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Bovine Tuberculosis

CONTENTS.

CITY OF BIRMINGHAM.

HEALTH DEPARTMENT.

REPORT

— ON —

The Prevention of Cattle Tuberculosis in Denmark,

— BY —

PROFESSOR BANG'S METHOD.

AUGUST, 1908.

PRECIVAL JONES LIMITED, 148-149, GREAT CHARLES STREET, BIRMINGHAM

Council House,
Birmingham.
August, 1908.

To the Chairman and Members of
The Health Committee.

Gentlemen,

On May 12th you instructed us to visit Denmark, and to inquire into and observe in operation on the spot the methods reported to be successfully yet inexpensively employed there in freeing herds of cattle from tuberculosis. In accordance with such instructions we have now to report that we have visited Copenhagen, various places in Zeeland, Kiel and Hamburg, and obtained the information detailed in this report.

INTRODUCTORY.

In order that your Committee may have before them the facts which led to the above-mentioned visit of inquiry, we have thought it desirable to set out briefly as an introduction the proceedings which led up to this report, and also some of the facts in regard to the disease.

The Report of the 1901 Royal Commission on Tuberculosis established the fact that bovine tuberculosis is capable of causing tuberculous disease in the human subject. The findings of the Commissioners in proof of this have already been placed before you in the extract printed on pages 16 and 17 of the Report on "Tuberculosis and the Milk Supply in Birmingham," and only one paragraph need here be repeated, viz. : "There can be no doubt that in a certain number of cases the tuberculosis occurring in the human subject, especially in children, is the direct result of the introduction into the human body of the bacillus of bovine tuberculosis; and there can also be no doubt that in the majority, at least, of these cases the bacillus is introduced through cow's milk. Cow's milk containing bovine tubercle bacilli is clearly a cause of tuberculosis and of fatal tuberculosis in man."

In the light of this conclusion, the results of the milk examinations recorded in the report on "Tuberculosis and the Milk Supply in Birmingham," showing that about 10 per cent. of the churns of outside milk coming into the stations in Birmingham contained living tubercle bacilli, were at least disturbing. The danger of such milk to the inhabitants, particularly to infants and invalids, is obvious.

In other large towns in this and foreign countries, where such investigations have been undertaken, somewhat similar results have been obtained.

After considering the above-mentioned Report, your Committee convened a conference of the leading Municipal Authorities interested, on February 28th, 1908.

At this Conference it was resolved to seek an interview with the President of the Local Government Board and the President of the Board of Agriculture and Fisheries, and lay the facts before them. Subsequently such interview took place at the Local Government Board Offices, at which the Presidents expressed their concurrence in the main with the views of the conference as to the necessity for legislation on the milk supply, as evidenced by the facts recorded, and they foreshadowed the introduction of a Bill to deal with the question. In addition the Conference directed a letter—a copy of which will be found on page 38—to be sent to all Sanitary Authorities in England, setting out the main facts as to danger of tuberculous milk.

It was felt that, owing to the extensive prevalence of the disease throughout the country, the large percentage of existing bad cowsheds and the relatively small remuneration derived from the dairy industry, the difficulties in the way of satisfactory legislation are so many as to make it unlikely that the Government will take any really effective steps to deal with the matter at the present time. Particularly is this the case when we bear in mind the existing state of public opinion, and the failure yet to fully appreciate the harmfulness of the disease, and the large sum of money that would be required to eradicate tuberculosis from our herds.

In the meantime, and pending Government action, your Committee thought that in the City of Birmingham, where public opinion has been aroused on this subject, there was an opportunity of proceeding in the direction of getting a larger supply of tubercle-free milk than is at present available. The recommendations of the 1896 Royal Commission indicated a possible method of procedure as follows :—

"We recommend that funds be placed at the disposal of the Board of Agriculture in England and Scotland, and of the Veterinary Department of the Privy Council in Ireland, for the preparation of commercial tuberculin, and that stock owners be encouraged to test their animals by the offer of a gratuitous supply of tuberculin and the gratuitous services of a veterinary surgeon on certain conditions. These conditions shall be :—

(a) That the test be applied by a veterinary surgeon.

(*b*) That tuberculin be supplied only to such owners as will undertake to isolate reacting animals from healthy ones.

(*c*) That the stock to be tested shall be kept under satisfactory sanitary conditions, and more especially that sufficient air space, ventilation, and light be provided in the buildings occupied by the animals.

We recommend that the Board of Agriculture in England and Scotland, and the Veterinary Department of the Privy Council in Ireland, undertake the circulation among Agricultural Societies of instructions for the proper use of the tuberculin test, with explanation of the significance of reaction, and directions for effective isolation of reacting animals''

No action on the part of the Government to put the above scheme in operation has been taken in consequence of the doubt cast by Koch on the transmissibility of bovine disease to man. As already stated, this has since been conclusively settled in the affirmative.

On May 11th, 1908, your Medical Officer had a consultation with the Veterinary Superintendent, and subsequently submitted a proposition to your Committee based on the above recommendations. This was briefly as follows :—

That in the first instance, dairy farmers supplying Birmingham with milk should have their herds tested at the expense of the Municipality, and should have the benefit of the advice of the Corporation Veterinary Staff, provided they discarded wasters, separated the infected from the non-infected, and carried out certain other simple precautions which would in due course eliminate tuberculosis from their herds at a very moderate cost to the Municipality, and probably at an equally small cost to the dairy farmers.

It was pointed out to your Committee that in Denmark many herds of cattle were reputed to be either free, or practically free, from tuberculosis, and that this freedom was due to the adoption of very simple methods devised by Professor Bang, the Principal of the Veterinary College at Copenhagen. Before making any offer to the farmers who supply Birmingham with milk your Committee deemed it essential that the fullest information should be obtained as to Bang's method and its practicability for adoption in the Birmingham area, and with this in view a deputation was appointed to visit Denmark.

VISIT TO COPENHAGEN.

On Saturday, June 6th, we arrived at Copenhagen, and shortly afterwards Professor Bang called at our hotel, and had an interview with us in regard to our programme for the following three days. It was arranged that on one day we should visit certain large farms which had been under his care for some years, that on another day we should visit some smaller herds (owned by peasant proprietors) which had been similarly dealt with, and that on the third day we should be shown the two chief retail dairy establishments in Copenhagen. Professor Bang further kindly arranged that Mr. Markeberg, Government Veterinary Inspector, should accompany us on our visits during our stay in Copenhagen, and that he himself should also accompany us to the farms.

Before proceeding to record the particulars of our visits to the Zeeland dairy farms and the Copenhagen retail milk establishments, a reference to the position of the dairying industry in Denmark and to the introduction of tuberculosis among the dairy herds there is necessary, also a short explanation of Bang's method of eradicating the disease.

THE DANISH DAIRY INDUSTRY.

With regard to the dairying industry in Denmark we found conditions which, in some respects, correspond closely to our own, while in others they differ widely. As in England, the dairymen may be roughly divided into two groups: (1) those who supply milk to the towns for consumption, and (2) those who use the milk for the manufacture of butter and cheese.

Many of those who supply the towns with milk have freed or practically freed their herds from tuberculosis by adopting the simple measures described under the term "Bang's method." They benefit by this inasmuch as they are thereby enabled to sell their milk as "baby milk," which by Government order must be the product of cows certified free from tuberculosis. The retail price of such tubercle-free milk is approximately twice that of ordinary milk.

The dairymen supplying the butter factories have not so generally recognised the necessity of freeing their herds, although many of them have voluntarily done this. In the butter factories it has been found practicable so to treat the cream as to sterilise it without injury, and thus kill the germ of tuberculosis when present. This, we were informed, is now regularly done according to Government regulations in all factories, so that for practical purposes Danish butter may be regarded as free from tubercle infection. Similarly the separated milk returned to the farms from the factory must be sterilised at the factory. This eliminates the risk of causing tuberculosis in calves or pigs which are fed on this milk. Dairying is the chief industry of the country, and, being looked upon as of the highest national importance, great attention has been given to it. The up-to-date freehold peasant farmers, generally recognising the advantage of combination, have joined together and established dairy factories in each locality where their produce is systematically handled so as to ensure a uniformly high standard of excellence. In this way, by combination, Danish dairy farmers secure market facilities and prices otherwise unattainable, and have continuously available the advice of an expert in modern scientific dairying.

The records of milk-yield generally kept have proved of much benefit. Farmers know accurately the yearly milk yield in quantity and quality of each cow, and also the milk history of each. In this way unprofitable cows are recognised with certainty and got rid of.

It is by this general combination among farmers, together with skilled and careful attention to details, that Denmark has come to be recognised as the first dairy country in the world. This pre-eminent position in the dairy world is due to her people rather than to any excellence in her soil. Much praise has been given to her farmers, but not a word too much. The great and continued increase in her dairy exportations is clear evidence of this, and at the same time affords convincing testimony of the appreciation in which Danish dairy produce is held universally.

With regard to the origin of bovine tuberculosis in Denmark it is of interest to record a fact drawn attention to by Bang, viz., that the history of the introduction and spread of tuberculosis among Danish cattle clearly illustrates the contagious character of the disease, though needless to say, the facts were not at first generally interpreted in this way. A century ago the Danish herds were free, or practically free, from tuberculosis. Bang has traced the subsequent gradual introduction of the infection first from Switzerland, then from Schleswig, and later by shorthorn cattle from Great Britain. The disease, thus imported, spread very slowly for a time, owing to the fact that most of the cattle were home reared. Even up to the present time it is possible to find exclusively home-reared herds that have been continuously free. In 1892 two such herds were tested, one of thirty-eight and the other of thirty-nine cattle, and found absolutely free. Professor Bang pointed out that the extensive in-breeding at these farms did not in any way predispose the stock to disease, or induce disease in them as is so generally supposed to be the case. Out of 10,344 farms examined up to January, 1904, no less than 2,664 farms, containing 33,956 cattle, were declared free on the first testing. Most of these were small farms carrying under twenty-five head of cattle. On the other hand, infected herds have been examined where it was possible to attribute the disease with certainty to an imported animal. In Bang's experience infection in Danish herds has spread in one of two ways : (1) by placing a diseased cow among healthy cows, (2) by feeding calves with milk containing tubercle infection.

PROFESSOR BANG'S METHOD.

It is impossible to give in a single statement any adequate description of "Bang's method," because somewhat different procedures are employed in dealing with the varying conditions found among cowkeepers in Denmark. The guiding principle, however, governing Bang's method as described by himself during the course of our visit, and observed by us in practical operation on the farms visited, is the gradual eradication of infection. He relies upon segregation and isolation, and not upon slaughter. Only cows with tuberculosis of the udder, and wasters manifestly dangerous to others from extensive open generalised tuberculosis, are slaughtered. Essentially his method depends upon: (1) the use of tuberculin to diagnose the disease; (2) the complete separation of healthy animals from diseased, and (3) the gradual rearing up of a healthy non-infected stock to replace in due course the infected. It is obvious that the process is a slow one, and that it requires continuous persistent watchfulness on the part of the farmer. It has now been in use in Denmark for a sufficiently long time, not only to demonstrate the possibility, but to establish the fact that complete success may be obtained without any large expenditure of money. Professor Bang told us that there were between 600 and 700 herds of dairy cattle in Denmark which had been freed from tuberculosis as the result of applying these measures. In addition to these, there were many herds which had been tested at one time, but in which the process had been abandoned for one reason or another, usually because of the slowness of the process, or on account of the disappointment caused by re-infection of healthy stock in a way which was not apparent to the farmer.

(1) *The Value of Tuberculin.*

A well recognised difficulty in Denmark is that tuberculin is not an absolutely infallible guide in distinguishing the healthy from the diseased cattle. There has, therefore, to be recognised the possibility of an occasional error such as may arise from an uncertain or absent reaction in recently infected cattle, or in emaciated extensively diseased ones, or more rarely from some unexplained individual idiosyncrasy. If the uncertain reactors are separated from the healthy stock until a subsequent test shows them to be decisively free, and this second test is not deferred too long, this source of error may safely be disregarded in practice. Some importance is attached to an early application of the second test, as a recently infected animal undetected at the first test may conceivably become a new source of infection if the condition remains for any length of time undetected from an undue delay in applying the second test. Professor Bang, while fully recognising and making allowance for the limitations of tuberculin above described, maintains its reliability in competent hands, and in practice unhesitatingly accepts a decisive reaction or non-reaction as absolutely diagnostic.

(2) *Separation of Healthy from Diseased.*

After the slaughter of cows suffering from udder tuberculosis and wasters, the herd is divided into a "free portion" and an "infected portion." Bang recommends the removal of one of these to another farm, or failing this, to another shed as far apart from the original premises as possible. Where neither of these is available he, as a last resource, advises the separation of the diseased from the healthy by a brick or a wooden partition in the cowshed, unprovided with doorway or other opening, and the restriction of each group to a separate end of the shed. At one time separation by partition in this way was deemed sufficient, but the risks of communication from time to time during the year are so great that wherever buildings some distance apart are procurable their use is advised. Similarly in summer, separate fields are prescribed, but on small farms their provision may not be possible. In such cases the diseased are restricted to the one end of the field and the healthy to the other. In Denmark, where it is the custom to tether all cattle at grass, their isolation on small farms is more easily secured than it could be here. Although the risk to bovines living out of doors cannot be very great, it is conceivable that predisposed animals may become infected even in the open from the soiling of grass by those affected with open tuberculosis. The only safe way is the complete separation of diseased from healthy both in the house and at grass.

