab twenty-five days after actual infection. On the contrary, it would seem that when infection is effected by a comparatively small amount of infective material visible symptoms in the ordinary sense do not show themselves until after a longer period than twenty-five days, and it would be quite easy even for an observant person to pass over affected sheep in what might be called the incubative stage of the disease. The following observation, which is only one of a series, illustrates this, and shows the progress of the disease in an experimental animal from the time of infection to that at which ordinary examination would enable one seriously to suspect the existence of scab.

Experiment I, Ewe 72.—On 2nd October 1908 a quantity of wool and scurf was received at the laboratory from an affected sheep; neither the acari nor their eggs were numerous in this sample. On 3rd October a small portion of the material was tied into the wool of a healthy sheep (Ewe 72). This animal was clinically examined every day, and material from its skin, in the neighbourhood of the inserted wool, was submitted to the most careful microscopical examination. On 17th October, *i.e.*, fourteen days after infection, one adult male acarus was found (the first), but no clinical symptoms of scab were evident. No further acari could be found until 27th October, when one young adult was discovered. From the 2nd to the 13th November only an occasional acarus could be discovered in material taken from the skin. The sheep showed no outward symptoms which would have been likely to attract attention, but, on parting the wool and examining the skin carefully, one could see that there was a small irritated patch at the site of infection. It was not until 26th November, *i.e.*, fifty-four days after infection, that the acari could be discovered in fair numbers in material taken from the skin, and it was between 13th and 26th November that unmistakable clinical symptoms showed themselves.

It is not intended to suggest that these observations entitle one to say that fifty-four days is always the interval in practice between infection and the first appearance of definite symptoms. The above is only one of a few observations, but so far I have not met with distinct signs of scab in less time than about twenty-five days after infection. It would appear probable that under natural conditions the infection is seldom what might be called a very heavy one. Assuming, for example, that only one or two females are transferred from an affected to a healthy sheep, and that they lay eggs, three of them would lay no more than about forty-five eggs, and it is reasonable enough to suppose that all these eggs would not

hatch out. The classical period occupied by transition from egg to an ovigerous female is about sixteen days, so that during this period subsequent to infection the sheep would harbour a relatively small number of acari. It would require, theoretically speaking, another five to ten days for the second crop of larvæ to hatch out. This crop, of course, would be considerable, even on the assumption that each female laid fifteen eggs, and that only 50 per cent. of these hatched out. It seems possible that it is not until the second or even the third brood appears that distinct symptoms are evident. This, however, does not fully account for those very long periods which have been observed between infection and the appearance of visible symptoms.

With reference to the effect of a single dipping, I am not prepared to say that one dipping will not cure scab in the first few days after infection, nor can it be denied that a single dipping temporarily checks the spread of scab in an infected flock, but it has only a limited effect upon the dissemination of the disease from flock to flock through sales, and it carries one only a short distance towards eradication. The claim that one dipping will cure well-developed cases of scab rests on the following observations: first, that during an interval of twelve days between the first and second dippings no acari could be found on certain sheep put under observation; and second, that in the case of some scabby sheep no acari could be found during a period of a month to six weeks after one dipping. In view of the long interval which often occurs in practice between contact with infection and the appearance of symptoms, and between the latter and an unsuccessful dipping, a conclusion based upon a period of observation of a month to six weeks is hardly warrantable. There is also evidence to show that a badly infected flock may not be cured by two dippings at short intervals. There is this important difference, however, that there is satisfactory evidence that scab can be eradicated from infected flocks by carrying out two annual dippings with a short interval between each.

Assuming that all the larvæ, nymphæ, and adults are destroyed, as may be by one properly conducted dipping, one must inquire by what means the infection is kept up during the long intervals. Suspicion points to unhatched eggs, or, less likely, to acari in the moulting stages. Of course I am aware that recurrent cases after dipping have been attributed to re-infection from fences, rubbing posts, etc., but, even if this explanation be correct, it still leaves the long intervals unexplained, as frequently the affected sheep have passed most of the interval away from the scene of infection.

