

## **Tuberculosis in Man, an Animal Health Problem.**

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KOCH who discovered the tubercle bacillus in 1882, is reported to have stated at the British Congress for Tuberculosis in London in 1901, that man is not susceptible to the bovine type of organism. McFadyean opposed Koch at this Congress since he was not satisfied that the evidence at Koch's disposal justified his conclusions.

Ravenel who also opposed Koch at that Congress was, according to Hull (1930) the first author to show that the bovine type of tubercle bacillus is pathogenic for man. Today it is generally accepted that the bovine type of organism can produce even open pulmonary lesions in man. The figures quoted by Griffith and Munro (1944) of the proportional frequency of human pulmonary tuberculosis due to bovine infections in Scotland and England, are: Orkney Islands 25·8 per cent.; the rural districts of the mainland of north-east Scotland 9·1 per cent.; the rest of Scotland 5·2 per cent.; the city of Aberdeen 4·4 per cent.; the north and middle regions of England 2·0 per cent.; the southern part of England 0·6 per cent.

Hedvall (1941) discussed very fully some 67 cases of bovine tuberculosis in man, giving also the source of infection where possible.

Bovine tuberculosis is, therefore, undoubtedly a public health problem, but in this paper it is intended to emphasize the exact opposite, that is that human tuberculosis is an animal health problem. Since the available evidence concerns the bovine only, it is not intended to discuss man as a source of tuberculosis, for the dog, pig, bird or horse.

As man may have open lesions of tuberculosis as a result of infection with the human type of tubercle bacillus as well as with that of the bovine type, he could by contact infect bovines with either of these two organisms, if the bovine is susceptible to both.

Stenius (1938) states "wherever macroscopic tuberculosis lesions are found in slaughtered cattle it may be considered unlikely that the human type infection is concerned. Human type infection never causes typical tuberculosis lesions in cattle under natural conditions, the animals never become clinically tuberculous. This does not hold good for laboratory experiments".

He states further that originally (1899) when testing the herds in Finland the percentage reactors was found to be 10 per cent. In 1910 the intradermal test was used and after 20 years of intensive control work, the percentage reactors was 4 per cent., but in very few of these reactors, was there any evidence of lesions of tuberculosis. Using apparently normal lymphatic glands from such reactors, for biological test, it was shown that the sensitization, was due to the human type of organism. He showed further that soon after tuberculous attendants regularly handled calves free from tuberculosis, positive reactions to the tuberculin test appear and when such attendants are removed, the animals will sooner or later again give negative reactions. The author further considers that the subcutaneous test is inclined to be negative in the case of human and avian type infections.

Hillemark (1946) on the other hand isolated the human type of organism from 12 bovines. In seven (five cows and two calves) no lesions were seen but the organisms were isolated culturally and biologically. In five the human organisms were isolated from lesions in the lung and various lymphatic glands. Humans with open lesions, looking after the animals were thought to be the source of infection.

Turning now to cases of humans who were responsible for the direct transmission of infection with the bovine type of organism to cattle, some interesting reports are published.

Tice (1944) found reactor calves in a clean herd (1929). Infection appeared to be due to milk from an untested herd. When testing this herd for the first time, 100 per cent. infection was established. The whole herd was slaughtered, stables cleaned and disinfected. Apparently the new herd was then tested from time to time with negative results, until 1942, when five reactors were found in testing 24 animals. Within three months the remaining animals also reacted positively. These animals were all destroyed and within the year another herd of 12 animals was introduced. It is not quite clear what length of time elapsed between the actual introduction of the clean herd and the first test in October 1942, when two reactors were found, but within five months after the test in October 1942 every single animal in the herd reacted positively. Further clean animals were introduced, but these, one and all reacted positively within six months after introduction.

The owner had been a patient in a tuberculosis sanatorium in 1942. When the organisms from his own sputum and those obtained from the lesions of the animals were typed, they were found to be of the bovine type.

The author believes that the owner became infected from his original herd in 1929; some years later he developed open lesions and then within a short period of time, infected three successive herds.

Waldike Nielsen and Plum (1940) give a description of 17 herds which were free from tuberculosis and which became infected by humans with open pulmonary tuberculosis due to the bovine type of organism. The 17 herds contained 632 head of cattle and 384 of these gave positive tuberculin reactions. They recount with monotonous regularity, the sudden appearance of positive tuberculin reactors in a herd which was previously giving consistently negative reactions and in nearly all cases they were eventually able to trace a human attendant or owner with tubercle bacilli of the bovine type in the sputum.

Magnusson (1941) also discusses some cases of both the human and bovine types of infection in man, transmitted to cattle.

Plum (1946) mentions a case where an apparently healthy milker infected 90 head of cattle with the bovine type of organism and states that on farms with a very high incidence of bovine tuberculosis in cattle, it was found that four to five times the number of children reacted to the tuberculin test, than is the case on farms where tuberculosis in cattle is not really present. He also mentions a case where a person, who apparently had an open tuberculous lesion of the hand, infected a cow, whilst assisting this animal in the delivery of a calf.

#### TUBERCULOSIS IN THE ONDERSTEEPOORT HERD.

Briefly, the history of this herd is:—

The last test carried out on the herd, previous to 1940, was in 1938. A few cases were then found in two camps.

In 1940 16 positive cases and six doubtful reactors were found out of 178 bovines at Onderstepoort and one positive and one doubtful reactor out of 502 bovines on the adjoining farm Kaalplaas.

Positive and doubtful reactors were all slaughtered. Of the 16 positives at Onderstepoort, 13 showed extensive lesions, some generalized, and in three no lesions were observed.

The one positive at Kaalplaas had small lesions in the bronchial and mediastinal glands and no lesions were observed in the doubtful reactor. This one positive animal out of 502 animals, was undoubtedly infected at Onderstepoort, as it was transferred to Kaalplaas a month before the test.

Three months later the Onderstepoort animals, 183 in number were again tested. One was positive and another a doubtful reactor—both were slaughtered and both showed lesions. Subsequently only one further case was encountered but after that the animals all tested negatively and no further cases of tuberculosis were encountered until, during the course of 1949, two bovines in a nutrition experiment were slaughtered. They had both given negative tuberculin tests within the previous year. Small lesions were found in the mediastinal glands of each. Acid fast organisms were identified in smears made from the lesions. This was a most unexpected observation and the possibility that the infection had a human source was immediately considered. Unfortunately the organisms found in these lesions were lost when an attempt was made to type them. The humans who had close contact with these animals were two Europeans and a native attendant. All three complained of coughing, two appeared to be under weight and the third, in a good state of nutrition, complained of an irritating cough as well as sweating at night. These symptoms were so suspicious that all three were sent to hospital for X-ray examination with, however, completely negative results.

At the annual test in July 1949 an alarming state of affairs was revealed when 10 positives and a number of doubtful reactors were found.

*Details of the Annual Test 19/7/49—22/7/49.*

224 Bovines were tested with the double intradermal test. Of these 10 gave positive reactions and 11 doubtful reactions.

The positives were: 7191, 7937, 9047, 32, 1095, 1442 [donors of blood for the gallsickness (anaplasmosis) vaccine]; 2593 (3 days stiffness experiment); 2636 (bull, carrying the recessive porphyrin gene); 2641, 2748 (nutrition experiment).

The doubtful reactors were: 4168 (Jersey cow under observation); 2942, 2943 (East Coast fever experiment); 2050 (lumpy skin disease experiment); 2413, 2354, 2511 (contagious abortion experiment); 2246 (nutrition experiment); 2606, 2882, 2947 (private cows).

The positives were all slaughtered and lesions of tuberculosis were found in six (7937, 9047, 32, 1095, 1442, 2593); actinomycosis but no tuberculosis in one (7191) and no lesions at all in three (2636, 2641, 2748).

Four of the doubtful reactors (2942, 2943, 2413 and 2050) were slaughtered. Only one of these (2413) showed lesions of tuberculosis, but before slaughter, was declared positive with the short thermal tuberculin check test (Gregory) and 2050 was declared negative with the same test. The other two, 2942 and 2943 were not subjected to this check test.



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Jersey cow 4168 died from natural anthrax infection and no post mortem examination was made.

The remaining six doubtful reactors were subsequently declared negative and were not slaughtered.

Ten days after the double intradermal test, seven animals (six positive Nos. 7191, 7937, 9047, 32, 1095, 1442 and one retest 4168) were subjected to the ordinary subcutaneous test. Three cubic centimetres of tuberculin were injected at 9 p.m. on 2.8.49 and from the 9th hour (6 a.m.) on 3.8.49, the temperatures were taken every 3 hours until 9 p.m. on 3.8.49. Details of this test together with the full history, lesions, etc., of each animal, will be presented below.

*Details of the Macroscopic and Microscopic Changes Recorded in the Case of the Individual Animals Slaughtered with the Complete History of Each Animal.*

In presenting details of the tests and of the macroscopic and microscopic examination carried out, these animals will be dealt with in 3 groups.