(3) *Rearing a New Stock.*

Having secured as effective separation of the existing stock as circumstances will permit, and provided for a systematic and thorough disinfection of premises, Bang next turns his attention to raising a healthy young stock. Perhaps his most noteworthy achievement has been the rearing up of tubercle-free herds derived from infected parents. He, in fact, has replaced tuberculous herds by healthy ones by simply removing the calves at birth from their infected parents to a place free from infection, and making quite sure that no infection subsequently gained access to them. The calves are fed on milk heated to 80° C. (=176° F.) (sufficient to kill tubercle bacilli), except immediately after birth, when they get milk from cows already proved to be tubercle free, because this is better tolerated than boiled milk. In practice it is desirable to avoid rearing the calves of cows with very advanced tuberculosis, as it is in these that the few cases of intra-uterine infection are found. Since no measures are infallible it is possible that a calf affected with latent or undetected tuberculosis at birth, or that has subsequently been infected by imperfectly sterilised milk, may have been put with the others. To guard against this, calves, like the other stock, are tested with tuberculin. Subsequently, the whole stock are submitted to testing with tuberculin every half year, any reactors being at once removed. When these measures are efficiently maintained for two or three years a real success, at comparatively little cost to the farmer, is secured, but it must be admitted that the effective isolation and maintenance of the stock in two separate herds for several years entails constant vigilance and much real work.

VISITS TO FARMS WHERE BANG'S METHODS HAVE BEEN APPLIED.

On Monday, June 8th, accompanied by Professor Bang and Mr. Markeberg, our first visit was paid to several large dairy farms at Vordingborg, in the South of Zeeland, owned by Sir O. S. Oxholm, G.C.V.O., in whose herds Bang's method has for a number of years been in operation. We were most cordially and graciously welcomed by Sir Oscar, who personally conducted us over his farms. We were also accompanied by his manager, Mr. Spanj, who has had control of the several herds during the time they have been under Professor Bang's supervision, and by the local veterinary surgeon, Mr. Neilson, who has carried out the half-yearly tuberculin testing, and the bi-monthly clinical inspection of the herds. Sir Oscar Oxholm had invited these gentlemen to meet us and to accompany us on our visits to his herds and farms with a view to affording us first-hand information respecting any point we might desire to inquire about.

As regards the buildings, the cowsheds at Rosenfeld and the other farms were empty at our visit, all the cattle, as is the custom in Denmark in summer, being tethered continuously night and day in the fields at grass. The buildings, both old and new, were well designed for the maintenance of general good health in the stock, and for the easy cleansing of sheds. The cubic space, floor space, and means of ventilation, were adequate. The provision of concrete mangers and water troughs, impervious floors, and large gutter channels, supply the means for maintaining cleanliness of cows and of sheds. These sheds, though generally excellent, may be regarded as too large from the point of view of their suitability for facilitating the prevention and eradication of tuberculosis. The stabling of many animals in one shed is a defect, as it is always more easy to limit the spread of an infectious disease in small than in large sheds Moreover, apart from this question of infection, the limiting of the numbers stabled in one shed to twelve or sixteen, or such number as can be looked after efficiently, and milked by one attendant, is useful in affording ready evidence of the relative dairying qualifications of each attendant.

We next visited the dairy, to which, immediately after milking, the milk is conveyed. It is here strained into the transport milk churns, and cooled down by refrigeration to 5° C. (= 41° F.), at which temperature it is maintained by placing the churns in a mixture of ice and salt. Thus prepared, the milk is ready for transport by rail to the Copenhagen Dairy Company. Being the product of certified tubercle-free cows, it is sold as nursery or baby milk.

The quantity of ice used is very considerable, a fact readily apparent from the huge amount in store. All of the ice is obtained from ponds in the neighbourhood, and stored till required.

We then visited the several herds of cows in the fields. The sight presented by 200 or 300 red cows tethered a few yards apart round a large field of rich, dark green, luxuriantly growing rye grass and clover is striking. Every cow completely consumes the portion of grass within her reach before being moved. To prevent treading, soiling, and waste of grass only a small move is made each time, and three moves are made per day. This plan of tethering is said to be economical, and so when feeding cows on long rye grass and clover the almost universal custom in Denmark is to tether. It appeared to us that this tethering is an additional safeguard against the spread of tuberculosis in preventing close contact between the cows. The cows all looked healthy, clean-skinned, and in good milking condition, but not fat. They bore the appearance of being fair but not deep milkers. It may be remarked that this corroborates the views frequently expressed by dairy authorities in this country, viz., that Danish cows do not individually yield more milk than dairy cows here. The yield was said to average 6,000 lbs., and there is a record of one cow having given 14,000 lbs. The herds were mostly of the red Danish breed, but there was a section of Jerseys, and a few others were said to be of the Holstein, Dutch, or Jutland breeds. The cows in Denmark are milked in the fields in summer and in the cowsheds in winter. They are milked three times a day—each dairymaid milking sixteen cows. In no case did we hear any cow cough during our visit—good evidence of absence of pulmonary tuberculosis. As already mentioned, Bang's isolation methods for eradicating tuberculosis have been in operation in Sir O. S. Oxholm's herds for a number of years, and tabular statistical details of the results are given on the opposite page.

SIR O. S. OXHOLM'S HERDS IN SOUTH ZEELAND.

RESULT OF TESTING BY BANG'S METHOD, FROM 1895 to 1908

Date of Test.	Rosenfeld Herd.				Oregaards Herd.				Auno Herd.				Kundskovgaard Herd.				Totals.			
	No. Tested.	Reactors.	Non-Reactors.	% Reactors.	No. Tested.	Reactors.	Non-Reactors.	% Reactors.	No. Tested.	Reactors.	Non-Reactors.	% Reactors.	No. Tested.	Reactors.	Non-Reactors.	% Reactors.	No. Tested.	Reactors.	Non-Reactors.	% Reactors.
1895	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	448	350	98	78·1
1896	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	192	25(1)	167	13·02
1897	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	229(2)	38	191	16·6
1898 (July)...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	268	32	236	11·9
1898 (Nov.)...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	337(3)	10	327	2·9
1899	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	273(4)	56	217	20·5
1900 (1st) ...	76	27	49	35·5	156	5	151	3·2	—	—	—	—	44	—	44	—	276	32	244	11·5
1900 (2nd) ..	—	—	—	—	169	10	159	5·9	—	—	—	—	72	—	72	—	241	10	231	4·1
1901	41	7	34	17·0	159	2	157	1·2	—	—	—	—	68	2	66	2·9	268	11	257	4·1
1902	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	325	18	307	5·5
1903	61	4	57	6·5	192	2	190	1·0	—	—	—	—	78	—	78	—	331	6	325	1·8
1904 (1st) ...	120	11	109	9·1	234	4	230	1·7	—	—	—	—	89	—	89	—	443	15	428	3·4
1904 (2nd) ...	127	10	117	7·8	248	4	244(5)	1·6	29	15	14	51·7	71	1	70	1·4	475	30	445	6·3
1905 (Feb.)...	121	5	116	4·1	—	—	—	—	—	—	—	—	—	—	—	—	121	5	116	4·1
1905 (May)...	107	9	98	8·4	227	12(6)	215	5·3	—	—	—	—	96	4	92	4·1	430	25	405	5·8
1905 (Sept.)..	91	13	78	14·2	226	—	226	—	97	3	94	3·1	79	1	78	1·2	493	17	476	3·4
1906 (Spring)	114	2	112	1·7	210	1	209	·4	89	1	88	1·1	127	3	124	2·3	540	7	533	1·3
1906 (Autmn.)	200	3	197	1·5	217	2	215	·9	89	—	89	—	135	—	135	—	641	5	636	·77
1907 (Spring)	231	5	226	2·1	228	9(7)	219	3·9	—	—	—	—	125	5	120	·4	584	19	565	3·2
1907 (Autmn.)	249	3	244	2·0	227	6	221	2·6	137	4	133	2·9	139	2	137	1·4	752	17	735	2·2
1908	290	10	280	3·4	216	1	215	·4	133	1	132	·7	145	7	138	4·8	784(8)	19	765	2·4

(1) Eleven of the 25 were calves. (2) 310 former reactors untested. (3) 300 former reactors untested. (4) 287 former reactors untested. This was a bad year. (5) No former reactors left at this farm, therefore the infection originated either from stables or undetected (probably recently infected) case at former test. Two of the 4 were calves. (6) Eleven of these were calves. (7) Spring results usually worst, owing to herds having been in stables all winter. (8) At this date there remained 180 cows that had previously reacted.

From the foregoing table it will be observed that although the disease has not been absolutely stamped out, it has been so far reduced during the last half-dozen years that it may be regarded as practically eradicated. Possibly the continued existence of a small percentage of cases may be traceable in some way to the segregated reactors, which still number 180. Professor Bang informed us that in herds where in the course of time tuberculosis was nearly eliminated it is considered a wise policy to remove the remaining infected animals, and do away at once with the last possibility of infection by them.

When Bang commenced operations in 1895 Sir O. S. Oxholm's cattle numbered 448 head. Of these 350 reacted and ninety-eight were free: that is to say, 78 per cent. were diseased. The herd was then divided into sound and unsound portions. In the following year the sound portion, together with added calves, numbered 192. Of these twenty-five reacted to the test, eleven being calves. In 1897 the portion of former reactors were reduced to 310; the sound, including additions, numbered 229. On testing the 229 thirty-eight reacted, or 16.6 per cent. In 1898 the non-reactors in stock, including the calf additions, numbered 268. Of these thirty-two reacted, or 11.9 per cent. From this year onwards half-yearly testing has been practised. In 1900 the reactors and non-reactors were placed on separate farms and have been kept separate since. From this time the percentage of reactors has been comparatively small. Last year it was 2.4 per cent., as against the 78 per cent. in 1895, and this reduction has been effected at little actual cost to the owner, for although doubtless there has been a real cost in maintaining separate herds, against this may be set the gain from the absence of wasters. We asked Sir O. S. Oxholm what it had cost him to free his herds, and he replied to the effect that instead of there being any loss he had derived considerable profit, while Professor Bang, at whose instigation the work was commenced, had got the honour.

Quite apart from his experience at Sir Oscar Oxholm's farms, Mr. Neilson, the veterinary surgeon, has had extensive experience in the practical eradication of tuberculosis from numerous other herds, and as one of his appointments illustrates the practice of combination among farmers common in Denmark it may be mentioned here. This appointment, a type of others, is that of veterinarian to a group of about 100 small dairy farmers who have joined together in a common endeavour to eradicate tuberculosis from their herds. The farms in this instance carried from ten to thirty cows each, and collectively contained over 2,000 head of stock. The services of the veterinarian at each farm, and the cost of the tuberculin used, are paid for by the Government, provided the farmer complies with the Danish State laws in regard to the separation of the diseased from the healthy, and to the slaughter of all wasters affected with tuberculosis of the udder.

Our next visit was to Mr. Langermann's farm at Fairholme, near Frederiksborg, in the North of Zeeland. The cowsheds were large, open, and good sheds, somewhat similar in construction and fittings to those at Rosenfeld, the floors, mangers, and gutters having a rough but impervious concrete surface. Each standing was provided with a cast-iron automatic water trough, with lid which the cow can raise when drinking, but which closes when she ceases. Suspended in front of each standing was a card containing the past milk record of each cow. As at Rosenfeld, there was also here a milk straining and cooling room, with adjoining ice-room. In summer the straining and cooling are done immediately after milking in the milking paddock, to which the water supply, refrigerator, ice supply, and strainers are conveyed. On this farm the cows are let loose in the grass fields as in England. We arrived at the mid-day milking time and found the herd collected in a temporary enclosure at the corner of the field. Collectively the cows looked a serviceable lot, their general appearance being that of good milkers. All looked healthy and quite free from any suspicion of pulmonary disease, and all were in good condition. They were mostly of the Danish red breed with black noses. We were informed that the black nose is regarded as a valuable characteristic in Danish red cattle, inasmuch as it is evidence of freedom from shorthorn blood, and therefore its possessors are less likely to be the subjects of tuberculosis. It would appear from this that the English pedigree shorthorns formerly introduced into Denmark have left a somewhat unenviable reputation.

The milkers—mostly women—wore white milking costumes and head gear. Each carefully washed and dried the udders of the cows she had to milk, and then her own hands before commencing to milk. The milk was strained immediately through a Swedish Ulander strainer, and was cooled down to about 5° C. The churns were then set in a mixture of salt and ice ready for transport to the Copenhagen Dairy Company.

The price Mr. Langermann receives for this milk is 28 ore per two litres, as compared with 21 ore per two litres—the price usually paid for uncooled non-certified milk (=2d. per quart).

The first testing on this farm took place a number of years ago, but the herd was not then tested throughout, only thirty calves being done, and of these fifteen reacted. A few years later Mr. Markeberg, in conjunction with the local veterinary surgeon, attended and tested twenty of the best cows, all of which reacted. It is only in recent years that Bang's isolation methods have been adopted. Here the results have been most gratifying, there not being a single reactor at either of the two last testings. Details of the result since 1905 are as follows :—

		Former Reactors.		Former non-Reactors with addition of young.					
1905	Spring	66	...	187	Of the	187	when tested	19	reacted.
	Autumn	61	...	176	"	176	"	11	"
1906	Spring	66	...	179	"	179	"	4	"
	Autumn	—	...	183	"	183	"	5	"
1907	Spring	—	. .	183	"	183	"	1	"
	Autumn	—	...	188	"	188	"	0	"
1908	Spring	—	...	197	"	197	"	0	"

This farmer in a few years, as the result of some trouble and care, but without much pecuniary expenditure (the Government having paid the cost of testing), has experienced the satisfaction of having converted a herd of which 26 per cent. were tuberculous into a herd absolutely free from disease.