As the result of further investigations since my report of 1907, I have been able to satisfy myself by special inquiries that one of the other peculiar features of scab is correct, viz., that sometimes only one or two visibly and even badly affected sheep may be found in a large flock which have been running together for months. The interpretation put upon this by some farmers is, that it is only necessary to treat the visibly affected; the correct interpretation in a campaign of eradication is, however, that since all the sheep in contact must be under serious suspicion they should be treated as if affected. Further, it sometimes happens that cumulative circumstantial evidence points to certain farms disseminating sheep scab,

but veterinary inspection fails to find visibly affected animals in the original flocks, although several lots sold to reputedly clean farms have developed scab. It has been found on inquiry that some of the original flocks were clean to all appearance, and had been dipped two or three times, with long intervals, during the year. Such observations raise a strong suspicion that dipping of this kind may sometimes result in scab being concealed from the most careful flockmasters. In a campaign of eradication it seems necessary to accept cumulative evidence of a circumstantial kind, even in the absence of visible evidence, and to regulate specially the distribution of sheep from such farms or sheep runs, by making movement off the premises subject to double dipping.

In illustration of some of the above-mentioned points concerning the epizootiology of sheep scab the details in connection with the following selected outbreaks will be found of interest:—

Outbreak No. 1.

Date of first outbreak, 28th June 1909; total sheep on farm, 114; three visibly affected at the time of visit by veterinary inspector; whole flock dipped, 29th June and 11th July; visibly affected also dressed.

A second outbreak occurred 30th October, *i.e.*, eighty-one days from the last dipping; there were only nineteen of the original 119 sheep left; the number of these affected was eighteen; veterinary inspector reported the lesions to be only a few days old; no fresh contact had taken place since the last outbreak; the dip used in the first outbreak was one of the weakest of the approved dips. It seems probable that the second outbreak was due to the failure of the first dipping; the long interval is to be noted.

Outbreak No. 2.

Date of first outbreak, 30th September 1908; total sheep on farm, seventy-eight; ten visibly affected at the time of veterinary inspector's visit; veterinary inspector reported the lesions to be several weeks old. The only contact with infection which could be traced occurred in January of the same year; the interval was then nearly eight months, less several weeks during which the veterinary inspector thought they must have been affected. The whole flock was dipped on the 2nd and 16th October, and on the 2nd November after the veterinary inspector had certified that he could find no appearance of scab.

A second outbreak occurred 18th March 1909, *i.e.*, four months from last dipping; it occurred amongst a lot of twelve which were all that remained from the first outbreak; two only were affected; veterinary inspector said they had been affected for a week or so; the two affected were the two which showed the most marked lesions in the first outbreak. The farmer, who was determined to get rid of scab, dipped his sheep five times from 18th March to 8th July, and no outbreak has since been reported from this farm.

Outbreak No. 3.

Date of first outbreak, 4th January 1909; total sheep on farm, thirty-one; three visibly affected; veterinary inspector said lesions were one or two weeks old. Owner bought thirty-one sheep from A on 3rd November 1908; A also sold forty to B at the same time, who sold twenty of them to C on 10th November 1908. B's sheep were examined and found free from visible scab on 7th January 1909; C's sheep were also examined on 7th January,

when one was found very slightly affected. Disease evidently originated from A's premises. Assuming that the sheep were infected no earlier than 3rd November, *i.e.*, the day they left A's premises, the disease had taken slightly less than two months to show itself in C's sheep; but A had dipped his sheep on the 21st October 1908, and B, whose sheep showed no sign of scab, had re-dipped his lot on the 6th November. A's remaining sheep were treated as if affected with scab, and nothing further followed in his flock.

Second outbreak occurred 3rd May, *i.e.*, two months and a few days from the last dipping, amongst the same thirty-one sheep; three visibly affected; veterinary inspector said lesions were a few days old; no movement had taken place in the interval; outbreak was attributed locally to re-infection from fences. It appeared, however, that a mixture of different dips had been used in the first outbreak, and we know that this sometimes renders the bath inefficient. It seemed not improbable that the three affected in the second outbreak were the same three as in the first, but the evidence on this point was not conclusive. Circumstances point to failure of the dipping in the first outbreak.

Outbreak No. 4.