*Group 1.*—Comprises animals 7191, 7937, 9047, 32, 1095, 1442 and 2593. These animals were kept in strict isolation in the group of gallsickness stables and were used as donors of blood for the gallsickness vaccine. They never came into contact with any other cattle or other animals, except humans who fed and handled them.

*Group 2.*—Comprises one animal No. 2413. It is one of a group in contagious abortion experiments. This animal was housed in at least 6 different paddocks and was, therefore, in contact with other Onderstepoort cattle, but since 4.5.1949, i.e. about 2½ months before it gave a positive test, was housed in a paddock in which tuberculous bovines were kept until August 1947.

*Group 3.*—Comprises animals 2636, 2641 and 2748. They had from time to time been in contact with other cattle. No lesions were present in these animals.

*Group 1.*

*Bovine 7191.*—Born at Onderstepoort on 10.6.36 and on the same day transferred to the gallsickness group of isolation stables. Since 1937 this animal had been bled to produce gallsickness vaccine. It was tested regularly since 1936. Details of a few of the tests are given below:—

BOVINE 7191.

| Date.         | 0 Hours. | 48 Hours. | 72 Hours. | Result.   |
|---------------|----------|-----------|-----------|-----------|
| 16.11.36..... | 5        | n.n.      | —         | Negative. |
| 4. 8.37.....  | 4        | 5         | 6         | Negative. |
| 21. 5.40..... | 8        | 9         | n.n.      | Negative. |
| 30. 8.40..... | 9·3      | 8·7       | n.n.      | Negative. |
| 18. 6.41..... | 9·8      | 18·2      | 20·5      | Retest.   |
| 26. 5.42..... | 9·4      | 8·8       | n.n.      | Negative. |
| 3. 7.43.....  | 10·8     | n.n.      | —         | Negative. |
| 10. 2.48..... | 8·5      | 9·0       | n.n.      | Negative. |
| 19. 7.49..... | 11·0     | 19·0      | 25        | Positive. |

n.n.=No nodule.



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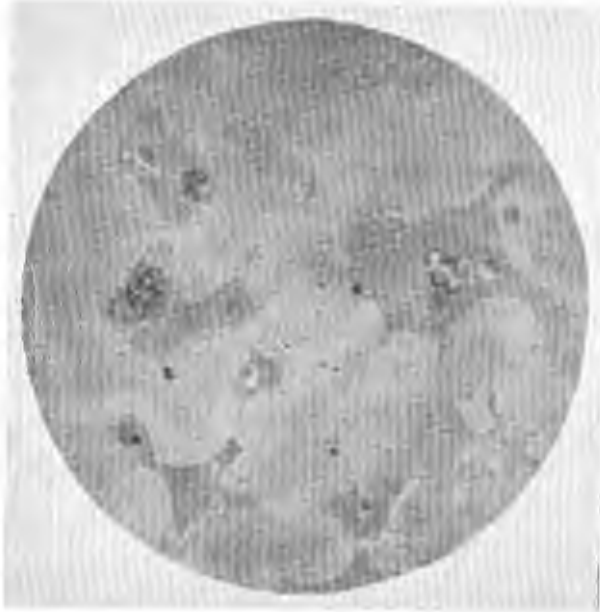


FIG. 1.—Bovine 7191. Positive intradermal as well as subcutaneous tuberculin test, but showing only lesions of actinomycosis in the lymphatic gland.



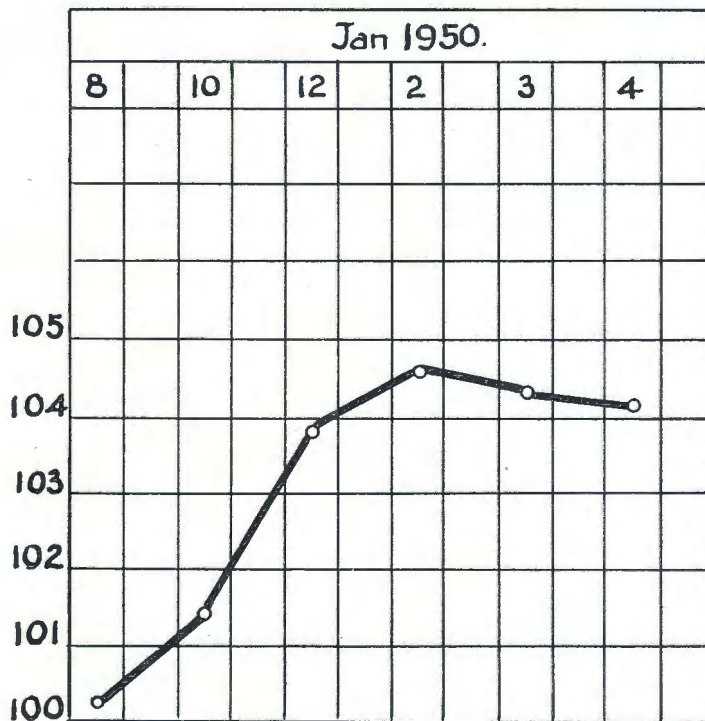
FIG. 2.—Bovine 7191. Lymphatic gland with actinomycosis.

Here, then, was an animal which had shown an undoubted positive intradermal reaction and an undoubted positive subcutaneous tuberculin test, in which actinomycosis was certainly present, but in which no evidence of tuberculosis could be found. (Direct smear examination, histologically and biologically).

Unless organisms of the human type were responsible for the sensitization to the tuberculin or the lesions were so small that they were missed at the very careful post mortem examination, one must conclude that actinomycosis sometimes may sensitize animals to tuberculin. Further confirmatory evidence of this conclusion was obtained when dealing with another animal, 4162, in the Onderstepoort herd.

This animal was transferred from an agricultural college to Onderstepoort, for mastitis work. In October, 1949, she gave a negative double intradermal test. When tested three months later, she gave a doubtful intradermal test. The short thermal tuberculin test as described by Gregory (1949) was then applied and a typically positive reaction was obtained, the temperature rising to 104.6 at the 6th hour. (See temperature chart below.)

TEMPERATURE CHART. BOVINE 4162.



The animal was slaughtered; soft pus was present in the cheek muscles on the left side, and both mandibular glands contained pus. Actinomycosis was established but no acid and alcohol fast organisms could be recognized on direct smear examination.

Histological examination of the mandibular glands showed typical lesions of actinomycosis, but no lesions of tuberculosis.



If it is true that actinomycosis may sometimes produce sensitization towards tuberculin, then there is possibly a relationship between the products of the tubercle bacillus and those of actinomycosis. We know that streptomycin is being used as a curative remedy for tuberculosis and although this substance is not made from the organisms which cause actinomycosis it is nevertheless made from a related organism.

In the case of some of these problem reactors, it may be useful to prescribe treatment with iodides as well as penicillin, during the retest period, when in the absence of tuberculosis, the animals may give a negative test, when the actinomycosis infection had been successfully treated.

*Bovine 7937.*—Born on 1.6.39 at Onderstepoort and since birth was kept in strict isolation in the group of gallsickness isolation stables.

Details of the double intradermal test carried out on this animal are:—

## BOVINE 7937.

| Date.                       | 0 Hours. | 48 Hours. | 72 Hours. | Result.   |
|-----------------------------|----------|-----------|-----------|-----------|
| 21. 5.40.....               | 11·0     | 11·0      | —         | Negative. |
| 30. 8.40.....               | 13·0     | 12·0      | 14·6      | Negative. |
| 18. 6.41.....               | 10·5     | 13·6      | 16·2      | Negative. |
| 26. 5.42.....               | 10·9     | 10·3      | —         | Negative. |
| 3. 7.43.....                | 9·7      | n.n.      | —         | Negative. |
| 4. 7.44.....                | 8·8      | n.n.      | —         | Negative. |
| 10. 2.48.....               | 9·0      | 9·0       | —         | Negative. |
| 19. 7.49... (Shoulder)..... | 9·0      | 15·0      | 16·0      | Positive. |
| (Neck).....                 | 7·5      | 27·0      | 36·0      | Positive. |

n.n.=No nodule.

The measurements 9:15:16 for the test on the 19.7.49 were obtained when for some reason or other the tuberculin was injected behind the shoulder. On examining the reaction at the 48th hour, there was a diffuse thickening but no well-defined swelling. At this stage it was decided to make an additional injection of the tuberculin into the skin at the side of the neck where in due course a typical positive reaction appeared. The reaction alongside of the neck was much easier to interpret than the one behind the shoulder.

The subcutaneous test (10 days after intradermal) was inconclusive. See temperature chart below.