We next visited Mr. H. Neilsen's farm at Bjerygaard, in Tjoreby, near Hillerod. This is a type of a well-to-do peasant proprietor's farm. It is in a state of high cultivation, carrying a fine stock of horses, cattle, and pigs. The cows, all of the red Danish breed, were of uniform good quality, in excellent condition, and presented all the appearance of good milkers. We were informed that several had for years given from 7,000 lbs. to 8,000 lbs. of milk, and they had a record of one which had given 12,000 lbs. Here the general system of tethering stock is followed. During our visit we had a demonstration of the Danish method of ascertaining and registering the milk yield of each cow. An agent is employed by the farmers in combination to go round to twenty different farms, and to take particulars of the yield of milk with the percentage of fat obtained from each cow at the three times of milking on one day every three weeks. This gentleman arrived while we were inspecting the herd. He estimated the weight of the milk of each cow by gauging, and took small samples of the milk of each for subsequent fat analysis by Gerber's method. Mr. Neilson's herd at present numbers 38 cows, and is entirely free from tuberculosis. Some thirty years ago he informed us the herd was so affected with tuberculosis, and so many died, that it had to be entirely disposed of. After a time the farm was restocked, but seven years later tuberculosis again appeared. The herd was then tested, divided into two portions and separated according to Bang's method, with the result that for the last ten years the herd had been free from disease, except that in 1906 a bull that had been exhibited at an agricultural show became affected, and in 1907 one cow reacted. At the spring test in 1908 there were again no reactors. The details of the reactors each year during eradication were as follows :—

	Non reactors, plus addition of young stock after 1895.	
1895	43	Of these 11 reacted.
1896	47	„ 2 „
1897	53	„ 3 „
1898	51	„ 1 „
1899	51	„ 0 „

Since then, with the exception of the two cases mentioned, the herd has been free from the disease.

In addition to the evidence obtained at these visits we have received the records of the results at many other farms, showing what can be achieved by Bang's method.

Perhaps one of the most interesting of these records is that given by Bang in regard to the first experiment he made officially. Here he attempted to free a herd of 208 cattle at Thurebylille in 1892. Eighty per cent. of the cows, 40 per cent. of the bulls, and 40 per cent. of the calves and heifers were tubercular to begin with. The two sections were separated by means of a partition of wood. Separate attendants were employed, and the cattle grazed in separate fields. The distance between the two sections was so small that from the first it was considered that there was considerable risk. The herd was tested every six months from April, 1892, and at intervals some few cases of infection occurred among those supposed to be free. The infected cows continued to give milk, and their calves, so long as they were healthy, were added to the healthy section. Progress at first was slow, but in the end the result at this farm has been good, notwithstanding the unfavourable conditions. Briefly, the results were as follows :—

	Healthy.	Reacting.	Total.
1892	77	131	208
1899	183	44	227
1902	244	0	244

The whole of these cows came from the original stock, and most of them were derived from tubercle-infected mothers.

COST OF BANG'S METHOD.

The cost of freeing a herd is an item which we hoped to be able to obtain quite definite information in regard to, but unfortunately this proved to be impracticable. The veterinary services and tuberculin are supplied gratuitously, but the question of expense of providing separate accommodation for the cattle must vary in every instance.

Where temporary wooden sheds have to be provided, this is cheaply done, in Denmark, as wood is plentiful. On the other hand, the constant watchfulness of the farmer and his staff does have a money value difficult to estimate. The practical point is that the cost in Denmark is so small as to be a negligible quantity so far as the farmer is concerned.

Illustrative case A. Farm not visited by deputation.— Tuberculin was first applied in 1895. Out of twenty-three head of cattle tested one old cow and four calves did not react, the other eighteen cattle reacted. After testing the animals the healthy were housed in a small shed separate from the cowhouse. The farmer retained most of the reacting animals, removed their new-born calves, and reared them with the milk of healthy cows. In 1898 he found that one animal amongst the supposed healthy reacted. In 1901 he had twenty-eight healthy cattle with three reactors, and in 1902 there were thirty animals, all of which were healthy. In answer to the inquiry as to how much the experiment cost, the farmer told Professor Bang that the erection of the two little cow-houses cost £10 10s., and that was all the direct outlay, the other expenses being of little importance and consisting of the additional labour. In this case the farmer supervised the work himself.

Illustrative case B. Farm not visited by deputation.— On this farm there were fifty-three cattle. In 1896 they were tested with tuberculin, and forty-one were found to react. The herd was divided, and the diseased separated from the healthy partly by a wooden partition in the cowshed and partly by using another building at a distance. In 1903 this farmer possessed fifty-five head of healthy cattle, and in July of that year told Professor Bang that the cost did not exceed £2 15s.

Illustrative case C. Farm not visited by Deputation.—This farm was at Borupgaard, near Horsens. In 1894 139 animals reacted, and eighty-six were found to be healthy. Of the adult animals 82 per cent. reacted. Separation was effected by means of a wooden partition built across the cowhouse, in which partition was a door. There was, however, a separate shed for the calves, and another for the heifers and bullocks.

Re-testing was done every six months, and at each re-testing there were some reactors, viz., from 1 to 4 per cent. among the healthy section. No animal was imported, and with the exception of one all the animals in the reacting section were kept as lông as they would have been otherwise, that is to say, until age, or disease, or progress of the tuberculosis caused the animals to be sold or slaughtered.

In 1898 the infected section included sixty-one animals, in 1899 forty, in 1902 twenty-four, and at last in 1903 the remaining eighteen in the infected section were sold. At this date the tubercle-free animals had increased from eighty-six to over 230. In November, 1904, among 250 animals one reacted. The owner of this herd has kept a very accurate account of his expenses, and estimates the cost of the experiment at £5 10s.

Illustrative case D. Farm not visited by Deputation.—This farm is at Ourupgaad, in the island of Falster. The owner commenced by testing only the calves, heifers, and bullocks on his farm. He found 152 healthy animals and thirty-one reactors. They were separated, and the reactors were confined to a building a distance away from the original farm. During the following years the number of healthy animals increased, until in 1897 all the healthy animals were confined to one farm, though there were a few reactors shut up in a special stable. These few reactors, however, caused some of the non-reactors to become infected, and delayed the final result. In 1894 the healthy section was distributed over four farms and consisted of 766 head of cattle, of which twelve reacted. In addition to this herd he still possesses 110 animals, partly old ones which have not been tested, and partly younger animals which have reacted. These were kept together at a separate farm.

Some farmers have gone to a large expense owing to selling old reacting cows too soon. This is contrary to Bang's suggestions that the sale should only be made when the number of diseased cattle is small, so as to obviate the inconvenience of dealing with two herds instead of one.

GOVERNMENT AID.

In 1893 an Act of Parliament was passed enabling the Government to take certain steps against tuberculosis in cattle. One power given was the free supply of tuberculin and the necessary veterinary assistance upon condition that the farmer separated the healthy from the diseased animals in an effective way.

In the first instance only calves and heifers were tested, but in 1895 all stock on a farm was tested if desired. By the same law it was also provided that the calves should be supplied only with milk from healthy cows, or else milk which had been heated. In addition, the thorough disinfection of the cowsheds was added to the conditions. By the law of March 26th, 1898, certain further powers were given. (See appendix for translation of this law.) This has been amended in two directions by the law of 1904: (*a*) the method of fixing the price of the condemned animal was altered, and (*b*) the temperature of 85° C. to which milk has to be heated was reduced to 80° C.

In addition to the important power conferred by this Act in the supply and use of tuberculin on certain conditions, it will be noted that a cow supposed to be affected with tuberculosis of the udder, if proved, is required to be slaughtered at once, and compensation is paid out of the imperial fund by a method which, although appearing to be somewhat complicated, is said to work quite smoothly and to be satisfactory. In every instance before compensation is paid a piece of the udder is examined at Professor Bang's laboratory, and out of 2,174 pieces so examined less than 1.2 per cent. proved apparently to be healthy. Professor Bang laid great stress on the immediate slaughter of cows with udder tuberculosis, as such were the most fertile sources of the disease, not only to the human subject but to cattle.

COPENHAGEN MILK SUPPLY.

Although an inquiry into the milk supply of Copenhagen was not among the items in the programme of our visit to Denmark, the Copenhagen milk supply companies' methods have been in recent years so often and favourably reported upon that being there we welcomed the opportunity of inspecting their establishments.

In Copenhagen there are, we learned, four large retail milk companies, each of which with the view of obtaining milk derived only from healthy cows employs a salaried superintendent veterinarian, with whom local veterinary surgeons in the various districts co-operate for inspecting the herds.

Copenhagen Municipal Regulations in regard to milk make it obligatory that all milk sold as nursery or infant milk shall be the product of cows certified free from tuberculosis, and stipulate that the cows so certified shall be tested annually with tuberculin and inspected clinically bi-monthly. But the Copenhagen Milk Companies go a step further and prescribe half-yearly testing of all herds whose milk is sold as infant milk.

The time at our command would not permit our visiting more than the establishments of the two chief companies, viz., those of the Copenhagen Milk Supply Company and of the Danish Dairy Company. These two companies differ essentially in their methods of dealing with the milk. The one relies upon the preservation of the good qualities of the milk by refrigeration, the other by sterilisation.

The Copenhagen Company, whose methods are of world-wide repute, and have been the model for similar dairy companies in other countries, distributes the natural milk of well-fed, healthy, clean-kept cows, cooled by refrigeration to 5° C. immediately after milking, as observed during our visit to farms and recorded in connection therewith.

Mr. Busck, the managing-director, attaches great importance to the refrigeration commencing immediately the milk has left the udder. For this purpose he has devised a most ingenious milking pail provided with a space to contain a freezing mixture, so that the milk is cooled immediately.

The refrigerated milk is conveyed in the company's small churns by rail in vans to their private siding at the Company's headquarters in Copenhagen. The vans are double walled to maintain a constant inside temperature, and fitted with removable bottoms to facilitate cleansing. When the weather renders it necessary the temperature is lowered by the addition of an ice-box. The milk is weighed on arrival, sampled for fat and tested as to flavour. It is then very effectually filtered by upward filtration through filters specially constructed, and fitted with layers of fine gravel, coarse sand, and fine sand, separated from each other by finely perforated tin. The top is covered with several folds of cloth fastened at the edge. Separate filters are used for baby milk, ordinary milk, cream, etc., and they are thoroughly cleansed and sterilised daily. The milk, after filtration, runs into cans or bottles—ordinary milk in green bottles, infant milk in white—the bottles are then placed in baskets and packed in ice ready for conveyance in horse or hand carts to the customers throughout the city. The amount of ice used by the company is said to be about 3,000 tons a year. Our visit commenced at the somewhat unusual hour of 10 p.m. on Sunday night—the hour at which the milk for next morning's distribution is received. Nevertheless, despite the unusual hour, Mr. Busck, the managing-director, and Mrs. Busck, who had been informed of our intending visit, with kind intent were there ready to explain in detail the Company's procedure in supplying the inhabitants with pure milk from healthy cows. During our visit the night staff of white-costumed, immaculately clean and healthy-looking employés, male and female, were busily engaged in receiving, weighing, filtering, and bottling the milk to be ready for next morning, and a very interesting and busy scene they presented.

The procedure at the Danish Dairy Company's establishment, which we visited at mid-day, is very different. Here, after sampling the milk as received and testing it with respect to acidity, temperature, etc., it is filtered, sterilised by raising the temperature momentarily to 90° C., gradually cooled and then bottled ready for sale. At both establishments a very important part of the procedure is the thorough cleansing and sterilisation of empty milk vessels. The vessels are first drained of any remaining milk, washed with cold water, then washed with hot soda water, scrubbed by a revolving brush, washed with lime water, rinsed with filtered cold water, steamed, and dried ready for use.

The general impression made upon us was that the inhabitants of Copenhagen are unusually well served in their milk supply, and we venture to think that though the Copenhagen milk supply is a subject not strictly included in our inquiry, this digression relating to our visit to these dairies may not be deemed quite irrelevant.

Apart from the excellent regulations on milk hygiene so briefly outlined, these companies merit high commendation for employing in every-day practice with greater stringency than the law requires those measures described above which are designed to prevent milk tuberculosis in children, and which deserve the widest emulation.

OSTERTAG'S METHOD.

Before summarising the results of our visit we think there should be placed before you a brief account of what is being done in North Germany to suppress bovine tuberculosis. In the provinces of Schleswig Holstein, Saxony, Brandenburg, Pommerania, East Prussia, etc., what is know as Ostertag's method is in operation. This has been devised by Professor Ostertag, of Berlin, with a view to securing a gradual reduction of tuberculosis in bovines by the comparatively inexpensive process of eliminating all cases of open teuberculosis from dairy herds.

We desired to obtain at first hand reliable information respecting this procedure. As it was possible to get this at Keil and Hamburg on our way home we thought that the opportunity should not be lost, and accordingly we called at the laboratory of Professor Bugge at the Agricultural Institute, Kiel, and at the Hygienic Institute, of which Professor Dunbar is the head, at Hamburg.

Professor Ostertag's method is based on the fact that every case of tuberculosis originates from infection thrown off by an open or infectious case of the disease. In conviction of this he has devised his method for the early diagnosis and immediate separation of such open cases, and believes that in this way he can, to a large extent, prevent infection of the healthy and limit the spread of the disease.