Date of first outbreak, 13th March 1908; total sheep on farm, sixty-six; visibly affected, two; veterinary inspector's report said lesions were a few weeks old; owner had brought no fresh sheep on to his farm since September 1907, *i.e.*, about six months before; disease broke out amongst the last lot purchased; there was no other outbreak in the neighbourhood. The contacts to the affected were not dipped, but showed no visible symptoms of scab when freed on 1st June, *i.e.*, after eighty-one days isolation.

Date of second outbreak, 17th March 1909; total sheep, forty; visibly affected, eight; the second lot affected were bought in October 1908 (about five months before) from a farm afterwards found to be infected; veterinary inspector was uncertain about the length of time they had been affected, but they had been examined by a veterinary surgeon in January 1909, when they showed no visible symptoms; therefore, since they had not been treated, they could not have shown visible signs from October to January. The interval in this case would be three months at least. The sheep received a final dipping, and were freed after inspection on 9th August 1909.

Date of third outbreak, 4th December 1909; total sheep on farm, fifty-four; visibly affected, thirty-three; veterinary inspector said lesions had existed some weeks; the date of the last dipping was 9th August; the interval between last dipping and this outbreak was 147 days less about a month, say 100 days.

Outbreak No. 5.

Date of first outbreak, 11th March 1908; total sheep 250; visibly affected, nine; veterinary inspector said affected for three weeks; owner purchased affected lot on 17th September 1907, *i.e.*, about six months before, at a farm sale which started other outbreaks. According to the veterinary inspector's report, the net interval must have been four to five months. Date of freedom, 27th May 1908. Not stated that contacts were dipped.

Second outbreak, 22nd December 1908; total sheep 300; visibly affected, eight; veterinary inspector said lesions a week old; at least one of the affected was known to have had scab in the previous outbreak; the interval in this case was very long, being seven months; all contacts were dipped before freedom.

Date of third outbreak, 27th March 1909; total, 300; visibly affected, one; veterinary inspector said lesions were about a week old, and that the sheep was affected in the last outbreak, but appeared to be quite cured on

the 22nd February; the interval then was about a month in this case, and evidently the dipping had failed; all the sheep on farm were dipped twice before freedom on 1st July 1909; no outbreak has occurred since.

Outbreak No. 6.

Date of outbreak, 27th February 1909; total sheep, 153; visibly affected, one; lesions well advanced; flock re-examined by Board's veterinary inspector, who confirmed diagnosis and number of the affected. The affected sheep was bought with others on the 25th December 1908, before which time it must have been infected; it must have run with the flock for over two months without any of its fellows becoming visibly affected.

Outbreak No. 7.

Date of outbreak, 6th March 1909; total sheep, 205; visibly affected, eighty; veterinary inspector stated lesions to be one month old; no movement on to the farm had taken place since 31st August 1908; all the sheep had been dipped in October 1908; the net interval from dipping was probably in this case about three months.

Outbreak No. 8.

Date of first outbreak, February 1904; premises freed, 31st May 1904.

Second outbreak, 22nd March 1905; interval, ten months; total sheep, eighty-one; visibly affected, twenty; no movement had taken place for six months; all sheep on the farm were twice dipped before freedom.

Third outbreak, 20th March 1906; interval, twelve months; total sheep, sixty-three; affected, five; veterinary inspector said lesions were about six weeks old; no new sheep had been purchased for over a year; all sheep were dipped twice before freedom.

Date of fourth outbreak, 4th January 1908; interval, eighteen months; total sheep, sixty-eight; visibly affected, eighteen; veterinary inspector said lesions were three weeks old; all the sheep had been dipped once in August 1907, four months before outbreak.

Outbreak No. 9.

Date of outbreak, 11th March 1909; total sheep, eighty-nine; visibly affected, two; veterinary inspector said lesions were six weeks old; no movement of sheep on to farm for twelve months; owner was in the habit of dressing every single sheep he found suffering from skin irritation, and probably in this way the disease had been kept in check for at least a year, but was not eradicated.

Outbreak No. 10.

Date of first outbreak, 13th February 1908; total sheep, 140; visibly affected, ten; veterinary inspector said lesions were recent; all sheep on the farm were dipped before freedom.

Date of second outbreak, 19th March 1909; interval, one year; total sheep, eighty-eight; visibly affected, three; veterinary inspector said lesions were recent; no fresh sheep had come on to the farm since last outbreak.

Outbreak No. 11.