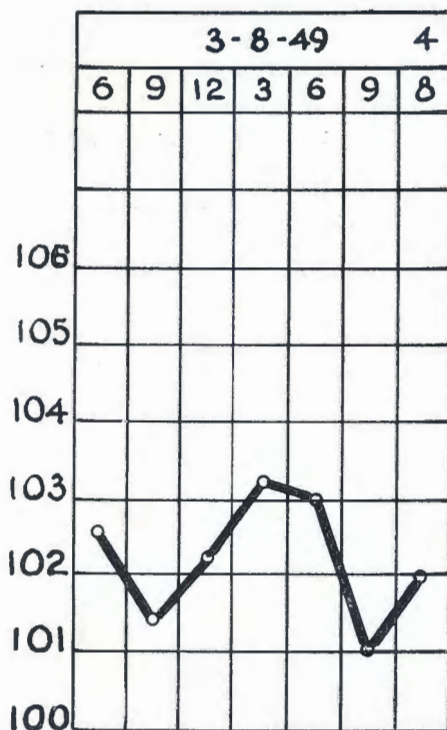
Just about a week after the subcutaneous test the single intradermal test using P.P.D. tuberculin was applied, injecting the tuberculin on the right side of the neck, whereas all previous injections were made on the left side. There was slight diffuse thickening of the skin. This inconclusive reaction was considered to be due to desensitization as a result of the subcutaneous test.

The animal was slaughtered on the 8.8.49. The only lesions like those of tuberculosis were found in the mediastinal lymphatic gland. This gland was only slightly enlarged. Small lesions with caseation and calcification were present. Alcohol and acid fast organisms were present in smears made from the lesion. Histologically there were typical lesions of tuberculosis with caseation and calcification—epithelioid and Langhans' giant cells. No other lesions were found except that the prescapular gland showed, on section, a circumscribed area, resembling



a tumour macroscopically. Histologically the gland showed lymphoid hyperplasia, but a tumour could not be diagnosed with confidence. There was, however, in addition a certain amount of tissue reaction, with a fair number of neutrophiles, increased eosinophiles and even infiltration with plasma cells.

TEMPERATURE CHART. BOVINE 7937.



An attempt was made to type the organisms but the strain was unfortunately lost during the course of this work.

*Bovine 9047.*—Born on 15.11.40 at Onderstepoort and since birth was kept in complete isolation in stables 10-13 as was the case with 7937. The animal was regularly used as a donor for the gallsickness vaccine.

Details of the recorded tests are:—

## BOVINE 9047.

| Date.         | 0 Hours. | 48 Hours. | 72 Hours. | Result.                             |
|---------------|----------|-----------|-----------|-------------------------------------|
| 18. 6.41..... | 12.4     | 11.4      | n.n.      | Negative.                           |
| 26. 5.42..... | 11.8     | 11.0      | n.n.      | Negative.                           |
| 3. 7.43.....  | 10.3     | n.n.      | —         | Negative.                           |
| 4. 7.44.....  | 10.8     | 17.6      | 21.8      | Circumscribed swelling<br>negative. |
| 10. 2.48..... | 9.0      | 10.0      | n.n.      | Negative.                           |
| 19. 7.49..... | 8.6      | 30.0      | 54.0      | Diffuse swelling<br>Positive.       |

n.n.=No nodule.

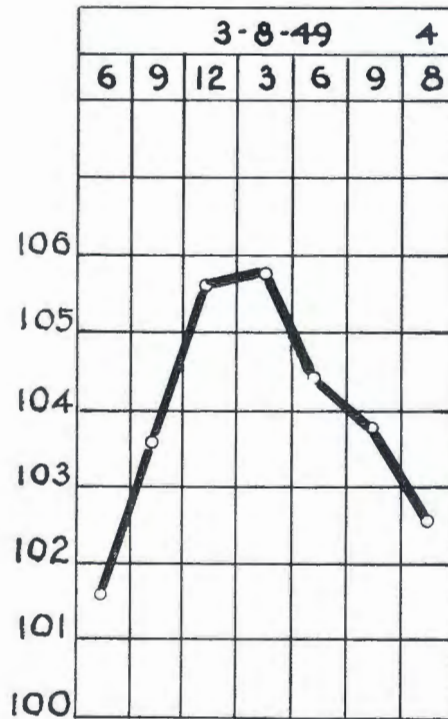
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These animals were all tested annually except during 1947. The tests for 1945 and 1946 were also negative; however, as a result of an oversight they were not recorded in the stockbook and the actual measurements which were made at the time cannot be traced. That the interpretation that the circumscribed swelling which appeared at the 1944 test, was negative, was correct, was confirmed by the completely negative test in 1948.

During the 1949 test, when the animal reacted positively, its temperature rose to 104° F. during the 24 hours after the first intradermal injection.

Ten days after the double intradermal test, the subcutaneous test was applied, giving a typically positive reaction rising to 105·8° F. the 18th hour after injection (see below):—

TEMPERATURE CHART. BOVINE 9047.



The animal was slaughtered on the 11.8.49. Very slight lesions were found in one lung and typical lesions in the bronchial and mediastinal lymphatic glands, with caseation and calcification. Acid and alcohol fast organisms were demonstrated by direct microscopic examination of smears from the lesions.

Two guineapigs were given subcutaneously 1 mg. culture from infected gland material. Generalized lesions developed in the spleen, liver and lungs.

Two rabbits were given intravenously 0·01 mg. culture from infected gland material. The one rabbit died before lesions could develop and in the other lesions generalized in the lungs, kidneys and spleen.

Four mice were given 0.5 mg. of culture also from infected gland material, intraperitoneally. All died and showed tuberculosis in the lungs.

Although the organism was not examined culturally, the results of the biological examination indicate that it was the bovine type.

*Bovine 32.*—Was born at Onderstepoort on the 21.4.41 and had been kept under conditions of strict isolation with the other donors of blood for the gall-sickness vaccine and itself was bled from time to time since 12.10.42. This animal had consistently given completely negative tests until 19.7.49. Details of the tests are:—

## BOVINE 32.

| Date.         | 0 Hours. | 48 Hours. | 72 Hours. | Results.  |
|---------------|----------|-----------|-----------|-----------|
| 18. 6.41..... | 5.5      | 6.8       | 8.0       | Negative. |
| 26. 5.42..... | 8.6      | 7.5       | n.n.      | Negative. |
| 3. 7.43.....  | 9.2      | 9.0       | n.n.      | Negative. |
| 4. 7.44.....  | 7.8      | 8.2       | n.n.      | Negative. |
| 10. 2.48..... | 10.8     | 8.0       | n.n.      | Negative. |
| 19. 7.49..... | 8.5      | 40.0      | 56.0      | Positive. |

n.n.=No nodule.

During the first 24 hours after the first intradermal injection of the positive test on the 19.7.49 the temperature rose to 105° F. and at the 48th hour the temperature was still 103.6° F. Ten days after the intradermal test, the ordinary subcutaneous test was applied when the temperature rose to 106.6° F. at the 15th and 18th hours after injection; see temperature chart below.

*Post Mortem Examination.*—The bronchial and mediastinal glands were markedly enlarged, with caseation and calcification. Acid fast organisms were present in smears made from the lesions. No other lesions of tuberculosis were observed.

*Microscopic Examination.*—The lesions were typical for tuberculosis. There was extensive caseation and calcification was present. In places young tubercles were present.

*Biological Test.*

16.3.50 1 mg. culture injected into 2 guineapigs, subcutaneously.

16.3.50 0.01 mg. culture injected into 2 rabbits, intravenously.

16.3.50 0.5 mg. culture injected into 2 mice, intraperitoneally.

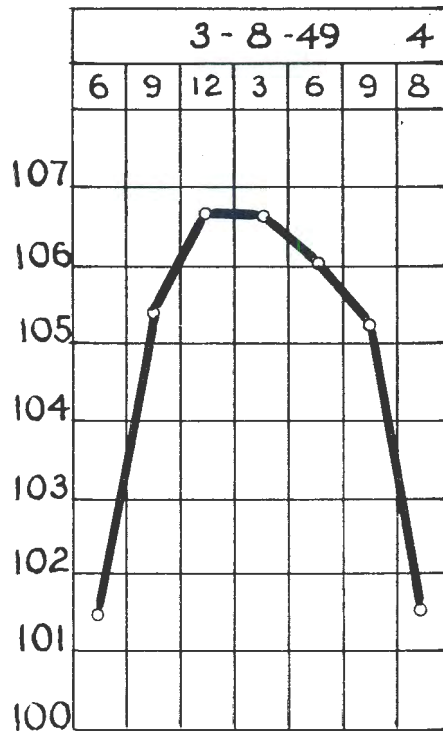
On the 20.4.50 one rabbit died and showed generalized tuberculosis with lesions in the lungs, spleen and kidneys.

On the 24.4.50 the remaining rabbit and the 2 guinea-pigs and 2 mice were destroyed. The rabbit had generalized lesions in the lungs, spleen and kidneys, both guinea-pigs had generalized tuberculosis and both mice had lesions in the lungs. These results indicate that it was the bovine type of organism.



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TEMPERATURE CHART. BOVINE 32.



*Bovine 1095.*—Born on 8.6.43, at Onderstepoort and since birth was kept in complete isolation in stables 10-13. Until it gave a positive test on the 19.7.49, the animal consistently tested negatively. Details of the tests are:—

BOVINE 1095.

| Date.         | 0 Hours. | 48 Hours. | 72 Hours.    | Result.   |
|---------------|----------|-----------|--------------|-----------|
| 3. 7.43.....  | 4.9      | n.n.      | —            | Negative. |
| 4. 7.44.....  | 8.3      | n.n.      | —            | Negative. |
| 10. 2.48..... | 12.0     | 11.5      | —            | Negative. |
| 19. 7.49..... | 9.2      | 50.0      | Too large to | measure.  |

n.n.=No nodule,

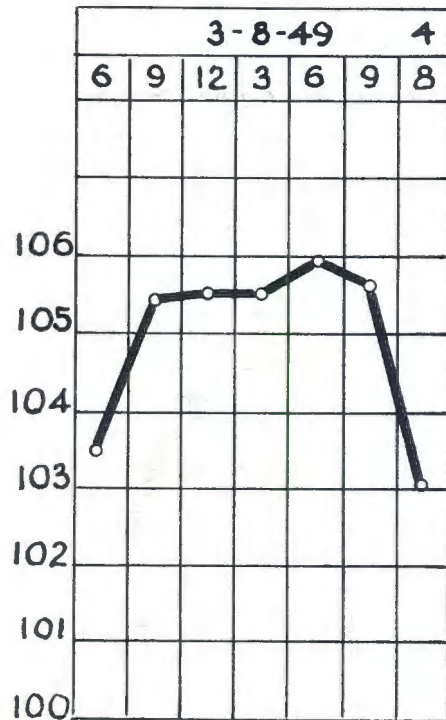
After the second intradermal injection of the positive test on the 19.7.49 the temperature rose from the normal 102.2° F. to 104.4° F. Ten days after the intradermal test the subcutaneous test was applied.

At the 9th hour after injection the temperature had already risen to 103·6° F. and reached its peak at the 21st hour when it was 106° F.

*Post Mortem Examination.*—The animal was slaughtered on the 10.8.49. The mediastinal glands were markedly enlarged. Acid fast organisms were present in smears made from the lesions which were typical for tuberculosis both macro- and microscopically. No other lesions of tuberculosis or of any other disease were observed.

*Biological Test.*—On the 26.4.50 two rabbits, two guinea-pigs and 6 mice were injected in the usual way with cultures of the organisms. Both rabbits died on the 26.5.50, one with severe lesions in the lungs and the other with generalized lesions in the lungs, spleen, liver and kidneys. Both guinea-pigs were destroyed on the 26.5.50 and both showed generalized lesions in the lungs, spleen and liver.

TEMPERATURE CHART. BOVINE 1095.



The 6 mice were also destroyed on the 26.5.50 and all had lesions in the lungs. These results indicate that the organism was of the bovine type.

*Bovine 1442.*—Born at Onderstepoort on 7.6.44. This animal was in isolation with the other gallsickness animals (stables 10-13) until 29.12.48, when it was transferred to a loose box, in Stable No. 3. It was by itself in complete isolation in this loose box. The animal also gave consistently negative reactions to the double intradermal tuberculin test, until it gave a positive test on the 19.7.49.

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The available details of its tests are:—

BOVINE 1442.

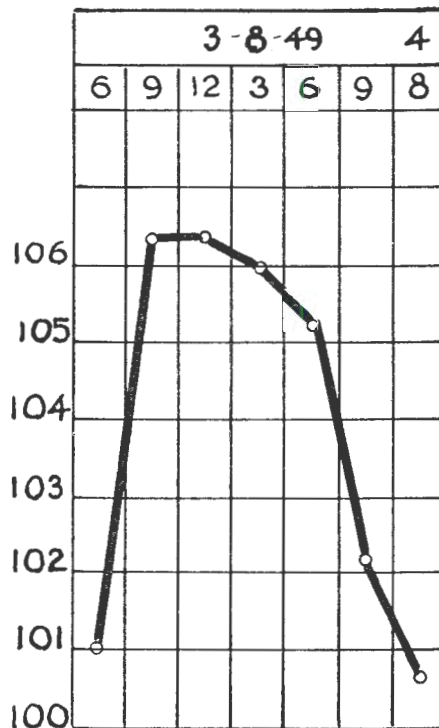
| Date.         | 0 Hours. | 48 Hours. | 72 Hours. | Result.   |
|---------------|----------|-----------|-----------|-----------|
| 4. 7.44.....  | 5.1      | n.n.      | —         | Negative. |
| 10. 2.48..... | 8.0      | 8.5       | —         | Negative. |
| 19. 7.49..... | 5.5      | 27.0      | 36.0      | Positive. |

n.n.=No nodule.

After the first intradermal injection, the temperature rose to 103° F. and after the second injection to 105° F.

About ten days after the intradermal test, the subcutaneous test was applied and the temperature rose to 106.4° F. at the 12th and 15th hour after injection. (See temperature chart below.)

TEMPERATURE CHART. BOVINE 1442.



*Post Mortem Examination.*—The animal was slaughtered on the 10.8.49. There was a small lesion in one lung with caseation and calcification. The bronchial gland was markedly enlarged, showing on section, typical lesions macroscopically, but a certain amount of pus was also present.



*Histological Examination: Lung.*—Some very young tubercles were present consisting of epithelioid cells and Langhans giant cells, without any caseation or calcification (see Figure 4).



FIG. 3.—Lung with open lesions of tuberculosis into bronchus.  $\times 22$ .

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FIG. 4.—Lung showing young lesions of tuberculosis.  $\times 210$ .

In these young lesions (Fig. 4) neutrophils were not infrequent and sometimes they looked like microscopic abscesses when they lay in groups amongst the giant cells.

Some of the smaller bronchi contained exudate (Figure 3); portions of the mucous membrane of this bronchus were completely destroyed (Figures 5, 6 and 7). Under higher magnification (Figure 7) the wall of the bronchus was seen to be involved in typical tuberculous granulation tissue, with epithelioid and giant cells. In places lesions with caseation and calcification were also seen. This was undoubtedly a case of open pulmonary tuberculosis and this animal might have been responsible for transmitting the infection to some of the other animals of this group, which was maintained under very strict conditions of isolation in so far as other cattle were concerned.

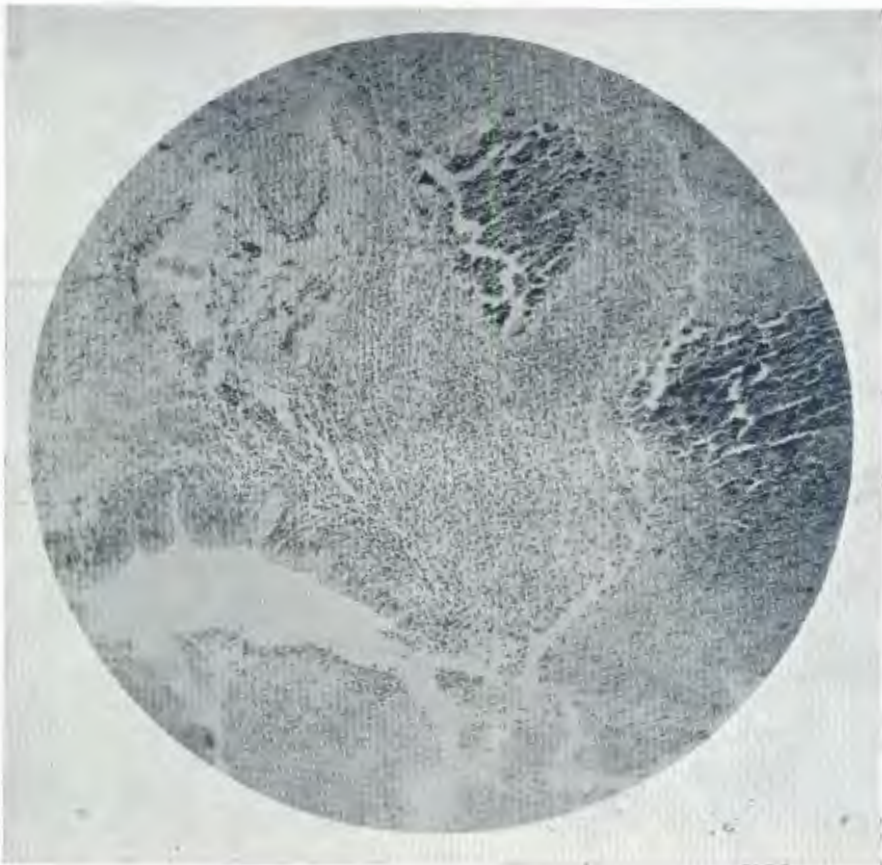


FIG. 5.—Specimen 37679. Bovine 1442. Same as figure 3, higher magnification.  $\times 80$ .



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FIG. 6.—Specimen 37679. Bovine 1442. Lung with open lesions of tuberculosis into bronchus.  $\times 210$ .

The bronchial lymphatic gland showed very extensive lesions with caseation, calcification and typical tuberculous granulation tissue.

*Biological Examination.*—On the 20.4.50 two guinea-pigs, two rabbits and six mice were injected in the usual way. These small animals were all killed on the 3.6.50 i.e. 5 to 6 weeks after injection. The one rabbit had lesions in the lungs and kidneys and the other lesions in the lungs, kidneys, spleen and liver. In both guinea-pigs, there was generalization and all the mice showed lesions in the lungs. The organism was considered to be of the bovine type.

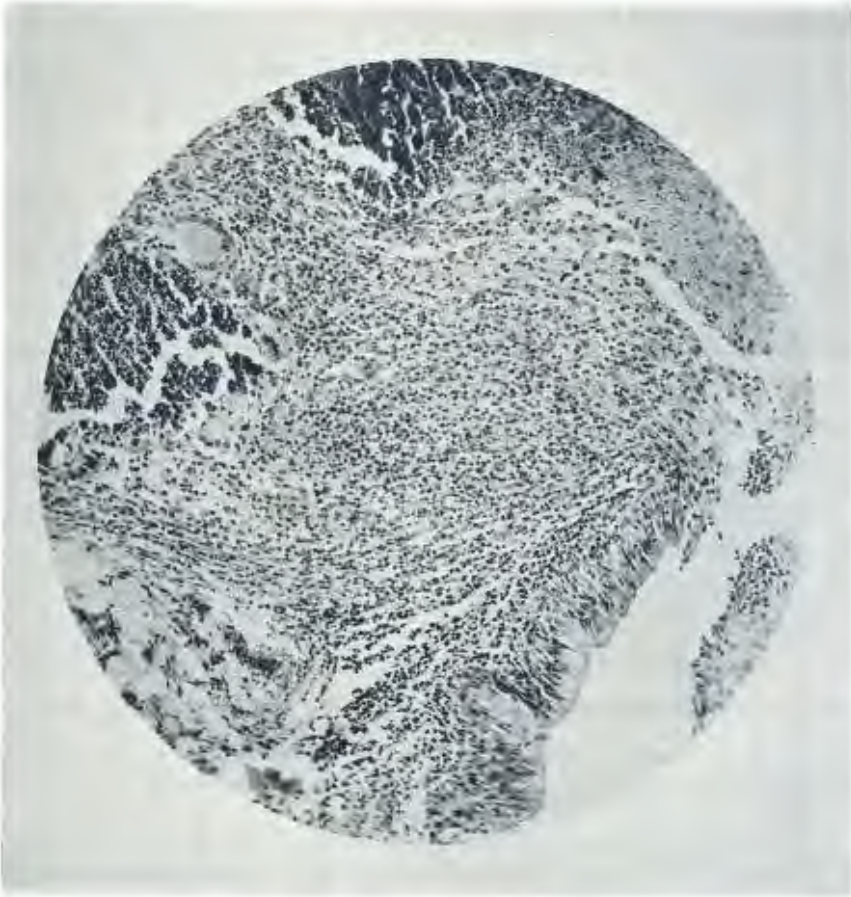


FIG. 7.—Specimen 37679. Bovine 1442. As figures 3 and 5, showing lesions of bronchial mucous membrane.  $\times 210$ .

*Bovine 2593.*—Was born on the 2.4.46 and was also kept in isolation with the other gallsickness animals. On 5.1.49 it was transferred to Stable No. 3, where it was kept in a loose box by itself. On 1.3.49, it was transferred to the lumpy skin disease stable where some other cattle were also kept under experimental conditions. The tuberculin test carried out on this animal at the annual test

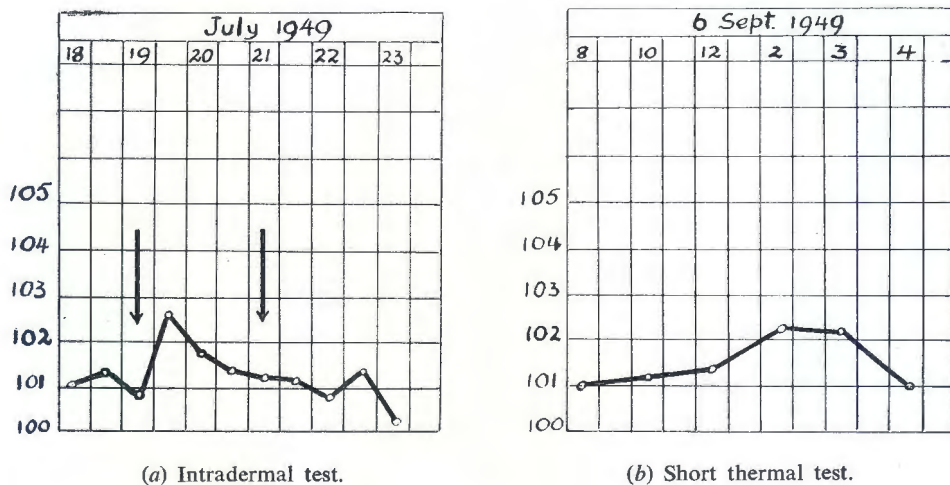
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on 10.2.48 gave these readings: 9.5-8.2-no nodule—negative. With the double intradermal test carried out on the 21.7.49, the readings were: 8.2, 24.0, 55.0. The animal was not slaughtered immediately.

About seven weeks after the double intradermal test the short thermal tuberculin test, as carried out by Gregory (1949), was applied. Four c.c. of the P.P.D. tuberculin were injected subcutaneously and the temperatures were taken every two hours for eight hours. There was a very slight rise in temperature at the 6th and 7th hours of just over 1° F., but clearly not a positive reaction, according to Gregory's directives. This animal was kept constantly in a dark stable and ordinarily showed very little variation in the morning and evening temperatures. Apparently the slight rise which was recorded was not due to the normal variation.

This animal's temperatures were also recorded during the time it was undergoing the intradermal test. These are recorded, with those of the short thermal tuberculin test on the same chart. (See temperature Chart—Bovine 2593 below.)

TEMPERATURE CHART. BOVINE 2593.



A slight rise of just over 1° F. also occurred after the first injection, but no rise was recorded after the 2nd injection.

*Post Mortem Examination.*—The results of this examination were anticipated keenly, since the intradermal test was definitely positive, whereas the short thermal tuberculin test was negative, albeit not as undoubtedly negative as the intradermal test was definitely positive.

Small lesions having the typical appearance of tuberculosis macroscopically, were found in the bronchial lymphatic glands alone. Direct smear examination revealed alcohol and acid fast organisms.

*Histological Examination—Specimen 38096.*—The lesions were typical for tuberculosis. In sections stained with Ziehl-Neelsen tubercle bacilli were present (see Figure 8).



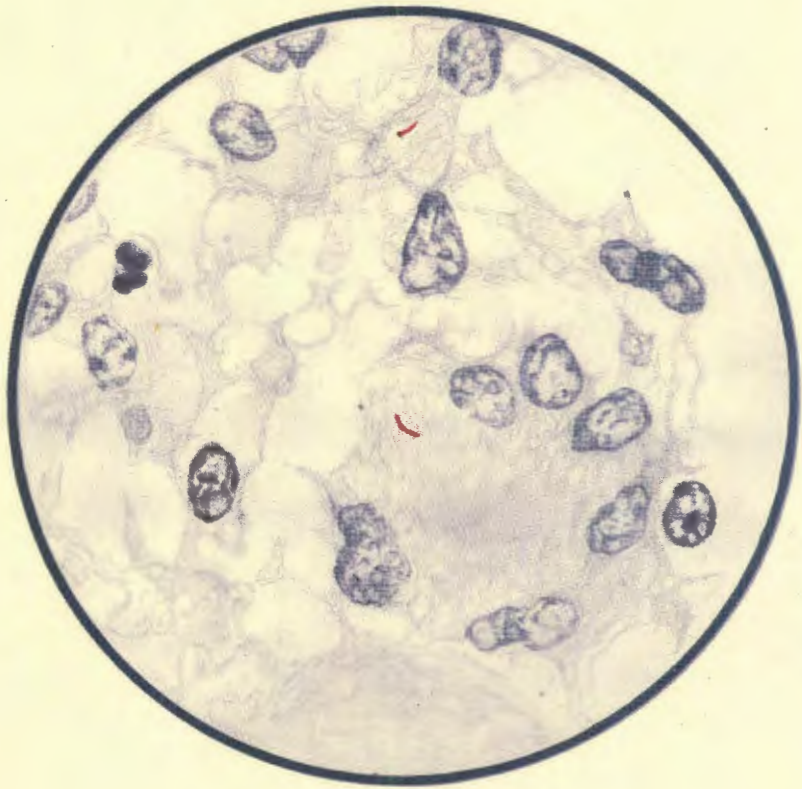


Fig. 8.—Animal 2593. Specimen No. 38096. Tubercle bacilli  
in a giant cell and in an epithelioid cell.



In Figure 8, organisms are seen in a giant cell and in an epithelioid cell in the same field. This must be considered complete proof of the presence of tuberculosis, in spite of the negative short thermal tuberculin test.

*Typing of the Organism.*—The organisms were unfortunately not typed in this particular case.

The question now arises as to why this animal which was so highly sensitive to the intradermal test, showed no or, at the most, only very slight sensitization, to the large dose of concentrated tuberculin seven weeks later. Can the explanation be, that this large amount of concentrated tuberculin, in a highly sensitized animal will have the effect of suppressing the temperature reaction, which it induces in less sensitized cases?

Maunder (1949) in discussing the paper by Gregory (1949) referred to 40 animals which reacted positively to the single intradermal test and 18 of these tested negatively to the short thermal tuberculin test. All these 18 animals had lesions on post mortem examination. He concluded that the short thermal tuberculin test was of lower potency than the single intradermal test and that the single intradermal test which was applied four weeks earlier had caused some desensitization.

In the case of animal 2593 the double intradermal test was applied seven weeks before the short thermal tuberculin test, but two other animals (Nos. 2413 and 2641) which were tested in exactly the same way and at the same time, gave positive reactions, the temperatures rising to 105·4° F. and 104° F. respectively at the 8th hour after injection. Animal 2413 showed lesions, but none were found in 2641. The cause of the sensitization in animal 2641 will be discussed later in this paper. One cannot generalize on the results of such small numbers but in the case of these two animals, there was no significant desensitization. In this connection Buxton and Glover (1939) state "the results which we have obtained in this country, have given no indication, that the intradermal test, when properly applied, induces any desensitization to the subcutaneous test or *vice versa*". They also quote Plum (1937) who produced desensitization by repeatedly injecting large doses of tuberculin subcutaneously, but after a period of rest of about 3 weeks, sensitivity was completely restored.

The fact that this animal failed to react to the short thermal tuberculin test, does not detract materially from the value of this test as a check test, if, as was believed, the temperature was suppressed by the large dose of tuberculin injected subcutaneously into this highly sensitized animal.

This is not the type of animal in which this test will be used. Gregory (1949) advocates the test for (1) detection of generalized cases, missed by the intradermal test, in herds that are under regular test; (2) testing of latent cases, which gave indefinite reactions to the intradermal test, (may now show up as definite reactors with lesions) and (3) in presumably clean herds, where a proportion of cattle show slight reactions to the intradermal test.

In the routine tests described, the double intradermal test generally was used, but recently, the single test was also used. Without going very critically into the available data, in this paper, the general impression is, that the single test with tuberculin at the strength advocated by the British Authorities (Veterinary Record, 31st May, 1947) i.e. 3 mg. per c.c. will give a more pronounced reaction at the 48th hour, than the first injection double tuberculin at a strength of 1·5 mg. per c.c., but at the 72nd hour, the reaction of the double test is more

pronounced than that of the single test. Furthermore the single test, with tuberculin at 3 mg. per c.c. strength is inclined to produce a greater number of non-specific reactions. Since tuberculin at the strength of 1.5 mg. per c.c. has given such excellent results in the double test, there is no reason why it cannot be used in the single test. The reasons for making this statement are:—

- (1) If there is no nodule at the site of injection a second injection is not necessary.
- (2) If there is a small circumscribed nodule, the reaction is obviously negative and if now a second injection is made, a doubtful reaction may be produced as a result of traumatic injury to the tissues.
- (3) A truly doubtful reaction, such as might appear in animals with a low degree of sensitization, will admittedly occur in a greater proportion of cases, when using 1.5 mg. per c.c. as a single test, than would be the case when using 3 mg. per c.c., but such doubtful reactions could then very well be controlled by, amongst others, the short thermal test. Using a stronger tuberculin in such cases one may get an even more unsatisfactory result, namely false positives.

#### *Source of Infection of Group 1.*

Animal 7191 can be ignored since it was shown to be infected with actinomycosis and no lesions of tuberculosis were found.

Animals 7937, 9047, 32 and 1095 were either born in this gallsickness group of isolation stables, or were transferred there on the day of birth. Since then they were kept in strict isolation, in so far as other animals were concerned. The only outside contact they made, was by means of:—

- (1) Their food and bedding;
- (2) new introductions; and
- (3) human attendants or humans handling them experimentally.

Animals 1442 and 2593 were transferred to isolation stable No. 3 on the 29.12.48 and 5.1.49 respectively. Animal 2593 was again transferred to another isolation stable on 1.3.49, where it was used in a lumpy skin disease experiment. For all practical purposes, these two animals can also be regarded as having been kept in strict isolation, in so far as other cattle, which could have transmitted the infection, were concerned. During the last 4½ months, before animal 2593 gave a positive test, it was in contact with other cattle in a lumpy skin disease experiment, but all these cattle gave negative intradermal tests.

These facts show clearly that outside cattle, with the exception of 12 new introductions can be excluded as a possible direct source of infection.

Before dealing with (1) the food; (2) the 12 new introductions and (3) humans as the source of infection, it is as well to consider the possibility of a hidden bovine voider of tubercle bacilli, amongst this group of 60 isolated animals. The necessary evidence could be obtained by slaughtering all these animals, but they are much too valuable to be sacrificed in this manner. As far as is known tuberculosis has never before, and certainly not during the last 30 years been observed, in any animal in these stables. As they become old and are no longer used as donors for the gallsickness blood, they are slaughtered. Up to now, tuberculosis has not been observed in any.



The only one of the six which had open lesions was 1442 and this animal had consistently given completely negative intradermal tests up to the time it gave an undoubted positive reaction, during the annual test of 1949. It is possible that this animal transmitted the infection to some of its fellows, but it must first of all have become infected from some source other than direct contact with infected cattle.

From 8 a.m. to 2 p.m. these 60 animals run in an enclosure with a concrete floor without a roof measuring 21 yards by 25 yards. From 2 p.m. and throughout the night, they are housed in two adjoining stables with doors closed, but with open window ventilation. Animals 9047, 32 (standing as neighbours at one end), 1442 and 2593 (neighbours at the other end) and 1095 (standing with other cattle at the opposite side, with a wide passage of nine feet between the two rows) were all in Stable No. 12. Animal 7937 stood in the other stable. If there was a hidden voider amongst these animals, they were in such close contact, that within a relatively short time, there should have been an almost 100 per cent. infection.

#### (1) *Food and Bedding as a Possible Source of Infection.*

The hay and bedding of these animals are sterilized by steam, primarily with the object of destroying any ticks which may be present, but any tubercle bacilli would incidentally also be destroyed. The only food which is not sterilized is the maize silage and a special concentrate ration, consisting of mealie meal, bran, peanut meal, lucerne meal, with small amounts of bonemeal, copper and iron sulphate. A weeks supply of this ration is mixed and stored in bags.

The maize silage is usually at least 6 months old, before it is fed. A certain amount of heat is produced in silage-making, but a temperature of 140° F. apparently is only reached, when silage is made in a special manner. It can be accepted that in maize silage a temperature, corresponding to the thermal death point of the tubercle bacillus generally is not reached.

Lactic acid, acetic and even other acids may be present in silage, but the two acids which occur in greatest concentration are lactic and acetic acids. In the Onderstepoort silage, these two acids were found to be present in equal amounts, with a total acid content of 4.4 per cent. in six months old silage, immediately it is removed from the silo in the fresh state. Hutyra, Marek and Manninger (1945) state that "the tubercle bacilli are dissolved by 1 per cent. lactic acid". It would, therefore, seem that the amount of acid in maize silage should be in a concentration that will ensure the death of the tubercle bacilli.

The concentrate ration could be responsible for the infection, but then it should also produce infection in a proportion of the other 160 odd bovines at Onderstepoort, since these animals also received this concentrate ration, albeit in smaller amounts. As already shown the greatest number of infected animals, were found amongst the 60 gallsickness animals (10 per cent.). However, even if the concentrate ration were infected, its direct source of infection was much more likely to be from a human, than from a bovine.

#### (2) *New Introductions as the Source of Infection.*

On the 26.3.49, i.e. about four months before the first positive cases were found, 12 animals (Nos. 4097-4108) were added to the group of gallsickness animals. They were tested for the first time on the 26.3.49, four months later a second time (19.7.49) and three months later (26.12.49) a third time.

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It is considered unnecessary to quote the details of these tests, as in not a single instance was there even the slightest suspicion of a reaction.

### (3) *Human Attendants and Humans Handling the Animals Experimentally as the Source of Infection.*

Man, as the source of infection is postulated because :—

1. This group of animals used for the production of anaplasmosis vaccine had always been kept in complete isolation, in so far as other animals were concerned.
2. Tuberculosis has, as far as is known, never before and certainly not during the last 30 years been observed in any animal in these isolation stables.
3. All the animals were tested annually, with the intradermal tuberculin test and new introductions were not admitted unless they passed the tuberculin, as well as the contagious abortion tests.
4. The food and bedding as fully discussed is exceedingly unlikely as a source of infection.
5. As these animals become too old or for some other reason useless as donors of blood for the vaccine, they are slaughtered, the organs and carcasses are inspected by a veterinarian and up to now, no evidence of tuberculosis has been observed.
6. The history of this outbreak of tuberculosis amongst these animals is in accord with what has been found by other workers, where man was incriminated as the source of infection, namely, a herd free from tuberculosis and consistently testing negatively for years, suddenly reveals reactors.

In some of the cases reported by these workers [Waldike, Nielson and Plum (1940)] previously quoted, a human voider of the bovine type of organism was actually in close contact with the cattle which became infected and it was assumed that the human being concerned was responsible for the infection of the cattle, as complete experimental proof is in the circumstances not possible. In some cases, a human source was assumed, even where a human voider of the bovine type of organism was not located.

In the case of the outbreak of tuberculosis described in the gallsickness group of Onderstepoort cattle, in complete isolation, a possible human source of the infection, accordingly was also sought.

Two natives are in constant attendance on the animals in these stables. Two Europeans have for years been associated with these animals experimentally and to withdraw the blood for the vaccine. Some 12 natives handle these animals from time to time, whilst they are being bled or in order to take their temperatures as a routine procedure twice daily.

Drs. Dicks and Bodenstab, both assistant medical officers of health of the Pretoria Municipality were good enough to make a medical examination of these natives, as well as subject them to the tuberculin test.



No clinical cases were found on medical examination, but only three of the 14 natives were negative to the tuberculin test.

Thirteen of these natives were also screened with negative results and the two Europeans in contact with these animals, were similarly screened and found to be negative.

Another native, James, who for a long time handled these animals eventually was medically boarded and retired on the grounds of chronic bronchitis and chronic rheumatism. After a great deal of trouble this native was located, as he was thought to be a likely source of the infection. In the meantime, however, his health had greatly improved, but in any case no evidence of tuberculosis was found on X-ray examination.

Another native, Edward, who was in close contact with these animals for some time, left the service and was not available for examination. He is supposed to have complained of headaches from time to time but no other information concerning him is available.

It was, therefore, not possible to find the human voider of the bovine tubercle bacilli. The native personnel is unfortunately constantly changing and it was not possible to make an examination of all the native attendants, who had left Onderstepoort during the last 3 years. This being the case and even though no human with open pulmonary lesions due to the bovine type of organism, was found, it is thought that, after taking all the available evidence into careful consideration, especially in view of the facts, that these animals were kept under very strict conditions of isolation in so far as other animals were concerned and that tuberculosis had never before been present in this group of animals, a human voider of the bovine tubercle bacillus was operating, possibly only for a relatively short period of time.

*Group 2.—Animal 2413.*

This animal is considered as a separate group, because it was not kept under such strict conditions of isolation as those of group 1 and it is, therefore, possible, although extremely unlikely, that it could have picked up the infection from other cattle.

*History.*—This animal was born on 15.11.45 on our adjoining farm Kaalplaas. There it was vaccinated against paratyphoid and injected intravenously with heartwater infected blood. On 9.6.47 when it was about 18 months old, it was transferred to Onderstepoort, where at different times, it was vaccinated against anthrax, blackwater and lamsiekte (botulism). It was transferred to at least six different camps, until finally it was placed in a contagious abortion experiment in Camp 60A.

In 1946 and 1947 it gave negative double intradermal tuberculin tests. On the 10.2.48 it was again tested, the measurements being 12·0-15·0-negative. At the annual test on 19.7.49 the readings were 10·0-22·0-24·0. This is really a positive reaction but since the Onderstepoort animals were at that time regarded as being free from tuberculosis, it was decided to retest this animal with the short thermal tuberculin test. This check test, showed a definite positive reaction (see temperature chart animal 2413 below).

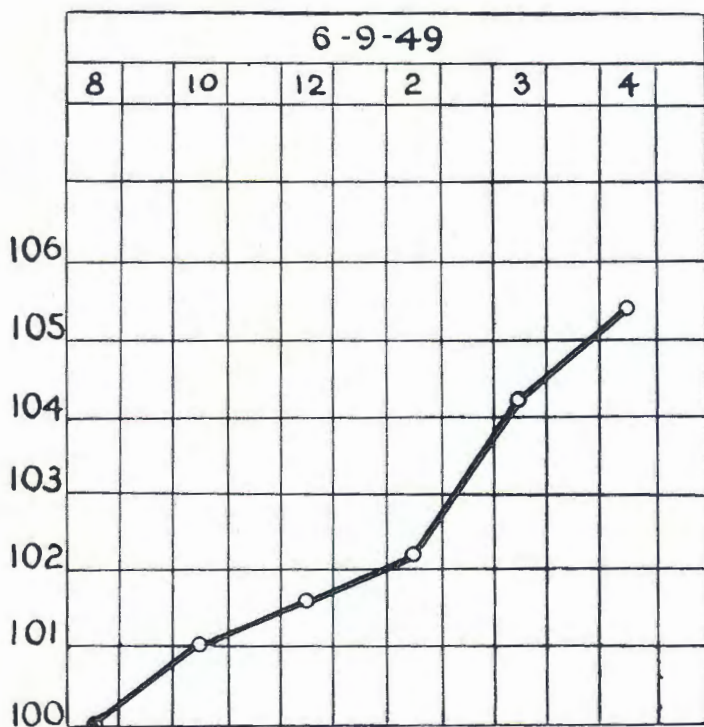
The animal was slaughtered on the 12.9.49. Small lesions were found in the bronchial lymphatic gland.

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*Histological Examination.*—There was caseation and calcification with a good deal of induration. Acid fast organisms were present on direct smear examination as well as in Ziehl-Neelsen stained sections. The organisms were not numerous in the sections. Neutrophils were also extensively present, being irregularly scattered throughout portions of the gland, which was still free from caseation and calcification.

*Biological Examination.*—For typing two rabbits received .01 mg. of culture and eight guinea-pigs 1.0 mg. of culture. All these animals either died or were destroyed, within two months after infection and in all cases there was generalization. It was concluded that the organism was of the bovine type.

TEMPERATURE CHART. BOVINE 2413.



*Source of Infection.*—As already stated, this animal was not kept in such strict isolation as were the animals of Group 1. For the first 18 months it was running on the farm Kaalplaas having an area of some 3,000 morgen (6,000 acres). Since 1940 only three animals with tuberculosis were found at Kaalplaas, viz. one animal out of 502 tested in 1940, but this animal had closed lesions and came as an infected animal from Onderstepoort; and two in 1949, but these were animals that were sent to various districts in the Orange Free State in a lumpy skin disease experiment. They must have picked up the infection during this time and were unfortunately not tested before introduction to the herd at Kaalplaas. These two animals also had closed lesions. Even though this is the case, it is possible that animal 2413 could have made contact with infected cattle, possibly even at the boundary fence, which is not double-fenced.

In Camp 60A, animals experimentally infected with tuberculosis were kept until August, 1947. Animal 2413 was transferred to this camp on 4.5.49, i.e. about 20 months after the animals with tuberculosis were removed from this camp. It was in this camp for about  $2\frac{1}{2}$  months before the annual test, during which it reacted.

If tubercle bacilli voided by the experimentally infected bovines in this camp, could produce the infection, one will have to consider:—

- (1) Whether the lesions found in animal 2413, were such that they could have been produced in  $2\frac{1}{2}$  month; and
- (2) whether tubercle bacilli, existing under the conditions present in this camp, could remain viable for 20 months.

(1) *Age of Lesions.*—The nature and fate of the lesions in tuberculosis would seem to depend on the virulence of the organism and the state of resistance of the host even in cases of primary infection. With such variable factors it is clear, that it is not possible to determine accurately the age of the lesions. Medlar (1926) states that caseation is present in lesions of six, seven and eight weeks duration in the guinea-pig and Pottenger (1948) says that calcification may begin soon after caseation takes place. It seems, just possible, therefore, that the lesions found in this animal could have been produced in  $2\frac{1}{2}$  months. On the other hand the calcification and induration could very well be an indication that the lesions were much older.

(2) *Viability of the Tubercle Bacilli.*—Stenhouse Williams and Hoy (1930) found that:—

1. Under ordinary conditions in the south of England, bacillus tuberculosis may remain alive and virulent in cows' faeces exposed on pasture land for at least five months during spring and for four months during autumn. In summer no living organisms were demonstrated after two months.
2. Under special conditions e.g. protected from direct sunlight, the survival period may be four months during summer. In autumn faeces protected from earthworms, etc. yielded bacilli after six months.
3. Living and virulent tubercle bacilli were found after 12 months storage of naturally infected faeces and for a period of at least two years in artificially infected faeces".

In Camp 60A special conditions which could favour increased life for the organisms are present. There are trees and a shed closed on 3 sides, one corner of which never gets any sun. Even though Stenhouse, Williams and Hoy did not find viable tubercle bacilli in naturally infected faeces after six months, the fact that the organisms survived storage in artificially infected faeces for two years, suggests the (remote) possibility that the infection in some specially favoured spot could have survived for a period of 20 months and could, therefore, have been responsible for the infection of this animal 2413.

#### *Group 3—No Lesion Reactors.*

In this group are 3 animals 2636, 2641 and 2748. These animals were just under 3 years old. Animal 2636 was a bull, born at Onderstepoort and was used for breeding purposes as he carried the recessive porphyrin character. Animals



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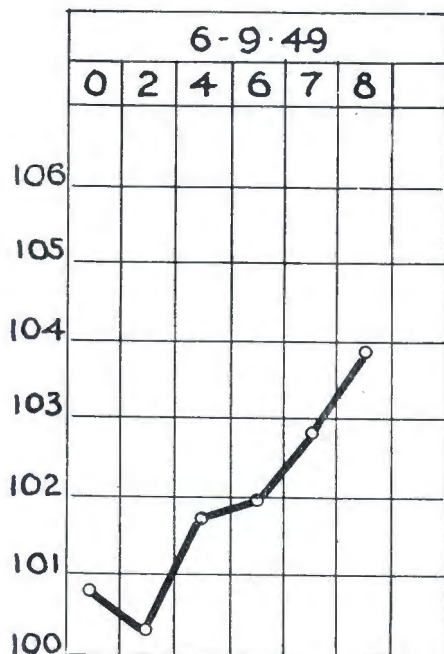
2641 and 2748 were both Zulu cattle, born at Kaalplaas and since 17.8.48 were used in a nutrition experiment at Onderstepoort. Details of the intradermal tuberculin tests carried out on these animals are presented below.

|      | Date.          | 0 Hours. | 48 Hours. | 72 Hours. | Result.                             |
|------|----------------|----------|-----------|-----------|-------------------------------------|
| 2636 | 10. 2.48.....  | 14.0     | 14.5      | 15.0      | Negative.<br>Positive.              |
|      | 19. 7.49.....  | 13.8     | 25.0      | 27.5      |                                     |
| 2641 | 3. 2.48.....   | 15.5     | n.n.      | —         | Negative.<br>Positive.              |
|      | 19. 7.49.....  | 10.0     | 15.0      | 23.0      |                                     |
| 2748 | 3. 2.48.....   | 12.8     | n.n.      | —         | Negative.<br>Positive.<br>Positive. |
|      | 19. 7.49.....  | 8.5      | 15.0      | 19.0      |                                     |
|      | 26. 10.49..... | 9.0      | 21.0      | 31.0      |                                     |

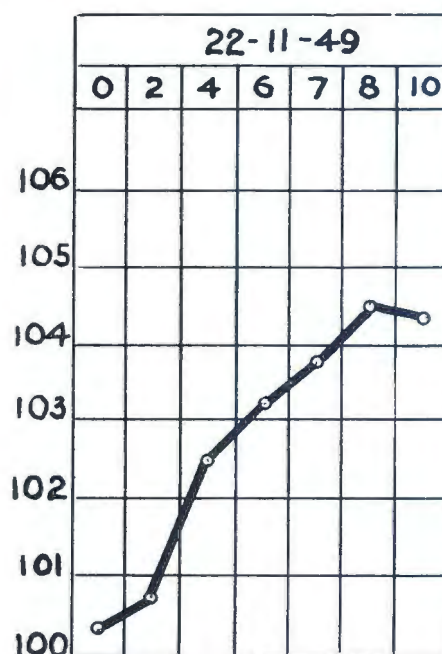
n.n.=No nodule.

Animals 2641 and 2748 were tested with the short thermal tuberculin test subcutaneously on the 6.9.49 and the 22.11.49 respectively. In both cases the tests were positive (see temperature charts below).

TEMPERATURE CHART. BOVINE 2641.



TEMPERATURE CHART. BOVINE 2748.



All three animals were slaughtered. No lesions were found in any of them. Pooled lymphatic glands from each of the animals 2636 and 2748 were used for biological examination and in the case of the material from 2748 as many as 24 guinea-pigs were injected, with negative results in both cases.



*Cause of Sensitization in Group 3.*—A number of different conditions have at one time or another been blamed as the possible cause of no lesions reactors. These are:—

1. The lesions are so small that they cannot be detected.
2. Infection with the avian type of organism.
3. Infection with the human type of organism.
4. Brucellosis.
5. Johnes disease.
6. The so-called skin lesions, with cold abscesses, etc., but other cases have also been seen with abscesses of the liver, in which no other cause for the sensitization could be found except that it was impossible to exclude human and avian infection with certainty.
7. Actinomycosis must now be added to the list as a possible cause.

Brucellosis, Johnes disease, skin lesions and actinomycosis can immediately be eliminated as possible causes, in the case of the three animals concerned, since no evidence of any of these conditions was present on post mortem examination and bearing in mind, in so far as brucellosis is concerned, that the one animal was a bull with normal genitalia and the other two were oxen. The other three possible causes will now be considered individually.

1. *Small Undetected Lesions Due to the Bovine Type of Organism.*—There is a possibility that this could be the case in so far as animal 2636 is concerned, since this animal was destroyed almost immediately after it gave a positive reaction. In the case of the other two animals the lesions should in ordinary circumstances have developed to recognizable macroscopic size, since animal 2641 was slaughtered six weeks after it reacted and animal 2748 more than three months after it reacted for the first time.

2. *Infection with the Avian Type.*—A comparative test was unfortunately not made, but these animals never came into contact with poultry. The poultry flocks at this institute are unfortunately not tested for tuberculosis, but the officer in charge of these 2,000 odd birds, is confident that they are all free from tuberculosis, since during the last 14 years, a detailed post mortem examination of every bird which died failed to show a single case of tuberculosis.

3. *Infection with the Human Type of Organism.*—By a process of elimination one must conclude that the human type infection was responsible for the sensitization in these cases. However, Francis (1947), quoting Stenius (1938) and Nielsen and Plum (1940), states that very few cattle infected with the human type react to the subcutaneous test and Stenius (1938) further maintains that only about a third of all cattle with avian type infection, react to the subcutaneous test with bovine tuberculin. The concentrated tuberculin used for the short thermal subcutaneous test is made from the human type of organism. It is not known if this could make a difference but the two animals tested in this way certainly gave a positive reaction. They might possibly not have reacted if the ordinary subcutaneous test with diluted tuberculin were used.

An attempt was made to locate the human source of this infection. The native attendant George fed and was in close contact with two of these animals (2641 and 2748). He is underweight and coughs. He was screened and pulmonary tuberculosis was established. Repeated attempts to demonstrate tubercle bacilli by direct smear examination of sputum and one biological examination, were unsuccessful. It is however well known that the tubercle bacilli are not constantly

present in sputum. Taking all the available evidence into consideration, it is thought that sensitization in these three animals was due to infection with the human type of organism.

#### SUMMARY AND CONCLUSIONS.

In testing the Onderstepoort herd of experimental animals, totalling 224 animals, 10 positive reactors were found in 1949. Since tuberculosis was eradicated from this herd in 1940 by slaughtering all reactors and doubtful reactors and since with the exception of one animal, no further cases were encountered at the annual tests during the last 9 years, this result was not only surprising, but also alarming.

Seven of the reactors were from a group of gallsickness vaccine reservoir animals, which were kept in complete isolation in so far as other cattle were concerned. Their hay and bedding were sterilized. The only food which was not sterilized was the silage and the concentrate ration. Since the Onderstepoort silage was shown to contain 4 per cent. acid, it was believed that any tubercle bacilli which might be present, would be destroyed. The concentrate ration could carry viable tubercle bacilli, but even if that were the case, the source of such infection was much more likely to be human than bovine. As these animals become too old or are for some other reason no longer suitable as donors of blood for the vaccine, they are slaughtered and in every case a post mortem examination is made by a veterinarian. During the last 30 years not a single case of tuberculosis was found in this group of isolation stables. Lesions were present in six out of the seven animals. The 7th had actinomycosis, which was thought to have been responsible for the sensitization in this animal. An attempt was made to type the organisms from all six animals. In four the bovine type was identified. In one the organisms were lost and in the other, owing to difficulties in obtaining good cultures for the biological examination, the results are not yet available.

It was concluded that a human being with open pulmonary lesions due to the bovine type of organism must have been responsible for the infection. All the available humans were tuberculin tested, medically examined and screened. A number of positive tuberculin reactors were found, but no clinical cases were found, on medical examination and on screening. Since the native personnel is constantly changing, it was unfortunately not possible to examine all those who were in close contact with these animals during the last two years.

In another group of three positive reactors no lesions were found and it is considered that these animals were sensitized by infection with the human type of organism. The native attendant in close contact with these animals was shown to have pulmonary tuberculosis on screening, but up to now the organisms could not be identified in his sputum by direct smear examination, nor by biological examination.

This experience with the Onderstepoort herd, makes it abundantly clear that man as a source of infection of the bovine with the human type of organism, with consequent sensitization and man with open pulmonary lesions due to the bovine type of organism, as a dangerous source of infection for bovines, can no longer be regarded as a rare academic curiosity, but must be faced as an important practical issue, where a serious attempt is being made to eradicate tuberculosis from cattle and to maintain them free from sensitization. Where the bovine as the source of infection has been eliminated and tuberculin tests are not carried out annually, or at the most every two years, serious and disastrous setbacks may occur, when a human being with open lesions, due to the bovine type of organism, introduces the infection to a herd.

## ACKNOWLEDGMENTS.

The assistance given by Prof. Oosthuizen, Drs. Walpowitz, Jacobs and Engelbrecht of the Pretoria hospital and Drs. Dicks and Bodenstab of the Pretoria City Council, in connection with the screening, medical examination and tuberculin tests on human beings, is very much appreciated.

I also want to thank my colleague Mr. Myburgh of the biochemical section for assistance with the determination of the acid concentration in Onderstepoort silage and my colleagues Drs. Sutton and van Drimmelen for carrying out the typing of the organisms obtained from the reactors.

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