The open or dangerous cases are those of advanced tuberculosis of the lungs and air passages, tuberculosis of the udder, urino-genital organs and intestines, that is to say, those cases in which there are open tuberculous lesions in organs with means of external communication. It is only such cases and no other that can transmit the infection. Professor Ostertag lays great weight on the fact that in the majority of cases of tuberculosis in cattle the disease is limited to situations from which infection cannot be thrown off, and that such cases are for the time being at least not dangerous.

In the pamphlets which have been issued advocating the adoption of this method it is stated that the dangerous tuberculous animals only amount to about 2½ per cent. of the herd.

As the object of Ostertag's procedure is the elimination of infecting cattle from among the healthy the degree of success which attends his measures depends upon the extent to which it is possible in every-day practice to diagnose dangerous cases immediately they occur. It has to be admitted that the real difficulty lies in ascertaining precisely when a non-infectious or non-dangerous case becomes an open or infectious one. This is more difficult than distinguishing between infected and free animals by means of tuberculin. The tuberculin reaction, so accurate in capable hands in differentiating between infected and uninfected cattle, is of no assistance in distinguishing dangerous from non-dangerous cases. It simply indicates the existence of disease and gives no information as to its extent. The few rare cases of advanced tuberculosis in which the reaction fails are not a source of much difficulty, as these are ones which can, as a rule, be diagnosed by clinical examination with certainty.

In Ostertag's method reliance is placed on conjoint veterinary inspection and bacteriological investigation. The herd is submitted annually to a careful clinical veterinary examination of each animal. Soon after this inspection a mixed sample of the herd's milk is taken and sent for bacteriological examination. Further specific examination of any animal is undertaken whenever for any reason that is necessary. As stated above, the recognition of dangerous animals in the more advanced stages of the disease is often not very difficult, and as a rule in these cases the clinical examination will suffice. In all other suspected cases where the condition cannot be positively decided by clinical examination resort is made to bacteriological methods. Samples of milk (preferably the last milk), udder tissue, sputum, or other excretions, are taken by the veterinary surgeon from suspected cows, and sent to an accredited bacteriological laboratory for examination. The samples are specially examined for living tubercle bacilli, which, when proved to be present, is positive evidence of the nature of the case. In this way the existence of infectious cases is positively ascertained.

For the purpose of giving effect to Ostertag's method arrangements have been made between the Department of Agriculture and the various Agricultural Societies for the voluntary systematic veterinary inspection of herds and the bacteriological examination of specimens from suspects.

Laboratories at which, under this agreement, the bacteriological examination of specimens is now systematically undertaken have been established at Konigsberg, Stettin, Berlin, Halle, Kiel, and Rotterdam.

The various Agricultural Societies have arranged that their members who subscribe for the purpose shall have their herds inspected in accordance with the method above described at special terms. Under this agreement the owner is obliged to sign a declaration that he will isolate any animal immediately after it is certified to be suffering from open tuberculosis; he is also reminded that he must slaughter it or sell it to be slaughtered at the earliest possible moment. The earlier it is slaughtered the better, as the less will be the ultimate loss. The owner is under the further necessary obligation of thoroughly cleansing and disinfecting his premises.

As a general routine procedure all farmers are urgently recommended to keep the calves apart from their mothers and to feed them on boiled milk; also to prohibit the common reprehensible practice of giving to young pigs the milk of diseased cows. These precautionary measures to prevent tuberculosis of the young are deemed of the greatest importance owing to the high susceptibility of calves and young pigs, and the great danger of tuberculous milk.

With a view to making Ostertag's method and the arrangement made for giving effect to it as widely known as possible, the various Agricultural Societies have issued handbills fully setting forth Professor Ostertag's contentions and recommendations, and specifying the price contributing members will be charged under the above agreement. The cost to members is as follows:—

Entrance fee of 5 marks for herds up to 25 in number.

Entrance fee of 10 marks for herds above 25 in number.

A yearly fee of 50 pfg. for each animal up to 50 and 25 pfg. for each animal over 50.

Fee for bulls over six months 2 marks.

The lowest fee for one herd is 10 marks.

Certificates are given to the farmers certifying the results of the examinations. We had an opportunity of seeing certain of these. They distinguished: (1) animals highly infectious, signifying whether proved (*a*) by clinical examination, or (*b*) by bacteriological investigation; (2) animals about which there remained a doubt and with respect to which further observation was necessary; and (3) non-dangerous animals.

We obtained from the Keil Laboratory a statement of the results of the work in Schleswig Holstein given below :—

Year.	Number of animals examined.	Number of animals affected with infectious tuberculosis.	Number of animals affected with lung tuberculosis.	Number of animals with udder tuberculosis.	Number of animals with uterine tuberculosis.
1903–4	2,425	63 (2·8%)	65	1	2
1904–5	6,527	135 (2·1%)	130	3	2
1905–6	11,000	213 (1·9%)	186	22	2
1906–7	23,278	451 (1·96%)	426	30	2

It is obvious that much real good can be effected on Ostertag's lines. Its being a voluntary measure is no doubt against it, and while it remains voluntary the extent of its adoption will probably not be great. At the same time it is a distinct step forward, and on the farms where it is in operation it may confidently be expected to somewhat reduce the prevalance of the disease. It will also probably help to educate public opinion up to the point at which a compulsory measure will be possible.

Apart from any limitation due to its optional character, Ostertag's method lies under the disability that it is practically impossible to recognise each case the moment it becomes infectious. It is probable that an animal may be intermittently infectious for some time without being suspected, and it is quite possible that one may be continuously infectious for a time before either the owner or the inspector becomes aware of it, and yet in the meantime be infecting others. The extensive prevalance of unsuspected tuberculosis revealed by tuberculin in well-cared-for herds from which all recognised wasters are systematically eliminated points with a considerable degree of certainty to infection in this way.

In our opinion Ostertag's method, to be really effective, requires to be compulsory, and to be supplemented by the use of tuberculin. Unless all the infected are first segregated from the free, it is clearly impossible to effectively guard against infection of the healthy.

VISIT TO HOHENBUCHEN MODEL DAIRY FARM.

When at Hamburg, through the kindness of Professor Dunbar, we had the privilege of inspecting Mr. Lippert's large model dairy farm at Hohenbuchen. The herd consisted of over 200 fine, healthy-looking, tubercle-free (as evidenced by tuberculin test) dairy cows. All were spotlessly clean, standing in rows on plentiful straw beds. The tail of each was attached by a string to a wire extended above the cows; this suspends the tail two or three inches above the ground when the cow is lying, and so prevents soiling.

The cow-sheds had glazed brick walls and imperviously-surfaced mangers, floors, and gutters, and each standing had a covered water trough with separate water supply. There was an electric light installation, also a good supply of cleansing water, and adequate cubic space, light and ventilation.

The clean condition of cows and sheds, together with the systematic rejection of the fore milk, careful washing of cows' udders, and attendants' hands, and the other precautions taken at milking to secure absolutely clean milk, presented a striking object lesson as to how a pure milk can be obtained.

The milk is immediately cooled, strained, and otherwise dealt with on the lines of the Copenhagen Milk Supply Company, then conveyed in double-walled vans to Hamburg, where it is sold as tubercle-free nursery milk.

In addition to visiting this farm we had the opportunity of discussing the whole question of the prevention of cattle tuberculosis with Professor Dunbar, and subsequently with the officer who is charged with the supervision of the milk supply at Hamburg.

GENERAL CONCLUSIONS.

As a result of the information given us in Denmark, and from what we saw there, we are able to set out some general conclusions :—

1. Bang's method has proved itself in Denmark during the past sixteen or seventeen years to be a practicable and economical method of ridding herds of dairy cattle of tuberculosis.

2. We consider it to be a method which may equally well be introduced into this country with a probability of even better results ensuing than have been met with in Denmark.

3. The method is somewhat slow in operation, but has the advantage of not being costly, and of causing little or no disturbance to the trade of the milk producer. (A warning is necessary against the indiscriminate slaughter of cows reacting to tuberculin on account of the cost which such slaughter occasions.)

4. The difficulties met with in practice are neither numerous nor serious, and apart from those relating to accommodation and the labour involved, they are likely

mainly to arise from the want of appreciation of the fact that tuberculosis is an infectious disease, spread like other infectious diseases in a number of ways.

RECOMMENDATIONS.

We are so strongly impressed with the necessity of doing something in this country to limit the amount of tuberculosis that we take this opportunity of making certain suggestions.

Recognising that no action can be satisfactory which is not of a general character, and applicable to the whole country, we feel that Government action is necessary, probably on the lines we have described as being in existence in Denmark. As a preliminary measure we suggest that in the interest of the stock-owners themselves and of the human population, two methods should be brought into operation :—

1. The scheduling of all cases of open tuberculosis in cattle under the Contagious Disease (Animals) Acts. This will bring inspection to every herd, and will be the means of eliminating uniformly the worst of the infecting cattle ; and

2. The offering of tuberculin and veterinary assistance to those farmers who undertake to carry out the necessary precautions on the lines set out on page 3 et seq. of this report, and which were recommended by the Royal Commission.

Pending the introduction of a Government Bill very good results could, we think, be obtained by Birmingham, and at very little cost to the Corporation, if dairy farmers supplying milk to the City were offered the necessary tuberculin and veterinary advice on the lines set out in the Report of the Medical Officer to the Health Committee on May 11th, 1908.

We desire to acknowledge the great assistance we received from Michael Pearman, Esquire, an expert in dairy farming, who volunteered to accompany us, and whose judgment was always valuable and helpful.

Your Committee have already expressed to Professor Bang its great appreciation of the exceptional services he has rendered; no amount of trouble appeared to be too great for him.

To Mr. Markeberg, of Copenhagen, to Professor Dunbar, of Hamburg, and Professor Bugge, of Kiel, our most grateful thanks are due.

We are,
Gentlemen,
Your obedient Servants,
(Signed)—

JOHN CHARLES DEXTER,
Deputy Chairman of the Health Committee.

JOHN ROBERTSON, M.D.,
Medical Officer of Health.

JOHN MALCOLM, F.R.C.V.S.,
Veterinary Superintendent.

APPENDIX I.

THE COUNCIL HOUSE,
BIRMINGHAM,
March 21st, 1908.

SIR,

TUBERCULOSIS AND THE MILK SUPPLY.

A conference was held at the Town Hall, Manchester, on Friday, February 28th, of delegates representing the Public Health Committees of the Cities of Liverpool, Manchester, Birmingham, Leeds, and Sheffield in regard to the danger to man of milk containing the living infection of tuberculosis.

Each of the above cities has had by reason of local Acts of Parliament considerable experience in the examination of samples of dairy milks for this infection. The result of this experience may be briefly stated by saying "*that the milk in about* 10 *per cent. of the churns sent into these towns contains the living infection of tuberculosis.*"

From experience elsewhere it is almost certain that this high proportion is exceeded in many districts.

The Report of the Royal Commission on Tuberculosis issued in January, 1907, states that "there can be no doubt that in a certain number of cases the tuberculosis occurring in the human subject, especially in children, is the direct result of the introduction into the human body of the bacillus of bovine tuberculosis; and there can also be no doubt that in the majority at least of these cases the bacillus is introduced through cows' milk. Cows' milk containing bovine tubercle bacilli is clearly a cause of tuberculosis, and of fatal tuberculosis in man."

With this important statement, and the knowledge that in their own towns the amount of infected milk was large, the conference decided to approach the Government with a view to getting effective steps taken to eradicate bovine tuberculosis.

The conference felt much strengthened in urging adequate preventive measures by the knowledge that any steps which will effectively deal with tubercle-infected milk will at the same time benefit all consumers of milk in the direction of ensuring a cleaner supply. And again, they feel that the direct benefit to farmers and butchers in preventing loss due either to the reduced value of the stock or to the seizure of tubercular meat intended for human food will be an important one.

The Conference passed the following resolution :—

> "That having regard to the experience of the five towns whose delegates have conferred on this subject, and also to the return recently made to the House of Commons at the request of Dr. Rutherford, a representation be made to the Presidents of the Local Government Board and the Board of Agriculture and Fisheries with a view to inducing these Boards to take effective steps to enforce uniformly throughout the country proper and suitable inspection of dairies and cowsheds, and for regulating the construction of such dairies

> and cowsheds so as to ensure cleanliness and suitable hygienic conditions; and further, that the Government be respectfully asked to include in their prospective legislation dealing with milk, clauses calculated to bring about the eradication of tuberculosis from bovines within a measureable period of years."

It is intended to present this resolution to both the Local Government Board and the Board of Agriculture.

The Conference felt that the subject is of much importance to every town, and therefore requested that your Authority be communicated with in order that you may take steps either by memorial or otherwise to urge the present Government to deal effectively with this important subject, and that you may also ask your Members of Parliament to help in every possible way.

I am,

Yours faithfully,

THOMAS FLETCHER,

Chairman of the Conference
and Chairman of the Health Committee
of the Corporation of Birmingham.

APPENDIX II.

LAW IN REGARD TO COMBATING CATTLE TUBERCULOSIS.

AMALIENBORG,

March 26th, 1898.

WE, Christian IX., by God's Grace, King of Denmark, etc., make known that the Rigsdag has passed the following law, which we have ratified and assented to :—

1.—A sum of 100,000 crowns, which is entered in the annual budget of the Chancellor of the Exchequer, shall be put at the disposal of the Minister of Agriculture for helping stock owners who wish to make use of tuberculin as a diagnostic for combating tuberculosis in cattle. The test of tuberculin shall be tried on the animals according to the rules fixed by the Minister of Agriculture. The subsidy will only be granted to owners who guarantee to keep the animals found healthy by the test apart from the animals which are suffering from tuberculosis, or which have not yet undergone the test with tuberculin.

