U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.
BULLETIN No. 7.

INVESTIGATIONS

CONCERNING

BOVINE TUBERCULOSIS,

WITH

SPECIAL REFERENCE TO DIAGNOSIS AND PREVENTION.

CONDUCTED UNDER THE DIRECTION OF DR. D. E. SALMON,
CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., September 10, 1894.

Sir: I have the honor to transmit herewith a report submitted by Dr. Theobald Smith covering investigations made by himself, and by Drs. F. L. Kilborne and E. C. Schroeder under his direction, concerning the diagnosis and prevention of tuberculosis. I also transmit in this connection a report submitted to me by Dr. E. A. de Schweinitz on tuberculin and its use.

The researches which are the basis of these reports have been most carefully conducted, and the results are of great importance and interest on account of the accuracy of the observations and the light which they throw on the prevention and control of the most widespread and destructive plague that affects man and the domesticated animals.

The facts here presented do much to clear away the uncertainties which have confronted the practical sanitarian, and a continuation of such investigations, particularly if on a somewhat more extended scale, will soon enable us to clearly define the action necessary to protect the farmer from the ravages of the disease among his live stock and the consumer from the danger of taking into his system the infected products of tuberculous animals. In such studies it is the farmer who is most interested. Not only does he suffer the loss of his animals from the disease, but he is among the largest consumers of meat and milk, and, consequently, the health of himself and family is proportionately endangered. The farmer must also suffer the inconvenience and the greater part of the loss resulting from efforts for the eradication of the contagion. When these efforts are made by the State, it is a question whether this loss is not greater to the cattle owner, on account of the inconvenience of the season selected and the damaging effects of the publicity, than would follow from his individual action to accomplish equally beneficial results. The time has come, therefore, for our farmers to study this question carefully and decide, in the light of the facts published for their benefit, whether it would not be preferable to themselves free their herds from this plague, rather than wait the necessarily slow and often unpleasant action of the constituted authorities.

Very respectfully,

D. E. Salmon,
Chief Bureau of Animal Industry.

Hon. J. Sterling Morton,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., July 21, 1894.

Sir: I have the honor to submit herewith some preliminary investigations and studies dealing with bovine tuberculosis both from an economic and a sanitary point of view. The former has been more or less neglected and the demands of public health allowed to overshadow it. It seems, however, that the difficulty is one which must be met primarily from the agricultural side and in the interests of agriculture. If this is successful the public health problem will have solved itself.

The articles contained in this bulletin are more or less technical inasmuch as they deal with fundamental problems. A chapter on the practical aspect of the whole subject has been added which embodies general suggestions on prevention. These will be readily understood by all interested in the practical bearing of bovine tuberculosis.

It remains for me to thank Dr. Cooper Curtice, formerly New York State cattle inspector, for the courtesy of permitting me to examine with him about 70 tuberculous animals slaughtered under the direction of the New York State Board of Health.

Very respectfully,

Theobald Smith,
Chief of Division of Animal Pathology.

Dr. D. E. Salmon,
Chief of Bureau of Animal Industry.

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CLINICAL PART.

By F. L. Kilborne, B. V. S., and E. C. Schroeder, M. D. V.

GENERAL HISTORY AND SANITARY CONDITION OF THE HERD.

In the year 1869 a small number of Jersey cattle, comprising 1 bull, 1 cow, and 3 heifers, were purchased at a fair in Baltimore, Md., and brought to the District of Columbia, where they were added to a herd of 25 cows of no particular breed, which belonged to the Soldiers' Home. The so-called common cows were sold as rapidly as their places could be filled by the progeny of the Jerseys and such of their own offspring as were sired by the Jersey bull.

A second Jersey bull was secured in the year 1874 and a third in the year 1886. The last bull died in the year 1889, after only two days of noticeable sickness. Previous to the introduction of the third bull the herd had increased to double the original number of cattle, and consisted exclusively of either pure Jerseys or cows in which the Jersey strain predominated. They were amply fertile and in good condition. A few deaths had occurred, some from parturient apoplexy and others from unknown causes, but the death rate never exceeded reasonable bounds.

An outbreak of abortion, which assumed a contagious form, occurred in the year 1882, and was not overcome until a considerable number of cows had been removed from the herd and their places filled with new stock. One bull, 6 cows, and 3 heifers of Holstein breed and 12 common cows were bought. The former came from Clifton, Va., and the latter mainly from Montgomery County, Md. The common cows were again sold as soon as their places could be taken by the offspring of the Holstein cattle and of the remaining Jerseys, and only the most vigorous and productive of the latter were retained. The Holstein cattle had the preference because the Jerseys seemed to have lost their former vitality.

The process of thinning out the common cows, and more gradually the Jerseys, continued without interruption, and the herd slowly increased in number until the time of the tuberculin test, when it consisted of 60 animals, the majority of which were more or less pure Holstein cattle and the balance Jerseys. The general condition of the herd was excellent, and with the exception of 2 or 3 cows it contained nothing which was suggestive of disease on superficial examination.

A second Holstein bull, from either New York or Pennsylvania, took the place of the first in the year 1887. The first was sold in good condition, but the second was sent in 1892 to the veterinary station of the Bureau of Animal Industry, and was found extensively tuberculous on post-mortem examination.

In addition to the several bulls spoken of, there were at different times several other bulls which were the progeny of and raised in the herd.

The stables in which the herd was kept are located in the grounds of the Soldiers' Home. Together with an unused horse stable, a dairy room, a number of box stalls, tool houses, storerooms, and open sheds, they form a rectangle which incloses a paved yard not less than 100 feet long and 60 feet wide, the long diameter of which extends north and south. All the buildings are entered through the inclosed yard.

The principal stable, which is the only structure more than one story high, is 75 feet long and 40 feet broad, and forms the greater portion of the eastern side of the rectangle. The upper story is used as a hay loft. The lower story, with the exception of a space 18 feet wide at the northern end, is occupied by three rows of fourteen stalls each, two facing each other, and separated by a passage 4 feet wide, and a third row with its rear turned towards the other two, from which it is separated by a space 4 to 5 feet wide.

Two smaller stables used for cattle form the southwestern angle of the rectangle. The smaller of the two is 25 feet square and contains two rows of six stalls, facing each other, with a passage 3 to 4 feet wide between. In the larger, which measures 40 by 30 feet, are two rows of ten stalls, facing each other and separated by a passage 4 to 5 feet wide. In the latter stable the cattle are fastened in stanchions, in the other two by means of chains.

All the buildings are of brick excepting the second story of the principal stable. The stalls are about 4 feet wide and have plank floors which rest upon a layer of cement. In the rear of each row of stalls is a covered drain with openings at regular intervals. At the head of each stall is a trough and hay rack.

The light and ventilation are good. In the largest stable, in which the ceiling is lowest, the latter is at least 8 feet high. This stable is ventilated by two air shafts. Light is obtained in all the stables through numerous glazed windows which can be opened in warm weather. The floors are dry and kept scrupulously clean.

The drainage from all the stables collects in a covered cesspool which is in the inclosed yard about 10 feet from the center of the main stable. This pool has one objectionable feature. It is 9 feet deep and the discharge pipe leading from it is only 3 feet beneath the surface, and hence the drainage from the stables to the depth of 6 feet stagnates constantly in this pool and frequently gives rise to very disagreeable odors. The discharge pipe from the cesspool empties into a neighboring creek.

Extending southeast from the main stable is a patch of ground 2 to 3 acres in extent, about five times as long as it is broad, inclosed by a fence. This is known as the cow yard. It slopes gradually down to within 10 to 12 feet of the creek into which the drainage from the stables is eventually discharged. In the lower portion of the cow yard the cattle are watered, the water being pumped from a spring into a long trough elevated about a foot from the ground.

The lower portion of the cow yard is also used as a dumping place for the leaves collected from various portions of the Home grounds, and when these become mixed with the droppings of the cattle and saturated with moisture a veritable swamp is formed, through which the cattle must pass to reach the water.

The manure from the stables was hauled each day to a place specially provided in the rear of the cow yard, where it remained at most a few days at a time. It was used to improve the condition of such portions of the Home grounds as needed fertilizing.

The spring from which the drinking water was obtained is apparently well removed from any source of contamination.

During the warm months the herd was kept constantly out of doors. At 4 a. m. the milch cows were driven into the stable, milked, turned into the cow yard with the other cattle, and from there the entire herd was driven into pasture. About 11 a. m. all the cattle were returned to the cow yard, the milch cows were again driven into the stable, milked, turned back into the cow yard, and from there, with the rest of the cattle, back into pasture. At 6 p. m. all the cattle were returned to the cow yard, where they remained until the following morning.

When the pasturage was not good the milch cows received a small amount of feed of one kind or another while in the stable to be milked

During the cold months the cattle were not allowed to go into pasture, but were given fresh air and exercise in the cow yard, where they remained from one to eight hours, according to the state of the weather. The cows were milked at the same hours during the summer and winter. When not allowed to go into pasture the cattle were fed a mixture of cut beets, cut hay, and mill feed, one meal at 5:30 a. m. and another at 2:30 p. m., and a good feed of long hay in the evening. The quantity of the mixed feed varied according to the size and productivity of the animal, and was a half bushel at each feeding for a cow giving milk.

All the water for the cattle was obtained in the cow yard excepting only a small quantity which was mixed with the feed. This was from

a cistern supplied with rain water from the roof of the main stable, at the northeastern corner of which it was located.

No special restricted pasture was set apart for the cattle. A piece of ground from which the first crop of grass had been cut for hay was selected every day or two, and the cattle were confined to it by herdsmen. Particular instructions were given the herdsmen not to let the cattle drink from any creek or pond which might be near or in the pasture.

The bulls were never turned into pasture but were confined in inclosures of sufficient size to give them the needed exercise and air.

Shortly previous to the time of parturition the cows were placed in box stalls. The calves were allowed such portions of the milk of their dams as they needed during the first two months, after which they were fed cut hay mixed with meal or bran, or were turned out to pasture.

The cows were served by the bull three months after calving, so as to produce one calf every twelve to fourteen months.

When bedding was needed in the stalls it consisted of leaves collected on the Home grounds. No particular care was taken to train the cattle to occupy the same stalls at all times.

HISTORY OF TUBERCULOSIS IN THE HERD.

The first definite history of tuberculosis in the herd dates back to February, 1889. An inspector of the Bureau of Animal Industry was directed to examine the herd, and the result was that four Jersey cows were condemned as tuberculous. Post-mortem examination confirmed the diagnosis. Two of the cows were killed and examined at the Soldiers' Home and two sent to the veterinary station of the Bureau and kept under observation until the time of their death.*

When the above inspection was made the man in charge of the cattle was closely questioned in regard to diseases and deaths in the herd. The information obtained at this time was of a character to lead to the supposition that some of the former deaths were due to tuberculosis. The cattle were again examined by a Bureau inspector in the fall and winter of 1891 and 1892, and one Jersey heifer (No. 338) pronounced tuberculous.

November 14, 1892, the Holstein bull which entered the herd in 1886 was sent to the veterinary station of the Bureau. He had an offensive nasal discharge, and both submaxillary glands were greatly enlarged. Tuberculosis was suspected, but could not be definitely diagnosed, and hence a tuberculin injection was tried. The test was made November 15 and 16 and a positive reaction obtained. November 17 both submaxillary glands were cut out and found to be tuberculous.

December 9 and 10, 1892, and January 19 and 20, 1893, the bull was again tested with tuberculin and positive reactions obtained in both

* Bulletin No. 3 of the Bureau of Animal Industry, pp. 60-62, Nos. 155 and 156.

instances. He was killed January 26, 1893, and the post-mortem examination showed extensive tuberculosis.*

After the first tuberculin test of the bull had given a positive reaction and the excised glands had been found tuberculous, the view, which had been gaining strength for some time, that tuberculosis was very general in the herd assumed almost the character of a fact, and it was further supported by another careful examination of the cattle extending over two days at the beginning of December, 1893. Several undoubted cases of tuberculosis were diagnosed, three or four times as many more animals were distinctly to be looked upon with suspicion. The condition of a very large portion of the remaining cattle was such that a diagnosis of tuberculosis with the methods usually employed by the practical veterinarian could not be made. Yet they showed little irregularities of various kinds which made it impossible, in the presence of so much tuberculosis, to pronounce them certainly free from the affection.

With matters in this uncertain state it was concluded to seek more reliable results from a general tuberculin test, and this was all the more desirable because the Bureau had been seeking a favorable opportunity for some time to test the value of tuberculin as a diagnostic agent on a larger scale than had been previously possible.

TUBERCULIN TESTS.

A preliminary tuberculin test was made directly after the last examination of the herd. Five cows were selected and their temperature taken every two hours from 6 a. m. to 8 p. m. December 6, 1892. The following morning at 6 o'clock each animal received an injection of tuberculin under the skin on the left side of the neck, and the temperature was again taken every two hours until 8 p. m., and once in addition to this at 9 p. m. December 8 the temperature was again taken at 11 a. m. to determine whether it had returned to normal in the animals which had shown an elevation the previous day. (For the degrees of temperature, obtained per rectum, during the test, see table, p. 59.)

The substance injected was the regular "Tuberculinum Kochii" imported from Germany. It was used in a 10 per cent solution. The diluent was distilled sterile water to which one-half per cent of carbolic acid had been added. Each animal received a dose of the solution equivalent to 0.4 cc. of pure tuberculin.

The reactions following the injections were quite surprising, and implied the presence of even more tuberculosis than had been suspected. Two of the cows selected, Nos. 306 and 311, which were included in the preliminary test particularly because of their excellent condition and apparently perfect freedom from disease gave high reactions. Cows Nos. 303 and 314 were selected as well-developed cases of

* For the tuberculin tests and the post-mortem notes see p. 58.

tuberculosis, and in them the reactions simply confirmed the previous diagnosis. Cow No. 304 alone gave no reaction; she had long suffered from a cough and was regarded as a highly suspicious case. The post-mortem examinations made later on fully verified the results of the test.

More extensive tuberculin tests were begun February 1, 1893. In these it was determined to observe the cattle with sufficient care while under the influence of the tuberculin to detect, if possible, any symptoms which might present themselves in tuberculous animals in addition to the rise in temperature. To do this effectually the whole herd could not be tested at one time, and hence it was divided into sections, and the different sections tested successively until every animal, with the exception of only one, had passed through two tests. Sufficient time was always allowed to pass after the first injection before the second was made to avoid interference of the former with the latter.

The tuberculin used was of two kinds, respectively specified as tuberculin K and tuberculin S. The former has already been described in connection with the preliminary test. Tuberculin S was prepared in the chemical laboratory of the Bureau of Animal Industry by Dr. E. A. de Schweinitz, and was injected in a 12½ per cent solution.

During the test the cattle were treated as nearly as possible in the customary manner. Just before the test they were turned into the cow yard for an hour, where they had access to fresh drinking water, then they were driven into the stable where they remained until the conclusion of the test. The drinking water, which at other times was obtained in the cow yard, was brought to the cattle in the stable during the test, and on very cold days was slightly warmed by the addition of a quart or two of boiling water to three or four gallons of cold water.

For the first test 10 head of cattle were selected. Commencing 9 a. m., February 1, 1893, the temperature, pulse, and respiration of each animal were taken every hour until 9 a. m. the next morning, when each animal received an injection of tuberculin S, immediately after which the temperature, pulse, and respiration were again taken, and every hour from then on until thirty-two hours had passed.

March 15, 1893, a second lot of 14 head was selected and treated in precisely the same manner. (For a full description of each animal and the dose of tuberculin each received, see cattle Nos. 301 to 324, pp. 31–41; for the temperature, pulse, and respiration of the cattle during the test, see tables, pp. 60–65.)

An examination of the tables shows that a small, marked increase in the frequency of the pulse often accompanies the rise in temperature resulting from an injection of tuberculin, and that in many cases a greater frequency in the respiration also occurs. But there is nothing sufficiently characteristic about this to give it value as additional evidence of the presence or absence of tuberculosis. The same conclusion

was previously reached by other experimenters with tuberculin.* Consequently, in the following tests the condition of the pulse and respiration was not noted. It was further observed that in few if any cases the rise in temperature commenced before the sixth hour after the injection, and that little or nothing was to be gained by taking the temperature during the first six to eight hours. This fact led to a change in the hour of making the injection from 9 a. m. to 12 p. m., in order to overcome the unpleasant necessity of remaining with the cattle all night. The temperature was then taken every hour from 7 or 8 a. m. until 11 p. m. At 12 p. m. the injections were made, and taking the temperature after injection was commenced the following morning at 6 or 7 o'clock, from which time on it was taken hourly until 10 p. m.

Cattle bearing Nos. 325 to 337, inclusive, were injected with tuberculin K, March 21, 1893; cattle Nos. 338 to 346, inclusive, were injected with tuberculin K, March 27, 1893; cattle Nos. 347 to 353, inclusive, were injected with tuberculin S, April 12, 1893, and cattle Nos. 354 to 363, inclusive, were injected with tuberculin S, May 1, 1893. (For a description of each animal and the dose of tuberculin given, see cattle Nos. 325 to 363, inclusive, pp. 41–59; for the temperature of the cattle during the tests, see tables, pp. 66–69.)

The second injections were made on the following dates: March 21, 1893, cattle Nos. 301, 302, 305, 307, 308, 309, and 310 received each an injection of tuberculin K. March 27, cattle Nos. 312, 313, 315, 317, and 319 to 324 inclusive, received each an injection of tuberculin K.† April 12, cattle Nos. 318, and 328 to 337 inclusive, received each an injection of tuberculin S. May 1, cattle Nos. 339 to 353, inclusive, received each an injection of tuberculin S. May 25, cattle Nos. 325, 326, 327, and 354 to 363 inclusive, received each an injection of tuberculin S. The same date the following cattle also received a third injection of tuberculin S. The same date the following cattle also received a third injection of tuberculin S: Nos. 305, 308, 309, 315, 319, 320, 321, 322, 334, 336, and 339. (For the temperature before and after the second and third injections, see tables, pp. 69–74.)

Cow No. 338 was so far advanced in tuberculosis before the time for a second injection arrived that she was killed in practically a dying condition.

Of the 63 animals included in the entire series of tests, 60 were examined post-mortem, and in all but 7 lesions of tuberculosis were present.‡

Before we can determine in what measure the results of the tuberculin injections correctly indicated the presence or absence of a tuberculous

* Deutsche Zeitschrift f. Thiermed., XVIII (1891), p. 99, Arbeiten a. d. kaiserl. Gesundheitsamte, VIII (1892), p. 55.

† The 5 cows included in the preliminary test did not receive a second injection in the general tests.

‡ Three cows, Nos. 325, 326, and 327, included in the tuberculin tests, were not killed. They were private property, and strictly speaking, did not form part of the herd.

affection, we must form a more or less definite idea of what is in truth to be called a reaction. On this point little agreement apparently exists between different observers, which is not an extraordinary fact when we consider the marked normal variations in the temperature of milk cattle, the readiness with which the temperature of many animals is influenced by slight and frequently unrecognizable causes, the dissimilar conditions under which different herds live, the lack of constancy in the quantity of tuberculin injected, and the possible variations in the strength, purity, and state of preservation of the tuberculin used.

The elevation in the temperature necessary to constitute a reaction has variously been given from 0.5° C. to 1° C.* (0.9° F. to 1.8° F.). But it is not sufficient to consider merely the number of degrees the temperature after the injection rises above the temperature before the injection. The height reached by the temperature and the duration of the elevation certainly can not be disregarded. In estimating the reliability of the results from tuberculin injections where the temperature after the injection is low, Eber maintains that a rise of not less than 0.5° C. must occur, and be continuous during many hours, before the presence of fever can be conclusively affirmed. A low temperature after the injection is specified as 39.5° C. (103.1° F.).† This is a rule which we believe it is necessary to observe. As an aid in estimating the result of the present series of injections, two synoptic tables of the first and second injections, respectively, are given below. In these will be found the maximum temperature before and after injection, the number of hours between each injection and the first rise in temperature, the number of hours the temperature remained elevated, the difference in degrees in each case between the highest temperature before and after the injection, and the presence or absence of tuberculosis on post-mortem examination.

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* Arbeiten aus dem Kaiserlichen Gesundheitsamte, VIII (1892), pp. 84–86. See also two footnotes in Deutsche Zeitschrift f. Thiermed., XVIII (1892), p. 325.

† *Ibid.* XVIII (1892), p. 322.

A.—*First injection of tuberculin.*

No. of animal.	Date of injection.	Kind and dose of tuberculin used.	Maximum temperature before injection.	Maximum temperature after injection.	Number of hours after the injection when the temperature first exceeded the maximum of the previous day.*	Number of hours after the injection during which the temperature was higher than the maximum of the previous day.†	Amplitude of reaction.	Date when killed and examined post-mortem.	Absence or presence of tuberculosis (+ present, — absent).
			° *F.*	° *F.*			° *F.*		
301	Feb. 2, 1893	0.25 cc. S	102.0	106.8	7	18	4.8	Mar. 24, 1893	+
302	do	do	102.2	107.4	6	19	5.2	do	+
303	Dec. 7, 1892	0.4 cc. K	102.5	107.0	8	10+	4.5	Mar. 18, 1893	+
304	do	do	102.2	102.6		3	0.4	Apr. 21. 1893	—
305	Feb. 2, 1893	0.25 cc. S	101.8	102.8		3	1.0	June 29, 1893	—
306	Dec. 7, 1892	0.4 cc. K	102.6	106.0	10	8+	3.4	Mar. 21, 1893	+
307	Feb. 2, 1893	0.25 cc. S	102.4	107.6	8	17	5.2	Apr. 4, 1893	+
308	do	do	102.3	104.6	7	11	2.3	June 5, 1893	+
309	do	do	102.4	104.8	9	13	2.4	do	+
310	do	0.125 cc. S.	102.8	105.8	7	13	3.0	Apr. 4, 1893	+
311	Dec. 7, 1892	0.4 cc. K	102.5	106.0	10	8+	3.5	Mar. 21, 1893	+
312	Mar. 16, 1893	0.25 cc. S	103.0	105.2	6	17	2.2	Apr. 28, 1893	+
313	do	do	102.3	106.6	7	18	4.3	Apr. 7, 1892	+
314	Dec. 7, 1892	0.4 cc. K	102.5	106.0	10	8+	3.5	Mar. 18, 1893	+
315	Mar. 16, 1893	0.25 cc. S	102.4	106.8	6	16	4.4	June 1, 1893	+
316	do	do	102.6	106.2	10	13	3.6	Apr. 7, 1893	+
317	do	do	103.0	105.8	10	13	2.8	Apr. 21, 1893	+
318	do	do	103.2	107.4	7	16	4.2	Apr. 14, 1893	+
319	do	do	103.3	102.8			−0.5	July 3, 1893	+
320	do	do	102.6	104.2	12	7	1.6	June 15, 1893	—
321	do	do	102.2	103.4	13	7	1.2	June 29, 1893	—
322	do	0.2 cc. S	102.5	103.0	13	6	0.5	July 3, 1893	+
323	do	0.25 cc. S	103.5	106.4	10	12	2.9	Apr. 12, 1893	+
324	do	do	104.0	105.8	7	17	1.8	do	+
325	Mar. 21, 1893	0.4 cc. K	102.0	102.0			0	Not killed.	
326	do	do	102.2	102.8		3	0.6	do	
327	do	do	103.2	103.4		1	0.2	do	
328	do	do	102.0	104.2	7—	13	2.2	May 12, 1893	+
329	do	do	103.0	107.5	7—	16+	4.5	Apr. 28, 1893	+
330	do	do	102.2	105.8	9	14+	3.6	Apr. 25, 1893	+
331	do	do	102.0	106.2	8	15+	4.2	Apr. 18, 1893	+
332	do	do	102.4	107.1	7—	16+	4.7	Apr. 14, 1893	+

* A minus sign after a number indicates that the temperature following the injection had already risen above the maximum of the previous day the first time it was taken after injection.

† A plus sign after a number indicates that the last time the temperature was taken after injection it was still higher than the maximum of the previous day.

A.—*First injection of tuberculin*—Continued.

No. of animal.	Date of injection.	Kind and dose of tuberculum used.	Maximum temperature before injection.	Maximum temperature after injection.	Number of hours after the injection when the temperature first exceeded the maximum of the previous day.*	Number of hours after the injection during which the temperature was higher than the maximum of the previous day.†	Amplitude of reaction.	Date when killed and examined post-mortem.	Absence or presence of tuberculosis (+ present, − absent).
			° *F.*	° *F.*			° *F.*		
333	Mar. 21, 1893	0.3 cc. K	102.0	106.9	7−	16+	4.9	Apr. 18, 1893	+
334	do	0.4 cc. K	102.4	102.9		8	0.5	July 6, 1893	+
335	do	do	102.2	107.8	7−	16+	5.6	Apr. 25, 1893	+
336	do	do	102.6	106.0	8	15+	3.4	June 1, 1893	+
337	do	do	102.6	105.5	9	14	2.9	Apr. 14, 1893	+
338	Mar. 27, 1893	0.3 cc. K	103.6	103.8		1	0.2	Apr. 4, 1893	+
339	do	0.4 cc. K	102.0	103.6	7−	16+	1.6	June 19, 1893	+
340	do	do	101.6	104.0	7−	16+	2.4	May 23, 1893	−
341	do	do	103.0	105.6	7−	16+	3.0	May 19, 1893	+
342	do	do	102.2	106.0	7−	16+	3.8	do	+
343	do	do	101.6	107.0	7−	16+	5.4	May 12, 1893	+
344	do	do	101.8	105.2	9	15+	3.4	May 16, 1893	+
345	do	do	101.6	106.9	7−	16+	5.3	May 12, 1893	+
346	do	do	101.8	106.4	10	14+	4.6	May 16, 1893	+
347	Apr. 12, 1893	0.2 cc. S	102.8	106.8	9	15+	4.0	May 5, 1893	+
348	do	0.25 cc. S	102.7	106.2	10	14+	3.5	May 3, 1893	+
349	do	do	102.6	106.7	7−	16+	4.1	May 5, 1893	+
350	do	0.35 cc. S	101.6	106.0	9	15+	4.4	May 10, 1893	+
351	do	0.25 cc. S	102.6	106.7	7−	16+	4.1	May 3, 1893	+
352	do	do	103.0	106.2	9	15+	3.2	May 10, 1893	+
353	do	do	102.6	103.8	12	7	1.2	May 3, 1893	−
354	May 1, 1893	do	103.5	106.0	10	13+	2.5	June 8, 1893	+
355	do	do	102.8	105.4	11	12+	2.6	do	+
356	do	do	102.0	104.0	12	11+	2.0	June 12, 1893	+
357	do	do	102.8	103.0		3	0.2	July 13, 1893	−
358	do	do	102.0	105.6	12	11+	3.6	May 27, 1893	+
359	do	do	103.2	107.3	7−	16+	4.1	June 15, 1893	+
360	do	do	102.4	102.8		1	0.4	July 6, 1893	+
361	do	do	102.6	105.8	10	13+	3.2	May 27, 1893	+
362	do	do	102.8	104.8	8	13	2.0	June 12, 1893	+
363	do	do	103.2	106.0	11	10	2.8	June 19, 1893	+

* A minus sign after a number indicates that the temperature following the injection had already risen above the maximum of the previous day the first time it was taken after the injection.

† A plus sign after a number indicates that the last time the temperature was taken after injection it was still higher than the maximum of the previous day.

B.—*Second injection of tuberculin.*

No. of animal.	Date of injection.	Number of days since the first injection.	Kind and dose of tuberculin used.	Maximum temperature before injection.	Maximum temperature after injection.	Number of hours after the injection when the temperature first exceeded the maximum of the previous day.	Number of hours after the injection during which the temperature was higher than the maximum of the previous day.	Amplitude of reaction.	Date when killed and examined post-mortem.	Absence or presence of tuberculosis (+ present, — absent).
				° F.	° F.		° F.			
301	Mar. 21, 1893	47	0.4 cc. K	102.7	106.5	7—	16+	3.8	Mar. 24, 1893	+
302	do	47	do	102.2	106.8	7—	16+	4.6	do	+
303	Feb. 2, 1893	57	0.25 cc. S	102.0	105.6	7	18	3.6	Mar. 18, 1893	+
304	do	57	do	102.3	102.6		1	0.3	Apr. 21, 1893	—
305	Mar. 21, 1893	47	0.4 cc. K	102.0	103.0	15	5	1.0	June 29, 1893	—
306	Feb. 2, 1893	57	0.25 cc. S	102.2	106.4	11	14	4.2	Mar. 21, 1893	+
307	Mar. 21, 1893	47	0.5 cc. K	103.0	106.3	7—	15+	3.3	Apr. 4, 1893	+
308	do	47	0.35 cc. K	102.2	103.0	7—	11	0.8	June 5, 1893	+
309	do	47	do	102.4	104.0	16	3	1.6	do	+
310	do	47	0.2 cc. K	102.6	106.0	7—	11	3.4	Apr. 4, 1893	+
311	Mar. 16, 1893	99	0.25 cc. S	102.4	106.6	8	15	4.2	Mar. 21, 1893	+
312	Mar. 27, 1893	11	0.4 cc. K	102.0	104.8	7	16+	2.8	Apr. 28, 1893	+
313	do	11	do	102.4	104.4	10	12	2.0	Apr. 7, 1893	+
314	Mar. 16, 1893	99	0.25 cc. S	102.6	107.0	7	14	4.4	Mar. 18, 1893	+
315	Mar. 27, 1893	11	0.4 cc. K	102.2	105.2	7—	13	3.0	June 1, 1893	+
316	do	11	do	103.1	106.0	10	14+	2.9	Apr. 7, 1893	+
317	do	11	0.3 cc. K	102.8	102.7			—0.1	Apr. 21, 1893	+
318	Apr. 12, 1893	27	0.2 cc. S	103.4	107.2	7—	15+	3.8	Apr. 14, 1893	+
319	Mar. 27, 1893	11	0.2 cc. K	103.0	103.0			0	July 3, 1893	+
320	do	11	0.3 cc. K	102.8	102.6			—0.2	June 15, 1893	—
321	do	11	do	102.5	102.0			—0.5	June 29, 1893	—
322	do	11	0.2 cc. K	102.8	104.2	12	3	1.4	July 3, 1893	+
323	do	11	0.3 cc. K	103.4	105.2	7—	6	1.8	Apr. 12, 1893	+
324	do	11	do	102.8	107.0	7—	16+	4.2	do	+
325	May 25, 1893	65	0.25 cc. S	102.8	103.0	17	2	0.2	Not killed.	
326	do	65	do	103.0	103.4		1	0.4	do	
327	do	65	do	102.0	103.6	7—	14+	1.6	do	
328	Apr. 12, 1893	22	do	102.7	105.4	9	14	2.7	May 12, 1893	+
329	do	22	do	103.4	105.8	7—	16+	2.4	Apr. 28, 1893	+
330	do	22	do	102.0	105.2	7	16+	3.2	Apr. 25, 1893	+
331	do	22	do	101.8	105.8	7—	16+	4.0	Apr. 18, 1893	+
332	do	22	do	102.8	106.2	7—	16+	3.4	Apr. 14, 1893	+
333	do	22	do	102.4	105.6	9	9	3.2	Apr. 18, 1893	+
334	do	22	do	101.8	102.5	16	5	0.7	June 6, 1893	+
335	do	22	do	102.0	105.2	7—	12	3.2	Apr. 25, 1893	+
336	do	22	do	102.8	104.9	12	12+	2.1	June 1, 1893	+

B.—*Second injection of tuberculin*—Continued.

No. of animal.	Date of injection.	Number of days since the first injection.	Kind and dose of tuberculin used.	Maximum temperature before injection.	Maximum temperature after injection.	Number of hours after the injection when the temperature first exceeded the maximum of the previous day.	Number of hours after the injection during which the temperature was higher than the maximum of the previous day.	Amplitude of reaction.	Date when killed and examined post-mortem.	Absence or presence of tuberculosis (+ present, — absent).
				° *F.*	° *F.*		° *F.*			
337	Apr. 12, 1893	22	0.25 cc. S	102.0	105.0	7—	16+	3.0	Apr. 24, 1893	+
338*									Apr. 4, 1893	+
339	May 1, 1893	35	0.25 cc. S	103.0	103.5	0	1	0.5	June 19, 1893	+
340	do	35	do	102.2	102.6	14	4	0.4	May 23, 1893	—
341	do	35	do	103.4	106.0	8	16+	2.6	May 19, 1893	+
342	do	35	do	103.4	104.2	19	5	0.8	do	+
343	do	35	do	102.6	106.2	7—	14	3.6	May 12, 1893	+
344	do	35	do	102.4	102.0			—0.4	May 16, 1893	+
345	do	35	do	102.4	106.4	7—	16+	4.0	May 12, 1893	+
346	do	35	do	102.6	103.5	12	9	0.9	May 16, 1893	+
347	do	19	0.2 cc. S	103.6	104.2	17	2	0.6	May 5, 1893	+
348	do	19	0.25 cc. S	102.2	103.2	12	10	1.0	May 3, 1893	+
349	do	19	do	102.0	103.8	7—	16+	1.8	May 5, 1893	+
350	do	19	0.35 cc. S	102.2	105.0	12	11+	2.8	May 10, 1893	+
351	do	19	0.25 cc. S	102.4	105.6	7—	16+	3.2	May 3, 1893	+
352	do	19	do	104.0	104.3	7—	2	0.3	May 10, 1893	+
353	do	19	do	102.6	104.3	12	10	1.7	May 3, 1893	—
354	May 25, 1893	24	do	102.6	103.0	17	5+	0.4	June 8, 1893	+
355	do	24	do	103.2	102.8			—0.4	do	+
356	do	24	do	102.0	102.8	17	5	0.8	June 12, 1893	+
357	do	24	do	105.0	102.5			—2.5	July 13, 1893	—
358	do	24	do	101.8	102.9	13	10	1.1	May 27, 1893	+
359	do	24	do	103.4	103.0			—0.4	June 15, 1893	+
360	do	24	do	102.2	102.5		1	0.3	July 6, 1893	+
361	do	24	do	102.4	102.5		1	0.1	May 27, 1893	+
362	do	24	do	102.4	103.0	16	4	0.6	June 12, 1893	+
363	do	24	do	102.8	102.7			—0.1	June 19, 1893	+

* Received no second injection.

Table A gives the result of the first injections. The absence or presence of a reaction supported by the absence or presence of tuberculosis is so clear in 50 of the 60 animals examined post-mortem that they require no special attention. This leaves 10 animals of more doubtful character, which we will consider in order (see pp. 31–58 for complete notes):

No. 305.—The maximum temperature after injection, which is 102.8° F., is not sufficiently high, although it is 1° F. above the maximum temperature previous to injection, to pass as a reaction in a herd of 63 cattle among which 18 gave a maximum temperature of 102.8° F. or more before injection. Neither is the elevation in the temperature after injection over and above the maximum temperature before injection (only three hours) of sufficient duration to be regarded as a reaction. Hence the absence of tuberculosis in this animal was properly indicated by the tuberculin injection.

No. 319.—Failed to give a reaction and on post-mortem examination was found tuberculous. The tuberculous foci were small, largely calcareous, and the surrounding tissue free from recent infiltration.

No. 320.—Gave a low reaction in the absence of tuberculosis. The animal is a heifer, which had been served by the bull every three weeks for five or six months previous to the date of conception, February 15, 1893, just one month before the injection.

No. 321.—The highest temperature reached after injection was 103.4° F., and although this is 1.2° F. above the maximum temperature of the previous day, in consideration of the fact that the animal was seven months advanced in her first pregnancy, it is not sufficient to constitute a reaction. On post-mortem no tuberculosis was found, but the animal was affected with a liver disease.

No. 322.—No reaction and tuberculosis present. The lesions are similar to those in No. 319.

No. 334.—No reaction and tuberculosis present.

No. 338.—No reaction and very extensive tuberculosis present.

No. 340.—A decided reaction and no tuberculosis. The animal was supposed to be four months and ten days advanced in pregnancy at the time of the post-mortem examination, one month after the tuberculin test, but in her uterus was found a fetus, about three months old, dead and partly disintegrated.

No. 353.—Will have to pass as a case showing no tuberculosis on post-mortem, but giving a very low or somewhat doubtful reaction.

No. 360.—No reaction and tuberculosis present. Similar to Nos. 319 and 322. A guinea pig inoculated died from tuberculosis in two months.

Thus we have 52 instances out of 60 in which the presence or absence of tuberculosis was correctly indicated by the use of tuberculin as a diagnostic agent, giving a general average of $86\frac{2}{3}$ per cent.

It is questionable whether the absence of reactions in cases Nos. 319, 322, and 360 should have much weight. They must, indeed, be ranked as failures, but they were in all probability stationary cases of disease, dangerous neither to themselves nor other cattle. It is also interesting to note that the two animals without tuberculosis, which must be regarded as having given a reaction, Nos. 320 and 353, show a feebler reaction, which commenced at a later hour and was of shorter duration than the reaction in any animal decidedly tuberculous.

The standard of what should constitute a reaction could conveniently be raised high enough for the herd to exclude these two cases from the number of animals giving a reaction without increasing the number of animals found tuberculous without a reaction.

An examination of Table B, which gives the results of the second injections, will show that the first part corresponds very well with Table A. The results in the latter portion of the table are not reliable, a fact for which we can account at the present time only by assuming the existence of some defect in the tuberculin used.

Since the above was written several instances have come under observation where a second injection failed altogether to produce a reaction in animals which gave a very decided reaction after the first injection, notwithstanding that the two injections were separated by a very considerable period of time.*

OTHER CONDITIONS ASSOCIATED WITH THE TUBERCULIN INJECTIONS.

Swelling and tenderness at the seat of injection, sufficiently severe to be clearly noticeable, were present in less than 20 per cent of the cattle, and were as common among the nontuberculous which gave no reaction as among the tuberculous animals which reacted.

Muscular trembling or shivering, as if from a severe chill, noticeable especially in the flank, was a common occurrence. It was seen in 25 to 30 animals, either after the first or second injection; some cattle showed this condition after the first injection and not after the second, and *vice versa*. It accompanied as a constant feature neither the highest reactions nor those of longest duration, nor was it confined to animals with lesions of a particular kind in character or extent. The most interesting feature about it is that wherever it was seen lesions of tuberculosis were found on post-mortem examination.

A decided softening of the feces, an acceleration of the pulse and respiration, arching of the back, coldness of the hind quarters and extremities, loss of appetite and temporary suspension of rumination, the latter during the time the fever was greatest, are conditions which were observed in a considerable number of animals, but like the swelling and

*Quite recently 6 cows received an injection of tuberculin, which was followed in twenty-four days by a second injection. The following table gives the results of the two injections. For the first injection tuberculin S was used; for the second tuberculin K. Only one animal (No. 5) included in the table was pregnant; it was her fourth pregnancy, in which she was five months advanced at the time of the last injection. It is to be regretted that the animals included in the table could not have been killed and examined post-mortem.—E. C. S.

No. of cow.	Highest temperature before first injection.	Highest temperature after first injection.	Highest temperature before second injection.	Highest temperature after second injection.	Reaction after first injection.	Reaction after second injection.
	° *F.*	°	°		° *F.*	° *F.*
1	102.8	106.2	101.9	104.8	3.4	2.9
2	104.0	106.5	101.7	102.0	2.5	0.3
3	102.8	104.0	102.3	105.1	1.2	2.8
4	101.4	104.8	101.8	106.4	3.4	4.6
5	101.8	104.0	102.4	104.7	2.2	2.3
6	102.6	106.0	102.1	104.0	3.4	1.9

tenderness at the seat of injection, they have apparently no practical significance.

So far as it was possible to observe, no unfavorable condition was produced in any animal by the tuberculin injections. In regard to this matter most observers are agreed.*

A reduction in the milk secretion, if this occurred, was only temporary, and too small in amount to attract attention in a large herd of which only a comparatively small number of cattle were under the influence of the tuberculin at one time. It is reasonable to suppose that the quantity of milk from cattle affected by a loss of appetite was slightly diminished in consequence of the smaller amount of food consumed. The reduction in the milk secretion observed in cattle tested with tuberculin in Karlsruhe and Mannheim was attributed to this cause and to the disturbance of the animal while undergoing the test.† A decided reduction in the milk secretion was observed in cattle tested in Berlin, but the specific gravity of the milk remained unaffected.‡ §

* Deutsche Zeitschrift f. Thiermed. XVIII (1891), p. 97. Arbeiten a. d. Kaiserlichen Gesundheitsamte, VIII (1892), p. 86.

† *Ibid.*, p. 86.

‡ *Ibid.*, pp. 40, 41.

§ The amount of milk secreted by 65 to 70 cows in a herd of 134 cattle which were injected with tuberculin in Virginia was 800 pounds the day before and 750 pounds the day after the injection. In 71 per cent of the herd the injection was followed by a reaction.

Unfortunately this herd could not be kept under observation a longer time than the tuberculin test actually required to determine the number of animals affected with tuberculosis, and hence no exact data could be secured on the amount of milk secreted by the cows during the first eight to ten days after the injection. On this last point the manager of the herd informs me that a reduction in the amount of milk commenced the day after the injection, that it was progressive during several days, and reached its climax the fourth or fifth day, and that the daily amount of milk then increased again until it reached its normal about the tenth day.

In this connection the following table may be of interest. It includes 6 cows, each of which was injected with 0.3 cc. of tuberculin K. The amount of reaction (the difference between the highest temperature the day before and the day after the injection) is given in degrees F., and the amount of milk in pounds the day before and after the injection.

No. of cow.	Amount of reaction.	Milk before injection.	Milk after injection.	Reduction in milk after injection.
1	2.9	16.1	15.0	1.1
2	0.3	27.1	27.8	−0.7
3	2.8	17.7	16.2	1.5
4	4.6	22.5	17.1	5.4
5	2.3	17.3	17.1	0.2
6	1.9	30.9	29.1	1.8
Total		131.6	122.3	9.3

Of the above cows all, except No. 5, had calved within the last two to five months, and were not pregnant. No. 5 had calved eight months previous to the test and was five months advanced in pregnancy.

In another herd in Virginia, in which 15 cattle were injected with tuberculin, and 70 per cent of the milk cows reacted, a marked reduction in the amount of milk yield during the first few days after the injection was reported.—E. C. S.

In our test we made no examination of the urine. In the Berlin tests already referred to it was observed that the specific gravity remained uninfluenced, but that the alkalinity and the amount of sodium chloride were increased in almost every case, in tuberculous as well as non-tuberculous cattle. This condition was very marked the second day after the injection, and reached its highest point the fourth day. The increased alkalinity and the increased amount of sodium chloride did not keep pace with each other, so that when the alkalinity had reached its highest point a reduction occurred in the sodium chloride and inversely.*

All the injections with tuberculin in cattle published up to March 15, 1892, have been included in a general résumé by A. Eber.† He describes the various conditions it is necessary to observe in experiments the purpose of which is to determine the value tuberculin possesses as a diagnostic agent in tuberculosis. The conditions are much the same as those now generally accepted, and correspond fairly well with the conditions we have observed in our work. After applying them to the tuberculin injections with which his résumé deals, he finds 443 cases sufficiently free from objectionable features to answer as material for reliable conclusions. Of the 443 animals injected, the condition as regards tuberculosis was correctly determined in 375 cases, which is equivalent to 15.35 per cent of failures. The result of the first injections in the Soldiers' Home herd compares favorably with this, and while it is a rate of failures too high to give more than partial satisfaction, it is so great an improvement over all other known methods by which tuberculosis can be diagnosed that the importance of tuberculin can hardly be too highly estimated. It must also be borne in mind that the eight animals in the Soldiers' Home herd in which the tuberculin is represented as having given false results are, with one exception, involved in a degree of doubt. Nos. 319, 322, 334, and 360, which gave no reaction, certainly were not free from lesions of tuberculosis, but in 3 of the 4 animals there was no recent infiltration, and if the lesions in all four animals had been concentrated in only one animal, they would still have been too slight to have given the remotest intimation of their presence where their detection depended on the usual methods of examination. The absence of tuberculosis in Nos. 320, 340, and 353 is questionable in the presence of the reaction after injection with tuberculin, in the sense that absence here may mean, simply, not found after careful search. Because of economical considerations the carcasses of the cattle in which the lesions were slight, or apparently absent, were not mutilated to any extent which would have destroyed their value as food.

The absence of a reaction in No. 338 is peculiar; it was an advanced case of tuberculosis, in which the affection was readily diagnosed almost

* *Ibid.*, p. 55.

† Deutsche Zeitschrift f. Thiermedicin, XVIII (1892), p. 321.

a year previous to the injection. Other observers have noticed that occasionally very advanced cases of tuberculosis fail to react, and that the reaction is frequently highest in young animals in the first stages of the disease.*

CONCLUSIONS AND SUGGESTIONS.

It is not necessary to repeat the many favorable opinions expressed by different observers in support of the value which is claimed for tuberculin as an aid in diagnosing doubtful cases of tuberculosis in cattle. The number of instances in which the conditions indicated by the results of the injections do not conform to the conditions found on post-mortem examination is so many times less the number of errors from all other methods used to diagnose tuberculosis, and there are so many cases of tuberculosis which could not possibly be detected by any other method, that even they who are least inclined to favor the use of tuberculin can not fail to recognize its importance.

The precise composition of tuberculin is unknown, its exact qualities have not been determined, and the methods used to test its strength and purity are imperfect. With further improvement in these respects we may expect more accurate results from tuberculin injections in the future.

To make a tuberculin test for practical purposes we believe it necessary to observe the following rules. In laying down these few simple rules we have kept in mind that it is desirable, from an economical point of view, to strip every test for practical purposes of all unnecessary labor or expenditure of time.

The temperature of the animals to be tested should be taken every two hours at least six or seven times before the injections are made, because without a knowledge of the variations before the injections it is frequently impossible to estimate correctly the value of the elevations after the injections. This precaution may have the appearance of an unnecessary waste of time and labor where the temperature before the injections varies only within what are usually regarded strictly normal limits for cattle. But the temperature does not always confine itself within these limits, and strictly normal limits for one herd and one set of conditions are not strictly normal limits for all herds and all conditions, and the exceptions, which certainly can not be justly neglected, can be selected only by a number of accurate measurements.

The importance of this rule will become more apparent if we turn to the temperature tables and examine the temperature previous to injection of the 14 animals in which a height of 103° F. was reached.

The following table gives the numbers of the 14 animals, the highest point reached by the temperature before the injection and the hour in which that point was reached, the temperature of each animal at 9

*Arbeiten a. d. kaiserlichen Gesundheitsamt, VIII (1892), pp. 54 and 55. The Journal of Com. Med. and Vet. Arch., Vol. XV (1894), p. 13.

a. m. the same day, and the difference in degrees between the highest temperature and the 9 a. m. temperature.

No. of animal.	Highest temperature before the first injection and the hour of occurrence.	Temperature, 9 a. m., before first injection.	Difference between the highest and lowest.	No. of animal.	Highest temperature before the first injection and the hour of occurrence.	Temperature, 9 a. m., before first injection.	Difference between the highest and lowest.
	° F.	°	°		° F.	°	°
312	103.0— 4 p. m.	100.0	3.0	329	103.0— 6 p. m.	100.6	2 4
317	103.0— 5 p. m.	101.0	2.0	338	103.6— 2 p. m.	102.2	1.4
318	103.0— 6 p. m.	98.8	4.2	342	103.0—10 p. m.	101.8	1.2
319	103.3— 5 p. m.	99 8	3.5	352	103.0— 6 p. m.	102.6	0.4
323	103.5— 5 p. m.	99.7	3.8	354	103.5— 6 p. m.	101.8	1.7
324	104.0— 5 p. m.	101.0	3.0	359	103.2— 6 p. m.	101.2	2.0
327	103.0—11 a. m.	102.8	0.2	363	103.2— 6 p. m.	101.9	1.3

We have here 14 animals which, with the exception of Nos. 324, in the last stages of pregnancy, and 338, a case of tuberculosis diagnosed previous to the test, gave no evidence of an affection or a condition accompanying which a great variation in temperature, or an unusually low or high temperature, could be expected; and yet, if these animals had received an injection of tuberculin between 9 and 10 a. m., the day the temperature in the tables was taken, and the presence or absence of a reaction later in the day had been determined from the state of the temperature at 9 a. m., even if the tuberculin in the supposed injections had been absolutely inert, at least three-fourths of the animals would have been looked upon as giving decided reactions.

The degrees of temperature above given were all taken previous to the first injections. If we now turn to the temperature of the same animals taken previous to the second injections, we find that in eight of them very similar variations exist, and that only two of them have a really normal temperature, showing clearly that in many individuals the variations are sufficiently constant to make their determination by precise measurements practically necessary in every tuberculin test from which reliable results are expected. In other words, the variation in the temperature of an animal during the course of a day is frequently so great that, if this variation is not determined, and the temperature is taken only once previous to a tuberculin injection, it is merely a matter of chance if a high temperature, natural to the animal and independent of the action of the tuberculin injection, is not confounded with or erroneously taken for a reaction.

Special stress is laid on this point because, in a recent article which speaks of the use of tuberculin, the opinion is expressed that while a long series of temperatures before injection may be more scientific, a single temperature before injection at 9 p. m. is sufficient for practical purposes.*

An examination of the degrees of temperature of the 24 animals included in Tables II to IX, which were taken during twenty-four con-

* The Journal of Comp. Med. and Vet. Arch., XV (1894), p. 12.

secutive hours previous to injection, will show that the maximum daily temperature was reached four times at 8 a. m., twice at 3 p. m., eight times at 4 p. m., eight times at 5 p. m., once at 6 p. m., and once at 9 p. m. The minimum temperature, with two exceptions, occurred before the hour of noon. Hence, while it is probable that the chances for error with a single temperature before the injection are less when that temperature is taken in the evening, or, better still, in the afternoon between 4 and 5 o'clock, it is clear, with the maximum daily temperature varying in the hour of its occurrence all the way from 8 a. m. to 9 p. m., that the hour at which a single temperature is taken does not signify much, and that it is insufficient in many, if not in all, cases for reliable conclusions.

Next comes the tuberculin, and this unfortunately, which is the most important consideration, is beyond the control of the inspector. The domestic tuberculin, with which our experience is largest, has certainly shown some peculiarities which are best explained by assuming a variation to exist in the strength of preparations of different dates. The imported tuberculin has given fairly constant results in our hands, but we have not used it with sufficient frequency to say that it is better than the domestic article. Dr. Curtice, whose experience with the foreign substance is more extensive, gives some reasons to doubt the constancy of its strength.*

The tuberculin should be properly diluted. One part of tuberculin to 9 parts of water containing from one-half to 1 per cent of carbolic acid has found general favor. The tuberculin prepared by the Bureau of Animal Industry is diluted in the form of a 12½ per cent solution before it leaves the laboratory, and is ready for injection as received.

The dose, if the tuberculin is of the usually supposed strength, is from 4 to 5 cc. (about 1 to 1¼ drams) of the 10 per cent solution of the imported tuberculin, or from 2 to 2½ cc. (about one-half to three-fourths dram) of the 12½ per cent solution of the Bureau tuberculin, for an adult animal of medium size. In our work we have found the Bureau tuberculin to be a little stronger than the German tuberculin.†

The point at which the injection is made seems immaterial. The most convenient place is the side of the neck where the skin is thin, and a large, strong needle gives much more satisfaction than a small, fine one.

After the injection the temperature should again be taken in eight or ten hours, and from then on every two hours until a decided reaction, continuous during several hours, has occurred, or until eighteen or twenty hours have passed since the time of the injection.

In the Soldiers' Home herd the temperature, which commenced to rise before the tenth hour, generally remained elevated from ten to sixteen hours. The temperature, which remained practically equivalent

* The Journal of Comp. Med. and Vet. Arch., xv (1894), p. 13.

† Quite recently other veterinarians have been using very small doses.

to the temperature of the previous day until fourteen or sixteen hours after the injection, never rose high enough or retained its elevation long enough to be taken as a reaction. Nothing will be lost, therefore, by waiting ten hours before taking the first temperature after the injection, or by discontinuing to take the temperature after eighteen to twenty hours.*

In a number of tests made by us for practical purposes only, the temperature of the cattle was taken before the injections every two hours, from 8 a. m. to 8 p. m. The injections were made at 10 p. m. and the temperature after the injections was again taken the following day at 8 a. m., and continued every two hours until 8 p. m. In the herds tested in this manner only the animals which gave reactions were killed, and thus far we have yet to meet the first case which reacted and did not show tuberculosis on post-mortem examination.

PATHOLOGICAL PART.

By Theobald Smith.

The post-mortem examinations of the sixty animals in this herd were made by the writer with the assistance of Drs. Kilborne and Schroeder. Great care was exercised in order that accurate information might be gained concerning the true significance of the results obtained with tuberculin published in the preceding pages. Incidentally, however, a number of interesting facts were observed, some of which have been casually mentioned by other writers, but without that emphasis which is due them as elucidating the channels of infection. Fortunately many of the animals were still in that stage of the disease which permitted the accurate determination of the original focus of infection. Autopsies upon tuberculous cattle are made mainly when the tubercular virus has become pretty generally disseminated through the lymphatic glands and even over the serous membranes and through the various vital organs. A determination of the point in the body whence the virus has spread is, in many of these cases, out of the question. On the other hand, when the disease is in an incipient or quiescent stage it is hidden away in the lymphatic glands, and unless a thorough search is made through every gland in certain regions of the lymphatic system, the disease may be overlooked. This search is not likely to be made on general principles, for it is exceedingly tedious, and not usually of any definite value in diseases other than tuberculosis.

The autopsies in the herd under investigation were limited to the head, the thorax, the abdomen, and the glands of the limbs. Owing to the amount of time spent in searching through the other parts of the body, the brain was not examined in all cases. Inasmuch as this

* When very small doses of tuberculin are used these rules may not hold.

organ is not likely to be primarily affected, and tuberculosis of the central nervous system is quite rare, the inferences and conclusions that may be drawn will not be affected by this omission.

Before discussing the lesions more in detail I deem it desirable to call the attention of the reader to pages 139 and 140, which give, in tabulated form, the distribution of the disease in the body as shown by the organs and structures involved. The table needs no explanation beyond the statement that the entire distribution of the disease is given, nothing being omitted which came to light at the autopsy. The diagnosis, where any doubt existed, was made by the microscopic examination of sections. In several cases guinea-pigs were inoculated to test the vitality of the virus in cheesy material.

The first thing that will strike the reader as remarkable in looking over these tables is the high percentage of infection in a herd in which not more than 5 or 6 showed evidence of disease. The concealed character of the affection was not always limited to the very mild infections, but in some cases considerable lung disease remained unobserved during life. Of the 60 animals killed only 7, or about 12 per cent, were free from all traces of tuberculosis. In the remaining 53 the disease varied very much in intensity, ranging from the smallest, probably quiescent focus in one of the thoracic glands, to advanced tuberculosis.

In order to present these cases more intelligibly I shall discuss, in the order named, (1) tuberculosis of the glands of the head and neck, (2) of the thoracic organs, and (3) of the abdominal organs.

In the head the disease was restricted mainly to the retro-pharyngeal glands (*Glandulæ tracheales seu cervicales superiores* [*profundæ*]). These glands are easily reached after removing the tongue, and it is convenient to remove them together with the tonsils for examination. From the table it will be seen that these glands were diseased in 9 cases (17 per cent). In 5 they contained the only foci discoverable. In the remaining 4 disease of other structures also was present. The submaxillary lymph glands were free in all cases. In one case (No. 315) the tonsils and one parotid lymph gland were tuberculous.

The retro-pharyngeal glands, situated dorsad and to one side of the pharynx and larynx, receive the afferent lymphatic vessels from the parotid and the submaxillary lymph glands* and hence the territory drained by the lymphatic vessels, which finally enter these glands, includes the mucous membrane of the mouth and nose, in other words, of the entire portion of the respiratory and digestive tract lodged in the head and upper portion of the neck.

In the five cases in which tuberculosis of the retro-pharyngeal glands was the only discoverable focus (Nos. 309, 315, 329, 344, and 352), the tubercle bacillus must have been carried from the mucous membrane of the mouth, nose, tonsil, or pharynx into the gland. We do not know, therefore, whether the virus was deposited from respired air or taken

* Encyklopädie der gesammten Thierheilkunde, VI, 216.

in with the food. Infection of these glands, however, is generally regarded as introduced with the food. In case of No. 337 there was also lung disease, and it is impossible to determine whether the infection was primary or due to bacilli coughed up from the lungs. The same may be said of No. 343.

In No. 363, on the other hand, the infection of this gland was probably independent of the infection of the thoracic glands. The number of cases of tuberculosis which may be overlooked, if these glands are not examined, is by no means insignificant. In the herd under discussion the 5 animals affected with primary tuberculosis of the glands of the head (about 9 per cent) did not manifest during life any difficulties in breathing. In fact, the glands had not become large enough to cause any obstruction to respiration or deglutition.

The disease in the *thoracic organs* is of considerable interest to us, for it confirms the statement made by other observers that most cases of bovine tuberculosis are of pulmonary origin. This means that tubercle bacilli are taken up mainly in the dried condition and carried by currents of air as dust into the ramifications of the air tubes.

A glance at the table shows that out of fifty-three cases of tuberculosis, forty-seven, or 88.6 per cent, were affected with tuberculosis of organs situated in the chest. The disease involved one or all of the following structures: Bronchial glands, mediastinal glands, lung tissue (including air tubes), pleura.

The distribution of the lesions is of considerable interest. The lungs themselves were affected in 20 animals, while the other 27 had lesions in either bronchial or posterior mediastinal glands, or both, without lung disease. Taking it for granted at present that in nearly all cases the tubercle bacilli which are lodged in the bronchial and mediastinal glands have passed through the lungs, the great predominance of pulmonary infection, as compared with other channels of infection in this herd, becomes evident.

It is of considerable importance to note that of 47 animals having tuberculous lesions in the thorax, 27 had only gland tuberculosis. If, in other words, the lungs only had been examined and the lymph glands associated with them neglected, either in part or as a whole, 48 per cent of the cases would have been passed as free from tuberculosis. In a few of these, however, the mesenteric glands were likewise affected, so that some might have been detected from these foci.

Turning to infection, by way of *the digestive tract*, we may note at the outset that of the 53 infected animals only one had tuberculous lesions of the mucous membrane of the small intestine. In this case (No. 338) tuberculosis had become generalized over the entire lymphatic system, the lungs were almost completely converted into tuberculous masses and the serous membranes of thorax and abdomen were studded with them. The animal was very weak and lying down most of the time shortly before it was killed. Nevertheless, there was no

macroscopic evidence of generalized tuberculosis, for the parenchyma of liver, spleen, and kindneys was free from visible tuberculous lesions. The intestinal infection consisted of an infiltration of all Peyer's patches, followed by marked thickening of the walls and subsequent ulceration. The borders of the excavated patches were thickened until the latter assumed a decided boat-shaped outline. The mesenteric glands were very large and completely caseous.

Infection by way of the intestinal tract was indicated in fourteen cases by tuberculosis of a smaller or larger number of mesenteric glands.

To these should be added three cases in which only the portal system was infected and in which the infection probably came from the digestive tract. There were, therefore, in all eighteen cases with tuberculous lesions, resulting from an entrance of the bacilli by way of the intestines. The question whether this infection was primary, or secondary to disease of the lungs is worthy of consideration and may be partially answered by an examination of the individual cases.

In the severe case with tuberculous ulceration of Peyer's patches the tubercle bacilli probably came from the lungs. That they were discharged in abundance was demonstrated by the condition of the larynx and trachea. The mucous membrane of this tube was densely packed with tubercles, so as to form a compact elevated layer. The tubercle bacilli coughed up from the lungs produced tuberculosis of the trachea and when swallowed the bacilli attacked the intestinal walls. Among the remaining seventeen cases there are some (Nos. 307, 335, 347, 348, 355, and 358) in which the infection must be regarded either as independent of or simultaneous with the chest affection, since it would be impossible to explain how tubercle bacilli could travel from a closed focus in the bronchial and mediastinal glands to the mesenteric or the portal glands, and to them only.

There is but one case (No. 333) in which there was intestinal infection without lung infection.

The cases that still remain are all associated with disease of the lungs (Nos. 303, 306, 311, 314, 318, 324, 336, 337, 339, and 362). In these the infection of the mesenteric glands and the liver may have been contemporaneous with the lung infection. Of the tubercle bacilli introduced into the body at the same time some may have found their way into the digestive tract, others into the lungs. A perusal of the autopsy notes will show, however, that, at least in some of these cases, the intestinal infection is more recent and much less pronounced than the lung infection, and may have been brought about by swallowing tuberculous matter coughed up from the air tubes.

The infection of the liver or the lymph glands at the hilus, already mentioned above, was observed in nine cases. In six of these the infection of the liver was associated with tuberculosis of the mesenteric glands, and hence it is reasonable to regard them as both originating in the digestive tract. Of the three cases remaining, two showed tuber-

culosis of the glands at the hilus, and in one the liver contained a large tuberculous focus. These were probably of intestinal origin, for the infection of the body as a whole was either very slight (Nos. 307, 335) or else traceable to pulmonary disease (No. 324).

The infection by way of the lungs was, therefore, much more prevalent in this herd than infection by way of the intestines, the ratio being as 2.6 to 1, even if we regard all the cases of intestinal infection as primary, which I think no one will concede. In fact, the ratio is probably nearer 5 to 1.

A point very important from the standpoint of prevention is the condition of the bacilli when entering the body. Primary lung infection can not take place unless the bacilli are inspired with the air. They must, therefore, be dried and carried as dust. Hence in 88.6 per cent of the cases the infection, either as a whole or in part, was caused by dried bacilli capable of floating in the air.

The udder was found free from tuberculous deposits in all cases. In one, however (No. 303), there were large caseous foci in the pubic or udder lymph glands. These are evidence of a former infection of the udder itself. Taking this and all other cases of equal severity into consideration I am inclined to look upon this infection as internal in origin, that is, carried to the udder in the blood from some other focus, and not as a result of infection from without. There was no sign of uterine infection in any animal.* In several cases of advanced tuberculosis of the appendages of uterus (ovaries and Fallopian tubes) and slight tuberculosis of the uterus itself which have come under my observation during the past three or four years the infection evidently traveled from the peritoneum, which was extensively diseased in such animals.

A summary of the disease in this herd, grouped with regard to the distribution of the lesions, is presented in the following table:

Total number of animals in the herd examined	60
Total number of animals infected (88 per cent)	53
Number in which retropharyngeal glands only were affected	5
Total number in which retropharyngeal glands were affected	9
Number in which disease of the thoracic organs was detected	47
Number in which lungs were affected	20
Number in which thoracic glands but not the lungs were diseased	27
Number in which only bronchial glands were affected	5
Number in which only mediastinal glands were affected	5
Number in which lungs diseased and glands healthy	1
Number with exclusively thoracic lesions (air infection)	26
Number in which digestive tract, including head glands, affected	26
Number in which intestinal walls were affected	1
Number in which mesenteric glands were affected	16
Number in which portal glands were affected	10
Number in which mesenteric and not portal glands affected	10

* The very advanced case (No. 338) was not examined with reference to this organ.

Number in which portal and not mesenteric glands affected	4
Number in which parenchyma of liver involved	2
Number in which serous membranes affected	2
Number in which udder glands affected	1

SUMMARY OF TUBERCULIN REACTION AND AUTOPSY NOTES.

[The clinical notes and the tuberculin reactions were supplied by Drs. Kilborne and Schroeder. For the autopsy notes Dr. Smith is responsible.]

No. 301.—Cow, three-fourths Holstein, 4 years old. Weight, 850 pounds. Calved summer of 1892; still giving milk. Pregnant since August 21, 1892. Condition good.

February 2, 1893: 9 a. m., first injection, 0.25 cc. tuberculin S.; 6 to 7 p. m., periods of trembling observed. Feces softened and passed more frequently than usual. Before injection, minimum temperature, 100.1° (10 a. m.); maximum, 102° (3 p. m.). After injection, minimum temperature, 101.2° (1 p. m.); maximum reached in twelve hours, 106.8° (9 p. m.). (For complete record see p. 60.)

March 21, 1893: Midnight, second injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102.7° (4 p. m.);* after injection, reached in sixteen hours, 106.5° (4 p. m.). (For complete record see p. 69.)

March 24, 1893: Killed for examination.

Autopsy.—Thorax: All the bronchial and posterior mediastinal glands infected. The disease appears as foci of grayish infiltration in which are delicate networks of yellowish lines (necrosis). The foci are up to one-half inch in diameter and all appear to be in about the same stage.

Lungs: Trachea and bronchi free from any visible tuberculous changes.

Abdomen: One mesenteric gland contains a focus about three-eighths inch in diameter completely transformed into gritty particles.

One gland at the portal fissure contains a tuberculous focus about one-half inch in diameter in which the disease process is perhaps somewhat farther advanced than in the bronchial glands.

No. 302.—Holstein cow, 5 years old. Weight, 850 pounds. Calved July, 1892; still giving milk. Pregnant since September 30, 1892. Condition good.

February 2, 1893: 9 a. m. first injection, 0.25 cc. tuberculin S.; 5 to 10 p. m., pulse fuller and stronger than before injection. Respiration somewhat accelerated. Feces softened. Before injection, minimum temperature, 100° (9 a. m.); maximum, 102.2° (4 p. m.). After injection, minimum temperature, 101° (1 p. m.); maximum, reached in ten hours, 107.4° (7 p. m.). (For complete record see p. 60.)

March 21, 1893: Midnight, second injection, 0.4 cc. tuberculin K.

March 22: 10 a. m., periods of slight trembling observed. Before injection, maximum temperature, 102.2° (6 p. m.); after injection, reached in twelve hours, 106.8° (12 a. m.). (For complete record see p. 69.)

March 24, 1893: Killed for examination.

Autopsy.—Thorax: The caudal two-fifths of right caudal lobe of lungs completely tuberculous. The disease appears most advanced along the cephalic border of the involved mass. Here the lung tissue is transformed into soft caseous masses containing some gritty particles, which are over one-half inch in diameter and inclosed in connective tissue capsules. Toward the caudal extremity of the lobe the foci are yellowish, necrotic, but not yet broken down, excepting in a few cases. The bronchus contains a few soft grayish and some caseous tubercles breaking through the mucosa. There are several cheesy masses lying free on the mucosa. At bifurcation there are two irregular spots on the mucosa of trachea one-half inch in diameter, made up of young and caseous tubercles.

*In giving the hour of minimum and maximum temperature when the same occurs more than once the hour of first occurrence is given.

A second focus of disease is found embedded in the left caudal lobe. It consists of a soft caseous mass about one-half inch in diameter without any surrounding recent infiltration and not in direct relation with any air tube.

The most caudal of the posterior mediastinal glands is from six to ten times the normal size and contains upwards of fifty tuberculous foci, from one-eighth to one-half inch in diameter. They are all necrotic but not yet softened. Only one of the bronchial glands contains a focus about three-eighths inch in diameter, which is in the same stage as those in the mediastinal glands.

No. 303.—Holstein cow, 5 years old. Weight, 950 pounds. Calved July, 1892; still giving milk. Pregnant since December 2, 1892. Condition good, but has an occasional hacking cough.

December 7, 1892, 6 a. m.: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102.5° (8 a. m.); after injection, reached in ten hours, 107° (4 p. m.). (For complete record, see p. 59).

February 2, 1893, 9 a. m.: Second injection, 0.25 cc. tuberculin S. From 10 p. m. February 2 to 5 a. m. February 3 the respiration was more or less labored and the cough more frequent. Feces softened, and passed more frequently than usual. Before injection, minimum temperature, 99° (10 a. m.); maximum, 102° (4 p. m.). After injection, minimum temperature, 100.3° (12 a. m.); maximum, reached in eleven hours, 105.6° (8 p. m.). (For complete record see p. 60).

March 18, 1993: Killed for examination.

Autopsy.—Udder: In one of the lymph glands on the right half of the udder four tuberculous foci, varying from one-eighth to one-half inch in diameter. The glands of the left half of the udder contain a number of tuberculous foci, from one-fourth to 1 inch in diameter. All contain a mortar-like substance, with many gritty particles, and appear to be of the same age. The udder itself does not show any disease.

Thorax: The lungs are more or less affected. In the right there are a few nodules in the cephalic lobe; in the caudal lobe a mass as large as a hen's egg, and the entire caudal half involved. In the left lung there is one small nodule in cephalic lobe, three foci fully one-half inch in diameter in the ventral lobe. The caudal lobe is affected very much like its corresponding right lobe. The various foci are situated chiefly along the median dorsal border of the lungs. The contents of the foci are mainly soft, cheesy in character, the individual masses reaching the size of a hen's egg.

Bronchial and posterior mediastinal glands are enlarged and contain caseous foci one-eighth to one-fourth inch in diameter, embedded in a considerable quantity of hyperplastic tissue. The anterior mediastinals contain a few small nodules.

Abdomen: The mesenteric glands are likewise involved. The foci are caseous but still partially firm in texture, and vary from one-eighth to one-half inch in diameter. Small intestine normal.

The glands at the portal fissure are enlarged and contain caseous nodules.

No. 304.—Holstein cow, 5 years old. Weight, 850 pounds. Calved July, 1892, and is giving milk. Pregnant since September 19, 1892. Condition very good.

December 7, 1892: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102.2° (6 p. m.); after injection, 102.6° (6 p. m.). (For complete record see p. 59.)

February 2, 1893, 9 a. m.: Second injection, 0.25 cc. tuberculin S. Before injection, minimum temperature, 98.6°* (9 a. m.); maximum, 102.3° (4 p. m.). After injection, minimum temperature, 101.2° (1 p. m.); maximum, 102.6° (6 p. m.). (For complete record see p. 60.)

April 21, 1893: Killed for examination.

Autopsy.—No tuberculosis.

*The low initial morning temperature in a few cases was probably due to the fact that the cattle were turned into the yard, where they had access to cold water, just before the experiment commenced.

No. 305.—Holstein cow, 5 years old. Weight, 1,000 pounds. Calved October 23, 1892, and is giving milk. Pregnant. Condition good.

February 2, 1893, 9 a. m.: First injection, 0.25 cc. tuberculin S. Before injection, minimum temperature, 99.4° (9 a. m.) maximum; 101.8° (3 p. m.) After injection, minimum temperature, 100.7° (1 p. m.); maximum, 102.8° (5 p. m.). (For complete record see p. 61.)

March 21, 1893, midnight: Second injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102° (6 p. m.); after injection, reached in sixteen hours, 103° (4 p. m.). (For complete record see p. 69.)

May 25, 1893, midnight: Third injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 101.6° (6 p. m.); after injection, reached in seventeen hours, 103.6° (5 p. m.). (For complete record see p. 74.)

June 29, 1893: Killed for examination.

Autopsy.—No traces of tuberculosis discoverable.

No. 306.—Cow, fifteen-sixteenths Holstein, 6 years old. Weight, 950 pounds. Calved summer of 1892; is giving milk. Pregnant since November 3, 1892.

December 7, 1893, 6 a. m.: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102.6° (8 a. m.); after injection, reached in fourteen hours, 106° (8 p. m.). (For complete record see p. 59.)

February 2, 1893, 9 a. m.: Second injection, 0.25 cc. tuberculin S. Before injection, minimum temperature, 99.6° (10 a. m.); maximum, 102.2° (8 a. m.). After injection, minimum temperature, 100.4° (1 p. m.); maximum, reached in thirteen hours, 106.4° (10 p. m.). (For complete record see p. 61.)

March 21, 1893: Killed for examination.

Autopsy.—Thorax: In the caudal extremity of the left caudal lobe, near the median border and not directly associated with any bronchus, is a tuberculous mass about 1½ inches in diameter. This mass consists of an aggregation of soft cheesy masses, each provided with a connective tissue capsule, and about one-fourth inch in diameter. In the bronchus of this lobe are three or four tuberculous excrescences of the mucosa about three-sixteenths inch in diameter. In the most caudal of the posterior mediastinal glands, which is 5 inches long and 1½ inches wide at widest portion, there are a considerable number of tuberculous foci varying from one-sixteenth to one-half inch in diameter. Several are almost entirely calcareous. The remainder are in a stage indicative of rapid hyperplasia and necrosis. In another gland of the same series near the bifurcation of the trachea, as well as in one of the bronchial glands, there are three or four similar foci.

Abdomen: In many of the mesenteric glands there are minute tubercles with caseous centers, from one to four in a gland, mainly in the cortex. Scattered through the liver tissue chiefly under capsule are small yellowish nodules about one-eighth inch in diameter, probably of parasitic origin.

No. 307.—Cow, half Holstein, 4 years old. Weight, 800 pounds. Calved October 14, 1892, and is giving milk. Pregnant. Condition good.

February 2, 1893: 9 a. m., first injection, 0.25 cc. tuberculin S.; 8 to 9 p. m., marked trembling. Respiration more or less labored. Feces much softened.

Before injection, minimum temperature, 100.8° (4 a. m.); maximum, 102.4° (4 p. m.). After injection, minimum temperature, 101° (1 p. m.); maximum, reached in twelve hours, 107.6° (9 p. m.). (For complete record see p. 61.)

March 21, 1893: Midnight, second injection, 0.5 cc. tuberculin K.

March 22: 7 to 8 p. m., trembling, which becomes very marked about 8 p. m., and then gradually wears off. Feces softened. Before injection, maximum temperature 103° (4 p. m.); after injection, reached in fourteen hours, 106.3° (2 p. m.). For complete record see p. 69.)

April 4, 1893: Killed for examination.

Autopsy.—Thorax: In the most caudal of the posterior mediastinal glands there are about five tuberculous foci ranging from one-fourth to one-half inch in diameter.

They consist of grayish translucent tissue in which is disseminated a network of yellowish lines. One contains a minute calcareous nucleus.

Abdomen: In some mesenteric glands are worm tubercles containing an earth-colored mass.

One of the portal glands contains three tuberculous foci of same character as those in mediastinal gland. The contents are dry and in part calcareous.

No. 308.—Holstein heifer, 2 years old. Weight, 500 pounds. Has never been served by bull. Condition fairly good.

February 2, 1893: 9 a. m., first injection, 0.25 cc. tuberculin S. Before injection, minimum temperature 101° (1 p. m.); maximum, 102.3° (4 p. m.). After injection, minimum temperature 101.1° (12 a. m.); maximum, reached in ten hours, 104.6° (7 p. m.). (For complete record see p. 61.)

March 21, 1893: Midnight, second injection, 0.35 cc. tuberculin K. Before injection, maximum temperature, 102.2° (7 p. m.), after injection, reached in nine hours, 103° (9 a. m.). (For complete record see p. 69.)

May 25, 1893: Midnight, third injection, 0.2 cc. tuberculin S. Before injection, maximum temperature 102.4° (6 p. m.); after injection, reached in eighteen hours, 103° (6 p. m.). (For complete record see p. 74.)

June 5, 1893: Killed for examination.

Autopsy.—The only focus of tuberculosis in this animal is contained in a mediastinal lymphatic gland situated on the dorsal aspect of the trachea at the branching off of the bronchus going to the right cephalic lobe of the lungs. The focus consists of a soft, cheesy, partly gritty mass about one-half inch in diameter. The surrounding tissue is not infiltrated, the gland only slightly enlarged.

No. 309.—Heifer, a mixture of Jersey and Holstein, 2 years old. Weight, 500 pounds. Pregnant since January 22, 1893. Condition fairly good.

February 2, 1893: 9 a. m., first injection, 0.25 cc. tuberculin S.; 6 to 8 p. m., marked trembling, especially violent about 7 p. m. Before injection, minimum temperature 100° (10 a. m.); maximum, 102.4° (5 p. m.). After injection, minimum temperature 101° (12 a. m.), maximum, reached in eleven hours, 104.8° (8 p. m.). (For complete record see p. 62.)

March 21, 1893: Midnight, second injection, 0.35 cc. tuberculin K. Before injection, maximum temperature 102.4° (4 p. m.); after injection reached in sixteen hours, 104° (4 p. m.). (For complete record see p. 69.)

May 25, 1893: Midnight, third injection, 0.2 cc. tuberculin S. Before injection, maximum temperature 102° (8 a. m.); after injection, reached in eighteen hours, 102.6° (6 p. m.). (For complete record see p. 74.)

June 5, 1893: Killed for examination.

Autopsy.—Left retropharyngeal gland enlarged to twice its normal size. On section the parenchyma appears of a more or less uniformly yellowish gray color, and in it are imbedded a considerable number of calcareous particles one-twelfth to one-eighth inch in diameter. The corresponding right gland is larger than normal, but on distinct tubercular changes are detected in it.

No. 310.—Jersey heifer, 18 months old. Weight, 350 pounds. Has never been served by bull. Condition fairly good.

February 2, 1893: 9 a. m., first injection, 0.125 cc. tuberculin S. Before injection, minimum temperature 100° (9 a. m.); maximum, 102.8° (8 a. m.). After injection, minimum temperature, 102° (12 a. m.); maximum, reached in nine hours, 105.8° (6 p. m.). (For complete record see p. 62.)

March 21, 1893: Midnight, second injection, 0.2 cc. tuberculin K. Before injection, maximum temperature 102.6° (4 p. m.); after injection, reached in sixteen hours, 106° (4 p. m.). (For complete record see p. 69.)

April 4, 1893: Killed for examination.

Autopsy.—Thorax: In the most caudal of the posterior mediastinal glands are two tuberculous centers. One is one-half to three-fourths inch in diameter and made up of irregular gritty particles up to one-eighth inch in diameter, embedded in a translucent grayish matrix. The second focus is likewise calcareous. Between the two are pale yellowish necrotic foci about one-eighth inch in diameter, some with a central calcareous particle.

In the gland situated dorsally on the trachea at the root of the bronchus going to right cephalic lobe there are a considerable number of foci varying from one-eighth to one-fourth inch in diameter, the larger calcareous.

No. 311.—Cow, half Holstein, 7 years old. Weight, 850 pounds. Is giving milk. Pregnant since August 24, 1892.

December 7, 1892: 6 a. m., first injection, 0.4 cc. tuberculin K. Before injection, maximum temperature 102.5° (8 a. m.); after injection, reached in twelve hours, 106° (6 p. m.). (For complete record see p. 59.)

March 16, 1893: 9 a. m., second injection, 0.25 cc. tuberculin S.; 9 to 10 p. m., slightly trembling. Before injection, minimum temperature 100° (9 a. m.); maximum, 102.4° (5 p. m.). After injection, minimum temperature, 100.2° (11 a. m.); maximum, reached in fourteen hours, 106.6° (11 p. m.). (For complete record see p. 62.)

March 21, 1893: Killed for examination.

Autopsy.—Thorax: On caudal border of right cephalic lobe, extending inward from free margin for about 1½ inches, is a tuberculous focus 1 inch thick, visible on both lung surfaces and projecting above both surfaces in the collapsed condition of the lung. This focus is situated between the two main branches of the bronchus supplying the lobe. A smaller branch may be traced into it. It consists of a number of small foci up to one-half inch in diameter, made up of soft putty-like cheese, with a central, slightly firmer core, the whole imbedded in fairly firm, not very abundant, connective tissue. Some of the foci are not yet broken down and consist of a yellowish, necrotic center and a grayish, translucent periphery. No calcification is observed. A small segment of the lung tissue on median border of this focus is in a state of tuberculous infiltration of more recent date. The bronchial tubes of this lobe are free from abnormal contents. The mediastinal gland, situated dorsally near right supernumerary bronchus, contains one large focus over one-half inch in diameter, made up of a yellowish, rather soft, cheesy mass. A second focus in the same gland is nearly as large as the first, and contains, in addition to dry, yellowish, cheesy material, a calcareous mass, one-eighth inch in diameter. Besides these, the more or less hyperplastic gland substance contains six or more small necrotic foci.

Abdomen: In the mesenteric glands a few small caseous tubercles are present.

No. 312.—Holstein cow, 6 years old. Weight, 800 pounds. Is giving milk. Pregnant since January 2, 1893.

March 16, 1893: 9 a. m., first injection, 0.25 cc. tuberculin S.; 4:30 p. m., slight trembling, which becomes so violent by 5:30 p. m. that it interferes with counting the pulse. This trembling does not cease entirely until 12 p. m. at 8 p. m. feces considerably softened, each passage followed by straining. Very little of the usual allowance of hay eaten during the evening. Before injection, minimum temperature, 99.8° (10 a. m.); maximum, 103° (4 p. m.). After injection, minimum temperature, 100.4° (11 a. m.); maximum reached in nine hours, 105.2° (6 p. m.). (For complete record see p. 62.)

March 27, 1893, midnight: Second injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102° (4 p. m.); after injection, reached in eleven hours, 104.8° (11 a. m.). (For complete record see p. 69.)

April 28, 1893: Killed for examination.

Autopsy.—Thorax: In the cephalic lobe of the right lung on the median border is a small focus of disease about 1 inch in diameter. A small bronchus leads to it and

near the focus its mucosa is sprinkled with grayish tubercles. The affected lung tissue contains much connective tissue inclosing calcareous foci. There are very few appareutly fresh tubercles.

The posterior mediastinal glands are all affected. The most caudal of the series is cousiderably enlarged, and coutains five dry, largely calcareous foci up to one-half iuch in diameter. There is, in addition, in one end of the gland a considerable development of fresh, grayish tubercles; the same is true of the opposite end of the gland. The second gland of the series coutains a small, calcareous focus about one-eighth inch in diameter. The third gland, about 1 inch iu diameter, contains three or more similar foci. Its exterior is more or less nodulated and retracted. The fourth gland coutains two similar foci and some recent infiltration. The fifth is in the same coudition as the fourth. The sixth glaud contains two similar foci. These glauds are moderately enlarged. The bronchial gland, situated on the root of the left bronchus is about 1½ uches in diameter, of slightly irregular outline, and contaius in its center a partly calcareous focus one-half inch in diameter and several small foci of more recent origin. The other bronchial glands are also involved.

Abdomen: On the peritoneal aspect of the diaphragm and attached to the reticulum is a tumor about 1½ inches in diameter, containiug a small quantity of creamy pus within a dense connective tissue capsule, and surrounded by a considerable quantity of gelatinous-looking connective tissue (traumatism due to foreigu body from reticulum).

No. 313.—Cow, fifteen-sixteeuths Holstein, 6 years old. Is giving milk. Pregnaut since November 25, 1892.

March 16, 1893: 9 a. m., first injection, 0.25 cc. tuberculin S. 9 p. m., periods of slight trembling observed. 10:20 p. m., the trembling is very marked, but ceases by 11 p. m. The long hay not eateu this evening.

March 17, 2 a. m.: Several periods of slight trembling. Before iujectiou, miuimum temperature, 99.4° (10 a. m.); maximum, 102.3° (4 p. m.) After injectiou, minimum temperature, 100.6° (11 a. m.); maximum, reached in fourteen hours, 106.6° (11 p. m.). (For complete record see p. 63.)

March 27, 1893, midnight: Second iujection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102.4° (4 p. m.); after iujection, reached in thirteeu hours, 104.4° (1 p. m.). (For complete record see p. 69.)

April 7, 1893: Killed for examination.

Autopsy.—The only tuberculous lesions found in this animal are two soft masses, about one-half iuch in diameter, in the bronchial gland at the root of the left bronchus.

With a small quantity of this caseous material 2 guinea-pigs were inoculated subcutaneously.

Oue killed two and one-half months after inoculation showed an ulcer at the place of inoculation and the neighboring lymphatics caseous. The spleen aud liver contained masses of tubercles, the retrogastric and the bronchial glands were enlarged and uecrotic.

The second, killed in a dying condition three mouths after iuoculation, showed very extensive tuberculous changes in liver, spleen, and lungs.

In the cow there is considerable enlargement of all thoracic lymph glands, probably due to traumatic pneumonia, resulting from the passage of a foreign body from the reticulum through the diaphragm.

On the serous aspect of the reticulum there is a patch of gelatinous tissue, about 6 by 8 inches square and from one-half to 1 iuch thick, attaching it to diaphragm. The nearest lymph glauds of the paunch are eularged and contain creamy pus. In the thorax the right ventral lobe is enlarged, very firm, and adherent to ribs and diaphragm. A tubular connective tissue passage extends from diaphragm into the affected lobe. The phrenic end is now closed. When this passage was cut a milky pus of penetrating but not offensive odor flowed out from a cavity in the affected

lung tissue about as large as a hen's egg. The firmness of the surrounding lung tissue is due mainly to inflammatory thickening of the interlobular and subpleural tissue. This is most pronounced on the periphery of the cavity, where it forms a thick capsule and decreases gradually from it. The cut surface of the lung tissue presents a marbled appearance in consequence of this condition.

No. 314.—Jersey cow, 6 years old. Weight, 850 pounds. Is giving milk. Pregnant since September 7, 1892.

December 7, 1892, 6 a. m.: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102.5° (4 p. m.); after injection, reached in fourteen hours, 106° (8 p. m.). (For complete record see p. 59.)

March 16, 1893: 9 a. m., second injection, 0.25 cc. tuberculin S. 10:30 p. m., respiration quite short and quick. Very little of the long hay eaten. Feces much softened. Before injection, minimum temperature 99° (9 a. m.); maximum, 102.6° (8 a. m.). After injection, minimum temperature, 100.8° (12 a. m.); maximum, reached in twelve hours, 107° (9 p. m.). (For complete record see p. 63.)

March 18, 1893: Killed for examination.

Autopsy.—Thorax: In the caudal lobe of right lung a triangular mass of tuberculous infiltration about 2 inches in diameter, situated on the cephalic border.

Costal pleura of the left side extending backward from the eighth rib is beset with a small number of isolated and confluent, in part pediceled, tubercles.

In the cephalic lobe of the left lung two tuberculous foci, one about one-half inch in diameter, the other consisting of two nodules, each about one-fourth inch in diameter.

In the caudal lobe of the left lung, near the center, a tuberculous mass of triangular outline, about 4 inches across and 2½ inches thick, tapering toward the lateral border of the lobe.

The tuberculous foci consist of round, encapsuled masses from three-eighths to one-half inch in diameter. The contents, with some exceptions, are still quite firm, not easily disintegrated. Calcareous particles not present. They are surrounded by regions of hypercæmic lung tissue infiltrated with small, partly caseous tubercles or else with lung tissue of nearly normal appearance containing many miliary tubercles. The bronchi leading to the affected regions contain more or less viscid mucus. One leading to a focus more or less softened and broken down contains tubercles on the mucosa.

Bronchial gland at root of left bronchus about 1½ inches in diameter. Contents putty-like, inclosed in a dense capsule in which are embedded small caseous tubercles.

The large posterior mediastinal gland, 4 by 2 by 1½ inches. Parenchyma caseous, as with bronchial gland.

Abdomen: One of portal glands contains a small caseous focus about one-eighth inch in diameter.

A few mesenteric glands contain small, in part caseous, tubercles. Glands not enlarged.

No. 315.—Cow, half Holstein, 6 years old. Weight, 850 pounds. Calved December 2, 1892; is giving milk. Has not been served by bull since calving. Condition good.

March 16, 1893: 9 a. m., first injection, 0.25 cc. tuberculin S. 8 p. m., occasional slight, sharp cough. 9 p. m., pulse quite strong, but the beats are short and sharp. Before injection, minimum temperature, 98.6° (9 a. m.); maximum, 102.4° (5 p. m.). After injection, minimum temperature, 100.8° (12 a. m.); maximum, reached in twelve hours, 106.8° (9 p. m.). (For complete record see p. 63.)

March 27, 1893, midnight: Second injection, 0.4 cc. tuberculin K. Before injection maximum temperature, 102.2° (4 p. m.), after injection, reached in thirteen hours, 105.2° (1 p. m.). (For complete record see p. 70.)

May 25, 1893, midnight: Third injection, 0.5 cc. tuberculin S. Before injection, maximum temperature 103.1° (8 p. m.); after injection, reached in twelve hours, 105.3° (12 a. m.). (For complete record see p. —.)

June 1, 1893: Killed for examination.

Autopsy.—Right parotid lymph gland contains several tuberculous foci with cheesy contents embedded in a mass of firm connective tissue. These foci are each about one-fourth inch in diameter. Both retro-pharyngeal glands are enlarged, about 2 by 1 by ½ inch in size, quite nodular in form. On section both glands are almost completely converted into a mass of confluent tuberculous foci. Each focus is about one-fourth inch in diameter, with soft center of putty-like consistency and a rather firm connective tissue capsule. The disease in both glands is equally extensive and of about the same age. Both tonsils are enlarged and contain tuberculous foci. These appear as slightly elevated patches on the cut surface, firmer than the gland tissue and showing within their mass a network of small yellowish (necrotic) lines.

No. 316.—Jersey cow, 6 years old. Is giving milk. Pregnant since September 25, 1892.

March 16, 1893, 9 a. m.: First injection, 0.25 cc. tuberculin S. Before injection, minimum temperature, 100.8° (12 p. m.); maximum, 102.6° (4 p. m.). After injection, minimum temperature, 100.6° (11 a. m.); maximum, reached in fourteen hours, 106.2° (11 p. m.). (For complete record see p. 63.)

March 27, 1893, midnight: Second injection, 0.4 cc. tuberculin K.

March 28, 9 to 10 a. m.: Stands with back very much arched and trembles quite violently. Before injection, maximum temperature, 103.1° (4 p. m.); after injection, reached in twelve hours, 106° (12 a. m.) (For complete record see p. 70.)

April 7, 1893: Killed for examination.

Autopsy.—Thorax: A considerable number of tuberculous nodules in the large posterior mediastinal gland, and in the mediastinal near arch of aorta. About a dozen yellowish nodules, one-sixteenth inch in diameter, in the bronchial gland at root of left bronchus.

Abdomen: One small, doubtful nodule in a mesenteric gland.

No. 317.—Heifer, fifteen-sixteenths Holstein, 3 years old. Weight, 500 pounds. Reported to have been served by bull every three weeks during the past six months without becoming pregnant.

March 16, 1893: 9 a. m., first injection, 0.25 cc. tuberculin S. 8 p. m., trembling, which becomes very violent at 9 p. m., and ceases about 11 p. m. Before injection, minimum temperature, 100° (10 a. m.); maximum, 103° (5 p. m.). After injection, minimum temperature, 101.4° (12 a. m.); maximum, reached in eighteen hours, 105.8° (3 p. m.). (For complete record see p. 64.)

March 27, 1893, midnight: Second injection, 0.3 cc. tuberculin K. Before injection, maximum temperature, 102.8° (5 p. m.); after injection, 102.7° (1 p. m.). (For complete record see p. 70.)

April 21, 1893: Killed for examination.

Autopsy.—The only lesion of tuberculous nature in this animal is found in the bronchial gland at the root of the left bronchus. This gland is enlarged and contains about six foci, some of which are about one-half inch in diameter. All are caseous and a few contain a considerable number of calcareous particles.

In both kidneys the external surface is sprinkled over with small grayish spots up to one-twelfth inch in diameter. These correspond to streaks of the same color penetrating the cortex radially for a depth of one-eighteenth to one-sixth inch. Organs otherwise normal.

No. 318.—Heifer, fifteen-sixteenths Holstein, 1 year old. Weight, 500 pounds. March 16, 1893: 9 a. m., first injection, 0.25 cc. tuberculin S. 6:30 to 7 p. m., occasional periods of trembling. Hay only partly eaten. Before injection, minimum

temperature, 98.6° (10 a. m.); maximum, 103.2° (8 a. m.). After injection, minimum temperature 101.4° (12 a. m.); maximum, reached in ten hours, 107.4° (7 p. m.). (For complete record see p. 64.)

March 27, 1893: The temperature was taken for another injection, but owing to a rise from 102° at 8 p. m. to 105° at 11 p. m., due to an unknown cause, the injection was postponed.

March 28: The temperature was 104.8° at 7 a. m., 103.5° at 8 a. m., and 102° at 9 a. m., after which it continued normal. Excepting the elevation in temperature the animal was apparently in good health. (*See also* No. 357.)

April 12, 1893, midnight: Second injection, 0.2 cc. tuberculin S.

April 13, 9:20 a. m.: Periods of slight trembling. Before injection, maximum temperature, 103.4° (5 p. m.); after injection, reached in seventeen hours, 107.2° (5 p. m.). (For complete record see p. 70.)

April 14, 1893: Killed for examination.

Autopsy.—Thorax: In the right caudal lobe a tuberculous region about 4 inches long and 2 inches in diameter. This consists almost entirely of soft caseous masses embedded in a conglomerate of rather thin-walled, connective-tissue capsules. Only on the periphery the lung tissue is still recognizable as such. The surrounding lung tissue is free from recent infiltration. Trachea and bronchus of affected lobe free from tuberculous changes. Some cheesy masses found, in which tubercle bacilli were searched for with negative result. Posterior mediastinal glands consolidated into a mass 8 to 10 inches long and 3 inches in diameter at the center. This glandular mass is found on section to be grayish yellow in color and penetrated by a dense network of yellowish lines. The bronchial glands are free with one exception. This contains a single yellowish, caseous focus.

Abdomen: One of the mesenteric glands contains a single recent focus about one-eighth inch in diameter.

In one of the portal glands two gritty foci one-eighth and one-fourth inch in diameter.

No. 319.—Heifer, fifteen-sixteenths Holstein, 1 year old. Weight, 500 pounds. Has never been served by bull.

March 16, 1893, 9 a. m.: First injection, 0.25 cc. tuberculin S. Before injection, minimum temperature, 99° (11 a. m.); maximum, 103.3° (5 p. m.). After injection, minimum temperature 100.8° (12 a. m.); maximum, 102.8° (9 p. m.). (For complete record see p. 64.)

March 27, 1893, midnight: Second injection, 0.2 cc. tuberculin K. Before injection, maximum temperature, 103° (6 p. m.); after injection, 103° (7 p. m.). (For complete record see p. 70.)

May 25, 1893, midnight: Third injection, 0.2 cc. tuberculin S. Before injection, maximum temperature, 103.6° (6 p. m.); after injection, 102.9° (6 p. m.). (For complete record see p. 74.)

July 3, 1893: Killed for examination.

Autopsy.—In the left bronchial gland there are three small tuberculous foci largely calcareous. Recent surrounding infiltration absent. Slight adhesions of cephalic end of liver to surrounding structures.

No. 320.—Heifer, mixture of Jersey and Holstein, 2½ years old. Weight, 700 pounds. Pregnant since February 15, 1893. Previous to this she had been served by the bull every three weeks for five or six months without conceiving.

March 16, 1893, 9 a. m.: First injection, 0.25 cc. tuberculin S. Before injection, minimum temperature, 98.8° (9 a. m.); maximum, 102.6° (5 p. m.); after injection, minimum temperature, 99.8° (12 a. m.); maximum, reached in fourteen hours, 104.2° (11 p. m.). (For complete record see p. 64.)

March 27, 1893, midnight: Second injection, 0.3 cc. tuberculin K. Before injection, maximum temperature, 102.8° (4 p. m.); after injection, 102.6° (1 p. m.). (For complete record see p. 70.)

May 25, 1893, midnight: Third injection, 0.2 cc. tuberculin S. Before injection, maximum temperature, 102° (6 p. m.); after injection, reached in seventeen hours, 103.4° (5 p. m.). (For complete record see p. 74.)

June 15, 1893: Killed for examination.

Autopsy negative.

No. 321.—Jersey heifer, 3 years old. Pregnant since September 19, 1892.

March 16, 1893, 9 a. m.: First injection, 0.25 cc. tuberculin S. Before injection, minimum temperature, 100.4° (12 a. m.); maximum, 102.2° (6 p. m.). After injection, minimum temperature, 100.8° (1 p. m.); maximum, reached in fourteen hours, 103.4° (11 p. m.). (For complete record see p. 65.)

March 27, 1893, midnight: Second injection, 0.3 cc. tuberculin K. Before injection, maximum temperature, 102.5° (6 p. m.); after injection, 102° (5 p. m.). (For complete record see p. 70.)

May 25, 1893, midnight: Third injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102° (6 p. m.); after injection, reached in eighteen hours, 102.7° (6 p. m.). (For complete record see p. 74.)

June 29, 1893: Killed for examination.

Autopsy.—Traces of tuberculosis not discoverable. Slight adhesions of cephalic end of liver to diaphragm. In this region on the free border a yellowish mass of liver tissue about one-half inch in diameter. The color is due to more or less complete fatty metamorphosis of the liver cells.

No. 322.—Jersey heifer, 1 year old. Weight, 450 pounds. Has never been served by bull.

March 16, 1893, 9 a. m.: First injection, 0.2 cc. tuberculin S. Before injection, minimum temperature, 99.6° (9 a. m.); maximum, 102.5° (9 p. m.). After injection, minimum temperature, 99° (12 a. m.); maximum, reached in fourteen hours, 103° (11 p. m.). (For complete record see p. 65.)

March 27, 1893, midnight: Second injection, 0.2 cc. tuberculin K. Before injection, maximum temperature, 102.8° (5 p. m.); after injection, reached in thirteen hours, 104.2° (1 p. m.). (For complete record see p. 70.)

May 25, 1893, midnight: Third injection, 0.125 cc. tuberculin S. Before injection, maximum temperature, 102.2 (6 p. m.); after injection, 102.8° (5 p. m.). (For complete record see p. 74.)

July 3, 1893: Killed for examination.

Autopsy.—In the large mediastinal gland there is one tuberculous focus situated near the cephalic end of the gland. It is about one-half inch in diameter and almost completely calcareous. The surrounding tissue is free from recent infiltration.

No. 323.—Heifer, half Holstein, 2½ years old. Weight, 750 pounds. Pregnant since September 26, 1892.

March 16, 1893, 9 a. m.: First injection, 0.25 cc. tuberculin S. Before injection, minimum temperature, 99.7° (9 a. m.); maximum, 103.5° (5 p. m.); after injection, minimum temperature, 100.4° (11 a. m.); maximum, reached in fourteen hours, 106.4° (11 p. m.). (For complete record see p. 65.)

March 27, 1893, midnight: Second injection, 0.3 cc. tuberculin K. Before injection, maximum temperature, 103.4° (5 p. m.); after injection, reached in thirteen hours, 105.2° (1 p. m.). For complete record see p. 70.)

April 12, 1893: Killed for examination.

Autopsy.—In this animal the thoracic lymphatics only are involved. One bronchial gland measures 2 by 1 inch and is completely converted into a soft caseous mass. Similarly, three out of four of the chain of posterior mediastinal glands are as large hens' eggs and completely caseous. Calcification absent.

No. 324.—Heifer, fifteen-sixteenths Holstein, 3 years old. Weight, 800 pounds Pregnant since June 16, 1892.

March 16, 1893, 9 a. m.: First injection, 0.25 cc. tuberculin S. Has not eaten anything during the evening or night. Before injection, minimum temperature, 100.5° (10 a. m.); maximum, 104° (5 p. m.); after injection, minimum temperature, 102.5° (12 a. m.); maximum, reached in eighteen hours, 105.8° (3 a. m.). (For complete record see p. 65.)

March 17: Gave birth to a dead calf, followed by partial retention of the afterbirth.

May 27, 1893, midnight: Second injection, 0.3 cc. tuberculin K.

March 28, 7 to 8 a. m.: Periods of marked trembling. Before injection, maximum temperature, 102.8° (5 p. m).; after injection, reached in ten hours, 107° (10 a. m.). (For complete record see p. 70.)

April 12, 1893: Killed for examination.

Autopsy.—Thorax: The cephalic lobe of the right lung (cephalic half) is almost entirely involved in tuberculosis. Only a little tissue at the root of the bronchus and a few areas of the tip still air-containing. The lesion is an intermingling of soft caseous foci with surrounding, more recently infiltrated, lung tissue. The lobe appears as if made up of lumps of various sizes, owing to its collapsed state and the large size of the tuberculous masses. The bronchial mucosa is beset with a layer of recent tubercle eruptions near its root, and farther along yellowish flakes are found mingled with mucus.

The bronchial glands are all enlarged, the infiltrated parenchyma more or less caseous and containing gritty particles. One of these is as large as a goose egg and contains a number of rather small cheesy nodules.

The posterior mediastinal glands likewise contain caseous foci. The process appears less extensive here than in the bronchial.

Abdomen: One of the portal glands contains a tuberculous mass about one-half inch in diameter. This is still firm, yellowish, necrotic, and is surrounded by a thick capsule. The center contains calcareous particles.

On the convex surface of the liver is a flattish tuberculous mass about three-fourths inch square, elevated above the liver surface about one-eighth inch. On section it is found one-half inch thick, dipping beneath the surface of the liver; the center soft, caseous; the periphery firm, grayish translucent.

No. 325.—Grade Holstein cow, 6 years old. Weight, 850 pounds. Calved March 1, 1893, and has not been served by bull since; is giving milk.

March 21, 1893, midnight: First injection, 0.4° cc. tuberculin K. Before injection, maximum temperature, 102° (7 p. m.); after injection, 102° (5 p. m.). (For complete record see p. 66.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.8° (6 p. m.); after injection, 103° (5 p. m.). (For complete record see p. 70.)

Not killed.

No. 326.—Grade Holstein cow, 6 years old. Weight, 900 pounds. Calved February 14, 1893, and has not been served by bull since; is giving milk.

March 21, 1893, midnight: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102.2° (8 a. m.); after injection, 102.8° (4 p. m.). (For complete record see p. 66.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 103° (8 p. m.); after injection, 103.4° (3 p. m.). (For complete record see p. 70.)

Not killed.

No. 327.—Cow, 7 years old. Weight, 950 pounds. Calved during spring of 1892 and is still giving milk. Supposed to be pregnant since December 9, 1892.

March 21, 1893, midnight: First injection, 0.4 cc. tuberculin K.

March 22, 9 a. m.: Feces semifluid, very much thinner than usual. Before injection, maximum temperature, 103.2° (8 a. m.); after injection, 103.4° (4 p. m.). (For complete record see p. 66.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102° (4 p. m.); after injection, reached in fourteen hours, 103.6° (2 p. m.). (For complete record see p. 71.)

Not killed.

No. 328.—Cow, fifteen-sixteenths Holstein, 4 years old. Weight, 900 pounds. Calved December 29, 1892, and is giving milk. Pregnant.

March 21, 1893, midnight: First injection, 0.4 cc. tuberculin K.

March 22, 9:30 to 10 a. m.: Occasional periods of slight trembling. Before injection, maximum temperature, 102° (7 p. m.); after injection, reached in twelve hours, 104.2° (12 a. m.). (For complete record see p. 66.)

April 12, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.7° (4 p. m.); after injection, reached in sixteen hours, 105.4° (4 p. m.). (For complete record see p. 71.)

May 12, 1893: Killed for examination.

Autopsy.—In one tonsil an abscess about one-half inch in diameter, the contained pus like starch paste in appearance.

The tuberculous lesions were limited to the large posterior mediastinal gland. This is 5 by ½ by 1¼ inches in size. Near one end there are 5 dry, mortar-like masses one-fourth to one-half inch in size inclosed in thin-walled capsules. No recent infiltration in the surrounding gland tissue.

No. 329.—Cow, fifteen-sixteenths Holstein, 3 years old. Weight, 700 pounds. Calved February 1, 1893, and has not been served by the bull since; is giving milk.

March 21, 1893, midnight: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 103° (6 p. m.); after injection, reached in nine hours, 107.5° (9 a. m.). (For complete record see p. 66.)

April 12, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature 103.4° (4 p. m.); after injection, reached in ten hours, 105.8° (10 a. m.) (For complete record see p. 71.)

April 28, 1893: Killed for examination.

Autopsy.—In this animal the tuberculous lesions are limited to the retropharyngeal glands.

The right is as large as a small fist. The parenchyma has undergone diffuse necrosis. In the external layer of gland tissue are embedded a number of minute caseous tubercles.

The other gland is 4 by 1 by 1½ inches in size. It feels as if made up of a large number of lumps. On section the foci are caseous and embedded in more or less connective tissue. There is also some diffuse necrosis of the parenchyma.

No. 330.—Cow, 12 years old. Weight, 900 pounds. Calved October 14, 1892, and has not been served by bull since; is giving milk.

March 21, 1893, midnight: First injection, 0.4 cc. tuberculin K.

March 22, 9:30 to 10:30 a. m.: Very marked trembling. Feces somewhat softened and passed more frequently than usual. Before injection, maximum temperature, 102.2° (7 p. m.); after injection, reached in twelve hours, 105.8° (12 a. m.). (For complete record see p. 66.)

April 12, 1893, midnight: Second injection, 0.25 cc. tuberculin S.

April 13, 8:40 a. m.: Frequent periods of marked trembling. Before injection, maximum temperature, 102° (8 a. m.); after injection, reached in eleven hours, 105.2° (11 a. m.). (For complete record see p. 71.)

April 25, 1893: Killed for examination.

Autopsy.—The only tuberculous lesion discoverable in this case was found in the gland at the root of the left bronchus, as a small yellowish focus about one-eighth

inch in diameter. In sections of hardened tissue it appears separated from the remainder of the gland by a thin connective tissue capsule. The central portion is necrotic, the peripheral portion made up largely of granulation tissue in which giant cells are quite sparsely disseminated. Tubercle bacilli were not detected.

No. 331.—Holstein cow, 6 years old. Weight, 850 pounds. Calved January, 1892; is giving milk. Pregnant since September 22, 1892.

March 21, 1893, midnight: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102° (6 p. m.); after injection, reached in seventeen hours, 106.2° (5 p. m.). (For complete record see p. 66.)

April 12, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 101.8° (8 a. m.); after injection, reached in eighteen hours, 105.8° (6 p. m.). (For complete record see p. 71.)

April 18, 1893: Killed for examination.

Autopsy.—The only tuberculous lesion in this case is represented by a caseous focus about one-half inch in diameter, embedded in the caudal lobe of the left lung near median border. This focus is adjacent to a small bronchus and is associated with a tuberculous mass as large as a hemp seed. Scrapings from the inner wall of the capsule inclosing the caseous mass negative as regards tubercle bacilli.

A guinea pig inoculated subcutaneously with some of the caseous mass died three months later. The autopsy showed extensive tuberculous changes in the liver and spleen and isolated caseous masses in the lungs.

No. 332.—Holstein cow, 7 years old. Calved spring of 1892 and is still giving milk. Pregnant since August 27, 1892.

March 21, 1893, midnight: First injection, 0.4 cc. tuberculin K.

March 22, 10 a. m.: Feces slightly softened. Before injection, maximum temperature, 102.4° (3 p. m.); after injection, reached in twelve hours, 107.1° (12 a. m.). (For complete record see p. 66.)

April 12, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.8° (4 p. m.); after injection, reached in eighteen hours, 106.2° (6 p. m.). (For complete record see p. 71.)

April 14, 1893: Killed for examination.

Autopsy.—The tuberculous lesions in this case were limited to one of the smaller posterior mediastinal glands. A portion of this gland on section had a pale grayish appearance, which on closer examination and especially after a short sojourn in alcohol, appeared made up of very minute tubercles.

Sections of this region after hardening in alcohol were carefully examined. The suspicious focus was shown to consist of an aggregation of tubercles, each provided with one or more giant cells. In many of these from 1 to 3 tubercle bacilli could be demonstrated by Gabbett's stain.

There is evidence of former inflammation of the serous membranes of thorax in slight but firm adhesion of various lobes of the lungs to each other, to the diaphragm and the pericardium.

No. 333.—Jersey cow, 5 years old. Weight, 600 pounds. Calved, December 20, 1892, and has not been served by bull since; is giving milk.

March 21, 1893, midnight: First injection, 0.3 cc. tuberculin K.

March 22, 9 a. m.: Feces semifluid, much thinner than usual. Before injection, maximum temperature, 102° (7 p. m.); after injection, reached in nine hours, 106.9° (9 a. m.). (For complete record see p. 66.)

April 12, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.4° (8 a. m.); after injection, reached in thirteen hours, 105.6° (1 p. m.). (For complete record see p. 71.)

April 18, 1893: Killed for examination.

Autopsy.—In this animal the tuberculous infection is limited to the abdominal cavity.

Mesenteric glands: Two are involved. One contains three foci, each about one-eighth inch in diameter, two caseous and one calcareous. The other contains a partly caseous, partly calcareous, focus three-eighths inch in diameter, and one one-eighth inch in diameter. Several glands contain worm tubercles.

Liver: Two portal glands are moderately enlarged. One contains three firm, dry, casoous foci, the other contains two quite small yellowish foci.

In the large posterior lobe of the liver are two contiguous tuberculous foci embedded in the liver tissue and reaching the convex surface. One of these is fully 3 inches long and 2 inches thick. The other is about 1 inch in diameter. They are both made up of an abundance of dense connective tissue inclosing a large number of small, partly caseous foci, some of which are one-fourth inch in diameter. The diaphragm is adherent to the liver over these foci.

In the region of the second stomach, between it and the diaphragm, there are firm adhesions occasioned by traumatic inflammation and suppuration. When the adhesions are severed, several masses of firm, almost cartilaginous tissue (indurated glands) (?) are found in this adherent area surrounded by more or less gelatinous infiltration. The firm masses are softened centrally (abscesses).

No. 334.—Holstein cow, 3 years old. Weight, 1,000 pounds. Calved September, 1892; is giving milk. Pregnant since February 6, 1893.

March 21, 1893, midnight: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102.4° (3 p. m.); after injection, reached in fifteen hours, 102.9° (3 p. m.). (For complete record see p. 66.)

April 12, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 101.8° (9 a. m.); after injection, reached in seventeen hours, 102.5° (5 p. m.). (For complete record see p. 71.)

May 25, 1893, midnight: Third injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.2° (6 p. m.); after injection, reached in seventeen hours, 102.7° (5 p. m.). (For complete record see p. 74.)

July 6, 1893: Killed for examination.

Autopsy.—In the left bronchial gland a soft, caseous focus about one-half inch in diameter situated in the center of the gland. In the mediastinal gland near it, resting loosely on the root of the left bronchus, a similar focus. (Unfortunately the thoracic glands, removed for further examination in the laboratory, were rejected through some inadvertence. The remaining glands were of normal size, and if tuberculous the foci must have been quite small.)

No. 335.—Jersey cow, 5 years old. Weight, 700 pounds. Calved January 28, 1893, and has not been served by bull since; is giving milk.

March 21, 1893, midnight: First injection, 0.4 cc. tuberculin K.

March 22, 9:30 to 10:30 a. m.: Marked trembling. Before injection, maximum temperature, 102.2° (8 p. m.); after injection, reached in seventeen hours, 107.8° (5 p. m.). (For complete record see p. 66.)

April 12, 1893, midnight: Second injection, 0.25 cc. tuberclin S. Before injection, maximum temperature, 102° (4 p. m.), after injection, reached in twelve hours, 105.2° (12 a.m.) (For complete record see p. 71.)

April 25, 1893: Killed for examination.

Autopsy.—Left retropharyngeal gland is about 3½ inches long and 1 to 1½ inches thick, more or less nodular or lobulated. It contains an aggregation of soft, caseous foci from one-fourth to one-half inch in diameter. Foci in periphery of gland smaller and firmer than those centrally situated.

Thorax: The large posterior mediastinal gland contains two small firm caseous foci; the contiguous gland contains about ten foci one-eighth to three-sixteenths inch in diameter.

Of the bronchial glands the small one near the root of right main bronchus contains a firm caseous mass equal to one-half the bulk of the gland.

Abdomen: In one of the portal glands two firm, caseous masses about three-eighths inch in diameter. The liver tissue contains a few subcapsular nodules of parasitic origin.

No. 336.—Jersey cow, 8 years old. Weight, 800 pounds. Calved in spring of 1892, and is still giving milk. Not pregnant, and has not been served by bull since July 25, 1892.

March 21, 1893, midnight: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102.6° (7 p. m.); after injection, reached in seventeen hours, 106° (5 p. m). (For complete record see p. 66.)

April 12, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.8° (5 p. m.); after injection, reached in seventeen hours, 104.9° (5 p. m.) (For complete record see p. 71.)

May 25, 1893, midnight: Third injection, 0.35 cc. tuberculin S. Before injection, maximum temperature, 102.9° (6 p. m.); after injection, reached in twenty hours, 103.8° (8 p. m.) For complete record see p. 74.)

June 1, 1893: Killed for examination.

Autopsy.—Thorax: In the caudal lobe of right lung near the caudal extremity and about 3 inches from lateral border are three tuberculous foci in the lung tissue. One of these is situated on the periphery of a small bronchus and is about one-half inch in diameter, one section yellowish, the center broken down into a soft pus-like mass. The second focus is near the first, embedded in a lobule. Softening not yet begun. The third focus is nearer the first and is like second, but somewhat smaller. Near these on ventral surface of the lungs and directly under the same bronchus is a subpleural tuberculous mass resembling the second and third described. Slight yellowish mass in bronchus near these foci. The large posterior mediastinal gland is about 4 inches long and 1 to 1½ inches thick. On section fully one-half of the gland, especially the cortex, is involved and appears as a grayish mass in which there is an abundant network of yellowish lines and patches. Only one of the other mediastinal glands shows distinct tuberculous infection. In caudal portion is contained a tuberculous mass about one-half by one-fourth inch in diameter, which is in the same condition as gland just described. The bronchial glands are free from injection and quite markedly pigmented.

Abdomen: One of the mesenteric glands contains a tuberculous mass 1 by ½ by 1 by ¾ inches in size. On section this mass is oval in outline, sharply defined, firm. It consists of a close network of yellowish lines and patches, among which only a little grayish tissue is still visible. The process here seems slightly more advanced toward necrosis than in the thorax. Some worm nodules are also present in the mesenteric glands.

No. 337.—Cow, 12 years old. Weight, 950 pounds. Calved in spring of 1892, still giving milk. Pregnant since September 15, 1892.

March 21, 1893, midnight: First injection, 0.4 cc. tuberculin K.

March 22, 10 a. m.: Periods of slight trembling. Before injection, maximum temperature, 102.6° (8 p. m.); after injection, reached in fourteen hours, 105.5° (2 p. m.). (For complete record see p. 67.)

April 12, 1893, midnight: Second injection, 0.25 cc. tuberculin S.

April 13, 10 to 10:30 a. m.: Occasional periods of slight trembling. Before injection, maximum temperature, 102° (8 p. m.); after injection, reached in nineteen hours, 105° (7 p. m.). (For complete record see p. 71.)

April 14, 1893: Killed for examination.

Autopsy.—A soft caseous mass in one of the retropharyngeal glands one-half inch in diameter.

Thorax: In the principal lobe of the right lung a large tuberculous focus resembling closely that of No. 318 both as to the condition of the contents and the absence of any surrounding infiltration. The small air tube leading to it is occluded with yellowish cheesy material. Tubercle bacilli not detected in it.

One of the posterior mediastinal glands contains 4 caseous foci from one-fourth to one-half inch in diameter. The bronchial gland at root of left bronchus contains four quite small yellowish foci.

Abdomen: Mesenteric glands involved. A considerable number contain foci varying from one-eighth to one-fourth inch in diameter. They are very firm to the touch and project above the surface of the gland as round yellow bodies. The glands are not enlarged. The tubercular foci are all firm, necrotic, some largely calcareous. Besides the tuberculous changes, worm nodules are not uncommon.

No. 338.—Jersey cow, 3 years old. Weight, 500 pounds. Calved January 28, 1892. Condition, very thin. Shows symptoms of advanced tuberculosis, and has been isolated from herd for from fifteen to eighteen months.

March 27, 1893, midnight: Injected 0.3 cc. tuberculin K. Before injection, maximum temperature, 103.6° (2 p. m.); after injection, reached in seven hours, 103.8° (7 a. m.) (For complete record see p. 67.)

April 4, 1893: Killed for examination.

Autopsy.—Case of advanced tuberculosis. Retropharyngeal glands, tonsils, larynx, trachea, bronchi, lungs, thoracic glands, and the pleura extensively diseased. In the abdomen the various groups of lymphatics greatly enlarged and tuberculous. The omentum and serosa of stomachs are beset with patches of confluent tubercles.

All Peyer's patches of the small intestine are extensively infiltrated with tubercles and the mucosa ulcerated. The spleen, liver, and kidneys (excepting the serous coverings) are free from tuberculous changes recognizable with the unaided eye. The udder and pubic glands are likewise free from infection.

No. 339.—Cow, fifteen-sixteenths Holstein, 7 years old. Weight, 1,000 pounds. Calved summer of 1892, and is still giving milk. Pregnant since December 13, 1892.

March 27, 1893, midnight: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 102° (5 p. m.); after injection, reached in eleven hours, 103.6° (11 a. m.). (For complete record see p. 67.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 103° (5 p. m.); after injection, reached in nineteen hours, 103.5° (7 p. m.). (For complete record see p. 71.)

May 25, 1893, midnight: Third injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 103° (6 p. m.); after injection, 102.6° (5 p. m.). (For complete record see p. 74.)

June 19, 1893: Killed for examination.

Autopsy.—Thorax: In the lungs there are not less than 8 isolated tuberculous foci. Five of these are in the right caudal, 2 in the left caudal, and 1 in the right cephalic lobe. In the right caudal lobe 3 foci are situated along the dorsomedian region (i. e., in that portion of the lung tissue resting against the sides of the vertebra and the dorsal end of the ribs). They are situated above (or dorsal of) the main bronchus, excepting the most caudal of the 3 which surrounds the bronchus. These foci are visible on the lung surface. They vary in size, the smallest being three-fourths inch in diameter, the largest 2 or 2½ inches in diameter. They consist in the main of aggregations of cysts containing very soft, cheesy masses, inclosed in thin-walled capsules. These cysts vary in diameter from one-eighth to three-fourths inch. The focus nearest the root of the lobe is made up of several such cysts and a considerable mass of lung tissue which appears to consist of a large number of small cheesy foci. The peculiar yellowish mottled appearance of this tissue from the pleural surface and a careful inspection of the cut surface suggests aspiration of cheesy matter resulting in caseous broncho-pneumonia. The main bronchus, moreover, contains some loose cheesy masses. This lobe contains, in addition to these 3 foci, 2 small embedded ones situated near the lateral margin of the lobe, of which 1 is cheesy, the other firm, grayish in color.

In the left caudal lobe there are 2 foci. One in the dorsomedian region under the pleura, about three-fourths inch in diameter, consists of a soft central mass surrounded

by an aggregation of small cheesy masses. The other is about 1 inch in diameter and is made up entirely of soft cheesy foci.

On the caudal margin of the second cephalic lobe there is a small triangular region of very thin collapsed tissue in which are situated 3 small masses, consisting of a dense, grayish tissue inclosing a yellow cheesy nucleus.

Thoracic lymph glands: Large posterior mediastinal gland contains near the caudal end a dry, cheesy, partially gritty focus measuring one-half by one-fourth inch. In the same region there are 2 cheesy foci about three-sixteenths inch in diameter. Toward the middle there are 2 minute yellowish foci one-sixteenth inch in diameter. In mediastinal gland, situated on the œsophagus at the level of the bifurcation of the trachea, there is 1 small tubercle, with cheesy, yellowish center, about one-sixteenth inch in diameter. In bronchial gland at root of left bronchus there are 2 small foci, one-sixteenth and one-eight inch in diameter, of a grayish color and yellowish center. In the gland at root of right supernumerary bronchus there is a focus one-fourth inch in diameter, with yellowish, cheesy contents embedded in a firm, grayish capsule, and a second smaller focus composed almost entirely of firm, grayish tissue, with a minute yellowish center.

In 3 of the mesenteric glands there are several isolated tubercles, quite small, having a yellowish color. One gland also contains an aggregation of such tubercles.

No. 340.—Cow, fifteen-sixteenths Holstein, 9 years old. Weight, 1,100 pounds. Calved summer of 1892; is still giving milk. Pregnant since January 13. 1893.

March 27, 1893, midnight: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 101.6° (4 p. m.); after injection, reached in ten hours, 104° (10 p. m.). (For complete record see p. 67.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.2° (4 p. m.); after injection, reached in fifteen horrs, 102.6° (3 p. m.). For complete record see p. 72.)

May 23, 1893: Killed for examination.

Autopsy.—In this case tuberculous lesions could not be found. In the uterus a a fetus about 3 months old, dead and beginning to disintegrate. Free from odor.

No. 341.—Half Holstein cow, 9 years old. Weight, 900 pounds. Calved spring of 1892; still giving milk. Not pregnant, and has not been served by bull since June 24, 1892.

March 27, 1893, midnight: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 103° (9 p. m.); after injection, reached in eleven hours, 105° (11 a. m.). For complete record see p. 67.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 103.4° (6 p. m.); after injection, reached in twelve hours, 106° (12 a. m.). (For complete record see p. 72.)

May 19, 1893: Killed for examination.

Autopsy.—Lungs: In the right caudal lobe beneath the pleura of the dorsal surface there is a tuberculous focus about 1½ inches in diameter, not directly connected with any traceable branch of the bronchus. This focus is made up of lobules in different stages of caseation. In one lobe the cheese is very soft and easily removed. In others it is slightly firmer, but likewise removable without difficulty. The lung tissue surrounding this focus for a distance of one-half to 1 inch contains a considerable number of minute grayish tubercles. In the trachea, near the bifurcation, there are several small masses of cheesy matter lying loose on the mucous membrane. There are also 2 tuberculous patches on the mucosa, 1 at the place of bifurcation, the other about 1 inch from it, both made up of fresh tubercles mingled with the tubercular ulcers, which have elevated margins undermined with cheesy deposits. These ulcers are about one-fourth inch in diameter.

Thoracic glands: In the gland at root of left bronchus there are 5 or 6 small grayish tubercles, a few with minute yellowish centers. In the caudal mediastinal

gland, near its middle portion, there is one completely calcified focus about one-fourth inch in diameter, and several small translucent tubercles about one-sixteenth inch in diameter, all situated in the cortex. In middle of the same gland there is a constricted, retracted portion containing a few tubercles. In an adjacent portion also a few barely recognizable grayish tubercles. In another portion of cortex a small patch of recent infiltration.

No. 342.—Cow, fifteen sixteenths Holstein, 9 years old. Weight, 900 pounds. Calved December 14, 1892, and has not been served by bull since; is giving milk.

March 27, 1893, midnight: First injection, 0.4 cc. tuberculin K.

March 28, 8:30 a. m.: Trembling quite marked and stands with back slighly arched. Before injection, maximum temperature, 102.2° (5 p. m.); after injection, reached in twelve hours, 106° (12 a. m.). (For complete record see p. 67.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 103.4° (5 p. m.); after injection, reached in nineteen hours, 104.2° (7 p. m.). (For complete record see p. 72.)

May 19, 1893: Killed for examination.

Autopsy.—Thorax: In gland at root of left bronchus half a dozen tuberculous foci one-sixteenth to one-fourth inch in diameter, caseous and still firm. In the cephalic end of the large mediastinal gland one small similar focus. Traumatic inflammation of walls of second stomach owing to presence of wire 4 inches long.

(Owing to some mistake the affected glands were not taken to the laboratory for reëxamination. Hence the notes are somewhat incomplete.)

No. 343.—Cow, fifteen-sixteenths Holsteiu, 6 years old. Weight, 1,100 pounds. Calved during summer of 1892; still giving milk. Served by bull January 11, 1893, but is not pregnant.

March 27, 1893, midnight: First injection, 0.4 cc. tuberculin K.

March 28: 7:30 a. m., respiration accelerated; pulse, 80. Slight trembling with twitching of muscles, especially in the gluteal region. The back is slightly arched; 11 a. m., feces considerably softened. Before injection, maximum temperature, 101.6° (4 p. m.); after injection, reached in ten hours, 107° (10 a. m.). (For complete record see p. 67.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.6° (6 p. m.); after injection, reached in twelve hours, 106.2° (12 a. m.). (For complete record see p. 72.)

May 12, 1893: Killed for examination.

Autopsy.—A soft cheesy focus one-half inch in diameter in the left retropharyngeal gland.

Lungs: In the caudal lobe of the right lung on the lateral margin a small triangular area contains a few soft caseous foci and some more recent infiltration. In the caudal fifth of the same lobe there is a very small solitary, cheesy focus, and two of the same character in the same situation in the corresponding lobe of the left lung.

A much larger triangular focus of disease at the caudal border of the right ventral lobe consisting of an aggregation of cheesy masses up to one-fourth inch in diameter.

Thoracic glands: These are quite extensively diseased. That one of the series of posterior mediastinal glands which is situated near the arch of the aorta is fully 8 inches long and 5 inches wide. It is made up of a large number of communicating cavities filled with cheesy, partly liquefied matter. Another gland of the same series situated nearer the diaphragm is as large as a fist, and in the same condition as the preceding gland. The large mediastinal gland is not so far advanced. It contains a small number of cheesy tubercles and more or less recent infiltration. The 3 bronchial glands, one at the root of left bronchus, another at root of right bronchus, and the third at root of right supernumerary bronchus, are each as large as a fist, with contents cheesy and partly liquefied. A number of small glands not usually

detected in the normal lung, including the anterior mediastinal, are enlarged and contain one or more tuberculous foci.

Abdomen: On the tendinous portion of the diaphragm, mainly the right side, are a considerable number of flattish tubercular excrescences from one-eighth to three-fourths inch in diameter, consisting of agglomerations of tubercles some of which show slight central caseation. A thin membranous expansion extends from the diaphragm to the cephalic lobe of the liver, forming a false ligament. Along its free margin are a few tuberculous masses from one-eighth to one-fourth inch in diameter. One tubercle is firmly adherent to capsule of liver where the false ligament is attached to it. This mass is about one-half inch in diameter and one-fourth inch thick and made up of a capsule of dense connective tissue inclosing a firm yellowish caseous mass.

The parenchyma of the liver and the portal glands are normal.

The small extremity of spleen is adherent over an area about 6 inches square to reticulum by means of dense inflammatory tissue, one-half to 1 inch thick, containing abscesses and surrounded by gelatinous œdematous tissue. The spleen itself not affected. Cause, probably some foreign body.

No. 344.—Cow, fifteen-sixteenths Holstein, 6 years old. Weight, 900 pounds. Calved August, 1892; is giving milk. Pregnant since January 5, 1893.

March 27, 1893, midnight: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 101.8° (5 p. m.); after injection, reached in twelve hours, 105.2° (12 a. m.). (For complete record see p. 67.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.4° (6 p. m.); after injection, 102° (5 p. m.). (For complete record see p. 72.)

May 16, 1893: Killed for examination.

Autopsy.—In the right retropharyngeal gland are 3 tuberculous foci, each about one-half inch in diameter and consisting of grayish tissue penetrated by a network of yellowish lines.

No other tuberculous lesions discoverable.

Adhesion of cephalic end of liver to neighboring organs by means of inflammatory tissue containing a small abscess (traumatism). Sections of a portion of the retropharyngeal gland hardened in alcohol show that the region of the gland invaded is made up of a number of small foci, provided with giant cells.

No. 345.—Half Holstein cow, 9 years old. Weight, 1,000 pounds. Calved August, 1892; is giving milk. Pregnant since January 11, 1893.

March 27, 1893, midnight: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 101.6° (4 p. m.); after injection, reached in twelve hours, 106.9° (12 a. m.). (For complete record see p. 67.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection maximum temperature, 102.4° (6 p. m.); after injection, reached in nineteen hours, 106.4° (7 p. m.). (For complete record see p. 72.)

May 12, 1893: Killed for examination.

Autopsy.—The only tuberculous lesions in this case were found in the posterior mediastinal and the bronchial glands.

In the large posterior mediastinal gland there are about 6 foci one-eighth inch in diameter projecting as roundish bodies of a grayish translucent appearance above the cut surface. Each contains a yellowish necrotic center.

In the gland at root of left bronchus there are about 10 precisely similar foci. In the small gland at the root of the right bronchus, 1 similar focus.

Old fibrous adhesions between lungs and diaphragm, of slight extent.

No. 346.—Half Holstein cow, 9 years old. Weight, 1,000 pounds. Calved September, 1892; is giving milk. Pregnant since March 14, 1893.

March 27, 1893, midnight: First injection, 0.4 cc. tuberculin K. Before injection, maximum temperature, 101.8° (5 p. m.); after injection, reached in nineteen hours, 106.4° (7 p. m.). (For complete record see p. 67.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.6° (6 p. m.); after injection, reached in nineteen hours, 103.5° (7 p. m.). (For complete record see p. 72.)

May 16, 1893: Killed for examination.

Autopsy.—Thoracic glands: The gland at root of left bronchus made up of 3 separate glands. In one of these glands a tuberculous focus is one-fourth inch in diameter, of a gelatinous appearance, spongy, with yellowish particles sprinkled through it. In a second gland 3 similar foci, 2 one-fourth inch and 1 one-eighth inch in diameter. The large posterior mediastinal gland, about 5 inches long, one-half inch thick, and 2 inches wide at widest portion, contains tuberculous foci from one-half to one-fourth inch apart, situated mainly in the cortex. Foci most numerous at caudal end, where they are from one-eighth to one-fourth inch in diameter, and have a gelatinous appearance, with yellowish lines sprinkled in. They project above cut surface. These foci all appear to be of the same age, except two, one of which is about one-half inch in diameter and slightly older; the other is also one-half inch in diameter, and made up entirely of coarse, gritty particles. The gland at this point is retracted. In one of the more cephalic mediastinal glands 3 or 4 similar tuberculous foci.

Abdomen: In one mesenteric gland there is a tuberculous foci three-eighths inch in diameter, consisting of very firm cheesy material, in which is embedded a central calcareous particle. Traumatic inflammation around cephalic end of liver.

No. 347.—Holstein heifer, 2 years old. Weight, 600 pounds. Has never been served by bull.

April 12, 1893, midnight: First injection, 0.2 cc. tuberculin S.

April 13, 8:30 to 9 a. m.: Trembling very marked. Before injection, maximum temperature, 102.8° (4 p. m.); after injection, reached in sixteen hours, 106.8° (4 p. m.). (For complete record see p. 67.)

May 1, 1893, midnight: Second injection, 0.2 cc. tuberculin S. Before injection, maximum temperature, 103.6° (5 p. m.); after injection, reached in nineteen hours, 104.2° (7 p. m.). (For complete record see p. 72.)

May 5, 1893: Killed for examination.

Autopsy.—The tuberculous changes in this case are likewise confined to the thoracic lymph glands.

In three of the posterior mediastinal glands there are regions made up entirely of dense aggregations of grayish tubercles (recent infiltration). In one of these glands there is a small calcareous focus in the midst of the recent infiltration.

In the gland at the root of the left bronchus and in the one in the angle of bifurcation there are similar foci in which yellowish centers are visible.

No. 348.—Jersey cow, 8 years old. Weight, 800 pounds. Gave birth to triplets eighteen months ago and has not been in heat since; is not giving milk.

April 12, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.7° (4 p. m.); after injection, reached in seventeen hours, 106.2° (5 p. m.). (For complete record see p. 67.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.2° (8 p. m.); after injection, reached in seventeen hours, 103.2° (5 p. m.). (For complete record see p. 72.)

May 3, 1893: Killed for examination.

Autopsy.—Thorax: The large posterior mediastinal gland is 4 inches long and one-half inch thick (only slightly larger than normal). In the cortex are not less than 10 to 15 tuberculous foci up to one-fourth inch in diameter. Some are calcareous, others are in a state of partial necrosis. In another gland of the same group is a small calcareous focus.

Abdomen: In one mesenteric gland several small tuberculous foci. Horns of uterus more or less thickened (subinvolution). In the cavity some glairy fluid containing yellowish lumps.

No. 349.—Jersey cow, 4 years old. Weight, 750 pounds. Pregnant the first time since October 22, 1892.

April 12, 1893, midnight: First injection, 0.25 cc. tuberculin S.

April 13, 7:40 to 8:40 p. m.: Frequent and marked periods of trembling. Before injection, maximum temperature, 102.6° (4 p. m.); after injection, reached in ten hours, 106.7° (10 a. m.). (For complete record see p. 68.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102° (4 p. m.); after injection, reached in nineteen hours, 103.8° (7 p. m.). (For complete record see p. 72.)

May 5, 1893: Killed for examination.

Autopsy.—The tuberculous changes are limited to the thoracic lymph glands.

The bronchial gland at root of left bronchus as large as a hen's egg, more or less furrowed and lobulated. Its center is occupied by a completely calcified focus three-eighths inch in diameter. Throughout the remainder of the gland are disseminated yellowish foci one-eighth inch in diameter and one-eighth to one-fourth inch apart, projecting above the cut surface. In the large posterior mediastinal gland there are several foci of disease. One, near one extremity of the gland which is more or less nodulated, consists of an aggregation of small tubercles containing yellowish calcareous nuclei. In the center of the gland there is an aggregation of partly caseous tubercles surrounded by a zone of more recent infiltration.

No. 350.—Jersey bull, 6 years old. Weight, 1,400 pounds.

April 12, 1893, midnight: First injection, 0.35 cc. tuberculin S.

April 13, 8:30 to 9:30 a. m.: Very uneasy in stall. Stands with body drawn up and back very much arched. Very violent and continuous trembling. Before injection, maximum temperature, 101.6° (3 p. m.); after injection, reached in ten hours, 106° (10 a. m.). (For complete record see p. 68.)

May 1, 1893, midnight: Second injection, 0.35 cc., tuberculin S. Before injection, maximum temperature, 102.2° (5 p. m.); after injection, reached in seventeen hours, 105° (5 p. m.). (For complete record see p. 72.)

May 10, 1893: Killed for examination.

Autopsy.—In gland at root of left bronchus there is a considerable crop of minute grayish tubercles, about one-sixteenth inch in diameter, and situated mainly in the cortex. A few are larger than the rest and contain each a minute yellowish nucleus. The small gland at root of right main bronchus contains three tubercles undergoing necrosis, each one-sixteenth to one-eighth inch in diameter.

In one of the mediastinal glands a few small tubercles like those in left bronchial gland.

No. 351.—Holstein bull, 2 years old. Weight, 850 pounds.

April 12, 1893, midnight: First injection, 0.25 cc., tuberculin S.

April 13, 8 to 9 a. m.: Periods of very violent trembling every few seconds, amounting almost to a violent shaking of the whole body. Before injection, maximum temperature, 102.6° (5 p. m.); after injection, reached in nineteen hours, 106.7° (7 p. m.). (For complete record see p. 68.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.4° (6 p. m.); after injection, reached in nineteen hours, 105.6° (7 p. m.). (For complete record see p. 72.)

May 3, 1893: Killed for examination.

Autopsy.—Lungs: There are not less than 5 tuberculous foci in the lung tissue. One large one, 2 to 3 inches in diameter near the lateral margin of the left caudal lobe, projecting slightly above the dorsal surface of the lobe when in state of collapse. It consists of soft cheesy masses easily removed from the enveloping tissue. The surrounding lung tissue is infiltrated with young tubercles. A second focus, 1 inch in diameter, situated along median border of the same lobe deeply embedded in the lung tissue. The condition of this focus the same as that of the first.

Two smaller soft cheesy foci situated near cephalic margin of the same lobe each one-half to three-fourths inch in diameter.

Three quite small glands embedded in the lung tissue of this lobe between the pulmonary artery and main bronchus contain firm, partly necrotic foci. In the main bronchus near its root a few submucous tubercles. In the right cephalic lobe there is 1 soft cheesy focus about one-half inch in diameter.

Bronchial glands: The one at root of left bronchus about the size of a small fist. The one at root of right supernumerary bronchus contains 10 to 15 tuberculous foci. The one situated in the bifurcation is as large as a hen's egg and almost entirely converted into a caseous mass in which are embedded gritty particles. The posterior mediastinal glands are also involved and contain numerous foci from one-eighth to one-half inch apart, the larger soft and cheesy.

In general, all thoracic glands affected and a few large glands noted where in normal lungs they are so minute as to be overlooked.

The bronchial glands are farther advanced in disease than the mediastinals.

One gland removed with spleen, and in all probability belonging to the portal glands, contains two tuberculous foci, yellowish, cheesy, still firm, and partly calcareous.

No. 352.—Holstein cow, 3 years old. Weight, 700 pounds. Calved March 19, 1893, and has not been served by bull since; is giving milk.

April 12, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 103° (6 p. m.); after injection, reached in ten hours, 106.2° (10 a. m.). (For complete record see p. 68.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 104° (5 p. m.); after injection, reached in seven hours, 104.3° (7 a. m.). (For complete record see p. 73.)

May 10, 1893: Killed for examination.

Autopsy.—Left retropharyngeal gland about 2 inches in diameter, slightly irregular in shape. On section the parenchyma is found containing tuberculous foci made up of putty-like masses, mixed with a few calcareous particles. They vary from one-eighth to 1 inch in diameter, and are surrounded with considerable connective tissue.

No. 353.—Jersey cow, 4 years old. Weight, 600 pounds. Calved March 26, 1893, and has not been served by bull since; is giving milk.

April 12, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection maximum temperature 102.6° (4 p. m.); after injection, reached in seventeen hours, 103.8° (5 p. m.). (For complete record see p. 68.)

May 1, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, minimum temperature 102.6° (5 p. m.); after injection, reached in nineteen hours, 104.3° (7 a. m.). (For complete record see p. 73.)

May 3, 1893: Killed for examination.

Autopsy.—No tuberculous lesions were found in this animal.

No. 354.—Cow, fifteen-sixteenths Holstein, 9 years old. Weight, 1,100 pounds. Calved March 28, 1893, and has not been served by bull since; is giving milk.

May 1, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature 103.5° (6 p. m.); after injection, reached in twelve hours, 106° (12 a. m.) (For complete record see p. 68.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature 102.6° (6 p. m.); after injection, reached in eighteen hours, 103° (6 p. m.). (For complete record see p. 73.)

June 8, 1893: Killed for examination.

Autopsy.—Thorax: In the lungs there are 4 foci of tuberculous infection, all situated in the caudal lobes. They are best described separately.

Focus No. 1 is situated on the median edge of right caudal lobe about 1½ inches from caudal tip. The focus itself is about 1½ inches long and nearly three-fourths inch in

diameter; a few distended tortuous vessels pass over its surface. It feels as if made up of four or five quite firm and distinct foci. A small air tube leads directly to the focus, and along its course there are several small tuberculous foci in connection with its walls. The large focus is composed of several small foci easily separated by teasing. Each contains a pasty, pale-yellow mass, inclosed in a rather thin capsule. The remaining foci are situated in the left caudal lobe.

Focus No. 2 occupies a position symmetrical with No. 1. It does not show on the surface as does No. 1, but is easily felt with the fingers; slight catarrh of the air tube leading to this focus. It consists of about one-half dozen nodules up to one-half inch in diameter, situated around a somewhat dilated bronchiole. In the course of the main bronchus and about 3 inches from the tip of lobe and about 2 inches from the focus just described there are several small cheesy foci in connection with the walls of the bronchus.

Focus No. 3 consists of a mass of firm nodules, varying in size up to one-half inch in diameter and distributed over a region about 2½ inches square and one-half inch thick. Small air tubes are traceable in this focus. The larger nodules are cheesy, like those described. There is some slight recent infiltration in the periphery of the focus. The interlobular tissue is more or less increased in quantity.

Focus No. 4 consists of a number of small cheesy nodules, up to one-eighth inch in diameter, covering an area of about 1 cubic inch and embedded in a large amount of firm connective tissue. There is in one place some recent infiltration on the periphery.

The gland at the root of left bronchus is more or less irregular and nodular in outline, and contains a considerable quantity of connective tissue, and in its center a cheesy mass about one-quarter inch in diameter. Scattered over the periphery are three or four quite small gelatinous looking tuberculous foci, containing yellowish necrotic masses. In the gland at root of the right supernumerary bronchus, which is but slightly enlarged, there are three tuberculous foci from one-eighth to one-half inch in diameter, with cheesy contents. The gland situated on dorsal surface of trachea near supernumerary bronchus contains one gelatinous focus, yellowish in color, and about three-sixteenths inch in diameter. The most caudal of the posterior mediastinal glands is very irregular in outline, much nodulated and retracted. The gland is of the usual length, and at its thickest portion is 1 by 1½ inches thick. In the center of this enlarged portion there is a cheesy mass, surrounded by connective tissue from one-half to three-fourths inch in diameter. The nodules showing from the exterior are, in part, free from any tuberculous deposit, and are due to retraction of the gland tissue, probably a result of some previous infection. In one of the smaller mediastinal glands there are three quite small gelatinous-looking nodules. The small gland within the left caudal lobe, between bronchus and artery near their origin, contains two tuberculous foci.

No. 355.—Holstein cow, 5 years old. Weight, 900 pounds. Calved summer of 1892. Pregnant since August 31, 1892.

May 1, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature 102.8° (5 p. m.); after injection, reached in fourteen hours, 105.4° (2 p. m.). (For complete record see p. 68.)

May 25, 1893, midnight: Second injection, 0.25 cc., tuberculin S. Before injection, maximum temperature, 103.2° (8 p. m.); after injection, 102.8° (7 a. m.). (For complete record see p. 73.)

June 8, 1893: Killed for examination.

Autopsy.—Thorax: On the surface of the large posterior mediastinal gland there are two round, projecting yellow, nodules, one-eighth and one-sixteenth inch in diameter. They are calcareous and the surrounding tissue free from any infiltration.

In the bronchial gland, at root of left bronchus, 3 foci of similar size and character.

Abdomen: In one of the mesenteric glands there is a group of three firm yellowish tubercles (the whole one-fourth inch in diameter) in the cortical portion. In a neighboring gland there is a similar group of somewhat larger tuberculous nodules. The glands are not enlarged and there is no infiltration around the foci.

No. 356.—Cow, fifteen-sixteenths Holstein, 9 years old. Weight, 1,000 pounds. Calved November, 1892; is giving milk. Served by bull March 6, 1893, but is not pregnant.

May 1, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature 102° (4 p. m.); after injection, reached in seventeen hours, 104° (5 p. m.). (For complete record see p. 68.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature 102° (6 p. m.); after injection, reached in eighteen hours, 102.8° (6 p. m). (For complete record see p. 73.)

June 12, 1893: Killed for examination.

Autopsy.—Thorax: In the caudal lobe of the left lung there is a tuberculous focus, situated directly under the pleura of the dorsal surface close to the median edge and 4 or 5 inches from the caudal tip. The pleura over this focus is slightly opaque, and beneath it are three small tuberculous nodules, two of which contain a caseous center. The focus itself consists of a central soft caseous mass, inclosed in a rather thick-walled capsule and surrounded by a zone of infiltrated tissue one-fourth to one-half inch thick. The infiltration consists of tubercles up to one-eighth inch in diameter, many of them caseous. An air tube is not traceable to it.

In the bronchus of this same lobe near its origin and in the trachea are 2 grayish tubercular excrescences. The one in the trachea is about one-half inch in diameter and projects one-half inch above surface. The center is depressed. The whole appears as if the mucosa were lifted up by tubercular infiltration of the submucosa. Section of the tumor shows a caseous mass beneath. The excrescence in the bronchus is more convex and projecting, otherwise there are no marked differences.

In the large posterior mediastinal gland near one end are 4 completely calcified foci about one-eighth to one-fourth inch in diameter. The gland itself is not enlarged, and these foci feel as firm as bullets in the interior of the gland tissue.

No. 357.—Cow, fifteen-sixteenths Holstein, 8 years old. Weight, 1,000 pounds. Calved July 1, 1893; is giving milk.

May 1, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature 102.8° (6 p. m.); after injection, reached in fourteen hours, 103° (2 p. m.). (For complete record see p. 68.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature 105° (10 p. m.); after injection, 102.5° (7 a. m.). (For complete record see p. 73.)

The elevation in temperature previous to inoculation was due to an unknown cause; excepting it the cow was apparently in good health. She belonged to the last of the series of tests in this herd, else a third injection of tuberculin would have been made. (See Case No. 318.)

July 13, 1893: Killed for examination.

Autopsy.—Tuberculous lesions not discoverable. In the udder a number of completely yellow regions indicating fatty degeneration of gland substance.

Marked interlobular and subpleural emphysema of the cephalic and ventral lobes of the right lung and of the ventral lobe of the left lung. Uterus contains a milky, very foul-smelling fluid. Calf born thirteen days ago.

No. 358.—Cow, fifteen-sixteenths Holstein, 6 years old. Weight, 1,000 pounds. Calved summer of 1892; is still giving milk. Pregnant since January 20, 1893.

May 1, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102° (5 p. m.); after injection, reached in nineteen hours, 105.6° (7 p. m.). (For complete record see p. 68.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 101.8° (6 p. m.); after injection, reached in seventeen hours, 102.9° (5 p. m.). (For complete record see p. 73.)

May 27, 1893: Killed for examination.

Autopsy.—Thorax: The most caudal of the posterior mediastinal glands has its cephalic end considerably enlarged, three-fourths inch thick, and 1½ inches wide. On section the greater part is found to be in a condition of tuberculous infiltration, of a grayish appearance, in which are embedded a considerable number of soft cheesy foci containing a few gritty particles. One of these cheesy foci is fully one-half inch in diameter. Along the middle portion of the same gland is another tuberculous mass about 1 by ½ inch in size, containing 4 foci, some of which are firm and yellow, others are still grayish with yellowish lines within them.

The second gland of this group has about one-fourth of its mass in the same condition as that just described. This gland is about 1 by ½ by ½ inch in size. The third gland of the group, slightly larger than the second, is normal. The fourth gland, which is 1¼ by 1 by ½ inch has two-thirds of its substance in the same tuberculous condition. The fifth, sixth, and seventh glands of this group are normal.

The bronchial gland at root of right bronchus is slightly larger than normal and contains a region of grayish infiltration about 1 inch in diameter, containing 6 or more small yellowish foci, quite firm and gritty in the center. One mesenteric gland contains in its cortex a dozen or more small tubercles, some yellowish and nearly one-eighth inch in diameter, projecting markedly above the cut surface.

Traumatic inflammatory adhesion between second stomach and neighboring organs.

No. 359.—Holstein cow, 7 years old. Weight, 1,000 pounds. Calved, July, 1892; is still giving milk. Pregnant since August 25, 1892.

May 1, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 103.2° (6 p. m.); after injection, reached in fourteen hours, 107.3° (2 p. m.). (For complete record see p. 68.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 103.4° (6 p. m.); after injection, 103° (6 p. m.). (For complete record see p. 73.)

May 26, 8 p. m.: The cow gave birth to a healthy calf, after which the temperatures were no longer taken.

June 15, 1893: Killed for examination.

Autopsy.—Thorax: In the right caudal lobe near the median border on the dorsal aspect, and about midway between caudal and cephalic border there is a small focus about 1 to 1½ inches in diameter directly under the pleura, made up of a collection of foci in various stages of degeneration. The innermost are soft, caseous, and surrounded by a thick wall. Several of these communicate directly by means of small openings with a small, dilated bronchus filled with yellowish, cheesy matter. Some of the exterior foci are composed of a very thick grayish wall and a small, very soft, yellowish center. These are about one-fourth inch in diameter.

Large posterior mediastinal gland, the most caudal of the series, is of the usual size, but is found to contain firm nodules in its substance. On the flat surface opposite the hilus there is a collection of nodules projecting above the surface, which on section are made up of a central, yellowish core, surrounded by a grayish capsule. On cutting into the gland there are found four or five separate regions of disease, consisting each of one or more foci one-eighth to one-fourth inch in diameter, which are firm, grayish on section, and have a yellowish, necrotic center. There is only one gritty focus about one-eighth inch in diameter.

The next gland of the series is about 1 inch in diameter and contains about 4 one-fourth-inch foci, all in the same condition as those described. The third gland, about 1 inch in diameter, contains 1 such focus. The fourth gland, ¾ by ½ inch in size, contains 5 or 6 similar foci and 1 smaller gritty focus. The fifth gland, about one-half

inch in diameter, is very nodular and contains 1 central, completely calcified focus and several peripheral foci with necrotic centers, like preceding. The sixth gland is about 2 inches long, one-half inch thick, and feels very nodular to the touch. It contains about one dozen foci from one-eighth to one-fourth inch in diameter, made up of a grayish peripheral zone and a firm necrotic center. The seventh gland is about 1½ inches long, one-fourth inch thick, and contains 3 foci like those described. The small gland between the two bronchi at the bifurcation, which is about one-half inch in diameter, is almost entirely occupied by 2 foci, one-eighth and three-eighths inch in diameter, of the same character as the preceding.

No. 360.—Cow, fifteen sixteenths Holstein, 9 years old. Weight, 1,000 pounds. Calved April 12, 1893, and has not since been served by bull; is giving milk.

May 1, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.4° (4 p. m.); after injection, 102.8° (7 p. m.). (For complete record see p. 68.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.2° (6 p. m.); after injection, 102.5° (6 p. m.). (For complete record see p. 73.)

July 6, 1893: Killed for examination.

Autopsy.—In the large posterior mediastinal gland there are 3 tuberculous foci situated near the middle of the gland. They are respectively one-half, one-half, and one-fourth inch in diameter. They are completely caseous, without any surrounding infiltration, and embedded in considerable connective tissue, part of which seems to belong to the scar of a healed infection. Slight adhesion of cephalic end of liver. A guinea pig inoculated subcutaneously with some of the caseous material July 7 died just two months after inoculation. The usual lesions of tuberculosis (advanced tuberculosis of liver, tubercles in lungs, and in Peyer's patches of the intestines) were present.

No. 361.—Holstein cow, 8 years old. Weight, 950 pounds. Calved December, 1892, and is giving milk. Pregnant since March 9, 1893.

May 1, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.6° (5 p. m.); after injection, reached in nineteen hours, 105.8° (5 p. m.). (For complete record see p. 69.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.4° (8 p. m.); after injection, 102.5° (7 a. m.). (For complete record see p. 73.)

May 27, 1893: Killed for examination.

Autopsy.—In the large posterior mediastinal gland there is 1 small, completely calcified focus about one-eighth inch in diameter. It shows on the exterior as a slight cicatricial constriction. There is 1 other calcified focus not more than one-sixteenth inch in diameter. The gland itself is slightly larger than normal and shows evidences of former inflammation. The left abdominal aspect of the diaphragm is very much thickened by inflammatory tissue of almost cartilaginous firmness. The lesion is limited mainly to the muscular portion of the diaphragm, and covers an area 4 to 6 inches in diameter. There is also considerable inflammatory deposit in the form of a gelatinous exudate between the second stomach and the liver. In this deposit are embedded a few suppurative foci.

No. 362.—Holstein cow, 11 years old. Weight, 1,100 pounds. Calved early in summer of 1892, and is still giving milk. Pregnant since February 9, 1893.

May 1, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.8° (5 p. m.); after injection, reached in eleven hours, 104.8° (11 a. m.). (For complete record see p. 69.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.4° (8 p. m.); after injection, reached in eighteen hours, 103° (6 p. m.). (For complete record see p. 73.)

June 12, 1893: Killed for examination.

Autopsy.—Thorax: In the caudal lobes of both lungs there are three tuberculous foci:

(1) In the left caudal lobe, about 1 inch from caudal extremity, is a collection of two or three caseous, quite soft foci, the whole about one-half inch in diameter, inclosed in more or less connective tissue, and with periphery free from recent infiltration.

(2) Exactly corresponding in position to the preceding focus is one in the right caudal lobe, consisting of a soft, cheesy mass inclosed in a capsule.

(3) In the left caudal lobe there is a second focus situated near median border of lobe on its dorsal aspect and about 3 or 4 inches from the caudal tip of lobe. This focus, 1½ or 2 inches in diameter, on first cutting into it, appeared as a very recent infiltration. The almost normal lung tissue is studded with an immense number of miliary tubercles. On closer examination a contiguous focus of small caseous masses is found, and a small dilated air tube choked with caseous material in communication with this region.

The large posterior mediastinal gland contains three foci about one-fourth inch in diameter. These appear as grayish, gelatinous-looking masses projecting above the cut surface and containing some yellowish gritty particles. One of the other glands of this series contains two small foci of the same character.

Bronchial gland at the root of left bronchus contains about six similar foci. The glands at root of right bronchus, the one at the bifurcation, and the one at the root of the right supernumerary bronchus contain each a single similar focus.

Three mesenteric glands contain each several small, firm, yellow tubercles. A fourth gland is as large as a hen's egg, and on section the medullary portion is found converted into a yellowish, still firm, necrotic mass.

No. 363.—Cow, seven-eighths Holstein, 9 years old. Weight, 950 pounds. Calved January 31, 1893, and has not since been served by bull; is giving milk.

May 1, 1893, midnight: First injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 103.2° (6 p. m.); after injection, reached in fourteen hours, 106° (2 p. m.). (For complete record see p. 69.)

May 25, 1893, midnight: Second injection, 0.25 cc. tuberculin S. Before injection, maximum temperature, 102.8° (8 p. m.); after injection, 102.7° (5 p. m.). (For complete record see p. 73.)

June 19, 1893: Killed for examination.

Autopsy.—One of the retropharyngeal glands is somewhat enlarged and contains a cheesy focus from one-half to three-fourths inch in diameter. The very soft contents are surrounded by distinct, connective-tissue capsule.

Thorax: In the large posterior mediastinal gland, which is not visibly enlarged, there is in the middle of its length along one border a region about 2 inches long which appears very nodular from the exterior and feels firm and nodular to the touch. In this mass only one distinctly tuberculous focus is found. This is about three-sixteenths inch in diameter, firm, yellowish, and projecting markedly above the cut surface. One other minute yellowish focus discovered in this gland. In one other mediastinal gland there is some firm, cicatricial tissue in the cortex indicative of healed tuberculosis. In the gland situated on the dorsal aspect of the trachea, near the right supernumerary bronchus, there is a similar circumscribed mass of very fine nodular tissue and a minute yellowish tubercle. The right ventral and principal lobes are firmly adherent to the diaphragm by means of delicate connective-tissue expansions. Similar slight attachments are found between pericardium and diaphragm and pericardium and the smaller lobes.

Abdomen: Over the cephalic half of the convex surface of the liver there are a number of old, fibrous adhesions attaching the anterior to cephalic lobe and the diaphragm. In the same lobe are several regions of yellowish infiltration, probably of embolic origin and due to parasites.

Some of the coils of the small intestines are attached to the abdominal wall by expansions of thin, membranous connective tissue. In many of the mesenteric glands there are one or more worm tubercles.

The following case, one of the three bulls, was sent to the experiment station of the bureau November 14, 1892, some months before the general test of the herd was begun. On November 17 one of the cervical glands* was removed by Dr. Kilborne. It was 3 to 4 inches in diameter, composed of a thick-walled sac and semifluid contents. Two guinea pigs inoculated subcutaneously with some of the contents died of tuberculosis.

Three tuberculin injections were made in all, the results of which are given below:

First test.—Received an injection November 16, 6:30 a. m., of 0.5 cc. tuberculinum Kochii.

Temperature before injection.		*Temperature after injection.*	
Nov. 14—4:30 p. m.†	104.3	Nov. 16—6:30 a. m.	101.4
6:30 p. m.	102.2	9 a. m.	102.7
Nov. 15—8 a. m.	100.0	11 a. m.	103.6
12 m.	100.2	1 p. m.	104.2
4 p. m.	100.9	3 p. m.	104.2
8 p. m.	101.6	5 p. m.	104.6
		7 p. m.	103.6
		9 p. m.	103.0
		11 p. m.	102.4
		Nov. 17—8 a. m.	101.0
		1 p. m.	102.4
		5 p. m.	101.2

November 17, 1892: Excision of the tubercular gland.

Second test.—Received an injection December 10, 1892, 6:30 a. m., of 0.15 cc. tuberculin prepared in the chemical laboratory of the Bureau of Animal Industry.

Temperature before injection.		*Temperature after injection.*	
Dec. 9—8 a. m.	101.0	Dec. 10— 6:30 a. m.	101.0
1 p. m.	100.8	9 a. m.	101.2
5 p. m.	101.8	11:30 a. m.	102.2
		2 p. m.	102.0
		4 p. m.	102.0
		6 p. m.	103.2
		8 p. m.	103.0
		11 p. m.	102.8
		Dec. 11— 8 a. m.	101.4
		4 p. m.	102.8
		Dec. 12— 8 a. m.	101.0

*Probably the one denominated post maxillary in this bulletin.—T. S.

† Temperature taken immediately upon the arrival of the bull at the veterinary station after he had been walking 3 to 4 miles from the Soldiers' Home.

Third test.—Received an injection January 20, 1893, 7 a. m., of 0.35 cc. tuberculin prepared in the chemical laboratory of the Bureau of Animal Industry.

Temperature before injection.		*Temperature after injection.*	
Jan. 19— 8 a. m.	101.0	Jan. 20— 7 a. m.	100.8
12 m	101.4	9 a. m.	102.2
5 p. m.	101.0	11 a. m.	103.0
		1 p. m.	102.6
		3 p. m.	102.6
		6 p. m.	101.5
		8 p. m.	101.2
		10 p. m.	101.0
		Jan. 21— 8 a. m.	100.5
		12 m	100.8
		5 p. m.	102.6

January 26, 1893: Bull killed and examined post-mortem.

Extensive tuberculosis of glands of head. Tuberculosis of bones of sternum Axillary glands of both sides as large as hens' eggs and cheesy.

Advanced tuberculosis of all lobes of the lungs, associated with cavities and more or less fibroid induration. No pleural tuberculosis. All thoracic glands tuberculous and some as large as the closed hand.

In abdomen, mesenteric glands as well as the peritoneum free from disease. The portal glands free, but four cheesy foci in the liver tissue, one-half to 1 inch in diameter. Spleen free. Some small tubercles in medullary portion of parenchyma of kidneys near papillæ.

In this animal the advanced stage of the gland disease, the cavities in the lungs, the surrounding fibroid thickening, and the chronic generalized infection indicate that this was a long-standing case.

TABLES GIVING THE TEMPERATURE AS TAKEN BEFORE AND AFTER THE INJECTION OF TUBERCULIN.

By F. L. Kilborne and E. C. Schroeder.

Hour.	303		304		306		311		314	
	Dec. 6. Before.	Dec. 7. After.	Dec. 6. Before.	Dec. 7. After.	Dec. 6. Before.	Dec. 7. After.	Dec. 6. Before.	Dec. 7. After.	Dec. 6. Before.	Dec. 7. After.
6 a. m.	102.0	102.2	100.8	101.5	101.4	101.8	101.5	101.6	101.2	101.8
8 a. m.	102.5	102.5	101.8	102.2	102.6	103.0	102.5	102.6	102.0	101.8
10 a. m.	102.2	102.0	101.8	101.8	102.0	102.5	101.8	102.0	102.4	102.2
12 noon.	100.2	100.4	101.5	99.4	100.0	100.2	99.6	99.5	99.8	99.8
2 p. m.	100.8	104.4	101.0	101.2	100.6	102.4	100.2	101.8	101.2	102.5
4 p. m.	102.2	107.0	101.8	102.4	101.8	105.2	101.4	104.8	102.5	105.0
6 p. m.	102.5	106.6	102.2	102.6	102.3	105.8	101.5	106.0	102.2	105.6
8 p. m.	101.5	105.4	101.2	102.5	101.4	106.0	101.2	104.4	101.6	106.0
9 p. m.	.....	105.0	.....	102.2	.....	105.2	.....	105.1	.....	105.3
11 a. m., Dec. 8	.....	100.7	.....	101.0	.....	101.0	.....	101.0	.....	100.8

Injected tuberculin K 6 a. m. December 7, 1892.

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	301						302					
	Feb. 1–2. Before injection.			Feb. 2–3. After injection.			Feb. 1–2. Before injection.			Feb. 2–3. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m.	100.2	.....	.....	101.4	54	24	100.0	.....	.....	101.2	54	24
10 a. m.	100.1	.....	.....	101.4	54	24	100.0	.....	.....	101.6	54	18
11 a. m.	100.6	54	16	101.8	54	21	100.6	54	16	101.3	54	18
12 noon	101.1	50	18	101.3	54	24	100.6	48	16	101.0	54	21
1 p. m.	101.4	54	18	101.2	54	21	100.6	54	20	101.0	54	18
2 p. m.	101.6	54	30	101.4	54	18	101.0	48	18	101.3	54	18
3 p. m.	102.0	78	36	101.7	51	18	101.4	72	32	102.9	60	21
4 p. m.	101.8	72	36	102.8	90	24	102.2	72	32	104.0	72	30
5 p. m.	101.8	60	30	103.3	90	30	101.5	66	30	105.4	96	30
6 p. m.	101.6	60	32	105.0	75	30	101.4	60	30	106.6	84	36
7 p. m.	101.2	60	30	106.4	84	24	101.0	60	30	107.4	96	33
8 p. m.	101.5	54	30	106.6	84	30	101.0	54	28	107.0	90	36
9 p. m.	101.4	54	28	106.8	78	30	101.0	54	28	106.5	84	30
10 p. m.	101.4	54	30	106.4	78	36	101.3	54	30	106.0	84	30
11 p. m.	101.4	56	30	105.8	72	27	101.4	54	30	106.0	84	30
12 midnight	101.6	60	30	106.2	75	30	100.8	70	30	105.6	75	27
1 a. m.	101.4	54	26	105.8	84	30	101.4	66	30	105.0	72	30
2 a. m.	101.5	56	30	105.8	66	27	101.0	60	30	105.3	69	36
3 a. m.	101.4	54	32	105.0	78	39	100.8	54	27	104.8	72	30
4 a. m.	100.9	54	32	105.2	66	30	101.2	54	24	104.8	72	36
5 a. m.	101.6	54	30	104.4	78	36	101.7	54	21	103.9	72	36
6 a. m.	101.9	72	30	104.0	72	36	101.6	66	30	103.4	75	30
7 a. m.	101.6	48	18	103.2	72	42	101.7	60	21	103.1	66	32
8 a. m.	101.3	54	18	102.8	60	36	101.8	54	24	102.5	69	36
9 a. m.	Inj. tuberculin S.			102.4	60	40	Inj. tuberculin S.			102.4	66	30
10 a. m.	.....	.....	.....	101.6	60	24	.....	.....	.....	101.8	60	24
11 a. m.	.....	.....	.....	101.2	54	24	.....	.....	.....	101.8	57	27
12 noon	.....	.....	.....	101.2	66	33	.....	.....	.....	101.8	60	24
1 p. m.	.....	.....	.....	101.2	54	33	.....	.....	.....	101.8	60	24
2 p. m.	.....	.....	.....	101.2	57	30	.....	.....	.....	101.6	60	30
3 p. m.	.....	.....	.....	102.0	72	33	.....	.....	.....	102.5	68	32
4 p. m.	.....	.....	.....	102.2	78	36	.....	.....	.....	103.2	72	36

Hour.	303						304*					
	Feb. 1–2. Before injection.			Feb. 2–3. After injection.			Feb. 1–2. Before injection.			Feb. 2–3. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m.	99.1	.....	.....	101.5	54	27	98.6	.....	.....	102.2	54	24
10 a. m.	99.0	.....	.....	101.0	48	12	99.0	.....	.....	102.1	48	21
11 a. m.	100.0	48	20	100.6	48	18	98.8	48	12	102.2	51	21
12 noon	100.0	50	18	100.3	48	18	100.0	50	12	101.4	51	18
1 p. m.	100.6	50	20	100.6	57	24	100.9	48	16	101.2	54	18
2 p. m.	100.8	48	20	100.4	48	21	101.2	54	18	101.8	51	18
3 p. m.	101.6	70	40	101.8	51	24	101.8	72	32	101.9	48	21
4 p. m.	102.0	76	35	103.0	66	30	102.3	70	36	102.3	78	36
5 p. m.	101.8	66	24	103.7	72	33	101.7	66	30	102.3	72	24
6 p. m.	101.5	66	30	104.1	66	30	101.7	56	22	102.6	69	24
7 p. m.	101.2	60	30	105.2	60	36	101.4	62	26	102.0	60	21
8 p. m.	101.2	54	26	105.6	63	33	101.2	54	20	101.4	60	21
9 p. m.	101.0	60	36	104.8	63	30	101.4	60	30	101.6	60	24
10 p. m.	100.9	60	36	104.4	63	24	101.2	56	30	101.4	60	24
11 p. m.	101.3	66	30	104.2	72	36	101.6	54	24	101.6	60	24
12 midnight	101.0	54	30	104.0	72	36	101.0	54	24	101.6	60	21
1 a. m.	100.8	54	36	103.8	57	27	100.8	60	24	101.8	60	18
2 a. m.	101.0	50	32	104.0	66	42	101.2	60	24	101.4	60	15
3 a. m.	100.8	48	21	104.0	63	33	101.5	54	24	101.4	66	18
4 a. m.	100.8	54	30	103.8	72	39	101.4	54	24	101.6	60	24
5 a. m.	101.4	48	24	103.0	60	38	102.2	54	24	101.2	60	24
6 a. m.	101.4	54	24	103.2	66	36	101.8	60	24	102.0	66	22
7 a. m.	101.4	48	24	103.4	63	45	101.9	54	21	101.5	57	15
8 a. m.	101.6	60	24	103.0	66	48	101.8	60	24	101.4	60	24
9 a. m.	Inj. tuberculin S.			102.5	66	42	Inj. tuberculin S.			101.7	66	24
10 a. m.	.....	.....	.....	102.0	54	33	.....	.....	.....	101.0	57	21
11 a. m.	.....	.....	.....	102.0	54	30	.....	.....	.....	101.0	60	18
12 noon	.....	.....	.....	101.6	54	36	.....	.....	.....	100.8	54	24
1 p. m.	.....	.....	.....	101.4	60	33	.....	.....	.....	101.0	54	18
2 p. m.	.....	.....	.....	101.8	54	33	.....	.....	.....	101.4	54	24
3 p. m.	.....	.....	.....	102.4	78	42	.....	.....	.....	102.0	72	36
4 p. m.	.....	.....	.....	103.2	68	48	.....	.....	.....	102.0	72	36

* Given a preliminary tuberculin test December 7, 1892.

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	305						306					
	Feb. 1-2. Before injection.			Feb. 2-3. After injection.			Feb. 1-2. Before injection.			Feb. 2-3. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m	99.4			101.6	45	21	100.6			101.6	50	30
10 a. m	99.4			101.5	48	21	99.6			101.8	54	21
11 a. m	100.4	42	12	101.6	48	18	100.4	50	16	102.1	42	18
12 noon	100.4	42	12	101.0	42	15	100.6	44	18	100.8	42	21
1 p. m	100.8	48	12	100.7	48	15	101.2	54	20	100.4	45	18
2 p. m	101.0	48	18	101.2	48	18	101.2	50	26	101.0	45	21
3 p. m	101.8	70	30	101.2	45	21	101.9	66	36	101.8	48	21
4 p. m	101.8	78	30	102.1	72	30	102.0	72	30	102.4	72	30
5 p. m	101.4	66	24	102.8	75	30	101.4	62	24	102.2	72	36
6 p. m	101.2	51	24	102.0	54	24	101.1	54	36	102.2	54	24
7 p. m	101.3	56	24	101.8	54	18	100.8	54	28	102.0	54	24
8 p. m	100.7	54	24	101.6	60	21	100.9	54	30	104.0	60	27
9 p. m	101.0	50	30	100.6	54	18	100.6	54	30	105.3	66	36
10 p. m	101.0	54	26	101.0	54	18	100.8	48	30	106.4	72	33
11 p. m	101.0	54	20	101.0	54	18	100.8	66	30	106.0	75	33
12 midnight	101.0	48	20	101.6	48	15	100.8	48	32	105.8	60	30
1 a. m	101.0	48	24	101.2	51	18	100.9	48	24	104.4	72	48
2 a. m	101.4	54	27	101.6	78	15	101.0	45	30	103.4	60	42
3 a. m	100.8	57	24	101.2	60	24	100.7	48	24	103.5	63	39
4 a. m	101.4	54	24	101.2	54	15	100.8	48	24	103.8	63	33
5 a. m	101.2	54	20	101.0	57	20	101.3	54	24	103.7	63	30
6 a. m	101.8	54	18	101.2	54	18	101.7	52	21	103.7	66	33
7 a. m	101.7	54	21	101.4	54	12	102.1	54	21	103.4	72	30
8 a. m	101.8	48	21	101.5	54	18	102.2	48	24	103.1	63	42
9 a. m	Inj. tuberculin S.			101.5	54	18	Inj. tuberculin S.			102.6	60	42
10 a. m				101.0	48	15				101.8	54	33
11 a. m				100.8	48	18				101.7	54	30
12 noon				100.3	54	18				101.2	54	36
1 p. m				100.7	48	15				101.0	54	36
2 p. m				101.0	54	18				101.2	48	32
3 p. m				101.6	78	36				101.8	64	36
4 p. m				102.0	72	36				102.0	66	42

Hour.	307						308					
	Feb. 1-2. Before injection.			Feb. 2-3. After injection.			Feb. 1-2. Before injection.			Feb. 2-3. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m	101.0			101.9	54	27	101.8			101.6	48	24
10 a. m	101.4			101.4	45	24	101.3			101.4	48	21
11 a. m	101.2	48	12	101.7	42	18	101.3	48	14	102.0	39	15
12 noon	101.2	54	18	101.7	48	18	101.2	48	14	101.1	42	18
1 p. m	101.4	50	18	101.0	45	15	101.0	44	18	101.1	42	15
2 p. m	101.5	48	18	101.3	51	18	101.2	42	16	101.1	42	15
3 p. m	102.2	66	32	102.0	48	21	102.2	60	30	102.0	48	21
4 p. m	102.4	72	36	102.4	78	36	102.2	66	30	102.7	60	24
5 p. m	101.8	54	30	103.0	66	24	102.2	54	30	102.6	60	24
6 p. m	101.4	54	30	104.2	60	18	101.8	48	24	104.0	54	24
7 p. m	101.4	50	22	105.6	72	36	101.6	48	22	104.6	52	21
8 p. m	100.7	54	30	106.6	72	24	101.6	44	22	104.6	54	21
9 p. m	101.0	50	30	107.6	84	27	101.1	48	20	104.4	60	24
10 p. m	101.4	48	30	107.2	90	30	101.8	48	20	104.2	54	24
11 p. m	101.0	50	27	107.0	81	36	101.8	50	24	104.2	48	26
12 midnight	101.5	54	30	107.0	75	27	101.3	54	24	103.6	48	24
1 a. m	101.4	48	26	106.7	78	36	101.8	48	24	102.9	54	21
2 a. m	101.4	54	30	106.2	66	30	101.8	48	21	103.5	66	24
3 a. m	101.4	54	27	106.6	72	42	101.4	48	24	102.0	48	36
4 a. m	100.8	48	24	105.8	68	30	101.4	48	24	102.5	54	33
5 a. m	101.8	54	24	105.6	66	42	101.7	54	30	101.9	60	34
6 a. m	101.8	54	18	104.6	60	27	101.6	40	24	101.5	45	24
7 a. m	102.2	48	18	104.8	64	30	101.6	45	21	101.0	48	20
8 a. m	102.2	48	18	103.5	66	39	102.0	48	21	101.0	48	20
9 a. m	Inj. tuberculin S.			103.6	66	36	Inj. tuberculin S.			101.1	48	21
10 a. m				102.4	60	39				101.0	48	21
11 a. m				101.8	54	24				101.2	48	21
12 noon				101.2	54	24				101.0	60	30
1 p. m				101.4	54	30				100.7	42	18
2 p. m				101.4	54	24				101.0	48	21
3 p. m				102.2	66	36				102.0	60	32
4 p. m				102.4	60	36				101.8	66	36

* Given a preliminary tuberculin test December 7, 1892.

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	309						310					
	Feb. 1–2. Before injection.			Feb. 2–3. After injection.			Feb. 1–2. Before injection.			Feb. 2–3. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m.	100.4	.....	.....	101.0	42	18	100.0	.....	.....	102.4	70	21
10 a. m.	100.0	.....	.....	101.5	48	18	100.4	.....	.....	102.3	60	24
11 a. m.	100.4	42	12	101.5	45	21	100.8	44	14	102.3	54	18
12 noon	101.0	42	12	101.0	42	15	100.8	42	14	102.0	60	15
1 p. m.	101.0	48	12	101.2	36	15	101.2	54	15	102.2	60	15
2 p. m.	101.0	42	12	101.2	45	15	101.2	48	15	102.4	54	15
3 p. m.	100.8	66	30	101.5	42	18	102.0	72	28	102.4	60	18
4 p. m.	101.7	66	30	102.3	66	30	102.2	75	28	104.1	78	24
5 p. m.	102.4	56	30	102.2	60	27	102.0	72	28	104.1	112	24
6 p. m.	102.0	56	24	103.0	60	30	101.5	60	28	105.8	90	24
7 p. m.	101.8	48	24	104.6	54	15	101.6	66	28	105.2	84	18
8 p. m.	101.8	48	20	104.8	60	21	101.7	66	24	105.6	75	24
9 p. m.	101.4	42	24	104.8	72	30	101.4	66	24	104.8	78	21
10 p. m.	101.8	42	30	103.8	63	24	101.6	66	24	104.2	78	26
11 p. m.	101.6	48	24	104.2	48	24	101.6	60	20	104.0	96	24
12 midnight	101.8	42	24	104.0	54	21	101.8	54	26	103.8	78	27
1 a. m.	102.0	48	21	104.2	48	21	101.3	70	24	103.5	78	24
2 a. m.	101.7	60	27	103.6	60	27	102.0	66	24	103.2	66	18
3 a. m.	102.3	54	24	104.0	54	30	102.0	66	32	103.7	63	24
4 a. m.	101.8	54	24	103.1	54	24	101.8	66	24	103.1	69	21
5 a. m.	102.2	48	20	103.6	60	22	101.4	62	24	102.8	78	24
6 a. m.	102.2	48	18	103.0	78	21	102.0	60	21	102.2	72	21
7 a. m.	102.2	48	24	102.5	60	21	.....	.....	.....	.....	.....	.....
8 a. m.	101.2	48	18	102.0	51	18	102.8	72	24	101.8	66	20
9 a. m.	Inj. tuberculin S.			101.8	48	24	Inj. tuberculin S.			.....	.....	.....
10 a. m.	.....	.....	.....	101.3	48	18	.....	.....	.....	100.4	54	15
11 a. m.	.....	.....	.....	101.0	42	21	.....	.....	.....	.....	.....	.....
12 noon	.....	.....	.....	101.4	42	24	.....	.....	.....	100.6	60	18
1 p. m.	.....	.....	.....	100.8	48	21	.....	.....	.....	100.4	60	18
2 p. m.	.....	.....	.....	101.0	48	21	.....	.....	.....	.....	.....	.....
3 p. m.	.....	.....	.....	101.8	72	30	.....	.....	.....	.....	.....	.....
4 p. m.	.....	.....	.....	102.0	66	36	.....	.....	.....	.....	.....	.....

Hour.	311*						312					
	Mar. 15–16. Before injection.			Mar. 16–17. After injection.			Mar. 15–16. Before injection.			Mar. 16–17. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m.	100.0	48	18	101.0	42	15	100.0	48	12	101.8	54	21
10 a. m.	100.2	48	18	101.0	42	18	99.8	48	15	101.7	60	21
11 a. m.	100.2	48	15	100.2	40	18	100.4	57	18	100.4	60	15
12 noon	100.2	51	18	100.4	40	18	100.4	54	18	100.4	60	15
1 p. m.	100.2	48	18	100.4	42	15	101.2	54	18	101.2	60	18
2 p. m.	100.4	48	18	100.4	48	18	101.8	72	21	102.2	60	21
3 p. m.	101.0	66	24	100.4	66	24	102.6	78	36	103.4	66	30
4 p. m.	102.0	60	24	101.1	66	24	103.0	69	30	104.2	66	30
5 p. m.	102.4	54	24	102.8	84	21	102.4	66	27	103.8	84	33
6 p. m.	101.8	48	21	104.0	60	18	102.0	60	27	105.2	80	30
7 p. m.	101.5	44	20	104.4	60	20	101.8	60	24	104.8	80	24
8 p. m.	101.6	48	20	105.0	66	27	101.5	56	30	104.3	68	30
9 p. m.	101.2	54	24	106.0	72	24	101.4	60	24	104.2	80	30
10 p. m.	101.4	48	24	106.2	72	21	101.6	60	24	103.8	72	24
11 p. m.	101.5	60	20	106.6	63	26	101.5	56	28	103.8	72	24
12 midnight	100.6	56	24	106.3	72	24	100.8	68	24	104.7	78	24
1 a. m.	100.4	60	24	106.2	60	24	101.6	56	20	104.6	78	24
2 a. m.	100.6	56	20	105.4	66	27	101.8	66	24	104.8	72	33
3 a. m.	100.8	60	24	105.1	63	21	101.8	56	18	104.8	78	21
4 a. m.	100.8	44	24	104.2	68	21	101.6	60	24	104.8	78	21
5 a. m.	101.0	44	24	104.6	60	20	102.0	60	20	104.8	66	22
6 a. m.	100.6	48	18	104.6	60	21	102.2	60	20	104.6	84	21
8 a. m.	101.0	44	18	103.0	54	21	102.4	52	20	104.2	84	21
9 a. m.	Inj. tuberculin S.			.....	.....	.....	Inj. tuberculin S.			.....	.....	.....
10 a. m.	.....	.....	.....	101.4	60	18	.....	.....	.....	103.0	76	20
12 noon	.....	.....	.....	101.2	66	18	.....	.....	.....	102.8	72	24
1 p. m.	.....	.....	.....	100.8	60	20	.....	.....	.....	102.8	72	20

* Given a preliminary tuberculin test December 7, 1892.

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	313						314*					
	Mar. 15–16. Before injection.			Mar. 16–17. After injection.			Mar. 15–16. Before injection.			Mar. 16–17. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m.	99.6	54	18	101.8	60	24	99.0	60	14	102.0	54	21
10 a. m.	99.4	48	18	101.8	60	21	99.0	60	14	102.0	66	24
11 a. m.	100.0	60	18	100.6	60	18	99.8	48	18	101.2	66	18
12 noon	100.4	54	18	100.8	60	18	100.5	54	21	100.8	66	18
1 p. m.	100.4	54	21	100.8	60	18	101.0	54	21	101.3	54	21
2 p. m.	101.0	63	21	101.4	60	21	101.2	60	21	102.0	72	24
3 p. m.	102.0	72	33	102.2	72	30	102.0	78	33	102.4	72	24
4 p. m.	102.3	72	30	102.6	84	30	102.2	66	33	103.4	72	30
5 p. m.	102.1	66	30	103.1	66	21	102.0	66	30	103.0	60	21
6 p. m.	102.0	72	30	103.1	66	24	102.2	69	36	104.3	68	24
7 p. m.	102.2	60	24	104.6	72	24	102.0	66	28	105.4	72	24
8 p. m.	101.6	68	28	105.2	72	24	102.0	60	32	105.8	84	24
9 p. m.	102.0	68	24	106.0	72	24	101.8	56	28	107.0	72	30
10 p. m.	101.5	60	20	106.4	72	27	101.4	60	24	106.8	75	33
11 p. m.	101.8	64	30	106.6	75	26	101.5	60	24	106.6	72	27
12 midnight	101.4	64	24	106.0	84	30	102.0	56	20	106.0	72	24
1 a. m.	101.3	64	24	106.4	72	24	101.5	56	24	105.6	72	27
2 a. m.	101.4	60	20	106.0	84	30	101.6	64	24	104.6	72	24
3 a. m.	101.0	72	24	105.8	84	30	101.5	72	18	105.0	78	30
4 a. m.	101.2	60	18	106.2	69	33	101.2	66	24	103.0	48	18
5 a. m.	101.5	64	24	105.0	78	24	102.0	60	20	103.0	75	27
6 a. m.	101.4	60	18	105.2	66	24	102.2	66	24	102.6	60	18
8 a. m.	101.8	56	18	105.6	63	27	102.6	52	20	102.0	66	24
9 a. m.	Inj. tuberculin S.						Inj. tuberculin S.					
10 a. m.				103.2	66	20				100.8	64	24
12 noon				102.6	68	24				100.5	56	18
1 p. m.				102.0	60	24				100.8	64	18

Hour.	315						316					
	Mar. 15–16. Before injection.			Mar. 16–17. After injection.			Mar. 15–16. Before injection.			Mar. 16–17. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m.	98.6	54	18	101.8	57	24	101.3	60	12	101.4	60	16
10 a. m.	98.8	48	15	101.6	57	24	101.4	60	18	101.4	60	16
11 a. m.	99.4	54	18	101.2	57	24	101.6	60	18	100.6	60	18
12 noon	99.8	54	18	100.8	57	21	101.8	60	18	101.0	60	21
1 p. m.	100.0	54	18	101.2	48	24	101.6	60	18	101.3	54	18
2 p. m.	101.2	60	18	101.6	60	30	101.6	66	24	101.4	63	21
3 p. m.	102.0	66	30	102.6	84	30	102.2	78	24	101.6	78	30
4 p. m.	102.2	60	27	102.6	60	27	102.6	72	27	102.4	78	27
5 p. m.	102.4	60	30	102.2	60	24	101.4	78	24	102.0	78	30
6 p. m.	102.0	60	30	103.8	76	21	101.5	72	27	102.6	76	28
7 p. m.	101.6	60	28	104.5	60	24	101.4	66	24	103.2	80	24
8 p. m.	101.8	64	32	105.6	84	24	101.6	60	24	103.7	72	20
9 p. m.	102.0	56	24	106.8	75	27	101.4	64	24	105.3	72	20
10 p. m.	101.8	60	24	106.2	84	24	101.2	60	20	105.9	72	24
11 p. m.	102.0	60	20	106.2	72	24	101.5	60	24	106.2	84	24
12 midnight	101.2	56	28	105.6	81	28	100.8	64	30	106.0	72	33
1 a. m.	101.6	56	24	105.8	66	21	100.8	60	20	105.4	72	30
2 a. m.	101.5	56	24	105.6	78	27	101.3	64	18	105.2	72	30
3 a. m.	101.8	60	24	105.6	72	21	101.0	56	20	105.0	88	33
4 a. m.	101.8	57	24	105.0	60	20	100.8	56	24	104.8	84	24
5 a. m.	102.0	60	20	104.0	72	24	101.8	64	18	103.2	72	30
6 a. m.	101.8	60	20	104.0	72	22	101.5	60	18	102.8	72	27
8 a. m.	101.8	56	20	103.5	60	21	101.4	64	16	102.7	78	24
9 a. m.	Inj. tuberculin S.						Inj. tuberculin S.					
10 a. m.				102.2	56	24				101.8	72	18
12 noon				101.8	56	24				102.5	66	18
1 p. m.				101.6	56	24				102.3	64	24

*Given a preliminary tuberculin test December 7, 1892.

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	317						318					
	Mar. 15–16. Before injection.			Mar. 16–17. After injection.			Mar. 15–16. Before injection.			Mar. 16–17. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m	101.0	42	12	101.7	48	18	98.8	48	15	102.5	66	21
10 a. m	100.0	42	15	101.6	45	15	98.6	60	15	102.2	60	15
11 a. m	100.8	42	15	101.8	39	15	99.0	60	15	101.6	60	15
12 noon	100.8	42	15	101.4	39	15	99.4	54	15	101.4	54	15
1 p. m	100.8	39	12	101.4	39	12	100.0	54	18	101.6	54	18
2 p. m	101.3	42	15	102.0	51	15	100.2	54	18	102.0	66	24
3 p. m	102.0	54	24	102.0	66	27	101.4	72	24	103.0	72	30
4 p. m	102.6	60	24	102.6	72	24	102.7	72	24	105.2	72	24
5 p. m	103.0	66	24	102.0	72	21	102.8	72	27	105.2	78	21
6 p. m	102.4	60	20	102.2	66	24	103.0	60	27	106.6	80	20
7 p. m	102.0	44	20	103.4	56	16	102.4	66	24	107.4	76	24
8 p. m	102.0	48	24	103.5	64	18	102.0	60	24	107.2	72	27
9 p. m	102.0	48	20	104.5	66	18	102.2	60	24	107.0	72	24
10 p. m	102.2	44	24	105.4	69	18	102.0	56	18	106.4	78	24
11 p. m	102.0	56	24	105.4	66	21	102.0	60	20	106.4	72	27
12 midnight	101.8	48	16	105.6	60	18	101.6	64	20	105.4	84	24
1 a. m	102.0	60	24	105.4	78	18	101.4	56	24	106.2	78	27
2 a. m	101.7	44	20	105.6	78	22	102.2	52	18	106.0	84	24
3 a. m	101.8	56	18	105.8	72	21	101.6	56	18	105.4	84	30
4 a. m	102.0	54	18	104.8	75	22	101.5	60	24	105.0	84	30
5 a. m	102.0	40	18	104.8	66	18	102.0	60	18	105.0	78	27
6 a. m	101.8	44	18	104.4	60	21	102.2	72	20	104.8	78	27
8 a. m	101.8	44	15	104.2	51	21	103.2	60	18	104.2	72	24
9 a. m	Inj. tuberculin S.						Inj. tuberculin S.					
10 a. m				103.0	60	18				103.2	64	24
12 noon				102.2	52	18				103.2	66	20
1 p. m				102.4	60	18				102.6	72	18

Hour.	319						320					
	Mar. 15–16. Before injection.			Mar. 16–17. After injection.			Mar. 15–16. Before injection.			Mar. 16–17. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m	99.8	48	18	102.0	60	15	98.8	60	12	101.8	44	16
10 a. m	99.5	66	18	102.0	57	15	99.4	66	12	101.2	51	12
11 a. m	99.0	60	15	101.0	60	15	99.0	54	12	100.0	48	12
12 noon	100.8	54	15	100.8	54	15	99.4	54	12	99.8	48	12
1 p. m	101.4	54	15	101.0	48	15	100.4	54	12	99.9	51	12
2 p. m	101.6	48	15	101.3	57	18	100.3	66	15	100.2	57	15
3 p. m	102.0	60	24	102.2	60	21	100.8	78	30	101.0	69	24
4 p. m	103.0	66	24	102.7	60	21	102.0	78	24	102.0	72	24
5 p. m	103.3	66	24	101.0	66	21	102.6	63	24	101.0	66	21
6 p. m	103.1	57	18	101.5	60	20	102.2	69	15	101.6	66	18
7 p. m	102.2	60	20	102.3	60	16	102.0	60	18	102.0	60	20
8 p. m	103.0	56	16	102.5	54	14	101.5	52	16	102.5	72	18
9 p. m	103.1	52	24	102.8	63	15	101.5	60	24	103.2	60	20
10 p. m	102.5	60	20	102.6	63	18	101.6	60	24	103.6	60	15
11 p. m	102.5	60	20	102.8	54	18	101.5	60	20	104.2	66	12
12 midnight	102.4	56	16	101.8	66	21	101.4	56	16	104.2	66	15
1 a. m	101.8	60	20	101.8	54	15	101.2	64	16	103.6	57	18
2 a. m	102.0	64	18	102.2	57	18	101.0	56	24	103.2	60	15
3 a. m	102.0	60	18	101.6	54	15	101.2	60	24	102.8	60	18
4 a. m	102.2	54	24	102.0	72	18	101.5	56	18	102.6	72	21
5 a. m	101.8	56	24	101.8	60	15	101.4	60	15	102.2	66	18
6 a. m	101.8	60	18	101.5	60	15	101.5	66	24	102.5	66	18
8 a. m	102.5	56	16	101.6	54	18	101.6	48	18	101.8	60	15
9 a. m	Inj. tuberculin S.						Inj. tuberculin S.					
10 a. m				102.0	48	16				101.2	52	16
12 noon				101.8	54	18				101.5	48	16
1 p. m				101.8	56	18				101.0	60	12

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	321						322					
	Mar. 15–16. Before injection.			Mar. 16–17. After injection.			Mar. 15–16. Before injection.			Mar. 16–17. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m.	100.8	48	15	101.8	44	18	99.6	40	42	102.2	48	20
10 a. m.	100.6	51	15	101.6	44	12	99.6	42	12	102.0	48	15
11 a. m.	100.6	48	15	101.2	54	12	100.0	42	12	99.1	54	18
12 noon	100.4	48	15	100.9	51	12	100.2	42	12	99.0	51	15
1 p. m.	100.4	42	12	100.8	51	12	100.5	42	12	99.6	42	15
2 p. m.	100.8	54	15	101.2	48	15	100.4	48	18	99.8	54	18
3 p. m.	101.4	60	27	101.2	66	24	101.6	54	24	101.0	66	21
4 p. m.	101.8	60	24	102.2	54	24	102.4	54	24	101.2	54	21
5 p. m.	102.0	57	24	101.2	54	18	102.2	54	24	101.0	60	21
6 p. m.	102.2	54	18	101.6	52	15	102.3	54	21	100.8	60	20
7 p. m.	102.0	54	18	101.8	48	16	102.4	54	21	101.4	60	15
8 p. m.	101.8	64	20	101.6	60	12	102.0	52	20	101.8	52	12
9 p. m.	102.0	60	20	102.2	60	18	102.5	56	24	102.2	68	20
10 p. m.	101.8	60	24	103.0	60	18	102.0	48	24	102.8	54	18
11 p. m.	102.0	60	20	103.4	48	18	102.0	56	20	103.0	54	18
12 midnight	102.0	60	12	103.3	57	18	101.8	48	16	102.4	54	18
1 a. m.	101.6	56	24	103.2	57	18	102.2	52	16	103.0	57	18
2 a. m.	101.2	68	18	103.0	45	21	101.8	48	16	103.0	54	15
3 a. m.	101.8	60	18	102.6	48	18	101.8	56	18	103.0	58	15
4 a. m.	101.4	52	24	102.4	51	18	102.2	54	18	102.6	48	12
5 a. m.	100.8	60	18	101.8	54	18	102.0	60	18	102.5	54	12
6 a. m.	101.6	56	20	102.0	54	18	102.0	48	18	102.4	54	15
8 a. m.	101.5	44	20	101.8	48	12	102.2	48	12	102.8	54	12
9 a. m.	Inj. tuberculin S.						Inj. tuberculin S.					
10 a. m.				101.4	48	18				101.9	52	12
12 noon				101.6	60	18				101.8	48	15
1 p. m.				102.0	48	18				101.2	56	18

Hour.	323						324					
	Mar. 15–16. Before injection.			Mar. 16–17. After injection.			Mar. 15–16. Before injection.			Mar. 16–17. After injection.		
	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.	Temperature.	Pulse.	Respiration.
9 a. m.	99.7	50	15	102.0	57	18	101.0	72	21	102.6	68	18
10 a. m.	100.0	48	15	102.0	60	18	100.5	66	18	102.8	66	24
11 a. m.	100.2	54	18	100.4	60	18	100.8	72	18	102.6	66	21
12 noon	100.4	51	15	100.4	57	15	101.2	72	18	102.5	66	21
1 p. m.	101.0	48	15	101.4	57	18	101.5	66	18	103.4	66	24
2 p. m.	101.6	60	18	101.2	60	18	101.7	72	24	103.4	72	24
3 p. m.	101.8	72	30	101.6	66	24	102.9	84	33	103.8	84	30
4 p. m.	102.9	72	27	102.2	66	24	103.2	81	27	105.6	66	33
5 p. m.	103.5	72	27	102.5	66	24	104.0	78	30	105.0	78	24
6 p. m.	103.4	60	27	103.5	64	20	103.8	72	24	104.8	72	24
7 p. m.	102.6	60	24	104.2	72	20	103.6	72	30	104.6	80	30
8 p. m.	102.5	64	20	104.8	72	18	103.2	66	28	105.0	72	28
9 p. m.	102.4	64	28	105.8	60	18	103.0	64	24	105.6	80	30
10 p. m.	102.2	56	24	105.8	75	21	103.5	72	32	105.6	90	24
11 p. m.	102.2	60	20	106.4	78	21	103.2	64	24	105.4	90	24
12 midnight	102.0	60	18	106.2	84	24	103.0	60	20	105.4	90	30
1 a. m.	101.8	60	20	105.6	78	24	103.4	72	20	105.6	84	30
2 a. m.	101.8	60	18	106.0	72	24	103.0	68	24	105.6	84	30
3 a. m.	101.6	64	20	105.4	78	18	102.5	80	24	105.8	84	30
4 a. m.	101.4	60	24	105.2	87	30	103.2	72	24	105.8	84	30
5 a. m.	102.0	60	18	104.6	72	30	103.0	80	24	105.6	84	30
6 a. m.	102.0	56	24	103.8	66	24	102.8	72	24	105.4	84	30
8 a. m.	102.0	56	24	102.8	66	24	102.8	72	18	105.6	84	30
9 a. m.	Inj. tuberculin S.						Inj. tuberculin S.					
10 a. m.				102.0	72	24				104.5	80	30
12 noon				101.4	66	20				103.0	80	24
1 p. m.				101.2	60	18				103.6	76	30

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	325		326		327		328	
	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.
7 a. m	.....	100.7	.....	101.6	.....	102.4	.....	102.2
8 a. m	101.8	101.2	102.2	101.9	103.2	102.4	100.2	102.6
9 a. m	101.2	101.4	102.2	101.9	102.8	102.5	98.8	103.4
10 a. m	100.5	100.0	100.6	101.4	102.5	102.5	99.5	102.6
11 a. m	99.4	100.4	100.2	101.5	103.0	102.4	100.0	103.4
12 noon	100.2	100.4	100.8	101.5	102.6	102.2	99.5	104.2
1 p. m	101.0	100.6	100.8	101.2	102.4	102.2	100.5	104.2
2 p. m	101.2	101.0	101.6	102.0	102.2	102.2	101.4	103.4
3 p. m	101.2	101.6	101.6	102.2	102.2	102.4	101.4	103.6
4 p. m	101.6	101.8	102.0	102.8	102.2	103.4	101.8	103.6
5 p. m	.....	102.0	.....	102.5	.....	103.0	.....	103.8
6 p. m	101.4	101.6	101.5	102.4	102.0	102.4	101.8	103.0
7 p. m	102.0	101.4	101.6	102.0	102.4	102.5	102.0	102.5
8 p. m	101.8	101.0	102.0	101.8	102.6	102.2	101.8	102.0
9 p. m	101.8	101.2	101.5	102.4	102.4	102.8	101.2	101.8
10 p. m	101.8	101.4	101.6	101.8	102.6	102.6	101.0	102.0
11 p. m	101.8	.....	101.8	.....	102.8	.....	101.0	.....
12 midnight	Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.	

Hour.	329		330		331		332	
	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.
7 a. m	.....	106.5	.....	101.8	.....	102.0	.....	104.9
8 a. m	101.0	107.2	100.6	102.2	100.4	102.4	100.3	105.8
9 a. m	100.6	107.5	100.8	102.7	99.8	103.2	99.2	106.4
10 a. m	100.8	105.6	100.0	103.2	99.5	104.4	99.5	105.8
11 a. m	101.0	106.0	101.0	105.0	100.6	104.9	101.0	106.4
12 noon	100.2	106.0	100.8	105.8	100.2	105.6	101.2	107.1
1 p. m	101.4	106.0	100.4	105.8	101.1	105.8	101.4	106.6
2 p. m	101.2	105.4	101.6	105.8	101.0	105.8	101.9	106.2
3 p. m	102.2	105.8	101.8	105.6	101.2	105.6	102.4	105.8
4 p. m	102.8	105.4	102.0	105.5	101.6	105.8	102.3	106.3
5 p. m	.....	106.0	.....	105.4	.....	106.2	.....	106.2
6 p. m	103.0	105.0	101.8	104.4	102.0	104.8	102.4	105.8
7 p. m	102.8	105.4	102.2	103.6	101.8	105.0	102.4	106.8
8 p. m	102.6	105.5	102.0	103.0	101.8	105.0	102.0	106.5
9 p. m	102.4	105.6	101.2	104.2	101.8	105.0	101.8	106.2
10 p. m	102.6	105.4	101.5	104.6	101.4	105 6	101.8	105.8
11 p. m	102.4	.....	101.2	.....	101.2	.....	101.9	.....
12 midnight	Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.	

Hour.	333		334		335		336	
	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.
7 a. m	.....	106.0	.....	102.2	.....	103.0	.....	101.7
8 a. m	101.2	106.6	102.2	102.6	100.5	104.8	101.5	105.6
9 a. m	101.2	106.9	101.4	102.5	100.6	106.2	101.2	103.6
10 a. m	101.3	105.0	101.5	101.5	101.8	105.2	101.0	103.4
11 a. m	101.2	106.0	100.8	102.0	101.0	106.4	101.0	104.2
12 noon	101.2	106.6	100.0	102.6	100.8	105.9	100.2	104.2
1 p. m	101.0	105.8	101.4	102.5	101.2	106.6	100.6	104.3
2 p. m	101.2	105.0	101.6	102.5	101.1	106.6	101.4	105.4
3 p. m	101.6	104.0	102.4	102.9	101.6	106.0	102.0	105.6
4 p. m	101.6	103.8	102.2	102.6	101.5	106.8	102.5	105.6
5 p. m	.....	102.8	.....	102.5	.....	107.8	.....	106.0
6 p. m	101.6	103.0	101.8	101.0	102.0	106.5	102.5	104.6
7 p. m	102.0	103.4	101.8	101.0	102.0	107.2	102.6	104.6
8 p. m	101.6	103.4	101.2	102.2	102.2	107.8	101.6	104.6
9 p. m	101.7	103.0	101.6	101.6	102.0	107.2	101.5	104.0
10 p. m	101.8	102.8	101.4	101.2	102.0	107.0	102.2	104.2
11 p. m	101.9	.....	101.5	.....	101.8	.....	102.2	.....
12 midnight	Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.	

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	337		338		339		340	
	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.
7 a. m.	.....	102.2	.....	103.8	.....	102.4	.....	103.0
8 a. m.	101.0	102.2	102.2	103.0	99.8	102.0	99.9	102.5
9 a. m.	101.0	103.0	102.2	103.3	100.8	102.4	99.9	103.2
10 a. m.	100.5	103.0	103.0	103.6	101.2	103.4	100.6	104.0
11 a. m.	99.8	103.6	103.2	103.6	101.2	103.6	101.2	104.0
12 noon	99.8	105.0	103.3	103.2	101.0	103.4	101.0	103.6
1 p. m.	100.4	105.0	103.2	103.2	100.8	103.2	101.0	103.6
2 p. m.	101.2	105.5	103.6	103.2	100.8	103.0	101.4	102.8
3 p. m.	101.2	105.2	103.6	103.4	101.3	103.0	101.3	102.6
4 p. m.	101.4	105.5	103.2	103.6	101.4	102.8	101.6	102.6
5 p. m.	.....	105.2	103.2	103.0	102.0	103.0	101.6	102.6
6 p. m.	102.2	103.7	102.6	103.2	101.3	102.8	101.2	102.4
7 p. m.	101.8	104.0	102.4	102.8	101.4	102.8	101.0	102.0
8 p. m.	102.6	104.2	101.6	101.8	101.2	103.2	100.8	102.2
9 p. m.	102.0	104.0	101.6	101.8	101.2	103.2	101.0	102.2
10 p. m.	101.8	103.8	101.7	101.6	101.0	102.5	100.8	102.0
11 p. m.	101.6	.....	101.6	101.4	101.0	102.2	101.0	101.8
12 midnight	Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.	

Hour.	341		342		343		344	
	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.
7 a. m.	.....	103.7	.....	104.2	.....	106.2	.....	101.6
8 a. m.	101.0	103.0	99.6	104.8	100.8	106.0	99.8	101.7
9 a. m.	101.8	103.8	100.2	105.3	101.3	106.5	100.0	102.4
10 a. m.	102.0	104.0	100.4	105.6	101.0	107.0	100.4	104.0
11 a. m.	102.0	105.0	100.8	105.6	101.2	106.5	100.8	104.8
12 noon	101.8	104.7	100.6	106.0	101.0	106.2	100.6	105.2
1 p. m.	102.1	104.8	100.6	105.8	100.8	106.0	101.0	105.2
2 p. m.	102.0	104.0	101.0	105.0	101.0	105.0	100.8	104.1
3 p. m.	102.2	103.8	101.2	104.4	101.2	105.0	101.6	104.4
4 p. m.	102.4	104.4	101.5	105.2	101.6	105.2	101.7	105.1
5 p. m.	102.2	104.5	102.2	105.0	101.4	104.8	101.8	104.6
6 p. m.	102.6	104.2	102.0	104.5	101.2	104.5	101.5	104.2
7 p. m.	102.6	104.0	101.8	104.8	101.3	104.2	101.0	104.6
8 p. m.	102.8	104.2	101.7	104.0	101.2	103.6	101.5	103.2
9 p. m.	103.0	104.4	102.0	103.8	101.2	102.8	101.2	103.2
10 p. m.	102.5	104.4	101.6	103.2	101.2	102.8	101.6	102.5
11 p. m.	102.4	104.0	101.5	102.8	101.4	102.5	101.4	102.0
12 midnight	Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.	

Hour.	345		346		347		348	
	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.
7 a. m.	.....	102.0	.....	101.3	.....	102.6	.....	101.8
8 a. m.	99.8	102.5	99.4	101.4	100.6	102.4	100.2	101.6
9 a. m.	100.2	102.8	99.4	101.8	101.0	104.2	100.4	102.7
10 a. m.	100.2	104.8	100.2	102.8	101.1	105.4	101.0	103.6
11 a. m.	100.8	105.3	100.2	104.9	101.3	105.6	101.0	104.8
12 noon	100.6	106.9	100.6	104.8	101.4	105.4	101.0	105.6
1 p. m.	100.6	106.0	100.6	104.6	101.5	105.8	101.4	105.6
2 p. m.	100.4	105.4	101.2	104.8	101.6	105.7	101.4	105.2
3 p. m.	101.2	105.2	101.4	104.8	101.6	105.6	102.0	105.2
4 p. m.	101.6	106.2	101.7	105.2	102.8	106.8	102.7	106.0
5 p. m.	101.6	106.0	101.8	105.0	102.6	106.7	102.4	106.2
6 p. m.	101.4	106.0	101.3	105.2	102.4	106.6	102.4	105.7
7 p. m.	101.4	106.2	101.0	106.4	102.0	106.0	102.0	105.5
8 p. m.	101.2	105.2	101.0	105.3	102.0	106.1	101.6	105.6
9 p. m.	100.8	105.2	101.0	104.8	101.6	106.2	101.6	105.8
10 p. m.	100.6	104.6	100.5	105.2	101.6	105.8	101.4	105.6
11 p. m.	101.0	104.2	101.0	104.5	101.3	105.8	101.6	106.2
12 midnight	Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin S.		Inj. tuberculin S.	

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	349		350		351		352	
	Apr. 12. Before injection.	Apr. 13. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.
7 a. m.	.....	104.8	.....	101.4	.....	103.8	.....	103.0
8 a. m.	101.3	104.5	100.5	101.0	100.0	104.3	102.3	103.0
9 a. m.	101.8	106.0	100.6	103.4	101.2	105.4	102.6	104.9
10 a. m.	101.4	106.7	100.4	106.0	101.6	106.6	101.8	106.2
11 a. m.	101.8	106.5	100.6	105.4	101.6	106.4	101.4	106.2
12 noon	101.8	106.0	100.2	105.0	101.6	106.4	101.4	105.2
1 p. m.	101.6	106.2	100.6	105.0	101.2	106.2	101.6	105.2
2 p. m.	101.7	106.2	101.2	104.0	101.4	105.8	101.7	104.2
3 p. m.	102.2	105.6	101.6	104.8	101.0	105.8	102.4	104.4
4 p. m.	102.6	105.8	101.5	105.6	101.4	106.1	102.6	105.2
5 p. m.	102.2	106.0	101.6	105.6	102.6	106.4	102.8	105.3
6 p. m.	102.2	106.2	101.5	105.6	102.4	106.2	103.0	105.0
7 p. m.	102.0	105.8	101.2	105.0	102.2	106.7	102.8	104.5
8 p. m.	101.8	105.0	100.8	105.2	101.8	105.8	102.8	104.2
9 p. m.	101.8	104.2	100.8	105.4	101.7	105.8	102.2	104.2
10 p. m.	101.6	103.8	100.8	105.4	101.6	105.8	102.2	104.1
11 p. m.	101.6	103.5	101.0	105.2	101.6	105.5	102.2	104.4
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Hour.	353		354		355		356	
	Apr. 12. Before injection.	Apr. 13. After injection.	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.
7 a. m.	.....	102.2	.....	102.8	.....	101.8	.....	101.5
8 a. m.	101.4	102.2	.....	103.4	.....	101.6	.....	101.6
9 a. m.	102.2	101.8	101.8	103.2	100.5	101.8	100.4	101.6
10 a. m.	102.0	101.8	102.2	104.2	100.8	102.0	100.9	101.6
11 a. m.	102.0	102.6	101.8	105.4	101.0	103.2	100.8	102.0
12 noon	101.8	103.6	.....	106.0	.....	103.9	.....	102.6
1 p. m.	101.6	103.4	101.5	105.6	101.6	104.8	100.8	102.9
2 p. m.	101.2	102.6	101.8	105.4	101.6	105.4	101.4	103.6
3 p. m.	101.6	103.0	101.8	104.8	101.2	104.8	101.8	103.2
4 p. m.	102.6	103.4	102.6	104.4	101.8	104.2	102.0	103.6
5 p. m.	102.2	103.8	103.4	104.8	102.8	104.3	102.0	104.0
6 p. m.	102.5	103.4	103.5	.....	102.8	.....	101.8	.....
7 p. m.	102.2	103.4	102.6	106.0	102.0	104.0	101.6	104.0
8 p. m.	102.0	102.4	102.2	105.6	101.6	103.6	101.2	103.7
9 p. m.	102.0	102.4	102.4	105.0	101.4	104.0	101.2	103.5
10 p. m.	101.8	102.2	102.0	104.5	101.2	103.2	101.0	103.2
11 p. m.	101.8	102.0	101.8	104.2	101.4	103.0	100.8	102.8
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Hour.	357		358		359		360	
	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.
7 a. m.	.....	102.4	.....	101.6	.....	104.4	.....	101.2
8 a. m.	.....	102.2	.....	101.6	.....	104.8	.....	101.2
9 a. m.	101.8	102.4	101.4	101.2	101.2	106.0	101.8	100.6
10 a. m.	101.5	102.6	101.2	101.2	101.3	106.8	101.5	100.7
11 a. m.	101.7	102.8	101.2	101.6	101.5	106.9	101.4	100.6
12 noon	.....	102.9	.....	102.4	.....	107.0	.....	100.6
1 p. m.	101.4	102.8	101.3	102.8	101.4	107.2	101.4	101.0
2 p. m.	101.8	103.0	101.6	103.8	101.3	107.3	101.9	101.3
3 p. m.	101.8	102.8	101.2	103.6	102.5	105.4	101.5	101.4
4 p. m.	102.2	102.6	101.8	104.6	102.8	104.8	102.4	102.2
5 p. m.	102.6	103.0	102.0	105.0	102.8	105.2	102.2	102.4
6 p. m.	102.8	.....	102.0	.....	103.2	.....	102.4	.....
7 p. m.	101.4	102.2	101.2	105.6	102.6	106.2	101.6	102.8
8 p. m.	101.6	102.0	100.8	105.4	102.2	106.0	101.5	102.4
9 p. m.	101.6	101.2	100.8	104.6	102.4	104.7	101.2	102.2
10 p. m.	101.4	101.8	100.8	104.0	102.4	104.0	101.2	102.0
11 p. m.	101.4	101.5	100.6	103.8	102.2	103.6	101.0	101.8
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	361		362		363		301	
	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.
7 a. m	.....	101.6	.....	102.6	.....	102.0	.....	104.2
8 a. m	.....	101.9	.....	103.4	.....	102.4	100.4	104.8
9 a. m	101.6	102.4	101.2	104.0	101.9	101.4	100.5	105.7
10 a. m	101.3	103.6	101.4	104.4	101.2	102.4	99.8	104.6
11 a. m	101.6	104.4	101.2	104.8	101.3	103.8	99.6	104.9
12 noon	.....	105.2	.....	104.2	.....	104.4	100.8	105.8
1 p. m	101.2	105.0	101.2	104.0	101.3	105.4	101.4	105.6
2 p. m	101.2	105.0	102.0	103.6	101.6	106.0	101.2	105.6
3 p. m	101.8	104.8	101.8	103.0	101.5	105.0	102.0	105.6
4 p. m	102.4	104.2	102.2	103.4	102.4	105.0	102.7	106.5
5 p. m	102.6	105.2	102.8	103.4	102.8	105.8	.....	105.2
6 p. m	102.6	.....	102.2	.....	103.2	.....	102.7	104.8
7 p. m	101.6	105.8	101.2	103.8	101.8	105.2	102.0	105.0
8 p. m	101.7	105.5	101.2	103.6	101.6	104.0	101.8	104.5
9 p. m	101.6	104.5	101.5	102.4	101.6	103.4	101.9	103.8
10 p. m	101.4	103.7	101.4	103.0	101.6	103.2	101.8	103.6
11 p. m	101.4	103.2	101.2	102.6	101.8	103.0	101.8	.....
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin K.	

Hour.	302		305		307		308	
	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.
7 a. m	.....	104.9	.....	102.8	.....	103.5	.....	102.7
8 a. m	99.8	105.2	99.6	102.4	102.0	103.8	101.0	102.8
9 a. m	100.0	105.8	99.4	102.0	102.0	104.2	101.0	103.0
11 a. m	100.5	105.2	100.2	101.2	101.8	103.6	100.6	102.8
10 a. m	100.2	105.8	100.2	101.0	102.0	104.2	101.0	102.7
12 noon	100.6	106.8	100.4	101.0	101.6	105.4	101.0	102.8
1 p. m	101.0	106.5	101.0	101.3	101.7	105.8	101.4	102.4
2 p. m	101.0	106.2	100.8	101.2	102.0	106.3	101.2	102.6
3 p. m	101.6	106.0	101.2	102.0	102.0	106.0	102.0	102.8
4 p. m	102.0	106.8	101.7	103.0	103.0	106.2	102.0	102.8
5 p. m	.....	106.0	.....	102.4	.....	105.0	.....	102.5
6 p. m	102.2	105.4	102.0	102.5	102.2	104.0	102.0	102.2
7 p. m	101.8	105.4	101.8	101.8	102.5	103.8	102.2	102.0
8 p. m	101.7	105.0	101.5	101.8	102.6	103.8	101.8	101.5
9 p. m	101.3	104.2	101.4	101.4	102.4	103.0	101.7	101.0
10 p. m	101.6	104.2	101.4	101.8	102.2	103.0	101.8	101.3
11 p. m	101.6	.....	101.0	.....	102.0	.....	101.9	.....
12 midnight	Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.	

Hour.	309		310		312		313	
	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 21. Before injection.	Mar. 22. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.
7 a. m	.....	102.2	.....	103.7	.....	102.8	.....	102.5
8 a. m	101.5	102.4	102.2	103.8	100.8	102.8	100.6	102.4
9 a. m	100.8	102.3	101.8	104.0	100.9	103.0	101.5	102.4
10 a. m	101.0	100.6	101.4	102.0	100.9	104.4	101.5	103.2
11 a. m	100.8	100.7	101.2	102.2	101.2	104.8	101.8	103.8
12 noon	101.2	101.4	101.2	102.8	100.8	104.7	101.8	104.0
1 p. m	101.2	101.6	101.6	102.8	101.0	104.2	102.0	104.4
2 p. m	101.4	102.0	101.8	103.5	101.2	104.0	102.2	104.0
3 p. m	102.0	102.4	102.2	104.0	101.7	103.4	102.0	103.5
4 p. m	102.4	104.0	102.6	106.0	102.0	104.0	102.4	103.4
5 p. m	.....	102.5	.....	104.4	102.0	103.8	102.2	103.0
6 p. m	102.0	102.5	102.2	103.5	101.6	103.5	102.2	103.0
7 p. m	102.0	102.1	101.8	103.0	101.2	104.0	102.0	103.2
8 p. m	101.6	101.6	101.8	102.4	101.5	104.0	102.2	102.4
9 p. m	101.4	101.5	101.8	102.2	101.0	104.2	101.7	102.5
10 p. m	101.8	101.2	101.8	102.0	101.2	103.8	102.0	102.5
11 p. m	101.6	.....	101.6	.....	101.0	103.2	102.2	102.2
12 midnight	Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K	

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	315		316		317		318	
	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.
7 a. m.	.....	102.8	.....	102.3	.....	102.6	.....	104.4
8 a. m.	100.0	102.8	102.0	103.0	101.6	102.0	100.6	103.0
9 a. m.	100.0	103.4	102.1	103.0	101.5	102.1	99.8	103.2
10 a. m.	100.5	103.6	102.8	103.9	101.4	102.4	100.0	104.6
11 a. m.	100.5	104.6	102.8	104.5	101.4	102.4	100.3	105.3
12 noon	100.8	105.0	102.4	106.0	101.0	102.5	100.5	106.0
1 p. m.	100.8	105.2	102.6	106.0	101.2	102.7	101.6	106.0
2 p. m.	101.0	104.6	102.6	105.4	101.3	101.8	101.6	105.6
3 p. m.	101.6	103.2	102.4	104.8	102.0	101.2	102.2	106.2
4 p. m.	102.2	103.4	103.1	105.4	102.2	102.4	103.2	106.8
5 p. m.	101.8	103.2	102.5	105.4	102.8	102.5	103.4	107.2
6 p. m.	102.2	103.0	101.4	105.0	102.4	102 2	102.8	106.5
7 p. m.	101.6	103.0	101.5	105.2	101.8	102.1	103.0	106.4
8 p. m.	101.8	102.0	101.6	104.6	102.0	102.2	102.8	106.0
9 p. m.	101.6	102.0	101.8	104.5	102.5	101.8	102.5	105.6
10 p. m.	101.5	101.8	101.6	104.5	101.8	102.0	102.5	105.8
11 p. m.	101.6	101.5	101.6	104.0	101.8	101.8	101.8	105.6
12 midnight	Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin S.	

Hour.	319		320		321		322	
	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.
7 a. m.	.....	103.0	.....	102.2	.....	101.8	.....	102.0
8 a. m.	101.9	102.0	101.9	101.0	101.4	101.2	100.8	100.8
9 a. m.	101.8	102.0	101.6	101.4	101.6	101.2	101.4	100.8
10 a. m.	101.5	101.8	101.3	101.9	101.4	101.4	101.0	101.4
11 a. m.	101.4	101.8	101.4	102.2	101.3	101.4	100.9	102.4
12 noon	101.4	101.6	101.2	102.2	101.4	101.4	100.8	103.8
1 p. m.	101.4	101.8	101.0	102.6	101.2	101.4	101.2	104.2
2 p. m.	101.7	101.2	101.2	101.4	101.2	101.2	101.6	103.0
3 p. m.	101.9	100.8	102.4	101.0	101.8	100.4	101.8	101.0
4 p. m.	102.6	101.6	102.8	101.6	102.2	101.2	102.2	101.4
5 p. m.	102.8	102.8	102.8	102.0	102.0	102.0	102.8	102.8
6 p. m.	103.0	101.2	102.0	101.8	102.5	101.6	102.6	102.0
7 p. m.	102.6	102.2	102.2	101.8	102.4	101.8	102.6	102.2
8 p. m.	102.5	101.5	101.4	101.2	101.8	101.2	102.0	102.0
9 p. m.	101.4	101.6	102.2	101.4	102.0	101.2	102.0	101.2
10 p. m.	102.0	101.5	102.0	101.2	102.0	101.5	102.5	102.0
11 p. m.	102.0	101.3	101.6	101.0	101.5	101.2	102.0	101.5
12 midnight	Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin K.	

Hour.	323		324		325		326	
	Mar. 27. Before injection.	Mar. 28. After injection.	Mar. 27. Before injection.	Mar. 28. After injection.	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.
7 a. m.	.....	103.6	.....	105.2	.....	101.8	.....	101.8
8 a. m.	101.0	102.8	100.9	105.9	101.2	101.8	102.0	102.0
9 a. m.	101.4	103.2	101.2	106.5	.....	101.2	.....	101.3
10 a. m.	101.4	103.8	101.0	107.0	101.4	101.1	101.9	101.5
11 a. m.	101.4	105.0	101.2	106.6	.....	101.2	.....	101.7
12 noon	101.4	105.0	102.0	106.2	101.2	101.3	101.6	101.8
1 p. m.	101.2	105.2	101.8	106.2	.....	101.6	.....	101.8
2 p. m.	101.6	103.6	101.9	106.0	101.1	101.4	101.7	102.4
3 p. m.	102.2	102.8	102.5	106.2	.....	101.4	.....	103.4
4 p. m.	102.6	102.5	102.4	106.0	101.7	.....	101.8	.....
5 p. m.	103.4	102.8	102.8	106.0	.....	103.0	.....	103.0
6 p. m.	102.6	102.2	102.6	106.0	102.8	103.0	102.6	103.0
7 p. m.	102.2	102.6	102.2	106.2	.....	102.6	.....	102.5
8 p. m.	102.2	102.4	102.1	106.2	102.6	102.6	103.0	102.3
9 p. m.	102.5	102.0	102.6	105.6	.....	102.2	.....	102.0
10 p. m.	102.2	101.8	102.0	105.2	102.5	.....	102.4	.....
11 p. m.	102.0	101.6	102.3	105.0	.....	.....	.....	.....
12 midnight	Inj. tuberculin K.		Inj. tuberculin K.		Inj. tuberculin S.		Inj. tuberculin S.	

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	327		328		329		330	
	May 25. Before injection.	May 26. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.
7 a. m.	.....	102.4	.....	101.8	.....	104.0	.....	103.0
8 a. m.	101.6	102.4	101.7	101.8	102.3	104.2	102.0	102.6
9 a. m.	.....	102.2	101.5	102.8	102.3	104.9	101.4	103.9
10 a. m.	101.6	102.6	101.4	104.0	102.0	105.8	101.2	104.6
11 a. m.	.....	102.9	101.4	104.0	102.2	105.6	101.0	105.2
12 noon	101.3	103.2	101.0	104.6	101.8	105.6	101.0	104.8
1 p. m.	.....	103.0	100.8	104.6	101.6	105.4	101.2	104.0
2 p. m.	101.6	103.6	101.4	104.0	101.8	104.8	100.8	103.6
3 p. m.	.....	103.0	101.4	103.4	102.8	105.2	100.7	103.2
4 p. m.	102.0	.....	102.7	105.4	103.4	105.6	101.0	103.2
5 p. m.	.....	103.2	102.0	105.4	103.2	105.2	101.5	103.5
6 p. m.	102.0	102.8	101.8	104.5	103.0	105.2	101.4	104.2
7 p. m.	.....	102.5	101.5	104.2	102.7	105.0	101.4	103.6
8 p. m.	101.6	103.0	101.4	103.8	102.6	104.6	101.0	103.6
9 p. m.	.....	102.6	101.2	103.0	102.7	104.2	101.0	103.4
10 p. m.	101.8	.....	101.2	102.8	102.6	104.2	101.0	103.5
11 p. m.	.....	.....	101.0	102.5	102.2	104.0	101.0	103.2
12 midnight.	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Hour.	331		332		333		334	
	Apr. 12. Before injection.	Apr. 13. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.
7 a. m.	.....	103.8	.....	104.4	.....	102.0	.....	101.8
8 a. m.	101.8	103.2	101.2	104.2	102.4	102.0	101.4	101.6
9 a. m.	101.8	104.4	102.0	104.6	101.9	102.8	101.8	101.0
10 a. m.	101.4	105.2	101.8	105.8	101.0	103.5	100.4	101.0
11 a. m.	101.2	105.4	101.6	105.4	101.4	104.7	100.2	101.0
12 noon	101.0	104.8	101.4	105.4	101.5	105.4	101.2	101.0
1 p. m.	100.8	103.8	101.6	104.8	101.4	105.6	100.8	101.0
2 p. m.	101.2	103.2	101.6	104.2	101.0	103.9	100.6	101.2
3 p. m.	101.4	104.2	101.2	103.5	100.5	103.2	100.7	101.8
4 p. m.	101.8	105.2	102.8	104.9	101.8	103.5	101.8	102.2
5 p. m.	101.4	105.6	102.7	105.8	101.6	103.0	101.5	102.5
6 p. m.	101.6	105.8	102.4	106.2	101.6	102.2	101.6	102.2
7 p. m.	101.7	105.8	102.4	106.0	101.4	102.0	101.6	102.0
8 p. m.	101.6	105.6	102.2	105.4	101.5	101.8	101.4	102.0
9 p. m.	101.6	105.2	102.0	105.6	101.4	101.5	101.4	101.6
10 p. m.	101.8	105.2	102.0	105.2	101.4	101.5	101.2	101.8
11 p. m.	101.6	104.9	101.8	105.4	101.4	101.6	101.3	101.8
12 midnight.	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Hour.	335		336		337		339	
	Apr. 12. Before injection.	Apr. 13. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.	Apr. 12. Before injection.	Apr. 13. After injection.	May 1. Before injection.	May 2. After injection.
7 a. m.	.....	102.2	.....	102.0	.....	102.8	.....	101.3
8 a. m.	101.8	102.0	101.6	101.6	101.4	101.8	.....	101.4
9 a. m.	101.6	102.6	102.0	101.6	101.4	102.2	101.6	101.2
10 a. m.	100.8	103.8	101.4	102.0	101.4	102.2	101.8	101.2
11 a. m.	100.9	104.8	101.2	102.4	101.2	103.4	101.4	101.2
12 noon	100.9	105.2	101.2	103.8	101.2	104.0	.....	101.6
1 p. m.	101.2	104.2	101.0	104.4	101.2	104.8	101.1	101.4
2 p. m.	101.4	103.8	101.8	103.8	100.8	104.2	101.4	102.0
3 p. m.	101.5	102.8	101.6	103.5	101.8	104.4	101.2	102.0
4 p. m.	102.0	103.0	102.6	104.4	101.6	104.6	101.9	101.8
5 p. m.	101.8	102.6	102.8	104.9	101.6	104.8	103.0	102.5
6 p. m.	101.5	102.2	102.6	104.3	101.7	104.8	102.6	.....
7 p. m.	101.6	102.4	102.2	104.6	101.5	105.0	101.6	103.5
8 p. m.	101.6	101.8	102.0	103.6	102.0	104.6	101.6	103.0
9 p. m.	101.4	102.2	102.2	103.8	101.8	104.5	101.4	102.8
10 p. m.	101.4	101.8	101.7	103.4	101.8	104.5	101.0	102.2
11 p. m.	101.4	101.8	101.4	103.5	101.8	104.2	100.8	102.0
12 midnight.	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	340		341		342		343	
	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.
7 a. m	.....	101.6	.....	103.0	.....	101.8	.....	104.4
8 a. m	.....	102.0	.....	104.0	.....	102.2	.....	105.0
9 a. m	101.4	101.6	101.0	104.0	102.6	102.0	100.7	104.8
10 a. m	101.0	102.2	100.8	104.8	102.2	101.6	101.0	105.0
11 a. m	100.8	102.2	101.2	105.5	101.8	101.6	101.0	105.6
12 noon	.....	102.0	.....	106.0	.....	101.7	.....	106.2
1 p. m	101.0	102.0	101.0	105.8	101.4	102.0	101.1	105.6
2 p. m	101.2	102.4	101.5	105.6	101.4	102.4	101.0	105.8
3 p. m	101.4	102.6	101.5	105.0	101.4	102.4	101.2	104.8
4 p. m	102.2	102.0	102.3	105.0	102.8	101.4	101.6	104.0
5 p. m	101.8	102.4	103.2	104.8	103.4	102.3	102.4	104.0
6 p. m	101.6	.....	103.4	.....	103.2	.....	102.6	.....
7 p. m	101.0	102.4	102.2	106.0	102.0	104.2	101.6	103.8
8 p. m	101.2	102.2	102.0	105.8	102.2	103.7	101.4	103.2
9 p. m	100.8	101.8	101.7	105.5	101.9	103.5	101.2	102.8
10 p. m	100.8	101.8	101.4	105.0	101.8	103.8	100.8	102.4
11 p. m	100.8	101.7	101.4	104.8	101.8	103.4	100.8	102.2
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Hour.	344		345		346		347	
	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.
7 a. m	.....	101.4	.....	103.8	.....	101.4	.....	102.0
8 a. m	.....	101.4	.....	104.2	.....	101.2	.....	101.8
9 a. m	101.0	100.4	100.8	103.8	101.4	101.2	101.8	100 6
10 a. m	100.8	100.4	101.2	103.8	100.2	101.8	101.4	100.8
11 a. m	100.6	101.2	101.2	103.8	100.8	101.8	101.6	101.2
12 noon	.....	100.2	.....	105.4	.....	102.8	.....	101.2
1 p. m	100.8	100.4	101.2	105.6	100.8	103.0	101.0	101.4
2 p. m	101.3	101.2	101.2	106.0	101.0	103.2	101.6	101.6
3 p. m	101.2	100.8	101.5	105.4	101.0	103.0	101.8	102.0
4 p. m	102.1	101.6	101.4	104.8	101.8	103.2	102.4	103.0
5 p. m	102.0	102.0	102.2	105.2	102.4	103.4	103.6	103.5
6 p. m	102.4	.....	102.4	.....	102.6	.....	102.8	.....
7 p. m	101.2	102.0	101.2	106.4	101.5	103.5	103.0	104.2
8 p. m	101.2	102.0	101.4	106.2	101.6	103.2	102.8	104.2
9 p. m	101.2	101.5	101.2	105.8	101.4	102.8	102.8	103.4
10 p. m	100.8	102.0	101.0	105.4	101.4	102.5	102.8	103.5
11 p. m	100.8	101.8	100.8	105.0	101.0	102.2	102.8	103.2
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Hour.	348		349		350		351	
	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.
7 a. m	.....	101 6	.....	102.6	.....	101.2	.....	103.8
8 a. m	.....	101.6	.....	103.2	.....	101.8	.....	103.8
9 a. m	101.6	100.8	101.5	102.5	99.2	102.2	99.3	104.0
10 a. m	101.2	101.4	101.6	102.8	99.1	102.1	100.0	103.6
11 a. m	100.8	101.8	101.5	103.0	99.5	102.2	100.0	103.8
12 noon	.....	102.4	.....	103.4	.....	103.0	.....	104.8
1 p. m	101.0	102.4	101.5	103.4	100.6	102.8	101.0	104.8
2 p. m	101.4	102.6	101.6	103.3	100.8	103.4	101.2	105.0
3 p. m	101.2	102.2	101.6	103.0	101.3	103.5	101.6	104.6
4 p. m	101.8	102.8	102.0	102.8	101.8	104.2	102.2	104.6
5 p. m	102.0	103.2	102.0	103.2	102.2	105.0	102.2	104.7
6 p. m	101.6	.....	101.8	.....	101.6	.....	102.4	.....
7 p. m	102.0	103.2	101.6	103.8	101.6	104.8	102.2	105.6
8 p. m	102.2	102.8	101.6	103.2	101.2	104.6	102.2	105.2
9 p. m	102.2	102.6	101.4	102.7	100.8	104.4	102.0	104.5
10 p. m	102.2	102.4	101.4	102.2	100.8	103.8	101.8	104.3
11 p. m	102.2	102.2	102.0	102.0	100.8	103.5	101.2	104.0
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	352		353		354		355	
	May 1. Before injection.	May 2. After injection.	May 1. Before injection.	May 2. After injection.	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.
7 a. m		104.3		102.6		102.4		102.8
8 a. m		103.8		102.8	101.5	102.5	101.8	102.6
9 a. m	102.6	102.2	101.7	101.6		102.0		101.8
10 a. m	102.0	102.2	101.3	101.8	101.6	101.6	101.9	101.7
11 a. m	102.0	102.6	101.4	102.3		102.4		101.8
12 noon		102.4		103.0	100.7	102.4	101.6	101.8
1 p. m	102.2	103.0	101.0	102.6		102.0		101.9
2 p. m	102.6	103.0	101.6	102.8	101.0	102.4	101.5	101.8
3 p. m	102.4	102.6	101.4	102.6		101.8		101.8
4 p. m	103.7	102.6	102.4	103.2	101.5		101.7	
5 p. m	104.0	104.0	102.6	103.5		102.9		102.6
6 p. m	103.4		101.6		102.6	103.0	102.8	102.8
7 p. m	103.4	104.2	101.6	104.3		103.0		102.6
8 p. m	103.5	104.0	101.4	104.2	102.6	102.8	103.2	102.6
9 p. m	103.0	103.7	101.4	104.0		103.0		102.6
10 p. m	102.8	103.4	101.4	103.6	102.0		102.5	
11 p. m	102.6	103.2	101.4	103.2				
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Hour.	356		357		358		359	
	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.
7 a. m		101.5		102.5		102.2		101.4
8 a. m	101.6	101.4	101.4	102.2	101.2	102.0	102.0	101.4
9 a. m		100.8		101.8		102.2		101.2
10 a. m	101.1	101.2	101.5	101.7	100.6	101.8	102.0	100.8
11 a. m		101.2		101.5		101.8		100.6
12 noon	101.1	101.4	101.2	101.5	101.1	101.8	102.1	100.8
1 p. m		101.4		101.3		101.8		101.2
2 p. m	101.3	101.7	101.4	101.4	101.4	102.0	102.8	101.5
3 p. m		101.9		101.4		102.0		101.2
4 p. m	101.2		101.6		101.6		102.6	
5 p. m		102.5		102.0		102.9		102.2
6 p. m	102.0	102.8	103.0	102.0	101.8	102.6	103.4	103.0
7 p. m		102.7		102.0		102.2		102.8
8 p. m	102.0	102.4	103.1	101.8	101.6	102.1	103.2	Calved.
9 p. m		102.2		101.5		102.2		
10 p. m	101.7		105.0		101.3		103.0	
11 p. m								
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Hour.	360		361		362		363	
	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.
7 a. m		101.8		102.5		102.2		101.8
8 a. m	102.2	101.8	102.2	102.4	101.0	102.4	100.9	102.0
9 a. m		101.5		101.7		102.2		101.6
10 a. m	100.8	101.4	102.0	101.7	100.8	102.0	100.8	101.6
11 a. m		101.4		101.5		101.7		101.6
12 noon	101.0	101.6	100.9	101.6	100.7	102.0	100.7	101.5
1 p. m		101.3		101.3		101.9		101.6
2 p. m	101.5	101.8	101.4	101.8	100.9	102.2	101.0	102.0
3 p. m		101.6		101.8		102.3		102.2
4 p. m	101.2		101.3		101.6		101.4	
5 p. m		102.0		102.2		102.5		102.7
6 p. m	102.2	102.5	101.8	102.0	102.0	103.0	102.4	102.7
7 p. m		102.2		102.4		102.6		102.3
8 p. m	102.1	101.8	102.4	102.1	102.4	102.6	102.8	102.2
9 p. m		101.8		102.0		102.4		102.2
10 p. m	101.9		102.0		102.3		102.2	
11 p. m								
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Temperature as taken before and after the injection of tuberculin—Continued.

Hour.	305		308		309		315	
	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.
7 a. m.		101.7		101.2		101.4		104.0
8 a. m.	100.8	101.7	101.8	101.6	102.0	101.5	101.8	104.6
9 a. m.		101.5		101.4		101.6		104.4
10 a. m.	100.6	101.1	101.4	101.4	101.2	101.2	101.4	105.2
11 a. m.		101.3		101.4		101.0		105.2
12 noon	100.6	101.4	101.3	101.4	101.3	100.8	101.2	105.3
1 p. m.		101.3		101.4		101.0		104.7
2 p. m.	100.9	101.8	101.3	101.6	101.3	101.2	101.4	104.6
3 p. m.		101.8		101.0		101.2		104.3
4 p. m.	101.2		101.9		101.8		102.0	
5 p. m.		103.6		102.7		102.5		104.6
6 p. m.	101.6	103.0	102.4	103.0	101.5	102.6	102.8	104.5
7 p. m.		102.0		103.0		102.4		104.2
8 p. m.	101.4	102.0	102.2	102.7	101.6	102.2	103.1	104.0
9 p. m.		101.8		102.6		101.8		104.0
10 p. m.	101 0		101.9		101.2		103.0	
11 p. m.								
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Hour.	319		320		321		322	
	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.
7 a. m.		102.4		101.6		101.6		101.4
8 a. m.	102.7	102.5	101.7	101.5	101.2	101.6	101.5	101.5
9 a. m.		101.4		101.2		101.5		100.0
10 a. m.	102.0	101.5	101.5	101.4	101.6	101.4	101.3	100.5
11 a. m.		101.6		101.2		102.0		101.3
12 noon	101.4	101.8	101.2	101.5	101.6	101.9	100.9	101.6
1 p. m.		102.0		101.6		101.8		102.0
2 p. m.	101.6	102.2	101.4	101.6	101.5	102.0	101.2	101.9
3 p. m.		101.8		101.6		101.9		101.8
4 p. m.	103.0		101.4		101.9		101.4	
5 p. m.		102.6		103.4		102.6		102.8
6 p. m.	103.6	102.9	102.0	103.0	102.0	102.7	102.2	102.4
7 p. m.		102.8		102.6		102.6		102.6
8 p. m.	103.5	102.7	101.8	102.6	101.5	102.5	102.0	102.5
9 p. m.		102.6		102.5		102.2		102.2
10 p. m.	103.0		101.8		101.2		101.6	
11 p. m.								
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

Hour.	334		336		339	
	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.	May 25. Before injection.	May 26. After injection.
7 a. m.		101.8		102.6		102.0
8 a. m.	100.0	101.8	102.6	102.6	101.4	102.0
9 a. m.		101.0		102.2		101.4
10 a. m.	100.9	101.2	102.0	102.4	101.3	101.0
11 a. m.		101.4		102.8		101.2
12 noon	100.3	101.8	101.2	103.2	100.5	101.0
1 p. m.		101.6		103.0		101.8
2 p. m.	101.2	102.0	101.5	103.6	101.6	101.8
3 p. m.		102.1		103.6		102.4
4 p. m.	101.6		102.0		102.0	
5 p. m.		102.7		103.6		102.6
6 p. m.	102.2	102.4	102.9	103.6	103.0	102.6
7 p. m.		102.0		103.6		102.5
8 p. m.	101.5	101.8	102.8	103.8	102.2	102.5
9 p. m.		101.5		103.6		102.2
10 p. m.	101.8		102.6		102.2	
11 p. m.						
12 midnight	Inj. tuberculin S.		Inj. tuberculin S.		Inj. tuberculin S.	

FURTHER EXPERIMENTAL OBSERVATIONS ON THE PRESENCE OF TUBERCLE BACILLI IN THE MILK OF COWS.

By E. C. Schroeder, M. D. V.

The following experiments to demonstrate the presence of tubercle bacilli in milk are a continuation of the observations published on page 60 of Bulletin No. 3, 1893, of the Bureau of Animal Industry.

In the former work the principal question to be solved was the relation which exists between the condition of a tuberculous animal and the degree of milk infection. The same question was kept in view in the present work, but in addition to it some information was sought concerning the probable extent to which tubercle bacilli occur in the general city milk supply. Hence the following experiments divide themselves into two series: The first deals with city milk in the condition in which it reaches the consumer, and the second, with milk from cows without visible disease of the udder in which tuberculosis was diagnosed, either through a physical examination, or through the use of tuberculin injections.

The milk was injected into the abdominal cavity of guinea pigs partly in the form in which it was obtained from the dealer or the cow and partly after it had undergone a centrifugal process. The latter consisted in pouring a quantity of milk into glass tubes and rotating it in them fifteen minutes by means of a small hand centrifugal machine, which was made to revolve 1,500 times per minute. The fluid in the bottom of the tubes, together with the sediment, if there was any, was retained for injection and the balance of the milk discarded. The object of the centrifugal process was to concentrate, in the smallest amount of fluid, any tubercle bacilli present. It has been shown experimentally that the conduct of different bacteria varies in fluids subjected to centrifugal motion. Some bacteria rise to the surface, while others, and among them the tubercle bacilli, gravitate to the bottom.*

Cover-glass preparations were stained and examined for tubercle bacilli from every specimen of milk, excepting that from cow No. 283, but were found in no instance. Multinuclear leucocytes in greater or smaller numbers were present in the cover glasses from all specimens of milk excepting those marked dairy H and L. Among the numerous

* Scheurlen, Arbeiten a. d. Kaiserl. Gesundheitsamte, VII (1891), p. 269.

bacteria present a large coccus and a large thick bacillus predominated. Occasionally streptococci were seen in small numbers.

Nothing was known of the condition of the milk from the dairies and dealers at the time it was procured for examination, and consequently some precautions were believed necessary to avoid diseases of the guinea pigs from the accidental presence of miscellaneous septic or toxic bacteria. For this reason the milk injected into the first six guinea-pigs, which are given separately in Table I, was previously exposed to an elevated temperature, 60° C., for fifteen minutes. This procedure, it was thought would destroy the other germs, if such were present, or reduce their virulence sufficiently to make them harmless, without seriously affecting the tubercle bacilli. As a control in the heating process a suspension of tubercle bacilli was made in the manner described below and injected into the abdominal cavity of a guinea pig.

A small amount of the surface growth on an glycerin-agar culture of tubercle bacilli was scraped off and thoroughly triturated with 10 cc. of beef infusion. When the beef infusion had assumed a homogeneous cloudiness, and no clumps or solid particles visible to the naked eye remained, 0.5 cc. was removed with a sterile pipette and added to 5 cc. of milk, which was then exposed to a temperature of 60° C. for fifteen minutes.

The guinea pig which received this injection was chloroformed after eighty-five days and on post-mortem examination no lesions were found. Even before the guinea pig was killed the inference from its uninterrupted good condition was that the few tubercle bacilli which might be present in a specimen of mixed milk could not undergo the heating process without sacrificing their vitality. This view was further supported by the death of two guinea pigs in twenty-five and twenty-eight days, respectively, which were injected, shortly after the first guinea pig was injected, with similar suspensions of tubercle bacillus which had not been previously exposed to an elevated temperature. Hence after the first six injections, which are given in the following table, the heating process was discontinued:*

TABLE I.

No. of guinea pig.	Date of injection.	Date when killed.	Quantity injected.	Centrifugalized from—	Weight of guinea pig when injection made.	Weight when killed.	Source of milk.	Autopsy.
			cc.	*cc.*	*Ounces.*	*Ounces.*		
444 ♀	June 28, 1893	Sept. 23, 1893	5	40	20½	22	Dairy 1 ..	Negative.
445 ♀	....do	....do	5	40	24	31	...do	Do.
447 ♀	June 30, 1893	....do	5	40	14	18	Dairy 2 ..	Do.
448 ♀	....do	....do	5	a40	18	22	...do	Do.
455 ♂	July 8, 1893	Oct. 17, 1893	5	40	19	20½	Dairy 3 ..	Do.
456 ♂	....do	....do	5	40	17	20	...do	Do.

a The 40 cc. here represent the lower strata in a bottle containing 100 cc., which had stood on ice twenty-four hours.

* This rapid destruction of tubercle bacilli from a culture on glycerin agar (fifteen minutes at 60° C.) does not harmonize with the results of others. De Man (Archiv. f. Hygiene, XVIII., p. 123) finds that at 60° C., one hour is necessary to destroy tubercle bacilli in milk.—T. S.

The next table gives the results of 40 injections, which represent 19 specimens of milk. The milk, excepting that marked dairy Q, was delivered to private residences or bought in different sections of Washington, D. C., and nothing is known about the cows by which it was produced. Dairy milk Q was obtained from a herd of cattle in Virginia, numbering twelve milch cows, eight of which gave high temperature reactions after injection with tuberculin. In two of the eight cows tuberculosis could be readily diagnosed on physical examination. The milk from the twelve cows was drawn in the usual manner at the evening milking, poured into a large can, and allowed to stand about one-half hour. The can was then thoroughly agitated three to five minutes and a specimen of milk dipped out of the top and taken in a sterile bottle to the laboratory, where it was used for injections the following morning.

The use of the names "dairy" and "dealer" in specifying the source of the different samples of milk represented in the table is to distinguish a dairy or regularly established milk business from dealers with whom the sale of milk forms only a small fraction of their trade.

The following table records the injection of mixed milk obtained from the general milk supply of Washington, D. C. The injections were made into the peritoneal cavity, and the amount injected in each case was 5 cc:

TABLE II.

Number and sex of guinea pigs.	Date of injection.	Date when killed.	Centrifugalized from—	Weight of guinea pig when injection made.	Weight when killed.	Source of milk.	Volume of cream per 100 of milk.	Microscopic examination of sediment in centrifuge tubes.	Absence or presence of tuberculosis; present +, absent —.
			cc.	*Ounces.*	*Ounces.*				
457 ♂	July 12, 1893	Oct. 17, 1893	40	16	18	Dairy A	10	Slight sediment; a few leucocytes	—
458 ♂	do	do		17	18				—
459 ♂	July 14, 1893	do	40	12	21	Dairy B	10	Very slight sediment; numerous bacteria	—
460 ♂	do	do		19	20				—
461 ♂	July 15, 1893	do	40	15	20				—
462 ♂	do	Died July 17, 1893.				Dealer C	6	Numerous leucocytes and bacteria	—
463 ♀	July 19, 1893	Oct. 31, 1893	40	20	24	Dairy D	12	do	—
464 ♀	do	do		14	23				—
465 ♀	July 20, 1893	do	40	18	24	Dealer E	2¼	do	—
466 ♀	do	do		12	16½				—
467 ♂	July 28, 1893	Died Aug. 15, 1893.	40			Dealer F	7½	Few leucocytes and bacteria	—
468 ♂	do	Oct. 31, 1893		20	23½				—
469 ♂	Aug. 2, 1893	do	40	16	20	Dairy G	6	do	—
470 ♂	do	do		19	22				—
73 ♂	Jan. 31, 1894	Apr. 14, 1894	40	16	18	Dairy H	10½	No sediment in centrifuge tubes	—
74 ♂	do	do		18	21½				—
75 ♂	do	Died Apr. 6 1894.	40	18	14	Dairy I	6¾	Very abundant sediment; very many leucocytes.	+
76 ♂	do	Apr. 7, 1894		17	17½				—
77 ♂	do	Apr. 14, 1894	40	18	13	Dairy J	5¾	Leucocytes and a few bacteria	—
78 ♂	do	do		19	20				—
83 ♂	Feb. 2, 1894	May 2, 1894	40	14	20	Dairy K	9	Numerous leucocytes	—
84 ♂	do	do		17	23				—
85 ♂	do	do	40	13½	20	Dairy L	10	Numerous bacteria	—
86 ♂	do	do		20	30				—
87 ♂	do	do	40	14	18	Dairy M	6¾	Considerable number of bacteria and leucocytes.	—
88 ♂	do	do		16	21				—
89 ♀	Feb. 3, 1894	May 1, 1894	40	15	19	Dairy N	8½	Bacteria, leucocytes, and dirt	—
90 ♀	do	do		13	20				—
91 ♀	do	do	40	12½	18	Dealer O	4½	Leucocytes and bacteria	—
92 ♀	do	do		12	17				—
93 ♀	do	do	40	12	11	Dealer P	4	Leucocytes, bacteria, and dirt	—
94 ♀	do	do		12	21				—
103 ♀	Feb. 9, 1894	May 2, 1894	40	11½	18	Dairy Q	10	Few leucocytes; considerable number of bacteria.	—
104 ♀	do	do		15	22				—

176 ♀	Apr. 9, 1894	July 13, 1894	40	8½	13	Dairy R	16	A large amount of amorphous matter; a considerable number of leucocytes and bacteria of different kinds.
177 ♀	do	do		11½	19			
178 ♀	do	do	40	8½	15			
179 ♂	do	do		9½	20	Dairy S	14	Microscopic examination same as above
180 ♀	do	do		9	17½			
181 ♀	do	Died Apr. 21 1894.						General peritonitis

*For post-mortem notes see next page.

Guinea pig No. 462 died of general peritonitis two days after the injection.

Guinea pig No. 467 died of general peritonitis eighteen days after the injection. An abscess about one-half inch in diameter had formed at the seat of injection on the inner surface of the abdominal wall; this had ruptured and discharged its contents into the abdominal cavity. Cover glasses from the fluid in the abdominal cavity showed the presence of cocci in considerable numbers.

Guinea pig No. 75 died of tuberculosis sixty-three days after the injection. There were tubercles on omentum, a large tuberculous spleen, and large yellow necrotic patches in liver. Glands behind stomach and spleen very large and necrotic. Sternal and bronchial glands quite large, firm, necrotic. Lungs flesh red; much serum in pleural cavities. Scattering subpleural tubercles on lungs.* Cover glasses from various regions showed an abundance of tubercle bacilli.

Guinea pig No. 93 was affected with a disease the nature of which was not recognized. The autopsy notes are as follows:

Liver, pale in color and sprinkled with small, irregular, grayish or yellowish-white foci. Spleen enlarged to five times its normal dimensions and containing foci similar to those in the liver. The kidneys appear as two large, white tumors; on section they are seen to be more or less completely degenerated.† No tubercle bacilli or other germs detected in cover-glass preparations.

We see thus that among the 19 specimens of milk obtained from the general city milk supply, one contained the bacillus of tuberculosis in sufficient numbers to produce the disease in one of the two guinea pigs injected with it. Why one guinea pig should have remained unaffected is an unsolved question. The guinea pig which died of tuberculosis was injected with the milk in the form in which it came from the dairy, while the guinea pig which escaped the infection was injected with a specimen of the same milk which had previously been subjected to the centrifugal process. In this connection it must be remembered that the amount of milk which can be injected into the abdominal cavity of a guinea pig with any degree of safety is very small.

We may summarize the results recorded in Table II by the statement that now and then the mixed milk of dairies may contain comparatively large numbers of tubercle bacilli. In the foregoing series one out of 19 samples from different dealers or dairies contained tubercle bacilli.

Table III gives the results obtained by the injection of milk from cows in which tuberculosis was diagnosed either with or without the aid of tuberculin.

The milk was collected in sterile bottles, and, with the exception of samples from cow No. 283, represents a mixture of the product from all

* A careful examination of the lesions in this animal showed that the infection started from the abdomen and was due to the milk injected. The guinea pigs used in this laboratory are bred on the experiment station. Spontaneous tuberculosis has never been found in any case.—T. S.

† The disease in this guinea pig might be mistaken for tuberculosis. It differs from the latter, however, in the restricted, irregular size of the minute foci and the disease of the kidneys, which are almost invariably normal in tuberculous guinea pigs. The microscopic examination of the kidneys showed an extensive interstitial nephritis. The foci in the liver are situated in the interlobular tissue, and consist of infiltrations of round cells.—T. S.

four quarters of the udder. The milk from each quarter of the udder of cow No. 283 was drawn into a separate sterile bottle. Guinea pig No. 33 was injected with the milk from the right forward quarter, No. 34 from the left forward quarter, No. 35 from the right hind quarter, and No. 36 from the left hind quarter.

Table III.

Table recording the injection of milk from cows which were either known to be tuberculous or which gave a positive tuberculin reaction. Injections of 5 cc. in each case were made into the peritoneal cavity.

Number and sex of guinea pig.	Date of injection.	Date when killed.	Centrifugalized from—	Weight of guinea pig when injection made.	Weight when killed.	Source of milk.	Volume of cream per 100 of milk.	Microscopic examination of sediment in centrifuge tubes.	Absence or presence of tuberculosis (present +, absent —).
			cc.	*Ounces.*	*Ounces.*				
9♂	Nov. 25, 1893	Feb. 27, 1894		22	22½	Cow No. 272		No bacteria, a small number of leucocytes	—
10♂	do	do	40	25	20				—
11♂	do	do		19	21	Cow No. 273		do	—
12♂	do	do	40	25	25½				—
13♂	do	do		18	21	Cow No. 274		do	—
14♂	do	do	40	23	20				—
15♀	do	do		17	22	Cow No. 275		do	—
16♀	do	do	40	22	23				—
17♀	do	do		17	24	Cow No. 276		do	—
18♀	do	do	40	20	21				—
19♀	do	do		19	20	Cow No. 279		do	—
20♀	do	do	40	16	20				—
*23♂	Dec. 19, 1893	Mar. 16, 1894		22	24½				—
34♂	do	do		16	19	Cow No. 283		No cover glasses from milk examined	—
*35♂	do	do		25	24½				+
36♂	do	do		21	24				—
60♀	Jan. 24, 1894	Apr. 14, 1894		14	17	Cow No. 268		No bacteria, only a few leucocytes	—
61♀	do	do	40	16	20				—
62♀	do	do		15	16	Cow No. 273		do	—
63♀	do	do	40	14	17				—
64♀	do	do		15	18	Cow No. 276		do	—
65♀	do	do	40	14	17				—
66♀	do	do		14	18	Cow No. 279		do	—
67♀	do	do	40	12	16				—
95♀	Feb. 9, 1894	May 3, 1894		12	17	Cow No. W. 1	6⅝	Large number of leucocytes	—
96♀	do	do	40	13½	22				—
97♂	do	do		14	19	Cow No. W. 2	7⅛	Few leucocytes	—
98♂	do	do	40	13	20				—
99♀	do	do		10	16	Cow No. W. 3	20	do	—
100♀	do	do	40	12½	15				—
101♀	do	May 2, 1894		12	18	Cow No. W. 8	4⅜	Large numbers of leucocytes	—
102♀	do	do	40	10½	16½				—

* For special note see next page.

Guinea pig No. 35 was found tuberculous when killed. The dorsal third of the spleen was infiltrated with tubercles, probably by contiguity from the lymph glands associated with it, which are much enlarged and necrotic. The left testicle is converted into a thin walled sac filled with a thick, yellowish pus, resembling flour paste in consistency. Tubercle bacilli present in cover glasses. A guinea pig inoculated with a particle of spleen pulp became tuberculous.

On post-mortem examination cow No. 283 was found to be extensively tuberculous, but the udder and pubic lymph glands were found free from tubercular lesions after a very careful naked-eye examination.

The second series of inoculations thus include the milk from 12 tuberculous cows, from three of which injections were made at two different times sixty days apart. The milk from only one cow, an animal practically in the last stages of more or less generalized tuberculosis, produced the affection in one of the four guinea pigs injected with it.

In addition to these experiments, a third series was tried by injecting repeatedly into a number of guinea pigs the milk of the same animal. It was assumed that by increasing in this way the quantity of milk injected into the same guinea pig from the same cow more positive results might be obtained. The milk was injected directly into the abdominal cavity in every case. When centrifugalized, the quantity injected was derived from 40 cc. (1⅓ ounces).

MILK FROM COW No. 286.

This cow is in the last stages of tuberculosis, but has no visible affection of the udder.* See No. 286, Table v, p. 144.

Guinea pig No. 146 ♀.

March 16. Weight of guinea pig, 13 ounces; injected 5 cc. centrifuge milk.
March 19. Weight of guinea pig, 13¼ ounces injected 5 cc. centrifuge milk.
March 24. Weight of guinea pig, 14 ounces; injected 5 cc. untreated milk.
April 4. Weight of guinea pig, 14⅜ ounces; injected 5 cc. untreated milk.
April 12. Weight of guinea pig, 11½ ounces; no injection.

Up to the time of the last injection, on April 4, the guinea pig remained in good condition, and had been gradually gaining in weight. On April 18 it was found in a dying condition, and was killed and examined. Extremely emaciated. At the seat of one injection a small abscess, containing pale yellow pus. Similar abscesses, not less than a dozen, varying in size from a mustard seed to a pea, in the abdominal cavity. Adhesion of the liver to the abdominal wall and the stomach. Cover glasses show the presence of a coccus in considerable number. †

* For the extent of the disease and its distribution in this animal, see No. 283, Table v, p. 144. — T. S.

† The lesions in this and other guinea pigs which were inoculated with milk from cow No. 286 were evidently due to *Staphylococci* in the udder. The lesions included peritonitis, suppurative pericarditis, and multiple abscesses in the internal organs of those guinea-pigs which died prematurely, and firm adhesions of liver, stomach, and intestines to neighboring structures in those that recovered. *Staphylococci* were isolated from the milk directly and from one of the guinea pigs. This subject will receive more attention.—T. S.

Guinea pig No. 147 ♀.

March 16. Weight of guinea pig, 11 ounces; injected 5 cc. centrifuge milk.
March 19. Weight of guinea pig, 11 ounces; injected 5 cc. centrifuge milk.
March 24. Weight of guinea pig, 11 ounces; injected 5 cc. centrifuge milk.
March 26. Dead.

Marked injection of the veins of subcutis over the abdomen. Whitish discoloration of abdominal muscles at the seat of injection. Extensive viscid exudate in the abdomen. Pseudo-membranous deposit on spleen and liver, with whitish clumps intermixed. Hyperæmia of lungs with viscid, translucent pleural exudate.

No bacteria in cover glasses from abdominal exudate.

Guinea pig No. 154 ♀.

March 21. Weight of guinea pig, 11½ ounces; injected 5 cc. centrifuge milk.
March 24. Weight of guinea pig, 11 ounces; injected 5 cc. untreated milk.
April 4. Weight of guinea pig, 11 ounces; injected 5 cc. untreated milk.
April 12. Weight of guinea pig, 9½ ounces; no injection.
April 23. Weight of guinea pig, 10½ ounces; no injection.
July 13. Weight of guinea pig, 19 ounces.

Chloroformed and examined post-mortem. Firm adhesion of liver to diaphragm and stomach.

Guinea pig No. 155 ♀.

March 21. Weight of guinea pig, 14½ ounces; injected 5 cc. centrifuge milk.
March 24. Weight of guinea pig, 13½ ounces; injected 5 cc. untreated milk.
April 4. Weight of guinea pig, 15 ounces; injected 5 cc. untreated milk.
April 12. Weight of guinea pig, 15 ounces; injected 5 cc. untreated milk.
May 1. Died this morning.

The abdominal cavity is filled with a turbid reddish fluid. In the liver is a large abscess which is filled with a dirty yellowish red fluid. What is left of the liver tissue is soft and mushy in character, dark red in color, and sprinkled with minute necrotic areas. The intestine is adherent to the abdominal wall and the stomach to the abdominal wall and liver. The entire thoracic cavity is filled with a turbid reddish fluid, which coagulates slowly and forms a soft gelatinous clot. Lungs in a state of extreme congestion and very œdematous. Heart with the pericardium adherent. Between the heart and the pericardium, one small abscess. One small abscess between the skin and the abdominal wall.

The condition of the cow had been growing rapidly worse and had reached a stage at the time these injections were undertaken which would have led the average dairyman to exclude her from his herd.

Guinea pig No. 187 ♂.

May 5. Weight of guinea pig, 18½ ounces; injected 5 cc. untreated milk.
May 19. Weight of guinea pig 17½ ounces; injected 5 cc. untreated milk.
May 24. Weight of guinea pig, 17½ ounces; injected 5 cc. untreated milk.
July 13. Weight of guinea pig, 16½ ounces.

Chloroformed and examined post-mortem. Adhesion of liver to stomach, and intestine to abdominal wall.

Guinea pig No. 188 ♂.

May 14. Weight of guinea pig, 24½ ounces; injected 5 cc. untreated milk.
May 19. Weight of guinea pig, 25½ ounces; injected 5 cc. untreated milk.
May 24. Weight of guinea pig, 25½ ounces; injected 5 cc. untreated milk.
July 13. Weight of guinea pig, 28 ounces.

Chloroformed and examined post-mortem. No lesions.

Guinea pig No. 1893.

May 19. Weight of guinea pig, 12½ ounces; injected 5 cc. untreated milk.
May 24. Weight of guinea pig, 12½ ounces; no injection.
July 13. Weight of guinea pig, 19 ounces.
Chloroformed and examined post-mortem. No lesions.

MILK FROM COW NO. 285.

This cow gave a marked tuberculin reaction, but is in fairly good condition and has no visible affection of the udder.

Guinea pig No. 148 ♀.

March 16. Weight of guinea pig, 13½ ounces; injected 5 cc. centrifuge milk.
March 19. Weight of guinea pig, 14 ounces; injected 5 cc. centrifuge milk.
March 24. Weight of guinea pig, 14 ounces; injected 5 cc. untreated milk.
April 4. Weight of guinea pig, 14¾ ounces; injected 5 cc. untreated milk.
April 12. Weight of guinea pig, 14 ounces; injected 5 cc. untreated milk.
April 16. Weight of guinea pig, 15 ounces; no injection.
July 13. Weight of guinea pig, 23 ounces.
Chloroformed and examined. Adhesion of the intestine in two places to the abdominal wall.

Guinea pig No. 149 ♀.

March 16. Weight of guinea pig, 13½ ounces; injected 5 cc. centrifuge milk.
March 19. Weight of guinea pig, 13 ounces; injected 5 cc. centrifuge milk.
March 24. Weight of guinea pig, 13¾ ounces; injected 5 cc. untreated milk.
April 4. Weight of guinea pig, 14 ounces; injected 5 cc. untreated milk.
April 12. Weight of guinea pig, 13½ ounces; injected 5 cc. untreated milk.
April 23. Weight of guinea pig, 14½ ounces; no injection.
July 13. Weight of guinea pig, 22 ounces.
Chloroformed and examined post-mortem. Adhesion of stomach and intestine to liver.

Guinea pig No. 156 ♀.

March 21. Weight of guinea pig, 14½ ounces; injected 5 cc. centrifuge milk.
March 24. Weight of guinea pig, 14¼ ounces; injected 5 cc. untreated milk.
April 4. Weight of guinea pig, 15 ounces; injected 5 cc. untreated milk.
April 12. Weight of guinea pig, 15½ ounces; injected 5 cc. untreated milk.
April 13. Found dead.
On post-mortem examination a number of whitish clumps (probably casein) were found in the abdominal cavity between the coils of intestine and sprinkled over the liver, spleen, etc. A considerable amount of pale red, partly translucent, fluid in the abdominal cavity. General discoloration of the abdominal wall and serous surface of the intestine.

Guinea pig No. 157 ♀.

March 21. Weight of guinea pig, 10½ ounces; injected 5 cc. centrifuge milk.
March 24. Weight of guinea pig, 9¾ ounces; injected 5 cc. untreated milk.
April 4. Weight of guinea pig, 10 ounces; injected 5 cc. untreated milk.
April 12. Weight of guinea pig, 9½ ounces; injected 5 cc. untreated milk.
April 18. Found dead this morning.
Autopsy revealed the same condition as in guinea pig No. 146. There was, in addition, a collapsed and œdematous condition of the lungs and a purulent pericarditis.

MILK FROM COW NO 290.

This cow is supposed to be in an advanced stage of tuberculosis. She has given a reaction upon injection with tuberculin several times, but has no visible udder affection.

Guinea pig No. 183 ♂.

April 18. Weight of guinea pig, 13 ounces; injected 5 cc. untreated milk.
April 23. Weight of guinea pig 14½ ounces; injected 5 cc. untreated milk.
April 28. Weight of guinea pig, 15 ounces; injected 5 cc. untreated milk.
May 5. Weight of guinea pig, 16 ounces; injected 5 cc. untreated milk.
July 13. Weight of guinea pig, 23 ounces.
Chloroformed and examined post-mortem. Slight adhesion of intestine to abdominal wall.

Guinea pig No. 184 ♂.

April 18. Weight of guinea pig, 11½ ounces; injected 5 cc. untreated milk.
April 28. Weight of guinea pig, 13 ounces; injected 5 cc. untreated milk.
May 5. Weight of guinea pig, 14½ ounces; injected 5 cc. untreated milk.
July 13. Weight of guinea pig, 15 ounces.
Chloroformed and examined post-mortem. No lesions.

Guinea pig No. 185 ♀.

April 23. Weight of guinea pig, 10½ ounces; injected 5 cc. untreated milk.
July 13. Weight of guinea pig, 12 ounces.
Chloroformed and examined post-mortem. No lesions.

MILK FROM COW NO. 291.

This cow showed the presence of more or less tuberculosis on post-mortem examination, but had no visible affection of the udder.*

Guinea pig No. 186 ♂.

April 23. Weight of guinea pig, 13 ounces; injected 5 cc. untreated milk.
April 28. Weight of guinea pig, 13 ounces; no injection.
July 13. Weight of guinea pig, 15 ounces.
Chloroformed and examined post-mortem. No lesions.

Guinea pig No. 158 ♀.

April 18. Weight of guinea pig, 12 ounces; injected 5 cc. untreated milk.
April 23. Weight of guinea pig, 12½ ounces; injected 5 cc. untreated milk.
April 28. Weight of guinea pig, 13 ounces; injected 5 cc. untreated milk.
May 5. Weight of guinea pig, 14 ounces; no injection.
July 13. Weight of guinea pig, 17 ounces.
Chloroformed. Examination negative.

Tuberculosis was not found in any guinea pig in this last series of injections, notwithstanding the fact that the 4 cows furnishing the milk gave a high tuberculin reaction and are to all appearances in an advanced stage of the disease. Nos. 286 and 291 have been killed and found tuberculous (*see* Table v, p. 144).

The inference which may be drawn is the same suggested in Bulletin No. 3. It is that a careful inspection of all dairy herds which has for

* *See* No. 291, Table v, p. 144.— T. S.

its object the detection and removal of all advanced cases of tuberculosis, and especially of cows with diseased udders, would probably exclude the sale of most infected milk.

In this connection it may be worth while to mention that in a recent inspection of over 800 cows which belong to different dairy herds of a large city it was found that between 5 and 6 per cent of the animals had defective udders. In the majority of cases it was evident that the udder trouble was due to present or past affections other than tuberculosis, but in the remaining cases this could not be determined during life.

These experimental observations further show that now and then the presumably mixed milk of dairies may contain enough tubercle bacilli to prove fatal to guinea pigs in two months.

STUDIES IN BOVINE TUBERCULOSIS WITH SPECIAL REFERENCE TO PREVENTION.

By Theobald Smith.

[Plates I–VI.]

Tuberculosis among domesticated animals, more particularly among cattle, has during the past few years received a large share of attention mainly because of the possible direct influence on human health. With this idea in the foreground the bearing of this malady on agricultural interests has been more or less obscured. As a result we have a great mass of publications on the hygienic aspect of tuberculosis and but very little on the prevention of this disease among cattle. Many of the more valuable contributions to our knowledge have been made in order to define more definitely what degree of tuberculosis makes an animal unfit for human food. This point of view, while bringing out now and then valuable facts, does not pay sufficient attention to the animal during life. What to do in order to reduce the high percentage of infection among living animals has been tacitly ignored in all but a few recent publications. It became evident to the writer on beginning these studies that this was, after all, the most important aspect of the serious problem of bovine tuberculosis. If the disease can be restricted and repressed among cattle during life the hygienic problem will take care of itself.

To attack tuberculosis as it exists at present is undoubtedly a most difficult problem and the conditions which tend to repress or to augment its further dissemination are very complex. No single measure, however sweeping, is likely to be successful. A number of details will have to receive careful attention and, in the end, the success will depend largely upon the amount of intelligent watchfulness constantly exercised in various directions by the stock owner. The wide dissemination and the localized intensity of this disease will require, above all, concerted action in attempts for its repression. Though a strictly bacterial disease and introduced into the body only by the tubercle bacillus, which is always derived from some preëxisting case of disease, tuberculosis differs, nevertheless, from most animal diseases in very important particulars. Its unknown beginnings in the body and its slow insidious march after it has once gained a foothold are responsi-

ble for the existence of a large number of tuberculous animals in all stages of the disease. In the earlier stages, while the disease is still restricted to a single focus, the animal is to all outward appearances in perfect health. It is only after the infection has invaded several cavities of the body or produced mechanical obstructions that it becomes manifest. The prolonged latency of the first stage of the disease with little or no discharge of tubercle bacilli raises the question what should be done with such cases. A comparison with some other infectious diseases makes the predicament all the clearer.

When an animal becomes infected with anthrax or with Texas fever the specific microörganisms begin to multiply at once. Within twenty-four hours in the case of anthrax, a few days to a week in Texas fever, the symptoms are fully developed and death or recovery speedily follows. There can be no question here concerning degree of disease or utility of the animal during the earlier stages. The infected and the non-infected are divided by sharp unmistakable barriers. In tuberculosis, on the other hand, the infected animal is practically well during the earliest stages of disease, and the disease may become stationary, possibly healed. This peculiarity in the nature of tuberculosis modifies to a certain extent the usual measures employed to repress an infectious disease. In certain diseases the necessity for the destruction of all infected animals becomes imperative, because the disease must be kept restricted and suppressed as soon as possible. The present wide dissemination of this disease and its prevalence among other domesticated animals, such as dogs, cats, horses, goats, and, above all, its prevalence among man, makes the complete extinction of this malady an unrealizable problem.

It is largely due to these peculiarities that tuberculosis has received so little attention until recent years. Its unrecognizable beginnings and slow insidious march in the body made it appear on the surface as a disease not of infectious origin, but as one in which inheritance played an important part. After the discovery of the true cause in the form of a bacterium (*Bacillus tuberculosis*) by Koch the conception that infection played the most important role has gradually gained a firm foothold. Without in any way wishing to eliminate the factor of heredity, the writer has based the statements in the following pages entirely on the principle now universally recognized, that without the presence of the tubercle bacillus there can be no tuberculosis. If it can be shown that the tubercle bacillus can be kept away from cattle by adopting certain precautionary measures the discussion concerning heredity would be useless. If, however, this should prove to be impossible the problems of breed, heredity, and environment, or, in other words, the accessory causes, will require renewed study.

In the following chapters matters of technical importance are introduced in order to form a basis upon which to found the practical suggestions given at the close. These suggestions must be considered as

subject to change as investigations progress. The prevailing ignorance upon certain important aspects of the subject makes the publication of even fragmentary researches justifiable at the present time.

PRIMARY DISEASE OF THE LUNGS AND PULMONARY GLANDS (AIR INFECTION).

According to published statements of most authorities and our own observations tuberculosis of the lungs is the most frequent of all the primary forms of this disease in cattle. The absence of disease elsewhere in the body, or the character of the pulmonary disease itself when associated with tuberculosis of other organs, leads directly to the inference that the bacilli must have entered the lungs in the inspired air. Infection through the air is, therefore, the most serious problem to be dealt with. It takes place when the tubercle bacilli have become thoroughly dried, so that they can be carried like particles of dust in currents of air and drawn into the lung tissue through the air passages.

In discussing tuberculosis of the lungs we have two forms to deal with: (1) Disease of the lung tissue proper with disease of the corresponding lymph glands, and (2) disease of the lymph glands of the lungs without any traceable lung disease associated with them. Tuberculosis of the lung tissue is in perhaps 99 per cent of the cases associated with tuberculosis of the corresponding lymph glands, while disease of the latter without visible lung affection is quite common in the early stages of the disease.

TUBERCULOSIS OF THE LUNGS.

(Plates I, II, III, and IV.)

The earliest disease in the lung tissue is quite regularly located in the large caudal lobes. The other lobes are occasionally found diseased, but there seems to be no place of predilection excepting the lobes mentioned.* Thus, in the herd described in the first article there were 19 cases of lung tuberculosis. Of these—

The large caudal lobes were affected in	16
They were affected exclusively in	11
Both caudal lobes affected in	6
Left caudal lobe alone in	5
Right caudal lobe alone in	5
Right cephalic lobe affected in	6
Right cephalic lobe affected exclusively in	3
Left ventral (with other lobes) in	1
Right ventral (with other lobes) in	1
Left cephalic (with other lobes) in	1

* For the nomenclature of the lobes of the bovine lungs as used in these pages, *see* Pl. I and II.

In another herd comprising 9 cases of lung disease only 2 had other lobes, in addition to the large caudal lobes, affected. In a third herd, in which pulmonary tuberculosis was found in 6 animals, all had foci in one or both caudal lobes and only 2 of these had other lobes affected. In most cases both caudal lobes are involved. In those in which but one is diseased the left seems to be more frequently attacked.

This predilection for the larger lobes seems to be due to mechanical conditions. The two main bronchi which supply these lobes branch off from the trachea at an acute angle (*see* Pl. III). The course of the current of air passing along the trachea into the terminal bronchi is nearly straight. But, what is of more importance, the caudal lobes are more expansible than the smaller anterior lobes. This is evident from the construction of the thorax, as well as from an inspection of the lungs themselves. The pleura is denser, often wrinkled, over these lobes when collapsed, a condition which indicates marked stretching during the expanded state of the lobe. More air passes into the lobes, and the current may be of greater velocity than that entering the smaller lateral branches. Tubercle bacilli suspended in the entering current are thus carried directly into the main bronchi and deposited in them or their ramifications within the caudal lobes. There they set up disease somewhere near the main bronchus. In fact, the larger number of primary foci are found in that portion of the lung tissue above or dorsad of the main bronchus, i. e., in the portion of the lung tissue which rests under the ribs at their vertebral attachment. This portion is shown as a shaded area in Plate I. The foci are rarely directly contiguous with the main bronchus or its large branches, and in case of many the writer was unable to trace any air tube into or near them.

The caudal lobes, as the chief primary seat of pulmonary tuberculosis, are not more susceptible than other lobes. Their infection is solely due to the fact that tubercle bacilli are deposited in them rather than in other lobes. Immunity of any region of the lungs is not deducible from the writer's observations. As the disease advances it seems to become equally destructive in all lobes attacked as soon as bacilli have found their way into them. If, in fact, the writer should predicate greater susceptibility of any region of the bovine lung, it would be the ventral and cephalic lobes, especially the former. For, basing ourselves on the condition of lungs far advanced in tuberculosis, it would seem that these smaller, less expansible lobes are more severely involved, when once attacked, than the caudal lobes. This condition would be analogous to that prevailing in human lungs.

Pulmonary tuberculosis differs from the sporadic forms of broncho-pneumonia in that the lesions of the latter, like the pneumonias of swine, are governed in their distribution by gravity. The ventral lobes, so rarely the seat of earliest lesions in tuberculosis, are affected first in broncho-pneumonia. Thence the disease spreads upward, overflowing into the cephalic lobes and the contiguous portions of the

caudal lobes. Another characteristic of broncho-pneumonia not found in tuberculosis is the symmetrical affection of both lungs. This is also a result of the gravitation of infectious matter. The difference is due to the mode of infection. The bacteria of swine plague and bovine pneumonia are speedily killed by drying, and hence dead when in a condition to be carried in the air. They are not inhaled in the living state, but are carried into the lungs in fluids and catarrhal secretions, and thus come under the influence of gravity in their distribution, as suggested. A comparison of these pneumonias thus indirectly supports the view that tubercle bacilli are inhaled.

After the development of a primary focus of disease, other foci may appear as a result of repeated infection from without. It is not an uncommon thing to observe a number of disease centers, evidently independent of one another, in the same lung or even the same lobe. These foci enlarge and invade neighboring tissue. Having reached a certain age, the necrotic tissue becomes softened and discharges into a bronchus. Thence the discharged masses, with the contained virus, may be carried along the air tubes into other regions of the lungs, or, perhaps into the throat, where it may be swallowed or thrown outward. This upward discharge of tubercle bacilli is indicated by the formation of tubercles on the mucous membrane of the air tubes. Primary disease in this situation has not been observed in any case examined.

The settling down and multiplication of tubercle bacilli in the lung tissue seems to be quite independent of any preëxisting disease of the lungs. In about 150 cases examined only a very few showed pneumonic lesions or bronchial affections, and in these few cases these changes were either due to the gravity of the tuberculosis or else to traumatism. Catarrh of the bronchial tubes was rarely observed, and then only locally, in connection with a tuberculous focus which was discharging its contents and causing irritation of the bronchial mucous membrane. On the other hand, the grafting of tuberculosis upon other lung affections, such as broncho-pneumonia, is equally rare. There are, it seems, no preëxisting pneumonic or bronchial affections which can be regarded as forming the entering wedge for tubercle bacilli. These seem to find in the healthy lungs a favorable soil at all times. Any special predisposition, if such really exist, must be sought for in other conditions than those of visible lesions.

TUBERCULOSIS OF THE THORACIC GLANDS.

There are many cases of tuberculosis which are due to infection through the inspired air, but which do not lead to any primary disease of the lungs. This begins in the bronchial and the mediastinal lymph glands, into which the lymph from the lung tissue passes. That there may have been in such cases very insignificant disease of the lung tissue itself is conceded, but it certainly eludes a very careful

search with the naked eye. In every case which came under the writer's notice, the lungs were thoroughly inspected and manipulated with the hands, then the air tubes slit open and the manipulation and inspection repeated. The primary affection of the lymph glands is in some cases made more evident by the advanced stage of the tuberculous process in the latter, with no accompanying disease of the lungs themselves.

Before giving any illustrations of this form of primary tuberculosis, a brief description of the system of thoracic glands attacked will not be out of place here, especially as they are not fully or even accurately described in the somewhat meager anatomical literature of this subject. While, for example, some writers on tuberculosis tacitly assume that the posterior mediastinal glands belong to the lungs, writers on anatomy consider them independent of the lungs, and only refer to the bronchial glands as strictly lung glands. The writer regards the posterior mediastinal glands as strictly pulmonary glands. This would be deducible from their relation to tuberculosis of the bronchial glands and of the lungs themselves. But there is a more cogent reason than this. A careful comparative examination of the bronchial and the posterior mediastinal glands will show that the pigmentation so characteristic of the bronchial glands with advancing age is identical in quality and quantity in the two sets of glands. In old cows the posterior mediastinals are as densely pigmented as the bronchials. Moreover, the general appearance of the glands of the two sets is the same, and not to be confounded with glands from other regions of the body.*

The bronchial glands (Pl. III) are situated on the trachea at or near the root of the bronchi of the different lobes. They might with equal reason be denominated tracheal glands. Of these three are regularly present.

The largest gland, the one most frequently involved in tuberculosis, and hence of most importance to us, is situated against the trachea in the angle formed by the left main bronchus with it (Pl. III, A). It is from 1 to 1.5 inches in diameter and of an irregular outline. It is firmly attached to these tubes and rests on the left pulmonary artery. The aorta arches over and conceals it.

The next largest bronchial gland is situated at the root of the right supernumerary bronchus on its ventral aspect and is firmly attached to the air tube (Pl. III, C).

The third quite small gland (right tracheal) is situated against the right side of the trachea near the bifurcation (Pl. III, B). It is rarely more than one-half inch in diameter. It is found in the incision between the right ventral and the right caudal lobe, entirely concealed by sur-

* Each lymph gland or group of associated glands in the bovine body has a general facies of its own, and a little well-directed observation will soon enable the pathologist to tell the region whence came the gland, as the anatomist recognizes bones and pieces of bones from a skeleton familiar to him.

rounding lung tissue. A fourth small gland is encountered in some animals in the acute angle formed by the bifurcation of the trachea (Pl. III, D).

It seems probable that the gland first described, and denominated in these pages as the left bronchial, receives the lymphatics ramifying about the bronchi (the peribronchial lymphatics). It is not improbable that it receives the lymphatics of the right as well as of the left bronchus. Its situation allows this, and its large size, compared with that of the right tracheal and its frequent infection, support this view.

Within the parenchyma of the left caudal lobe I have encountered in rare cases diseased glands situated along the main bronchus, between it and the pulmonary artery. They may be found in the healthy lung, but only after careful dissection and search, as they are very small. They do not seem to play any important rôle in tuberculosis, for they rarely obtrude themselves on account of enlargement. They may be called intrapulmonary glands.

The posterior mediastinal glands (Pl. IV) form a series or chain of glands situated in the dorsal or posterior mediastinum between the posterior aorta dorsally and the œsophagus ventrally. This chain extends from the pillars of the diaphragm as far as the right supernumerary bronchus. Some of the glands of this group may be felt *in situ* after one side of the thorax has been removed, but they are best studied by removing the lungs and heart with posterior aorta and placing the mass with the dorsal aspect of the lungs uppermost. After the aorta has been cut away and reflected these glands come into view embedded in more or less fat, the lower ones resting on the œsophagus and pillars of the diaphragm and loosely held in position by means of connective tissue and the serous membranes inclosing the mediastinal space. The number of glands in this chain visible to the naked eye varies more or less in different animals. The hyperplasia or enlargement following tubercular infection or inflammation of the lungs may perhaps bring some into view and thus account for the variable number.

The most important and most constant gland in this group is the extreme caudal member of the chain near the tip of the caudal lobes (Pl. IV, *a*). It is the largest gland of the chain. In the normal state it is a flattened elongated body, from 4 to 6 inches long, three-fourths inch broad, and one-half inch thick, rather firmly attached to the muscular pillars of the diaphragm (*g*), and extending some distance back (caudal) of the large ligament of the lungs (*i*). Its cephalic end is usually divided, the left lobe projecting farther toward the head than the right. It is highly probable that this gland consists of two glands fused together.

From this gland as a starting point the remaining glands seem to range themselves in two incomplete series on the right and left side of the mediastinal space. One series terminates in the left bronchial gland, the other extends farther toward the head to the gland of the

supernumerary bronchus. The two chains may consist of three or four glands only, or there may be as many as seven.

The difference between the bronchial and posterior mediastinal glands in their relation to the lungs is this, that the former are firmly and snugly attached to the air tubes, while the latter rest upon the œsophagus, and are loosely connected with the lungs through the mediastinal portion of the pleura. Both, as stated above, are identical in appearance and in quantity and nature of pigment. It is probable that the mediastinal glands receive lymph vessels which ramify beneath the pleura (the subpleural lymphatics and their accessories), while the bronchial glands drain the immediate vicinity of the air tubes through the deep or peribronchial lymphatics.

If we turn to the literature of this subject we shall find that the views just expressed are quite different from those in current works on anatomy. As regards the functions of the posterior mediastinal glands the following statement may be quoted:

Die hinteren Mittelfelldrüsen haben ihre Lage an der Herzbasis unter der hinteren Aorta und am Schlund. Zwerchfell-, Mittelfell-, Schlund- und Herzbeutellymphdrüsen entleeren sich in sie, ihre Verbindungen mit den Bronchialdrüsen ermöglichen den Abfluss.

Die oberflächlichen Lungenlymphgefässen bilden unter der Pulmonalpleura ein Netzwerk, das in die vorderen Mittelfell- und Bronchialdrüsen seinen Abfluss nimmt, in diese der Bifurcation der Trachea eingefügten *Gland. bronchiales,* Lungendrüsen, ergiessen sich auch die tiefen den Bronchialverzweigungen folgenden Lymphgefässe des Organes. (Article: Lymphgefässystem (Sussdorf), Koch's Encyklopädie der gesammt. Thierheilkunde.)

According to this definition, the posterior mediastinal glands receive the lymphatics of the diaphragm, mediastinum, œsophagus, and pericardium only. If this were true the particles of pigment and the tubercle bacilli would have to escape from the lungs into the thoracic cavity first before they could come within the reach of the posterior mediastinal glands. Furthermore, this definition assumes that all lymphatics of the lungs empty into the bronchial and anterior mediastinal glands. The relation of the latter to the lungs is highly doubtful, if by anterior mediastinals are meant the small group of glands within the thorax under the first rib. These glands are not pigmented. They receive the lymph from the chain of lymph glands of the head and neck, and tuberculous changes in them are traceable in most cases to tuberculosis of the neck glands. It is not to be denied—it is, on the whole, highly probable—that the posterior mediastinal glands may drain the territories mentioned in the definition, but that they also stand in direct relation to the pulmonary lymphatics seems to the writer unquestioned.

A uniform nomenclature of these two sets of glands does not exist. While the terms "bronchial glands," "posterior mediastinal glands," are in general use, R. Schmaltz* is inclined to identify the posterior

* Topographische Anatomie der Körperhöhlen des Rindes. Lieferung 1, S. 20, 21.

mediastinal with his œsophageal glands. The bronchial glands are separated by him into those which are attached to the trachea outside of the parenchyma of the lungs (*glandulæ lymphaticæ cardiales s. tracheales posticæ*) and those accompanying the bronchi into the lung tissue (*gl. lymph. bronchiales*).

In view of the confusion existing both as regards the name and the functions of the thoracic glands, a thorough reinvestigation of this subject, by reason of its important bearing on tuberculosis, is highly desirable. In the present article the writer maintains the position that not only the bronchial but also the posterior mediastinal glands as herein described are pulmonary glands, and that the anterior mediastinal glands at the root of the thorax are not connected with the lungs. A nomenclature of the functions would also be of far more service than one of position or location.

It has already been stated that tuberculous changes in the lung tissue are in almost every case accompanied by infection of the pulmonary glands, as might be anticipated from the functions of these glands. On the other hand, there are many cases of tuberculosis limited exclusively to the pulmonary glands. Combining these two groups of cases, it becomes evident that in almost every case of pulmonary infection the pulmonary glands are attacked. An examination of the tables on pages 139 to 144 shows this very clearly.

If we restrict our attention to the exclusively glandular tuberculosis some interesting facts are at hand. In the 53 cases of tuberculosis from one herd, 47 had been infected through the lungs. Of these, 27 had gland disease only, the lungs being free. A still closer analysis shows that in 5 cases the mediastinals alone, in 5 the bronchials alone, were diseased.

Among the bronchial set the left bronchial is most frequently involved. Among the mediastinals the large caudal gland is the favored seat of tubercles. This gland, on the whole, is perhaps more often found diseased than any other thoracic gland, and hence any other lymph gland in body. It should never be overlooked in searching for the primary seat of disease. In the 53 cases of the herd referred to, this gland was diseased in 34. The left bronchial was diseased in 24 cases only. The other glands of either group are not infrequently affected at the same time, but there is no regularity in this respect. In advanced cases all thoracic glands are diseased. In other herds a similar restriction has been observed by the writer, provided the disease was not too far advanced.

In 9 cases from one herd, 3 had tuberculosis of thoracic glands only.

In 17 cases from another herd 3 had tuberculosis of glands only.

In 8 cases from a third herd, nearly all of which were advanced cases, 1 had gland disease only.

Finally, in 34 cases from a fourth herd 11 had the thoracic disease restricted to the glands, but of these 10 had tuberculosis of other organs not in the thorax.

In order to get some information from carefully performed autopsies recorded by other observers, I looked over the brief protocols published recently by Röckl,* Schütz, and Lydtin.† These observers examined quite a number of animals, many of which had been recognized as tuberculous before the application of the tuberculin test. These do not concern us here, since they represent more or less advanced tuberculosis of the lungs. One series of 12 fattened cows from the same herd is of interest, since they correspond closely to the animals described in this bulletin.

Of these 12, one may be thrown out as doubtful, since some glands were not examined. Of the remaining 11, one was free from tuberculosis, the rest infected.

The 10 cases may be tabulated as follows:

No.	Bronchial glands.	Mediastinal glands.	Lungs.	Mesenteric glands.	Portal glands.	Udder.
1	+	—	—	—	—	—
2	+	+	—	—	—	—
3	+	+	—	—	—	—
4	—	+	—	—	—	—
5	—	+	+	—	—	—
6	—	+	+	—	—	—
7	—	—	+	—	—	+
8	—	+	+	+	—	—
9	+	+	—	—	+	—
10	—	—	—	+	—	—

From this table it will be seen that in 4 the thoracic glands only were affected. Five had pulmonary tuberculosis, and of these all but 1 had disease of the related glands. Infection by way of the lungs is indicated in 90 per cent of the cases.

In another series of 19 animals from the same dairy and in good condition 12 were found infected; 4 had gland tuberculosis only, the remainder pulmonary as well as gland tuberculosis.

Siedamgrotzki and Johne‡ report upon a miscellaneous lot of 40 animals, of which 23 were found tuberculous. Of these only 2 had the disease restricted to the thoracic glands. In most other cases the lungs and thoracic glands were diseased. In a few no mention is made of the thoracic glands. This may be due to an oversight.

Fischöder,§ in an analysis of 600 cases of tuberculosis observed at one of the German abattoirs, states that 599 had tuberculosis of the thoracic organs (infection through the air). In 210 of these, *i. e.* in more than one-third of the total number, only the pulmonary glands were involved.

* Arbeiten aus dem Kaiserl. Gesundheitsamte, VIII (1892), p. 1.

† *Loc. cit.*, p. 48.

‡ Deutsche Zeitschrift für Thiermedicin, XVIII (1891), p. 66.

§ Zeitschrift f. Fleisch- u. Milchhygiene, IV (1894), p. 8.

This preponderance of gland over pulmonary disease in the earliest stages of tuberculosis has not been pointed out with any emphasis as an important regularly occurring phenomenon. When the writer several years ago began his observations on tuberculosis for the purpose of studying the modes of infection, the disease of the thoracic glands was noticed by writers as something casual and accidental, to be classed with the numerous other freaks of tuberculosis. The necessity to find some even slight lesion to account for the tuberculin reaction has led recently to more careful examination of the cadaver and a better knowledge of the disease itself.

In summarizing the relation of the thoracic glands to tuberculosis we may safely lay down the general statement that in incipient or stationary disease the bronchial and posterior mediastinal glands play a more important rôle than any other set of glands in the body. The importance of a careful examination of them, especially of the most caudal mediastinal and the left bronchial gland, in determining the presence of tuberculosis is, therefore, self-evident.

The primary infection of the pulmonary glands and of other glands of the body is not accepted by all pathologists. Some claim that there must be lesions at the point of entry, in the lungs, for example, which are not recognizable, owing to their minute size. This subject will be more fully discussed farther on. Meanwhile the primary infection of lymph glands is accepted in this article as frequently occurring and in fact as a characteristic of bovine tuberculosis.

The penetration of tubercle bacilli into and through the lung tissue and their final lodgment in the lymph glands is probably due to the nature of the bacilli themselves. They are in a thoroughly dry condition before they can be inhaled. Passing through the trachea and into the bronchial tubes with the current of air, they are deposited, seized by some cell and carried into and along the lymph channels into some pulmonary gland in the same way as the pigment is carried. Why they do not multiply at the place of deposit is probably due to the inert state of the dried bacilli. Before they have assumed the vegetative state, they have been carried as harmless foreign bodies into the lymph glands, sharing thus the same fate as the inert particles of pigment. They manifestly are unable to call forth any chemotactic activity on the part of the body cells or to produce any so-called local irritation until they have begun to multiply. The dried state and the proverbially slow growth of tubercle bacilli subsequently may thus account for the penetration of tubercle bacilli far into the body before they begin to cause tuberculosis. In other regions of the body, such as the intestines, the tubercle bacilli can not be considered as dried, and here the simple inert character of the organism may account for its being carried into the mesenteric glands without producing recognizable lesions of the mucous membrane.

The infection of the pulmonary glands in the early stages of tuber-

culosis is in many respects a safeguard both to the affected animal and the rest of the herd. Tuberculosis of the lungs proper not only appears to be more destructive, but, by virtue of the situation of the focus of disease, a discharge of tubercle bacilli will take place sooner or later which may endanger other portions of the lungs or the throat, and which is always responsible for extensive secondary infection and great enlargement of the lymph glands, especially the mediastinal. The foci, primarily formed in the lymph glands, spread but slowly, and in many instances all tendency toward the dissemination of the lesions appears to be checked.

A question of much practical consequence presents itself here in regard to the effect of repeated infection. That cattle may be infected more than once is self-evident when we consider the chances for such infection. The writer has seen a few cases in which two independent infections of the large mediastinal gland could be assumed from the appearance and location of the disease foci. Again, the occurrence of a number of independent foci in the lungs is frequently observed. It might be supposed that the occurrence of disease of self-limited extent following infection might favorably influence the organism by a kind of immunizing or vaccinating process to resist equally well subsequent infection. This view must be regarded as true within certain limits, but the particular place where the second infection became located would to a certain extent modify the result. Thus, two infections of the thoracic lymph glands are less harmful than when the second infection lodges in the lung tissue itself, for this organ is more vulnerable and the bacilli more likely to become diffused. When, therefore, the lymph glands have become more or less impaired by disease the powers of absorption become less active, and future infections are likely to lodge in the lung tissue itself, because the bacilli may not be carried off with that promptness which characterized the working of the normal uninjured lymphatic system.

The practical application of these facts is obvious. The more frequent the infections the more rapid the disease and the speedier the danger of the one case to other animals. The fewer the tubercle bacilli in the air the more reduced the danger. It is highly probable that cattle may under conditions inhale a few tubercle bacilli without permanent injury. They may become absorbed into the lymph glands and there the disease focus remain small and finally heal. The writer has seen the large caudal gland of the posterior mediastinum extensively cicatrized by old completely healed tuberculous foci. Such changes will, of course, not be found excepting where the tubercle bacilli were originally deposited. When the disease has once extended beyond the confines of the primary focus it has acquired sufficient momentum to continue its destructive action uninterruptedly. The importance of reducing the amount of infection in a herd by all possible means and keeping it permanently reduced is one necessary condi-

tion requisite for the successful eradication of tuberculosis. Even if tuberculin does not reach every mild case, the perculiar nature of the affection in virtue of which a slight amount of infection may be overcome bridges over the gap which may have been left by turberculin.

The important facts bearing on tuberculosis of the lungs in cattle are briefly as follows:

(1) Primary infection through the air is more frequent under existing conditions than any other mode of infection.

(2) The early stages of the disease may consist of glandular affections only.

(3) The extent and rapidity of the disease depend at least in part upon the number of tubercle bacilli inhaled either within short or long periods of time.

(4) Tuberculosis of the lungs is not necessarily associated with any other recognizable lung affection as a preëxisting, favoring condition.

PRIMARY TUBERCULOSIS OF THE LYMPH GLANDS OF THE HEAD AND NECK.

(Plates v and vi.)

These glands are so frequently the seat of primary infection that they demand careful consideration. Before discussing their relation to the disease in detail we will review briefly their location and function. These glands are in pairs and symmetrically situated on both sides of the body. They comprise the submaxillary, the parotid, the retropharyngeal, and the postmaxillary glands.

Each submaxillary lymph gland or group of glands (Pl. vi, C) is situated on the inner aspect of the lower jaw, in front of the angle. The larger gland is hidden within the large anterior head of the submaxillary salivary gland (*f*) and covered with some fat. After the skin is removed a drawing away of the salivary gland from the bone exposes at once the gland, which has the usual flattish shape and is about 1.5 inches long. The other glands, if present, are situated nearer the angle. It receives the external lymphatics of the nose, lips, and cheeks, and the lymphatics of a portion of the mucous membrane of the nose and cheeks, and of the anterior portion of the tongue. It drains into the retropharyngeal gland.*

The parotid gland (Pl. vi, A) is situated quite superficially. If a line be drawn from the external meatus of the ear to the lower border of the orbit of the eye the upper end of the gland touches this line and is located about 1 inch in front of the meatus. The gland is about 1.5 to 2 inches long and is partially concealed by the anterior margin of the parotid salivary gland. This gland receives lymphatics from the ear, the parotid salivary gland, the temporal region, and the pharynx.

* The information here given concerning the respective territories drained by these glands is taken from Koch's Encyclopædia.

The most important pair of glands, so far as tuberculosis is concerned, are the retropharyngeal glands (*Gl. tracheales s. cervicales superiores*). These are somewhat larger than those just described. Their situation is most readily understood by examining Plate V, which represents the head of a Jersey cow sawn through in the median plane. The individuals of this pair of glands are in close proximity to each other and situated directly under the mucous membrane, covering the dorsal or posterior wall of the naso-pharynx (the passage leading from the nasal cavities into the œsophagus). Each rests laterally on the hyoid bone. Besides receiving the efferent vessels of the two sets of glands described they receive the lymphatics of the caudal region of the nasal cavities, including those of the pharynx.

In close proximity to these glands are another set which do not appear to figure in text-books; at least the writer has been unable to identify them with descriptions given. They are situated under the caudal or posterior margin of that portion of the submaxillary salivary gland which extends along the caudal margin of the parotid gland upwards towards the ear. The glandular mass is irregular and usually separable into two or three independent glands. They are denominated here postmaxillary (Pl. VI, B).

The tonsils are situated under the mucous membrane of the posterior region of the nasal passage. The opening is shown below the soft palate as a black spot in Plate V.

One or the other of the four pairs of glands described and the tonsils represent the seat of primary infection in many cases. An examination of the synoptic tables on pages 139 to 144 shows that the entire disease is not unfrequently limited to these glands.*

Of the four pairs, the retropharyngeal are by far the most frequently diseased. This is due primarily to the important position of this pair, and secondarily to the fact that it receives the lymph from the other pairs, excepting, perhaps the postmaxillary, into which it may drain. Hence it is uncommon to find any of the other glands affected without tuberculosis of these glands. On the other hand, they are diseased in many cases when none of the others are involved. Although both glands are usually diseased, it is not uncommon to find but one involved. In the tables referred to above one cross indicates disease of but one gland, two crosses of both glands.

The submaxillary glands are rarely diseased, hence any palpation or inspection of the intermaxillary space for enlarged glands is likely to prove fruitless in most cases. The parotid glands are also rarely infected primarily. A swelling or tumor in front of one or both ears is strongly suggestive of tuberculosis of these glands. Lastly, the postmaxillary glands are also infrequently diseased. Any enlargement causes a swelling to appear behind the lower jaw.

*Whether the postmaxillary glands may be primarily diseased or whether they receive the infection from the retropharyngeal glands remains to be determined.

The tonsils are less frequently diseased than one might suppose from their situation. The largest percentage of tonsilar disease was found in herd V (Table IV, p. 143). In one animal it appears to have been secondary to tuberculosis of one of the retropharyngeal glands. A small fistulous opening from the enormously enlarged gland was found in the roof of the posterior nasal passage. The tonsil of the same side appeared to have been only recently infected.

In tracing the channels of infection it is of considerable importance to determine how far tuberculosis of the retropharyngeal glands may be due to tubercle bacilli inhaled, or to such as are ingested with the food. Writers are in general agreed that disease of these glands is the result of food infection. It is not improbable that bacilli inspired in the air are frequently deposited in the nasal passages with the dust. Whether such bacilli are absorbed from the surface of the normal mucous membrane is questionable. In the mouth, on the other hand, the opportunities for slight laceration of the mucosa are more numerous, and hence the chances for infection of the lymph glands better. Moreover, the tonsils may be active in the absorption of particles through the agency of migrating leucocytes. If this be so it is strange that so little tuberculosis of the tonsils is found with so much infection of the retropharyngeal glands. Perhaps here, as in the lungs, the absorption and passage through the tonsils into the lymph glands goes on very rapidly, so that opportunity for multiplication is not given until the bacilli have reached the lymph glands.

Besides the chances for direct infection from without these head glands may also be secondarily infected with tubercle bacilli, which are coughed up from the lungs when the disease in the latter organs is far advanced and the broken-down tissue is discharging into some air tube.

If, as seems very probable, infection of the glands of the head is to be ascribed largely to those tubercle bacilli which are taken into the mouth with the food, the source of the bacilli may be looked for in the milk or in the tuberculous discharges from nose and vagina, which cattle may take into their mouth when they lick one another. The food may also be infected with these discharges.

Tuberculosis of these glands always forms a prominent feature of the bovine disease. In Herd I (Table I, p. 139) the retropharyngeal glands were diseased in 9 out of 60 animals. In 5 of these no other focus of disease could be found. Of the remaining four cases two were probably secondarily infected with tubercle bacilli discharged from softened foci in the lungs. In Herd II (Table II) the percentage of cases with tuberculosis of the glands of the head is very high. An analysis of the lesions found in the lungs indicates that perhaps a few may have been infected secondarily from bacilli discharged from ruptured foci in the lungs. Again in Herd V (Table IV) the infection of the lymph glands of the head stands out prominently.

Tuberculosis of the retropharyngeal glands may become serious by

impeding respiration and deglutition. An examination of Plate V will show that any enlargement of these glands will diminish the size of the pharynx. When they become very large and are associated with enlarged, diseased tonsils, the difficulty in breathing may become very great by the encroachment of the passage from two directions. Case H, page 143, is a good illustration of this condition. Though the animal breathed with difficulty and was emaciated, the only serious tuberculous lesions existed in the throat glands and the tonsils. Those in the chest were trifling. In cow No. 292 (Table V) one of the retropharyngeals measured 5 by 4 by 3 inches, the dimensions of the normal gland of the opposite side being $1\frac{1}{2}$ by 1 by $\frac{1}{4}$ inch, or only one one hundred and sixtieth of the volume of the tuberculous gland. A minute opening from this gland through the mucosa of the roof of the nasal passage was found, through which putrefactive bacteria had entered, and the disintegrated tuberculous tissue was discharging outward. The enormous gland had greatly encroached on the space of the pharynx and the epiglottis was displaced so as to appear obliquely placed. A serious result of this condition was the presence of small pneumonic foci in the lungs, due to the aspiration of foreign particles. The impaired swallowing permitted such particles to enter the trachea. In the minute plugged air tubes of the affected lobules, vegetable fibers were found completely encrusted with leucocytes. Only traces of tuberculosis were found in the lungs and one gland in the mesentery was affected. The visible signs of disease in this animal may thus be attributed exclusively to the enormous throat gland.

The comparative frequency of tuberculosis of the glands of the head in the herds examined by the writer does not appear to be paralleled in other countries. The latest most extensive figures of Fischöder include only 6 cases of tuberculous "cervical glands" out of 600, or but 1 per cent. This small percentage it is hard to account for.

PRIMARY TUBERCULOSIS OF THE MESENTERIC GLANDS, THE INTESTINES, AND THE LIVER.

The glands within the layers of the mesentery are very frequently the seat of tuberculous lesions. A glance at the tables is sufficient to show this. In nearly all cases the evidence is pretty positive that the tubercle bacilli were absorbed from the contents of the intestines and not from the circulating blood. They must, therefore, have passed through the stomachs with the food and resisted the destructive action of the digestive process. When we come to analyze this mode of infection more minutely the source of the infectious material is not always recognizable with certainty, since disease of the mesenteric glands is rarely seen by itself, other foci being in almost every case associated with it. In the cases summarized in Tables I to V, only one animal is shown to have exclusively disease of the mesenteric glands and of the

liver (No. 333 in Table I). In all the remaining cases there are tuberculous foci either in the lungs themselves or in pulmonary lymph glands, which indicate infection through the inspired air as well. These cases range themselves in two groups, those in which the lungs themselves are affected, and those in which only the pulmonary glands are diseased. In the former group of cases the tubercle bacilli may have been coughed up from the disintegrating foci in the lung tissue, swallowed and absorbed from the intestines into the mesenteric glands. In the latter group this could not occur because the tubercle bacilli are locked up in the lymph glands of the thorax. In this group, therefore, the infection of the digestive tract must be regarded as independent of the lung infection.*

A careful examination of the autopsy notes of herd I (pp. 31 to 59) will show that even in many cases of pulmonary disease, either the lesions are not far enough advanced to account for the disease of the mesenteric glands, or else the stage of disease in the latter is as old as, or perhaps older, than the lung disease. Hence we may safely affirm that in many cases of tuberculosis the animals have both inhaled and ingested the tubercle bacilli, thus starting at the same or at different times, two independent foci of disease.

Tuberculosis of the mucous membrane of the intestines is very rare. The writer very carefully examined the digestive tract of the animals included in Table I without finding tuberculous changes in the mucous membrane, with the exception of one advanced case (No. 338), in which there was evidently an abundant discharge of tubercle bacilli from the lungs. In this case, which was near the point of death, all Peyer's patches of the small intestine were extensively infiltrated with tubercles. (See p. 124 for worm tubercles vs. genuine tubercles).

In the animals included in the other tables, no systematic examination of the intestines was made, i. e., the tube was slit up throughout its extent in only a few cases, but the serous surface was more or less carefully inspected to note any signs of disease in Peyer's patches.

The presence of tubercle bacilli in the liver may manifest itself by tuberculous foci in the liver tissue, or what is more common, by tuberculosis of the lymph glands situated in the portal fissure, and denominated portal glands in the tables. An inspection of these will show, out of 123 tabulated cases, 29 with tuberculous portal glands. Of these, 12 have deposits in the liver at the same time. Three have disease of the latter without corresponding infection of the glands. Hence, in determining the presence or absence of infection of the portal system the portal glands must be carefully searched for tubercles.

Tuberculosis of the liver is probably, in most cases, a result of food infection. This is made evident by the fact that in most cases of liver tuberculosis the mesenteric glands are also diseased. In the 29 cases

*Nos. 346, 348, 355, 358 in Table I; Nos. 599 in Table II; J in Table III.

tabulated all but 4 are associated with disease of the mesenteric glands. Of these four one is associated with disease of throat glands, also indicative of food infection. In the three cases remaining the disease may be secondary to lung disease in one and primary in two.

The sources of the bacilli which enter the portal system may be several. The bacilli may be absorbed directly from the mucous membrane of the intestines into the venous radicles of the portal system. They may also pass from some focus in the mesenteric gland into the portal system. In either case the original source is the contents of the intestines. Primary infection of the liver during fetal life will be discussed further on.

OTHER ORGANS WHICH MAY BE PRIMARILY DISEASED.

We have seen that the primary foci of infection are in the great majority of cases situated (1) in the lungs or the bronchial and mediastinal glands, and (2) in the glands of the neck and head, the mesenteric glands, the portal glands, and in the substance of the liver. The first indicate infection through the inspired air, the second through the food. Of the other seats of primary disease only the udder and the genital organs (the uterus) come into consideration. Bang* is inclined to believe that tuberculosis of the udder does now and then appear primarily in animals which are in very good condition. A case recently examined is of interest in this connection.

A large Jersey cow, registered, 6 years old, kept in a large herd under very good sanitary conditions, has had some trouble with the right half of the udder for two years. During this time only the anterior quarter of this side was milked. At the beginning of this year (1894) she gave birth to a calf, but "did not clean well." She was killed in April, although in very good condition at the time if we except the vaginal discharge. The affected half of the udder was uniformly larger than the secreting half and very firm. The autopsy showed the following conditions:

The right half of the udder with the exception of a narrow anterior segment was involved uniformly in tuberculosis The cut surface had a mottled pink and pale yellowish appearance throughout. A few circumscribed areas were somewhat further advanced in caseation, for they appeared more uniformly opaque, yellowish, the pinkish element having disappeared. No old focus of disease could be found in the udder from which a dissemination of the virus into the surroundings could be inferred to have taken place. Cover-glass preparations made by gently scraping the cut surface and rubbing the material so obtained on slides showed many tubercle bacilli. Sections of the organ hardened in alcohol were equally conclusive as to the nature of the affection. Every acinus was the seat of one or more tubercles. In some a

* Deutsche Zt-chr. f. Thiermed., xi (1884), p. 45.

little of the secreting epithelium was still left; in others it had been completely crowded out by the neoplasms. In only a small percentage of the tubercles was the center necrosed. Tubercle bacilli were very abundant, both in the numerous giant cells and in the peripheral zones of each tubercle. The pubic lymph glands in this animal were very much enlarged and contained minute, isolated, and confluent necrotic foci. Tuberculosis was detected in other organs, as shown in the following post-mortem notes, dictated by the writer:

Both retropharyngeal glands contain small foci of tuberculosis of recent origin. In both principal lobes of the lungs there are a considerable number of foci, involving each one or more lobules. Some are uniformly necrotic, but not softened; others are composed of groups of isolated tubercles. In the smaller lobes a small number of similar foci exist. The large mediastinal gland is 4 by 2 by 3 inches in size. It contains large yellowish, partly calcareous foci. Left bronchial gland, about 2 inches in diameter, in the same condition.

A whitish pasty exudate in one horn of the uterus, the walls of which are nearly half an inch thick and contain small caseous foci. Tuberculosis determined in sections of hardened tissue.

This case is peculiarly interesting on account of the extensive tuberculous infiltration of the udder. Was it infected from without or through the blood? The most reasonable explanation seems to be the latter. The disease in the lungs, the uterus, and the udder was, according to microscopic examination, in about the same stage. That of the mediastinal glands was in a more advanced stage. The probability is that, during the violent disturbance occasioned by the birth of the calf, tubercle bacilli were carried into the circulation from the older focus in the mediastinal glands. They lodged and subsequently multiplied in the organs mentioned. The uniform diffusion of the disease in the udder might be explained by a rapid disintegration of some small foci and the downward dissemination of the tubercle bacilli through the milk ducts.

Another hypothesis entertained by the writer was the infection of the udder from without through the milk ducts. This would appear well nigh impossible in an udder milked twice a day, by which process all entering tubercle bacilli would be washed out promptly. Considering, however, that in this animal the affected quarter had not given milk for two years, we can not rely on the washing out of the ducts in this instance. Another question naturally arises in this connection, whether tubercle bacilli are capable of growing along a milk duct in competition with other bacteria. We know that they are often present in enormous numbers in necrotic tissue, but whether they may live in the secretions of a mucous surface so as to become disseminated is open to serious doubt when we bear in mind their peculiar parasitism.

Another mode of entrance would be through injuries of the udder itself. If the injury were deep enough the bacilli might be deposited directly in the gland tissue, but a mere abrasion is hardly a suitable place of entry. In deep lacerations the tubercle bacilli would very probably have to compete with pyogenic bacteria introduced at the same time.

The whole subject of udder tuberculosis needs more careful study, especially with reference to the question of primary infection. This question is of great importance because a primary infection would be all the more dangerous since it might be associated with an otherwise healthy organism and thus ward off suspicion until much damage has been done by the milk.

Primary infection of the uterus from without could hardly take place excepting during copulation. The bull may carry tubercle bacilli from one cow to another without necessarily being diseased himself, as in the case of tuberculosis of the uterus associated with vaginal discharge. In case the genital organs of the bull are affected the transmission of tuberculosis to the cow is easily understood. Nevertheless, primary tuberculosis of the uterus does not appear to be very common. In most cases with diseases of this organ, the infection may be traced to some other preëxisting focus in the same animal. Local infection of the bull from the cow seems to be comparatively rare in spite of the fact that tuberculous lesions of the uterus associated with the discharge of tubercle bacilli in catarrhal secretions are not infrequent. Even tuberculosis of the vagina and vulva have been reported.*

An interesting case of probable infection through the genital organs is No. 634, in Table II. A bull calf about 8 months old, which had given a reaction after the injection of tuberculin, was killed and carefully examined. Only one focus of disease was found. The pubic glands were enlarged and studded with yellowish tubercles. Since there was no other primary focus in the body, no indication of generalized infection, the only explanation left was the contraction of the disease from some cow with tuberculous uterus. The bacilli were absorbed from the external genital organs and deposited in the corresponding lymph glands.

A case of primary tuberculosis of the penis in a bull was reported by A. Eber† several years ago.

THE RELATION OF THE LYMPHATIC SYSTEM TO THE PRIMARY SEAT OF TUBERCULOSIS IN CATTLE.

In the preceding chapter it was pointed out that a large proportion of the cases in which tuberculosis was either in an incipient stage, or else restricted to a single focus, the lesions were found in the lymphatic glands, which drain certain organs exposed to infection and not in these organs themselves, and it has been tacitly assumed that the tubercle bacilli passed through these organs into the respective lymph glands without leaving any trace of disease behind.

Thus in infection by way of the lungs the tubercle bacilli pass through the tissues of the parenchyma, and are carried in the lymph

* Deutsche Zeitschrift f. Thiermedicin, XVIII (1891), p. 195.

† *Loc. cit.*, p. 188.

channels to the corresponding lymph glands. In infection by way of the intestines, the tubercle bacilli pass through the mucous membrane into the mesenteric glands, or by way of the portal system, into the liver. The same may be said of the mouth and nose. The bacilli deposited on the mucous membrane are carried into the lymph glands without causing any visible lesion of the mucous membrane. These conditions hold for only a portion of the cases which come under observation, for in the remainder the parenchyma of the organs is involved in the disease. In some of these cases, however, there still remains the question whether the earliest lesions may not have been limited to the lymph glands.

That tubercle bacilli may pass into the lymph channels of organs without leaving in the latter any trace of disease was first distinctly pointed out by Weigert* with regard to tuberculosis in children. He called attention to the fact that tubercle bacilli may enter the mouth, the lungs, and the intestines, and affect the respective lymph glands without first causing disease of these organs. In case of the lungs, secondary infection may take place later on from the lymph glands by contiguity. He furthermore pointed out that scrofula in children is explained by the absorption of tubercle baciili from the mouth and their retention and multiplication in the glands of the neck. In adults the reverse is usually true. The parenchyma of the organs becomes affected first, and the lymph glands afterwards.

Bollinger† likewise admits the absorption of tubercle bacilli without the appearance of a local lesion.

Veterinary pathologists have also called attention to this peculiar behavior of tubercle bacilli. Hartenstein‡ speaks of the lymph glands as excellent reagents for the presence of tubercle bacilli in the body Eber-Johne§ and Rieck‖ also refer to the restricted localization of tubercle bacilli in the lymph glands. Baumgarten,¶ on the other hand, maintains the position that tubercle bacilli can not pass any organ or mucous membrane without causing tuberculous lesions at the place of entry.

Tangl,** working on this theme at his suggestion, comes to the same conclusion. The latter found that in guinea pigs the application of tubercle bacilli to the uninjured conjunctiva produced at first local and subsequently generalized tuberculosis. In rabbits, on the other hand, neither local nor subsequently general tuberculosis was produced. The

* Jahrbuch für Kinderheilkunde, XXI (1884).

† Tenth International Congress at Berlin, 1890.

‡ Archiv f. wiss u. prakt. Thierheilkunde XVI (1890), S. 354.

§ Encyklopädie d. gesammt. Thierheilkunde (Article Tuberculosis).

‖ Archiv f. wiss. u. prakt. Thierheilkunde, XIX (1893), S. 1.

¶ Pathologische Mykologie. Arbeiten a. d. path-anatom. Institut zu Tübingen. I. Ueber experimentelle congenitale Tuberkulose.

** Centrablatt für allgemeine Pathologie, I (1890), S. 763.

experimental observations of Dobroklonski* do not appear to give much support to Baumgarten's view. He fed guinea pigs with a few drops of pure cultures of tubercle bacilli and studied the mucous membrane of the intestines at different intervals. He found that, although the epithelium remained intact, the solitary and agminated follicles, or Peyer's patches, soon began to show signs of disease. The tuberculous changes might also, though very rarely, take place in the subepithelial layer of the mucosa. The rapidity with which the bacilli penetrated into the lymphatic system was demonstrated by the fact that tubercle bacilli were found as early as the fourth day in the mesenteric glands, and that the tubercles appeared as soon in these glands as in the lymph follicles of the intestine.

Whichever view we may adopt, the fact remains, that in a very large number of cases of bovine tuberculosis in the earlier stages a most careful scrutiny reveals only disease of the lymph glands. If the bacilli do cause disease of the lungs on their way to the thoracic glands the lesion remains invisible to the naked eye and heals up. The same may be said of the intestines and mucous membrane of the mouth and nose.

DISSEMINATION OF TUBERCLE BACILLI WITHIN THE BODY FROM THE PRIMARY FOCUS.

After the lodgment of tubercle bacilli in the primary focus, where their multiplication stimulates the formation of the neoplasms or tubercles peculiar to this malady, the disease may after a time become stationary and the tuberculous products finally undergo calcification. In most cases, however, the disease, after being purely local for a time, and not disturbing the normal functions of the animal to any recognizable degree, spreads from the original focus more or less rapidly and invades the more organs and structures the longer the life of the affected animal. The courses which the virus takes in moving from the primary focus or foci to establish new centers are subject to much puzzling variation and have been the subject of much investigation and speculation. The development of the meat-inspection service in Germany has stimulated discussion in this field perhaps more than in any other connected with bovine tuberculosis.† In general the tubercle bacilli may be disseminated either by the lymph or the blood channels or by both combined. To these may be added the dissemination by contiguity, which is probably responsible for most forms of tuberculosis of the serous membranes (pearly disease). Inasmuch as this is a very important type of the disease we will discuss it by itself first.

*Archives de Médecine expérimentale, II (1890), p. 253.

†Those who would pursue this phase of the subject are referred to the writings of Ostertag, Schmidt-Mühlheim, Hartenstein, and those of Carl Weigert for human tuberculosis.

This form of the disease, if such it may be justly called, has always created more or less interest, largely owing to the very remarkable growths produced on parts of the body at once exposed to view when the carcass is opened. Formerly it was customary to consider tuberculosis of the organs and tuberculosis of the serous membranes (pleura, pericardium, peritoneum) as more or less distinct, although associated forms, of disease. This view is gradually giving way as our knowledge of the progress of the disease in the body is becoming more thorough. Rieck,* with reference to this same subject, says that former statistics which maintain that there is a large number of cases of tuberculosis of the serous membranes exclusively must rest upon partial examination. He himself states that in all of the many cases examined by him at the Leipsic abattoir pearly disease was associated either with tuberculosis of the bronchial, mediastinal, or mesenteric lymph glands.

So far as the writer's observations have gone they fully confirm Rieck's statement that tuberculosis of the serous membranes is not primary. In the 53 tuberculous animals of the herd in Table I tuberculosis of the serous membrane was observed but three times. In one case (No. 338) it was associated with widely disseminated and severe lesions of the lungs and lymphatic apparatus. In the second case (No. 314) the costal pleura was affected by contiguity from a large pulmonary focus, and in the third case (No. 343) the abdominal diaphragm was studded with tubercles which were secondary to disease of the thoracic glands.

In the cases presented in the other tables tuberculosis of the serous membranes is also associated with glandular tuberculosis.

The very small percentage of cases in which the serous membranes were found diseased by the writer, and the absence of any primary infection of these membranes, are facts significant in confirming Rieck's statement that tuberculosis of the serous membranes is quite a secondary phenomenon and does not deserve the attention which has been accorded to it up to the present. It is probably never present in incipient cases or in such as have been healed or become stationary in the earliest stages. If tuberculosis of the pleura or peritoneum is found it should be regarded as an indication that further search be made, especially in the thoracic and the mesenteric glands, for the seat of primary infection.

In the many isolated cases of advanced tuberculosis examined during the past five or six years by the writer tuberculosis of the serous membranes was never absent. Sooner or later these membranes become the seat of a more or less extensive tubercle eruption. This may occur when the disease travels by contiguity, as from lung tissue to pulmonary pleura, and thence to the costal pleura, to which the diseased pulmonary pleura soon become adherent. Or it may be due to a

*Archiv f. wiss. u. prakt. Thierheilkunde, XIX (1893) S. 1.

backward flow of lymph, an occurrence confirmed, in the writer's opinion, by case No. 343, p. 48. In this animal there were several tuberculous foci in the lungs but no pleural tubercles. The posterior mediastinal and the bronchial glands were at least as large as fists (one mediastinal 8 by 5 inches) and consisted mainly of sacs of partly cheesy, partly puriform matter. The large caudal mediastinal gland was least affected. Curiously enough the abdominal aspect of the diaphragm was studded with a considerable number of flattish, rather large, sessile, tuberculous masses. An adhesion between the diaphragm had led to the formation of a similar mass on the capsule of the liver. Between this and the diaphragm the adhesion had expanded into a very delicate false ligament, on the free margin of which were several tuberculous masses.

The infection of the peritoneal surface of the diaphragm must have originated in this case from the lymphatic glands of the thorax, which receive the lymphatics of the diaphragm. The capsule of the liver was infected by contiguity for the parenchyma and the portal glands were normal. The mesenteric glands likewise were free from disease, hence the intestinal origin of the infection must be excluded. The tubercle bacilli could not have traveled through the diaphragm from the pleural side, for there was no disease of the pleura. There seems to be no other explanation than that the tubercle bacilli were forced back from the greatly enlarged, tuberculous, lymphatic glands of the posterior mediastinum into the lymph channels, which have their roots in the diaphragm. The possibility of such a retrograde movement of tubercle bacilli or cells containing them is made evident when we bear in mind the peculiar conditions. The bronchial and mediastinal glands were very large, one alone as large as a child's head. The filling up of much of the available thoracic space by these glands must have led during paroxysms of coughing to a considerable positive pressure within the cavity of the thorax, by which lymph may have been forced back into the peritoneal cavity. This mode of distribution of the tubercular virus may perhaps be not so rare as would appear at first thought, and it may be that a careful examination of a large number of animals in which the disease is still more or less restricted to the thorax will demonstrate occasional infection of the serous membranes in this way.

These observations, added to those of Rieck, go far toward proving that what has been called pearly disease in cattle is nothing more than a manifestation of a more or less advanced stage of tuberculosis of certain organs, especially the lymph glands, from whence it has overflowed, as it were, through the lymphatic system. This condition may be brought about, at least in part, by a marked resistance of certain organs of the bovine organism to tuberculosis. The lymphatic system offering least resistance becomes the seat of a chronic, prolonged disease process, in which the serous membranes, after a time, take part. This marked localization of the process is well exemplified in No. 338.

Besides the lungs no other organ was attacked by visible tuberculous changes. The disease was restricted to the lymphatic system, including the large serous cavities and, lastly, Peyer's patches of the small intestine.

We may then summarize the ways in which tuberculosis of the serous membranes takes place as follows: (1) By escape of bacilli from some focus of disease situated under one of the serous coverings, such as lungs, liver, intestines, and associated lymph glands. If many bacilli enter a serous cavity an extensive eruption of tubercles is likely to appear in the peritoneum, chiefly on the omentum; in the thorax, mainly on the dependent portion of the lungs. (2) By an accidental temporary reversion of the lymph current by which bacilli may be carried backward from the diseased gland. (3) The disease may travel from pleura to peritoneum and from peritoneum to pleura by a simple growth of the tubercles through the diaphragm (Weigert).

Tuberculosis of the serous membranes seems to cause least damage to the animals affected, if we are to judge from occasional autopsies, in which an enormous number of tubercles on these membranes may be compatible with a very fair condition of the animal, provided organs like lungs and liver are not seriously involved at the same time. There is, of course, more or less encroachment of space and perhaps considerable impediment to the normal gliding of organs on neighboring structures. A case of this kind is found on Table II (No. 590). On opening the abdominal and thoracic cavities an exceedingly extensive eruption of tubercles was found on peritoneum, pleura, pericardium, and epicardium. The impression conveyed by this appearance was of extensive organic disease. This was not the case, however. In the head the submaxillary and retropharyngeal glands were badly diseased, but in the thorax the lungs were free, in spite of the pleural affection, and the disease was restricted to the large mediastinal gland. In the abdomen the peritoneal disease had invaded the uterus. The mesenteric and lymphatic glands were affected and the serous covering of the liver was studded with tubercles, but there was no disease of the parenchyma of the liver, spleen, or kidneys. In this case the pearly disease may have started from a tuberculous mesenteric gland.

It does not appear probable, from observations made at autopsies, that organs are invaded to any extent by tuberculosis starting on their serous covering. There is, however, one important exception. Tuberculosis of the Fallopian tubes and of the uterus appears to be largely an extension of the disease by contiguity from the peritoneal covering of these and adjacent organs.

DISSEMINATION OF TUBERCLE BACILLI IN THE LYMPH CHANNELS.

The spreading of tuberculous lesions from one gland to another in the direction of the lymph stream is frequently observed. The progress,

however, seems to be so slow that this mode is frequently overtaken by others and the animal succumbs before much progress is made.

Successive infection of the glands of the head and neck is now and then noticed. In No. 611 (Table II) all the glands of only one side of the head (left parotid, submaxillary, retropharyngeal, and post maxillary) were diseased, those of the other side healthy. In another case not tabulated the infection could be traced from the glands of the head to those at the root of the neck. In No. 292 (Table V) the right retropharyngeal and post maxillary glands and the right tonsil were diseased, the corresponding structures on the left side normal.

In tuberculosis of the mesenteric glands the bacilli may, as has been stated, become diffused over the peritoneum or, what is more probable, carried into the thoracic duct.

In tuberculosis of the liver the tubercle bacilli are usually carried into the portal lymph glands at the hilus. They may also be carried through the lymph channels, which are said to pass from the liver into the thoracic cavity. Here they would probably be deposited in the large caudal mediastinal gland. This mode of infection of the mediastinal gland is probably extremely rare. For in incipient cases the mediastinal glands are in many cases diseased and the liver free. On the other hand, the liver may be extensively diseased, but the mediastinals free (No. 333, p. 43).

While tubercle bacilli appear to be usually carried in lymph channels with the current, one case of evidently retrograde movement of the tubercle bacilli has been noticed and already referred to on page 111.

DISSEMINATION OF TUBERCLE BACILLI THROUGH THE BLOOD (GENERALIZED INFECTION).

The virus of tuberculosis does not vegetate in the blood. Its presence in this fluid is accidental, due to the rupture of a caseous focus into some blood vessel, or into lymph channels (right and left thoracic ducts) emptying directly into the blood stream. The disease is therefore, as a rule, pretty generally distributed by repeated primary infection, by the lymphatic system and by auto-infection before indications of blood infection are manifest. Even after tubercle bacilli have entered the circulation they are speedily fixed in the parenchyma of the various organs, so that unless there is a continual discharge of tubercle bacilli into the blood from some focus of disease the blood infection is very temporary.

Infection of the blood may occur repeatedly in the more advanced stages of tuberculosis. Comparative pathologists have for convenience adopted two designations for two somewhat different forms of the generalized disease. When the blood has been infected with only a small number of tubercle bacilli, foci may be found scattered through the body, but only in small numbers. This condition has been denomi-

nated by Ostertag as chronic generalized tuberculosis. When a large number of bacilli have escaped into the circulation and an eruption of a large number of tubercles appears in various organs, such as kidneys, spleen, and liver, the disease has been called acute, generalized tuberculosis. The chronic form with occasional tuberculous foci in the parenchyma of organs or the glands associated therewith is not uncommon; the acute form, however, at least in that stage in which numerous tubercles are visible to the unaided eyes within the spleen, liver, and kidneys, is quite rare. The chronic form is seen chiefly in old cows which have struggled with tuberculosis for many years and in which, during this long period, there has been perhaps one, perhaps more temporary entries of tubercle bacilli into the circulation. It is now and then seen in comparatively young animals.

The parenchyma of the liver, spleen, and kidneys appears to be more or less opposed to the multiplication of tubercle bacilli, for even when there has been blood infection at some time the tubercle bacilli may leave these organs where they have been deposited by the blood stream and pass by way of the lymph channels into the lymph glands belonging to such organs, where the destructive process assumes proportions soon visible to the unaided eye. Hence, in endeavoring to trace any generalized infection, the lymph glands of such organs as the kidneys should always be examined. It is this fact which led Hartenstein to regard the lymph glands as the best (and often the only) reagents for the presence of tuberculosis in cattle. That generalized infection may have occurred without being recognizable to the unaided eye is proved by case No. 233 reported in Bulletin No. 3, page 62. The milk of this animal contained tubercle bacilli shortly before death. The udder was free, but in the pubic glands a few small yellow tubercles were found. In a fresh section of liver tissue giant cells were observed, and when subsequently sections of hardened tissue were examined numerous beginning foci of disease were found, each consisting of one or two giant cells embedded in a slight zone of round cells and containing tubercle bacilli.

Generalized infection may thus be recognized by the discovery of foci of disease in organs not accessible to the virus in any other way than through the circulation, or in the lymph glands of such organs. Tuberculosis of the subcutaneous lymph glands and of those situated in the muscular tissue of the trunk and limbs is universally accepted as indicative of the generalized disease. Such glands may be infected from without, but infection through wounds of the skin is probably quite rare.

The terms blood infection and generalized infection are not directly synonymous and require further definition. When tubercle bacilli enter the portal circulation from the digestive tract, they are carried into the liver where they may all be filtered out and fixed. Should they pass into the hepatic circulation they may reach the right side of the heart

and thence be distributed through the lungs. In order that they may gain the general or systemic circulation they must pass through the capillaries of the lungs to reach the left side of the heart. Hence we may have a local infection of the portal circulation, as well as of the pulmonary circulation without infection of the blood going to the whole body. When tubercle bacilli enter the thoracic duct from diseased glands of the abdomen or thorax, they enter the venous system and therefore they must first run the gauntlet of the capillary system of the lungs before they may enter the general circulation. The condition most favorable to infection of the entire body is tuberculosis of the lungs with discharge of tubercle bacilli into any branch of the pulmonary vein. They will then pass directly to the left side of the heart to be distributed over the entire body. Should tuberculous foci break into arteries the conditions would be somewhat different and their consequences easily traced. Their denser coat probably prevents this accident from occurring.*

Generalized infection has been quite frequently observed at German abattoirs. Referring to our own cases in Tables I, II, and III, and excluding those on Tables IV and V as being mainly selected for their suspicious or bad condition, we have among the first lot of 108 animals 3 cases of generalized infection.† If we take those advanced cases given in Tables IV and V, exclusive of D and No. 237, not known to be tuberculous when killed, we have out of 12 cases 4 with generalized disease. This bears out the general assumption that, with rare exceptions, generalized disease appears late in the course of the disease.

Generalized infection, both chronic and acute, has received considerable attention, especially by German authorities, because of its important bearing on the infectiousness of meat and milk. Infection of the bony and muscular tissue, and more particularly the lymph glands embedded in them, is regarded as of sufficient gravity by the German meat-inspection authorities to forbid the utilization of the meat of such animals, excepting after it has been cooked under the direction of these authorities. Since tuberculosis of the bones and muscular tissue, or of the glands embedded in them, is possible only after the virus of tuberculosis has been transmitted in the blood, generalized infection manifesting itself in any part of the body throws suspicion on the meat.

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*The immunity, as it were, of at least the larger arteries, owing to the denser structure of their walls, is very well shown in contagious bovine pleuropneumonia. In this disease the coats of the pulmonary veins embedded in the diseased region are frequently penetrated by cell infiltration from the surrounding connective tissue. This leads to inflammation of the intima and thrombosis. In the arteries, on the other hand, thrombi are not found.

†The diagnosis in one of these cases (No. 303, page 32) is based on the presence of old tuberculous deposits in the udder (pubic) lymph glands. Inasmuch as the infection may have come from without through the udder (although this the writer is not inclined to believe), blood infection in this case is somewhat doubtful.

Generalized infection is furthermore of great importance in its bearing on the infection of milk. The possibility of udder infection from without being conceded, we nevertheless find that most of the udder tuberculosis encountered is a result of blood infection. The tubercle bacilli are carried from some internal focus by way of the blood into the udder. Hence, in all cases of generalized disease, the milk should be regarded as dangerous. The difficulty from the practical standpoint lies in the recognition of such generalized infection during life. With the meat the question is simple enough and resolves itself into the thorough inspection of every carcass at the abattoir by a trained inspector. With the living animal we have only a few guides, such as the condition of the udder (pubic) lymph glands or the enlargement of some of the superficial lymph glands, such as those of the shoulder and flank. But even these guides are untrustworthy and liable to lead to erroneous inference at any time. This question of the relation of tuberculosis to the public health is too broad a one to be discussed here and it has been referred to simply to call attention to the important practical bearing of blood infection in tuberculosis.

INFECTION OF ANIMALS BY THEIR OWN TUBERCULOUS DISCHARGES (AUTO-INFECTION).

Cattle may become reinfected by their own tuberculous discharges and thereby materially hasten the dissemination of the disease in their own bodies. Perhaps the most common process of reinfection is the swallowing of tubercle bacilli which have been coughed up from some disintegrating focus in the lung tissue. Tubercle bacilli coughed up in this way frequently produce more or less extensive tuberculosis of the bronchial tubes, the trachea, and the larynx. It has already been stated that tuberculous lesions of these structures have not been observed excepting where the lung tissue itself is involved and the disintegrated tissue is breaking into an air tube. The inference that infection of the air tubes is secondary to the lung lesion, is, therefore, justifiable. The tubercle bacilli coughed up may further infect the tonsils and lymph glands of the head and neck. When they are swallowed tuberculosis of the digestive tract and the liver may follow as with primary infection from without and simulate an infection of the food.

To what extent such auto-infection actually takes place it is impossible to estimate, for any infection which has produced lesions within the reach of the digestive tract may have come from without as well as from the lungs. It is probably of little significance when the discharged material from the lungs is slight in amount. When it becomes very abundant there may be extensive secondary disease of the intestines, as in the case of No. 338 (page 46), in which the Peyer's patches of the small intestine were completely infiltrated with tubercles.

A consideration which complicates any estimate of secondary infection is the varying susceptibility of different organs to infection with age. The writer is inclined to the view that the region of the throat and that of the small intestine are more likely to absorb tubercle bacilli early in life than later on, while the lungs seem to become with age the preferred seat of the disease. The demonstration of this assumption is complicated by the fact that calves are more exposed to food infection than adult animals, because of the dangers of tubercle bacilli in the milk. One point in favor of the increased immunity of the digestive tract later in life is indicated by the absence of lesions in those animals in which there is manifestly a discharge of tubercle bacilli from the lungs. This is borne out by the cases included in Table I, in which throat infection and lung infection are usually not associated together. The whole subject is a difficult one and not of sufficient economic importance at the present time to deserve much attention on our part. Of more importance is the possible infection of the udder, through the teats, from discharges of the same animal, especially the vaginal discharges when tuberculosis of the uterus is present.

HEREDITY AND TUBERCULOSIS.

The transmission of the bacillus of tuberculosis from the parents to the offspring before birth must be clearly distinguished from the transmission of certain bodily conditions which favor the multiplication of tubercle bacilli after infection.

The slow insidious progress of this disease in the infected body, its apparent disappearance and subsequent reappearance after variable periods of time, together with the somewhat peculiar modes of dissemination of the bacilli within the body have made the investigation of this subject unusually difficult. There are some pathologists who claim that much of this disease is contracted before birth. The majority of authorities are, however, inclined to the view that only very few cases are the result of transmission before birth and that infection after birth is the rule.

This subject is of special importance to us, for it is highly desirable to know to what extent animals are born with the disease and under what circumstances the transmission of the virus before birth is likely to take place. A tuberculous calf is more dangerous than a tuberculous cow, because it may carry foci of disease in the udder even before this organ begins to secrete.

The tubercle bacillus may be conceived of as passing from parent to offspring in several ways:

(1) It may pass in the semen of the male and infect the ovum directly.

(2) The ovum may be infected by disease of surrounding structures (peritoneum, ovaries, Fallopian tubes) in the female.

(3) The fetus may be infected by the passage of tubercle bacilli from the maternal placenta into the fetal circulation.

As regards the two first-mentioned ways little need be said. As shown by A. Gærtner,* the possibility of a direct transmission of tubercle bacilli from father to offspring is so slight that it need hardly be taken into consideration. On the other hand, it has been shown by Gærtner that tubercle bacilli may pass from the mother into the ovum, but this mode of infection must likewise be regarded as very rare.

The infection through the placenta is probably the most frequent cause of congenital tuberculosis. It may take place when, in consequence of generalized tuberculosis of the mother, tubercle bacilli are in the circulation and become lodged in the placenta, whence, through some ruptured vessel, they may pass into the blood of the fetus. The same is perhaps even more likely to occur when the uterus has become the seat of tuberculous changes either secondarily or primarily through infection. To what extent tuberculosis of this organ must have progressed before conception ceases or the fruit fails to mature seems not to be known.

It may be considered as definitely settled by experiment and observation that the bacilli may pass from the mother to the fetus under certain conditions. The differences of opinion refer merely to the relative frequency of its occurrence. Baumgarten claims that with most cases of tuberculosis among human beings the disease begins before birth and is thus "inherited." Gærtner,† after thoroughly sifting the whole subject and enriching it with experiments of his own, comes to the conclusion that in the human subject the tubercle bacillus frequently passes from the mother to the fetus. He does not, however, take the extreme position held by Baumgarten.

It remains for us to consider how frequently calves are born with tuberculosis. Only a small number of cases of congenital tuberculosis have been reported. Of these a few deserve mention.

In 1885 Johne‡ found tuberculous lesions in the liver, portal glands, lungs, and bronchial glands of a fetus 8 months old. The mother had been examined at the abattoir and found affected with advanced pulmonary tuberculosis.

Malvoz and Brouwier§ have reported two cases of congenital tuberculosis. In both the glands at the hilus of the liver, the liver tissue itself, and the glands at the hilus of the lungs contained tuberculous foci. The lungs themselves were intact.

Bang‖ found, in the course of extensive inquiries and personal obser-

* Ueber die Erblichkeit der Tuberculose. Zeitschrift für Hygiene, XIII (1893), p. 101–251.

†*Loc. cit.*

‡ Fortschritte der Medicin, 1885 p. 198.

§ Annal. de l'Institut Pasteur, 1889, p. 189.

‖ Deutsche Zeitschrift f. Thermedicin, XVI (1890), p. 409.

vations in Denmark, that congenital tuberculosis was not such a rare occurrence after all. He presents three cases examined by himself. In the first case, a calf born dead, the glands at the hilus of the liver contained cheesy-calcareous foci. In the second case, a calf presumably 2 days old, the liver, the bronchial, mediastinal, lumbar, and perhaps other lymph glands contained cheesy-calcareous deposits. A few were found in the lung tissue. In the third case, a calf about 14 days old, the liver, with portal glands, the lungs, with bronchial and mediastinal glands, and one kidney contained tuberculous lesions.

Lungwitz* found in a fetus about 6 months old tuberculous lesions in the lungs, liver, bronchial, mediastinal, mesenteric, and retroperitoneal lymph glands. The dam, about 10 years old, was affected with generalized tuberculosis, including tuberculosis of the uterus and placenta.

In a second case the dam, but 2 years old, was affected in the same way as the first mentioned. The fetus, about 4½ months old, was affected with generalized tuberculosis. Lesions were found in the liver, spleen, kidneys, lungs, and corresponding lymph glands. The author adds that in the Leipsic abattoir, where these cases were encountered, he and Rieck had examined in all about 200 fetuses, which came from diseased cows. The two cases reported were the only ones found. We have thus but 1 per cent of transmitted disease in case of 200 pregnant animals which failed to pass the inspection owing to advanced generalized disease.

Quite recently Bärlund† found two cases of congenital disease. Both calves were about a week old when killed. Calcified as well as fresh tubercles were found in the lungs and lymph glands of thorax.

The occurrence of infection before birth is thus positively established by these cases; but have we any reason to believe that much of the disease of later years is due to the transmission of tubercle bacilli in the uterus?

The answer to this question must be based mainly on pathological data obtainable by the thorough post-mortem examination of a large series of cases. Animals in which the disease is already well advanced are of but little service in the study of this question, since it is impossible to trace definitely the place in the body where the bacilli first began to multiply. The tuberculin tests furnish a considerable number of cases in which the disease is in its earlier stages and still restricted to one or more primary foci. To these we must look for aid in the solution of this problem.

If we examine such cases carefully we shall find that usually the lymph glands of the throat, the lungs, or the intestines are diseased. These glands have been described in detail and their mode of infection pointed out in a previous chapter. This consists in brief in the passage

* Archiv. f. wiss. u. prakt. Thierheilkunde, xx (1894), p. 204.

† Centralblatt f. Bakteriologie, xv (1894), p. 498.

of one or more tubercle bacilli through certain tissues and their lodgment and multiplication in the lymph glands into which the lymph of such tissues drains. This peculiar settling down of tubercle bacilli in case of so many infected animals in the glands which receive lymph from organs or membranes in direct contact with the outer world (food and air) is very good evidence that the tubercle bacilli are carried from without inward. If they had been deposited in these glands by means of the blood during the fetal period, the question arises why not in other glands which after generalized infection appear equally susceptible to disease?

In a large number of cases of incipient disease the mediastinal or the bronchial glands which receive lymph from the lungs are the only diseased organs. Why should the virus localize in these glands by preference unless they are the first places of deposit from the air drawn into the lungs.

There is every reason to believe that most of the tuberculosis of cattle is not transmitted at or before birth, but is contracted later on in life by contagion. Baumgarten, on the other hand, explains the isolated disease of the lymph glands as inherited, because tubercle bacilli, according to his views, can not enter the body without leaving some disease at the point of entry. This phase of the subject has already received some attention on page 108. We can not at present accept Baumgarten's theory, and believe that tubercle bacilli, may pass through the lungs, for instance, by way of the lymphatics into the lymph glands without causing visible disease of the lungs themselves. Bang,* on the other hand, is inclined to accept Baumgarten's view and to regard disease of the mediastinal glands as a result of congenital disease.

Not only does the location of the disease as stated above militate against this view, but the occurrence of gland tuberculosis three or more years after birth is quite common. Baumgarten would explain this as a kind of latency of the virus, but in many cases the disease in full-grown animals is still quite fresh. The writer recalls the case of a cow 7 years old in which the lesion was limited to one of the thoracic glands in the youngest stage recognizable. The tubercles were distinct as minute granulations, and under the microscope no necrosis could be detected.

If all the cases of tuberculosis of lymph glands were to be accounted for as the result of intrauterine infection nearly all bovine tuberculosis must be regarded as congenital.

Since the probability of an intrauterine infection of the posterior mediastinal glands is much greater than that of the throat or mesenteric glands, it is worth while to examine for a moment the ways in which the pulmonary glands may become infected from this direction. It is conceivable that tubercle bacilli may become lodged during intrauterine life in the mediastinal glands by taking the following courses:

* Deutsche Zeitchrift f. Thiermedicin, XVI (1890), p. 409.

(1) They may pass from the placenta directly into the right side of the heart through the ductus venosus and thence to the lungs. Here they may become filtered out of the blood and carried in the lymph channels into the mediastinal glands.

(2) They may pass through the liver first, thence through the heart, and then follow the course indicated under 1.

(3) They may pass into the liver, there become filtered out into the lymph channels, in which they may be carried through the diaphragm into the thoracic glands.

(4) They may be filtered out of the blood which passes through the mediastinal glands.

Of these channels the last is hardly to be thought of when we bear in mind what a minute percentage of the total blood passes through the mediastinal glands at any given moment. Why other equally susceptible glands should not become affected at the same time seems inconceivable. The third channel is so complicated that if it were actually followed we should also expect to find tuberculosis of the liver and the portal glands. The first and the second seem the most direct. As only a small portion of blood does not pass through the liver, we might expect to find the liver or its glands (portal) in nearly all cases of congenital disease affected together with the pulmonary glands. In the cases cited above all but Bärlund have reported tuberculous changes in the liver or its glands. In the tuberculosis of adult life we find much tuberculosis of the mediastinal glands without corresponding disease of the liver or its glands, a fact militating against the fœtal origin of the infection and in favor of inhalation as the real channel.

A further argument against the theory of congenital tuberculosis as a prominent factor is that drawn from statistics which demonstrates an increase of the number of infected animals with age. Any latency of the disease in calves is hardly acceptable, for it seems on the whole more rapidly fatal in the young than in the old.

The only fairly positive case of congenital tuberculosis which the writer has encountered is that of a Jersey calf whose history is worth recording here. The calf was born December 12, 1893. The mother was recognized as being ill three months before. Her udder was normal. After penning the calf with her and allowing it to take as much milk from the dam as it pleased for one month the dam was killed. The calf was killed when $4\frac{1}{4}$ months old. It was apparently in good health. The autopsy, however, revealed a case of extensive generalized tuberculosis.

Right knee fold gland contains a large caseous focus; left normal.

Left submaxillary gland contains a minute, entirely gritty focus, the right a large caseous-calcareous focus. The postmaxillary glands contain a few small foci.

Extensive tuberculous deposits on the costal and pulmonary pleura and on the pericardium. Great enlargement and necrosis of mediastinal and bronchial glands.

In the lung tissue a small number of recently necrosed foci one-half to three-fourths inch in diameter.

A few tubercles on omentum. The portal glands as large as hen's eggs, completely necrotic, with much embedded calcareous matter. In the liver only a few small (one-eighth to one-half inch) foci. On the capsule a few flattish excrescences. In the spleen some necrotic tubercles one-fourth inch in diameter. One flattish tubercle on capsule.

Renal glands tuberculous.

Mesenteric glands varying in size up to hen's eggs; completely necrotic, with calcareous particles.

While it is not to be denied that this calf may have contracted the disease through the milk, yet the writer is inclined to look upon the disease as contracted from the mother before birth, since the extent of the disease is hardly explainable in any other way. The writer has also seen several other cases of disease in animals not over 2 years old in which the generalized infection, with but slight lesions at any one point, suggested either congenital disease or infection very early in life. There is, to be sure, no positive proof of congenital infection in such cases, but the wide dissemination of tuberculous lesions at an early age is very suspicious when we bear in mind that tuberculosis becomes generalized only after prolonged local disease.*

Among those who have given this subject considerable attention Nocard is inclined to regard congenital disease as uncommon and safely left out of account in considering means of prevention. The writer is inclined to accept the same view from an independent study of this question. The best view to take of this subject is the one suggested by Gaertner, that congenital tuberculosis or the transmission of tubercle bacilli from the mother to the fetus is but one of the many ways in which the virus is disseminated. Circumstances at times may contribute to more, at times to less, infection of this kind. There is no doubt that

*After this article had left the writer's hands a second case of intrauterine infection, much more convincing than the one referred to in the text, was dissected. A brief description here is justifiable on account of the comparative rarity of such cases.

A cow, about 5 years old (No. 268 in Table V), was killed in an extremely emaciated state twenty-one days after giving birth to a calf. The autopsy showed very extensive, probably primary, disease of the lungs and pulmonary glands. From the lungs the coughed-up tubercle bacilli had recently invaded the retropharyngeal and the mesenteric glands. The portal system was also infected.

The pleura had become involved by contiguity with the lung disease and thence the peritoneum had become affected. Blood infection was indicated by slight disease of both kidneys.

In the left horn of the uterus an area about 2 to 3 inches square was involved. The wall was much thickened and on section aggregations of tubercles were found in the submucous tissue, some with necrotic centers. About six of the cotyledons were involved.

The calf killed at the same time (21 days old) showed unequivocal marks of congenital tuberculosis. The lesions were limited to the liver and its glands, one kidney and its gland, and two posterior mediastinal glands. The tuberculous masses were in all cases necrotic and calcareous centrally.

It seems that the disease of the uterus in the mother was older than three weeks. The calf was probably infected from this focus before birth.

if tuberculosis should be allowed to increase uncontrolled in the future as in the past congenital tuberculosis will increase in frequency and thus at the very beginning of life lay the foundations for a disease which under this form will render the affected animal a great menace to public health as well as a dead loss to agriculture.

Much has been said and written concerning the inheritance of a certain combination of bodily characters which increase the chances of the subject to contract the disease when exposed to it or which tend to a more rapid course of the disease after it has once gotten a foothold in the body. It is an exceedingly difficult subject to discuss, because we know little or nothing definite about it. Theoretically there seems to be no reason why some animals or breeds should not be more susceptible than others, but the conditions under which observations can be made to prove or disprove this theory are complex and likely to bring out erroneous conclusions. The element of contagion is such a prominent factor at all times that individual or racial susceptibility can not be studied satisfactorily until it can be successfully controlled. Inherited susceptibility is also not separable from acquired susceptibility due to depressing environment and unsuitable food.

A more satisfactory method of approaching the subject would be the experimental inoculation of individuals from different breeds, chosen as nearly alike as possible, and a careful study of the progress of the induced disease. Such experiments, though expensive both as to time and money, might throw more light on the subject of tissue immunity than prolonged observation of the disease as acquired naturally. If, however, the disease can be controlled by weeding out all tuberculous animals from a herd at certain regular intervals and thus removing the element of contagion entirely, the question of heredity of disposition will no longer be of any practical importance, for there can be no tubercles without the tubercle bacillus.

THE DIFFERENTIAL DIAGNOSIS OF TUBERCULOUS LESIONS.

In the recognition of tuberculosis at the post-mortem examination errors may be made in two directions: Certain alterations in the tissues which are tuberculous in character may be overlooked and certain changes may be pronounced tuberculous which are due to other causes.

The peculiar tissue reaction which leads to the formation of minute tubercles, their coalescence, and the subsequent caseation or calcification of the mass of new tissue formed thereby, needs not be seen frequently by a trained eye before their characteristics are firmly impressed on the mind. There is, furthermore, the constantly recurring affection of the lymph glands either with or without disease of the vital organs which belongs to no other disease of cattle.

It may, however, occur now and then that the disease process is so recent that the changes induced are too slight to be detected by the

naked eye. The earliest visible manifestations in the lymph glands are seen on the cut surface as whitish patches, having, when viewed in a good light, a slightly granular appearance. Simple hyperplasia of the lymph glands in which the follicles appear on the cut surface as smooth, whitish, slightly elevated, round patches must be carefully distinguished from early tuberculous lesions. This hyperplasia is simply an increase in the number of lymph cells composing the follicle, and is especially conspicuous in young animals. In these the glands lack the pigment markings which appear later on in life, and the uniformly whitish appearance of the cut surface may erroneously suggest tuberculosis. It is not to be denied that the beginnings of tuberculosis may now and then lurk in these follicles, but after somewhat extensive examination of sections of such regions and a uniformly negative outcome, the writer is inclined to believe that they may safely be passed over.

Mistakes are more likely to occur by confusing lesions due to other bacteria, to parasites, and to traumatism with those of tuberculosis, unless a certain amount of caution and reserve is exercised and the aid of the microscope or of those especially trained is invoked.

Bacterial lesions, which resemble tubercles closely and which go to make up the pathological condition known as pseudo-tuberculosis, have been found among sheep and smaller animals, but not among cattle. A general review of this subject will be found in Bulletin No. 6 of the Bureau of Animal Industry (pp. 87–95), to which the reader is referred.

Forms of broncho-pneumonia may now and then simulate tuberculosis of the lungs, but the characteristic distribution, as described on page 91, will generally assist in making a prompt diagnosis. One of these forms of pneumonia has been described by Kitt* who found in sections of the lung tissue masses of a specific bacillus. The various cases of broncho-pneumonia examined by the writer were so readily distinguishable from tuberculosis that any remarks would be superfluous. Among the more common as well as more perplexing lesions frequently found in cattle, those due to entozoa stand first and deserve a more detailed description.

WORM NODULES IN THE SMALL INTESTINE.

These have been looked upon as the result of true tuberculosis in several cases which have come to the writer's notice. They are very common in the region about Washington. The writer has also seen them in New York. In tissues from cattle slaughtered at Chicago they were likewise recognized. It is highly probable that they are widely disseminated in our country.†

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* Eine bacilläre Pneumonie beim Rinde. Monatshefte für praktische Thierheilkunde, 1 (1890), p. 145.

† They have been noticed by Dr. Arango in Colombian (South American) cattle.—The Veterinary Journal, 1894, p. 105.

They may be readily seen by the naked eye, but their relative abundance is more easily determined by passing the intestine either slit open or still uncut through the hands. The intestinal wall then feels as if beset with shot-like bodies. When the tube is slit open, the mucous membrane appears elevated by small hemispherical tumors varying in size from barely visible nodules to bodies as large as peas or even larger. These tumors are, as a rule, isolated. Rarely several are close together. Only in very extensive infection of sheep are they frequently so abundant as to form by their aggregations large elevated patches or beds. They are not all of the same size in the same animal, but vary as stated. If we examine these projections more closely we shall find that in all but the smallest ones the center appears opaque and yellowish. This yellow nucleus is more or less irregular in outline. The mucous membrane covering them is unharmed except as to the presence of a little depression on the summit of the nodule, which is probably the point of exit of the once encysted worm. This opening may be in the center of a bluish spot, probably the débris of a hemorrhage, caused by the outward-moving worm. In the larger nodules a slight pressure forces from this minute opening some of the softened contents of the cyst.

The situation of the nodules is in the submucous tissue. The mucous membrane may be scraped away and leave the nodule intact. When a small one is teased out of its surroundings and crushed between two slides the parasitic worm, about 1 mm. ($\frac{1}{25}$ inch) long and almost invisible to the unaided eye, may be detected in some cases. The larger the nodule is the less likely the search for the worm will be successful.

The larger tumors, usually about one-fourth inch in diameter, consist of a thin, smooth capsule containing putty-like substance of a yellowish or greenish-yellow color, easily removed. In very old tumors the thin capsule may inclose a calcified mass of very irregular surface.

In some cases most of these intestinal tumors have a decided bluish color. This is probably due to some former hemorrhage, as suggested above.

These tumors may be distinguished from true tubercles in a variety of ways. In the first place, tuberculosis of the mucous membrane of the intestines is quite rare. The writer has seen but one case in 150 tuberculous animals. In this the Peyer's patches were involved.* Infection by way of the intestines shows itself mainly in the mesenteric glands. Any affection of the mucous membrane without disease of these glands must be looked upon with suspicion. This worm affection is, furthermore, very common in certain regions, and usually affects all animals alike.

The character of the worm tubercle is quite different from that of the true tubercle. Setting aside the recognition of the worm, which is possible only in young tumors, we have sufficient points of difference to make a diagnosis with the naked eye possible in most if not in all

*See autopsy notes of No. 338, p. 46.

cases. The contents of the worm tubercle is made up of leucocytes entirely, whereas the brittle, cheesy contents of the true tubercle is usually a mass of granular and fatty detritus. With the true tubercle there is usually more or less change in the immediate surroundings of the tubercle. The wall is infiltrated and thickened and shades both outwards and inwards. Smaller tubercles are also frequently found in the tissue around the large focus. In the worm tubercle the capsule is thin, sharply defined, and quite independent of the contents, which are easily removed. Finally, the characteristic histological structure of true tubercles enables us to decide with the aid of the microscope should other simpler means fail.

OTHER LESIONS SIMULATING THOSE OF TUBERCULOSIS.

Parasitic lesions of the mesenteric glands are not uncommon in the region about Washington. How widely distributed they may be the writer is unable to state from present information. They simulate the lesions of tuberculosis, but are as a rule distinguishable from them on close scrutiny. They resemble somewhat those of the intestinal walls, and the writer was inclined to consider them caused by the same parasite when in the spring of 1893 their true cause was revealed to us. At that time Dr. E. C. Schroeder, in assisting the writer at autopsies of the Soldiers' Home herd, was cutting open the mesenteric glands systematically in search for tuberculosis. He noticed a small parasite quickly crawling out of some cavities exposed by the knife. A close, naked-eye examination showed the characters of *Linguatula* (*Pentastomum*) *tænioides*. The material was handed over to Dr. Stiles, zoölogist, for further study.

The cavities made by these organisms are at first mere excavations of the gland tissue and are filled with a blackish mass made up of the pigmented débris of the gland tissue. In later stages they become filled up with a cheesy matter which finally becomes calcified. They vary in shape and size, and rarely exceed one-fourth inch in diameter. They are separated from the gland tissue by a thin capsule. This is completely filled with the cheesy matter, which is entirely homogeneous, greenish in color, and putty-like in consistency. In this stage the mass is shown to be made up entirely of leucocytes.

The later stage is characterized by the calcification of the contents into a stone of irregular surface crushed only when considerable force is used. The stone is easily pulled out of its capsule, which it fills completely. These hard masses are frequently situated directly under the cortex and sometimes project above the gland surface.

These gland nodules are thus readily distinguished from true tubercles by their contents. In the latter the necrosis is not uniform, and the resulting caseous mass occupies only a portion of the neoplasm and shades into the peripheral, still firm and organized zone of the tubercle.

The contents are therefore not removable in toto, except after complete softening and circumscription of the tuberculous process. The cheesy mass is, moreover, mainly fatty and granular débris. With true tuberculosis an extension of the process is usually noticeable; with worm tubercles this is not the case, the capsule is directly contiguous with healthy gland tissue, and all evidence of encroaching infiltration is absent.

Isolated tubercle-like lesions are found occasionally under the cortex of the liver, which are probably of parasitic origin. Unless tuberculosis has been plainly recognized in the glands at the hilus or elsewhere in the body, the diagnosis should be left open until such nodules have been examined under the microscope.

Yellow patches, due to fatty degeneration, may appear on the margin of the liver, probable as a result of embolism. Though they resemble more or less closely the necrotic patches of the tuberculous liver in guinea pigs, they contain no traces of the tuberculous process. In general tuberculous foci in the liver of cattle are roundish and provided with a thick, dense, connective tissue wall.

The importance of a correct diagnosis of tuberculosis of the udder makes it imperative that mistakes be avoided in determining the nature of any abnormal appearances on post-mortem examination. It is essential that statistics of udder tuberculosis be accurate, for it is upon them that the future action of sanitarians will be largely based in dealing with this disease. It is highly probable that udder tuberculosis whenever encountered will be generally recognized as such. It is equally probable that other changes may now and then be called tuberculosis. In this connection attention should be called to the aberrant appearances occasionally presented by the freshly-cut surface of udder tissue. The usual pinkish surface is, in some cases, variegated by patches of yellow representing foci of intense fatty changes. In portions which have lost the power to secrete the increase of connective tissue compresses the lobules and gives the cut surface a granular appearance which might be mistaken for tubercular infiltration. Very deceptive are certain yellow nodules which project above the cut surface. They are lobules distended with fat and have the normally soft consistency of udder tissue. In any case of suspected udder tuberculosis the tubercle bacilli should be demonstrated, or else the histological structure of tubercle determined in sections of hardened tissue.

Another set of deceptive lesions frequently encountered at autopsies of cattle are those due to the action of foreign bodies swallowed with the food. The frequency with which this is observed and the extensive, often fatal, injuries which are induced thereby, ought to impress cattle-owners with the necessity of carefully protecting their herds from such calamities.

The lesions due to foreign bodies are usually situated on the second stomach (reticulum) in the form of enlargements or tumors, varying in

size up to an orange. The smaller ones have an almost cartilaginous hardness, and when incised a small amount of creamy pus is found in the center. In the larger ones the capsule is equally dense but not so thick relatively. They also contain the homogeneous creamy pus, which usually has a penetrating but not offensive odor.

These abscesses are associated with more or less increase in the connective tissue and the binding down of the ventral or narrower end of the liver to the diaphragm. This condition is so common that the writer has seen very few older cows without attachments of the liver to the stomach. The situation of the abscesses described, their consistency and contents are sufficiently characteristic to prevent any errors of diagnosis, if attention has been once called to them.

Foreign bodies not infrequently work their way into the thoracic cavity where they may produce abscesses in the lung tissue. These are readily distinguishable from softened tuberculous foci by their relation to adhesions of the lungs to the diaphragm and subphrenic lesions. Such abscesses are also associated with hyperplasia of the interlobular tissue of the surrounding lung tissue and firm red hepatization of the latter. Cavities due to tuberculosis are as a rule surrounded by a zone of easily recognizable fresher tubercle eruptions, which at once place the nature of the cavity beyond doubt.

SOME PRACTICAL SUGGESTIONS FOR THE SUPPRESSION AND PREVENTION OF TUBERCULOSIS.

By Theobald Smith.

In endeavoring to seek appropriate means for the suppression of this disease, we find ourselves confronted with conditions quite different from those obtaining for most other infectious diseases. These conditions are in brief as follows:

(1) The present wide dissemination of the disease, no territory being absolutely free from it.

(2) The large percentage of infected cattle which are in the earliest stages of the disease, or in which the lesions are insignificant, stationary, or healed.

(3) The absence of disturbances of health for considerable periods of time after infection.

(4) The possible transmission of tubercle bacilli from cattle to man, more particularly in the milk.

Nearly all of these peculiarities have their source in the slowly and insidiously progressive nature of the affection which prolongs the duration of the disease from days to months and years. It is this character which makes the complete eradication of bovine tuberculosis a work of huge proportions, involving serious financial sacrifices.

In the following pages the subject of prevention is dealt with as it may be applied by the individual stock-owner, since this disease, more than any other, needs the combined efforts of individuals for its restriction. It makes the greatest havoc in the herd in which it exists, and rarely travels to other herds, excepting in the diseased animal which is purchased or exchanged. It is, in fact, possible for each herd-owner to protect himself quite successfully from outside infection, as is shown in the following pages which treat of the contagiousness of the disease, the removal of affected cattle, and some general sanitary measures.

THE CONTAGIOUSNESS OF THE DISEASE

Is linked to the tubercle bacillus. Without it, tuberculosis can not develop. Hence, our knowledge of the transmission of the disease is derived largely from what we know of the life history of the tubercle bacillus within and without the animal body.

We have seen in the foregoing chapters that tubercle bacilli may pass from the diseased animals in one or more of the following ways:

(1) In discharges from mouth and nose in case of advanced lung disease, or of disintegration of enlarged throat glands. (Disintegrated parotid, postmaxillary, and submaxillary glands may discharge externally.)

(2) In discharges from bowels in advanced stages.

(3) In discharges from vagina in case of tuberculosis of the uterus.

(4) In milk when the udder is tuberculous or the disease generalized.

(5) From the mother to the fetus in case of tuberculosis of the uterus or advanced generalized disease.

We have also seen from investigations of others and of our own that infection of cattle occurs in the following ways:

(1) Fully nine-tenths of all diseased animals have been infected by inhaling the tubercle bacilli, dried and suspended in the air.

(2) Fully one-half of all diseased animals have been infected by taking tubercle bacilli into the body with the food. Frequently both food and air infection are recognizable in the same animal.

(3) Animals are infected, though rarely, during copulation. In such cases the disease starts in the uterus and its lymph glands or in the sexual organs and corresponding lymph glands of the bull.

(4) Perhaps from 1 to 2 per cent of all calves are born tuberculous.

We may define the dangers of infection somewhat more definitely by the statement that in any herd, even in those extensively infected, only a small percentage of the diseased animals, namely, those which are in an advanced stage, or such as have the disease localized from the very beginning in the udder, or the uterus, or the lungs, are actively shedding tubercle bacilli. It is these that are doing most, if not all, of the damage by scattering broadcast the virus.

Disease of the udder is particularly dangerous, because the milk at first appears normal for some weeks and therefore would be used with impunity. Moreover, the tubercle bacilli in the diseased gland tissue are unusually numerous.*

The owners of cattle should thus pay special attention to the condition of the udders. Any which are found to increase slowly in size without any indication of inflammatory processes recognizable by the presence of heat, pain, and redness, and which become very firm without showing at first any alteration in the appearance of the milk, should be promptly segregated and the entire milk rejected until a diagnosis can be made by a veterinarian.

Similarly in tuberculosis of the uterus the vaginal discharge may contain many tubercle bacilli. This, deposited anywhere, may lead to the extensive dissemination of the virus, or it may be carried by the

* This fact, mentioned by Bang, the writer has had the opportunity to confirm in case of two tuberculous udders examined recently.

bull to other cows. A diagnosis may be made by the examination of the discharge for tubercle bacilli.

The foregoing statements apply to individual herds only. To what extent does the danger extend beyond the diseased herd to others in the neighborhood? To this we may give the general answer that there is no danger unless the animals mingle on the pasture or in the stable. Tubercle bacilli are not carried in the open air, or if they are, their numbers are so small that the danger of infection is practically absent.

It is also highly doubtful whether they are ever carried in sufficient numbers by third parties from place to place to become in any sense a danger. The reasons for this must be sought for in the tubercle bacillus itself. The diseased cow is the only manufacturer of tubercle bacilli* as well as the chief disseminator. Tubercle bacilli after having left the body of the cow (and usually in small number) do not increase in numbers in nature but suffer a steady decrease and final extermination in four to six months at the longest. Only after they have entered the bodies of susceptible animals do they again begin to multiply. Hence with this disease the only danger to other herds lies in direct contact, or in the transfer of a diseased animal or of milk from such an animal. The greatest danger exists in the immediate surroundings of the infected and loses itself as the distance increases.

REMOVAL OF DISEASED ANIMALS.

In order that any infectious disease may be effectually controlled it becomes of the utmost importance to recognize in the living animal not only advanced stages but even the slightest infection. This essential requirement seems to have been found in tuberculin. In the first article of this bulletin (pp. 7 to 74) the reader will find a detailed statement of its uses. The writer wishes to add here only a few remarks from a pathological point of view. Extensive use of tuberculin in Europe and in this country has shown that in a certain percentage of healthy animals a high reaction may follow the injection of tuberculin. On the other hand a small percentage of animals which fail to react show tuberculous lesions at the autopsy. How are we to interpret these inconsistencies?

Nocard, a prominent French authority,† is moved to state that an elevation of temperature of 2 or more degrees Fahrenheit after the injection of tuberculin invariably means infection, and that if lesions are not found at the autopsy this has been badly performed. Most German authorities are not inclined to accept the infallibility of tuberculin. The writer sides with the latter, for he has failed to detect disease after hours of searching in some cases. In several others which

*Other domestic animals may now and then be tuberculous, but this danger is hardly worth considering at present.

†Congrès pour l'étude de la tuberculose chez l'homme et chez les animaux, 1894, p. 22.

gave no reaction the lesions, though slight, were as marked as in others in which a high fever reaction had been obtained.*

It is not to be denied that in the one class of cases the lesions may be so slight, the changes so recent, that they escape attention, and that in the other class the lesions, which are usually quite restricted, are undergoing a healing process. However, we have not yet reached that stage of information which will permit us to explain satisfactorily these discrepancies, and hence we can not as yet unqualifiedly accept the infallible action of tuberculin, and we must content ourselves with the statement that it is a diagnostic agent of very high power.

Accepting the great value of tuberculin in revealing tuberculosis not recognizable by any other means during the life of the animal we are confronted by the necessity of segregating those animals which have reacted with a high temperature and either curing or slaughtering them.

The cure of tuberculosis with tuberculin has been attempted by a small number of observers. Frequent injections of small doses into guinea pigs were made by Pfuhl† and by Kitasato‡ with the result that while the disease was greatly prolonged in some animals a cure was not attained. Others have attempted to heal experimental tuberculosis of the eye in rabbits. The most prolonged observations made by Trudeau§ in this country have shown that while a cure may be apparently brought about a relapse is likely to occur at any time. With cattle the case is somewhat different. If tuberculin could be made to point out those numerous cases in which the disease is restricted to one or more small foci in the lymph glands a course of treatment with injections of tuberculin might be successful in stimulating the body to a speedy healing of these foci. But in selecting tuberculous animals with tuberculin it is quite impossible to discover how much disease is present. To treat any but the most incipient cases would be worse than useless. The same objection would hold for any other remedy likely to be introduced. The treatment of this disease is not to be recommended, therefore, and other means of disposal must be sought.

Nocard,‖ in view of the fact that many animals which give a marked tuberculin reaction have only insignificant lesions in the body, recommends that all such as give a distinct reaction be rigorously quarantined from the rest of the herd. The healthy animals should be placed in thoroughly disinfected stables and new animals admitted only after they have successfully passed the tuberculin test. He further recommends the prompt fattening for slaughter of the infected animals which are in good condition. The lesions will be so slight, he adds, that no

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* *See* Nos. 319, 322, 334, 360, pp. 39 to 56, and D, Table IV.

† Zeitschrift f. Hygiene, XI, p. 241.

‡ Zeitschrift f. Hygiene, XII, p. 321.

§ Trans. of the Association of Amer. Physicians, 1893, 1894.

‖ *Loc. cit.*

inspector dare demand the seizure of the meat at the abattoirs. During the fattening they may be used as before the test. The preventive measures recommended by him thus comprise the tuberculin test with segregation of the infected animals. These must not be used for breeding nor must they be sold, exchanged, or given away. The owner can only give them up to the butcher.

If we accept Nocard's view of the infallible action of tuberculin his suggestions require no amendment. We are not inclined to accept it at present, however. Hence it is essential that the tuberculin test be repeated not later than after an interval of six months, so that it may reveal any cases not detected at the first test. Future repetitions are equally important, as the disease germs may possibly be introduced later on by tuberculous human beings, or by tuberculous cats, dogs, and other domesticated animals.

In the absence of the tuberculin test or of organized official inspection, the stock owner should carefully and promptly remove from his herd and have destroyed:

(1) All animals which show emaciation with coughing and any suspicious discharges from the nose.*

(2) Those animals with enlarged, prominent glands about the head (in front of the ears, under and behind the lower jaw), or enlarged glands in front of the shoulder, in the flank, and behind the udder.

(3) Animals with suspected tuberculosis of uterus and udder.

GENERAL SANITARY MEASURES.

It will probably require more or less time before the use of tuberculin will have become generally established. Hence preventive measures of a general character must still be kept in view for some time to come. These measures partly suffer shipwreck from the fact that it is often difficult to recognize even advanced disease during life. Still, much can be done to reduce the amount of infection by following out certain general and specific suggestions which the renewed study of the disease has either originated or else placed on a more substantial basis.

Perhaps the most important preliminary suggestion to be made is that the owner of cattle should endeavor to familiarize himself as much as possible with the general nature of tuberculosis, its cause, the ways in which the virus may leave the body of the sick and enter that of the well, and, lastly, the ways in which it spreads within the body. He will by the acquisition of such fundamental knowledge lift himself above the plane where quackery and specifics abound, and understand pre-

*Now and then emaciation is due to other causes, such as the presence of foreign bodies in the chest, parenchymatous disease of liver and kidneys, chronic bronchopneumonia, etc. Animals affected with these diseases are of no permanent value, and their destruction is, in the end, an actual saving, since such maladies are not curable.

cisely what to expect after the disease has entered his herd and how to meet the demands of public health. He should, moreover, make himself acquainted with the peculiar appearance of tuberculous growths in the body and open every animal that dies, so that he may know to what extent his animals are dying of this malady. Wherever possible the services of a skilled veterinarian should be made use of. Sanitary precautions should begin with the removal of diseased and suspected animals, as stated above. This is the most essential requirement, for diseased animals are the only breeding places of the specific virus.

After the removal of these, attention should be paid, first of all, to the stables. Here during the long confinement in the winter months we may look for most of the inhalation disease so common in tuberculous cattle. Even when only a few cases of tuberculosis have been found the stables should be disinfected by removal of all dirt and the subsequent application of disinfectants. Since tubercle bacilli are more resistant than most other disease germs the strength of the disinfecting solution must not be less than as given. The following substances may be used:

(*a*) Corrosive sublimate (mercuric chloride), 1 ounce in about 8 gallons of water (one-tenth per cent). The water should be kept in wooden tubs or barrels and the sublimate added to it. The whole must be allowed to stand for twenty-four hours, so as to give the sublimate an opportunity to become entirely dissolved. Since this solution is poisonous it should be kept covered up and well guarded. It may be applied with a broom or mop and used freely in all parts of the stable. Since it loses its virtue in proportion to the amount of dirt present, all manure and other dirt should be first removed and the stables well cleaned before applying the disinfectant. After it has been applied the stable should be kept vacant as long as possible. Before the animals are allowed to return it is best to flush those parts which the animals may reach with their tongues to remove any remaining poison.

(*b*) Chloride of lime, 5 ounces to a gallon of water (4 per cent). This should be applied in the same way.

(*c*) The following disinfectant is very serviceable. It is not poisonous, but quite corrosive, and care should be taken to protect the eyes and hands from accidental splashing:

Crude carbolic acid	½ gallon.
Crude sulphuric acid	½ gallon.

These two substances should be mixed in tubs or glass vessels. The sulphuric acid is *very slowly* added to the carbolic acid. During the mixing a large amount of heat is developed. The disinfecting power of the mixture is heightened if the amount of heat is kept down by placing the tub or glass demijohn containing the carbolic acid in cold water while the sulphuric acid is being added. The resulting mixture is added to water in the ration of 1 to 20. One gallon of mixed acids will thus furnish 20 gallons of a strongly disinfectant solution having a slightly milky appearance.

(*d*) Whitewash is not in itself of sufficient strength to destroy tubercle bacilli, but by imprisoning and incrusting them on the walls of stables they are made harmless until destroyed by prolonged drying. Whitewashing should be preceded by thorough cleansing.

Particular attention should be paid to the sides and ceiling of stable. All dust and cobwebs should be periodically washed down. Those parts coming in contact with the heads of cattle, stanchions, halters, troughs, etc., should be frequently cleansed and disinfected, even when they have not been used by avowedly diseased cattle.

The removal of virus from the stables should furthermore be promoted by the prompt removal of manure and by abundant ventilation. Good air has the effect of diluting infected air and thereby reducing the chance of inhaling dried, floating tubercle bacilli, or at least of reducing the number to be inhaled. It likewise improves the vigor of the confined animals and hence increases the resistance to infection.

Cattle should not be placed so that their heads are close together; each animal should have plenty of room,* and occupy the same place in the stable at all times. These precautions will prevent the nasal, lung, or vaginal discharges of one animal from striking the head or soiling the feed of another. It is true that it is impossible to prevent animals licking each other, but it should be remembered that prevention must begin with the removal of all cases which are suspected of discharging tubercle bacilli. Stables should, furthermore, be carefully protected from the expectorations of human beings affected with tuberculosis of the lungs.

Cattle should be housed as little as possible. The pasture has the effect of greatly reducing the chances of infection by a more or less rapid destruction of the virus, as well as by increasing the vigor of the animals through muscular exertion in fresh air. To what extent animals may pick up the virus on fields it would be difficult to estimate. That it is perfectly possible can not be gainsaid. A tuberculous animal may soil the ground over which it passes, and other animals may take up the virus with the food soon after.

It is not likely that the virus remains alive long enough on the ground to become dried and ready for inhalation. The action of sunlight, the alternate wetting and drying which goes on in nature, may be looked upon as destructive agents. Even if the tubercle bacilli became speedily dried, the great diluting effect of the open air would reduce to a minimum the chances of inhaling the virus.†

Among the other dangers to caution against is the infection of food and water. Drinking troughs should be so arranged that the surface

*Each cow should have at least 600 cubic feet of air space.

†If infection takes place in the open air, it would probably be food infection. Observers in making autopsies of cattle living chiefly out of doors should pay particular attention to the primary focus of infection, in order that some positive information on this important subject may be obtained.

water is constantly flowing away. Discharges from the nose or mouth left floating on the surface may be drawn in by healthy cattle while drinking. Each person must, in such cases, use his own judgment and ingenuity to prevent infection in accordance with the quantity of water at his disposal.

To restrict the dissemination of the disease among young stock, the safest plan is to bring skimmed milk and other dairy products to the boiling point before feeding them. If the cows are positively known to be healthful this may be unnecessary, but where any doubt exists the heating should be resorted to. Such a precaution will, furthermore, reduce scouring among calves, which is probably due, in a great measure, to bacteria in the food.

In presenting the foregoing suggestions, the writer has endeavored to keep in view two conditions: (1) That in which tuberculin is not within reach and only unusual watchfulness can be exercised in separating suspected animals from the healthy, and (2) that in which tuberculin is tried, but with the view that it is not wholly infallible and requires to be seconded with other precautionary measures. If tuberculin is infallible most of the suggestions made fall to the ground as unnecessary unless the disease can be readily reintroduced by man or diseased animals of other species—a possibility of wholly unknown dimensions at present.

These suggestions might be criticised because they tacitly assume that a herd can live and thrive even when tuberculosis is present. This criticism may be answered by the fact, experimentally demonstrable, that the introduction, into the body of the very susceptible guinea pig, of different numbers of tubercle bacilli is followed by a rapidly or a very slowly progressive disease, according to the quantity of virus. Hence, if, even where tuberculosis is present and not recognizable, all precautions are taken to reduce in every possible way the number of tubercle bacilli in the air, the food, and the milk, it is evident that if the experimental data are accurate, the amount and intensity of disease may be reduced and possibly the unavoidable, slight infections become healed. It is not the purpose of the writer to make the neglect of the tuberculin test justifiable, but it is evident that, with the present great prevalence of tuberculosis, all means must be resorted to to keep the disease from making still further inroads. The more conservative such means the more likely are they to find favor. The amount of disease to be combated, the large financial resources required by more radical measures, makes it probable that the measures suggested will have to be kept in operation for an indefinite time to come.

The study of tuberculosis, though prosecuted for many years, has still many problems of prevention to solve, especially those which pertain to the conditions underlying predisposition. Is the breed or descent of the animal of much importance, or is it the conditions under which each animal is compelled to live which determine the readiness with which the dis-

ease destroys the body? These are vital questions, and their answer must have an important modifying influence on the future success of dairying and stock-raising. As we are now entering upon an era of suppression of this disease, it should be borne in mind that radical measures are the best to begin with, and that after the disease has been weeded out of each large herd by tuberculin one or more times such herd becomes, in a sense, an experiment in the prevention of this disease, with the element of contagion presumably completely eliminated. The future will then decide how much is to be feared from the lapses of tuberculin, from sources of the virus outside of the bovine species, and from heredity, breed, and environment as predisposing agents.

TUBERCULOSIS AND THE PUBLIC HEALTH.

Much of the difficulty which arises when radical measures for the suppression of this disease are discussed is the economic value of the products of cattle, the meat and the milk. The somewhat heterogeneous views prevailing in this country concerning the use of the flesh of animals having but trifling tuberculous lesions are offset by the pretty definite attitude of European authorities, who claim that the meat from incipient cases of tuberculosis is entirely fit for food. This attitude enables Nocard in his recommendations to suggest the prompt fattening of all infected animals for the butcher. This difficulty has been solved temporarily in this country by turning the flesh of cattle which gave a reaction after the tuberculin test, even when the lesions were insignificant, into fertilizers. How far such destruction of food is called for in the interests of sanitation and sentiment is a question which must be left for future discussion and the wealth of the country to settle.

The use of the milk from infected animals is a question difficult to deal with when we consider on the one hand the clamors of public health and on the other those of the dairyman who finds it temporarily impossible to maintain his business if a large number of animals are at once withdrawn from his herd. It will be observed that Nocard does not forbid the use of the milk of incipient cases. Here also he avoids the stumbling block of reform in dairy matters by not making restrictions unnecessarily severe.

In order to obtain more information on the presence of tubercle bacilli in milk the work reported by Dr. Schroeder on pages 75 to 87 was undertaken as a continuation of former investigations already published in Bulletin No. 3. These investigations, so far as they refer to single animals, confirm those of all former observers, that the milk of tuberculous animals is not so frequently infected as has been supposed. It may be laid down as a general rule that the milk of animals in the earliest stages of tuberculosis and with perfect udders does not contain tubercle bacilli. Only such as show signs of labored breathing and of emaciation, such as have enlarged external glands, or some difficulty

with the udder or the uterus,* should be looked upon with grave suspicion and their milk excluded at once from sale. If these extenuating circumstances be borne in mind by the public health officials much hardship may be now and then avoided and the work of extermination of the disease be carried on more smoothly and more effectually in the end.

Another phase of this question which should not be overlooked is the relative danger of the air of cow stables to human beings. If more than three-fourths of all tuberculous cattle have been infected through the air of cow stables why is not the air of stables equally dangerous to human beings frequenting them? It would certainly be of interest for public health officers to look into this matter more closely.

TABLES SHOWING THE DISTRIBUTION OF TUBERCULOUS LESIONS IN THE BODY OF INFECTED CATTLE.

In the following pages an attempt has been made to tabulate the lesions as found in tuberculous cattle during the past two years, in order that the reader may see at a glance the extent of the lesions, their location, and the probable manner of infection.

The preponderance of air over food infection in the Washington herd is well shown in Table I. In Table II the conditions are different. Food infection played a prominent part in this herd, as shown by the frequency with which the throat and mesenteric glands were found diseased.

In Table III air infection again predominates. In Tables IV and V mainly advanced cases are given in which the primary foci of infection are not definitely traceable.

The amount of disease in any given organ is indicated roughly by the number of crosses, a single cross indicating slight infection. Disease of the retropharyngeal glands is not indicated in this way, a single cross being used to indicate disease of the right or the left side. Generalized or blood infection is indicated in the three last columns; pearly disease in the columns headed peritoneum and pleura.

It should be noticed that in this list of 126 head of diseased cattle, among which there were not less than 100 milk cows, one case with tuberculous udder and three others with infected udder glands were found.

*Vaginal discharges may contaminate the milk with other pathogenic bacteria unless extreme cleanliness is observed.

TABLE I.—*Distribution of tuberculous lesions in herd I (District of Columbia).*

Number.	Age.	Infection probably through food.*						Peritoneum.	Uterus.	Infection through the air.				Glands of muscles.	Pubic or udder glands (milk probably infected at some time).	Remarks.
		Retropharyngeal glands.		Other glands of head.	Mesenteric glands.	Portal glands.	Liver.			Lungs.	Bronchial glands.	Posterior mediastinal glands.	Pleura.			
		R.	L.													
301	4				+	+					++	++				
302	5									+++ and bronchi.	+	+++				
303	5				+	+				+++	+	++			+	Infection probably generalized.
304	5															
305	5															
306	6				+					++	+	+				
307	4					+						+				
308	2										+					
309	2		+													
310	1½										+	+				
311	7				+					+	+					
312	6									+	+	++				
313	6										+					Traumatic pneumonia.
314	6				+	+				+++ and bronchi.	+	+	+			
315	6	+	+	Postmaxillary; tonsils.												
316	6										+	+				
317	3										++					
318	1				+	+				++	+	+++				
319	1										+					
320	2½															
321	3															
322	1											+				
323	2½										++	++				
324	3					+	+			++	++	+				
328	4											+				
329	3	+	+													
330	12										+					
331	6									+						

* In these tables no attempt is made to separate those cases in which the infection of the digestive tract may have been secondary to disease of the lungs. Hence the percentage of food infection here indicated may be somewhat higher than is actually the case.

TABLE I.—*Distribution of tuberculous lesions in herd I (District of Columbia)*—Continued.

Number.	Age.	Infection probably through food.							Infection probably through the air.					Pubic or udder glands (milk probably infected at some time).	Remarks.
		Retropharyngeal glands.		Other glands of head.	Mesenteric glands.	Portal glands.	Liver.	Peritoneum.	Uterus.	Lungs.	Bronchial glands.	Posterior mediastinal glands.	Pleura.	Glands of muscles.	
		R.	L.												
332	7										+				
333	5				+	+	++								
334	3										+	+			
335	5		+			+					+	++			
336	8				+					++		++			
337	12		+		+					++	+	+			
338	3	+	+	(?)	++	+		+	(?)	++++	++	++	++		
339	7				+					++	+	+			
340	9														
341	9									++	+	+			
342	9										+	+			
343	6		+					+		++	+++	+++			
344	6	+													
345	9										+	+			
346	9				+						+	+			
347	2										+	++			
348	8				+						+	+			
349	4										+	+			
350	6										+	+			
351	2					+				++	++	++			
352	3		+												
353	4														
354	9									+++	+	+			
355	5				+						+	+			
356	9									++and trachea.		+			
357	8														
358	6				+						+	++			
359	7									+	+	++			
360	9											+			
361	8											+			
362	11				+					++	+	+			
363	9		+									+			

TABLE II.—*Distribution of tuberculous lesions in a portion of herd II (New York).*

Number.	Age.	Infection probably through the food.						Peritoneum.	Uterus.	Infection probably through the air.				Glands of muscles.	Pubic glands (milk infected at sometime).	Remarks.
		Retropharyngeal glands.		Other glands of head.	Mesenteric glands.	Portal glands.	Liver.			Lungs.	Bronchial glands.	Posterior mediastinal glands.	Pleura.			
		R.	L.													
586	5									+	+	+				
587	15			Submaxillary	++	+				+	+	+	++	Right prescapular, right axillary.		Infection generalized.
590	11	+	+	do	++	+		+++	+			++	+++			
591	8	+	+		+					++		+				
592	4	+	+							+++	+	+	+			
593	4	+	+		+						+	+				
594	5									+	+					
595	4	+	+		+	+	+	+		+++	++	++	++		+	Renal glands tuberculous, infection generalized.
597	4				+	+	+			++	++	++				
598	4	+	+							+	+	+				
599	4				+	+					+					
600	3			Submaxillary	+						+	+				
601	4				++	++	++			+	+	+				
602	3		+	Parotid	+	++	+			+	+	+				
606	2										+	+	+			
609	4	+	+		+		+			+		+				
610	4				+	+	+			++	+	+				
611	4	+	+	Left parotid and submaxillary.								+				
614	2									+	+	+				
615	2									+		+				
616	2	+	+													
617	1				+	+						+				
619	3	+					+				+	+				
620	2									+		+				
621	2	+	+							+	+					
622	1			Submaxillary	+		+									
623	2									++	+	+				
625	1		+		+	+	++			+		+				
626	1				+							+				
630	1				+					+						
631	1	+	+		++							+				
633	2	+	+									+				
634 (bull calf)	3														+	
635	2	+	+							+	+	+				

TABLE III.—*Distribution of tuberculous lesions in portions of herds III and IV (New York).*

Case.	Age.	Retro-pharyngeal glands.		Infection probably through the food.				Peritoneum.	Uterus.	Infection probably through the air.				Glands of muscles.	Pubic or udder glands.	Remarks.
		R.	L.	Other glands of head.	Mesenteric glands.	Portal glands.	Liver.			Lungs.	Bronchial glands.	Posterior mediastinal glands.	Pleura.			
Herd III.																
A (in milk)	7				+ + +					+ + +	+	+ +				
B (in milk)	6½	+	+		+	+	+			+ + +	+ +	+ +				
C (bull)	(?)									+	+	+ +				
D (in milk)	4½	+	+		+ +	+ +				+ +	+	+ +				
E (in milk)	3¾									+ +	+ +	+ + +				
F (in milk)	4											+				Traumatic pericarditis, no active inflammation.
G (in milk)	6	+								+	+					
H (not in milk)	3½									+		+				
I (in milk)	4¼									+	+	+				
J (in milk)	2¾				+							+				
K (not in milk)	2¾										+					
L (not in milk)	1½				+					+		+ +				
Herd IV.																
A (in milk)	4										+					
B (in milk)	6										+					
C (in milk)	9										+					
D (in milk)	3½	+			+ +	+				+	+					
E (not in milk)	2				+	+ +				+	+	+		Two shoulder and one knee-fold gland.		Generalized disease.
F (in milk)	14				+					+ +	+	+				
G (in milk)	6				+					+ + +	+	+ +				
H (in milk)	8									+ + +	+	+				
I (in milk)	11				+ +					+ + and trachea	+	+ +	+			

TABLE IV.—*Distribution of tuberculous lesions in a portion of herd V (Virginia).*

Case.	Age.	Retropharyngeal glands.		Infection probably through the food.				Peritoneum.	Uterus.	Infection probably through the air.				Glands of muscles.	Pubic glands (udder glands).	Remarks.
		R.	L.	Other glands of head.	Mesenteric glands.	Portal glands.	Liver.			Lungs.	Bronchial glands.	Posterior mediastinal glands.	Pleura.			
A (in milk)	6	+	+						+	++	+	++			++	Extensive tuberculosis of right half of udder.
B (calf)	⅓			Submaxillary, postmaxillary.	+++	+++	+	++		+·	+	++	+++	Right knee-fold.		Tuberculosis of renal glands; tuberculous foci in spleen (generalized, probably congenital tuberculosis).
C	3	+	+	Tonsils, postmaxillary.	+++	++	+++		+ and pelvic gland.	+++	+	++	++			Tuberculosis of trachea, kidneys (generalized infection).
D	2											+				
E	2	+			+					+		++				
F	2	+	+	Tonsils	+											
G	2									+	++	+				Traumatic pneumonia.
H	2	+	+	Both tonsils, both postmaxillary.						+	+	+				Tubercles in spleen (generalized infection).

TABLE V.—*Distribution of tuberculous lesions in miscellaneous cases from various herds.*

Case.	Age.	Retropharyngeal glands.		Infection probably through the food.						Infection probably through the air.				Glands of muscles.	Pubic glands (udder glands).	Remarks.
		R.	L.	Other glands of head.	Mesenteric glands.	Portal glands.	Liver.	Peritoneum.	Uterus.	Lungs.	Bronchial glands.	Posterior mediastinal glands.	Pleura.			
No. 237												+				
No. 258		+	+	Both submaxillary.	++	+	++	+++ and retroperitoneal glands.	+	++	++	++	+		+	
No. 259				Middle tracheal gland.	+					++	++	++				
No. 266										+	+	+				Died of parturient apoplexy.
No. 268	5		+		+	++	+		+	+++	++	+++	+			Tubercles in kidneys and renal glands; infection generalized.
No. 268*a* (calf of No. 268).	21 days.					++	+					++				Tubercles in spleen and one kidney. Intra uterine infection.
No. 276	3	+	+	Both tonsils	+	+	+	+++	+	+++	++	+++	+++			Foci in spleen, kidneys (generalized infection).
No. 283			+	Left tonsil	++	+	+			+++	+++	+++	+			Tubercle bacilli in milk. (*See* p. 82.)
No. 286		+	+		++					+++	+	++				
No. 291	4	+	+		++	+	+				+					Traumatism of second stomach, with abscesses in connective tissue.
No. 292	10	+		Right tonsil and postmaxillary.	+					+		+				Right retropharyngeal very large, discharging through opening into posterior nasal passage; aspiration pneumonia.

PLATE I.—*Dorsal aspect of the bovine lungs.*

The lungs are laid so that the dorsal (or upper) surface is shown. The various lobes are drawn apart so that their outlines may be distinctly seen. The lobes are named in the text as follows:

a, a_1, right and left caudal lobes, respectively.

b, b_1, right and left ventral lobes.

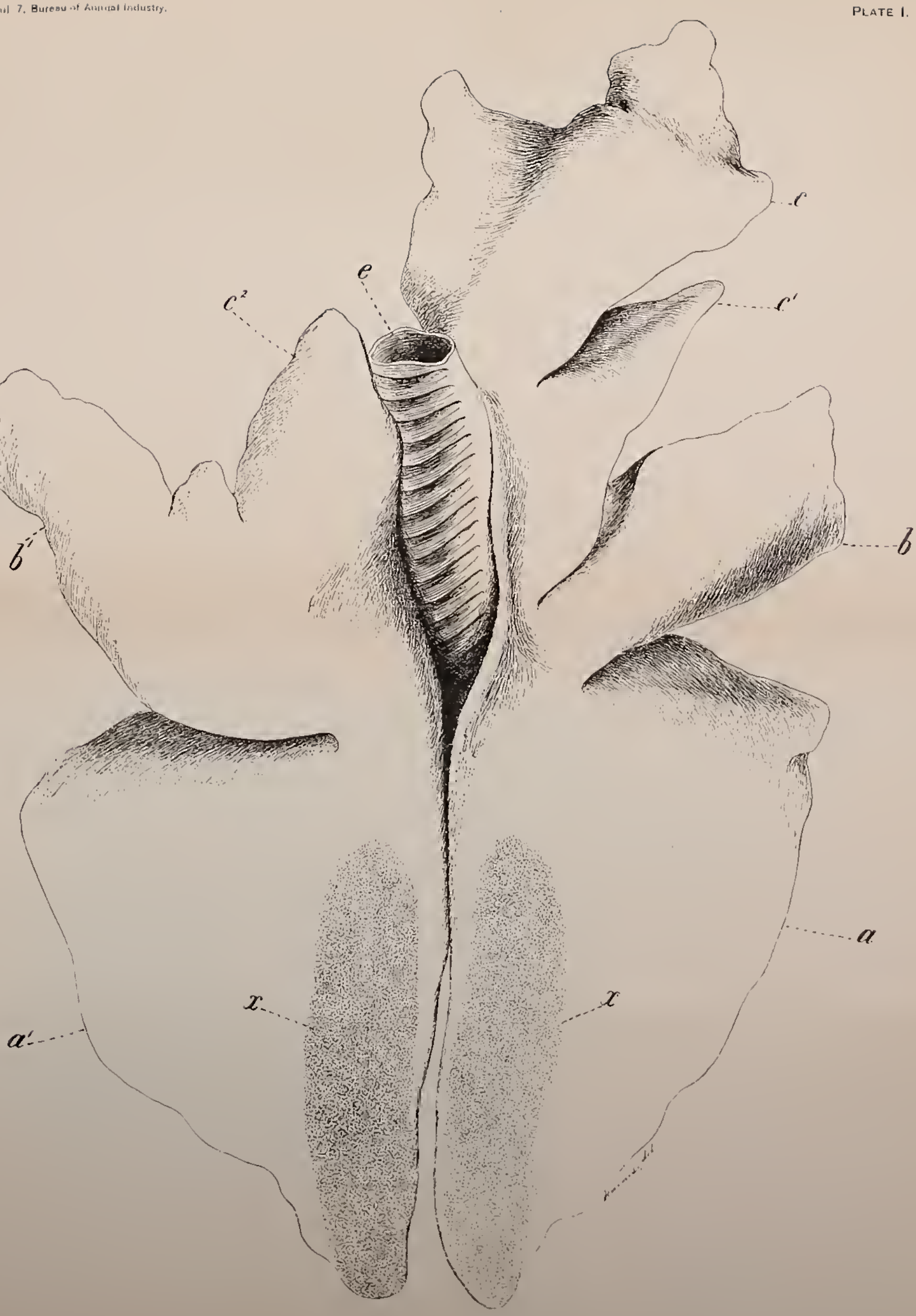
c, c_1, the two portions of the right cephalic lobes, denominated first and second cephalic lobes.

c_2, left cephalic lobe.

e, trachea.

x, region most frequently involved in the earliest stages of pulmonary tuberculosis. The lesions in this stage are, as a rule, embedded in the lung tissue so as to remain invisible from the surface.

DORSAL ASPECT OF THE BOVINE LUNGS. (× ⅛).



DORSAL ASPECT OF THE BOVINE LUNGS. (½).

PLATE II.—*Ventral aspect of the bovine lungs.*

The letters correspond to those on Plate I.

a, a_1, right and left caudal lobes.

b, b_1, right and left ventral lobes.

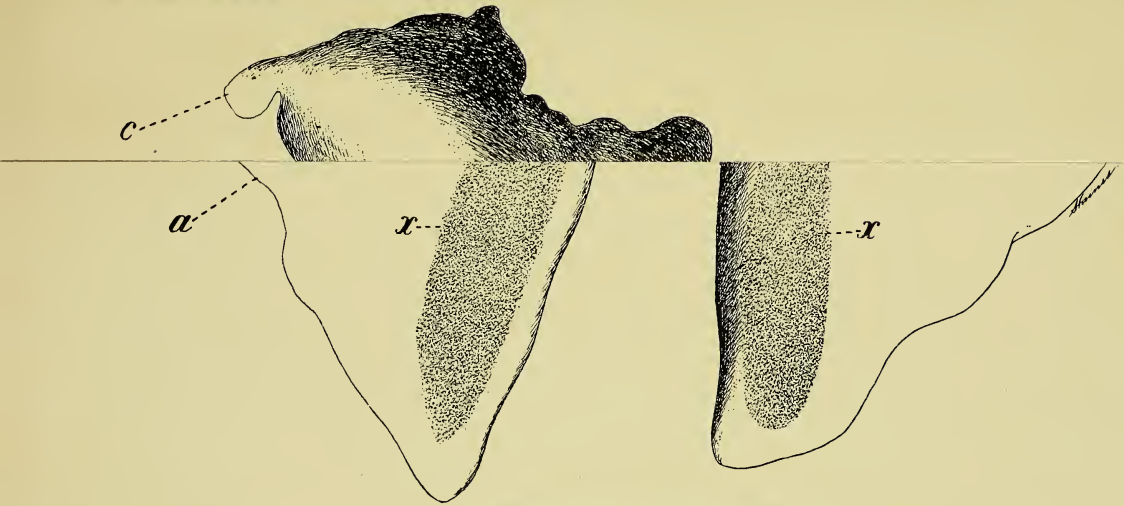
c, c_1, first and second right cephalic lobes.

c_2, left cephalic lobe.

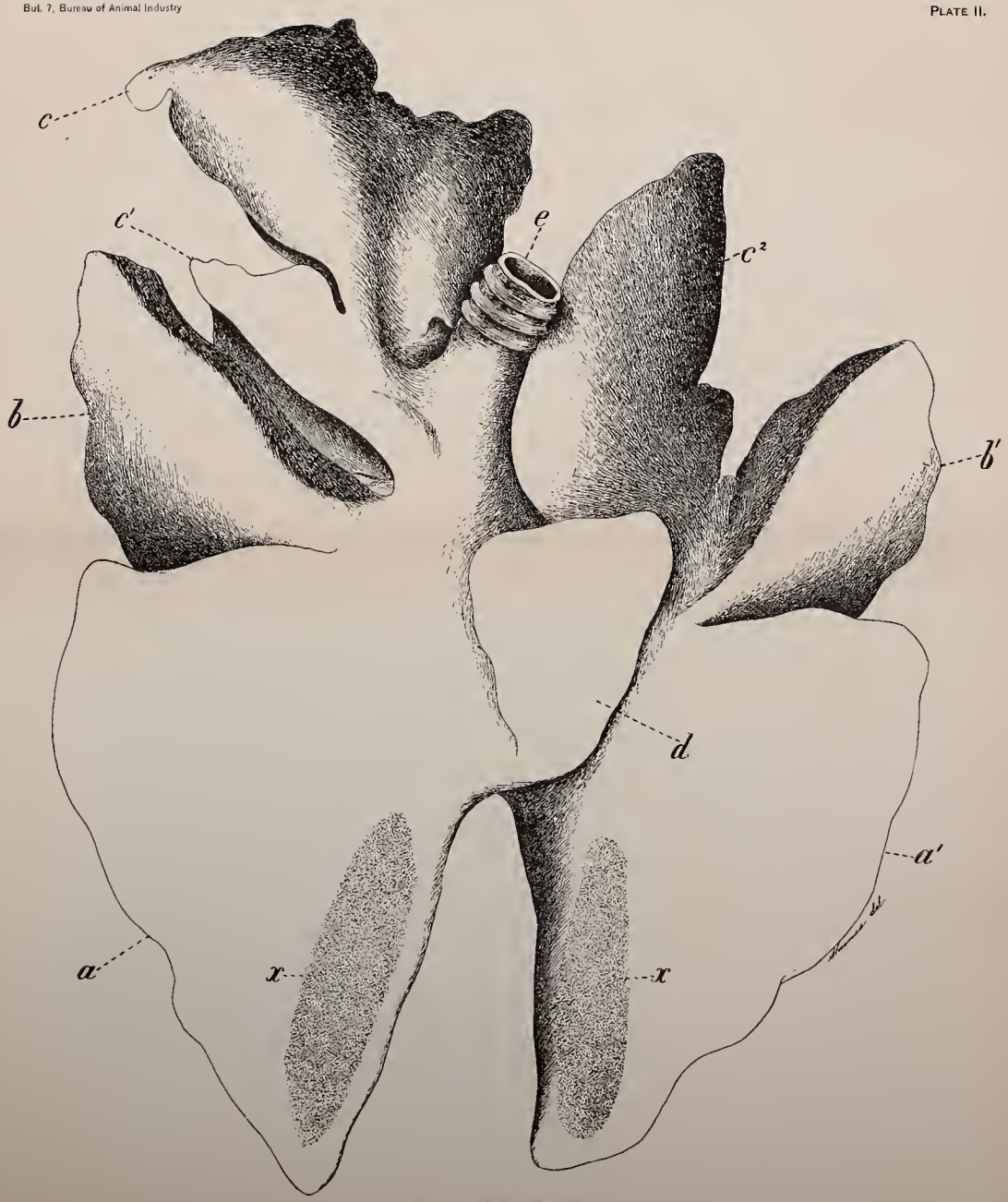
d, azygos or median lobe (belonging to the right lung). This lobe is involved in the most advanced cases only.

e, trachea.

x, usual location of the earliest lesions of tuberculosis.



VENTRAL ASPECT OF THE BOVINE LUNGS. (× ⅔).



VENTRAL ASPECT OF THE BOVINE LUNGS. (× ⅓).

PLATE III.—*Trachea and bronchial tubes of the bovine lungs showing attached bronchial glands.*

a, a_1, air tubes supplying the right and left caudal lobes.
b, b_1, air tubes supplying the right and left ventral lobes.
c, c_1, branches of the right supernumerary bronchus supplying the first and second cephalic lobes of the right lung.
c_2, air tube supplying the left cephalic lobe.
d, branch to azygos lobe.
e, trachea.
A, left bronchial lymph gland.
B, right tracheal lymph gland.
C, lymph gland at root of right supernumerary bronchus.
D, gland in the angle between bronchi; not always present.

The minute intra-pulmonary glands, situated along the main bronchi, are not shown.

TRACHEA AND BRONCHIAL TUBES OF THE BOVINE LUNGS, SHOWING ATTACHED BRONCHIAL GLANDS. (×⅔).

PLATE IV.—*Dorsal aspect of the bovine lungs showing the position of the posterior mediastinal glands.*

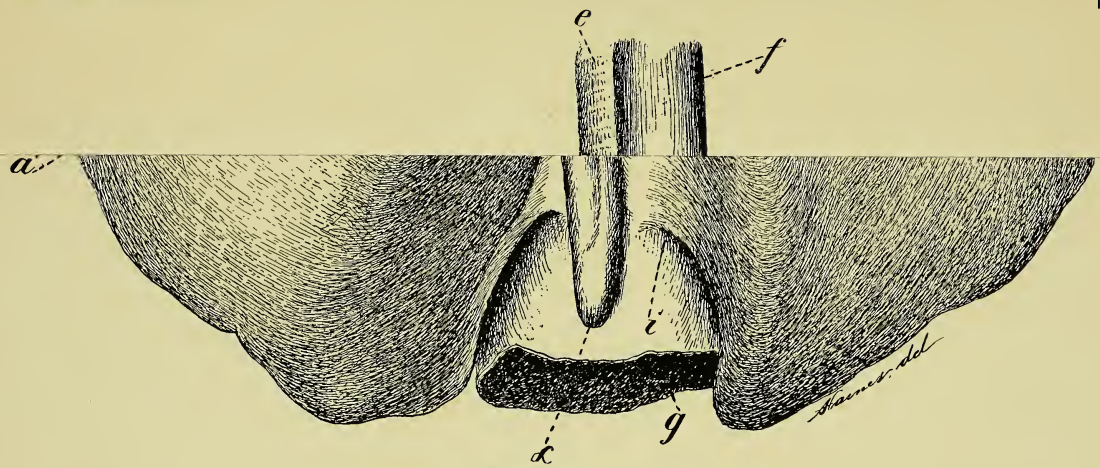
a, a_1, caudal lobes.
b, b_1, ventral lobes.
c, c_1, c_2, cephalic lobes.
e, trachea.
f, œsophagus.
g, muscular pillars of the diaphragm.
h, posterior aorta cut through just beyond the arch and reflected so as to uncover the left bronchial gland A, resting against the root of the left bronchus.
i, caudal margin of the ligament of the lungs (*ligamentum latum.*)

The mediastinal glands are shown, most of them resting on the œsophagus. The aorta, fat, and pleural layers which inclose the posterior mediastinal space laterally, are removed.

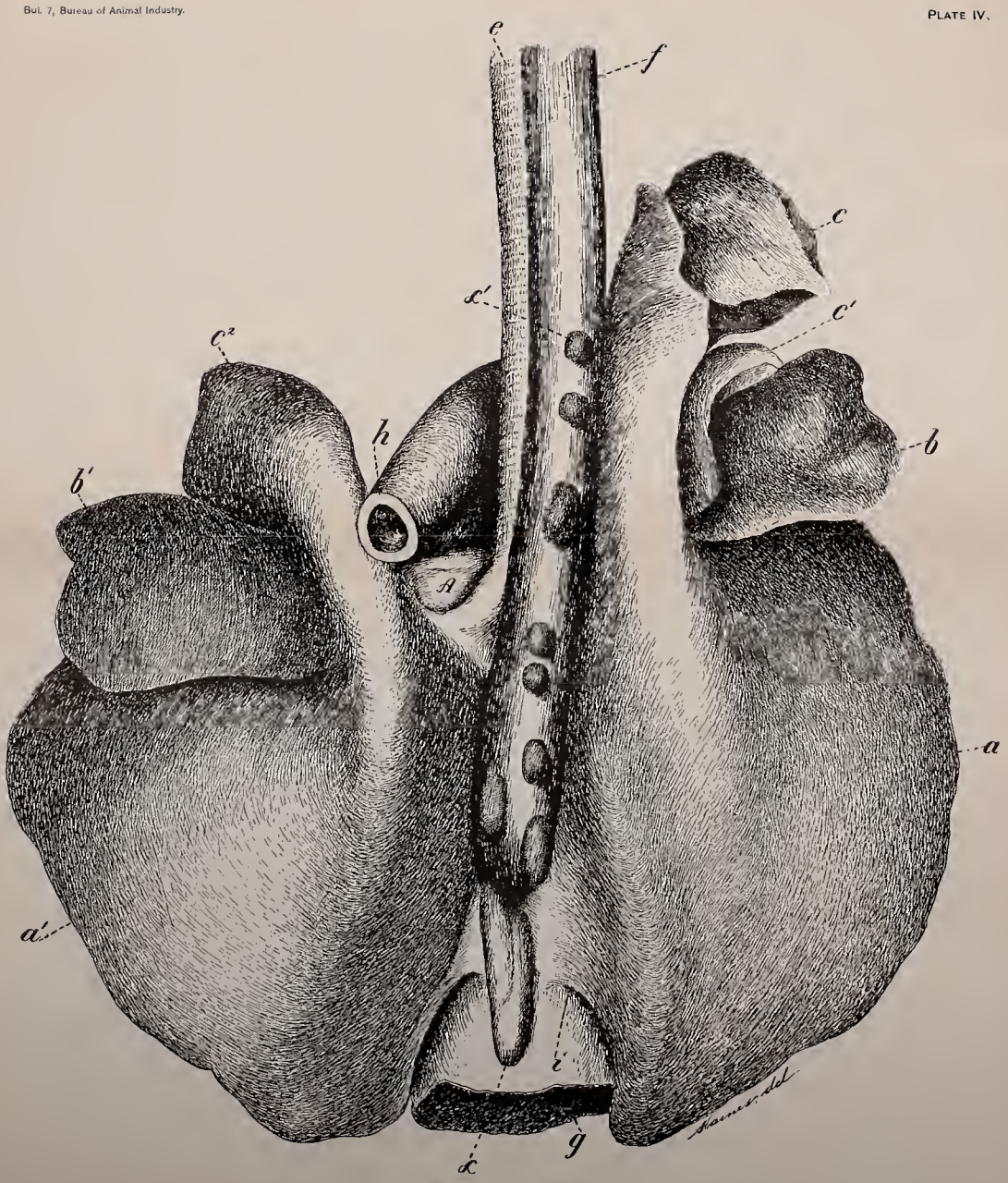
α, the large caudal gland resting below the œsophagus on the pillars of the diaphragm. This gland may be left in the body when the lungs and heart are removed unless special care is taken.

The remaining mediastinal glands are arranged in two sets, on the right and the left margin of the œsophagus. In this animal there is but one gland in the left chain. α is the gland most frequently diseased and in many cases enormously enlarged.

α_1, the most cephalic of the mediastinal series.



POSTERIOR MEDIASTINAL GLANDS. (× ⅔).

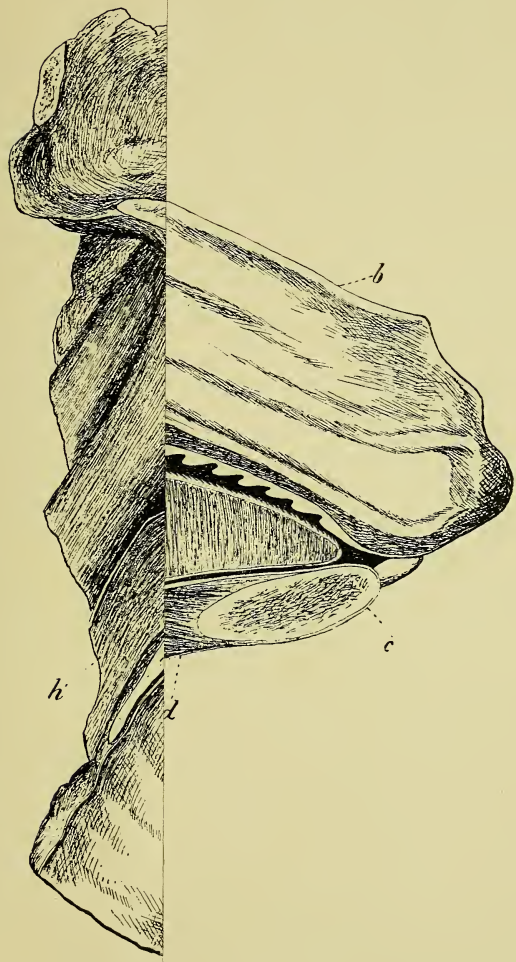


POSTERIOR MEDIASTINAL GLANDS. (× ⅔).

PLATE V.—*Section through the median plane of the head of a cow to show location of the (left) retropharyngeal gland.*

a, brain cavity.
b, nasal septum.
c, lower jaw, sawn through.
d, tongue.
e, posterior nasal passage.
f, trachea.
g, epiglottis, resting against soft palate.
h, œsophagus.
A, left retropharyngeal gland, in this case enlarged to twice the normal size by tuberculous deposits.

The opening into the left tonsil is shown as a dark spot under the soft palate. The tonsil itself is situated beneath the mucous membrane, where the cut surface of the palate appears and projects slightly above this, so as to lie in part under the mucosa of the posterior nasal passage.

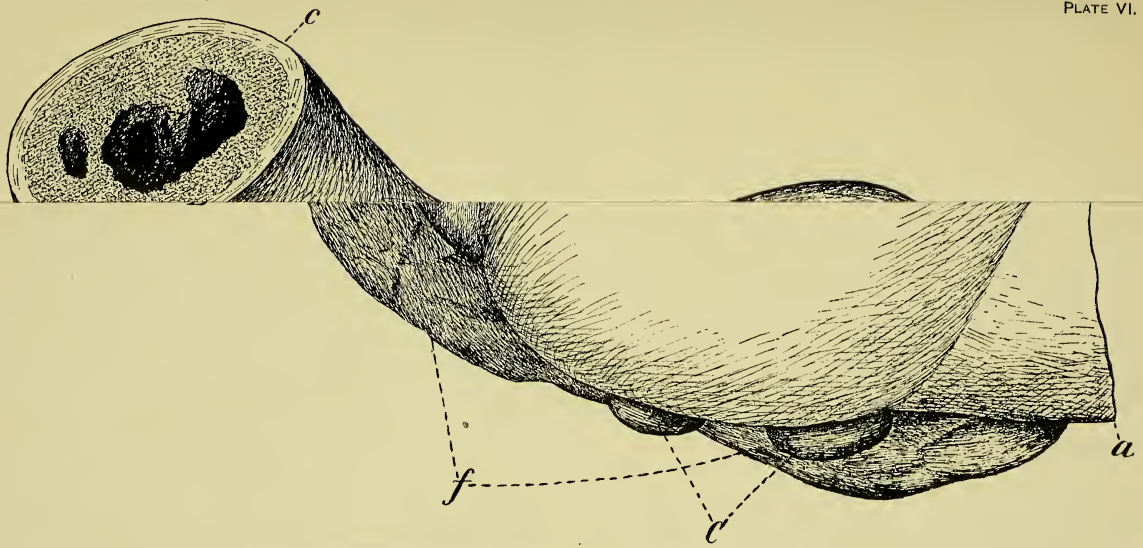


MPH GLAND. (×½).

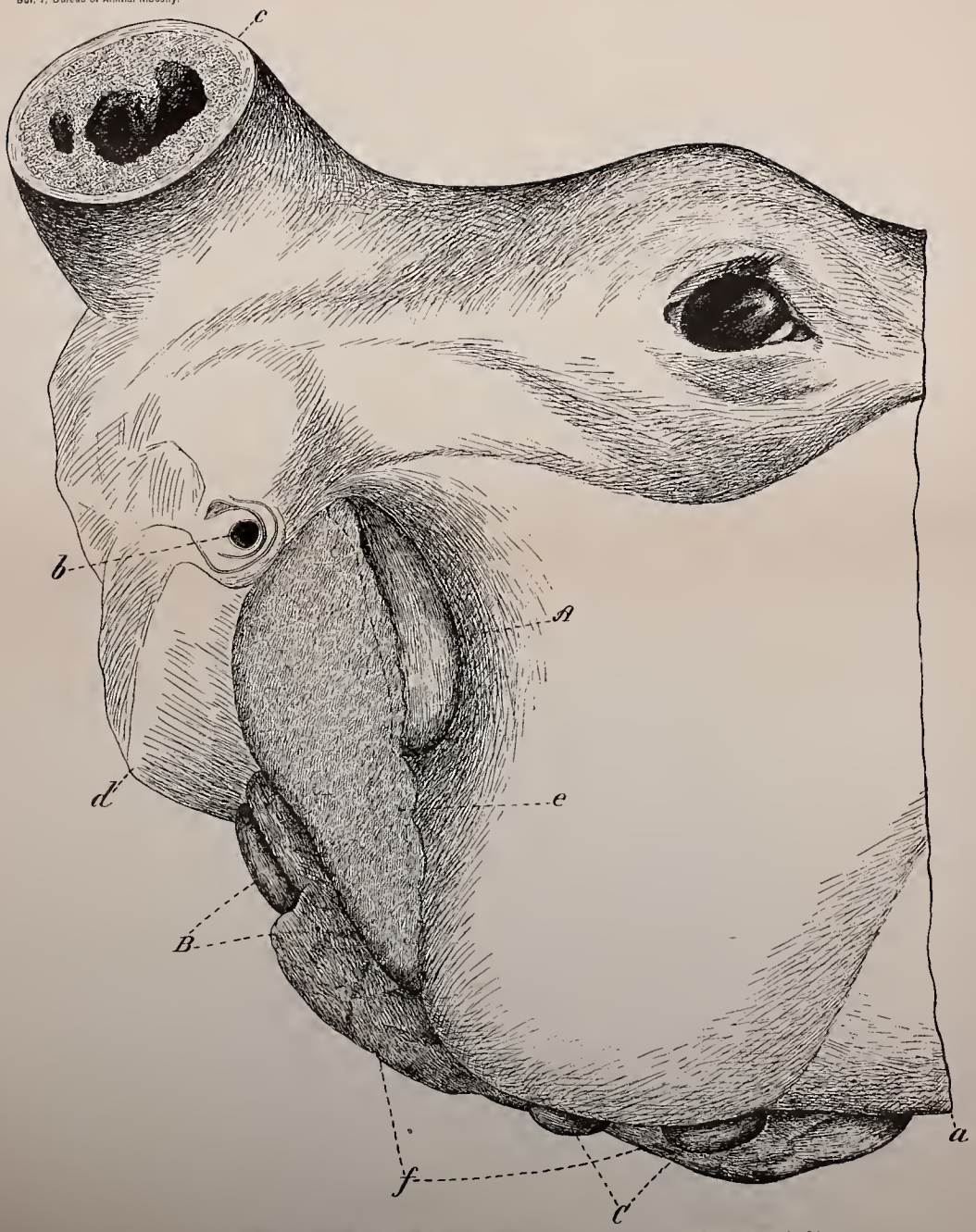
SECTION THROUGH THE MEDIAN PLANE OF THE HEAD OF A COW TO SHOW LOCATION OF (LEFT) RETROPHARYNGEAL LYMPH GLAND. (×½).

PLATE VI.—*Right lateral aspect of posterior half of a steer's head with skin and superficial fat removed to show location of lymph glands.* ($\times \frac{2}{3}$.)

a, lower jaw.
b, ear passage.
c, horn, sawn through near base.
d, styloid process of occipital bone.
e, parotid salivary gland.
f, submaxillary salivary gland.
A, right parotid lymph gland, partly hidden under the anterior border of the parotid salivary gland.
B, right post-maxillary lymph glands, the greater portion concealed beneath the submaxillary salivary gland.
C, right submaxillary lymph glands between ramus of lower jaw and submaxillary salivary gland.



LATERAL ASPECT OF POSTERIOR HALF OF A STEER'S HEAD TO SHOW LOCATION OF LYMPH GLANDS. ($\times \frac{7}{10}$.)



LATERAL ASPECT OF POSTERIOR HALF OF A STEER'S HEAD TO SHOW LOCATION OF LYMPH GLANDS. ($\times \frac{1}{10}$)

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
BIOCHEMIC LABORATORY,
Washington, D. C., July 1, 1894.

SIR: I herewith submit a few points of general interest with reference to tuberculin, its composition, use, and effect on the milk when injected into cows.

Respectfully.

E. A. DE SCHWEINITZ,
Chemist of Bureau of Animal Industry.

Dr. D. E. SALMON,
Chief Bureau of Animal Industry.

TUBERCULIN AND ITS USE.

By E. A. DE SCHWEINITZ, PH. D.

As the use of tuberculin upon man proved more or less disappointing, due in a measure to its improper application, attention was turned to its value as a diagnostic agent for tuberculosis in cattle.

The preliminary tests made in France and Germany showed that tuberculin was a fairly reliable agent. This indicated that if properly applied tuberculin might be useful in indirectly checking and controlling consumption in man by paying due attention to its distribution among animals. Accordingly, about three years ago, experiments in its manufacture and use were begun in the Biochemic Laboratory in Washington. The preliminary and comparative tests with this and the tuberculin manufactured in Europe proved the Bureau tuberculin to be equally reliable, as will be seen from the accompanying report of comparative tests made at the Wisconsin Station by Dr. Russell.

In order to attract attention to the prevalence of tuberculosis in cattle, the resulting dangers to man, and the value of tuberculin in controlling it, the Bureau of Animal Industry offered to supply the boards of health and State experiment stations with this material, to be used in diagnosing disease, provided reports were made of the results obtained. The demand for the tuberculin increased very rapidly, requests coming from all parts of the United States, Canada, and the West Indies.

During the six months, beginning January 1, 1894, there has been manufactured and distributed from the Biochemic Laboratory of the Bureau, tuberculin sufficient for about 4,600injections, which, at the price charged in New York for Koch's tuberculin, would have cost about $3,500. This does not include the tuberculin used by the Bureau for testing some special herds, which would be about 300 injections more. The Bureau has also been supplying mallein for the diagnosis of glanders, the use of which has proved exceedingly valuable. This will be referred to in detail in another bulletin.

The tuberculin prepared by the Bureau is always tested on tuberculous cattle in order to have, as far as possible, a uniform material, so that results from different localities can be satisfactorily compared.

Reports of the results of the injection and post-mortem notes have been received from a number of different parties, the largest number from the experiment station of Vermont and board of health of Massachusetts. In all cases where the animals showed a characteristic reaction and were killed, the autopsy proved the presence of tuberculosis.

The report made by Dr. Russell upon the comparative value of the Bureau and Koch tuberculin, the results of which are appended in Tables VII and VIII, was as follows:

The number of animals selected for the test was 18, mostly high-grade stock. The herd was divided into two equal parts and the one lot injected with the Bureau tuberculin, the other with the imported article. After four to seven weeks the injections were repeated, the order of procedure being changed. Those that had received the imported product were given the Bureau tuberculin and those that had received the Bureau tuberculin were given the imported product.

Out of a possible 15 cases, as two animals of the herd did not react with either injection and were not slaughtered and one animal was excluded by an accident in the experiment, the Bureau tuberculin gave 14 correct diagnoses. In one case (Beauty), neither the Bureau nor the imported tuberculin showed a reaction, though autopsy proved the presence of tuberculous lesions. In 4 cases, Gay, Aggie, Galena, and Daisy, the second injection with the imported tuberculin failed to show a reaction, though the first injection with the Bureau tuberculin had shown a marked reaction, which was confirmed by the autopsy. This lack of reaction from the Koch tuberculin may have been due to the fact that the amount of tuberculin was not as strong as that used on the first injection, though in two similar cases, Polly and Melvina, the same quantity of Koch tuberculin showed a good reaction upon the second injection, after a marked reaction had been shown by the first injection with Bureau tuberculin. These tests have shown again the entire reliability of the Bureau tuberculin.

By some a decided local reaction has been noted at the point of inoculation of tuberculin. Dr. Russell reports that where care was used in sterilizing the syringe no irritation resulted. Unless such precautions are observed, therefore, any local reaction is to be attributed, not to tuberculin, but to septic infection.

In a great many instances the disease is found to be but slightly advanced in a number of animals, so that the milk from such animals would not necessarily be injurious. This, however, could be proven only by careful examination and inoculation experiments.

That tuberculin has some curative properties is undoubtedly proved and these might be utilized to advantage in many instances. In March two tuberculous cows were brought to the station for experiment. In one the disease had been diagnosed by Dr. Schroeder upon physical examination and both had responded to the tuberculin test. One of these, No. 286, was with calf at the time, which she subsequently dropped and it was to all appearances in perfect health.

The milk from this cow used for the inoculation of guinea pigs by Dr. Schroeder caused the death of a number of the animals, but not from tuberculosis. No tubercle bacilli could be detected by centrifugalizing and subsequent microscopical examination of the milk. The calf was kept for several months, all the time with the mother, and

had all the milk. After two months she received an injection of 0.75 cc. tuberculin, but failed to show any reaction. The mother showed a reaction upon the first and a slight reaction upon the second injection, a marked reaction upon the third, and upon subsequent injections a slight reaction. On the contrary, No. 285, which had shown a high reaction upon the first injection, gave but a slight reaction on the second, and subsequent thereto no reaction at all, as can be seen from the Tables I and V. The animal was thrifty and apparently in fairly good health and had improved since brought to the station. It will receive more injections of tuberculin, but has to all appearances been benefited by the action of the tuberculin.

Now, as to the nature of the active principle of tuberculin, the investigations of Kühne, especially, have shown that as ordinarily prepared, the culture fluid contains so much peptone, with which there is always more or less albumose, that it is impossible to separate the true products of the bacillus from the other substances present in the culture media. The simplest way to avoid this difficulty, which was also encountered by the writer, is by the use of fluid for the cultivation of the bacillus in which glycerin, mineral salts, and asparagin or urea were the food for the germs.

I have used two formulas, both of which have given fairly satisfactory results in regard to growth:

1. Water, 1,000 cc.
   Glycerin, 70 grams.
   Acid pot. phosphate, 1.0 gram.
   Am. phosphate, 10 grams.
   Sodium chloride, 10 gram.
   Asparagin, 2 grams.
   Mag. sulphate, 0.2 gram.

2. Water, 1,000 cc.
   Glycerin, 70 grams.
   Sodium chloride, 6 grams.
   Calcium chloride, 0.1 gram.
   Mag. sulphate, 0.3 gram.
   Ac. pot. phos., 2.5 grams.
   Am. lactate, 6.5 grams.
   Asparagin, 3 grams.

After sterilization of the ripe artificial cultures, the germs were removed by filtration and the mineral salts by dialysis. The addition of absolute alcohol to the dialysed solution, free from mineral salts, produced a white flocculent precipitate. After drying in vacuo over sulphuric acid this was difficultly soluble in water, swelling up, partially soluble in dilute NaOH, insoluble in salt solution. Its water solution yielded a slight opalescence with nitric and acetic acid, and a precipitate with ammonium sulphate. The substance gave the biuret reaction as well as the xanthoproteic, but did not respond to Millon's test. It was free from ash, did not contain sulphur, but phosphorus, the latter combined in the molecule, as it was evident after boiling the substance with nitric acid.

The precipitate, therefore, would seem to belong to the class of the nucleo-albumins.

As there had not been a particle of albuminoid matter in the solution this was a purely synthetical product of the germ life.

The reaction of this nucleo-albumin was tested on a tuberculous guinea pig; 0.002 gram dissolved in water caused within six hours a rise of temperature from 102.6° to 104° F.

The solution of the substance that passed through the dialyser contained at first only the mineral salts and some glycerin. After two days some of the albumin had passed through the membrane. The solution free from albumin failed to give any alkaloidal reactions, and produced no rise of temperature in tuberculous guinea pigs. Asparagin, as such, appeared to be no longer present in the solution, and the mineral phosphoric acid and nitrogen had become incorporated in the organic molecule. This is but a brief notice of a study of the active principle of tuberculin as prepared from artificial cultures, and is being pushed as rapidly as the difficulty and nature of the work will allow.

The danger of injecting tuberculin in healthy animals in moderate quantity is slight. In healthy guinea pigs I have found that an injection of a dose twenty times as large as that required to produce a reaction in a diseased cow may kill, but will not always do so. There is no danger of infection if the tuberculin is properly prepared.

In order to see the effect, if any, in introducing tuberculin into the stomach we have fed tuberculous guinea pigs varying quantities of tuberculin. A dose of 0.5 cc. diluted tuberculin which, when injected, will produce a rise of temperature 2.5° to 3° F., when fed to another pig in the same stage of the disease is without effect. If the dose be made twelve times as great there is a slight rise of temperature in four to six hours. Repeated daily feeding of small doses of tuberculin, 2.5 cc., will cause a slight rise of temperature after the fourth day in tuberculous pigs, showing its action to be cumulative. Upon healthy pigs the larger dose is without effect. Such a quantity is entirely out of proportion to that which man or animals could get under any ordinary conditions, and from the appearance of the stomach in the guinea pigs the rise of temperature is due to the irritation rather than the dissemination of the tuberculin through the system.

Although the active principle of tuberculin is very resistant to the action of artificial digestion in a 0.2 per cent pepsin and 1 per cent hydrochloride acid solution, under the action of the different ferments and acids of the stomach it would probably be more rapidly decomposed. In the case of invalids and children there might be some irritating and poisonous action resulting from tuberculin.

Dr. Schutz* claims that the effect of tuberculin injection does not change the specific gravity of the milk.

We have made a few examinations of the milk from healthy and tuberculous cows taken the day before injection, the day of injection,

*Arbeiten aus dem Kaiserlichen Gesundheitsamte, 1892, p. 40, Vol. XIII.

when the temperature was about at the maximum, and the day or two after injection as shown in the tables. Nos. 113 and 217 were healthy animals; Nos. 285, 286, 110, 290, tuberculous. Through an error on the part of an assistant the samples brought for analysis were, in Table II, the first portion of each milking, except in case of Nos. 286 and 113, where the entire amount was saved. The error was not discovered until too late to make the corrections with these animals, but the results are comparative.

In the results noted in the other tables the analyses were made from the entire milking. Cows Nos. 285, 286, 217, and 113 were ordinary animals. No. 290 was a Jersey. In this work I have been ably assisted by Mr. J. A. Emery, who has made a large proportion of the milk analyses.

The Tables IV and VI show that the acidity of the milk from the tuberculous cows was less than that from the healthy, and the amount of volatile fatty acids was decidedly less. This can not be attributed to the breed of the animal, as No. 290, a Jersey, shows almost as low as No. 285. The figures for volatile fatty acid are calculated on the number of cubic centimeters of n/10 $Ba(OH)_2$ solution required for the neutralization of the volatile acids from 1 gram of fat of each sample. Table VI shows the average daily variation in the milk of the animals Nos. 285, 217, and 290 under normal conditions, while Tables II, III, and IV show the changes in the milk constituents under the action of the tuberculin.

In Tables I and V are given the temperatures of the individual animals during the tests with tuberculin on the dates corresponding to those upon which the milk was collected for analysis.

In general, the results show a decrease in total solids in the tuberculous animals after the injection. In the healthy animals there is also a slight decrease in solids but not as much as in the diseased animals.

There is also a decided variation in the proportion of fat before and after injection of the tuberculin as well as albuminoids and sugar. The fat and sugar decrease, the albuminoids show a slight increase. The latter may, in part, be attributed to the presence of a small amount of tuberculin in the milk. This variation in the constituents of the milk would indicate that, while under examination with tuberculin, the milk of the animals should either not be used at all, or close attention paid to the fact that tuberculin will cause such variations. These results are but preliminary to a more extended examination.

As the inspection of tuberculous animals continues, more careful examinations will be made of the milk, and other interesting questions relative to tuberculin and its effects will be studied.

RELATION BETWEEN THE TIME AFTER INOCULATION AND THE REACTION WITH TUBERCULIN.

In order, if possible, to arrive at some idea as to the length of time after inoculation with tuberculosis before an injection with tuberculin would show a reaction, the following experiments were begun some time ago. These were interrupted but are being continued again. The result obtained with the first two sets of experiments may be recorded here, and will be found in Tables IX and X. Guinea pigs, about 1 pound in weight each, Nos. 421, 424, 425, 426, 429, and 430, were inoculated with tuberculosis from an emulsion of the surface growth of an agar culture in 10 c. c. P. b. b. on July 10, 1893. Nos. 427, 428, 431, 432, 433, 435, and 436 were reserved as checks.

The first injection was made July 13 with 0.25 c. c. tuberculin on No. 429, and a rise of temperature in three hours of 3.2° F. was noted. The animal showed at the point of inoculation with the germ a slight swelling, otherwise was apparently in good health. July 20, the injection upon No. 429 was repeated, 0.125 c. c. tuberculin being used, and Nos. 430 and 428 were also used. The check showed no rise of temperature, while the inoculated ones showed a rise of about 1° F. each. This was ten days after the inoculation. July 21 and July 26 the injection was repeated on Nos. 429 and 430, respectively, with a rise of 1° F., but the checks still showed no reaction.

Nos. 425 and 426 on July 22, both of which had been inoculated on July 10 with the same amount of a culture of tuberculosis gave, when injected with tuberculin, a rise of 1.6° and 0.6° F., while the check showed a fall of temperature.

Tested again on July 29 both pigs showed about the same rise in temperature as before.

Nos. 424 and 425 when first tested showed about the same reaction as the others, the same number of days after injection, as did also No. 421, six days after the injection. No. 424 died from general tuberculosis on August 12, just two months after the inoculation. As it seemed from these injections that the tuberculin produced a reaction almost as soon as the germ was introduced into the system and before any local lesion, other than the inflammation set up at the point of inoculation could be formed, the experiment was repeated with results as recorded in Table X.

For this experiment pigs Nos. 482, 483, 485, and 486 were inoculated, and Nos. 481, 484, 487, and 488 retained as checks. They were inoculated October 7, 1893. October 26, pig No. 482, which had on October 25 shown a reaction with tuberculin, was chloroformed and examined. There were a few small tubercles in the lungs, otherwise the animal was apparently healthy. Five days after the inoculation the pigs showed a slight reaction; ten days after, no reaction; eighteen days after, no reaction. The first injection of tuberculin probably interfered with the others, and also retarded the advance of the disease.

No. 486 received the first injection of tuberculin eleven days after inoculation, but showed no reaction. When tested again, twenty-four days after, there was a rise of temperature of 1° only. Four months afterwards the pig was found dead, and although there were a few tubercles in lungs and liver, and the glands of the knee near the point of inoculation were tuberculous, the animal had died from other causes.

In the case of No. 483, the first injection, seven days after the inoculation, as well as the subsequent ones, eleven and twenty-four days after, showed a reaction of 1°. The pig was chloroformed on November 5, just one month after inoculation, but beyond a very slight swelling at the point of inoculation there was no sign of lesions. The injection with tuberculin had probably checked the disease. In the case of No. 485, the first injection with tuberculin showed a rise of 0.4° F. nine days after inoculation. The second, eighteen days after, a rise of 0.6° F., and one month after, a rise of 2°. The pig was found dead on December 8, two months after the inoculation. The glands at the knee-fold were enlarged and tuberculous, the lungs were hemorrhagic and contained a few tubercles; liver and spleen normal.

In two instances the checks gave a slight reaction upon the first injection with tuberculin, but when chloroformed immediately and examined seemed healthy, and their temperature before inoculation had been a little high.

Two guinea pigs that had been inoculated with tuberculosis on July 10 received an injection of tuberculin again on November 8, and showed a marked rise of temperature. They were both found dead a month later, and autopsy showed ulceration where inoculated, liver enlarged and fatty, lungs covered with tubercles.

These experiments tend to show that the reaction in temperature may be influenced by the location of the lesions. So far, however, in the examination of tuberculous cattle it has been impossible to show any fixed relationship between the character and extent of the tubercular lesion and the amount of reaction.

To see what lesions would be produced by infecting guinea-pigs with feeding them tubercle cultures, 5 pigs were selected, and on May 24, 1894, fed 0.5 and 1 c. c., respectively, of liquid tubercle culture. On June 22, 1894, 1 of these pigs was chloroformed. To outward appearances the animal was healthy. The autopsy showed the lungs to be congested and covered with a large number of incipient tubercles. The liver was soft and friable, and the spleen pale and covered with a number of tubercles. The stomach and intestines did not show any signs of tuberculosis.

On July 10 another one of this set of pigs was chloroformed. Autopsy showed about the same condition as the first one, viz, incipient tuberculosis in the spleen and lungs, but the other organs were apparently normal.

The 3 other pigs of this set were to all appearances perfectly healthy, though they all had a high temperature, viz, 103.5°–104° F.

In the case of glanders Nocard has found that if the virus is introduced into the stomach with the food of the animal the disease will develop rapidly, but the lesions will be found in the lungs and spleen, with no sign of disease in the stomach. The tests on guinea pigs would point to the possibility of a similar action in the case of the tubercle bacillus when taken in through the alimentary tract.

TABLE I.—*Temperature reactions of cows on repeated injections of tuberculin.*

	Date.	Time.	Healthy cows Nos.— 113.*	217.*	Date.	Time.	Second injection. tuberculous cows Nos.— 285.†	286.†
			Temperature.				Temperature.	
Day before injection.	1894.				1894.			
	Mar. 30	6 a. m.....	101.2	101.5	Mar. 19	11 a. m....	102.3	102.2
	Mar. 30	8 a. m.....	101.7	102.3	Mar. 19	1 p. m....	102.0	102.2
	Mar. 30	10 a. m....	101.8	102.2	Mar. 19	3 p. m....	102.0	102.2
	Mar. 30	12 m.....	99.0	100.7	Mar. 19	5 p. m....	101.0	101.5
	Mar. 30	2 p. m.....	100.7	101.4	Mar. 19	7 p. m....	101.7	101.7
	Mar. 30	4 p. m.....	100.8	102.0	Mar. 19	9 p. m....	101.0	101.8
	Mar. 30	6 p. m.....	101.0	102.5				
	Mar. 30	8 p. m.....	100.8	101.7				
	Mar. 30	10 p. m....	100.5	101.0				
	Mar. 31	6 a. m.....	100.5	101.4				
	Injected 2 cc. tuberculin at 7 a. m.				Injected 2 cc. tuberculin at 11 p. m.			
Day when injected...	Mar. 31	10 a. m....	101.7	102.8	Mar. 20	6 a. m.....	101.0	101.2
	Mar. 31	12 m.....	101.4	101.4	Mar. 20	8 a. m.....	101.4	101.0
	Mar. 31	2 p. m.....	101.0	101.8	Mar. 20	10 a. m....	101.2	101.2
	Mar. 31	4 p. m.....	101.5	102.5	Mar. 20	12 m.....	101.2	101.6
	Mar. 31	6 p. m.....	101.5	103.0	Mar. 20	2 p. m	103.2	101.0
	Mar. 31	8 p. m.....	100.0	100.7	Mar. 20	4 p. m	103.5	102.8
	Mar. 31	10 p. m....	100.4	101.4	Mar. 20	6 p. m	103.2	101.6
	Apr. 1	8 p. m.....	100.8	101.4	Mar. 20	8 p. m	103.2	103.0
					Mar. 20	10 p. m ...	101.6	103.0
					Mar. 20	12 p. m ...	100.8	102.6
					Reinjected at 12:15 a. m. with.....		Tuberculin— 6 cc.	Tuberculin— 4 cc.
					Mar. 21	7 a. m.....	101.2	102.3
					Mar. 21	9 a. m.....	101.8	103.0
					Mar. 21	11 a. m....	101.0	102.8
					Mar. 21	1 p. m.....	101.4	102.5
					Mar. 21	3 p. m.....	101.2	102.4
					Mar. 21	5 p. m.....	101.2	102.0
					Mar. 21	7 p. m.....	102.0	103.0
					Mar. 21	9 p. m.....	101.4	103.4
					Mar. 21	11 p. m....	101.0	102.4
					Mar. 22	7 a. m.....	101.0	101.0

* Milk collected March 31 and April 1 at 7 a. m.

TABLE I.—*Temperature reactions of cows on repeated injections of tuberculin*—Cont'd.

	Date.	Time.	Second injection healthy cow No. 217.†	Third injection tuberculous cows Nos.— 285.†	286.†	Date.	Time.	Tuberculous cows Nos.— 110.†	290.†
			Temperature.					Temperature.	
Day before injection.	1894.					1894.			
	Apr. 12	2 p. m...	97.2	98.8	101.2	Apr. 16	2 p. m...	100.5	.....
	Apr. 12	4 p. m...	98.7	100.0	101.8	Apr. 16	5 p. m...	99.8	.....
	Apr. 12	6 p. m...	101.6	100.5	102.8	Apr. 17	6 a. m...	100.8	.....
	Apr. 12	8 p. m...	101.2	101.0	102.8	Apr. 17	8 a. m...	100.4	.....
						Apr. 17	10 a. m...	101.4	.....
						Apr. 17	12 m	100.5	101.0
						Apr. 17	2 p. m...	99.5	102.0
						Apr. 17	4 p. m ..	99.7	101.8
						Apr. 17	6 p. m...	101.5	102.8
						Apr. 17	8 p. m...	101.0	101.5
			Injected 2 cc. tuberculin at 11 p. m.				Injected 2 cc. tuberculin at 11:30 p. m.		
Day when injected...	Apr. 13	6 a. m...	101.4	101.0	103.4	Apr. 18	6 a. m...	101.2	102.5
	Apr. 13	8 a. m...	102.2	101.4	103.2	Apr. 18	8 a. m...	101.0	103.0
	Apr. 13	10 a. m...	101.2	102.0	104.2	Apr. 18	10 a. m...	103.8	104.3
	Apr. 13	12 m	102.0	101.0	104.5	Apr. 18	12 m	105.8	105.0
	Apr. 13	2 p. m...	101.2	101.8	105.0	Apr. 18	2 p. m	104.7	105.0
	Apr. 13	4 p. m...	101.2	101.7	105.2	Apr. 18	4 p. m	105.7	105.4
	Apr. 13	6 p. m...	101.4	102.4	103.0	Apr. 18	6 p. m	105.4	104.6
	Apr. 13	8 p. m...	101.2	101.8	102.6	Apr. 18	8 p. m	104.0	104.6
						Apr. 18	11:30 p. m	101.4	105.0
						Apr. 19	7 a. m ...	100.0	102.8

† Milk collected at 5 p. m.

TABLE II.—*Percentage variation in the constituents of the milk from healthy and diseased cows produced by the injection of tuberculin.*

NO. 285.

Date.	Total solids.	Sugar.	Albuminoids.	Fat.	Ash (in milk).	Ash (in total solids).	Chlorine (in milk).	Chlorine (ash).	Chlorine (total solids).	Remarks.
Mar. 19	14.48	3.33	3.15	8.19	.669	4.61	.010	1.55	.077	Before injection (injected 11 p. m., tuberculous.)
20	10.32	3.12	3.41	2.55	.692	6.71	.010	1.47	.098	After injection.
21	12.43	3.12	3.93	5.11	.732	5.88	.0046	.632	.037	Reinjected (12:15 a. m.).
22	11.25	2.72	3.75	5.12	.802	7.13	.016	2.09	.149	After reinjection.

NO. 286.

Mar. 19	15.44	2.72	4.32	8.19	.661	4.28	.011	1.69	.066	Before injection (injected 11 p. m., tuberculous).
20	13.51	2.72	4.23	6.12	.712	5.27	.005	.786	.041	After injection.
21	15.22	2.63	4.23	8.21	.724	4.71	.0049	.681	.032	Reinjected (12:15 a. m.).
22	13.50	2.50	4.50	6.13	.769	5.70	.015	2.04	.114	After reinjection.

NO. 113.

Mar. 31	11.01	4.17	3.26	2.54	.775	7.03	.023	3.03	.213	Before injection (healthy).
Apr. 1	10.69	3.84	3.20	1.52	.696	6.53	.041	6.57	.429	After injection.

TABLE II.—*Percentage variation in the constituents of the milk from healthy and diseased cows produced by the injection of tuberculin*—Continued.

NO. 217.

Date.	Total solids.	Sugar.	Albuminoids.	Fat.	Ash (in milk).	Ash (in total solids).	Chlorine (in milk).	Chlorine (ash).	Chlorine (total solids).	Remarks.
Mar. 31	10.83	4.17	2.96	2.23	.723	6.67	.0023	.325	.0216	Before injection (healthy).
Apr. 1	10.38	4.16	2.89	2.54	.750	6.81	.072	3.75	.255	After injection.

NO. 286.

Apr. 12	16.24	1.92	2.44	(*)	.822	5.30	.....	.....	.....	Before injection (tuberculous).
13	12.62	1.56	2.72	(*)	.720	5.70	.043	6.01	.343	After injection.

* Quantity of milk insufficient for a determination.

NO. 110.

Apr. 17	12.59	3.84	3.23	5.14	.672	5.33	.050	7.54	.402	Before injection (tuberculous).
18	12.58	3.84	3.20	4.12	.750	5.96	.061	8.17	.487	After injection.
19	10.52	3.84	3.19	3.08	.666	6.53	.056	8.10	.530	Second day after injection.

NO. 290.

Apr. 17	13.62	3.84	3.48	5.65	.684	5.04	.052	7.70	.388	Before injection (tuberculous).
18	15.31	3.57	3.25	7.23	.786	5.13	.089	11.43	.587	After injection.
19	11.23	3.57	3.43	3.08	.667	5.66	.051	7.71	.437	Second day after injection.

NO. 217.

Apr. 12	11.03	4.17	1.26	2.56	.681	6.17	.054	8.05	.497	Before injection (healthy).
13	9.77	3.57	1.39	1.53	.727	7.44	.060	8.35	.621	After injection.

TABLE III.—*Percentage variation in the constituents of the milk from healthy and diseased cows produced by the injection of tuberculin.*

NO. 286.

Date.	Specific gravity.	Total solids.	Ash (milk).	Ash (total solids).	Albuminoids.	Sugar.	Fat.	Remarks.
May 15	1.031	10.52	.711	6.75	2.89	3.84	3.05	Before injection of tuberculin.
16	1.029	11.13	.715	6.39	2.81	3.84	3.57	Do.
17	1.029	10.83	.728	6.93	2.71	4.16	2.55	After injection of tuberculin.

NO. 285.

May 16	1.023	17.01	.761	4.47	4.35	2.77	10.27	Before injection of tuberculin.
17	1.027	14.27	.718	5.23	4.01	3.12	6.03	After injection of tuberculin.

Increase after injection in sugar, ash, and specific gravity.
Decrease after injection in fat, albuminoids, and total solids.

TABLE IV.—*Percentage variation in the constituents of the milk from healthy and diseased cows produced by the injection of tuberculin.*

NO. 285.

Date.	Total solids.	Sugar.	Albuminoids	Fat.	Ash (milk).	Acidity lactic acid	No. cc. $\frac{n}{10}$ NH_4OH required for 1 cc. milk.	No. cc. $\frac{n}{10}$ $Ba(OH)_2$ for volatile fat acids in one gram fat.	
May 31	17.33	3.33	3.41	8.95	.672	.....	.....	3.48	Before injection.
June 1	14.60	3.57	2.80	6.13	.663	.....	.....	4.85	Do.
5	17.77	2.77	2.88	10.25	.620	.084	.094	4.00	After injection.

NO. 286.

May 31	10.41	4.16	0.74	2.29	.625	.....	.....	9.34	Before injection.
June 1	10.17	5.00	1.02	2.55	.610	.....	.....	11.68	Do.
5	10.44	4.16	1.04	2.55	.556	.124	.138	12.15	After injection.

NO. 217.

May 31	12.03	4.16	2.82	2.43	.711	.....	.....	10.04	Before injection.
June 1	10.25	4.16	2.29	1.27	.666	.....	.....	15.74	Do.
5	11.26	4.16	2.70	2.03	.688	.176	.196	16.45	After injection.

NO. 230.

May 31	15.57	3.33	3.26	7.66	.622	.....	.....	5.09	Before injection.
June 1	14.96	3.85	2.70	7.17	.707	.....	.....	4.99	Do.
5	15.87	3.33	3.31	8.19	.549	.097	.108	5.93	After injection.

TABLE V.—*Temperature reaction of cows on repeated injections with tuberculin.*

Date.	Time.	Fourth injection. tuberculous cows Nos.— 285.	286.	Date.	Time.	Fifth injection. tuberculous cows Nos.— 285.	286.	Third injection— Tuberculous cow No. 290.	Healthy cow No. 217.
		Temperature.				Temperature.		Temperature.	
May 16	7 a. m.	100.4	99.6	May 31	6 a. m.	100.7	100.2	101.0	100.2
	9 a. m.	99.4	100.2		8 a. m.	100.2	100.0	100.5	100.0
	11 a. m.	100.8	100.6		10 a. m.	101.5	101.2	101.0	101.2
	1 p. m.	101.0	100.6		12 m.	101.2	100.2	101.0	100.8
	3 p. m.	100.0	101.0		2 p. m.	101.2	101.8	101.5	101.4
	5 p. m.	101.4	101.5		4 p. m.	101.2	101.0	100.4	100.7
	7 p. m.	101.0	101.4		6 p. m.	101.7	101.6	102.0	102.0
	10 p. m.	101.0	101.0		8 p. m.	101.8	102.6	102.4	102.2
	Injected 2 cc. tuberculin at 10:15 p. m.				Injected 2 cc tuberculin.				
May 17	7 a. m.	100.8	100.2	June 1	6 a. m.	101.5	100.4	102.6	100.7
	9 a. m.	101.0	100.6		8 a. m.	101.2	100.5	103.0	101.5
	11 a. m.	101.4	100.8		10 a. m.	102.4	102.4	105.0	101.4
	1 p. m.	101.7	101.0		12 m.	103.2	102.0	105.6	101.8
	3 p. m.	101.0	101.6		2 p. m.	103.4	102.4	105.6	101.0
	5 p. m.	101.2	102.2		4 p. m.	103.7	102.8	105.0	102.2
	7 p. m.	101.8	103.5		6 p. m.	102.5	103.2	104.0	101.7
	9 p. m.	101.8	102.6		8 p. m.	101.8	102.4	103.2	101.8

TABLE V.—*Temperature reaction of cows on repeated injections with tuberculin*—Cont'd.

Date.	Time.	Sixth injection. tuberculous cows Nos.— 285.	286.	Calf of 286.*
		Temperature.		Temperature.
July 5	7 a. m.	101.0	100.5	
	9 a. m.	101.6	100.7	102.0
	11 a. m.	102.8	103.2	101.6
	1 p. m.	102.6	102.2	102.4
	3 p. m.	103.0	102.7	102.8
	5 p. m.	102.8	102.4	103.2
	7 p. m.	103.2	103.8	102.6
	9 p. m.	102.0	102.7	103.8
	Injected at 9 p. m.	Tuberculin. 2 cc.		¾ cc.
July 6	7 a. m.	101.4	100.8	101.8
	9 a. m.	101.4	100.6	101.2
	11 a. m.	103.0	103.0	101.8
	1 p. m.	102.6	101.6	102.0
	3 p. m.	103.0	102.6	102.8
	5 p. m.	101.5	101.8	103.0
	7 p. m.	101.7	101.6	103.4

* Two months old.

TABLE VI.—*Normal daily percentage variations in the constituents of milk from diseased and healthy cows.*

NO. 285.

Date.	Total solids.	Sugar.	Albuminoids.	Fat.	Ash (milk).	Iodine number.	No. cc. $\frac{n}{10}$ $Ba(OH)_2$ req. for volatile fat acids in one gram fat.	Acidity (lactic) acid.	No. cc. $\frac{n}{10}$ NH_4OH required for 1 cc. milk.
June 11	16.24	3.12	4.15	8.71	.403	36.07	3.40	.062	.07
12	14.47	3.12	4.16	6.14	.530	.....	3.74	.070	.07
13	14.25	3.12	3.94	6.65	.478	34.43	4.86	.068	.08
14	14.53	3.12	4.13	7.67	.638	30.68	4.34	.065	.07
15	14.34	3.12	3.99	6.65	.662	38.74	4.65	.062	.07

NO. 217.

June 11	11.97	4.16	4.17	2.03	.590	28.97	12.52	.149	.17
12	10.82	4.16	3.83	1.52	.692	21.17	15.09	.158	.18
13	11.30	4.16	3.97	2.02	.751	29.10	14.55	.160	.18
15	11.62	4.16	4.25	2.03	.767	27.76	18.07	.160	.18

NO. 290.

June 11	16.35	3.12	4.26	8.19	.596	30.51	5.25	.094	.106
12	15.13	3.84	3.95	6.64	.620	28.79	5.51	.118	.114
13	15.71	3.33	4.03	7.15	.592	28.85	7.94	.119	.124
14	15.31	3.57	4.01	7.14	.625	.....	6.80	.114	.130
15	16.22	3.84	4.25	7.66	.641	27.14	6.64	.115	.130

TABLE VII.—*Temperature records of station herd taken previous to first inoculation with tuberculin.*

[Wisconsin Experiment Station herd, by Dr. Russell.]

No.	Name.	4 a. m.	6 a. m.	8 a. m.	12 m.	4 p. m.	8 p. m.	Average normal temperature.	Date of inoculation.	Kind of tuberculin.	Weight of animal.
											Pounds.
1	Polly			101.3	101.8	101.6	101.0	101.42	Feb. 20, 10 p. m.	B. A. I.	776
4	Gay			101.0	100.9	101.3	101.0	101.50	....do	B. A. I.	871
9	Daisy			99.6	101.2	101.4	101.2	100.85	....do	B. A. I.	778
2	Bessein	101.8		101.6	101.4	102.0		101.70	....do	B. A. I.	992
3	Doubtful	101.5		101.6	101.4	101.2		101.42	Feb. 23, 5 p. m.	B. A. I.	952
5	Aaggie	101.1		101.7	101.0	101.3		101.28	....do	B. A. I.	1,017
6	Galena	101.2		101.2	100.4	101.0		101.20	....do	B. A. I.	978
15	Melvina	101.8		102.1	102.0	102.0		101.97	....do	B. A. I.	1,280
16	Miss Cowslip (sixth)	101.0		101.8	100.8	101.6		101.30	....do	B. A. I.	1,317
7	Rue	103.3	101.4		99.4	100.0		101.25	....do	Koch	980
8	Neth. Nugget	100.2	100.6		100.4	101.7		100.73	March 13, 4 p. m.	Koch	1,122
10	Bunn	102.3	102.2		101.8	102.0		102.08	....do	Koch	1,260
11	Beauty	101.1	101.2		99.6	101.6		100.88	....do	Koch	1,120
12	Bessie (second)	102.0	102.0		100.4	101.8		101.55	....do	Koch	930
13	Palmyra	101.2	101.7		100.6	101.6		101.28	....do	Koch	906
14	Pansy	102.3	102.0		101.6	101.9		101.95	....do	Koch	816
18	Colantha Rosa	102.1	102.1		102.0	102.1		102.08	....do	Koch	933
19	Experimentalist	101.1	101.5		101.0	102.0		101.40	....do	Koch	1,336

TABLE VII—Continued.

Temperature records of station herd subsequent to first inoculation with tuberculin.

Hours after injection.

No.	Name.	Average normal temperature.	6 hours.	8 hours.	9 hours.	10 hours.	11 hours.	12 hours.	14 hours.	16 hours.	18 hours.	20 hours.	24 hours.	28 hours.	40 hours.	Reaction above average normal.	Reaction above highest normal.
1	Polly	101.42			103.9		104.9	106.0	106.2	103.4	105.0	105.4				4.8	4.6
4	Gay	101.05			101.7		102.7	103.9	104.4	104.0	102.5	101.5				3.4	3.1
9	Daisy	100.85			102.4		103.8	99.5	100.6	102.4	102.4	101.5				3.0	2.4
2	Bessein	101.70		102.3		102.7		103.3	103.2	103.3	102.6	102.4				1.6	1.3
3	Doubtful	101.42		101.2		101.5		101.9	102.3	103.1	102.4	101.6				1.7	1.5
5	Aaggie	101.28		102.8		104.0		105.2	105.6	104.9	103.8	102.3				4.3	3.9
6	Galena	101.20		101.8		102.4		103.4	104.2	104.9	103.7	102.5				3.7	2.7
15	Melvina	101.97		105.2		106.4		106.3	105.6	106.4	105.0	105.1				4.4	4.3
16	Miss Cowslip	101.30		101.6		102.0		102.2	102.5	102.5	101.8	101.9				1.2	0.9
7	Rue	101.25	101.2	102.2		101.5		102.8	101.2		101.6	98.7	102.0			1.6	1.4
8	Nugget	100.73	101.7	102.0		101.9		102.1	102.4		103.5	101.8	102.4			2.8	1.8
10	Dunn	102.08	101.6	101.4		101.4		101.6	101.5		102.7	102.1	102.7			0.6	0.4
11	Beauty	100.88	100.6	101.2		101.2		101.3	101.6		102.5	101.0	101.9			1.6	0.9
12	Bessie (second)	101.55	101.6	101.7		101.4		102.1	102.1		104.6	103.2	102.5			3.1	2.4
13	Palmyra	101.28	102.0	101.6		101.7		102.3	103.2		104.9	102.4	102.2			3.6	3.2
14	Pansy	101.95	102.0	102.0		102.0		102.3	102.5		104.0	103.1	102 8			2.0	1.7
18	Colantha Rosa	101.86	102.5	102.4		102.8		103.3	104.0		106.5	105.0	103.3	103.2	103.7	4.6	4.4
19	Experimentalist	101.40	101.4	101.0		101.9		102.4	102.3		105.7	106.5	105.2	104.2	104.8	5.1	4.5

TABLE VIII.—*Temperature records of herd preliminary to second inoculation.*

Wisconsin Experiment Station herd, by Dr. Russell.

No.	Name.	4 p. m.	6 a. m.	12 m.	3 p. m.	Average normal temperature.	Date of inoculation.	Kind of tuberculin.	Weight of animal.
									Pounds.
1	Polly	102.3	102.3	100.6	101.8	101.70	March 20, 4 p. m	Koch	779
4	Gay	101.2	101.6	99.7	101.4	100.00	do	Koch	855
9	Daisy	101.1	102.2	99.9	101.7	101.22	do	Koch	796
2	Bessein	101.1	101.8	101.8	101.1	101.45	May 3, 4 p. m	Koch	814
3	Doubtful	101.7	101.4	102.0	101.5	101.65	do	Koch	853
5	Aaggie	101.4	101.6	102.7	100.1	101.45	do	Koch	916
6	Galena	102.2	101.8	101.8	99.7	101.38	do	Koch	941
15	Melvina	101.1	101.1	101.1	101.2	101.12	do	Koch	1,240
16	Cowslip	102.0	101.9	103.2	101.4	102.12	do	Koch	1,236
7	Rue	100.5	101.5	101.4	100.3	100.92	do	B. A. I	880
8	Nugget	101.3	101.8	101.8	101.8	101.68	do	B. A. I	958
10	Bunn	101.3	101.3	101.3	101.3	101.30	do	B. A. I	1,151
11	Beauty	101.6	101.5	101.8	101.5	101.60	do	B. A. I	982
13	Palmyra	101.6	101.1	101.7	101.5	101.48	do	B. A. I	821
14	Pansy	101.7	101.4	102.0	100.9	101.50	do	B. A. I	795
12	Bessie (second)	101.3	99.6	100.3	100.0	100.30	do	B. A. I	694
18	Colantha Rosa	101.9	101.4	101.9	101.2	101.60	do	B. A. I	955
19	Experimentalist	102.0	101.2	102.0	102.0	101.80	do	B. A. I	1,261

TABLE VIII—Continued.

Temperature after inoculation.

No.	Name.	Average normal	Hours after inoculation. 5 hours.	8 hours.	10 hours.	13 hours.	16 hours.	18 hours.	20 hours.	24 hours.	Reaction above average normal.	Reaction above highest normal.	Autopsy.
1	Polly	101.70	103.7	104.5	104.9	105.1	103.4	102.7	102.6	.....	3.4	2.8	Tuberculous.
4	Gay	101.00	101.3	101.2	101.1	101.5	101.7	101.5	101.1	.....	0.7	0.1	Do.
9	Daisy	101.22	101.9	101.2	101.7	101.7	101.8	102.0	102.3	99.7	1.1	0.1	Do.
2	Bessein	101.45	101.5	101.5	101.2	101.4	102.0	102.9	101.5	.....	1.4	1.1	Not killed.
3	Doubtful	101.65	101.4	101.2	101.8	102.5	102.2	102.1	102.0	.....	0.8	0.5	Do.
5	Aaggie	101.45	102.2	102.0	101.8	102.0	102.2	102.4	102.9	102.7	1.5	0.2	Tuberculous.
6	Galena	101.38	101.7	101.7	101.6	101.7	102.2	101.8	101.6	.....	0.8	0.0	Do.
15	Melvina	101.12	102.3	101.8	101.9	102.4	101.9	102.2	103.1	103.0	2.0	1.9	Do.
16	Cowslip	102.12	102.5	101.8	102.4	102.1	103.6	103.4	103.4	.....	1.4	0.2	Not killed.
7	Rue	100.98	101.0	101.0	101.4	103.1	104.0	104.5	104.4	.....	3.5	3.0	Tuberculous.
8	Neth Nugget	101.68	101.5	101.8	102.2	103.3	105.2	104.9	104.7	.....	3.5	3.4	Do.
10	Bunn	101.30	100.9	101.3	101.5	103.4	103.3	102.6	102.4	.....	2.1	2.1	Do.
11	Beauty	101.60	101.6	101.4	101.8	102.6	102.9	102.7	102.5	.....	1.3	1.1	Do.
13	Palmyra	101.48	101.3	101.5	101.9	104.6	105.4	105.5	105.1	.....	4.0	2.8	Do.
14	Pansy	101.50	102.0	103.0	103.9	105.0	104.9	104.6	104.2	.....	3.4	3.0	Do.
12	Bessie (second)	100.30	104.1	103.6	103.0	102.6	102.0	101.8	101.9	.....	3.8	2.8	Do.
18	Colantha Rosa	101.60	101.8	102.1	101.8	102.6	103.1	102.7	102.1	.....	1.4	1.1	Do.
19	Experimentalist	101.80	102.4	105.0	105.7	103.6	103.9	104.9	105.4	103.8	3.9	3.7	Do.

TABLE IX.—*Reaction in temperature with tuberculin in tuberculous guinea pigs at different dates after infection.*

	No. 429.			No. 426.			No. 426 II.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection.	July 20	10 a. m..	102. 6	July 21	10 a. m..	103. 4	July 22	9 a. m...	102. 4
	Injected ⅓ cc. tuberculin.			Injected ⅓ cc. tuberculin.			Injected ⅓ cc. tuberculin.		
After injection	July 20	12 m....	102. 8	July 21	12 m....	104. 4	July 22	11 a. m..	103. 2
	July 20	2 p. m...	103. 6	July 21	2 p. m...	104. 4	July 22	1 p. m...	104. 0
	July 20	4 p. m...	103. 0	July 21	4 p. m...	103. 4	July 22	3 p. m...	103. 2

	No. 424.			No. 424 II.			No. 429 II.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection.	July 24	10 a. m..	103. 2	July 25	10 a. m..	103. 4	July 26	10 a. m..	102. 8
	Injected ⅓ cc. tuberculin.			Injected ⅓ cc. tuberculin.			Injected ⅓ cc. tuberculin.		
After injection	July 24	12 m....	104. 2	July 25	12 m....	103. 2	July 26	12 m....	104. 6
	July 24	2 p. m...	104. 4	July 25	2 p. m...	103. 8	July 26	2 p. m...	103. 8
	July 24	4 p. m...	103. 6	July 25	4 p. m...	103. 2	July 26	4 p. m...	103. 4

	No. 429 III.			No. 426 III.			No. 426 IV.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection.	July 27	10 a. m..	102. 4	July 28	10 a. m..	103. 2	July 29	10 a. m..	102. 6
	Injected ⅓ cc. tuberculin.			Injected ⅓ cc. tuberculin.			Injected ⅓ cc. tuberculin.		
After injection	July 27	12 m....	103. 8	July 28	12 m....	104. 0	July 29	12 m....	103. 8
	July 27	2 p. m...	103. 0	July 28	2 p. m...	103. 8	July 29	2 p. m...	104. 0
	July 27	4 p. m...	103. 4	July 28	4 p. m...	103. 6			

	No. 430.			No. 430 II.			No. 425.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection.	July 20	10 a. m..	103. 0	July 21	10 a. m..	102. 6	July 22	9 a. m...	103. 6
	Injected ⅓ cc. tuberculin.			Injected ⅓ cc. tuberculin.			Injected ⅓ cc. tuberculin.		
After injection	July 20	12 m....	102. 8	July 21	12 m....	103. 6	July 22	11 a. m..	103. 8
	July 20	2 p. m...	103. 6	July 21	2 p. m...	103. 6	July 22	1 p. m...	104. 2
	July 20	4 p. m...	103. 6	July 21	4 p. m...	103. 4	July 22	3 p. m...	104. 0

	No. 425 II.			No. 421.			No. 421 II.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection.	July 24	10 a. m..	102. 0	July 25	10 a. m..	102. 6	July 26	10 a. m..	102. 8
	Injected ⅓ cc. tuberculin.			Injected ⅓ cc. tuberculin.			Injected ⅓ cc. tuberculin.		
After injection	July 24	12 m....	103. 6	July 25	12 m....	103. 4	July 26	12 m....	104. 6
	July 24	2 p. m...	104. 0	July 25	2 p. m...	103. 6	July 26	2 p. m...	103. 6
	July 24	4 p. m...	104. 0	July 25	4 p. m...	103. 4	July 26	4 p. m...	103. 6

TABLE IX.—*Reaction in temperature with tuberculin in tuberculous guinea-pigs at different dates after infection*—Continued.

	No. 430 III.			No. 430 IV.			No. 425 III.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection.	July 27	10 a. m.	102.6	July 28	10 a. m.	103.0	July 29	10 a. m.	103.6
	Injected ⅛ cc. tuberculin.			Injected ⅛ cc. tuberculin.			Injected ⅛ cc. tuberculin.		
After injection	July 27	12 m.	104.2	July 28	12 m.	104.2	July 29	12 m.	104.0
	July 27	2 p. m.	102.4	July 28	2 p. m.	104.3	July 29	2 p. m.	104.6
	July 27	4 p. m.	103.6	July 28	4 p. m.	104.0			

Checks.	No. 428.			No. 435.			No. 433.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection	July 20	10 a. m.	104.0	July 21	10 a. m.	102.4	July 22	9 a. m.	102.2
	Injected ⅛ cc. tuberculin.			Injected ⅛ cc. tuberculin.			Injected ⅛ cc. tuberculin.		
After injection	July 20	12 m.	103.4	July 21	12 m.	102.6	July 22	11 a. m.	101.2
	July 20	2 p. m.	103.4	July 21	2 p. m.	102.6	July 22	1 p. m.	101.8
	July 20	4 p. m.	102.6	July 21	4 p. m.	102.6	July 22	3 p. m.	102.4

Checks.	No. 432.			No. 431.			No. 435 II.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection	July 24	10 a. m.	101.2	July 25	10 a. m.	101.6	July 26	10 a. m.	102.6
	Injected ⅛ cc. tuberculin.			Injected ⅛ cc. tuberculin.			Injected ⅛ cc. tuberculin.		
After injection	July 24	12 m.	100.6	July 25	12 m.	102.0	July 26	12 m.	103.6
	July 24	2 p. m.	101.6	July 25	2 p. m.	102.8	July 26	2 p. m.	103.0
	July 24	4 p. m.	102.4	July 25	4 p. m.	103.0	July 26	4 p. m.	102.8

Checks.	No. 436.			No. 427.			No. 428.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection	July 27	10 a. m.	102.6	July 28	10 a. m.	101.8	July 29	10 a. m.	102.8
	Injected ⅛ cc. tuberculin.			Injected ⅛ cc. tuberculin.			Injected ⅛ cc. tuberculin.		
After injection	July 27	12 m.	102.4	July 28	12 m.	102.6	July 29	12 m.	103.2
	July 27	2 p. m.	103.0	July 28	2 p. m.	102.2	July 29	2 p. m.	104.0
	July 27	4 p. m.	103.0	July 28	4 p. m.	102.0			

TABLE X.—*Reaction in temperature with tuberculin in tuberculous guinea pigs at different dates after infection.*

	No. 482.			No. 482.			No. 486.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection.	Oct. 12	10 a. m..	101.8	Oct. 16	9:30 a.m.	102.6	Oct. 18	9:30 a. m.	102.2
	Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.		
After injection.	Oct. 12	1:15 p.m.	102.8	Oct. 16	11:30 a.m.	102.4	Oct. 18	11:30 a.m.	102.4
	Oct. 12	3:45 p.m.	103.0	Oct. 16	3 p. m ...	102.2	Oct. 18	3:30 p.m.	101.6
							Oct. 18	6 p. m ...	102.4

	No. 482.			No. 486.			(Inoculated July 10, 1893.) No. 426.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection.	Oct. 25	9:30 a. m.	102.0	Nov. 1	9:30 a. m.	102.2	Nov. 8	10 a. m..	103.0
	Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{4}$ cc. tuberculin.		
After injection.	Oct. 25	12 m	102.8	Nov. 1	12 m.....	102.2	Nov. 8	12 m.....	105.0
	Oct. 25	2 p. m	102.6	Nov. 1	2 p. m ...	102.6	Nov. 8	2 p. m ...	106.2
	Oct. 25	4 p. m ...	102.4	Nov. 1	4 p. m ...	103.2	Nov. 8	4 p. m ...	105.0
	Oct. 25	6:15 p.m.	102.2	Nov. 1	6 p. m ...	102.4			

	No. 487 (*a*).			No. 487 (*a*).			No. 484 (*d*).		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Checks. Before injection	Oct. 12	10 a.m...	103.0	Oct. 16	9:30 a.m.	103.4	Oct. 18	9:30 a. m.	102.4
	Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.		
Checks. After injection	Oct. 12	1:15 p.m.	104.0	Oct. 16	11:30 a.m	103.4	Oct. 18	11:30 a.m.	104.0
	Oct. 12	3:45 p.m.	103.8	Oct. 16	3 p. m ...	103.0	Oct. 18	3:30 p. m.	103.0
				Oct. 16	6 p. m...	102.4	Oct. 18	6 p. m....	102.8

	No. 487 (*a*).			No. 484 (*d*).			(Inoculated July 10, 1893.) No. 425.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Checks. Before injection	Oct. 25	9:30 a.m.	103.2	Nov. 1	9:30 a.m.	101.8	Nov. 8	10 a. m ..	103.4
	Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{4}$ cc. tuberculin.		
Checks. After injection	Oct. 25	12 m	103.2	Nov. 1	9:30 a.m.	102.2	Nov. 8	12 m	104.2
	Oct. 25	2 p. m ...	103.0	Nov. 1	2 p. m ...	102.6	Nov. 8	2 p. m ...	106.4
	Oct. 25	4 p. m ...	103.0	Nov. 1	4 p. m ...	102.6	Nov. 8	4 p. m ...	105.8
	Oct. 25	6:15 p. m.	102.8	Nov. 1	6 p. m ...	102.4			

TABLE X.—*Reaction in temperature with tuberculin in tuberculous guinea pigs at different dates after infection*—Continued.

	No. 483.			No. 485.			No. 483.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection.	Oct. 14	9:30 a.m.	102.8	Oct. 16	9:30 a.m.	102.4	Oct. 18	9:30 a.m.	103
	Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.		
After injection.	Oct. 14	11:30 a.m	103.8	Oct. 16	11:30 a.m	102.0	Oct. 18	11:30 a.m	104.0
	Oct. 14	2:30 p.m.	103.8	Oct. 16	3 p.m...	102.8	Oct. 18	3:30 p.m.	103.4
	.....	.....	.....	Oct. 16	6 p.m...	102.6	Oct. 18	6 p.m...	103.4

	No. 485.			No. 483.			(Inoculated Oct. 7, 1893.) No. 485.		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Before injection.	Oct. 25	9:30a.m.	102.6	Nov. 1	9:30a.m.	102.4	Nov. 8	10a.m...	102.0
	Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{4}$ cc. tuberculin.		
After injection.	Oct. 25	12 m	103.4	Nov. 1	12 m	102.6	Nov. 8	12 m.....	103.6
	Oct. 25	2 p.m ...	103.2	Nov. 1	2 p.m ...	102.6	Nov. 8	2 p.m ...	104.0
	Oct. 25	4 p.m ...	103.0	Nov. 1	4 p.m ...	103.4	Nov. 8	4 p m ...	103.0
	Oct. 25	6:15 p.m.	103.0	Nov. 1	6 p.m ...	103.0			

	No. 486 (*b*).			No. 481 (*c*).			No. 488 (*b*).		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Checks. Before injection	Oct. 14	9:30 a.m.	102.2	Oct. 16	9:30 a.m.	103.0	Oct. 18	9:30 a.m.	102.0
	Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.		
After injection	Oct. 14	11:30 a.m	101.8	Oct. 16	11:30 a.m	102.6	Oct. 18	11:30 a.m	102.6
	Oct. 14	2:30 p.m.	102.8	Oct. 16	3 p.m...	102.8	Oct. 18	3:30 p.m.	101.6
	.....	.....	.....	Oct. 16	6 p.m...	102.8	Oct. 18	6 p.m...	102.8

	No. 481 (*c*).			No. 488 (*b*).			(Inoculated Oct. 7, 1893.) No. 481 (*c*).		
	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.
Checks. Before injection	Oct. 25	9:30 a.m.	103.0	Nov. 1	9:30 a.m.	102.0	Nov. 8	10 a.m ..	103.6
	Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{8}$ cc. tuberculin.			Injected $\frac{1}{4}$ cc. tuberculin.		
After injection	Oct. 25	12 m.....	103.0	Nov. 1	12 m.....	101.6	Nov. 8	12 m	103.6
	Oct. 25	2 p.m ...	102.8	Nov. 1	2 p.m ...	102.0	Nov. 8	2 p.m ...	103.8
	Oct. 25	4 p.m ...	102.8	Nov. 1	4 p.m ...	102.2	Nov. 8	4 p.m ...	103.6
	Oct. 25	6:15 p.m.	102.6	Nov. 1	6 p.m ...	102.2