Date of outbreak, 22nd April 1909; total sheep, ten; visibly affected, ten; veterinary inspector said lesions were some weeks old; these were the first sheep owner ever had, and no other sheep were near his premises; owner bought them from A on 2nd February, and they were the only sheep A ever had; A bought them from B in October 1908; they were

dipped before purchase and again by A before 2nd November; B was found to have scab on his farm on 20th December 1908; he had had several outbreaks before; the interval from last dipping in this case was five months, less say a month (*see* Veterinary Inspector's Report).

Outbreak No. 12.

Date of outbreak, 18th March 1909; total sheep, thirty-eight; visibly affected, eight; veterinary inspector said lesions were a month old; no sheep had ever been on this farm before, and the present lot were brought on in September 1908; the net interval in this case was about four months.

Outbreak No. 13.

Date of outbreak, 2nd November 1909; total sheep, eight; visibly affected, two; there had been no sheep on this farm for two years until the above arrived on the 7th July 1909; all the sheep had been dipped once in August, and the disease was discovered when they were collected to be dipped a second time on 2nd November; the first dipping had evidently checked the disease but failed to cure it; the interval in this case was over two months from date of dipping.

Outbreak No. 14.

Date of outbreak, 25th May 1909; total sheep, forty-two; visibly affected, eighteen; the eighteen were ewes and the other twenty-four were their lambs; the lambs and ewes must have been in contact about two months, but none of the former were visibly affected; the ewes were bought in October, and had been dipped once at the end of August; the interval between dipping and the time owner saw enough to become alarmed was nearly eight months; veterinary inspector said the ewes had been affected for a considerable time.

Outbreak No. 15.

Date of first report, 30th March 1909; total sheep, sixteen; two showed irritation of the skin; the disease was not diagnosed as scab, but the owner dipped the sheep once about 2nd April.

Date of second report, 2nd September; total sheep, forty-seven; visibly affected, one; veterinary inspector said lesions were very recent; the diagnosis was confirmed by one of the Board's veterinary inspectors, who also said there was only one visibly affected. These sheep had all been in a high walled pasture since March 1909; before March they had been on the farm of another owner where scab subsequently broke out in September, and it was on this account that these sheep were re-examined; the interval from dipping in this case was nearly five months; it should be noted also that only one of the forty-seven was visibly affected.

Outbreak No. 16.

Date of outbreak, 6th December 1909; total sheep, thirty; visibly affected, one; veterinary inspector said lesions were recent; the sheep came from an infected farm on 14th October, but had been dipped before leaving. The interval was about two months.

Table I. is also of particular interest, as all the sheep concerned in the various outbreaks were dispersed by a sale from the same infected farm at the same time. One must, of course, make some allowance for delay in tracing and reporting, but even with this allowance the periods are long.

Table I.

All the sheep on this list were dipped previous to sale, which took place on the 24th September 1909.

<i>Outbreak.</i>	<i>Date on which Declared.</i>	<i>Number of Days from Date of Sale.</i>
A	11th December 1909	78
B	21st December 1909	88
C	14th December 1909	81
D	21st December 1909	88
E	4th January 1910	102

The present Order provides for the separation and treatment of the affected sheep, and for the isolation during a period of fifty-six days of those which have been in contact, but, of course, the premises are not released from restrictions until the sheep have been examined by a veterinary inspector and certified free from scab.

From what has already been said, it is evident that the provisions of the Sheep Scab Order, for the isolation during fifty-six days of sheep which have been in contact with infection, cannot be regarded as a sufficient safeguard. It would certainly have more effect if Local Authorities had the isolated sheep examined periodically, and if a further isolation period of fifty-six days were imposed from the dates upon which each further case is discovered. This, however, would entail very considerable extra expense, and often, from the owner's point of view, an impracticably long period of isolation. The most satisfactory and effective way of dealing with this difficulty is to have all the contact sheep effectively dipped.

Table II. shows the results of inspecting isolated contact sheep (these were not dipped) in connection with eight outbreaks, and demonstrates how the disease may develop in sheep which were apparently clean when scab was first discovered in the flocks, and which were isolated but not dipped :—

Table II.

<i>Outbreak.</i>	<i>Date when Declared.</i>	<i>Number Visibly Affected.</i>	<i>Interval between First and Second Visit.</i>	<i>Additional Number found Visibly Affected at Second Visit.</i>	<i>Total Number of Sheep on Farm.</i>
A	1st Dec. 1909	1	38 days	5	—
B	1st Jan. 1909	25	19 "	12	225
C	8th Jan. 1909	2	13 "	4	18
D	21st Dec. 1909	12	35 "	11	108
E	16th Dec. 1909	15	41 "	10	65
F	7th Jan. 1910	5	20 "	1	160
G	8th Jan. 1910	11	20 "	6	104
H	8th Jan. 1910	1	31 "	1	24

Another point of interest is the well-known fact that the number of outbreaks of sheep scab follows a regular curve throughout the year. The outbreaks begin to increase distinctly in number in the month of October, and have usually reached their maximum in December and January. From January a somewhat gradual but steady decline takes place, and in June, July, August, and September, particularly in July and August, the number of outbreaks is negligible. To account for the decline, it is said to be due (*a*) to shearing; (*b*) to the sheep not being crowded together to the same extent as in the colder months; (*c*) to the improvement in their bodily conditions when the new grass becomes available; (*d*) to the decline of commercial movements; (*e*) to summer dipping. None of these explanations is fully satisfactory.

With regard to (*a*), it may be pointed out that the decline is well advanced before the shearing season begins. Moreover, in the writer's experience, the parasites can be found flourishing during the months when outbreaks are numerous on parts of the body which have been rendered almost bare. With reference to (*b*), one could understand how this might increase the number of affected animals in infected flocks, but it cannot be held to have much influence on the number of separate outbreaks throughout the country at a time when comparatively little movement is taking place. With regard to (*c*), I think one must admit, although the reason for it seems somewhat obscure, that sheep in good bodily condition are less prone to contract scab, and, therefore, less likely to disseminate it. On the other hand, I have usually found no difficulty in experimentally infecting well fed sheep in the open during the months of the year in which scab is prevalent. With reference to (*d*), one is bound to admit that cessation of interchange must cause a marked decline in the number of outbreaks, and it is convenient here to recall that the increase after the autumn movements of sheep is generally admitted to be accounted for by the latter.

Limited and increased movements of sheep, however, do not satisfactorily account for all the epizootiological circumstances surrounding the decrease and increase in the number of outbreaks. During July and August, when the number of outbreaks is quite negligible (two or three over the whole country), one can hardly believe that infection in some form is entirely absent from the numerous flocks in which sheep scab breaks out, or from which it is disseminated, later in the year; and one is almost forced to inquire whether there is anything in connection with the habits of the parasite which can account for the almost complete disappearance of scab, at least in a visible form, during some of the summer months, and its reappearance in winter. Bearing on this point, it may be mentioned again that in a large number of the winter outbreaks scab does not appear in a visible form amongst either the old stock or the recently purchased until two, three, or even more months after the latter came on to the farm.

With reference to (*e*), one must also admit that one dipping will at least check the progress of scab, but, if we accept this as the explanation of the decline and apparent disappearance of scab in certain months of the year, we still leave unexplained why the decline begins before the dipping takes place, in what form

the infection persists and afterwards causes the disease to break out in a visible form, and why the interval between the disappearance and reappearance of visible symptoms is usually one, two, or more months, having regard to the generally accepted life cycle of the parasites.

The results of certain experimental observations carried out at the laboratory offer another possible explanation for the apparent disappearance of scab in the summer months.

Experiment I. (continued).—Ewe 72. This ewe, which was infected in October 1908, and kept in the open, became badly infected with scab. The disease spread over the body, and by the 3rd February 1909 it had invaded the head and legs. The acari were numerous present in material taken from these regions, and they had re-invaded parts of the body which had been stripped of wool by the disease. Acari were found in varying numbers up to the 24th February, when regular examination was discontinued. It was begun again on the 16th March (interval, nineteen days), but from this day onwards daily examination failed to reveal a single acarus, and the animal's skin became normal. This ewe was kept under observation until the 19th December, and no recurrence of the disease took place.

On the 19th December and on the 15th January 1910 Ewe 72 was again experimentally infected with material from the field. She suffered from another marked attack of scab. No live acari could be found after the 3rd March. The disease ceased to spread, and by the end of April the lesions had practically healed.

Experiment II.—Lamb 1068 was placed in contact in an open pen with Ewe 72 on the 15th January 1910, when the latter was showing slight clinical signs of scab. Contact continued for several months, and was most intimate, as the lamb was a male. Notwithstanding this, however, Lamb 1068 did not become infected.

Experiment III.—Ewe 194 and Lamb 1069. On the 15th January 1910 Ewe 194 was infected with material from the field, and on the same date Lamb 1069 was put in contact in an open pen.

The first acarus was found on Ewe 194 twenty-four days after infection, but it was not until the thirty-ninth day that they were numerous. The disease spread from the middle of the back to the extremities, and the ewe had a bad attack of scab. On 21st April a few acari were found, but on this date regular examination was discontinued. It was begun again in the last fortnight of May, as the animal appeared to be recovering. No acari could be found from this time onwards, and the lesions disappeared.

Lamb 1069 showed no symptoms until the forty-first day of contact, when it was only by very careful examination that a small patch of irritation was discovered. A single acarus, however, was discovered at this date. On the forty-fourth day the symptoms were quite distinct, and on the day following acari were fairly numerous in preparations made from the lesions.

This lamb had only a moderately marked attack of scab, and acari were present up to the 21st April, when regular examination was discontinued.

It was begun again as in the case of Ewe 194, but no acari could be found, and the lesions had disappeared by the 1st June.

It is to be noted with regard to these experiments that recovery took place in four cases during the months in which the number of outbreaks shows a marked decline, although neither shearing nor dipping was practised.

Spontaneous recovery and the disappearance of the acari at this season may possibly account to a large extent for the great decline

in the number of outbreaks, but, even if this be the case, we are still left inquiring in what form and where the parasites persist until the next season of prevalence.

The questions in relation to the epizootiology of sheep scab which require further investigation might be shortly stated as follows:—

(1) The period of time after removal from affected sheep during which the acari and their eggs are capable of infecting other sheep. This, of course, has an important bearing on the question of indirect infection through infected folds and rubbing posts.

(2) The length of time during which the acari or their eggs may remain in a quiescent state upon sheep, and subsequently give rise to scab.

(3) The period of time after what may be called ineffective dipping one may expect the active symptoms of scab to reappear.

(4) Whether there is anything in connection with the habits of the parasite or the general condition of sheep which can account satisfactorily for the almost complete disappearance of scab, at least in a visible form, during the summer months.

Observations are proceeding with the view of trying to solve some of the problems raised above. Of course I am aware that sheep scab has been stamped out of some of our Colonies notwithstanding the unsolved problems in relation to the epizootiology of the disease. The general conditions in this country, however, are different, and since it is not possible to put in operation the more immediately effectual though cruder methods which were adopted in newer countries, one is compelled to investigate the disease more deeply in order to arrive, if possible, at a more acceptable method of attaining finality.

In view of the prevalence of sheep scab in certain parts of Wales, it is interesting to note that a Welsh King, Hywell Dda (Howell the Good), who died in 949 A.D., was the first to institute laws bearing on the disease. I am indebted to Mr A. N. Palmer, through Mr A. Seymour-Jones, Wrexham, for the following note on the ideas held by Howell's advisers, who were probably farmers, in relation to the period of isolation necessary to prevent infection in the case of sheep scab: "The seller of sheep ought to be liable for warranty in the case of scab from the Feast of All Saints to the Kalends of April," that is, from the 1st November to the 1st April (five months). Scab was no doubt most prevalent at the season mentioned, and the long period of warranty seems justified by our present observations. The injunction placed upon the buyer is rather remarkable: 'The buyer shall not put them (the sheep held on warranty) where sheep which have had scab have been until (unless?) the place has been isolated for seven years.' The period is long, but it is not permissible to think that these farmers of old acted entirely without knowledge of the disease. It seems more probable that, as the custom was to treat only the visibly affected sheep in infected flocks, they had found, as we find to-day, that under such a system of treatment scab may persist in flocks for several years; and, in the absence of knowledge concerning disinfection and the behaviour of the infecting agents when removed from the sheep, they were forced to the view that infection might persist under all circumstances for seven years.