Moreover, the Minister of Agriculture shall have, under this Act, the right to use a portion of the above mentioned sum for the purpose of helping cattle-breeding associations wishing to test special animals, and also for helping agricultural associations wishing to test with tuberculin the cows belonging to workmen.

Any owners who do not fulfil the obligations, which they have undertaken, to keep the animals found by test to be healthy apart from the portion of the herd found to be suffering from tuberculosis, or that has not yet undergone the test, must refund to the Chancellor of the Exchequer the subsidy received by them.

The requests of the owners or of cattle-breeding associations who wish to test their stock under this law, must be made through agricultural societies, and the requests will be then handed over to the Minister of Agriculture.

2.—The importation of cattle from abroad must be effected only through the routes which have been fixed by the Minister of Agriculture. Immediately after importation, the animals will be put in a special enclosure for quarantine, where they will be tested with tuberculin by the veterinary police surgeons according to the rules fixed by the Minister of Agriculture. This test will be made at the latest on the fifth day after the arrival of the animals. After the test the animals which have not reacted will be put at the disposal of the owner, and the animals which have reacted will be either sent back or taken at once to a public slaughter-house, where they will be slaughtered under the direction of the veterinary police surgeons.

The expenses incurred in providing the sheds for the quarantine and for the tests with tuberculin will be paid by the Government, whereas the other expenses will be paid by the importer.

The regulations contained in this section and in the preceding Section 1 shall be also available for any other diagnostic measures which veterinary science may discover in the war against bovine tuberculosis whenever such shall have been authorised by the Minister of Agriculture.

3.—The quarantine and the test with tuberculin may be omitted in the case of animals imported for slaughter. Such animals will be taken immediately to a public slaughter-house after having been branded.

The Minister of Agriculture may, however, permit the animals imported for slaughter to be taken, immediately after they have been branded, to a cattle market, where they shall be housed at a sufficient distance from other cattle in accordance with the instructions of the veterinary police surgeon. From such place they shall be taken straight to a public slaughter-house.

The cattle for slaughter referred to in this section shall be killed at the latest on the tenth day following the day of their arrival in the country.

4.—The Minister of Agriculture shall issue the necessary regulations for the branding of imported animals.

5.—Cows suffering from tuberculosis of the udder shall be killed. The slaughtering shall take place under the control of the veterinary police surgeon, or in a public slaughter-house. As an indemnity† for the slaughtered animal the owner shall receive a sum corresponding to a quarter of the value of the meat of the animal, and this value shall be fixed according to the current market prices. Moreover, for the portion of the meat which has been found unfit for human food by the veterinary surgeon, the owner shall receive another indemnity of half the value of the meat seized, and this value will also be fixed according to the current market prices. The portion of the meat found fit for human food will be put at the disposal of the owner.

The indemnity will be paid by the State.

6.—It is illegal for dairies to deliver milk or buttermilk for animals' food which has not been heated up to at least 85° Centigrade* (=185 Fahrenheit). Exception may be made to this rule when an accidental circumstance has prevented the heating, but the fact must then be communicated to the person who receives the milk.

† Since altered. See page 25. * Since altered to 80°.

When cleaning the centrifuge the material adherent to the sides must be burned.

7.—It is illegal to import from abroad either milk or buttermilk if the Minister of Agriculture decides that there is not sufficient or satisfactory proof that these have been heated to a temperature of at least 85° Centigrade. Under special conditions, however, the Minister of Agriculture has authority to dispense with this prohibition.

8.—The control over the execution of this law is given to veterinary inspectors, to custom-house officers, to inspectors of factories, and to inspectors of butter and margarine, acting under the instructions of the Minister of Agriculture.

9.—Offences against Sections 2, 3, 6, and 7 of this law will be prosecuted in the police court, and will be punished with fines of from ten to 200 crowns. In the cases mentioned in Sections 6 and 7 the prohibited produce will be confiscated and heated to the prescribed degrees mentioned in these sections. The sum realised by the sale will be placed in the treasury of the town of Copenhagen, and if outside Copenhagen the sum will be put in the box in aid of the poor.

10.—This law comes into force on the 1st April, 1898, except as regards the provisions of Sections 2, 3, and 4, which begin on the 1st June, 1898, and the provisions of Section 6, which come into force on June 1st, 1899. Any motion for revising the law must be addressed to the Rigsdag before the end of the year 1902.

APPENDIX III.

SUPPLEMENT TO THE SANITARY MEASURES FOR COPENHAGEN WITH REGARD TO THE REGULATIONS AS TO DEALING IN MILK, &c.

1. All milk which is sold in the City, as well as all places where milk, which is intended for sale in the City, is kept, used, or sold, shall be under the inspection of the Sanitary Authority, and the special regulations relating to them shall be strictly carried out.

The term "Milk" in these Regulations comprises also cream, in so far as the provisions are applicable to the latter article.

2. No person shall, without previous notice to the Sanitary Inspector, sell milk in the City, nor import any milk into the City for the purpose of sale. Notice must be given of the removal of a milk business, as well as the establishment of branches.

Owners of milch cows in Copenhagen shall forthwith give notice to the Sanitary Inspector whenever an attack of contagious disease, such as tuberculosis, occurs in their herd. They shall further obtain from the Copenhagen Sanitary Authority, and keep exhibited, copies of the abstract of the Sanitary Regulations relating to cow-keeping, together with a copy of these Regulations.

4. Cow's milk, with the exception hereinafter mentioned, can only be sold as "fresh milk," "half skimmed milk," and "skimmed milk." Milk shall only be sold as

"fresh milk" from which there has not been taken any part of its natural ingredients, and the fatty contents of which are at least 2.75 per cent. Adding skimmed or half-skimmed milk to fresh milk precludes the said milk from being sold as "fresh milk," even if the fatty contents are not thereby reduced below 2.75 per cent.

Milk may be sold as "skimmed milk" from which a greater or less part of its natural fatty substance has been taken.

The term "half-skimmed milk" may be used when the fatty substances are at least 0.75 per cent.

5. Milk sold under the term "infants' milk" must be fresh milk which, besides satisfying the requirements stated in Section 4, has been directly after milking cooled to 12° Centigrade or under, and the fatty contents of which are at least 3 per cent. Furthermore, milk which is sold under the definition "infants' milk" shall be taken exclusively from cows which

(1) Within one year previously have been subjected to the tuberculin test with negative results, and

(2) For at least fifteen days previously upon veterinary examination have been found to fulfil the provisions in respect to sanitary condition, feeding, and cleaning, laid down by the Sanitary Authority in the general rules.

Every seller of infants' milk is bound on demand to make the Sanitary Authority acquainted with the source from whence the milk sold by him as "infants' milk" is obtained, and he shall, particularly when so required by the Sanitary Inspector, prove by production of veterinary certificate, that the Regulations provided by Section 1 and 2 have been complied with.

Whenever the Sanitary Authority does not find the veterinary certificate produced to be satisfactory, the Authority may require the dealer in infants' milk to comply with such further conditions as appear necessary for ensuring that the regulations relating to infants' milk may be fulfilled in a satisfactory manner.

By payment blank forms of certificates are obtained on application at the office of the Sanitary Inspector.

Infants' milk must only be sold in air-tight closed receptacles of clear or lightly coloured glass.

6. "Fresh milk," "half-skimmed milk," or "skimmed milk," together defined as "Pasteurised milk" shall, previous to satisfying the provisions stated in Section 4, have been heated up to at least 85° Centigrade*, and immediately after cooled down with a cooling apparatus to 8° Centigrade or less. Under the name "sterilised milk" must only be sold milk which has been sterilised according to a method approved by the Sanitary Authority. Pasteurised and sterilised milk must only be sold in closed completely air-tight vessels of clear or lightly-coloured glass, upon which respectively, the dates of pasteurising or sterilising and the name of the pasteuriser or steriliser are clearly indicated.

The vessels shall, before being filled up, either be sterilised or cleansed in a strong solution of soda or lime water.

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* Since altered to 80° Centigrade.

7. The term "child's milk mixture" (for which in so far as they relate to the mixing of serviceable milk, the regulations mentioned under "infants' milk," in Section 5 are in force) is applied to milk which is allowed to be sold in bottles mixed with water and sugar. An accurate indication of the ingredients and constituents of the mixture must be printed on the label of the bottle.

The mixture shall always be pasteurised.

8. Butter (churned) milk, curdled milk, preserved milk, and the like, must be declared to be such at the time of sale. The same applies to milk of other animals than cows.

9. All milk shall be strained through a close strainer immediately after milking, and be further handled with care and cleanliness. Every milk-producer shall be answerable in this respect, or, in so far as the warranty cannot be binding upon him, then the respective purveyor or dealer. All objects and appliances with which milk comes in contact shall be kept properly clean.

10. It is forbidden to sell milk—

which in colour, smell, taste, or appearance differs from the ordinary sort;

which comes from cows which have recently calved, and whose milk is not yet serviceable for boiling;

which comes from cows suffering from obvious tuberculosis, anthrax, symptomatic anthrax, hydrophobia, jaundice, inflammation of the udders, pyæmia and septicæmia, inflammation from poisoning, foot and mouth disease, cow-pox in advanced stage, severe diarrhœa, or other disease attended with fever, or from cows which are being treated inwardly or outwardly with medicaments which are likely to pass into the milk and affect its condition in an injurious manner;

which is mixed with water, or ice, or with preservatives, such as boric acid (antiseptic), salicylic acid, or other substances which are regarded by the Sanitary Authority as injurious to health, or with other extraneous matter (see, however, Section 7);

which contains dirt or uncleanness of any kind.

Milk which after standing two hours precipitates a visible sediment will be considered as unduly contaminated.

In order to secure the observance of these Regulations the Sanitary Authority may at any time demand a statement from whence milk which is sold in Copenhagen has been obtained, and may, when they think it desirable, require from the respective dealers the production twice monthly of the veterinary certificate as to the sanitary condition of the cows, their cleaning, and feeding, according to the general established Regulations of the Sanitary Authority.

11.—In milk shops, at which milk of the kinds named in Section 4 is sold, every purchaser shall be provided with the necessary notification of what kind of milk he receives. The notification shall be in distinct capital letters at least one inch in size, and the purveyor shall, as far as possible, so contrive that the notification is so placed as to be conspicuous to the public.

When the milk is sold in bottles they shall be of clear or light coloured glass. The indication of the contents, with the vendor's name, shall be conspicuously exhibited and marked in a lasting manner on the side of the bottle, or on the stopper.

The same applies to milk which is intended for disposal here in the City.

Descriptions of milk other than those named in these Regulations are forbidden, on receptacles and bottles as well as in advertisement placards, unless the Sanitary Authority in every instance gives its consent thereto.

In conveying milk to the City, and in storing and selling it in the City, the dealer may not use any measure made of wood, or untinned copper, brass or zinc, nor any rusty receptable, nor any metal receptacle containing lead-enamelling which is cracked or broken apart, nor any receptacle of clay and the like in which there are crevices, nor any damaged glass ware, nor any covered-over receptacle of such a nature as to injure the milk or cause curdling.

Vessels for carrying milk shall be provided with tightly-closing lids, which shall be fastened to them with chains.

All measures employed in milk dealing shall be provided with suitable handles, so that any contact of the milk with the hands in measuring out shall be avoided.

Receptacles in which milk is sent out, or stored, or from which it is sold must not be applied to any other use.

Paper must not be used in the tightening of lids, nor any guttapercha containing lead or any other unclean or injurious material. Gauze or linen must only be used once.

Purveyors of milk using carts on which are also carried yeast, dripping, or such like, may only supply these articles in tightly-closed receptacles.

It is forbidden to convey milk or receptacles intended for milk along with dung or in uncleansed dung carts.

12. Places in the city in which it is intended that milk shall be disposed of, stored, dealt with, or sold, shall be daily ventilated and carefully cleansed.

Where the floor is of planks and not covered with linoleum or other such-like material which is impervious to moisture, it shall be varnished, and the openings between the planks shall be filled up with putty. The floor shall be cleansed daily with a damp cloth. Once a week the floors, doors, and panels shall be carefully cleaned, and the windows rubbed.

Where the walls and ceilings are not composed of marble or other stone, material, glass, or the like, or painted with oil colour, they shall be whitewashed or lime-coloured at least twice yearly. With respect to walls and ceilings which can be washed this shall be done at least four times yearly.

Dry sweeping in such places must not be done

In every place where milk which is intended to be disposed of in the City, shall be stored, dealt with, or sold, there shall be placed a water-spittoon.

No other goods must be dealt in at the same place as milk except bread, cakes, honey, groats, butter, margarine, dripping, eggs, sodawater, and beer in bottles, with sugar goods from closed receptacles. Mangling, laundry, or other similar work must not be carried on in the same place where milk is dealt in.

The place must not be used as a dwelling or night lodging, nor be in direct communication with places which serve as night lodgings, nor with other places which are used as dwellings, unless between these and the milk department an air-tight door is placed, which must not be kept open. Cellars which have an opening to a drain must not be used for keeping, dealing in, or selling milk.

The Regulations contained in this paragraph do not apply to places where milk exclusively is sold and is drawn off from air-tight closed receptacles, nor to places where there is no drawing off or pouring out.

13. When any person who is employed in milking, selling, or dealing in milk, or who lives in connection with a milk supply, becomes affected with symptoms of illness which resemble any acute infectious disease (including typhoid, scarlatina, diphtheria, or other acute throat complaint, inflammation of the brain, erysipelas, cholera), or with any serious chronic infectious complaint (including lung disease), a doctor shall at once be called in, and if he so directs the illness shall be as soon as possible notified to the Sanitary Authority, who may then require that the sick person be removed from the place in question.

No person who is suffering from a spreading or infectious skin disease, or has large foul sores or bandages on the hands or face, and no person who is suffering from any acute infectious fever must be employed in milking, dealing in, or selling milk. Cleanliness of apparel and person will be required from everyone who is employed in milk businesses or in sale of milk.

14. For a breach of the Regulations which affect personal behaviour, besides the person in question, the proprietor of the business, and, according to circumstances, likewise the deliverer of the milk or milk purveyor are also answerable when the breach occurring can be laid to his charge. In so far as the milk is not sold in closed, but in the deliverer's sealed or lead provided receptacles, the seller is answerable that the milk he is selling corresponds with the description under which it is sold.

15. A copy of these Regulations shall be hung in a conspicuous place in every milk store. On application to the Third Division of the Police of Copenhagen copies of such Regulations may be obtained free of charge.

16. The Rules in Section 12 relating to the regulation of places of sale and their condition come into force one year after the confirmation of such Rules, and the rest of the Rules a half-year after their confirmation.

Ministry of Justice, the 3rd May, 1904.

BULLETIN No. 2.

The Hannah Dairy Research Institute

Reactors in Tuberculin-Tested (Licensed) Herds

BY

ALEXANDER B. FOWLER, B.Sc. (Agric.)

AND

NORMAN C. WRIGHT, M.A., Ph.D.

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PART II.—*(Continued)*.

The authors desire to express their appreciation of the willing assistance given them throughout this inquiry by the owners of licensed herds and by County Veterinary Inspectors.

They also desire to record their thanks to the Scottish Certified and Grade A (T.T.) Milk Producers' Association for a grant towards the cost of the issue of this Bulletin.

PREFACE

BY

T. Drummond Shiels, Esq., M.C., M.B., M.P.,

Parliamentary Under Secretary of State for the Colonies, and Chairman of the Research Grants Committee of the Empire Marketing Board.

I have pleasure in writing this introduction to an account of what I regard as a valuable investigation into a matter of great public interest and importance.

During recent years rapid progress has been made in the establishment of tuberculin-tested herds. This progress has been accelerated by the institution of special grades of milk which are produced and sold under official licence. Unfortunately, the demand for such graded milk has failed to keep pace with the supply, a fact which is largely due to the ignorance of the public—and even of the medical profession—of the conditions under which the milk is produced.

The issue of this Bulletin is therefore opportune. The Bulletin deals only with one phase of the subject, namely, the extent to which licensed tuberculin-tested herds are in fact free from infection. This aspect is, however, an extremely important one: not only because of its intimate relationship with public health, but also in view of its close connection with farming practice.

The Bulletin provides for the first time an authoritative statement of the incidence of infected stock in a representative group of tuberculin-tested herds. The full details are available in the following pages. But I would emphasise here that the outstanding feature revealed by the collected figures is the very small proportion of infected animals in the herds investigated, and the negligible risk of infection to those who consume milk which is produced under the stringent precautions incumbent on the owners of licensed tuberculin-tested herds. In reaching these important conclusions, the authors of the Bulletin have made a valuable contribution to the subject.

It is, however, obvious that, if tuberculin-tested herds are to obtain the full confidence of the potential consumer of graded milk, infection on licensed farms must be entirely eliminated. The authors have therefore gone a step further in their investigations, and have attempted, by means of personal visits to individual farms, to determine the major sources through which infection may be contracted in a herd.

In spite of the difficulties inherent in such a method of investigation, the authors have, by a careful analysis of all available evidence, been able to arrive at certain important conclusions. These conclusions have not only resulted in the formulation of eminently practical recommendations, but have opened up the path to fresh investigations into the sources of infection and the elimination of disease.

It must, however, be emphasised that such conclusions are tentative: the collection of empirical information from admittedly questionable sources can never take the place of accurately controlled laboratory or field experiments. Many significant contributions to science, and particularly to the applied sciences of medicine and agriculture have, however, had their origin in the exhaustive collection and the painstaking analysis of information secured in practice.

The well balanced presentation of the evidence relating to the various sources of infection, and the originality of thought which lies behind many of the suggestions which are put forward, leads one to hope that the authors may be given an early opportunity to confirm and to extend their findings under more strictly controlled conditions.

In view of the recognised importance of Milk as a food, it is essential that it should be made safe, and we must welcome every effort towards that end. The Empire Marketing Board and the Medical Research Council have made possible certain other investigations into the tuberculous infection of milk which are now proceeding in Scotland. The various scientific and administrative bodies in Scotland are co-operating in every way possible. It is for the Press and those with knowledge of the subject to see that information regarding this fundamental food product is made more available to the general public. The health of the people, especially of the children, and the prosperity of an important branch of agriculture are involved.

I am sure that all concerned will welcome the contribution to our knowledge of this subject which has been made by Mr. Fowler and Dr. Wright.

T. DRUMMOND SHIELS.

13th January, 1931.

INTRODUCTION.

It is well recognised that the incidence of tuberculosis among dairy cows can, by appropriate means, be greatly reduced. Eradication of bovine tuberculosis has, for instance, been in progress for a number of years in Canada and in the United States, with promising results. Even in these countries, however, there appears to be considerable difficulty in effecting the complete eradication of the disease from a given area. A small percentage, either of stock or of herds, remains infected in spite of drastic measures which are taken to eliminate all sources of reinfection. The figures given in Table I. show the progressive decrease in the number of reactors in a selected area in Canada, but they illustrate at the same time the very slow elimination of infected animals in the later stage of eradication. ([1])

TABLE 1.

PROGRESSIVE DECREASE IN INFECTION IN THE FRASER VALLEY AREA, CANADA.

Date of Test.	Number of Cows.	Percentage of Reactors.
May, 1926	46,174	7.9
March, 1927	46,191	1.1
October, 1928	46,480	0.76
October, 1929	50,603	0.37

In this connection it is also suggestive that, in the United States, a maximum of one half of one per cent. of reactors is *permitted* under the " Modified Accredited Area Plan." ([2])

Elimination of the disease from Canadian and American dairy herds is facilitated by the rapidity with which sources of infection can be removed through the policy of the wholesale slaughter of reacting animals. Conditions in this country present a very different problem. In the first place, the percentage of infected stock is probably far higher. In the second place, there exists in this country no general scheme for the eradication of tuberculosis, and the responsibility for the clearing of herds rests entirely on individual owners. The difficulties are considerable. The owner has to face considerable financial loss in the initial clearing of his herd, since no Government compensation is payable for the loss of reactors ; he has to contend with the risk of reinfection resulting from highly infected premises ; the market from which he can purchase guaranteed tubercle-free stock is limited ; and, even when he has established a free herd, he is subject to continual danger through the contamination of his stock from neighbouring farms where infection is rife.

(1) For these references see p. 46.

Published figures on this subject are scanty, and reliable data relating to the causes of infection and reinfection are meagre. The most complete figures available for an individual herd are recorded by Bowes ([3]). The figures refer to the dairy herd at Manor Farm, Garforth, and cover a period of eighteen years. At the commencement of this period (1908) the herd was tested and was found to contain 65% reactors. For the first six years no attempt was made to free the herd by the immediate sale of reactors, but young stock were isolated from their reacting mothers and were reared, as far as practicable, free from the possibility of infection. By 1915 the reactors had been reduced to about 26%, and it was decided that more active steps should be taken to get rid of the remaining infected stock. Measures were therefore taken to ensure that all reactors were sold off as soon as practicable after the test. In-calf cows were to be kept until the end of their lactation, and then sold. Reacting cows not in-calf were not to be served, but were to be fed off at the end of their lactation. This decision was immediately followed by a progressive decrease in the number of reactors, the figures for 1916 and following years being 11.8%, 5.1%, 7.8%, 8.3%, nil, 1.9%, 1.5%, nil, 9.1%, nil. The high figure at the end of this series (9.1%) was stated to be due to contact with infected bought-in cattle. Similar, but less extensive, data have been published from the University College of North Wales ([4 and 5]). These data refer to the dairy herd at the College Farm, and extend over the period Spring 1920 to Autum 1928. The initial test showed 51% of the herd to be reactors. Conditions for successful eradication were not good; there was ample accommodation for the isolation of reactors in separate buildings, but the cattle—both reactors and non-reactors—were allowed to graze together during the grazing seasons until 1925. "Clinical" cases were looked for at each test, and were at once removed from the herd, but the wholesale disposal of reactors was not feasible, owing to the necessity of keeping up the supply of milk for sale. The percentage of reactors showed, however, a progressive decrease up to 1925, when the number had been reduced to such proportions that the few remaining reactors could be entirely isolated and the sale of graded milk commenced. Subsequently there was never more than one reactor at each six-monthly test. It is interesting to note that a crop of reactors appeared among the heifers in 1925, believed to be due to the consumption of infected milk from reacting cows.

A more comprehensive set of data has been published by Liversage ([6]). The data were obtained in the course of an inquiry into the economics of the production of Grade A (Tuberculin-tested) Milk, and referred to a total of twenty-eight herds. For the details of the individual herds reference may be made to the original publication: the following forms a brief summary of the data. The average proportion of reactors on the 28 farms at the first test was 27%, the proportion on individual farms varying from 75% to 2%. Of the 28 farms, 23 had less than 40% reactors.

At the second test the proportion reacting worked out at an average of 7%—a remarkable reduction over the total of 28 herds. At subsequent tests, Liversage states that the herds reached a fairly stable condition, particularly where replacements in the herds were made entirely from home-bred stock. The average proportion of reactors after the first year's testing worked out for the 28 farms at 4% per test, or 8% per annum. Liversage draws attention, however, to certain cases where the technique of the test was questioned. Omitting these cases (limited to four farms), the average proportion of reactors was found to work out at 1.2% per test, or 2.5% per year. It may be noted here that this figure agrees closely with that found in our own work (*vide infra*).

Prior to 1923 a small number of owners of Scottish dairy herds were consistently using the tuberculin test, there being a limited sale for tuberculin-tested milk and a promising market for tubercle-free stock. In 1923 the Milk (Special Designations) Order (Scotland) came into operation, and this provided an incentive to an increasing number of producers to establish licensed tuberculin-tested herds. By the Autumn of 1923 sixteen producers had been granted licences for the sale of either Certified or Grade A (Tuberculin-tested) Milk. This number increased progressively during the ensuing years, and by 1928 there were more than ninety licensed herds in Scotland.

At this stage the movement was threatened with a serious setback. A licensed dairy herd in the south-west of Scotland, which had hitherto been relatively, if not entirely, free from reactors, was found at an official six-monthly test to have a very high percentage of reacting animals. While it had been generally recognised that sudden—and often unexplained—recurrence of infection took place in licensed herds, the magnitude of the infection in this herd (amounting to 32 animals out of a herd of 43) and its very sudden appearance after a period of comparative freedom from reactors, raised serious doubts in the minds of a number of owners of licensed herds.* The existence of such doubts was recognised by the Scottish Board of Health, who made the following comment in their subsequent Annual Report (7) :—

> " It is perhaps natural that when, after a herd has become established as tubercle-free, a large proportion of the animals are discovered at a subsequent test to be reactors, the producer should at first ascribe the cause to factors over which he has

* " At the September meeting of the Central Executive Committee of the National Farmers' Union of Scotland, Mr. John Speir declared that there was very widespread dissatisfaction regarding the test administered for the purpose of ascertaining whether tuberculosis was present in dairy cattle. A recent case in Lanarkshire, where a very large percentage of a fine dairy herd had been declared to be reactors, had caused grave concern throughout the whole country and in England, and it was felt that a thorough searching inquiry into the various tests and the methods of administration was urgently called for . . . . He moved that the Union should ask the Scottish Board of Health and the Board of Agriculture for Scotland to confer with representatives of the Union with a view to instituting some suitable form of inquiry into the whole matter."—From *The Farmer and Stockbreeder*, 1928.

no control. Even the accuracy of the tuberculin test itself as a reliable indication of the presence of the disease may be impugned on various grounds, but in the cases that have been brought to light under the Order it can be said with confidence that the accuracy of the tuberculin test has been abundantly proved."

It appeared, however, that the time had arrived when an exhaustive inquiry might usefully be made by some independent body with a view to determining the frequency of the appearance of reactors in established licensed herds and, if possible, the main sources from which infection was derived.

With the co-operation of the owners of licensed herds in Scotland the Hannah Institute has undertaken such an inquiry. The detailed findings of this inquiry are set forth in the following pages.

PART I.

The Incidence of Reactors in Tuberculin-Tested (Licensed) Herds.

METHOD OF COLLECTING INFORMATION.

The scope of the inquiry was limited to licensed tuberculin-tested herds in Scotland, *i.e.*, herds producing either Certified or Grade A (Tuberculin-tested) Milk. In general, information was restricted to the first and subsequent *official* tests* as carried out by County Veterinary Inspectors. In a limited number of cases, where the herd had been tested for a number of years prior to that in which the Milk (Special Designations) Order took effect, details for the full period of testing were also included.

In collecting information, the County Veterinary Inspectors were first communicated with, and from them were obtained the names of the owners of licensed herds.† One of the authors (A. B. F.) then visited each herd personally, and obtained such information from individual owners as was available. Out of a total of one hundred and ten licensed herds, information was supplied by the owners of ninety-six. Thirteen owners could supply no information with regard to their herds. The majority of such herds belonged to landed proprietors, whose managers had left, taking the herd history with them. In only one case was information absolutely refused.

In collecting and tabulating the information thus made available, figures for the incidence of reactors in each herd were normally limited to milking stock and in-calf heifers. In a few special cases other animals were included among the reactors.

SUMMARY OF INFORMATION OBTAINED.

The full figures for the number of reactors in each individual herd are detailed in the Appendix to this report. A summary of these figures is contained in Table 2.

An examination of these summarised figures shows that the proportion of reactors in newly established herds was relatively

* Note that the preliminary or "clearing" tests were not included. The figures refer solely to tests administered after the granting of a licence.

† In Scotland the responsibility for the administration of the Milk (Special Designations) Order lies with the Local Authority. There is no central bureau where collected information of this nature is available.

(1) *The Value of Tuberculin.*

A well recognised difficulty in Denmark is that tuberculin is not an absolutely infallible guide in distinguishing the healthy from the diseased cattle. There has, therefore, to be recognised the possibility of an occasional error such as may arise from an uncertain or absent reaction in recently infected cattle, or in emaciated extensively diseased ones, or more rarely from some unexplained individual idiosyncrasy. If the uncertain reactors are separated from the healthy stock until a subsequent test shows them to be decisively free, and this second test is not deferred too long, this source of error may safely be disregarded in practice. Some importance is attached to an early application of the second test, as a recently infected animal undetected at the first test may conceivably become a new source of infection if the condition remains for any length of time undetected from an undue delay in applying the second test. Professor Bang, while fully recognising and making allowance for the limitations of tuberculin above described, maintains its reliability in competent hands, and in practice unhesitatingly accepts a decisive reaction or non-reaction as absolutely diagnostic.

(2) *Separation of Healthy from Diseased.*

After the slaughter of cows suffering from udder tuberculosis and wasters, the herd is divided into a "free portion" and an "infected portion." Bang recommends the removal of one of these to another farm, or failing this, to another shed as far apart from the original premises as possible. Where neither of these is available he, as a last resource, advises the separation of the diseased from the healthy by a brick or a wooden partition in the cowshed, unprovided with doorway or other opening, and the restriction of each group to a separate end of the shed. At one time separation by partition in this way was deemed sufficient, but the risks of communication from time to time during the year are so great that wherever buildings some distance apart are procurable their use is advised. Similarly in summer, separate fields are prescribed, but on small farms their provision may not be possible. In such cases the diseased are restricted to the one end of the field and the healthy to the other. In Denmark, where it is the custom to tether all cattle at grass, their isolation on small farms is more easily secured than it could be here. Although the risk to bovines living out of doors cannot be very great, it is conceivable that predisposed animals may become infected even in the open from the soiling of grass by those affected with open tuberculosis. The only safe way is the complete separation of diseased from healthy both in the house and at grass.

(3) *Rearing a New Stock.*

Having secured as effective separation of the existing stock as circumstances will permit, and provided for a systematic and thorough disinfection of premises, Bang next turns his attention to raising a healthy young stock. Perhaps his most noteworthy achievement has been the rearing up of tubercle-free herds derived from infected parents. He, in fact, has replaced tuberculous herds by healthy ones by simply removing the calves at birth from their infected parents to a place free from infection, and making quite sure that no infection subsequently gained access to them. The calves are fed on milk heated to 80° C. (=176° F.) (sufficient to kill tubercle bacilli), except immediately after birth, when they get milk from cows already proved to be tubercle free, because this is better tolerated than boiled milk. In practice it is desirable to avoid rearing the calves of cows with very advanced tuberculosis, as it is in these that the few cases of intra-uterine infection are found. Since no measures are infallible it is possible that a calf affected with latent or undetected tuberculosis at birth, or that has subsequently been infected by imperfectly sterilised milk, may have been put with the others. To guard against this, calves, like the other stock, are tested with tuberculin. Subsequently, the whole stock are submitted to testing with tuberculin every half year, any reactors being at once removed. When these measures are efficiently maintained for two or three years a real success, at comparatively little cost to the farmer, is secured, but it must be admitted that the effective isolation and maintenance of the stock in two separate herds for several years entails constant vigilance and much real work.

VISITS TO FARMS WHERE BANG'S METHODS HAVE BEEN APPLIED.

On Monday, June 8th, accompanied by Professor Bang and Mr. Markeberg, our first visit was paid to several large dairy farms at Vordingborg, in the South of Zeeland, owned by Sir O. S. Oxholm, G.C.V.O., in whose herds Bang's method has for a number of years been in operation. We were most cordially and graciously welcomed by Sir Oscar, who personally conducted us over his farms. We were also accompanied by his manager, Mr. Spanj, who has had control of the several herds during the time they have been under Professor Bang's supervision, and by the local veterinary surgeon, Mr. Neilson, who has carried out the half-yearly tuberculin testing, and the bi-monthly clinical inspection of the herds. Sir Oscar Oxholm had invited these gentlemen to meet us and to accompany us on our visits to his herds and farms with a view to affording us first-hand information respecting any point we might desire to inquire about.

As regards the buildings, the cowsheds at Rosenfeld and the other farms were empty at our visit, all the cattle, as is the custom in Denmark in summer, being tethered continuously night and day in the fields at grass. The buildings, both old and new, were well designed for the maintenance of general good health in the stock, and for the easy cleansing of sheds. The cubic space, floor space, and means of ventilation, were adequate. The provision of concrete mangers and water troughs, impervious floors, and large gutter channels, supply the means for maintaining cleanliness of cows and of sheds. These sheds, though generally excellent, may be regarded as too large from the point of view of their suitability for facilitating the prevention and eradication of tuberculosis. The stabling of many animals in one shed is a defect, as it is always more easy to limit the spread of an infectious disease in small than in large sheds. Moreover, apart from this question of infection, the limiting of the numbers stabled in one shed to twelve or sixteen, or such number as can be looked after efficiently, and milked by one attendant, is useful in affording ready evidence of the relative dairying qualifications of each attendant.

We next visited the dairy, to which, immediately after milking, the milk is conveyed. It is here strained into the transport milk churns, and cooled down by refrigeration to 5° C. (= 41° F.), at which temperature it is maintained by placing the churns in a mixture of ice and salt. Thus prepared, the milk is ready for transport by rail to the Copenhagen Dairy Company. Being the product of certified tubercle-free cows, it is sold as nursery or baby milk.

The quantity of ice used is very considerable, a fact readily apparent from the huge amount in store. All of the ice is obtained from ponds in the neighbourhood, and stored till required.

We then visited the several herds of cows in the fields. The sight presented by 200 or 300 red cows tethered a few yards apart round a large field of rich, dark green, luxuriantly growing rye grass and clover is striking. Every cow completely consumes the portion of grass within her reach before being moved. To prevent treading, soiling, and waste of grass only a small move is made each time, and three moves are made per day. This plan of tethering is said to be economical, and so when feeding cows on long rye grass and clover the almost universal custom in Denmark is to tether. It appeared to us that this tethering is an additional safeguard against the spread of tuberculosis in preventing close contact between the cows. The cows all looked healthy, clean-skinned, and in good milking condition, but not fat. They bore the appearance of being fair but not deep milkers. It may be remarked that this corroborates the views frequently expressed by dairy authorities in this country, viz., that Danish cows do not individually yield more milk than dairy cows here. The yield was said to average 6,000 lbs., and there is a record of one cow having given 14,000 lbs. The herds were mostly of the red Danish breed, but there was a section of Jerseys, and a few others were said to be of the Holstein, Dutch, or Jutland breeds. The cows in Denmark are milked in the fields in summer and in the cowsheds in winter. They are milked three times a day—each dairymaid milking sixteen cows. In no case did we hear any cow cough during our visit—good evidence of absence of pulmonary tuberculosis. As already mentioned, Bang's isolation methods for eradicating tuberculosis have been in operation in Sir O. S. Oxholm's herds for a number of years, and tabular statistical details of the results are given on the opposite page.

Sir O. S. Oxholm's Herds in South Zeeland.

RESULT OF TESTING BY BANG'S METHOD, FROM 1895 to 1908

Date of Test.	Rosenfeld Herd.				Oregaards Herd.				Auno Herd.				Kundskovgaard Herd.				Totals.			
	No. Tested.	Reactors.	Non-Reactors.	% Reactors.	No. Tested.	Reactors.	Non-Reactors.	% Reactors.	No. Tested.	Reactors.	Non-Reactors.	% Reactors.	No. Tested.	Reactors.	Non-Reactors.	% Reactors.	No. Tested.	Reactors.	Non-Reactors.	% Reactors.
1895	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	448	350	98	78·1
1896	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	192	25(1)	167	13·02
1897	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	229(2)	38	191	16·6
1898 (July)...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	268	32	236	11·9
1898 (Nov.)...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	337(3)	10	327	2·9
1899	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	273(4)	56	217	20·5
1900 (1st) ...	76	27	49	35·5	156	5	151	3·2	—	—	—	—	44	—	44	—	276	32	244	11·5
1900 (2nd) ..	—	—	—	—	169	10	159	5·9	—	—	—	—	72	—	72	—	241	10	231	4·1
1901	41	7	34	17·0	159	2	157	1·2	—	—	—	—	68	2	66	2·9	268	11	257	4·1
1902	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	325	18	307	5·5
1903	61	4	57	6·5	192	2	190	1·0	—	—	—	—	78	—	78	—	331	6	325	1·8
1904 (1st) ...	120	11	109	9·1	234	4	230	1·7	—	—	—	—	89	—	89	—	443	15	428	3·4
1904 (2nd) ...	127	10	117	7·8	248	4	244(5)	1·6	29	15	14	51·7	71	1	70	1·4	475	30	445	6·3
1905 (Feb.) ...	121	5	116	4·1	—	—	—	—	—	—	—	—	—	—	—	—	121	5	116	4·1
1905 (May) ...	107	9	98	8·4	227	12(6)	215	5·3	—	—	—	—	96	4	92	4·1	430	25	405	5·8
1905 (Sept.)..	91	13	78	14·2	226	—	226	—	97	3	94	3·1	79	1	78	1·2	493	17	476	3·4
1906 (Spring)	114	2	112	1·7	210	1	209	·4	89	1	88	1·1	127	3	124	2·3	540	7	533	1·3
1906 (Autmn.)	200	3	197	1·5	217	2	215	·9	89	—	89	—	135	—	135	—	641	5	636	·77
1907 (Spring)	231	5	226	2·1	228	9(7)	219	3·9	—	—	—	—	125	5	120	4	584	19	565	3·2
1907 (Autmn.)	249	3	244	2·0	227	6	221	2·6	137	4	133	2·9	139	2	137	1·4	752	17	735	2·2
1908	290	10	280	3·4	216	1	215	·4	133	1	132	·7	145	7	138	4·8	784(8)	19	765	2·4

(1) Eleven of the 25 were calves. (2) 310 former reactors untested. (3) 300 former reactors untested. (4) 287 former reactors untested. This was a bad year. (5) No former reactors left at this farm, therefore the infection originated either from stables or undetected (probably recently infected) case at former test. Two of the 4 were calves. (6) Eleven of these were calves. (7) Spring results usually worst, owing to herds having been in stables all winter. (8) At this date there remained 180 cows that had previously reacted.

From the foregoing table it will be observed that although the disease has not been absolutely stamped out, it has been so far reduced during the last half-dozen years that it may be regarded as practically eradicated. Possibly the continued existence of a small percentage of cases may be traceable in some way to the segregated reactors, which still number 180. Professor Bang informed us that in herds where in the course of time tuberculosis was nearly eliminated it is considered a wise policy to remove the remaining infected animals, and do away at once with the last possibility of infection by them.

When Bang commenced operations in 1895 Sir O. S. Oxholm's cattle numbered 448 head. Of these 350 reacted and ninety-eight were free: that is to say, 78 per cent. were diseased. The herd was then divided into sound and unsound portions. In the following year the sound portion, together with added calves, numbered 192. Of these twenty-five reacted to the test, eleven being calves. In 1897 the portion of former reactors were reduced to 310; the sound, including additions, numbered 229. On testing the 229 thirty-eight reacted, or 16.6 per cent. In 1898 the non-reactors in stock, including the calf additions, numbered 268. Of these thirty-two reacted, or 11.9 per cent. From this year onwards half-yearly testing has been practised. In 1900 the reactors and non-reactors were placed on separate farms and have been kept separate since. From this time the percentage of reactors has been comparatively small. Last year it was 2.4 per cent., as against the 78 per cent. in 1895, and this reduction has been effected at little actual cost to the owner, for although doubtless there has been a real cost in maintaining separate herds, against this may be set the gain from the absence of wasters. We asked Sir O. S. Oxholm what it had cost him to free his herds, and he replied to the effect that instead of there being any loss he had derived considerable profit, while Professor Bang, at whose instigation the work was commenced, had got the honour.

Quite apart from his experience at Sir Oscar Oxholm's farms, Mr. Neilson, the veterinary surgeon, has had extensive experience in the practical eradication of tuberculosis from numerous other herds, and as one of his appointments illustrates the practice of combination among farmers common in Denmark it may be mentioned here. This appointment, a type of others, is that of veterinarian to a group of about 100 small dairy farmers who have joined together in a common endeavour to eradicate tuberculosis from their herds. The farms in this instance carried from ten to thirty cows each, and collectively contained over 2,000 head of stock. The services of the veterinarian at each farm, and the cost of the tuberculin used, are paid for by the Government, provided the farmer complies with the Danish State laws in regard to the separation of the diseased from the healthy, and to the slaughter of all wasters affected with tuberculosis of the udder.

Our next visit was to Mr. Langermann's farm at Fairholme, near Frederiksborg, in the North of Zeeland. The cowsheds were large, open, and good sheds, somewhat similar in construction and fittings to those at Rosenfeld, the floors, mangers, and gutters having a rough but impervious concrete surface. Each standing was provided with a cast-iron automatic water trough, with lid which the cow can raise when drinking, but which closes when she ceases. Suspended in front of each standing was a card containing the past milk record of each cow. As at Rosenfeld, there was also here a milk straining and cooling room, with adjoining ice-room. In summer the straining and cooling are done immediately after milking in the milking paddock, to which the water supply, refrigerator, ice supply, and strainers are conveyed. On this farm the cows are let loose in the grass fields as in England. We arrived at the mid-day milking time and found the herd collected in a temporary enclosure at the corner of the field. Collectively the cows looked a serviceable lot, their general appearance being that of good milkers. All looked healthy and quite free from any suspicion of pulmonary disease, and all were in good condition. They were mostly of the Danish red breed with black noses. We were informed that the black nose is regarded as a valuable characteristic in Danish red cattle, inasmuch as it is evidence of freedom from shorthorn blood, and therefore its possessors are less likely to be the subjects of tuberculosis. It would appear from this that the English pedigree shorthorns formerly introduced into Denmark have left a somewhat unenviable reputation.

The milkers—mostly women—wore white milking costumes and head gear. Each carefully washed and dried the udders of the cows she had to milk, and then her own hands before commencing to milk. The milk was strained immediately through a Swedish Ulander strainer, and was cooled down to about 5° C. The churns were then set in a mixture of salt and ice ready for transport to the Copenhagen Dairy Company.

The price Mr. Langermann receives for this milk is 28 ore per two litres, as compared with 21 ore per two litres—the price usually paid for uncooled non-certified milk (=2d. per quart).

The first testing on this farm took place a number of years ago, but the herd was not then tested throughout, only thirty calves being done, and of these fifteen reacted. A few years later Mr. Markeberg, in conjunction with the local veterinary surgeon, attended and tested twenty of the best cows, all of which reacted. It is only in recent years that Bang's isolation methods have been adopted. Here the results have been most gratifying, there not being a single reactor at either of the two last testings. Details of the result since 1905 are as follows :—

		Former Reactors.		Former non-Reactors with addition of young.					
1905	Spring	66	...	187	Of the	187	when tested	19	reacted.
	Autumn	61	...	176	"	176	"	11	"
1906	Spring	66	...	179	"	179	"	4	"
	Autumn	—	...	183	"	183	"	5	"
1907	Spring	—	..	183	"	183	"	1	"
	Autumn	—	...	188	"	188	"	0	"
1908	Spring	—	...	197	"	197	"	0	"

This farmer in a few years, as the result of some trouble and care, but without much pecuniary expenditure (the Government having paid the cost of testing), has experienced the satisfaction of having converted a herd of which 26 per cent. were tuberculous into a herd absolutely free from disease.

We next visited Mr. H. Neilsen's farm at Bjerygaard, in Tjoreby, near Hillerod. This is a type of a well-to-do peasant proprietor's farm. It is in a state of high cultivation, carrying a fine stock of horses, cattle, and pigs. The cows, all of the red Danish breed, were of uniform good quality, in excellent condition, and presented all the appearance of good milkers. We were informed that several had for years given from 7,000 lbs. to 8,000 lbs. of milk, and they had a record of one which had given 12,000 lbs. Here the general system of tethering stock is followed. During our visit we had a demonstration of the Danish method of ascertaining and registering the milk yield of each cow. An agent is employed by the farmers in combination to go round to twenty different farms, and to take particulars of the yield of milk with the percentage of fat obtained from each cow at the three times of milking on one day every three weeks. This gentleman arrived while we were inspecting the herd. He estimated the weight of the milk of each cow by gauging, and took small samples of the milk of each for subsequent fat analysis by Gerber's method. Mr. Neilson's herd at present numbers 38 cows, and is entirely free from tuberculosis. Some thirty years ago he informed us the herd was so affected with tuberculosis, and so many died, that it had to be entirely disposed of. After a time the farm was restocked, but seven years later tuberculosis again appeared. The herd was then tested, divided into two portions and separated according to Bang's method, with the result that for the last ten years the herd had been free from disease, except that in 1906 a bull that had been exhibited at an agricultural show became affected, and in 1907 one cow reacted. At the spring test in 1908 there were again no reactors. The details of the reactors each year during eradication were as follows :—

	Non reactors, plus addition of young stock after 1895.	
1895	43	Of these 11 reacted.
1896	47	" 2 "
1897	53	" 3 "
1898	51	" 1 "
1899	51	" 0 "

Since then, with the exception of the two cases mentioned, the herd has been free from the disease.

In addition to the evidence obtained at these visits we have received the records of the results at many other farms, showing what can be achieved by Bang's method.

Perhaps one of the most interesting of these records is that given by Bang in regard to the first experiment he made officially. Here he attempted to free a herd of 208 cattle at Thurebylille in 1892. Eighty per cent. of the cows, 40 per cent. of the bulls, and 40 per cent. of the calves and heifers were tubercular to begin with. The two sections were separated by means of a partition of wood. Separate attendants were employed, and the cattle grazed in separate fields. The distance between the two sections was so small that from the first it was considered that there was considerable risk. The herd was tested every six months from April, 1892, and at intervals some few cases of infection occurred among those supposed to be free. The infected cows continued to give milk, and their calves, so long as they were healthy, were added to the healthy section. Progress at first was slow, but in the end the result at this farm has been good, notwithstanding the unfavourable conditions. Briefly, the results were as follows :—

	Healthy.	Reacting.	Total.
1892	77	131	208
1899	183	44	227
1902	244	0	244

The whole of these cows came from the original stock, and most of them were derived from tubercle-infected mothers.

COST OF BANG'S METHOD.

The cost of freeing a herd is an item which we hoped to be able to obtain quite definite information in regard to, but unfortunately this proved to be impracticable. The veterinary services and tuberculin are supplied gratuitously, but the question of expense of providing separate accommodation for the cattle must vary in every instance.

Where temporary wooden sheds have to be provided, this is cheaply done, in Denmark, as wood is plentiful. On the other hand, the constant watchfulness of the farmer and his staff does have a money value difficult to estimate. The practical point is that the cost in Denmark is so small as to be a negligible quantity so far as the farmer is concerned.

Illustrative case A. Farm not visited by deputation.—Tuberculin was first applied in 1895. Out of twenty-three head of cattle tested one old cow and four calves did not react, the other eighteen cattle reacted. After testing the animals the healthy were housed in a small shed separate from the cowhouse. The farmer retained most of the reacting animals, removed their new-born calves, and reared them with the milk of healthy cows. In 1898 he found that one animal amongst the supposed healthy reacted. In 1901 he had twenty-eight healthy cattle with three reactors, and in 1902 there were thirty animals, all of which were healthy. In answer to the inquiry as to how much the experiment cost, the farmer told Professor Bang that the erection of the two little cow-houses cost £10 10s., and that was all the direct outlay, the other expenses being of little importance and consisting of the additional labour. In this case the farmer supervised the work himself.

Illustrative case B. Farm not visited by deputation.—On this farm there were fifty-three cattle. In 1896 they were tested with tuberculin, and forty-one were found to react. The herd was divided, and the diseased separated from the healthy partly by a wooden partition in the cowshed and partly by using another building at a distance. In 1903 this farmer possessed fifty-five head of healthy cattle, and in July of that year told Professor Bang that the cost did not exceed £2 15s.

Illustrative case C. Farm not visited by Deputation.—This farm was at Borupgaard, near Horsens. In 1894 139 animals reacted, and eighty-six were found to be healthy. Of the adult animals 82 per cent. reacted. Separation was effected by means of a wooden partition built across the cowhouse, in which partition was a door. There was, however, a separate shed for the calves, and another for the heifers and bullocks.

Re-testing was done every six months, and at each re-testing there were some reactors, viz., from 1 to 4 per cent. among the healthy section. No animal was imported, and with the exception of one all the animals in the reacting section were kept as long as they would have been otherwise, that is to say, until age, or disease, or progress of the tuberculosis caused the animals to be sold or slaughtered.

In 1898 the infected section included sixty-one animals, in 1899 forty, in 1902 twenty-four, and at last in 1903 the remaining eighteen in the infected section were sold. At this date the tubercle-free animals had increased from eighty-six to over 230. In November, 1904, among 250 animals one reacted. The owner of this herd has kept a very accurate account of his expenses, and estimates the cost of the experiment at £5 10s.

Illustrative case D. Farm not visited by Deputation.—This farm is at Ourupgaad, in the island of Falster. The owner commenced by testing only the calves, heifers, and bullocks on his farm. He found 152 healthy animals and thirty-one reactors. They were separated, and the reactors were confined to a building a distance away from the original farm. During the following years the number of healthy animals increased, until in 1897 all the healthy animals were confined to one farm, though there were a few reactors shut up in a special stable. These few reactors, however, caused some of the non-reactors to become infected, and delayed the final result. In 1894 the healthy section was distributed over four farms and consisted of 766 head of cattle, of which twelve reacted. In addition to this herd he still possesses 110 animals, partly old ones which have not been tested, and partly younger animals which have reacted. These were kept together at a separate farm.

Some farmers have gone to a large expense owing to selling old reacting cows too soon. This is contrary to Bang's suggestions that the sale should only be made when the number of diseased cattle is small, so as to obviate the inconvenience of dealing with two herds instead of one.

GOVERNMENT AID.

In 1893 an Act of Parliament was passed enabling the Government to take certain steps against tuberculosis in cattle. One power given was the free supply of tuberculin and the necessary veterinary assistance upon condition that the farmer separated the healthy from the diseased animals in an effective way.

In the first instance only calves and heifers were tested, but in 1895 all stock on a farm was tested if desired. By the same law it was also provided that the calves should be supplied only with milk from healthy cows, or else milk which had been heated. In addition, the thorough disinfection of the cowsheds was added to the conditions. By the law of March 26th, 1898, certain further powers were given. (See appendix for translation of this law.) This has been amended in two directions by the law of 1904: (*a*) the method of fixing the price of the condemned animal was altered, and (*b*) the temperature of 85° C. to which milk has to be heated was reduced to 80° C.

In addition to the important power conferred by this Act in the supply and use of tuberculin on certain conditions, it will be noted that a cow supposed to be affected with tuberculosis of the udder, if proved, is required to be slaughtered at once, and compensation is paid out of the imperial fund by a method which, although appearing to be somewhat complicated, is said to work quite smoothly and to be satisfactory. In every instance before compensation is paid a piece of the udder is examined at Professor Bang's laboratory, and out of 2,174 pieces so examined less than 1.2 per cent. proved apparently to be healthy. Professor Bang laid great stress on the immediate slaughter of cows with udder tuberculosis, as such were the most fertile sources of the disease, not only to the human subject but to cattle.

COPENHAGEN MILK SUPPLY.

Although an inquiry into the milk supply of Copenhagen was not among the items in the programme of our visit to Denmark, the Copenhagen milk supply companies' methods have been in recent years so often and favourably reported upon that being there we welcomed the opportunity of inspecting their establishments.

In Copenhagen there are, we learned, four large retail milk companies, each of which with the view of obtaining milk derived only from healthy cows employs a salaried superintendent veterinarian, with whom local veterinary surgeons in the various districts co-operate for inspecting the herds.

Copenhagen Municipal Regulations in regard to milk make it obligatory that all milk sold as nursery or infant milk shall be the product of cows certified free from tuberculosis, and stipulate that the cows so certified shall be tested annually with tuberculin and inspected clinically bi-monthly. But the Copenhagen Milk Companies go a step further and prescribe half-yearly testing of all herds whose milk is sold as infant milk.

The time at our command would not permit our visiting more than the establishments of the two chief companies, viz., those of the Copenhagen Milk Supply Company and of the Danish Dairy Company. These two companies differ essentially in their methods of dealing with the milk. The one relies upon the preservation of the good qualities of the milk by refrigeration, the other by sterilisation.

The Copenhagen Company, whose methods are of world-wide repute, and have been the model for similar dairy companies in other countries, distributes the natural milk of well-fed, healthy, clean-kept cows, cooled by refrigeration to 5° C. immediately after milking, as observed during our visit to farms and recorded in connection therewith.

Mr. Busck, the managing-director, attaches great importance to the refrigeration commencing immediately the milk has left the udder. For this purpose he has devised a most ingenious milking pail provided with a space to contain a freezing mixture, so that the milk is cooled immediately.

The refrigerated milk is conveyed in the company's small churns by rail in vans to their private siding at the Company's headquarters in Copenhagen. The vans are double walled to maintain a constant inside temperature, and fitted with removable bottoms to facilitate cleansing. When the weather renders it necessary the temperature is lowered by the addition of an ice-box. The milk is weighed on arrival, sampled for fat and tested as to flavour. It is then very effectually filtered by upward filtration through filters specially constructed, and fitted with layers of fine gravel, coarse sand, and fine sand, separated from each other by finely perforated tin. The top is covered with several folds of cloth fastened at the edge. