CONCLUSION.

Gentlemen, I am afraid I have taken up far too much of your time, but the question I have been referring to is one of tremendous importance, and I entreat you to give it your most earnest consideration. If you have followed what I have said, it is clear that I only advocate the use of antiseptics at the very commencement of the treatment, but at that time, in order to serve the purpose, they must be sufficiently powerful. I am much opposed to their use in suppurating wounds. Some object to the use of these strong antiseptics on the ground that they may cause a slough. This, however, is a mistake; used as I have advised they may kill a microscopic layer of the surface of the wound, but they cause no visible slough. Even if they did cause a slough, if you have destroyed the bacteria the slough is of no consequence; it will be absorbed like any other piece of dead tissue, and what does a slough matter as compared with the life and future usefulness of the patient? It is very trying for those of us who are parents to feel that any day we may hear of the death of our boys in battle. If they die on the field of battle, they at least die nobly in fighting for their country and for the safety of those they have left behind. Surely it makes it still harder for us to know that if they escape death on the field of battle they may still, as the result of imperfect disinfection of the wounds, die from sepsis or be maimed for life. I beg of you to consider this matter calmly and logically and without prejudice, and see that every possible means is taken to avoid this great calamity.

**EXPERIMENTS REGARDING DIFFERENT METHODS
OF TUBERCULIN-TESTING.¹**

(From the Research Institute, Royal Veterinary College, London.)

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THE principal purpose of the present article is to place on record the results observed in a considerable number of young cattle which were tested in various ways with tuberculin after they had been intentionally and certainly infected with tubercle bacilli. The observations have been spread over the past three or four years, and the recording of temperatures and of the local effects produced by the tuberculin has been carried out by the various members of the Research staff during that period, including Messrs J. T. Edwards, B.Sc., F. C. Minett, B.Sc., R. H. Knowles, M.R.C.V.S., C. J. R. Lawrence, M.R.C.V.S., R. Daubney, M.R.C.V.S., and A. H. Adams, M.R.C.V.S.

The chief points upon which the experiments and observations bear are:—

1. The temperature effects produced (*a*) in healthy and (*b*) in

¹ The experiments were carried out by the aid of a grant from the Board of Agriculture and Fisheries.

infected animals by the intravenous inoculation of living tubercle bacilli.

2. The temperature reactions produced in infected animals subcutaneously tested with homologous or heterologous tuberculin.

3. The reactions produced in infected animals by the intracutaneous and conjunctival tests.

4. The comparative merits of the three different methods of applying the tuberculin test—subcutaneous, intracutaneous, and conjunctival.

Except where otherwise stated, the animals to which numbers are assigned were calves under six months old at the time when they first figure in the tables, but some of them were over two years old before the final test.

The tuberculin used for the subcutaneous tests corresponded in strength with what is generally termed "dilute," but it would be more correctly described as "unconcentrated." It contained carbolic acid in the proportion of $\frac{1}{2}$ per cent.

For the conjunctival and intracutaneous tests a "concentrated tuberculin" was used. This was prepared by evaporating freshly prepared tuberculin, without carbolic acid or other added preservative, over a water bath until it was reduced to one-fifth of its original volume. Such concentrated tuberculin contains 20 per cent. of glycerin—that is, on the assumption, known to be not quite correct, that the whole of the original 5 per cent. glycerin present in the culture liquid remains after the growth of tubercle bacilli has been completed.

In the manufacture of the three kinds of tuberculin—bovine, human, and avian—the same three strains of bacilli were employed throughout; and, although no precaution can ensure absolute uniformity of strength and composition in samples of tuberculin prepared at different times, there is no reason to suppose that what was used for the different tests varied to a degree that could affect the results.

With regard to the manner in which the subcutaneous tests were carried out, it need only be said that, except where the contrary is stated, the tuberculin was injected at an early hour in the forenoon, and usually at 6 or 7 o'clock. The dose of human tuberculin given to animals under a year old was 2 cc., and it was not considered necessary to give a smaller dose to young calves. In most cases the dose was increased to 3 cc. as the animals approached two years old. As will be seen from the tables, the temperature was taken at intervals of three hours, up to the fifteenth hour after injection.

The dose of concentrated tuberculin used for the conjunctival and intracutaneous tests was the same, viz., $\frac{1}{4}$ cc. The left eye was used for the former test and the right anal fold of skin for the latter.

In carrying out the conjunctival test an assistant twisted the animal's neck until the left eye was directed upwards, and the proper dose of tuberculin was then dropped within the palpebral fissure, slight force being used to separate the lids if necessary. No manipulation of the lids was used to assist in the distribution of the liquid over the eyeball and conjunctiva.

In looking for evidence of reaction the two eyes were always compared in a good light, an electric torch being used for the purpose at night.

The intracutaneous test was made by the aid of a 1 cc. hypodermic syringe with a slender needle, which was introduced at the centre of the free edge of the double cutaneous fold and pushed in until its point had just passed through the skin. The syringe was then attached and the injection made. Slight pressure was exerted on the marginal part of the fold in withdrawing the needle to prevent any escape of the liquid. When the operation is properly carried out the injected tuberculin can be felt like a pea-sized vesicle in the substance of the fold.¹

The local effect produced by tuberculin introduced at this point should be studied in the first place by standing directly behind the animal and viewing the anal region while an assistant forcibly elevates the tail, so as to place the two cutaneous folds on the stretch. After the thickness of the right and left folds has thus been compared with the eye, the right fold is felt between the thumb and fingers of the right hand, and the impression thus obtained may be corrected by grasping the left fold in the same way. Caliper-compasses may also be used to measure the thickness of each fold.

THE EFFECTS OF INTRAVENOUS INOCULATION OF TUBERCLE BACILLI ON THE TEMPERATURE.

Tables I. and II. show the variations in temperature which occurred in thirty-nine young cattle during the fifteen hours following an intravenous inoculation of living human or avian tubercle bacilli in doses varying from 10 to 20 mg.

Taking the highest temperature of the previous day as representing the normal, it will be observed that a rise of 2° or more occurred in four animals in Table I. and five animals in Table II. As an intravenous inoculation of bacilli usually influences the temperature of a tuberculous animal like a subcutaneous injection of tuberculin, it becomes interesting to inquire whether the considerable rise of temperature in the above nine animals can be accepted as evidence that they were already infected. The particulars with regard to these animals were as follows:—

No. 38. This animal was simultaneously tested by the conjunctival and intracutaneous methods on the 14th November 1911, and there was no reaction to either test. The temperature at the time of injection of the tuberculin was 103·2°, and the maximum during the following fifteen hours was 103·5°. There was thus no temperature reaction to the dose of concentrated tuberculin (equivalent to 1·25 cc. dilute) employed for the intracutaneous test.

No. 51 was tested simultaneously by the conjunctival and intracutaneous methods on the 7th November 1911, and there was no reaction to either test. The temperature was not taken on this occasion, but a week later the animal was submitted to a subcutaneous test and the maximum rise of temperature was 1·5°, the initial temperature being 102·5°. The highest temperature during the previous three days had been 103·6°.

No. 54 was tested on the same occasions, viz., by the combined conjunctival and intracutaneous methods on the 7th November, and by the

¹ We have followed custom in using the word "intracutaneous" for this method of testing, although recognising that it is a misnomer. It is not possible with certainty or accuracy to inject even a smaller quantity of liquid than $\frac{1}{4}$ cc. into the substance of the skin. The liquid in reality is left in the thin connective tissue layer between the two folds of skin.

subcutaneous method on the 14th November. There was no reaction to any of the tests. The maximum rise of temperature on the occasion of the subcutaneous test was $^{\circ}6$, but the initial temperature was $104^{\circ}2$.

No. 55 was tested at the same time as the preceding two, and there was no reaction to any of the tests. On the occasion of the subcutaneous test the initial temperature was $103^{\circ}5$, and the maximum temperature recorded during the following fifteen hours was $104^{\circ}1$.

The tuberculin test applied to these four animals thus provided no reason for supposing that they were tuberculous, and upon the whole it appears to be most probable that no one of them was tuberculous prior to the first intravenous inoculation, and that the rise of temperature on the occasion of that inoculation was accidental, or at least non-specific. At the same time it must be admitted that the great rise of $4^{\circ}9$ in No. 55 was highly suspicious of previous infection, although the temperature curve was irregular.

No. 65. Special interest attaches to this case because after the first intravenous inoculation with human bacilli on the 20th February 1913 the temperature rose to 107° , or $4^{\circ}4$ from the temperature of the previous day. Along with the others included in Table II., this animal had been subjected to a triple test with human tuberculin on the 28th January 1913, and there was then a rise of temperature from 102° at the time of injection to 105° at the fifteenth hour. There was no reaction to the intracutaneous test and no distinct reaction to the conjunctival test, although there was slightly excessive lachrymation of the left eye.

On the evidence, therefore, it appears probable that this animal was infected prior to the intravenous inoculation with bacilli, and that the rise of temperature on the occasion of that inoculation was a genuine reaction.

Nos. 66, 69, 70, 76. The temperatures of these four animals after a subcutaneous injection with tuberculin on the 28th January 1913 were as follows:—

	Inj.	3	6	9	12	15
No. 66 . .	102.8	103.4	102.4	102.8	103.8	103
No. 69 . .	102	103	101.6	102.4	102	104
No. 70 . .	101.6	102.6	102.4	104	102	102.6
No. 76 . .	102.8	99.8	100.6	102.6	102	102.2

In Nos. 66, 69, and 70 there was no reaction to the intracutaneous test, but in No. 76 the right anal fold was one and a half times as thick as normal at the sixth hour. At no other time was there more than an appreciable difference between the two folds.

In No. 66 there was a little muco-pus present at the sixth and fifteenth hours only. In No. 69 there was lachrymation and a particle of muco-pus as large as a barley grain at the ninth hour. In Nos. 70 and 76 there was no reaction whatever to the conjunctival test.

Probably in these four cases also the rise of 2° or more after the intravenous inoculation of bacilli was accidental or non-specific. It will be noted, however, that in the great majority of the animals in Tables I. and II. there was some rise of temperature during the

fifteen hours after the inoculation, and it cannot be considered surprising if such considerable doses of bacilli injected into the blood current produce a moderate rise of temperature even in a healthy animal.

Turning in the next place to the effects of a second intravenous inoculation on the temperature, it will be seen from Tables III., IV., and V. that with very few exceptions the inoculation was followed by a very marked temperature reaction, similar in its onset to the reaction to a subcutaneous injection of tuberculin, except that on an average it began and attained its height at an earlier period.

Apparently if there were no objections to the intravenous inoculation of either human or avian bacilli into the blood current, that might be employed as a test for the existence of tuberculous infection, and one which would be as reliable as a subcutaneous test with tuberculin.

Table VI. shows the temperatures of a group of five animals which were first "vaccinated" with human or avian bacilli, and then infected with bovine bacilli by intravenous inoculation. It will be noted that the temperature disturbance was not so severe in these cases, and that in two of them it did not reach 2°. No doubt this difference is attributable to the smaller dose of bovine bacilli used in these cases.

TESTS OF ANIMALS INFECTED WITH HUMAN OR AVIAN BACILLI.

Although in comparing the different results which we have observed in testing with tuberculin by the subcutaneous, conjunctival, and intracutaneous methods we shall deal mainly with the comparative effects produced in animals known to be infected with bovine tubercle bacilli, we have made a large number of observations of the same kind on animals previously infected by intravenous inoculation with either human or avian bacilli. Space will not permit us to describe the results of these tests in detail, and, at any rate, that does not appear to be necessary, as upon the whole the results were similar to those which were obtained in the comparative tests of animals infected with bovine tubercle bacilli. We may, however, take a single series of animals infected with human or avian bacilli and record the results of a simultaneous subcutaneous, conjunctival, and intracutaneous test.

The series which we select for the purpose contains seventeen animals which were subjected to a triple test on the 28th May 1913. The results of the subcutaneous tests on that occasion are shown in Table XV. A reference to that table will show that the animals numbered from 61 to 69 inclusive had been previously inoculated either once or twice with human tubercle bacilli, and that those numbered 71 to 79 inclusive had been inoculated once or twice with avian bacilli. All these animals had already been tested on two occasions since their first inoculation with human or avian bacilli. (See Tables XIII. and XIV.).

It will be seen from Table XV. that every animal in the series had a distinct reaction to the subcutaneous test with homologous

tuberculin, the rise of temperature in the different individuals varying from 2.2° to 4.1° .

The results of the other two tests were as follows:—

Conjunctival Tests.—Nos. 64, 68, 71, 73, 74, and 79. In these animals the result of the test was either entirely negative, or positive only in the sense that at one or two periods of observation during the twenty-nine hours following the instillation of the tuberculin into the eye there was a little lachrymation. In several of these cases, however, the lachrymation was *from both eyes*.

No. 61. Slight lachrymation at the sixth hour and a pinhead particle of muco-pus at the fifteenth hour.

No. 62. A particle of muco-pus as large as a barley grain at the ninth hour and another as large as a pin's head at the fifteenth hour.

No. 63. Slight lachrymation at the third and ninth hours and a particle of muco-pus twice as large as a pin's head at the twenty-ninth hour.

No. 66. A pinhead particle of muco-pus at the twelfth hour only.

No. 67. A particle of muco-pus as large as a barley grain at the third and sixth hours.

No. 69. At the fifteenth and eighteenth hours two pinhead particles of muco-pus were present in the left or tested eye, but at the latter period twice that amount of muco-pus was present *in the right eye*.

No. 72. At the eighteenth hour there was a pinhead particle of muco-pus, and on the following day, at the twenty-ninth hour, similar material to the volume of a barley grain was present.

No. 75. At the third hour there was slight lachrymation *from both eyes* and a pinhead particle of muco-pus in the left or tested eye. Three hours later there was still rather excessive lachrymation from both eyes.

No. 77. Muco-pus as large as a barley grain was present at the ninth hour only.

No. 78. At different periods there was slight lachrymation from the left eye only and at the twenty-ninth hour a pinhead particle of muco-pus was present.

Intracutaneous Tests.—Nos. 61, 62, 63, and 78. There was never more than an appreciable difference between the two anal folds and no difference at all after the ninth hour.

No. 64. At the third hour the right or injected fold was swollen to twice the normal thickness, but it declined afterwards, and the difference was not appreciable at the twelfth hour.

No. 65. At the third hour the right fold was four times as thick as the left, but it rapidly diminished in thickness, and the swelling was not appreciable from the ninth to the eighteenth hour. There was just an appreciable difference between the two folds on the following day.

No. 66. At no time was there more than an appreciable difference between the two folds, and there was no difference at all on the following day.

No. 67. At the point of injection the right fold was swollen to five times its normal thickness at the third hour. At the sixth hour the swelling had become more diffuse and the fold was not more than twice the normal thickness. After that, up to the twenty-ninth hour, there was not more than an appreciable difference between the two folds.

No. 68. At the third hour the right fold was three times the normal thickness, but after the sixth hour there was not more than an appreciable difference between the two folds.

No. 69. At the third hour there was an appreciable difference between the two folds, and this was also the case at the twelfth and fifteenth hours, after which there was no observable difference.

No. 71. At the third hour the right fold was twice the normal thickness, but by the ninth hour the swelling had disappeared.

No. 72. Never more than an appreciable difference in the thickness of the two folds, and no difference after the fifteenth hour.

No. 73. The right fold was from two to three times the normal thickness at the third and sixth hours, but after that there was no appreciable difference between the two folds.

No. 74. The right fold was about twice the normal thickness at the third hour. Six hours after that there was no appreciable difference between the two folds, and there was no difference on the following day.

No. 75. Slight difference between the two folds at the third and sixth hours, but after that no difference.

No. 77. At the third, sixth, and eighteenth hours there was an appreciable difference between the two folds, but no difference on the following day.

No. 79. At the third hour the right fold was three times the normal thickness, and at the sixth hour it was still twice as thick as the left. After that, up to the eighteenth hour, there was not more than an appreciable difference between the two folds, and on the following day there was no difference.

TESTS OF ANIMALS INFECTED WITH BOVINE BACILLI.

These are naturally the most important of our observations, because of their immediate bearing on the comparative reliability of the three tests in actual practice.

The facts can be best presented by giving in order the results of the successive tests of the different lots of animals.

SERIES I.

First Test.

This series includes five animals (*see* Table XVI.) which had been inoculated subcutaneously with bovine tubercle bacilli on the 9th February 1912, and which on the 26th March following were simultaneously tested by the subcutaneous, conjunctival, and intracutaneous methods with human tuberculin.

As will be seen from the table, each of these animals had a marked temperature reaction to the subcutaneous test, the rise in all exceeding 3° .

Conjunctival Tests.—Not one of these animals had what could be regarded as a distinct reaction to the conjunctival test. In Nos. 6, 11, and 25 the test was entirely negative. In No. 19 there was "some congestion with lachrymation" at the third hour, and at the ninth and fifteenth hours muco-pus of the volume of a pin's head was present at the inner canthus. In No. 59 the eye was normal throughout except at the fifteenth hour, when flakes of mucus amounting to the volume of a pea were present at and around the inner canthus.

Intracutaneous Tests.—In No. 6 the intracutaneous injection of tuberculin produced at the third hour a diffuse swelling of the cutaneous fold equal in volume to a pigeon's egg. Three hours later this swelling had become rather smaller, and at the ninth and fifteenth hours the cutaneous fold was about

twice the normal thickness. On the following day, at the twenty-seventh hour after the test was begun, there was only a slight difference in thickness between the right and left anal folds.

In No. 11 there was a swelling as large as a walnut in the injected cutaneous fold at the third hour, and at the ninth hour this had diminished to the size of a hazel nut. At the twelfth hour the injected fold was about twice as thick as the opposite one, and at the fifteenth hour and on the following day at the twenty-seventh hour it was three times the normal thickness (*see fig. 1*).

In No. 19 a swelling as large as a pigeon's egg and fairly well circumscribed had formed at the seat of injection at the third hour. By the fifteenth hour this had diminished to the size of a filbert nut, but it had again increased to

FIG. 1.

No. 11. Reaction to intracutaneous test at thirty-second hour (27th March 1912).

the volume of a pigeon's egg on the following day, at the twenty-seventh hour (*see fig. 2*).

In No. 59 the intradermic test had entirely negative results, there being not more than an appreciable difference in thickness between the two cutaneous folds at any of the periods of observation.

In No. 25 a swelling as large as a hazel nut had formed in the right fold after three hours. Three hours later this swelling had nearly disappeared, but at the twelfth and fifteenth hours the right fold had attained twice its normal thickness, and this thickening persisted until the following day (*see fig. 3*).

Second Test.

The same five animals were subjected to a second triple test with human tuberculin on the 14th May 1912, or rather more than three months after their infection with bovine tubercle bacilli. The results of the subcutaneous tests will be found in Table XVII., from which it will be seen that each of the five animals had a marked reaction to this test. The results of the other two tests were as follows:—

Conjunctival Tests.—No. 6. There was no reaction except that the left eye was watering at the ninth and twelfth hours.

No. 11. No reaction except a particle of muco-pus the size of a pin's head at the inner canthus at the twelfth hour.

FIG. 2.

No. 19. Reaction to intracutaneous test at thirty-second hour (27th March 1912).

No. 25. No reaction except lachrymation at the third hour, and some congestion at the sixth hour.

No. 19. Entirely negative.

No. 59. No reaction except lachrymation at the third hour.

Intracutaneous Tests.—No. 6. At the third hour a swelling as large as a pigeon's egg had formed at the seat of injection in the right anal fold. At the sixth hour this had increased somewhat in size. At the ninth hour the swelling was as large as a hen's egg. At the twelfth hour it had decreased considerably in size, and at the fifteenth hour the right fold was about one and a half times as thick as the left. On the following day, after twenty-four hours, the fold was two to three times the normal thickness.

No. 11. At the third hour a diffuse swelling had formed at the seat of injection, increasing the thickness of the fold about three times, and at the

sixth hour it was only about twice the normal. At the ninth, twelfth, and fifteenth hours it was from two to three times the normal thickness, and on the following day it was still about twice the normal thickness.

No. 25. At the third hour the fold was about twice the normal thickness, but it had decreased a little at the sixth hour, and at the ninth hour it was three or four times the normal thickness. It again decreased a little at the twelfth and fifteenth hours, but on the following day it was from two to three times the normal thickness.

No. 19. At the third hour a swelling as large as a hen's egg had formed in the right fold. At the sixth hour it was a little smaller, and it was found that some yellowish liquid had exuded through the skin and dried on the surface. At the ninth hour the swelling was of nearly the same size as before. At the twelfth and fifteenth hours and on the following day, after twenty-five hours, the fold was about three times the normal thickness.

FIG. 3.

No. 25. Reaction to intracutaneous test at twenty-ninth hour (27th March 1912).

No. 59. At the third and sixth hours the right fold was about twice as thick as the left. At the ninth hour it was three or four times the normal thickness, and at the twelfth and fifteenth hours it was about twice as thick as the opposite fold. On the following day the right fold was nearly as thick again as the left.

Third Test.

The same five animals were subjected to a third test on the 4th June 1912, or about four months after their infection by subcutaneous inoculation with bovine tubercle bacilli.

The result of the subcutaneous test will be found at the top of Table XVIII., from which it will be seen that only one of the

animals, namely, No. 6, failed to react to this test. No. 6 was tested with avian tuberculin, whereas human tuberculin was used for the other four.

Human tuberculin was used for the other two tests, the results of which were as follows:—

Conjunctival Tests.—In all five calves the result of the test was entirely negative, except in No. 19, in which the only abnormality noted during the twenty-four hours following the instillation of the tuberculin was the presence of muco-pus equal in volume to three millet seeds at the sixth hour.

Intracutaneous Tests.—No. 6 At the third hour the fold was two or three times the normal thickness around the point of injection. At the sixth hour there was only an appreciable swelling. The difference between the two folds was rather more marked at the twelfth hour, but it had become scarcely appreciable at the fifteenth hour, and there was no difference at all between the two folds on the following day.

No. 11. At the third hour a swelling as large as a pigeon's egg had formed at the point of injection at the right fold. At the sixth hour it had greatly declined, the fold being then about twice the normal thickness, and it remained in this condition at the ninth, twelfth, fifteenth, and twenty-fourth hours. There was still an appreciable difference between the two folds after forty-eight hours.

No. 19. At the third hour a swelling 1 inch in diameter had formed in the right fold, and at the sixth hour this had declined, the fold being then not more than twice the normal thickness. It remained unaltered at the ninth and twelfth hours, but the thickening was a little less at the fifteenth hour. No alteration had taken place on the following day.

No. 25. At the third hour the right fold was at least thrice the normal thickness. At the sixth, ninth, and twelfth hours it was about twice the normal thickness, but at the fifteenth hour there was only an appreciable difference between the two folds. On the following day the right fold was about twice as thick as the left.

No. 59. At the third hour the right fold was 1 inch thick at the point of injection and a swelling was extending down from it towards the tuber ischii. At the sixth, ninth, and twelfth hours the fold was about twice the normal thickness, but at the fifteenth hour there was only an appreciable difference between the two folds. There was only a little difference on the following day.

Fourth Test.

The same five animals were tested for the fourth time by the subcutaneous and conjunctival methods on the 19th July 1912, or over five months after their infection with bovine tubercle bacilli, human tuberculin being used for both tests.

The temperatures after the subcutaneous test will be found at the upper part of Table XIX., and it will be seen that four of the animals reacted distinctly to this test. The only animal in which the temperature did not rise at least 2° was No. 6, in which the maximum rise was 1.4°. It may be noted that this was also the only animal which failed to react to the previous subcutaneous test, and it is therefore doubtful whether the failure to react on the previous occasion was due to the test having been made with avian tuberculin.

The conjunctival tests had entirely negative results in all the five animals, except that in the case of No. 6 there was some lachrymation of the left eye at the ninth hour.

SERIES II.

First Test.

This series includes the last fourteen animals whose temperatures after a subcutaneous test with human tuberculin on the 14th May 1912 are shown in Table XVII. These animals had been inoculated subcutaneously with bovine tubercle bacilli on the 18th April 1912.

Every one of the animals had a distinct temperature reaction to the subcutaneous test on the 14th May, with the exception of No. 42, which had an initial temperature of 104.6° . Taking the temperature of the previous day as representing the normal, this animal also reacted to the subcutaneous test.

On the 14th May these fourteen animals were simultaneously tested with human tuberculin by the conjunctival and intracutaneous methods, with the following results :—

Conjunctival Tests.—In No. 10 the result of the test was entirely negative, except that there was a trace of muco-pus at the inner canthus at the twelfth hour.

In No. 37 there was excessive lachrymation at the third hour. At the sixth hour some congestion was noted. At the ninth hour there was slight lachrymation and congestion, and at the twelfth hour slightly increased lachrymation. At the fifteenth hour and on the following day the eye was quite normal in appearance.

In Nos. 42, 44, and 17 the test had entirely negative results, except that at some periods of observation it was thought there was slightly increased lachrymation.

In No. 18 there was some lachrymation and muco-pus of the volume of two pins' heads at the sixth hour. At all other periods of observation the eye was quite normal.

In Nos. 57 and 58 the test had entirely negative results.

In No. 22 there was a particle of muco-pus the size of a pin's head at the sixth hour, and this had increased to the volume of a split pea at the twelfth hour. A similar quantity was present three hours later, and at different periods there was also some increased lachrymation.

In Nos. 39, 54, 23, 47, and 50 there was no reaction, except possibly a little lachrymation at one single period of observation, and in the case of No. 23 muco-pus of the volume of a pin's head at the twelfth hour only.

Intracutaneous Tests.—In No. 10 at the third hour the right cutaneous fold was three times the normal thickness, and this had been reduced to twice the normal thickness at the sixth hour. At the twelfth hour there was only an appreciable difference between the two folds, but at the fifteenth hour the right one was nearly 1 inch in thickness. On the following day, after twenty-six hours, there was still a marked difference between the two folds, the right one being now about three-quarters of an inch in thickness.

In No. 37 the inoculated fold was twice the normal thickness at the third hour, and it had increased to three or four times the normal thickness at the ninth hour. On the following day it was still two or three times the normal thickness.

In No. 39 there was a swelling as large as a pigeon's egg at the third hour, and this had diminished to the size of a walnut at the sixth hour. At later periods, up to the following day, the right fold was at least twice the normal thickness.

In No. 42 the inoculated fold was about three times the normal thickness at the third hour. By the twelfth hour it was only about twice the normal thickness, but this difference between the two folds was maintained on the following day.

In No. 44 the fold was about twice the normal thickness at the third hour, and rather less than that at the twelfth hour, but about three or four times the normal thickness at the fifteenth hour. On the following day it was still twice the thickness of the opposite fold.

In No. 17 the fold was about three times the normal thickness at the third and sixth hours, and at the ninth hour it was noted to be as large as a pigeon's egg and firm. It had become smaller at the twelfth and fifteenth hours, but on the following day it was three or four times the thickness of the opposite fold (*see fig. 4*).

In No. 18. the fold had attained nearly twice the normal thickness at the third hour, and it remained in that condition until the twelfth hour. At the fifteenth hour it was three or four times the normal thickness, and next day it was about three times the normal thickness.

In No. 22 the fold was about twice the normal thickness at the third hour,

FIG. 4.

No. 17. Reaction to intracutaneous test at the twenty-seventh hour (15th May 1912).

and by the fifteenth hour it was three or four times the normal thickness. It was still about that thickness on the following day.

In No. 23 the fold was three times the normal thickness at the third and sixth hours, and from four to five times as thick at the ninth hour. At the fifteenth hour it was about three or four times as thick as normal, and next day it was about twice the normal thickness.

The swelling of the inoculated fold in No. 47 was almost exactly the same as in the previous animal.

In No. 50 the swelling at the third and sixth hours was noted to be about the size of a small walnut. It still remained that size at the twelfth hour, but at the fifteenth hour, in addition to a circumscribed swelling as large as a pigeon's egg, there was diffuse swelling of the fold. On the following day the swelling was still of the volume of a pigeon's egg.

In No. 54 the fold was about twice the normal thickness at the third and

sixth hours. At the ninth hour it was about 2 inches in thickness. At the fifteenth hour it had diminished, being then about three or four times the normal thickness, and it remained at that thickness on the following day.

In No. 57 the fold was about three times the normal thickness at the third and sixth hours, and at the ninth hour there was around the point of injection a swelling as large as a goose egg. At the twelfth hour the swelling had become reduced in size and was very diffuse. Three hours later the fold was about 2 inches thick, and on the following day it was still over 1 inch in thickness (three or four times the normal thickness).

In No. 58 the fold was twice the normal thickness at the third hour. At the ninth hour there was a circumscribed swelling as large as a pigeon's egg. At the twelfth hour the fold was again about twice the normal thickness, but it had increased at the fifteenth hour and on the following day it was about three or four times the normal thickness.

Second Test.

The same lot of animals was submitted to a second triple test on the 4th June 1912. The results of the second subcutaneous test will be found in Table XVIII., from which it will be noted that three of the animals, namely, Nos. 10, 37, and 42, received avian tuberculin, and avian tuberculin was also employed for the conjunctival and intracutaneous tests in these same animals. In all the other cases the tuberculin used was human for all three tests.

Examination of the table will show that there were only three animals in which the temperature during the fifteen hours following injection of the tuberculin failed to rise 2°. The exceptions were Nos. 37 and 42, both of which had received avian tuberculin, and No. 22, which had received human tuberculin.

The results of the other two tests were as follows:—

Conjunctival Tests.—In Nos. 10, 37, 39, 42, 18, 58, and 50 the eye was either normal throughout or presented nothing abnormal except slight lachrymation at one or more of the periods of observation.

No. 44. The result was negative except for a pinhead particle of muco-pus at the sixth hour.

No. 17. At the third hour both eyes were watery, and at the twelfth hour there was a pinhead particle of muco-pus in the left eye. This had increased to the volume of an oat seed at the fifteenth hour. At other periods of observation the left eye was normal.

No. 22. At the sixth, ninth, and twelfth hours some muco-pus was present in the eye, the maximum amount being at the twelfth hour, when it was equal in volume to a barley grain.

No. 23. At the sixth hour there was some lachrymation and muco-pus of the size of two pins' heads. A smaller quantity of muco-pus was present at the ninth hour.

No. 47. A trace of muco-pus was present at the ninth hour.

No. 54. At the fifteenth hour a pinhead particle of muco-pus was present.

No. 57. At the sixth hour two pieces of muco-pus collectively equal in amount to a barley grain were present. At the ninth hour a pinhead particle of muco-pus was present. At the twelfth hour the eye was clean, and at the fifteenth hour fresh muco-pus equal in volume to a pea was present.

The large proportion of animals which failed to have any reaction, or at least any distinct reaction, to this test is striking. It may be noted that three of the failures were the three animals tested with avian tuberculin.

Intracutaneous Tests.—No. 10. At the third hour the right anal fold was three or four times the normal thickness. Three hours later it was only about twice the normal, and at the ninth, twelfth, and fifteenth hours it had diminished until the difference between the two folds was scarcely appreciable. On the following day there was no appreciable difference between the two folds.

No. 37. At the third and sixth hours there was an appreciable swelling of the right fold, and by the fifteenth hour the difference between the two folds had become scarcely perceptible. There was no appreciable difference in the thickness of the two folds on the following day.

No. 39. At the third hour there was a swelling in the right fold as large as a hen's egg. This extended upwards to near the root of the tail and downwards to the tuber ischii. At the sixth hour the swelling had become reduced to the size of a pigeon's egg. At the ninth hour the swelling persisted, but was diffuse. At the twelfth hour the right fold was about three times the normal thickness. At the fifteenth hour there was only an appreciable difference between the two folds. On the following day the right fold was about twice as thick as the left.

No. 42. At the third hour there was a slight thickening of the right fold, but at all subsequent periods of observation up to the following day there was scarcely any appreciable difference between the two folds.

No. 44. At the third, sixth, and ninth hours the right fold was about twice the normal thickness, but after that the difference between the two folds was only appreciable.

No. 17. At the third hour the right fold was three times the normal. At the sixth hour it was about four times the normal thickness. At the ninth, twelfth, and fifteenth hours it was about twice the normal thickness. On the following day it had increased a little, being then about three times as thick as the left fold.

No. 18. At the third and sixth hours the right fold was about three times, and at the ninth hour about twice, the normal thickness. At the twelfth and fifteenth hours it had declined a little. On the following day it had still further declined, but there was still an appreciable difference between the two folds.

No. 22. From the third to the twelfth hour the right fold was about twice the normal thickness, but it had diminished by the fifteenth hour, and was only appreciable on the following day.

No. 23. From the third to the ninth hour the right fold was three or four times the normal thickness, and it afterwards declined, until at the fifteenth hour it was only about twice the normal thickness. It had increased rather than diminished on the following day.

No. 47. A swelling as large as a pigeon's egg had formed in the right fold at the third hour. At the sixth hour the right fold was three or four times the normal thickness, but from the ninth to the fifteenth hour it was only about twice the normal thickness, and that persisted until the following day.

No. 50. At the third hour there was a circumscribed swelling as large as a pigeon's egg at the seat of injection, and from the sixth to the twelfth hour the right fold was about three times the normal thickness. At the fifteenth hour it was about twice the normal thickness. On the following day it had increased to three or four times the thickness of the opposite fold.

No. 54. At the third, sixth, and ninth hours there was perceptible swelling of the right fold, and at the twelfth and fifteenth hours it was three or four times the normal thickness. On the following day it was about twice as thick as the opposite fold.

No. 57. At the third hour a well-defined swelling as large as a hen's egg had formed in the right fold, and the tissues around this were also swollen,

with a lateral extension across to the left fold. At the sixth hour the state of affairs was much the same (*see* fig. 5). At the ninth hour the swelling had declined somewhat, and there was a further reduction in its size at the twelfth hour. At the fifteenth hour the right fold was four or five times the normal thickness. On the following day the swelling was nearly as large as a pigeon's egg. A day later the right fold was still three or four times the thickness of the left.

No. 58. During the first nine hours there was only an appreciable difference between the two folds, but at the twelfth hour the right fold was about double the normal thickness. It had diminished somewhat at the fifteenth

FIG. 5.

No. 57. Reaction to intracutaneous test at eighth hour (4th June 1912).
(The right anal fold is seen in profile.)

hour, but on the following day it was three or four times the normal thickness.

Third Test.

On the 19th July 1912 the same animals were simultaneously tested for the third time by the subcutaneous and conjunctival methods, human tuberculin being used for both tests. On this occasion the intracutaneous test was not carried out.

The results of the subcutaneous tests are given in Table XIX., from which it will be seen that eight of the animals had a distinct reaction, while in the remaining five animals the rise of temperature was less than 2° . If the average temperature of the preceding day be taken as the normal, then all thirteen animals had a rise of 2° or more with the exception of No. 18.

The results of the conjunctival tests were as follows:—

Nos. 10, 39, 44, 18, 22, 23, 47, 50, and 54. In these cases the test was entirely negative.

Nos. 37, 17, and 57. The eye was normal throughout, except that at one or not more than two periods of observation there was possibly a little excessive lachrymation.

No. 42. At the ninth hour there was a pinhead particle of muco-pus, and at the twelfth hour a fresh particle of the same size had formed. At the fifteenth hour there was just a trace of muco-pus below the eye.

SERIES III.

First Test.

Included in this series are eight animals which were infected by subcutaneous inoculation with varying doses of bovine tubercle bacilli on the 20th July 1912. On the 14th August following, with two exceptions, they were simultaneously tested with human tuberculin by the subcutaneous, intracutaneous, and conjunctival methods, and the results of the first of these tests are given in Table XX., from which it will be seen that they all reacted very strongly, the rise of temperature in the different animals varying from 2.9° to 6.7° . Nos. 48 and 55 were not submitted to the conjunctival test, because at the time of the test they had some muco-pus in both eyes.

The results of the conjunctival and intracutaneous tests in the different animals were as follows:—

Conjunctival Tests.—No. 28. In this animal, at the sixth hour, muco-pus as large as a barley grain was present at the inner canthus, and in varying amounts it was also present at the ninth, twelfth, and fifteenth hours. At the last observation the amount present was about the same as at the sixth hour.

No. 29. At the sixth hour muco-pus of the volume of a barley grain was present, and on each subsequent observation up to the twenty-seventh hour it was present in about the same amount. (The muco-pus at each successive observation was noted to be a fresh formation.)

No. 41. In this animal slight lachrymation was noted at the sixth hour, and at the ninth and fifteenth hours there was muco-pus about the volume of an oat seed.

No. 38. Up to the fifteenth hour this animal's eye remained quite normal, but on the following day, at the twenty-eighth hour, muco-pus of the volume of a small oat seed was present.

In Nos. 21 and 53 there was no reaction at all to the conjunctival test.

Intracutaneous Tests.—No. 28. At the third hour the right fold was about twice the normal thickness, and it was about the same at the twelfth and fifteenth hours. On the following day, after twenty-seven hours, it was three or four times the normal thickness, and after another twenty-four hours there was still a marked difference between the two folds.

No. 29. At the third hour the fold was about three times the normal thickness, and, after having declined to about twice the normal thickness at the ninth hour, it had increased to three or four times the normal at the twelfth hour. It remained at that thickness at the fifteenth hour, and it was almost the same on the following day and up to the forty-eighth hour.

No. 38. The right fold was three times the normal thickness at the third hour, but by the twelfth hour it had declined until there was only an appreciable difference between the two folds. This was also the condition of affairs at the fifteenth hour and on the following day.

No. 41. At the third hour the right fold was about three times the normal thickness, but it had declined until, at the fifteenth hour, it was twice the thickness of the opposite fold. On the following day it was about the same.

FIG. 6.

No. 30. Reaction to intracutaneous test at twenty-ninth hour (15th May 1912).
(This animal's reaction is not described in the text.)

No. 21. At the third hour the right fold was about three times the normal thickness, but at the sixth, ninth, and twelfth hours it was only about twice the normal thickness. At the fifteenth hour it was three or four times the normal thickness, and after twenty-four and forty-eight hours from the time of inoculation it was still about the same.

No. 48. From the third to the fifteenth hour the right fold was three or four times the normal thickness. On the following day there was diffuse swelling of the fold, which was about 2 inches thick, and this had diminished only a little after another twenty-four hours.

No. 53. At the third hour the right fold was four to five times the normal thickness, and there was no alteration at the sixth hour. At the fifteenth hour it was about 2 inches in thickness, and it remained at this stage on

the following day. In another twenty-four hours it was three or four times as thick as the opposite fold.

No. 55. At the third hour the right fold was about three times as thick as the opposite one, and it afterwards declined until the difference was scarcely perceptible at the twelfth and fifteenth hours. On the following day, however, it was about twice the normal thickness, and twenty-four hours later it had declined considerably.

Second Test.

The same animals were subjected to a second triple test with human tuberculin on the 25th September 1912, and the results of the subcutaneous tests are shown in Table XXI. It will be seen that the whole eight animals had a marked reaction to the subcutaneous test, the rise of temperature in the different individuals varying from 2·8° to 5·5°.

The results of the other two tests were as follows:—

Conjunctival Tests.—No. 28. At the third hour there was already muco-pus around the inner canthus equal in volume to a split pea. Three hours later apparently fresh particles of muco-pus of about the same amount had formed. At the ninth hour a smaller amount was present, but both at the twelfth and fifteenth hours the muco-pus present was as large as a pea. On the following day the eye showed about the same amount of partially dried muco-pus.

No. 29. At the third and sixth hours two or three particles of muco-pus were present, and at the ninth hour it had increased to the volume of a pea and there was some lachrymation. A diminished amount was present at the twelfth and fifteenth hours, and on the following day the eye was clean but moist.

No. 38. At the third hour *both eyes were "weeping"* and muco-pus the size of a millet seed was present in the left or tested eye. About the same amount was present three hours later. At the ninth hour the eye was clean but lachrymation continued. At the twelfth hour the eye was about normal, and at the fifteenth hour muco-pus as large as a millet seed was present.

No. 41. At the third hour there was a little lachrymation, but at the sixth hour the eye appeared quite normal. At the ninth hour there were a few dried flakes of mucus, and at later periods of observation the eye was clean but watering a little.

No. 21. No abnormality except that the eye was watering a little at the twelfth hour.

No. 48. The eye was slightly moist at the third hour but normal at the sixth. At the ninth hour muco-pus as large as a barley grain was present, and about the same amount or rather more was present at the twelfth and fifteenth hours.

No. 53. Normal till the sixth hour, when the eye was watering a little and muco-pus as large as a barley grain was present. The condition was similar at the ninth hour, and at the twelfth and fifteenth hours smaller amounts of muco-pus were present.

No. 55. At the third hour *both eyes had a moist appearance* and a pinhead particle of muco-pus was present in the left or tested eye. At the sixth and ninth hours the eye was normal, but at the ninth hour muco-pus as large as a split pea was present, and this had diminished somewhat at the fifteenth hour.

Intracutaneous Tests.—No. 28. At the third hour the right anal fold was twice the normal thickness. At the sixth and ninth hours it had diminished,

and after that, up to the twenty-seventh hour, there was not more than an appreciable difference between the two folds.

No. 29. At no time was there more than an appreciable difference between the two folds.

No. 38. At the third hour a swelling as large as a pigeon's egg was present in the right fold. At the sixth hour the right fold was twice, and at the ninth hour three times, the normal thickness. It afterwards declined, being about twice the normal thickness at the fifteenth hour. On the following day it was appreciably thicker than the opposite fold.

No. 41. At the third hour the right fold was four times the normal thickness, and it afterwards declined until at the fifteenth hour it was still about three times the normal thickness. On the following day the difference between the two folds was quite distinct to the eye.

FIG. 7.

Reaction to intracutaneous test at fourth hour. Test of No. 22 on 27th November 1914. (Not described in text, but given here as a good example of a pronounced early reaction.)

No. 21. At the third hour there was an appreciable difference between the two folds, and at the sixth hour the right fold was about twice the normal thickness. It had declined at the ninth and twelfth hours, but at the fifteenth hour it was again about twice the normal thickness. On the following day there was only an appreciable difference between the two folds.

No. 48. At the third hour the right fold was three times the normal thickness, but at other periods, up to the fifteenth hour, it was only twice as thick as the left. On the following day there was only a pea-sized, circumscribed swelling in the right fold.

No. 53. At the third hour there was a swelling as large as a pigeon's egg in the right fold. This had diminished a little at the sixth hour, but at the ninth, twelfth, and fifteenth hours the fold was at least three times the normal thickness. On the following day there was a marked difference between the two folds, and a day later a swelling larger than a pigeon's egg had formed

round the seat of injection. As late as the fourth day after injection the right fold was still about three times the normal thickness.

No. 55. At the third hour the right fold was nearly twice the normal thickness, and that was not exceeded at any later period. At the fifteenth hour and on the following day there was only an appreciable difference between the two folds.

SERIES IV.

First Test.

This series includes twelve animals which were inoculated subcutaneously with bovine tubercle bacilli on the 21st June 1913, and which were simultaneously tested with human tuberculin by the subcutaneous, conjunctival, and intracutaneous methods on the 2nd July following.

The results of the subcutaneous test are shown in Table XXIV., from which it will be seen that, with the exception of two animals, all had a rise of temperature of at least 2° , and in these two cases the initial temperature was high— 103.6° in the case of No. 63 and 104.8° in No. 75.

The results of the other two tests were as follows:—

Conjunctival Tests.—No. 61. No result except muco-pus half the size of a barley grain at the sixth hour.

No. 62. Muco-pus half the volume of a barley grain at the sixth hour. Nothing at the ninth or twelfth hours, but muco-pus the size of two pins' heads at the fifteenth hour.

No. 63. Negative.

No. 64. At the sixth hour muco-pus of the volume of a barley grain. At the ninth and twelfth hours the eye was clean, but at the fifteenth hour there was again muco-pus, this time equal in volume to a pea.

No. 65. Negative.

No. 71. At the third and sixth hours it was noted that both eyes were very moist and that tears had run over the face. Both eyes were normal after the ninth hour.

No. 72. At each observation from the third to the fifteenth hour muco-pus varying from a pin's head to three or four times that amount was noted to be present.

No. 73. Negative.

No. 74. At the sixth hour muco-pus of the volume of a barley grain was present. The eye was clean between the ninth and twelfth hours, but at the fifteenth hour there was again muco-pus equal in volume to a split pea.

No. 75. There was no reaction in this case except that muco-pus of the volume of two pins' heads was present at the sixth and ninth hours.

No. 82. Negative.

No. 83. Negative.

Intracutaneous Tests.—In No. 61 the right fold was twice the normal thickness at each period of observation from the third to the twenty-seventh hour.

In No. 62 the result was almost exactly the same, except that there was an appreciable decline in the size of the swelling between the third and twelfth hours, this being followed by an increase to twice the normal thickness.

In No. 63 the result was the same, the injected fold being twice as thick from the third to the twenty-seventh hour.

In No. 64 the result was similar, except that from the ninth to the twenty-seventh hour the right fold was three or four times the normal thickness.

In No. 65 the right fold was about twice the normal thickness at the third and sixth hours. It had declined at the ninth hour, but increased to three times the normal thickness at the twelfth hour. At the fifteenth hour it had again declined slightly, but on the following day, at the twenty-seventh hour, it was twice as thick as normal.

In No. 71 at the third hour there was a soft diffuse swelling, increasing the thickness of the right fold four or five times. At the sixth hour this swelling had become better defined, and felt about the size of a hazel nut. It was in the same condition at the ninth hour, but at the twelfth hour it was noted that the fold was three times the normal thickness.

In No. 72 the right fold was three times the normal thickness at the third hour, but there was no appreciable difference between the two folds at the sixth and ninth hours. At the twelfth, fifteenth, and twenty-seventh hours the right fold was twice the normal thickness.

In No. 73 at the point of inoculation the right fold was about three times the normal thickness at the third, sixth, ninth, and twelfth hours, and at the fifteenth and twenty-seventh hours it was twice the normal thickness.

In No. 74 at the third hour the right fold at the point of inoculation was about three times the normal thickness. It had diminished a little and become very circumscribed and firm at the sixth hour. At the ninth, twelfth, and fifteenth hours the fold was three times the normal thickness, and it remained at the same size on the following day at the twenty-seventh hour.

In No. 75 at all periods of observation there was not more than an appreciable difference between the two folds, except at the twelfth hour, when the right fold was twice the normal thickness.

In No. 82 the right fold was about twice the normal thickness from the third to the ninth hour. At the twelfth hour it had increased to four times the normal thickness, and it remained at that size at the fifteenth and twenty-seventh hours.

In No. 83 there was only an appreciable reaction at the third and sixth hours, but the fold was twice the normal thickness at the ninth hour, and three times the normal thickness at the twelfth, fifteenth, and twenty-seventh hours.

Second Test.

On the 17th July 1913 ten of the same animals were again tested with human tuberculin by the subcutaneous, conjunctival, and intracutaneous methods. As will be seen from Table XXV., all these animals reacted to this second subcutaneous test with the exception of No. 82, and that exception can be accounted for by the fact that the animal's initial temperature was 105.2°. The last two animals in the table, Nos. 84 and 85, were healthy controls.

The results of the other two tests were as follows:—

Conjunctival Tests.—In No. 61 there was no reaction whatever except that muco-pus of the volume of two pins' heads was present at the ninth hour.

In No. 62 the test was also negative except for muco-pus of the size of one pin's head at the sixth hour.

In No. 63 there was muco-pus of the size of one pin's head at the sixth hour, and there was some lachrymation at the twelfth hour *from both eyes*.

In No. 64 muco-pus of the volume of a pin's head was present at the third hour. There was three or four times that amount at the sixth hour, and it

had increased to the volume of a split pea at the ninth hour. At the subsequent periods of observation the eye was clean.

In No. 71 there was muco-pus the size of two pins' heads at the third hour, and three hours later it had increased to the size of a pea. At this time there was also some lachrymation. Rather less muco-pus was present at the ninth hour, and after that the eye was clean. It should be noted that at the time when the tuberculin was instilled into the left eye of this animal it was observed that muco-pus of the volume of a barley grain was present in the right eye.

In No. 72 there was nothing abnormal except the presence of muco-pus as large as a pin's head at the ninth hour.

In No. 73 there was no reaction whatever.

In No. 74 muco-pus as large as a barley grain was noted at the ninth hour, and at all other times the eye was clean.

In No. 82, at the third hour, muco-pus of the volume of three pins' heads was *present in both eyes*, and this was still present at the sixth hour. At the ninth hour it had increased in the left eye (the one into which the tuberculin had been instilled) to the volume of a split pea, and the same amount was present at the twelfth hour. At the fifteenth hour the left eye was moist, and at the eighteenth hour muco-pus as large as a pea was present in it.

In No. 83 somewhat dried muco-pus as large as a pea was present at the third and sixth hours, and a smaller amount at the ninth hour. At the twelfth hour the eye was clean, and at the fifteenth hour a particle of muco-pus as large as a pin's head was present. At the eighteenth hour rather dried muco-pus as large as a pea was present at the inner canthus.

In Nos. 84 and 85, which were the healthy control animals of this test, there was no reaction whatever.

It will be observed that in each of the tuberculous animals except No. 73 muco-purulent matter was observed at one or more of the periods of observation, and if the slightest particle of such matter is to be regarded as evidence of tuberculosis, it may be said that all the animals with this one exception reacted. On the other hand, the only animals in this series which can be said to have had a good, or even moderate, reaction were Nos. 64, 71, 82, and 83.

Intracutaneous Tests.—In No. 61 the right fold was at least thrice the normal thickness at the third hour, the swelling being soft and circumscribed. It was of about the same dimension at the sixth and ninth hours, and at the twelfth, fifteenth, and eighteenth hours the fold was twice the normal thickness. At the twenty-seventh hour there was only an appreciable difference between the two folds.

In No. 62 the right cutaneous fold at the third hour showed a circumscribed swelling as large as a pigeon's egg. At the sixth hour the fold was noted to be three times the normal thickness, but at all subsequent periods of observation up to the twenty-seventh hour there was only an appreciable difference between the right and left folds.

In No. 63 there was only an appreciable difference between the two folds at the third and sixth hours, but the right fold was thrice the normal thickness at the ninth hour, and twice the normal at the twelfth hour. At subsequent periods of observation there was only an appreciable difference between the two folds.

In No. 64, at the third hour, there was a circumscribed swelling measuring 3 inches by $1\frac{1}{2}$ inches by 1 inch in the right fold. At the sixth hour this was noted to be as large as a hen's egg. At the ninth hour it had declined to about half that size, and at subsequent periods of observation up to the twenty-seventh hour the right fold was twice the normal thickness.

In No. 71 the right fold was three or four times the normal thickness at

the third hour, and it had increased to five times the normal at the sixth hour. From the ninth to the twenty-seventh hour it varied from three to four times the normal thickness.

In No. 72 the right fold from the third to the twelfth hour was about two or three times the normal thickness, and after that up to the twenty-seventh hour there was only an appreciable difference between the two folds.

In No. 73, at the third hour, there was a soft diffuse swelling increasing the thickness of the right fold to three or four times the normal, and at the sixth hour the swelling was as large as a hen's egg. At the ninth hour the fold was noted to be four times the normal thickness, but it had decreased to twice the normal thickness at the twelfth hour, and it remained at that thickness at the eighteenth and twenty-seventh hours.

In No. 74 the effect was almost the same as in the preceding case, the reaction being characterised by the large size of the swelling at the third, sixth, and ninth hours.

In No. 82 there was only an appreciable swelling of the injected fold at the third hour, but from the sixth to the twenty-seventh hour the fold was twice the normal thickness.

In No. 83, at the third hour, there was a painful circumscribed swelling as large as a filbert nut at the point of injection in the right fold, and at all periods of observation from the sixth to the twenty-seventh hour the fold was noted to be at least three times the normal thickness.

In Nos. 84 and 85 there was only an appreciable difference between the two folds at the third and sixth hours, and after that there was no difference.

A point that appears to be worthy of special notice in connection with this second intracutaneous test of the infected animals is that much more marked reactions were obtained in most of them at the third, sixth, and ninth hours as compared with the first test.

Third Test.

A combined triple test of six infected animals of the same lot was carried out with human tuberculin on the 8th August 1913, and reference to Table XXVI. will show that they all reacted to the subcutaneous test with the exception of No. 71, in which animal the rise from the initial temperature was only 1.6° . There was, however, a rise of 2.2° from the temperature of the previous day.

The results of conjunctival and intracutaneous tests were as follows:—

Conjunctival Tests.—No. 61. In this animal there was no reaction whatever to the conjunctival test during the first fifteen hours, but at the thirtieth hour muco-pus of the volume of a barley grain was present.

In Nos. 62 and 65 there was no reaction whatever.

In No. 71 there was muco-pus of the volume of a pin's head at the third hour, and double that amount at the sixth hour. After that the eye remained clean.

No. 72. In this animal the eye was clean at all of the periods of observation except the sixth hour, when muco-pus the size of a pin's head was present. At the thirtieth hour the eye was watering, and muco-pus the size of a barley grain was present.

No. 75. In this animal the eye was clean at all periods of observation except at the sixth hour, when muco-pus to the amount of two or three pins' heads was present, and at the ninth hour, when the muco-pus amounted to a barley grain.

Intracutaneous Tests.—No. 61. The right cutaneous fold was twice the

normal thickness at the third and sixth hours, but after that it declined, and the difference between the two folds was only appreciable at the fifteenth hour. On the following day, however, at the thirtieth hour, the fold was again twice as thick as normal.

No. 62. The right fold was twice the normal thickness at the third hour, but afterwards, including the following day, there was not more than an appreciable difference between the two folds.

No. 65. The right fold was twice the normal thickness at the third, sixth, and ninth hours. It had declined a little at the twelfth and fifteenth hours, but it was again twice the normal thickness at the thirtieth hour.

No. 71. At the third hour there was a good deal of diffuse swelling somewhat in front of the point of inoculation in the right fold, and at the sixth, ninth, and twelfth hours the right fold was twice the normal thickness. At the fifteenth hour it was about three times, and at the thirtieth hour about twice, the normal thickness.

No. 72. At the third hour there had formed at the point of inoculation in the right fold a soft swelling somewhat larger than a pigeon's egg, and this persisted at the sixth hour. At the ninth, twelfth, and fifteenth hours the fold was about one and a half times the normal thickness, but on the following day, at the thirtieth hour, there was only an appreciable difference between the two folds.

No. 75. At the third hour there was, as in the case of No. 71, some diffuse swelling of the tissues in front of the point of inoculation. At the sixth and ninth hours the fold was twice the normal thickness. It had diminished at the twelfth and fifteenth hours, but at the thirtieth hour it was again twice the normal thickness.

SERIES V.

First Test.

This includes six animals which were inoculated with bovine tubercle bacilli on the 28th July 1913, and which were submitted to a triple test with human tuberculin on the 8th August following. The temperatures on that occasion are given in Table XXVII., from which it will be seen that each of the animals reacted very distinctly to the subcutaneous test.

The results of the other two tests are as follows:—

Conjunctival Tests.—No. 66. Negative except for the presence of muco-pus about half the volume of a barley grain at the sixth hour.

No. 67. Negative, except that muco-pus the size of two pins' heads was present at the sixth hour.

In Nos. 70, 77, and 78 the test was entirely negative throughout.

No. 85. Negative throughout as regards the left or tested eye, but it was noted that at the ninth hour muco-pus as large as a pin's head was present in the *right eye*.

In this case also the inferiority of the conjunctival test as compared with the subcutaneous test for the detection of infection is manifest.

Intracutaneous Tests.—No. 66. The right anal fold was twice the normal thickness at the third and sixth hours, but after that up to the thirtieth hour there was only an appreciable difference between the two folds.

No. 67. At the third, sixth, and ninth hours the right fold was at least twice the normal thickness, and at the twelfth and fifteenth hours it was three times the normal thickness. On the following day, at the thirtieth hour, it was at least four times the normal thickness.

No. 70. The right fold was twice the normal thickness at the third

and sixth hours, but after that up to the thirtieth hour there was only an appreciable difference between the two folds.

No. 77. From the third to the thirtieth hour the right fold was about twice the normal thickness.

No. 78. At the third hour there was only an appreciable thickening of the right fold, but after that up to the fifteenth hour the fold was twice, and at the thirtieth hour it was about four times, the normal thickness.

No. 85. At the third and sixth hours there was no more than an appreciable difference between the two folds, but from the ninth to the thirtieth hour the right fold was at least twice the normal thickness.

Second Test.

The same six animals were for a second time submitted to a triple test with human tuberculin on the 26th August 1913, and the results of the subcutaneous tests are shown in the upper part of Table XXVIII. It will be observed that four of the animals had a rise of temperature over 2° , but in No. 70 the rise from the time of injection was only 1.7° , and in No. 85 it was 1.8° .

The results of the other two tests were as follows:—

Conjunctival Tests.—No. 66. The eye was clean at the third hour, and there was only a pinhead particle of muco-pus present at the sixth hour. From the ninth to the eighteenth hour and on the following day the eye was normal.

No. 67. At each observation from the third to the twelfth hour a little muco-pus was present, but the maximum amount did not exceed the volume of three pins' heads. At the fifteenth hour the eye was moist but without muco-pus, and on the following day it was normal.

No. 70. Eye normal throughout, except for one pinhead particle of muco-pus at the fifteenth hour.

Nos. 78 and 85. Negative throughout.

Intracutaneous Tests.—No. 66. At the third hour there was at the point of injection in the right fold a swelling which extended across the tail to the other side and measured 1 inch by 1 inch by $\frac{3}{4}$ inch. At the sixth hour the swelling was still about the same size, but it had now invaded the left fold. At the ninth hour the right fold was twice the normal thickness and the left three times the normal thickness. There was little alteration at the twelfth hour, but at the fifteenth hour there was only an appreciable thickening of both folds. On the following day the right fold was appreciably thicker than normal.

No. 67. In the right fold a rather soft, painful swelling measuring 5 inches by $1\frac{1}{2}$ inches by 1 inch had formed. At the sixth hour the swelling was about the same size, but it extended down the fold to the tuber ischii. It had declined considerably in thickness at the ninth and twelfth hours, and at the fifteenth hour it was noted to be about the size of a pigeon's egg. On the following day the right fold was between three and four times the normal thickness.

No. 70. At the third hour there was a swelling which increased the thickness of the right fold to double the normal. At the sixth hour the swelling had extended across into the left fold, which was now twice the normal thickness, the right being about three times the normal. At the twelfth hour the left fold had become normal, but the right was now twice the normal thickness, and it had persisted in that condition on the following day, at the twenty-seventh hour.

No. 77. From the third hour onwards, up to the following day, the right fold was about twice the normal thickness.

No. 78. Almost exactly the same as the preceding animal.

No. 85. At the third hour the right fold was three times the normal thickness. At other periods, up to the twenty-seventh hour, it was twice as thick as the opposite fold.

SERIES VI.

This series is of special interest, not only because it enables a further comparison to be made between the results of the three different methods of testing, but also because it enables one to compare the effect of bovine with human tuberculin when used by the conjunctival or intracutaneous methods.

The animals in question are those included in Table XXIII., and all of them, with the exception of No. 52, which was a naturally infected animal whose history is dealt with elsewhere (*see* p. 366), had been infected a considerable time previously with bovine tubercle bacilli, viz., Nos. 10, 17, 18, 22, 30, 37, 44, 47, 50, and 57 on the 18th April 1912; Nos. 21, 32, and 41 on the 20th July 1912; and No. 11 on the 9th February 1912.

All the animals had already been tested at least twice, but none more recently than about two months.

The triple test was carried out on the 22nd November 1912 and the tuberculin used for each of the three tests was as shown in Table XXIII.

It may be convenient to deal first with the nine animals in the table which were tested with bovine tuberculin. It will be observed that all of these animals reacted to the subcutaneous test with the exception of No. 11.

Conjunctival Tests.—No. 10. At the third hour muco-pus about half the volume of a barley grain was present in the eye. The eye was clean at the sixth hour, but at the ninth hour there was again the same amount of muco-pus. At the twelfth hour a rather smaller quantity of muco-pus was present. At the fifteenth hour the eye appeared a little moist but there was no muco-pus. On the following day, after twenty-seven hours, there was a trace of muco-pus near the inner canthus and a larger amount partially dried on the skin below the canthus.

No. 11. At the third hour muco-pus as large as a barley grain was present, and about half that amount at the sixth hour. At the ninth hour the eye was clean, and at the twelfth hour muco-pus was again present in the form of scattered particles, which were estimated to have the collective volume of a split pea. At the fifteenth hour the eye was moist, but there did not appear to be any fresh formation of muco-pus.

No. 18. The test was quite negative, except that muco-pus the size of a pin's head was present at the sixth hour.

No. 21. Muco-pus as large as a barley grain was present at the sixth hour, and, although the eye was only moist at the ninth hour, there was again muco-pus equal in volume to a split pea at the twelfth hour. This persisted until the fifteenth hour.

No. 30. Result negative, except that the eye was noted to be a little moist at the twelfth hour.

No. 37. Also negative except for the moist appearance of the eye at the twelfth and fifteenth hours.

No. 44. At the third hour the eye was clean. At the sixth hour muco-pus as large as two pins' heads was *present in both eyes*. At the twelfth hour mucoid material of the volume of a split pea was present at both sides, and this was also the condition of the eyes at the fifteenth hour. On the following

day muco-pus as large as a barley grain was present in and below the inner canthus of the left or tested eye, but there was also a little of the same material in the right eye.

No. 47. Result negative, except that the eye was a little moist at the twelfth hour.

No. 52. (Naturally infected animal). At the third hour the eye was clean, but at the sixth hour muco-pus the size of a pin's head was present. At the ninth hour fresh muco-pus equal in volume to a split pea was present in and around the canthus. At the twelfth hour some dried scales were present at the inner canthus, but no fresh muco-pus had been formed. At the fifteenth hour muco-pus the size of a pin's head was present.

Intracutaneous Tests.—No. 10. At the third and sixth hours the right anal fold was about twice the normal thickness. At the ninth hour there was only an appreciable difference between the two folds, and that continued up to the fifteenth hour. On the following day there appeared to have been a slight increase in the thickness of the right fold, but it was less than twice as thick as the left.

No. 11. At the third hour there was present in the right fold a soft oedematous swelling as large as a hen's egg. At the sixth hour it had diminished to the size of a hazel nut, and at the ninth, twelfth, and fifteenth hours there was only an appreciable difference between the two folds. That was also the case on the following day.

No. 18. At the third hour the right anal fold was twice the normal thickness, and a marked increase had taken place at the sixth hour, the fold being then about four times the normal thickness. It had declined a little at the ninth hour, and at the twelfth and fifteenth hours it was only twice the normal thickness. On the following day it had still further declined, being only about half as thick again as the opposite fold.

No. 21. From the third to the fifteenth hour the right fold was about twice the normal thickness, and on the following day it had diminished, but there was still a distinct difference between the two folds.

No. 30. At the third hour there was a firm and rather circumscribed swelling which doubled the thickness of the right fold around the point of injection. There was little alteration at the sixth, ninth, and twelfth hours, but at the fifteenth hour there was only an appreciable difference between the two folds, and this persisted until the next day.

No. 37. At the third hour a soft swelling about the size of a hazel nut had formed in the right fold. This had diminished at the sixth hour and was hardly appreciable at the ninth. At the twelfth hour there was a soft oedematous swelling as large as a pigeon's egg, but three hours later and on the following day there was only an appreciable difference between the two folds.

No. 44. There was little alteration at the third hour, but the fold was about three times the normal thickness at the sixth hour and also at the ninth. At the twelfth and fifteenth hours there was only an appreciable difference between the two folds, but on the following day the swelling had increased a little, the right fold being then nearly twice the normal thickness.

No. 47. An appreciable firm swelling was present at the third hour, but this increased until at the ninth hour the fold was three times the normal thickness. It was twice the normal thickness at the twelfth hour, but only appreciably thicker at the fifteenth hour and on the following day.

No. 52. Up to the ninth hour there was only an appreciable difference between the two folds, but at the twelfth hour the right fold showed a diffuse thickening and was about twice as thick as the left. At the fifteenth hour it had somewhat diminished, but on the following day there was still a distinct difference between the two folds.

The remaining six animals in Table XXIII. are those which were tested in all three ways with human tuberculin, and it will be

observed that in each of them there was a distinct temperature reaction to the subcutaneous test.

The results of the other two tests in them were as follows:—

Conjunctival Tests.—No. 17. At the third hour the eye was a little moist, and three hours later a thin string of muco-pus was present in the eye, which was also watering a little. At the ninth hour the eye was clean, and at the twelfth hour a pinhead particle of muco-pus was present. At the fifteenth hour the eye was moist but clean.

No. 22. At the third hour muco-pus of the volume of a barley grain was present, and what appeared to be fresh muco-pus to the same amount was present three hours later. There was also a little present at the ninth hour, but there appeared to have been no fresh formation of muco-pus at the twelfth and fifteenth hours. On the following day, after twenty-seven hours, muco-pus nearly equal to a barley grain in size was present in the left or tested eye, and there was also a small amount of *similar material in the right or untested eye*.

No. 32. Negative at all periods of observation except the sixth hour, when a thin string of muco-pus was present, and at the fifteenth hour, when there was distinct congestion of the conjunctiva and muco-pus as large as a millet seed.

No. 41. Muco-pus was present at only one period, viz., the sixth hour, and it then did not exceed half the volume of a barley grain. At the twelfth and fifteenth hours the eye appeared moist.

No. 50. Negative throughout except at the twelfth hour, when the eye was noted to be moist, and at the fifteenth hour, when a pinhead particle of muco-pus was present.

No. 57. At the sixth hour muco-pus the size of a barley grain was present, and there was a smaller amount three hours later, at which time the eye was very moist in appearance. At the twelfth hour the eye was watering and there was a smaller amount of muco-pus present. At the fifteenth hour the eye still appeared moist.

Intracutaneous Tests.—No. 17. At the third hour the right fold was about thrice the normal thickness, and at the two following periods of observation about twice the normal thickness. It had declined somewhat at the twelfth and fifteenth hours, and was barely twice the normal thickness on the following day.

No. 22. At the third hour a swelling as large as a hazel nut was present in the right fold, and after that, up to the fifteenth hour, there was no more than an appreciable difference between the two folds. On the following day there was no visible difference between the two folds.

No. 32. From the third to the twelfth hour the right fold was two or three times the normal thickness, and it had diminished at the fifteenth hour, but it was still nearly double the normal thickness on the following day.

No. 41. At no period was there more than an appreciable difference in the thickness of the two folds.

No. 50. At the third hour a firm swelling as large as a hen's egg had formed in the right fold. It subsequently diminished, and at the ninth hour it was only about the volume of a pigeon's egg. At the twelfth and fifteenth hours the right fold was three times the normal thickness, and on the following day it was about twice as thick as the opposite fold.

No. 57. At the third hour a rather firm swelling about the size of a pigeon's egg had formed in the right fold, and this had reached the size of a hen's egg three hours later. It was still about that size at the ninth hour, but after that it diminished until it was scarcely appreciable at the fifteenth hour. On the following day there was a marked thickening around the seat of injection and extending across to the other fold. The right fold was at least twice as thick as the left.

SERIES VII.

This is a series of five animals which on the 28th July 1913 were inoculated subcutaneously with bovine bacilli. The first four of these animals had previously been infected with human or avian bacilli, but the last animal (No. 84) was a healthy subject prior to this inoculation with bovine bacilli.

On the 26th August, or almost exactly a month after their infection with bovine bacilli, the five animals were submitted to a triple test with human tuberculin. The results of the subcutaneous test are shown in the lower part of Table XXVIII., from which it will be seen that they all reacted distinctly to this test, with rises of temperature varying from 2.6° to 4.4° .

The results of the other two tests were as follows:—

Conjunctival Tests.—No. 68. At the sixth and ninth hours muco-pus of the volume of two or three pins' heads was present, but at other periods the eye was normal.

No. 69. At the sixth hour muco-pus the size of two pins' heads, and at the fifteenth hour a smaller amount, was present. The eye was normal at other periods.

No. 79. Result negative, except that there was possibly a slightly excessive lachrymation at the ninth and twelfth hours.

No. 80. Muco-pus as large as two pins' head was present at the sixth hour, and the eye then had a moist appearance. No evidence of reaction at other periods.

No. 84. No reaction except the formation of a particle of muco-pus as large as a barley grain at the fifteenth hour and about half that amount on the following day, at the twenty-seventh hour.

Intracutaneous Tests.—No. 68. At the third hour there was a soft swelling about $1\frac{1}{2}$ inches by $\frac{3}{4}$ inch extending across the root of the tail. At the sixth hour the right fold was about three times the normal thickness and subsequently, up to the twenty-seventh hour, the fold was about twice the normal thickness.

No. 69. At the third hour the injected fold was about twice the normal thickness, and it had increased to three or four times the normal thickness at the sixth hour. It was about three times the normal thickness at the ninth hour, and after that, up to the twenty-seventh hour, it was twice as thick as the opposite fold.

No. 79. From the third hour onwards the right fold was from two to three times the normal thickness, and on the following day, at the twenty-seventh hour, it was twice as thick as the left fold.

No. 80. At the third hour there was a swelling about 1 inch by $1\frac{1}{2}$ inches by $\frac{1}{2}$ inch which extended across the root of the tail, and subsequently, up to the fifteenth hour, both folds were about twice the normal thickness. On the following day only the right fold was thickened, and it was then about twice as thick as the left.

No. 84. At the third hour the right fold had a swelling as large as a pigeon's egg. This swelling was rather smaller at the sixth hour, but at the ninth hour the right fold was three times the normal thickness. Subsequently, up to the twenty-seventh hour, it was about twice as thick as the left.

The same five animals were subjected to a second triple test with human tuberculin on the 2nd October 1913, and the results of the subcutaneous tests are given in Table XXIX. This table also includes No. 70, for which this was the third test since the animal's

infection with bovine tubercle bacilli on the same date as the others, viz., on the 28th July 1913.

As will be seen from the table, all the animals had a rise of temperature of at least 2° except No. 69, in which the maximum rise was 1.6° .

The results of the other two tests were as follows:—

Conjunctival Tests.—The result of this test was entirely negative in all the animals except No. 84, and in that the only evidence of reaction was the formation of muco-pus as large as two pins' heads at the sixth hour, and as large as a split pea at the ninth hour.

FIG. 8.

No. 84. Reaction to intracutaneous test at twenty-seventh hour (3rd October 1913).

Intracutaneous Tests.—No. 68. At the third hour the right fold was about twice the normal thickness, but at subsequent periods of observation, up to the twenty-seventh hour, there was no more than an appreciable difference in the thickness of the two folds.

No. 69. At the third hour the injected fold was three times the normal thickness, but at the sixth, ninth, and twelfth hours the swelling in that fold was only appreciable. It was about twice the normal thickness at the fifteenth hour, but at the twenty-seventh hour there was again only an appreciable difference in the thickness of the two folds.

No. 70. At the third hour there had formed round the point of injection a circumscribed swelling which increased the thickness of the fold about three times. At subsequent periods of observation, up to the twenty-seventh hour, there was no more than an appreciable difference between the two folds.

No. 79. At the third hour a circumscribed swelling about the size of a hazel nut had formed at the point of injection. At the sixth hour, at the

point of injection, the fold was about twice the normal thickness, but the swelling extended well forward into the fold. At the ninth hour the fold was three times the normal thickness, and at subsequent periods, up to the twenty-seventh hour, about twice the normal thickness.

No. 84. At the third hour the right fold was about twice the normal thickness, but it had declined at the ninth and twelfth hours. At the fifteenth hour the fold was again two or three times as thick as the opposite one. On the following day, at the twenty-seventh hour, a circumscribed swelling about the size of a hazel nut was present in the right fold, and this was about the same on the next day (*see* fig. 8).

RESULTS OF THE SUBCUTANEOUS TEST IN EXPERIMENTALLY INFECTED ANIMALS.

The variations in temperature which occurred in infected animals tested by the subcutaneous method are shown in detail at the end of this article, but a few of the more important points may be referred to here.

Reactions after Infection with Human or Avian Bacilli.

An analysis of the tests with homologous tuberculin applied for the first time to animals infected by the intravenous inoculation of human or avian bacilli brings out the facts shown in the subjoined table, in which -1.5° means that the rise of temperature from the time of injection did not reach 1.5° F.; 1.5° that it reached 1.5° but did not reach 2° F., and so on with the higher temperatures. The two right-hand columns show respectively the number of animals in which the temperature did or did not rise at least 2° F. The asterisk indicates that the initial temperature was over 103.5° F.

Human Infection.

Table.	-1.5°	1.5°	2°	2.5°	3°	3.5°	4°	5°	2°	-2°
XI. . . .	—	—	—	—	—	2	1	2	5	0
XII. . . .	1*	—	3	—	2	1	1	—	7	1*
XIII. . . .	—	—	—	1	1	1	2	—	5	0
XV. . . .	—	—	—	1	—	3	—	—	4	0
Totals . .	1	0	3	2	3	7	4	2	21	1*

Avian Infection.

Table.	-1.5°	1.5°	2°	2.5°	3°	3.5°	4°	5°	2°	-2°
VII. . . .	—	—	—	1	1	3	—	1	6	0
VIII. . . .	—	—	1	1	1	1	3	2	9	0
XII. . . .	—	—	1	—	—	1	1	1	4	0
XIII. . . .	—	—	1	2	1	—	—	—	4	0
XV. . . .	—	—	—	1	1	1	—	—	3	0
Totals . .	0	0	3	5	4	6	4	4	26	0

It will be seen from the table that, if a rise of 2° F. be accepted as a positive reaction, out of forty-seven animals infected with human or avian bacilli only one failed to react to the first test with

homologous tuberculin, and the exception (No. 42, Table XII.) was an animal in which the temperature was already over 103.5° F. at the time when the tuberculin was injected.

The following table shows the results of subcutaneous tests with heterologous tuberculin applied for the first time after a first or second intravenous inoculation with human or avian bacilli.

Infected Human, Tested Avian.

Tables.	-1'5°	1'5°	2°	2'5°	3°	3'5°	4°	2°	-2°
XI.	2*	—	—	1	1	1	—	3	2*
XIII.	1	1	1	—	2	—	—	3	2
Totals	3	1	1	1	3	1	0	6	4

Infected Avian, Tested Human.

Tables.	-1'5°	1'5°	2°	2'5°	3°	3'5°	4°	2°	-2°
IX.	1	2	3	1	—	—	—	4	3
XI.	—	—	2	—	—	2	—	4	0
XII.	—	1	—	1	1	1	—	3	1
XIII.	1	—	1	1	—	1	1	4	1
Totals	2	3	6	3	1	4	1	15	5

The animals tested were too few to justify a conclusion, but the figures indicate, what is *a priori* probable, that animals infected with avian or human bacilli react best to the corresponding tuberculin.

The tables at the end also furnish information regarding the results of second or third tests of animals inoculated with human or avian bacilli, and in these cases the average temperature reactions were lower. It must be remembered, however, that low temperatures in such animals may have correctly indicated recovery from the infection with human or avian bacilli.

Reactions after Infection with Bovine Bacilli.

It is, of course, to these reactions that the greatest interest attaches. The subjoined table shows at a glance the extent to which the temperature rose on the occasion of first, second, or third tests with human or bovine tuberculin after infection with bovine bacilli.

First Test.

Table.	-1'5°	1'5°	2°	2'5°	3°	3'5°	4°	5°	6°	2°	-2°
XVI.	—	—	—	—	2	3	—	—	—	5	0
XVII.	1*	—	2	1	1	5	4	—	—	13	1*
XX.	—	—	—	1	—	1	3	1	2	8	0
XXIV.	—	2*	2	—	2	3	2	1	—	10	2*
XXVII.	—	—	—	—	2	1	3	—	—	6	0
XXVIII.	—	—	—	2	—	—	3	—	—	5	0
Totals	1	2	4	4	7	13	15	2	2	47	3*

Second Test.

Table.	-1.5°	1.5°	2°	2.5°	3°	3.5°	4°	5°	2°	-2°
XVII. . .	—	—	—	1	3	—	1	—	5	0
XVIII. . .	1*	2	4	5	1	—	1	—	11	3
XXI. . .	—	—	—	1	1	1	2	3	8	0
XXV. . .	—	1*	1	3	1	3	1	—	9	1*
XXVIII. . .	—	2	1	—	2	—	—	1	4	2
XXIX. . .	—	1	1	1	2	1	—	—	5	1
Totals . .	1	6	7	11	10	5	5	4	42	7

Third Test.

Table.	-1.5°	1.5°	2°	2.5°	3°	3.5°	4°	2°	-2°
XVIII. . . .	—	—	2	—	1	—	1	4	0
XIX.	1	4	4	—	3	1	—	8	5
XXII.	—	—	2	—	2	—	—	4	0
XXVI.	—	1	3	—	1	1	—	5	1
Totals	1	5	11	0	7	2	1	21	6

The above figures show that out of a total of fifty animals tested for the first time after subcutaneous inoculation with bovine bacilli forty-seven had a positive reaction if a rise of 2° F. is so accepted, and that in the remaining three cases the temperature was already over 103.5° F. before the tuberculin was injected. These three cases were No. 42 in Table XVII., and Nos. 63 and 75 in Table XXIV. It need hardly be said that in general practice an animal with such a temperature must be considered unsuitable for the subcutaneous test.

When judged in the same way, the results of the second and third tests were not so good, but it will be seen that if 1.5° F. is taken as the critical temperature there were only two failures to react in the combined seventy-six tests.

A comparison shows that the reactions were on an average higher than those obtained after infection with human or avian bacilli, and it may be noted that the results contradict the opinion that "vaccination" with human or avian bacilli tends to mask a subsequent infection with bovine tuberculosis by preventing a reaction.

The only other point that need be referred to in connection with the results of the subcutaneous tests is the question whether bovine has any advantage over human tuberculin in testing animals for bovine tuberculosis. The figures given in Table XXIII. lend no support to the view that higher reactions are provoked by the former.

RESULTS OF THE CONJUNCTIVAL AND INTRACUTANEOUS TESTS IN EXPERIMENTALLY INFECTED ANIMALS.

Before attempting to draw any conclusions from the foregoing records with regard to the reactions which can be called forth in tuberculous animals by the conjunctival and cutaneous methods of

testing with tuberculin, it appears to be necessary to deal with the question whether the special tuberculin employed in our experiments was what may be called a good tuberculin for the purpose. This point must first be disposed of, because it is obvious that a particular brand of tuberculin might be bad in the sense that it was too weak to cause reactions at all, or to provoke well-marked reactions; or it might be bad in the sense that it contained some ingredient, other than the products of tubercle bacilli, capable of causing a marked reaction either in the conjunctiva or in the connective tissue. In view of the frequency with which we failed to obtain distinct reactions to the conjunctival and intracutaneous tests in animals experimentally infected with tuberculosis, it is especially evidence that the tuberculin was not bad in the first of these senses that must be adduced.

Fortunately there is no difficulty in proving that the concentrated tuberculin which we used was a good tuberculin in the sense that it frequently provoked most characteristic reactions in naturally infected adult tuberculous cattle. For the purpose we give below the record of various tests applied to four cows obtained for different experiments in the period 1911-13, and which were found to have contracted tuberculosis naturally. A comparison of dates with those in the tables at the end of the article will show that many of the tests of these cows were simultaneous with tests of the experimentally infected young cattle.

Cow No. 1. (Naturally Infected.)

An Ayrshire cow, four years old, which had been admitted to the College about six months previously, was first tested with human tuberculin on the 17th July 1911. Her temperature at the time of injection was 101.3° , and at the sixth, ninth, twelfth, and fifteenth hours afterwards it was 101.6° , 104.4° , 106.3° , and 105.6° respectively.

The cow was tested subcutaneously with human tuberculin for a second time on the 27th September following, and the temperature, which was 102° at the time of injection, was as follows when taken at intervals of three hours afterwards— 103.1° , 104.5° , 104.8° , and 101.6° .

Simultaneously with this subcutaneous test the cow was also tested by the conjunctival method with human tuberculin. The effect may be judged from the accompanying photograph (fig. 9).

On the 4th October 1911 the cow was tested by the intracutaneous method with human tuberculin, the injection being made at 4.30 P.M. Throughout the following day there was only a slight difference between the right and left anal folds, but on the next day the inoculated fold was twice the normal thickness. This difference was maintained on the third day, and on the fourth day the right fold was thrice the normal thickness. After this the difference between the two folds declined, but it was still visible on the 9th October, that is to say, on the fifth day after the injection of the tuberculin.

On the 7th November following the cow was simultaneously tested with human tuberculin by the conjunctival and intracutaneous methods, the tuberculin being injected at 2 P.M. The same evening at 10.30 P.M. muco-pus equal in volume to a pea was present at the inner canthus, and smaller quantities of the same material were present on the upper and lower eyelids. On the following day at 11 A.M. the left eye still showed a marked reaction, including the presence of muco-pus, slight congestion, and some lachryma-

tion. At 4 P.M. the discharge from the eye had stopped, but there was a good deal of dried muco-pus below the inner canthus.

At 11 A.M. on the 8th November there was a marked difference between the right and left anal folds, and this persisted throughout the day. On the 9th the thickening of the inoculated fold had declined a little, but there was still a pronounced difference between the two folds. On the 10th there was a further decline, but the inoculated fold was still perceptibly thicker than the other one.

For the third time the cow was tested with human tuberculin by the subcutaneous method on the 9th November. The temperature at the time of injection was 101.5° , and when afterwards taken at the sixth, ninth, twelfth, and fifteenth hours it was as follows— 103° , 104.6° , 105.2° , 103.4° .

On the 12th January 1912 the cow was submitted for the third time to a conjunctival test. In this case human tuberculin was instilled into the left eye and avian into the right eye at 8 A.M. At the third and sixth hours afterwards some muco-pus had formed in the left eye, and this had increased in amount at the ninth hour. Fresh muco-pus continued to be formed in

FIG. 9.

Cow No. 1. Conjunctival reaction at twenty-fifth hour (28th September 1911).

the left eye at the twelfth hour, but the reaction was declining at the fifteenth hour. The right eye remained normal until the twelfth hour, but there was then present in it a considerable amount of muco-pus, and a somewhat smaller quantity was present in that eye at the fifteenth hour.

On the 29th January 1912 the cow was tested for the fourth time by the conjunctival method. The instillation with human tuberculin was carried out at 8 A.M., and three hours afterwards there was a marked reaction, with muco-pus four or five times the volume of a pea, congestion of the conjunctiva, and increased lachrymation. The reaction continued throughout the day (see fig. 10), and at the twelfth hour there was fresh muco-pus equal to three times the volume of an ordinary pea. On the following day the reaction was still obvious.

On the 8th February 1912 a fifth conjunctival test was carried out with human tuberculin, and on this occasion the reaction was quite as pronounced as during the previous test.

On the 21st February a sixth conjunctival test was carried out, the tuberculin used being concentrated avian. At the third hour there was

appreciable congestion of the conjunctiva, and muco-pus of the volume of a barley grain was present at the inner canthus. At the sixth hour there was an increased amount of muco-pus, and the congestion continued although there was no lachrymation. At the ninth hour there was slight lachrymation and some muco-pus within the inner canthus and on the skin below it. At the twelfth hour muco-pus of the size of a pin's head was present, and at the fifteenth hour fresh muco-pus of the volume of a pea had formed. At the twenty-fourth hour the congestion had disappeared, and only a little dried muco-pus was present on the hairs of the eyelids.

On the 26th March 1912 the cow was submitted to a triple test, viz., a seventh conjunctival, a fourth subcutaneous, and a third intracutaneous. For the first human tuberculin was used, and for the other two tests avian tuberculin.

There was no distinct reaction to the subcutaneous test, the initial temperature being 102° and the highest temperature recorded during the following fifteen hours 102.4° .

There was a marked reaction to the conjunctival test, muco-pus being present from the third to the fifteenth hour. The maximum amount was

FIG. 10.

Cow No. 1. Conjunctival reaction at eighth hour (29th January 1912).

present at the sixth hour, when it equalled the volume of three peas. The reaction was still evident after twenty-four hours, some fresh muco-pus as well as a good deal of dried material being present in the eye.

Intracutaneous Test.—At the third hour the right anal fold was three times the normal thickness, at the sixth hour it had declined somewhat, and at the subsequent periods of observation up to the twenty-fourth hour there was no more than an appreciable difference between the two folds.

The early period at which the anal reaction attained its maximum on this occasion ought to be noted and also the rapid decline of the swelling.

On the 14th May 1912 the cow was again subjected to a triple test, the tuberculin used for each test being human.

Subcutaneous Test.—The initial temperature was 100.2° , and when taken afterwards at intervals of three hours it was as follows— 101.4° , 102.6° , 105° , 104.6° , and 103.6° .

Conjunctival Test.—There was again a marked reaction to this test, starting at the third hour and continuing until the following day (twenty-five hours). The maximum reaction was at the ninth hour, when the muco-pus present equalled three or four peas in volume.

Intracutaneous Test.—At the third hour there was a diffuse swelling of the right anal fold, which increased its thickness to about twice the normal.

This continued with little variation until the fifteenth hour. On the following day, after twenty-five hours, the thickening had declined and become more diffuse, but there was still quite a considerable difference between the two folds.

On the 4th June 1912 a triple test was again carried out, this being the ninth conjunctival, sixth subcutaneous, and fifth intracutaneous test. The tuberculin used for all three tests was human.

Subcutaneous Test.—The initial temperature was 100.4° , and the subsequent temperatures at intervals of three hours were as follows: 102.4° , 104.2° , 104.6° , 104° , and 102° .

Conjunctival Test.—There was again a marked reaction to this test, starting at the third hour and continuing until the following day. The maximum reaction was at the sixth hour, when the muco-pus present was equal in volume to two peas.

Intracutaneous Test.—There was only a slight increase in thickness of the right anal fold at the third hour. This had increased a little at the sixth hour, but it again declined, until it was only appreciable by the fifteenth hour. On the following day the right fold was about half as thick again as the left, and a day later about twice as thick.

On the 20th June, or a fortnight after the preceding test, the cow was again tested by the conjunctival method with human tuberculin. On this occasion there was again a positive reaction, although less intense than on any of the previous occasions. The reaction had begun at the third hour, and it had reached its maximum at the twelfth hour, when muco-pus of the volume of a barley grain was present. There was still slight evidence of reaction on the following day. This constituted the tenth conjunctival test to which the animal had been subjected.

On the 19th July 1912 the cow was simultaneously subjected to a subcutaneous (seventh) and a conjunctival test (eleventh). The tuberculin in both cases was human.

Subcutaneous Test.—There was no distinct reaction to this test. The initial temperature was 101° , and the maximum temperature recorded during the following fifteen hours was 102.4° .

Conjunctival Test.—At the third hour there was a mere trace of muco-pus in the left eye. At the sixth hour this had increased to the volume of a pea, and at the ninth hour there was muco-pus equal in volume to three or four pins' heads below the inner canthus. At the later periods of observation up to the following day the eye was quite normal.

To complete this animal's history it ought to be stated that it was killed on the 8th August 1912, and that the *post-mortem* examination revealed the following lesions:—

The bronchial and mediastinal glands each contained about half a dozen tubercles varying in size from a barley grain downwards. In the left lung there were three, and in the right two, tuberculous nodules, varying in size from a hazel nut to a pea. All these lesions were caseous.

Cow No. 2. (Naturally Infected.)

This was an old Welsh cow which had been purchased for experiment some months before it was tested with human tuberculin by the subcutaneous method on the 17th July 1911. The initial temperature was 101.3° , and taken at intervals of three hours afterwards, it was 101.8° , 103.2° , 105° , and 104.4° .

The cow was again tested with human tuberculin by the subcutaneous method on the 9th November, and on this occasion there was no reaction. The initial temperature was 101.2° , and the maximum temperature during the following eighteen hours was 101.8° .

On the 26th March 1912 the cow was subjected to a triple test, avian tuberculin being employed for the subcutaneous and intracutaneous tests, and human tuberculin for the conjunctival test.

Subcutaneous Test.—The dose of avian tuberculin injected was 8 cc., and the initial temperature was 101° . The subsequent temperatures at intervals of three hours were 102° , 104° , 104.6° , 105° , and 103° .

Conjunctival Test.—At the third hour there was slightly increased lachrymation and muco-pus equal in volume to three or four pins' heads. The eye continued in much the same state at the sixth, ninth, and twelfth hours. At the fifteenth hour only dried discharge was present, and there was no lachrymation. On the following day the eye was normal.

Intracutaneous Test.—At the third hour a diffuse swelling as large as a pigeon's egg had formed at the point of inoculation at the right fold, and this persisted at the sixth hour. At subsequent periods of observation up to the twenty-seventh hour the right fold was about twice the normal thickness.

On the 14th May 1912 the cow was again subjected to a triple test, this being the fourth subcutaneous, second intracutaneous, and second conjunctival test. In each case the tuberculin used was human.

Subcutaneous Test.—The initial temperature was 101.6° , and the subsequent readings at intervals of three hours were 102° , 104.2° , 105° , 104.2° , and 104° .

Conjunctival Test.—At the third hour there was excessive lachrymation from the left eye, and at the sixth hour several pieces of muco-pus, collectively equal to the volume of a pea, were present. The reaction continued to the fifteenth hour, when a still larger amount of muco-pus was present. On the following day the reaction had ceased.

Intracutaneous Test.—At no time up to the following day was there more than an appreciable difference between the right and left anal folds.

On the 4th June 1912 a triple test was again carried out with human tuberculin.

Subcutaneous Test.—The initial temperature was 101.2° , and the subsequent readings at intervals of three hours were 102.6° , 103.6° , 104° , 103° , and 103° .

Conjunctival Test.—There was a rather indifferent reaction to this test, the maximum amount of muco-pus not exceeding the size of a pin's head at the twelfth hour. At the fifteenth hour the eye was quite normal. On the following day the eye showed only a few dried specks of mucus or muco-pus.

Intracutaneous Test.—At the third hour the right anal fold was about twice the normal thickness, and this degree of thickening continued until the twelfth hour. After that the difference between the two folds was only appreciable, and that was also the state of affairs on the following day.

On the 20th June 1912 the cow was tested by the conjunctival method with human tuberculin. At all periods of observation up to the following day the eye was normal with the exception of the twelfth hour, when there was a collection of muco-pus about half the size of a pea.

The cow was tested for the last time on the 19th July 1912. On that occasion a combined subcutaneous and conjunctival test was carried out, this being the sixth of the former, and the fifth of the latter, test. Human tuberculin was used for both tests.

Subcutaneous Test.—There was no distinct reaction to this test. The initial temperature was 101° , and the maximum temperature during the following fifteen hours was 102.4° .

Conjunctival Test.—There was no reaction until the sixth hour, and then muco-pus of the volume of two pins' heads was present. At the ninth hour the eye was clean. At the twelfth hour a few dried flakes of mucus or muco-pus were present at the inner canthus, and at the fifteenth hour the

eye was watering a little, and some minute specks of muco-pus were present in the lachrymal secretion.

The cow was killed on the 8th August 1912, and at the *post-mortem* examination the following tuberculous lesions were found:—

The bronchial and mediastinal glands each contained a dozen tuberculous nodules varying in size from a horse bean downwards. In the left lung there were two tuberculous areas, and in the right lung one such area. Each of these areas measured about a couple of inches in diameter, and was largely caseous on section.

Cow No. 3. (Naturally Infected.)

This was a red Shorthorn cow, four years old, which was first tested simultaneously with human tuberculin by the subcutaneous and conjunctival methods on the 29th January 1912.

Subcutaneous Test.—The temperature at the time of injection was 101.4° , and at intervals of three hours afterwards it was 103.4° , 104.8° , 101.4° , 104.2° , and 103.4° . This must be regarded as a positive reaction to tuberculin, but the irregularity of the temperature curve is worthy of note.

Conjunctival Test.—At the third hour the eye was normal, but at the sixth hour there was a speck of muco-pus about the size of a pin's head at the inner canthus. Three hours later this had attained the size of a split pea, and at the twelfth hour there was a fresh deposit of muco-pus of about the same size. At the fifteenth hour what appeared to be the same muco-pus was still present without any fresh formation, but on the following day, after twenty-nine hours, there was a further quantity of muco-pus as large as a split pea.

21st February 1912. On this date the cow was again tested by the conjunctival method, this time with avian tuberculin, and the result was an entirely negative one. This ought to be compared with the positive result which was obtained with cow No. 1 on the same date.

26th March 1912. On this date the cow was submitted to a triple test, avian tuberculin being used for the subcutaneous and intracutaneous tests, while human tuberculin was instilled into the left eye.

Subcutaneous Test.—The temperature at the time of injection was 100.8° , and at intervals of three hours afterwards it was 101.4° , 105° , 105.8° , 104.2° , and 103.6° .

Conjunctival Test.—At the third hour two separate specks of muco-pus were present in the eye, one about the size of a pin's head and the other as large as a pea. Three hours later there was some lachrymation and muco-pus to the size of three peas had collected at and below the inner canthus (*see fig. 11*). At the ninth hour the eye contained no muco-pus, but there was still some lachrymation. At the twelfth hour the eye contained only some partially dried muco-pus, and at the fifteenth hour it was watering and muco-pus as large as a split pea was present.

Intracutaneous Test.—At no period of observation was there more than a just appreciable difference between the right and left anal folds.

4th June 1912. On this date the triple test was repeated again, using avian tuberculin for the subcutaneous and intracutaneous tests and human tuberculin for the conjunctival test.

Subcutaneous Test.—At the time of injection the temperature was 101° , and afterwards at intervals of three hours it was 101.4° , 103.8° , 105° , 103° , and 101.8° .

Conjunctival Test.—At the third hour there was some lachrymation and a pinhead particle of muco-pus. Three hours later the eye was still watering and muco-pus to the volume of three peas was present. At the ninth hour a similar amount of pus was present. At the twelfth hour fresh muco-pus of

the volume of a pea and a few flakes of dried material were present in the eye. At the fifteenth hour a somewhat larger amount of muco-pus was present as a single mass. After twenty-four hours only a few dried flakes were present at the inner canthus.

Intracutaneous Test.—At the third and sixth hours there was only an appreciable thickening of the right anal fold, but at the ninth and twelfth hours the right fold had twice the normal thickness. At the fifteenth and twenty-fourth hours the increased thickness was only appreciable, but after fifty-four hours the right fold was from three to four times the normal thickness.

19th July 1912. On this date the cow was simultaneously tested by the subcutaneous and conjunctival methods, human tuberculin being used for both.

Subcutaneous Test.—At the time of injection the temperature was 101.4° , and afterwards at intervals of three hours it was 101.4° , 103° , 104° , 104° , and 104.4° .

FIG. 11.

Cow No. 3. Conjunctival reaction at sixth hour (26th March 1912).

Conjunctival Test.—At the third hour mucoid material about half the volume of a pea was present at the inner canthus. At the sixth hour fresh muco-pus of the volume of a pea was present, and three hours later what appeared to be the same exudate partially dried was present a little distance away from the inner canthus. At the twelfth hour the eye contained two separate pieces of muco-pus close to the inner canthus, one about the size of an oatseed and the other about half that size. At the fifteenth hour there had been no fresh formation of exudate, and on the following day there was only dried material around the inner canthus.

The cow was killed on the 7th August 1912. The general condition was rather poor although the animal had improved a little lately. The *post-mortem* examination showed numerous caseous and calcareous nodules, varying in size from a hazel nut downwards, in both lungs. The bronchial and mediastinal glands were greatly enlarged and caseous throughout. Tuberculous lesions were also present in the liver, portal glands, kidneys, mesenteric glands, pleura, and peritoneum.

Cow No. 4. (Naturally Infected.)

This was a Devon cow about seven years old. It was subjected to the conjunctival test with human tuberculin on the 28th November 1913.

Six hours afterwards there was muco-pus to the volume of half a pea within the eyelids, and two similar particles were present on the face below the eye. On the following day, after twenty-six hours, moist muco-pus equal in amount to a barley grain was present below the inner canthus.

The cow was again tested in the same way on the 27th January 1914, and the condition of the eye seven hours after the instillation of the tuberculin is shown in fig. 12.

This cow was killed on the 2nd August 1914 and the *post-mortem* showed extensive tuberculous lesions in both lungs. Caseous and partly calcified nodules were also present in the bronchial and mediastinal glands and in the liver.

The results which have just been described prove that the concentrated tuberculin used by us was quite capable of producing good

FIG. 12.

Cow No. 4. Conjunctival reaction at seventh hour (27th January 1914).

conjunctival and intracutaneous reactions in tuberculous animals, and we have next to consider whether it was bad in the other sense, viz., that in virtue of some of its constituents it was capable of producing reactions of a non-specific character, *i.e.*, in non-tuberculous animals. The only substance open to any suspicion in this connection was the glycerin which it contained approximately in the proportion of 20 per cent.

Some authors, on evidence which is far from convincing, have claimed an advantage for glycerin-free tuberculin for the two tests with which we are now dealing, but, at least in regard to the preparation which we used, any suggestion that the glycerin present was capable of producing serious irritation, or effects likely to be mistaken for a specific reaction, appears to be negated by the following facts:—

During the period 1911-13 over eighty recently purchased calves, including those which appear in the tables at the end of the article, were tested at least once by the conjunctival method before they were subjected to any experiment. Some were tested a second time, so that a total of 109 conjunctival tests were made on calves which were supposed to be healthy. In 104 cases the results were entirely negative, the tested eye showing no abnormality of any sort when examined at intervals of three hours up to the fifteenth hour, and again after twenty-four hours—usually at the twenty-seventh hour. The five animals in which the result of the conjunctival test when first applied was not absolutely negative were all calves of about four or five months old. The first four, viz., Nos. 65, 66, 68, and 69, formed part of a lot of eighteen calves which were tested on the 28th January 1913. The fifth animal, No. 85, was tested along with three other recently purchased calves on the 17th June 1913. Particulars with regard to these were as follows:—

No. 65. There was a little lachrymation from the sixth to the fifteenth hour, and at the fifteenth hour both eyes were weeping a little. At no time was there any muco-purulent matter in the left eye.

It is hardly necessary to say that this cannot be cited as a case in which the glycerin caused any irritation, since there was no abnormality except very slight lachrymation, and that affected both eyes at one of the periods of observation. It is, however, of more interest to note that it is very probable that this calf was actually tuberculous at the time of the above test, for a simultaneous subcutaneous test was followed by a rise of temperature of 3° F., and a reference to Table II. will show that after the first intravenous inoculation of human bacilli on the 19th February following there was a most remarkable reaction, the temperature rising to 107° (*see also* p. 326).

No. 66. There was no distinct reaction to the subcutaneous test, but at the fifteenth hour there was a particle of muco-pus about the size of a barley grain in the left or tested eye. Neither muco-pus nor lachrymation was present at any other period of observation, but a pinhead particle of muco-pus was noted to be present at the sixth hour.

No. 68. Muco-pus equal in amount to half a pea was present at the ninth hour, and at the fifteenth hour both eyes were weeping a little. There was no reaction to the simultaneous subcutaneous test.

No. 69. At the ninth hour the left eye showed lachrymation and a particle of muco-pus smaller than a barley grain. At other periods of observation the eye was quite normal. There was no reaction to a simultaneous subcutaneous test.

No. 85. In this calf the only abnormality noted was the presence of a particle of muco-pus about the size of a barley grain at the twenty-seventh hour. There was no distinct reaction to a simultaneous subcutaneous test.

It may fairly be said that, although in these five cases the eye did not remain absolutely normal during the twenty-seven hours following the instillation of the tuberculin, the abnormalities noted were not beyond those which may occasionally be observed in the eyes of cattle that have not been tested, and that the absence of any sign of irritation whatever in the remaining 104 tests is opposed to the view that the presence of the glycerin in the tuberculin was responsible for the abnormalities noted in the five cases.

It may also be said that, in regard to our application of the conjunctival test to infected animals, the question whether the tuberculin

used was capable of causing non-specific irritations is not of much importance, as it is the frequent absence of reaction of any degree, rather than the unexpected occurrence of reactions, which requires explanation.

On the other hand, in considering whether the tuberculin used was a good preparation for the intracutaneous test, it appears to be of more importance to show that it did not provoke marked reactions in non-infected animals than to prove that it was capable of causing good reactions in infected animals. As to the latter point, attention may be called to the intracutaneous reactions which were obtained in some of the naturally infected cows.

Information as to the first point is furnished by the results of fifty-nine intracutaneous tests which were applied to the calves soon after their purchase and before they were subjected to any experiment.

In fifty-three of these cases there was either no swelling of the anal fold at all, or, at the most, a degree of swelling that could only be described as appreciable to the touch. This very slight degree of swelling was appreciable for lengths of time varying from three to thirty hours, and in two instances, Nos. 26 and 27, it could still be detected at the fortieth hour.

No. 26. When tested a week previous by the subcutaneous method there was a rise of temperature of 2.5° , but the animal when killed two years later was found to be free from tuberculosis.

No. 27. This animal had also been submitted to a subcutaneous test a week previous to the intracutaneous test, and there was a rise of temperature of 2° . This animal was found to have tuberculous lesions in the mediastinal and bronchial glands when killed two years later, but the possibility of natural infection with tuberculosis during the intervening period cannot be denied.

In the following five cases the intracutaneous test was followed by a more pronounced degree of swelling at the seat of injection.

No. 76. The anal fold was one and a half times the normal thickness until the sixth hour, after which the swelling had disappeared.

No. 78. The anal fold was twice the normal thickness at the third hour, but from the sixth hour onwards there was no appreciable difference in the thickness of the two folds. The intracutaneous test of these two calves was simultaneous with the conjunctival test on the 28th January 1913, previously referred to.

No. 80. At the sixth hour there was present a rather circumscribed swelling which increased the thickness of the right fold to about double the normal. This persisted with little alteration until the twelfth hour, but at the fifteenth hour and on the following day at the twenty-seventh hour the right fold was only about half as thick again as the left. There was no reaction to the subcutaneous and conjunctival tests applied on the same day.

No. 52. This calf was one of a lot of twenty which were brought to the College on the 3rd November 1911, and on the 7th November, along with other nine animals of the same lot, it was submitted to a combined conjunctival and intracutaneous test with human tuberculin. There was no reaction to the conjunctival test in any of the ten animals, and, excepting in No. 52, there was never more than a slight difference between the right and left anal folds as a result of the intracutaneous test. In Calf 52 also there was very little difference between the two anal folds during the first fifteen hours, and it was not until forty-eight hours after the injection that it was

noticed that the right fold was twice as thick as the other. A day later it was found that the difference between the two folds persisted, and on the ground of this reaction the calf was considered tuberculous and immediately isolated.

A week later, namely, on the 14th November, the calf was submitted to a subcutaneous test with human tuberculin. At the time of injection the temperature was 103.3° , and the maximum temperature recorded during the following fifteen hours was 104.2° , at the fifteenth hour.

On the 11th January 1912 the calf was submitted to a triple test with human tuberculin, and on this occasion the result of the subcutaneous test was markedly positive, the temperature rising from 101.4° at the time of injection to 106.2° at the twelfth hour. There was no reaction to the conjunctival test, but a fairly distinct reaction to the intracutaneous test, the right anal fold being about twice the normal thickness from the sixth to the twenty-seventh hour.

On the 29th February 1912 the conjunctival test was repeated, but without any reaction whatever.

The animal was tested again on the 25th September 1912, on which date a triple test was carried out. The initial temperature was 100.6° , and the maximum temperature during the following fifteen hours was 103° , at the sixth hour.

The only reaction to the conjunctival test was the presence of muco-pus about half the volume of a pea at the sixth hour and slightly excessive lachrymation at the third, ninth, and twelfth hours.

There was no reaction to the intracutaneous test on this occasion.

The last test was carried out on the 22nd November 1912 (see Table XXIII. and p. 350).

Isolation of the animal was maintained until 21st May 1913, when it was killed, and the *post-mortem* examination showed the following lesions:—

The right bronchial gland was enlarged to about twice the normal size, and towards its centre it contained a caseous and partly calcified nodule as large as a hazel nut. The left bronchial gland contained a caseous nodule about half the size of a pea. Only a single and partly calcified lesion was found in the right lung and none in the left.

There was slight pleural tuberculosis on both sides.

In reviewing these six cases it is apparent that the only animal in which any distinct reaction followed was No. 52, and the facts in connection with that animal do not lend any support to the view that the tuberculin employed was capable of causing a non-specific reaction, since there is no reason to doubt that the calf was actually tuberculous. This case is noteworthy in another connection, namely, because it was one in which the intracutaneous test revealed the existence of tuberculosis although a simultaneous conjunctival and subcutaneous test carried out a week later had negative results.

Our experience, therefore, is opposed to the view that the presence of glycerin in the proportion of 20 per cent. in tuberculin employed for the intracutaneous test is objectionable on the ground that it may provoke ambiguous reactions.

Having thus anticipated and answered the objection that the special concentrated tuberculin used in the conjunctival and intracutaneous tests was faulty, we may proceed to compare the results of these two tests with those of the subcutaneous test simultaneously applied to the same animals.

Unfortunately, owing to the difficulty of fixing or defining the

degree of reaction in the conjunctiva or in the anal fold of skin which should be accepted as evidence of infection, it is not possible to present the results of these two tests in the tabular form adopted in analysing the results of the subcutaneous tests.

It is obvious, however, that even if the slightest abnormality in the tested eye, such as temporary excess of lachrymal secretion or formation of a pinhead particle of muco-pus, be accepted as a positive reaction, the conjunctival was a long way behind the subcutaneous test when applied to diseased animals.

If one ignores a slight excess of lachrymal secretion, and regards as negative every case in which no muco-pus was present in the tested eye at any of the periods of observation, the conjunctival test failed absolutely in nearly 50 per cent. (77 out of 157) of the cases in which it was applied to the experimentally infected animals. This, however, does not mean that the test was positive in the remaining cases, for in twenty-nine cases the only evidence of reaction was a small particle of muco-pus present at one period of observation only.

Any estimate of the accuracy of the indications afforded by the intracutaneous tests must be influenced by the view adopted regarding the significance of pronounced early reactions which rapidly decline. The almost universal absence of such results in those cases in which this test was applied to young cattle supposed to be healthy leads us to regard these early reactions as "positive," and to reject the view that only those swellings which begin late and are slow to disappear should be accepted as evidence that the animal is tuberculous.

When the results are interpreted in this way, the intracutaneous test is seen to have had far fewer failures than the conjunctival, and the comparison is still in favour of the former if only slowly disappearing reactions are to be considered as positive.

Thus, if one regards as "positive" any swelling which makes the inoculated fold at least twice the normal thickness up to the fifteenth hour or later, then, out of 124 intracutaneous tests of infected animals 87, or 70 per cent., had a positive result.

But, in whatever way the reactions are interpreted, the intracutaneous test proved far less accurate than the subcutaneous.

COMPARATIVE ADVANTAGES OF THE THREE METHODS OF TESTING.

1. *The Subcutaneous Test.*—Tuberculin when injected under the skin of the neck or chest-wall of a tuberculous animal may cause (1) an elevation of the body temperature; (2) a systemic disturbance, manifested by acceleration of the respiratory movements, staring of the coat, coughing, diminished secretion of milk, loss of appetite, and diarrhoea; (3) a local reaction in the shape of inflammatory changes around the point where the tuberculin was injected. There is abundant experience to show that the second and third of these effects are so inconstant that their complete absence has no diagnostic importance, and any discussion of the value of the subcutaneous method of testing therefore turns upon the conclusions which

can be drawn from the observed behaviour of the temperature of the tested animal.

The paramount difficulty in the subcutaneous method of testing lies in the possibility that the animal's temperature may undergo an important elevation during the period of the test from causes entirely unconnected with the action of the tuberculin. Nervous disturbance in animals unaccustomed to handling may undoubtedly cause a misleading rise of temperature, but it is probable that non-specific rises are more frequently due to other causes, the exact nature of which, as a rule, cannot be determined. These may be called accidental rises if it is understood that the word implies merely that the animal's temperature would have exhibited the observed variation even if it had not been tested with tuberculin.

The chances of error in this direction are very great in cattle that are unaccustomed to housing and handling or which are tested in strange surroundings, but they are especially great in the case of calves and young cattle, and they are not absent in such animals even when they are not subject to any condition that would lead one to suspect irregularities of their internal temperature.

During the period 1911-13 seventy-five calves which had been bought for experiment had their temperatures taken twice, and in some cases thrice, daily for periods of one to three weeks after admission, as a preliminary to carrying out a subcutaneous test. It was found that great variations occurred, not only from day to day, but also during a single day. As a general rule, the temperatures were higher in the evening than in the morning, but this was by no means always the case. The highest temperature recorded in the different calves during the period of observation lay between 102° and 102.9° in 7, between 103° and 103.9° in 35, between 104° and 104.9° in 27, and between 105° and 105.8° (the highest temperature recorded) in 6.

The average lower limit of temperature during the three days preceding the test was 102.2° , and the average higher limit during the same period 103.8° (nearly). The temperature of the calf showing the least fluctuation varied only 0.1° during the three days, and that showing the greatest varied 4.8° .

In 19 cases the variation was less than 1° , in 22 cases it lay between 1° and 1.5° , in 17 cases between 1.5° and 2° , in 10 cases between 2° and 3° , in 5 instances it was more than 3° , and in 1 instance the variation amounted to 4.8° .

The average variation was 1.5° (approximately).

It ought to be added that without exception these were healthy-looking calves, in moderate condition, and not exhibiting any outward symptom of illness, except that in some of the lots diarrhoea was not uncommon among them for a few days after their admission.

As a rule the temperature after a month became more stable among the animals that had not been subjected to any experiment calculated to make it abnormal, but even then very disturbing irregularities occurred. Instructive examples of these are contained in Tables VII. and VIII., each of which gives the temperatures of a series of calves for fifteen hours on a particular day. In the first table the animals with even numbers were tested with tuberculin, while their fellows with odd numbers were left untested as controls.

In the second table the arrangement was the same, save that the animals with even numbers now served as controls.

It has been suggested above that one may include under the term accidental all rises of temperature which would have occurred even if the animal had not been tested, but it may be asked whether it is not possible that an injection of tuberculin may cause an elevation of temperature in an animal free from tuberculosis. There need not be much hesitation in giving a negative answer to this question, or in denying that there is any evidence to prove that tuberculin, even when injected in much larger doses than those employed in testing, is capable of producing any sensible disturbance of the temperature in a non-tuberculous subject. In other words, if one could exclude the accidental disturbances of temperature during the period of the test, every decided elevation might be accepted as proof of the animal's infection.

As has already been pointed out, the chief defect of the subcutaneous method is that its effects have in practice to be interpreted on the assumption that the temperature would not have undergone any notable elevation if the animal had not been tested. The test also falls short of a perfect method of diagnosis owing to the facts (1) that it cannot be employed in the case of animals whose temperature is already febrile; (2) that for a variable period after infection tuberculin will not produce a reaction; (3) that in many animals a decided reaction is followed by a period during which a repeated injection of tuberculin fails to cause any considerable rise of temperature. Owing to want of space these defects, which are now generally recognised, cannot be discussed here at length, and they are mentioned merely as part of the case against the subcutaneous test when that has to be compared with the other methods of employing tuberculin. It must be observed, however, that the second of the above defects is not peculiar to the subcutaneous method.

Among the defects of the subcutaneous method one may also include the difficulty of determining the exact elevation of temperature which should be accepted as a positive reaction. This difficulty is, of course, partly dependent upon the liability of the animal to rises of temperature which are accidental in the sense previously defined, but it is also due to the fact that in different tuberculous individuals the same dose of tuberculin may produce effects varying in intensity.

Closely connected with this point is the difficulty of determining what should be regarded as the normal temperature of the animal that is being tested. We do not propose to deal with that question here, but we may call attention to the different interpretation which would have to be placed on the results of a considerable number of our tests, according as the temperature at the time when the tuberculin was injected or the highest temperature of the previous day is to be regarded as the normal one (*see* especially Tables IX., X., XI., and XII.)

The rule for the interpretation of temperatures must be the one which according to the widest experience gives the smallest proportion of errors in diagnosis, but in the circumstances it cannot exclude such errors altogether. Moreover, the determination of the

critical temperature will depend upon the relative importance which is attached to the two possible errors—that of condemning a non-tuberculous animal or of allowing a tuberculous one to escape.

2. *The Conjunctival Method.*—The advantages that have been claimed for this method are—

(1) Its greater simplicity.

(2) That repeated positive reactions may be obtained with short intervals between the successive tests.

(3) That it produces no systemic disturbance and therefore no diminution in the yield of milk.

(4) That it may be employed in almost any circumstances provided the animal to be tested has normal conjunctivæ.

(5) That the results of the test are less difficult to interpret than the temperature variations upon which one has almost entirely to rely in the case of the subcutaneous method.

The first of the above advantages appears to have been over-estimated, for our results lead us to believe that if frequent errors are to be prevented the times at which the tested eye must be examined are as numerous, and must be spread over as long a period, as the observations which are necessary to detect a temperature reaction.

It must be admitted, however, that the conjunctival method is simpler, inasmuch as it is easier to ascertain the condition of the eyes than to take the temperature, especially in cattle not accustomed to handling.

It must also be conceded that repeated unequivocal conjunctival reactions *may* be obtained within a comparatively brief period, as is proved by the history previously given of the naturally infected Cow 1. In weighing this advantage, however, it must not be assumed either that quickly repeated conjunctival tests are always followed by clearly positive reactions or that distinct reactions to repeated subcutaneous tests are only obtainable when the intervals between them are long.

It appears to be a pretty general rule that in an animal which has given one good reaction to the conjunctival test a repeated test, even within a few days, will also have a positive result, but this rule is not without exceptions. Moreover, some animals will exhibit distinct reactions to several successive subcutaneous tests with intervals of not more than a week. In this connection attention may be called to Tables XXI. and XXII., which show the results of two successive subcutaneous tests with an interval of only five days.

The third and fourth of the advantages set forth above are indisputable, and the fourth particularly must be reckoned important.

On the other hand, the fifth claim is not supported by our experience, which shows that it is just as difficult to fix the amount of lachrymation, congestion, and muco-pus formation which is to be regarded as constituting a positive reaction, as it is to determine the critical temperature after a subcutaneous test. Here again one is confronted with the difficulty of distinguishing between the slight specific reactions and the conjunctival abnormalities that are accidental in the sense that they are unconnected with the action of the tuberculin. In the cases, however, in which the conjunctival reaction is very marked and confined to the tested eye there is hardly any chance of error in accepting it as specific, whereas one

can seldom or never feel equal assurance in interpreting a febrile temperature in the same way.

So far, in considering the conjunctival test only the advantages claimed for it have been reviewed, but when one method of testing has to be appraised against another, their relative reliability for the diagnosis of tuberculosis must outweigh all other considerations. Our experience compels us to give the preference to the subcutaneous method. The facts which have been recorded in the earlier part of this paper show the immensely greater accuracy of the subcutaneous test when applied to young cattle that have been experimentally infected with any of the three types of tubercle bacilli, but especially in the case of those infected with the bovine type. They also indicate that as a rule a longer period is required for the infected animal to develop the power of reacting to the conjunctival test, which is obviously a serious disadvantage in many circumstances.

It must be admitted that our results are more to the discredit of the conjunctival method than those which have been obtained by many other observers. It does not appear probable that the discrepancy is attributable to the different method of infection—experimental inoculation in most of our cases, and natural infection in the cases tested in general practice; nor can the failure of the conjunctival method in the case of the animals tested after infection with bovine bacilli have been due to the previous “vaccination” with human or avian bacilli, for similar failures were observed in the control animals which had not been vaccinated.

It does appear to be possible that the failure to develop the power of reaction to the conjunctival method is more frequent in young than in adult cattle, but even acceptance of that view would not affect the conclusion that in ordinary circumstances the subcutaneous test is far more reliable than the conjunctival, and that if only one test is to be employed it ought to be the former, unless its use is contra-indicated by some of the special considerations previously referred to.

3. *The Intracutaneous Test.*—In our experiments this method had fewer failures than the conjunctival, but it was much less accurate than the subcutaneous. It shares with the conjunctival method the advantage that marked reactions may with little chance of error be accepted as proof of infection, but also the disadvantage that negative results are far from justifying the conclusion that the animal is non-tuberculous.

It cannot be said that the interpretation of the results is any easier than in the case of the other two tests, the difficulty being to draw a hard and fast line between the slight transient swelling which forms at the point of injection in almost every animal and the larger and more lasting reactions which denote infection.

This method has the disadvantage that the tested animal must be examined for evidence of reaction not only on the day of the test but also on the following one, owing to the fact that late development of the swelling has great diagnostic importance.

It is possible that repeated reactions may be obtained after shorter intervals with the intracutaneous than with the subcutaneous method, but on this point further evidence is required.

In what precedes the three methods of testing have been compared as if the diagnosis had to be based on the results obtained by their separate employment, or as if it were commonly necessary to test by a single method. That, of course, is not the case, and the question of the relative reliability of the three methods of testing therefore loses most of the importance which it would otherwise have.

There are special circumstances in which the subcutaneous method cannot be used alone or in which its indications cannot be accepted with any degree of confidence. The most important of these are the existence of a high or unstable temperature in the animal that has to be tested, or a strong suspicion that it has recently been treated with tuberculin by subcutaneous injection in order to diminish its tendency to react. Only the first of these, however, is a positive barrier to the employment of the subcutaneous test. In all other circumstances the proper course is to test simultaneously by all three methods, for the combined indications which can be thus obtained afford a far surer guide to correct diagnosis than the result of any one of the methods applied by itself.

But it must be repeated that where the circumstances already mentioned do not forbid the use of the subcutaneous test it must not be omitted in favour of the conjunctival or intracutaneous tests, either separately or combined. The conjunctival method used alone is the least reliable of the three when its results are negative.

TABLE I.*

First Intravenous Inoculation with Human or Avian Bacilli.

1st Inoculation. 25.11.11	No.	24.11.11	25.11.11						Rise of temp. from time of inoc.	Rise of temp. from previous day.
			Inoc.	3	6	9	12	15		
10 mg. human	36	103.8	102.8	103.2	104.1	103.8	103	103.5	1.3	.3
do.	37	103.2	103	102.5	104	103.2	103	102.6	1	.8
do.	38	102	102	102.7	104.6	103.5	103.2	103	2.6	2.6
15 mg. human	39	102.5	102.6	103.4	103.8	103.2	102.8	102.5	1.2	1.3
do.	40	103.6	102.2	102.7	103.2	103.5	102.2	103.5	1.3	0
do.	41	104	103.6	104	105	104.6	104.2	104.4	1.4	1
20 mg. human	42	103.2	103.4	104	104.5	104.5	104	104	1.1	1.3
do.	43	104.5	102.8	103.6	104.8	104.7	103.8	102.7	1.7	.2
do.	44	102.8	103	103	104	103.7	104.2	103.6	1.2	1.4
do.	45	103	103.6	103.6	104	103.4	103.2	102.9	.4	1
20 mg. avian	46	104	104	103.6	104	103.5	102.5	102.5	0	0
do.	47	102.8	103.8	102.5	103.9	103.7	104	103.1	.2	1.2
do.	48	103.8	103.8	103	104.2	103.6	104.2	103.4	.4	.4
do.	49	104.2	103.4	102.3	104.9	104.2	103.6	103.4	1.5	.7
do.	50	104.5	104	103.3	104.1	104	103.8	103.8	.1	0
do.	51	102.2	102	101.3	105	104.7	104	103.6	3	2.8
do.	53	103	102.8	102.5	103	103.4	103.5	103	.7	.5
do.	54	102.5	102.5	101.7	104.7	103.6	103.8	103.6	2.2	2.2
do.	55	102.2	102.5	102.7	107.1	105.6	106	104.5	4.6	4.9

* In each table the figures at the heads of the columns of temperatures denote the hours after the inoculation or the injection of tuberculin.

TABLE II.

First Intravenous Inoculation with Human or Avian Bacilli.

1st Inoculation.	No.	19.2.13		20.2.13					Rise of temp. from max. of previous day.	
		A. M.	P. M.	Inoc.	3	6	9	12		15
20.2.13										
10 mg. human	61	102	102.8	The record of the temperatures at the time of inoculation was unfortunately lost.	102.2	102	103.4	102.4	101.4	1.6
do.	62	101.6	103		101.4	102.2	103.4	102.6	103	1.4
do.	63	100.2	102		100.2	102.2	102.6	102.4	100.4	.4
do.	64	102.6	101.8		102.4	102.8	102.6	103.8	102.4	1.2
do.	65	102.2	102.6		103.2	104	106.2	107	107	4.4
do.	66	101.4	101.4		102.6	102	103.6	102.4	103.6	2.2
do.	67	100.8	102.4		102.2	102	103	100.8	104	1.6
do.	68	102	102.4		102.6	101.6	102.8	102.4	104.2	1.8
do.	69	102.6	103		102.2	103	105.2	105.8	105.2	2.8
do.	70	102.4	103.4		101.6	104.6	106.4	106.2	106	3
10 mg. avian	71	103.4	103.6		100.6	102.6	103.8	103.4	104.8	1.2
do.	72	103.8	102.8		99.8	101.8	101.6	103	100	0
do.	73	103.4	102.8		101.2	102.4	103	102.8	101.2	0
do.	74	104.2	103		101	102.6	101.6	102.4	100.6	0
do.	75	101.6	102.6		101.4	102.6	104.2	103	102	1.6
do.	76	102.6	102.2		102.2	103.4	104.6	102.6	101.2	2
do.	77	103	102.4		101.6	103.2	103.2	102.6	102.2	.2
do.	78	103.4	103		100.2	102	103.2	102	103.4	0
do.	79	102.6	102.8		102.2	102.6	102.8	103.4	101	.6
do.	80	101.4	102.6		101.4	103	102.6	102	101.4	.4

TABLE III.

Second Intravenous Inoculation with Avian Bacilli.

1st Inoculation. 10.8.11	2nd Inoculation. 2.11.11	No.	2.11.11					Rise of temp. from time of inoc.
			Inoc.	3	6	9	12	
10 mg. avian	20 mg.	11	103.2	104.3	104.8	105.8	104.8	2.6
do.	do.	12	104.5	103	105.2	106.4	105.6	1.9
do.	do.	13	103.4	104.9	107.8	105	104.8	4.4
do.	do.	14	102.8	104	105	106.2	105	3.4
do.	30 mg.	15	104.1	104.2	105.8	105.4	105.3	1.7
do.	do.	16	103	103.2	105.2	105.4	104.2	2.4
do.	do.	17	102.8	104	105.6	106.2	105.2	3.4
do.	do.	18	103.8	105.3	106.8	105.2	105	3
do.	40 mg.	19	102.8	103.3	106.2	105.6	104.6	3.4
do.	do.	20	103.2	103.2	106.4	104.6	104.5	3.2
do.	do.	21	103.8	103.8	107.2	105.4	104.3	3.4
do.	do.	22	103.4	106	105.4	106.4	105	3
15 mg. avian	50 mg.	23	103.4	103.9	105.4	105	105.3	2
do.	Not inoc.	24	103.9	102.6	103.6	104	103	.1
20 mg. avian	do.	25	103.2	103.2	103.2	103.4	103	.2

TABLE IV.

Second Intravenous Inoculation with Human or Avian Bacilli.

1st Inoculation. 22.II.II	2nd Inoculation. 19.I.I2	No.	18.I.I2	19.I.I2						Rise of temp. from time of Inoc.	Rise of temp. from previous day.
			3 P.M.	Inoc.	3	6	9	12	15		
10 mg. human	20 mg. human	36	101'4	102	104	102'2	104	102'8	102	2	2'8
do.	do.	37	101'4	101'2	104	103'2	106'4	105'2	105'4	5'2	5
do.	do.	38	101'8	102	105	103'8	104	105'2	103'4	3'2	3'4
15 mg. human	25 mg. human	39	101'8	102	104'8	104'4	104'4	105	105	3	3'2
do.	do.	40	101'4	102'2	103'4	103'6	106'4	105'8	105'8	4'2	5
do.	do.	41	101'8	102'4	105'4	103'4	105'6	105'6	104'4	3'2	3'8
20 mg. human	30 mg. human	42	102'2	101'8	105'6	105'6	104'6	105'2	104'6	3'8	3'4
do.	do.	43	102	102	104'6	103'4	103'2	102'6	102'6	2'6	2'6
do.	do.	44	102'2	101'8	104'2	103'4	104'2	105'4	104	3'6	3'2
do.	do.	45	100	101'4	103'8	105'6	105'2	105'2	105	4'2	5'6
20 mg. avian	30 mg. avian	47	102'4	102	102'6	106'6	106	105'6	105'6	4'6	4'2
do.	do.	48	101'6	102'4	101'6	103	104'2	105	106	3'6	4'4
do.	do.	49	102'2	101'8	101'8	106	106	105	105'8	4'2	3'8
do.	40 mg. avian	50	102'4	102'6	102'4	105'4	104'8	104'2	104'2	2'8	3
do.	do.	51	102	101'6	103'8	105'4	105	106'2	106'6	5	4'6
do.	do.	53	102	102'2	102'4	106	105'2	106'4	106	4'2	4'4
do.	50 mg. avian	54	102	102'4	101'6	105	104'2	105'4	106'4	4	4'4
do.	do.	55	101'6	102'6	101'4	105	105'6	105'6	105	3	4
Not inoculated	Not inoculated	26	102'6	102'4	101	102	102'6	102'6	102'4	2	0
do.	do.	27	101'8	102'4	101'2	101'8	104'2	103	103'2	1'8	2'4
do.	do.	28	102	102'4	102'2	102	102'4	101'6	102	0	4
do.	do.	29	102	101'4	100'8	101'6	102'8	101'6	102	1'4	8

TABLE V.

Second Intravenous Inoculation with Human or Avian Bacilli.

1st Inoculation. 20.2.I3	2nd Inoculation. 23.4.I3	No.	22.4.I3		23.4.I3						Rise of temp. from time of inject.	Rise of temp. from max. of previous day.
			A.M.	P.M.	Inoc.	3	6	9	12	15		
10 mg. human	20 mg. human	66	102'6	101'6	102	103	103	105'4	105'2	104'2	3'4	2'8
do.	do.	67	103	103'2	102'4	102	103'6	107'4	105	105'2	5	4'2
do.	do.	68	100'8	104	101'4	103	105	106'8	104'8	104	5'4	2'8
do.	do.	69	101'4	103	101'4	101'8	102'2	106	105	103'4	4'6	3
do.	do.	70	101	102'6	101	102	103'8	105'8	104'4	104'2	4'8	3'2
10 mg. avian	20 mg. avian	77	103	102'8	102	103'8	105'4	105	105'2	103'8	3'4	2'4
do.	do.	78	103	103'2	102	102'8	104'4	105'6	105	104	3'6	2'4
do.	do.	79	104	103'6	103	106'2	106'2	105'6	105'4	105'2	3'2	2'2
do.	do.	80	103'4	103	103'4	103	106	106	106'2	104'8	2'8	2'8

TABLE VI.

First Intravenous Inoculation of Bovine Bacilli into Animals previously Infected with Human or Avian Bacilli.

Inoculations. 10.8.11 and 2.11.11	Inoculation. 9.2.12	No.	8.2.12	9.2.12						Rise of temp. from time of Inoc.	Rise of temp. from previous day.
				Inoc.	3	6	9	12	15		
10 mg. human (10.8.11)	3 mg. bovine intravenous	8	103	102'4	103'6	104	105'6	105	105	3'4	2'6
10 & 20 mg. avian	3 mg. bovine intravenous	12	104	102'8	103	103'6	105'6	103'6	102'4	2'8	1'6
10 & 30 mg. avian	3 mg. bovine intravenous	15	103'4	103	103	103	103'6	102'6	102'2	'6	'2
do.	4 mg. bovine intravenous	16	103'8	103	103	104	104'6	103'6	102'2	1'6	'8
10 & 40 mg. avian	4 mg. bovine intravenous	20	103	102	103	102'8	104	102'4	102'2	2	1

TABLE VII.

First Test after Infection with Human or Avian Bacilli.

Inoculation. 10.8.11	Tuberculin, 13.10.11	No.	11.10.11		13.10.11						Rise from temp. at inject.	Rise from max. temp. on previous day.
			A.M.	P.M.	Inj.	3	6	9	12	15		
10 mg. human	4 cc. avian	6	103	104	102'5	104'2	103'8	104	103'6	103'4	1'7	'2
do.	do.	8	103'5	103'5	101'6	103'1	104'2	104'6	104'7	103	3'1	1'2
do.	do.	10	103'1	104	101'6	102'4	103'5	104	104'4	104'2	2'8	'4
10 mg. avian	do.	12	104	103'8	103'2	103'5	103'8	106'3	106	105	3'1	2'3
do.	do.	14	102'5	102'7	101'2	102'3	104'6	106	104'8	104'4	5'8	3'5
do.	do.	16	103	103'4	102'2	102'5	103'7	105'6	105'8	103'5	3'6	2'4
do.	do.	18	103'8	103'5	103'2	103'8	104'7	104'8	105'7	104'3	2'5	1'9
do.	do.	20	103'5	102'2	101'7	102'3	102'9	105	105'5	103'7	3'8	2
do.	do.	22	103	103'4	102'5	103'2	105'4	106'2	105'9	105'4	3'7	2'8
do.	Not tested	11	103'4	104'1	102'1	102'4	103'2	103'2	103'3	102'8	1'2	0
do.	do.	13	104'1	104'2	102'3	103	103'3	104'6	105'3	103'4	3	1'1
do.	do.	15	103'3	103'2	103'7	103'8	103'9	103'7	103	103'7	'2	'6
do.	do.	17	102'8	104	101'6	102'6	102'9	103'4	104'6	103	3	'2
do.	do.	19	102'7	103	102'4	102'4	103	103'7	104	103	1'6	1
do.	do.	21	102'1	104'4	102'5	102'2	102'7	102'9	103'4	102'5	'9	0
15 mg. avian	do.	23	102'4	103'1	101'3	102'2	103'3	103'4	104'9	103'9	3'6	1'8
do.	do.	24	104	103'8	103'8	103'4	104'1	104'2	103'9	104'3	'5	'3
25 mg. avian	do.	25	102'1	103'4	101'5	102'9	104'4	103'3	103'3	102'5	2'9	1

TABLE VIII.
First Test after Inoculation with Avian Bacilli.

Inoculation. 10.8.11	Tuberculin. 19.10.11	No.	19.10.11						Rise of temp. from time of inject.
			Inj.	3	6	9	12	15	
10 mg. avian	4 cc. avian	11	102	102	104	106.5	106.2	105.4	4.5
do.	do.	13	102	102.2	104.1	105.6	107.1	106.4	5.1
do.	do.	15	102.6	102.7	103.6	105	104.8	104	2.4
do.	do.	17	101.7	102.4	102.8	104.4	105.4	104.8	3.7
do.	do.	19	102.3	102.4	105.2	105.1	104.8	104.8	2.9
do.	do.	21	102	102	103	105.7	106	104.8	4
15 mg. avian	do.	23	101.8	102	104.4	106.6	106.8	105.5	5
do.	do.	24	103.6	103.5	104.2	106.7	106.4	105.2	3.1
25 mg. avian	do.	25	102	102.4	103.6	106	105.4	105.4	4
10 mg. human	Not tested	6	102.7	103	102.7	103	103.9	103.3	1.2
do.	do.	8	101.7	101.8	103.3	102.7	103.7	103.7	2
do.	do.	10	101	102	102.7	103.5	103.4	103.3	2.4
10 mg. avian	do.	12	102.5	103.3	104	103.5	103.6	104.3	1.8
do.	do.	14	101.6	102.4	102.9	103	103.8	103.2	2.2
do.	do.	16	101.7	102	102.9	103	104.7	103.4	3
do.	do.	18	102.7	103	103.4	104.2	104	103.2	1.5
do.	do.	20	102.5	102.1	103	103.3	103.2	103.2	1.8
do.	do.	22	102.3	102	103.6	102.9	103.7	104.3	2

TABLE IX.
First Homologous and Heterologous Tests of Animals after Second Inoculation with Human or Avian Bacilli.

Inoculation. 2.11.11	Tuberculin. 10.1.12	No.	9.1.12		10.1.12						Rise of temp. from time of inject.	Rise of temp. from max. of previous day.
			2 P.M.	9 P.M.	Inj.	3	6	9	12	15		
Human	2 cc. human	10	102.7	103	101.7	102.8	106.2	104.6	103.6	102.6	4.5	3.2
Avian	do.	11	102.1	102.4	101.2	102.4	102.8	103	102.4	102	1.8	.6
do.	do.	12	103	103	101.8	103	104.2	102.5	102.4	102.8	2.4	1.2
do.	do.	13	103	102.4	101.5	102.5	104	103.2	103	101.8	2.5	1
do.	do.	14	102.8	102	101.2	102.5	103.2	103	102.2	101.6	2	.4
do.	do.	15	102.5	101.8	101.5	102.6	103.5	103	102.6	102.2	2	1
do.	do.	16	102.5	102.4	101.4	103	102.8	102.8	102.4	101.6	1.6	.5
do.	do.	17	102.6	102.2	101.6	102.6	102.6	102.3	102.4	102.4	1	0
do.	4 cc. avian	18	103.7	103.2	101.5	103.4	104	103.8	103.4	102.4	2.5	.3
do.	do.	19	102.8	103.2	101.6	102.2	103.8	104.2	103.9	103	2.6	1.4
do.	do.	20	102.2	102	101.6	102.6	103	103.2	102.2	102	1.6	1
do.	do.	21	102.2	102.2	101.4	101.8	103.8	106.8	104.9	103	5.4	4.6
do.	do.	22	102.4	102.4	102.2	102.4	104	104	103	101.8	1.8	1.6
do.	do.	23	102.6	102.8	101.2	102.2	103.4	103.8	104.2	104.5	3.3	1.7
do.	do.	24	104.2	102.4	102	103.5	104	103.2	104	103.2	2	0
do.	do.	25	102	102.2	101.2	103.3	104	104	103.4	102.6	2.8	1.8

TABLE X.

Homologous and Heterologous Tests of Animals previously Inoculated with Human or Avian Bacilli.

Inoculation.	Tuberculin. 26.3.12	No.	25.3.12	26.3.12						Rise of temp. from time of inject.	Rise of temp. from previous day.
			Noon.	Inj.	3	6	9	12	15		
Avian	3 cc. human	13	101'4	103	101'2	101'2	103'6	103	102'8	.6	2'2
do.	do.	14	101'6	103	101'2	102	104	102	102'4	1	3'4
do.	do.	17	102	103	101'2	102'8	104'2	103	102'6	1'2	2'2
do.	do.	18	101'4	103'2	101'2	101'4	103'2	103	102'4	0	1'8
do.	5 cc. avian	21	101	103'4	101'4	101'6	103'2	103'4	102'8	0	2'4
do.	do.	22	101'4	103	101'2	101'4	103'2	102'4	101'6	.2	1'8
do.	do.	23	100'8	102'6	101'2	101'6	104'6	104	103'4	2	3'8
do.	do.	24	103	104'6	102'2	103'4	103'6	103'4	104'8	.2	1'8
Human	3 cc. human	10	101'6	104	101'6	103'4	103'2	103'2	102'2	0	1'8
do.	do.	37	101'2	102'4	101'6	103'4	103'4	103	102'2	1	2'2
do.	do.	44	101'2	102'8	101	102'6	105	105	104'8	2'2	3'8
Not infected	do.	57	101'8	102'3	101	101'4	103'2	101'4	102'2	.9	1'4
do.	do.	58	101'4	102'4	101'2	101'4	102'4	102'4	102'8	.4	1'4
do.	do.	60	102'2	102'6	101	101'6	103'2	102'4	102'6	.6	1
Cow naturally infected	8 cc. avian	B.W.	102	101	102	104	104'6	105	103	4	5

TABLE XI.

First Homologous and Heterologous Tests of Animals after First Inoculation with Human or Avian Bacilli.

Inoculation. 25.11.11	Tuberculin. 12.1.12	No.	11.1.12		12.1.12						Rise of temp. from time of inject.	Rise of temp. from max. of previous day.
			A.M.	P.M.	Inj.	3	6	9	12	15		
Human	2 cc. human	36	103'4	102'4	101'8	101	105	105	105'6	105'4	3'8	2'2
do.	do.	37	102'8	101'4	101	101'8	105	106	104'8	104'4	5	3'2
do.	do.	38	103'4	100'6	101'4	101'8	105	105	104'2	103'6	3'6	1'6
do.	do.	39	103'4	101'6	101	101'6	105	105	104'4	104'4	4	1'6
do.	do.	40	104'2	101	101'6	100'6	106	106	105'2	104'4	5'4	1'8
Avian	do.	47	103'6	101'6	101'6	101'8	104'8	103'6	106'4	103'6	3'8	1'8
do.	do.	48	103'6	100'3	101'4	101'4	101'8	105	104	103'6	3'6	1'4
do.	do.	49	103'2	102'2	102	100'4	102'4	104'4	104'2	103	2'2	1'2
do.	do.	50	104'4	101'8	103	102'4	103'4	105	103'2	102'4	2	.6
Not inoculated	do.	52	Not taken	101'4	101	104'2	105	106'2	104'4	104'4	4'8	—
Human	4 cc. avian	41	103'6	100'8	102'4	102'4	104'6	105'4	105	105	.3	1'8
do.	do.	42	104'2	101'8	102'4	102'2	104'6	105'4	104'8	104	.3	1'2
do.	do.	43	104'8	100'6	102'4	102'2	103'6	105	103'6	102'2	2'6	.4
do.	do.	44	104'4	101	101'2	101'8	103'8	105	103'6	103'4	3'8	.6
do.	do.	45	103	99'2	102	100'8	102'8	105	104'6	104'2	3	2
Avian	do.	51	103'2	102	102'2	102'6	105	106'4	106'2	106	4'2	3'2
do.	do.	53	103'8	101	102	103	105'6	106'6	105'4	105	4'6	2'8
do.	do.	54	104	101'2	101'6	102	105	106	105'2	105'2	4'4	2'6
do.	do.	55	104	102'2	102'6	101'2	105	106'2	106'2	105	3'6	2'2
Not inoculated	Not tested	26	103'2	101'4	102	101'2	102	102'8	102'2	102	.8	0
do.	do.	27	104'2	101	101'4	100'8	102	103	103	101'6	1'8	0
do.	do.	28	103'8	101'8	102'8	100'8	102	102'8	102'2	102	0	0
do.	do.	29	103'8	101	100'8	101'2	102	102	102'2	102	1'4	—

TABLE XII.

First Homologous and Heterologous Tests after Second Inoculation with Human or Avian Bacilli.

Inoculations. 25.11.11 and 19.1.12	Tuberculin. 28.3.12	No.	27.3.12	28.3.12						Rise of temp. from time of inject.	Rise of temp. from previous day.
			4 P.M.	Inj.	3	6	9	12	15		
10 & 20 mg. human	3 cc. human	36	102'4	101'4	102'4	103'4	103'8	103'6	103	2'4	1'4
do.	do.	38	103	101'8	103'2	104	102'6	104	102'6	2'2	1
15 & 25 mg. human	do.	39	103'2	101	102'1	104'4	104	104'6	103'8	3'6	1'4
do.	do.	40	103	102	102'4	103'2	104	105	104'2	3	2
do.	do.	41	103'2	101'6	102'4	103'8	102'6	104'6	104	3	1'4
20 & 30 mg. human	do.	42	103'4	103'6	103'4	103'4	103'4	103	103	0	0
do.	do.	43	103	101'8	102'6	104'8	106	104'2	104'2	4'2	3
do.	do.	45	102'6	101'8	102'6	103	104	104	103	2'2	1'4
20 & 30 mg. avian	do.	47	102'6	101	102	102'8	104	104	103	3	1'4
do.	do.	48	102'8	101'4	102'4	103'2	102'6	103	102'2	1'8	4
do.	do.	49	102'4	101	102'2	103	103'6	103	103	2'6	1'2
20 & 40 mg. avian	do.	50	103'8	101'6	103'4	105'4	104	104	103	3'8	1'6
do.	5 cc. avian	51	102'4	101	102	104	104	105'6	106	5	3'6
do.	do.	53	103	100'8	102'2	103	103	105	104'2	4'2	2
20 & 50 mg. avian	do.	54	102'6	101'4	102'2	102'6	103'6	105	104'8	3'6	2'4
do.	do.	55	102'4	101'6	102'2	103'2	103'6	103'6	103'4	2	1'2

TABLE XIII.

First Homologous and Heterologous Tests after First Inoculation with Human or Avian Bacilli.

Inoculation. 20.2.13	Tuberculin. 20.3.13	No.	19.3.13		20.3.13						Rise of temp. from time of inject.	Rise of temp. from max. of previous day.
			A.M.	P.M.	Inj.	3	6	9	12	15		
10 mg. human	3 cc. human	61	101'6	102	102'4	103	105'6	106'6	105'8	105'2	4'2	4'6
do.	do.	62	100'8	101'6	102'2	102	103'8	106	105'6	104	3'8	4'4
do.	do.	63	100'8	103'2	102'2	101'8	105'4	104'8	104'6	104'2	3'2	2'2
do.	do.	64	101'8	101	102	100'8	102'4	104'4	104'6	103	2'6	2'8
do.	do.	65	99'2	101'4	102'4	99'4	104'4	106'4	105	103'8	4	5
do.	3 cc. avian	66	101'2	102'4	103'2	102'2	102'8	105'6	105'2	103'6	2'4	3'2
do.	do.	67	100'2	101'2	102'6	100	102'6	105	105'8	104'8	3'2	4'6
do.	do.	68	100'6	101'6	103	100	103'8	106	105	104'8	3	4'4
do.	do.	69	101'2	101'4	103'4	101'4	102'8	103'4	103'6	104	4'6	2'6
do.	do.	70	100'8	101	103	99'2	102'2	103'2	104	104'8	1'8	3'8
10 mg. avian	3 cc. human	71	101	103	103	101'4	104'6	106'6	105'6	104'6	3'6	3'6
do.	do.	72	99'4	101'6	103'4	98'8	101'4	104'4	104'6	104'2	1'2	3
do.	do.	73	101'8	101'6	103	100'4	102'4	105'4	105	104'2	2'4	3'8
do.	do.	74	100'4	102'6	103	99'4	102'8	105'6	105'8	104'8	2'8	3'2
do.	do.	75	100'4	102'6	102	101	105'2	106'4	105	103'4	4'4	3'8
do.	3 cc. avian	77	101'6	102'4	103	100	103	105'6	104'6	104	2'6	3'2
do.	do.	78	100'4	102'8	103'2	100	103'6	106	105'4	104'2	2'8	3'2
do.	do.	79*	101'8	—	104'4	102'2	104'4	106'4	105'6	105'4	2	—
do.	do.	80*	103'4	—	103'6	103	106'4	107	104'8	104'6	3'4	—

* Tests of these animals carried out 4.4.13.

TABLE XIV.

Second Homologous and Heterologous Tests after First Inoculation with Human or Avian Bacilli.

Inoculation. 20.2.13	Tuberculin. 17.4.13	No.	16.4.13		17.4.13					Rise of temp. from time of inject.	Rise of temp. from max. of previous day.	
			A.M.	P.M.	Inj.	3	6	9	12			15
10 mg. human	3 cc. avian	61	102'4	103	103	101'4	103'2	103'8	103'8	102'8	'8	'8
do.	do.	62	101'6	102'8	102'6	101'6	103	103	103'8	103'2	1'2	1
do.	do.	63	101'6	102'4	101'8	101'6	103'2	104	103'8	103	2	1'2
do.	do.	64	102'4	102'2	101'6	101'2	101'2	102'6	103'2	102'4	1'6	1
do.	do.	65	100'6	102'2	102'8	100	103'8	103'2	103'4	103'2	1	1'6
do.	3 cc. human	66	99'8	101'2	103	99'6	102'6	104'4	105'4	105	2'4	4'2
do.	do.	67	100'4	102'8	102'4	99'4	102'6	106	105'4	104'4	3'6	3'2
do.	do.	68	101	101'6	101'6	99	101'6	105'6	105'8	103'8	4'2	4'2
do.	do.	69	100'6	102'4	102'4	100'4	103	104'6	104	103'2	2'2	2'2
do.	do.	70	101	102'4	102'8	100'6	103'2	105'8	105	104'2	3	3'4
10 mg. avian	3 cc. avian	71	100'6	102'4	102'4	98'8	100	104	105'6	104'2	3'2	3'2
do.	do.	72	100'2	102'6	102	99'8	102	105'4	105'6	103'8	3'6	3
do.	do.	73	100	101	102	99	101	103'4	104'6	104	2'6	3'6
do.	do.	74	100'6	103'2	103	99'6	101'8	103	104	104'2	1'2	1
do.	do.	75	101	101'6	103	100'4	102'2	105	104'8	104'4	2	3'4
do.	3 cc. human	77	99'8	102'2	102'4	98'8	101	103	104	103'4	1'6	1'8
do.	do.	78	101'6	102'6	100'8	100'2	102'2	105'2	105'8	104'8	5	3'2

TABLE XV.

Homologous and Heterologous Tests after Inoculation with Human or Avian Bacilli.

Inoculations. 20.2.13 and 23'4'13	Tuberculin. 28.5.13	No.	27.5.13		28.5.13					Rise of temp. from time of inject.	Rise of temp. from max. of previous day.	
			A.M.	P.M.	Inj.	3	6	9	12			15
Once human	3 cc. human	61	103	102'8	102	102'2	105	105'6	104'6	103'6	3'6	2'6
do.	do.	62	102'6	102'8	101'4	101'8	103	105	105'3	104'4	3'9	2'5
do.	do.	63	103	103'2	101'2	101'8	103'6	104	105	104'4	3'8	1'8
do.	do.	64	103	102'6	101'2	101'8	102'4	103'3	103'4	102'2	2'2	'4
do.	do.	65	104	103'2	101'8	102	105	104'2	104'4	104'8	3'2	1
Twice human	do.	66	104'4	102'6	101'6	101'6	103'4	105'4	104'8	103'6	3'8	1
do.	do.	67	105'2	102'2	102'2	101	103'4	105'8	105'8	104	3'6	'6
do.	do.	68	102'2	102'8	101'8	101'7	104'6	105'4	105'2	103'8	3'6	2'6
do.	do.	69	103'4	102'6	101'4	102	102	103'2	104	103'6	2'6	'6
Once avian	3 cc. avian	71	104'6	102'2	102	101'4	102'4	103'8	104'2	103'6	2'2	'4
do.	do.	72	103'4	102'8	101'3	100'2	102'6	105'4	105	104'2	4'1	2
do.	do.	73	103	102'2	101'4	100'8	103'4	104	104'8	103'6	3'4	1'8
do.	do.	74	103	102'6	101'8	100'4	102'2	102'6	104	103'6	2'2	1
do.	do.	75	103	102'4	101'8	101	102'8	103'6	104'2	103'4	2'4	1'2
Twice avian	do.	77	103	101'8	102	100'4	103	103	105	105	3	2
do.	do.	78	103	103	101'6	101	102'6	104	104'4	103'2	2'8	1'4
do.	do.	79	104	102'2	101'5	101'8	103	104'4	105	105	3'5	1

TABLE XVI.

*First Test (26.3.12) after Inoculation with Bovine Bacilli (9.2.12).
Human Tuberculin, dose 3 cc.*

No.	25.3.12	26.3.12						Rise of temp. from time of inject.	Rise of temp. from previous day.
	Noon.	Inj.	3	6	9	12	15		
6	102'4	102'2	104	105'4	105'6	105'2	104	3'4	3'2
11	101'4	102	103'8	104'6	105'8	105'8	105'6	3'8	4'4
19	103'8	103	106	106'6	105'6	106	106	3'6	2'8
25	102	101'4	104	104	105	105	104'4	3'6	3
59	102'2	102'6	105'8	103'8	105	105	105	3'2	3

TABLE XVII.

*First and Second Tests after Inoculation with Bovine Bacilli.
Human Tuberculin, dose 2 cc.*

Bovine inoculation.		No.	14.5.12						Rise of temp. from time of inject.
			Inj.	3	6	9	12	15	
Second test.	9.2.12	6	102'8	101'2	103'6	106	105'6	103'8	3'2
	do.	11	102'8	101'4	103'4	106	105'8	104'6	3'4
	do.	19	102'4	101'2	103'6	105'6	104'8	104'2	3'2
	do.	25	102'8	100'2	103	105'6	105'4	104'2	2'8
	do.	59	102	100'4	105'2	106'6	105'2	105'4	4'6
First test.	18.4.12	10	102	102'6	104'2	105'6	104'4	104	3'6
	do.	37	102	102'2	104'4	104'8	104'2	103'4	2'8
	do.	39	102	101'4	103'4	105'8	105'8	104'4	3'8
	do.	42	104'6	103'6	104'2	104'8	104'8	103'6	2
	do.	44	102	102	103'4	105'6	104'2	104'6	3'6
	do.	17	102'2	102'2	105	106'6	106'2	105'8	4'4
	do.	18	103'2	103'2	105'8	106'4	104'8	104'4	3'2
	do.	22	102'4	99'8	102'2	106'4	105'4	104'8	4
	do.	23	102'3	100'6	103	105'8	105'8	105'4	3'5
	do.	47	101'6	103	104'6	105'6	105'6	105'6	4
	do.	50	101'8	102	104	105'4	104'6	104	3'6
	do.	54	103'4	100'8	103'8	105'8	105'2	104'8	2'4
	do.	57	102'8	102'2	105	107'2	105'4	105'8	4'4
	do.	58	104'6	105	107	106'6	105	104'2	2'4

TABLE XVIII.

Second and Third Tests after Inoculation with Bovine Bacilli, except the last Two Animals, which were Cows Naturally Infected.

Tuberculin.		No.	4.6.12						Rise of temp. from time of inject.
			Inj.	3	6	9	12	15	
Third test.	4 cc. avian	6	102'6	103	102'8	102'2	101'8	101'4	'4
	2 cc. human	11	101'8	103	103'8	102	102	101'6	2
	do.	19	102'2	103'8	104'4	103'8	104	103'8	2'2
	do.	25	101'8	103	105'2	105	102'8	103'6	3'4
	do.	59	101'4	102'8	105'8	104'6	104'6	104	4'4
Second test.	4 cc. avian	10	101'8	104	103'4	102	101'2	101'6	2'4
	do.	37	101'2	102'8	103	101'6	101	101	1'8
	2 cc. human	39	102'4	102'6	104'4	103'6	104	103'2	2
	4 cc. avian	42	102'4	103'4	103	101'4	101'6	101	1
	2 cc. human	44	101'8	103'2	104'2	104	103'2	102'4	2'4
	do.	17	102'4	103'6	105	104'6	104'4	104	2'6
	do.	18	102	103	105	104'2	105'2	103	3'2
	do.	22	101'4	102'2	103	100'8	102'2	102'2	1'6
	do.	23	102'2	104	104'6	103'8	105	103	2'8
	do.	47	102	102'2	104'8	103	103	103'4	2'8
	do.	50	103	104	105'8	105	104	103'2	2'8
	do.	54	102'2	103'2	105	103'6	104	102'6	2'8
	do.	57	101'6	104	105	104'8	105'8	105'6	4'2
	do.	58	104'6	105'4	106'6	104'4	104'4	104	2
	3 cc. human	A.	100'4	102'4	104'2	104'6	104	102	4'2
	do.	B.W.	101'2	102'6	103'6	104	103	103	2'8

TABLE XIX.

Third and Fourth Tests after Inoculation with Bovine Bacilli. Human Tuberculin, dose 3 cc.

No.		19.7.12						Rise of temp. from time of inject.	Rise of temp. from max. of previous day.
		Inj.	3	6	9	12	15		
Fourth test.	6	102'2	101'6	102'8	103'6	103	102'6	1'4	1'6
	11	101'2	100'8	102	102'8	104	101	2'8	2
	19	101'8	102	103'8	104'6	103	102'4	2'8	2
	25	101	101'6	102	102'8	101'6	105	4	4
	59	101'4	103'2	105	105	105	104	3'6	2'6
Third test.	10	102'4	101'4	102	103'2	103	103'4	1	1'8
	37	100'8	101'4	103'4	104'2	103'4	103'2	3'4	2
	39	102'2	101'6	103'4	104	103'6	103'6	1'8	2'4
	42	102	101	101'8	104	103'6	103'6	2	2'8
	44	101'8	101	102	102'4	102'6	103'8	2	2
	17	102'4	101'4	102'6	104	103'2	102'6	1'6	2'4
	18	102'2	101	101'8	102'4	103'2	103'8	1'6	1'8
	22	102'2	101'4	103	103'8	103'4	103'2	1'6	2'2
	23	101'8	101'4	103	104	104'6	104'8	3	2'4
	47	101'8	101'4	102'8	103'4	103	104	2'2	2'4
	50	102'4	102'4	104	104'8	104	103'6	2'4	2'2
	54	102	101'4	103'4	105	103'8	103	3	3'2
	57	102	101	103'8	105'4	104'6	105'6	3'6	3'8

TABLE XX.

*First Test (14.8.12) after Inoculation with Bovine Bacilli.
Human Tuberculin, dose 3 cc.*

Inoculations.		No. 13.8.12		14.8.12						Rise of temp. from time of inject.	Rise of temp. from previous day.
Human or avian. 25.11.11 and 19.1.12	Bovine. 20.7.12			Inj.	3	6	9	12	15		
Not infected do.	20 mg. bovine	28	101'5	100'7	100'8	107'4	107'3	106'8	105'7	6'7	5'9
Human, twice do.	40 mg. bovine	29	102'5	102'7	102'2	106'5	106'4	105'8	105	3'8	4
	20 mg. bovine	38	101'6	101'4	103'5	104'2	104'3	103	101'9	2'9	2'7
Avian, twice do.	40 mg. bovine	41	101'8	101'4	100'5	102'5	104'8	105'4	104'5	4	3'6
	20 mg. bovine	21	101'1	101'5	103'5	106'7	107	106'5	105'8	5'5	5'9
	do.	48	101'2	101'5	101'5	104'5	106'3	106	106	4'8	5'1
	40 mg. bovine	53	101'5	102'2	101'6	104	107	105'4	105'1	4'8	5'5
do.	50 mg. bovine	55	101'2	100'8	101'5	105	106'9	105'5	105'3	6'1	5'7

TABLE XXI.

Second Test after Inoculation with Bovine Bacilli, except the last Animal, which was a Healthy Cow. Human Tuberculin, dose 3 cc.

No.	24.9.12	25.9.12						Rise of temp. from time of inject.	Rise of temp. from previous day.
	4 P.M.	Inj.	3	6	9	12	15		
28	102	101'6	101'5	104'6	105'4	106	104'2	3'8	3'4
29	103	102'2	102	105	106'4	106	105'4	4'2	3'4
38	102'4	101'8	101'4	104'6	104'6	104	102'6	2'8	2'2
41	102'4	102	101'8	104	105'2	105	104'6	3'2	2'8
21	101'8	101'8	102	104'6	107	106'9	105'6	5'2	5'2
48	102	102	102	104'2	106'6	106	104'8	4'6	4'6
53	102'4	101	102'3	104'6	106'5	106'5	105'4	5'5	4'1
55	102'2	101'4	102	103'2	106'8	105'4	103'6	5'4	4'6
J	101'6	101'4	100'4	101'4	102	101	100	6	4

TABLE XXII.

Third Test after Inoculation with Bovine Bacilli.

Tuberculin. 30.9.12	No.	29.9.12	30.9.12						Rise of temp. from time of inject.	Rise of temp. from previous day.
			Inj.	3	6	9	12	15		
8 cc. avian	28	101'4	101'8	101'2	102'5	103'3	102	101'4	1'5	1'9
3 cc. human	29	101'6	101'8	101'4	104'5	105	103'2	102'8	3'2	3'4
do.	38	101'4	101'5	101'6	102'3	103'8	102'5	102'2	2'3	2'4
8 cc. avian	41	101'4	102'2	102'1	102'1	103	102'6	102	'8	1'6
do.	21	102	101'3	101'2	103'5	105'4	105'2	104'2	4'1	3'4
do.	48	102	101'9	101'4	102'8	104	102	102	2'1	2
3 cc. human	53	101'8	101'7	101'4	103'3	104'8	103'6	102	3'1	3
do.	55	102	101'2	101'6	102	103'2	102'7	102'4	2	1'2

TABLE XXIII.

*Comparative Tests with Human and Bovine Tuberculin of Animals
Inoculated with Bovine Bacilli.*

Tuberculin. 22.11.12	No.	22.11.12						Rise of temp. from time of inject.
		Inj.	3	6	9	12	15	
Bovine 3 cc.	10	101'8	101'8	104	105	104'2	104	3'2
do.	11	101'4	101'4	102'1	103'2	102'4	102	1'8
do.	18	102'2	102'4	104'2	106'5	107	105	4'8
do.	21	101'4	103'3	106	107	106	105'2	5'6
do.	30	101'4	101'6	104'1	105'5	105	102'6	4'1
do.	37	101'4	102'1	104	105'8	104	102'2	4'4
do.	44	101'2	101'7	102'7	104'5	103'8	103'4	3'3
do.	47	101'4	101'4	104'3	106'2	105	103'6	4'8
do.	52	102	102	102'8	103'8	104'4	104'3	2'4
Human 3 cc.	17	101'8	103	104'6	105'8	103'3	103'2	4
do.	22	101'6	101'2	102	103'8	102'2	102	2'2
do.	32	102'2	102	104'1	106'8	105'2	104	4'6
do.	41	102'2	101'8	103'6	105'6	104	104	3'4
do.	50	102'2	103'8	105'4	107'4	105'4	104	5'2
do.	57	101'6	101'4	104'2	107'1	106'2	106	5'5

TABLE XXIV.

*First Test (2.7.13) after Inoculation with Bovine Bacilli (21.6.13).
Human Tuberculin, dose 2 cc.*

No.	1.7.13		2.7.13						Rise of temp. from time of inject.	Rise of temp. from max. of previous day.
	A.M.	P.M.	Inj.	3	6	9	12	15		
61	101.8	103	102.2	102.2	104.6	105.8	104.8	103.4	3.6	2.8
62	101.6	102.6	102.2	102.4	105.2	107.2	105.8	104	5	4.6
63	101.6	103.6	103.6	102.6	104.2	104.8	104	103.6	1.2	1.2
64	101.4	102	101.6	102	103.8	104.8	105	103.4	3.4	3
65	101	102.6	102	101.8	104.2	105.6	104.8	103.1	3.6	3
71	102.2	103.8	103	104.8	104.4	104.6	105	104.2	2	1.2
72	103	103.6	102.8	104.8	106.6	106.8	105.8	104.6	4	3.2
73	101.6	104	102.6	103.6	104.8	105.8	105.4	104.4	3.2	1.8
74	102.2	102.4	102	103.2	104	105.6	105.2	105	3.6	3.2
75	101.8	104	104.8	104.2	105.8	105.8	105.4	104.4	1	1.8
82	103.8	106	105	105.6	106.6	107	106.6	106	2	1
83	105.2	104.6	103	104.2	107.2	106	105.4	104	4.2	2

TABLE XXV.

Second Test after Inoculation with Bovine Bacilli, except 84 and 85, which were Healthy Controls. Human Tuberculin, dose 2 cc.

No.	16.7.13		17.7.13						Rise of temp. from time of inject.	Rise of temp. from max. of previous day.
	A.M.	P.M.	Inj.	3	6	9	12	15		
61	102	102.4	101.6	105	104	105.2	104.6	103.2	3.6	2.8
62	101.6	101.4	101.8	103.9	104	105	104.2	102.6	3.2	3.4
63	102	102.4	102.4	104.8	103.6	105	104.6	102.8	2.6	2.6
64	102.4	102	100.8	104.1	103.2	104.3	104.4	102.4	3.6	2
71	103	103.4	102	104	103.2	105	105	105.6	3.6	2.2
72	102	103	102.4	104.2	103.4	105.3	105	104	2.9	2.3
73	101.2	102.2	100.8	104	103	105.3	104.6	104	4.5	3.1
74	101.4	102	102.4	104.8	102.6	105	104.6	103.6	2.6	3
82	105	105	105.2	106	106.8	106.2	105.6	106	1.6	1.8
83	103.6	105	104.4	105.5	106.4	106.2	106.4	105	2	1.4
84	100	102.6	102.4	104.6	102.2	103.2	103	103.4	2.2	2
85	101.4	101.8	103	104.2	102	103.1	103.6	102.8	1.2	2.4

TABLE XXVI.

*Third Test after Inoculation with Bovine Bacilli.
Human Tuberculin, dose 2 cc.*

No.	7.8.13	8.8.13						Rise of temp. from time of inject.	Rise of temp. from previous day.
		Inj.	3	6	9	12	15		
61	101	103'4	105'4	102'8	105	104'6	103'8	2	4'4
62	101	102	103'2	101'6	104	103'6	102'8	2	3
65	101'2	101'8	104'4	103'4	105'4	104'2	102'6	3'6	4'2
71	101'8	102'6	104	103'2	104'2	103'4	102'6	1'6	2'2
72	101'2	102	103'6	102	105	104'6	103'8	3	3'8
75	101'4	102	103'6	101'6	103'2	104	102'8	2	2'6

TABLE XXVII.

*First Test (8.8.13) after Inoculation with Bovine Bacilli (28.7.13).
Human Tuberculin, dose 2 cc.*

No.	7.8.13	8.8.13						Rise of temp. from time of inject.	Rise of temp. from previous day.
		Inj.	3	6	9	12	15		
66	101	101'2	103'6	103'4	105'4	104'6	103	4'2	4'4
67	102'2	102'2	105'4	104'4	107	105'8	104'6	4'8	4'8
70	101	102	104'2	101'8	105	105	105	3	4
77	101'4	101'8	104	103'4	105	104'6	103'6	3'2	3'6
78	101'8	102'2	105'4	105	106'4	104'8	104'4	4'2	4'6
85	103	101'2	103	104'4	104'6	105	105'4	3'8	2

TABLE XXVIII.

First and Second Tests (26.8.13) after Inoculation with Bovine Bacilli (28.7.13). Human Tuberculin, dose 2 cc.

	No.	25.8.13	26.8.13						Rise of temp. from time of inject.	Rise of temp. from previous day.
			Inj.	3	6	9	12	15		
Second Test	66	101'6	101	103'2	102'4	103'8	104	103	3	2'4
do.	67	101'8	101'4	103'6	103'2	106'4	105'4	103	5	4'6
do.	70	101'4	102'8	104'5	103'2	104'2	104'4	103'6	1'7	3'1
do.	77	101'4	103'2	105	104'8	105'4	105'2	103'8	2'2	3'6
do.	78	102	102	103'4	103'2	105	104'4	103'4	3	3
do.	85	102'6	102'6	102'8	102'8	104'4	104	104	1'8	1'8
First test	68	102'2	102'2	102'6	103'8	106'6	105	103'8	4'4	4'4
do.	69	101'2	102'2	103'2	102'8	104'6	105	103'8	2'8	3'8
do.	79	102'2	102'8	105	104	105'4	104'6	103'8	2'6	3'2
do.	80	102'6	102'4	104	103'4	106'6	105	103'6	4'2	4
do.	84	102'4	102'4	104'2	104'8	106'8	106'6	104'4	4'4	4'4

TABLE XXIX.

Second Test after Inoculation with Bovine Bacilli. Human Tuberculin, dose 3 cc.

No.	1.10.13	2.10.13						Rise of temp. from time of inject.	Rise of temp. from previous day.
		Inj.	3	6	9	12	15		
68	101'8	102'4	101'6	104'2	106	105'4	104'4	3'6	4'2
69	102'2	102	101'6	102	102'2	103'6	102'6	1'6	1'4
70	102	102'6	101'6	103	103'4	104'6	103'6	2	2'6
79	102'6	103	102	104'6	105	105'6	103'6	2'6	3
80	101	102'6	101'6	105	105'8	104'8	104'8	3'2	4'8
84	102'6	102	102'4	104	105	104'6	103'6	3	2'4

TABLE XXX.

*Various Tests after Inoculation with Bovine Bacilli (21.6.13).
Human Tuberculin, dose 3 cc.*

Previous inoculations. 20.2.13	Tuberculin. 2.10.13	No.	1.10.13	2.10.13						Rise of temp. from time of inject.	Rise of temp. from previous day.
				Inj.	3	6	9	12	15		
Human	3 cc. human	63	100'8	102'4	101'2	103'2	104	104'2	103'6	1'8	3'4
do.	do.	64	101'8	103	101'6	103'4	104'4	105	103'6	2	3'2
do.	do.	65	101'2	102'4	101'6	105'6	105	104	104	3'2	4'4
Avian	do.	73	101'4	103	99	101'6	102'4	103'8	103'4	'8	2'4
do.	do.	74	102'4	103'6	103'2	105'2	104'4	105	104	1'6	2'8
do.	do.	75	102	103	101'8	103'6	104'8	105	104'4	2	3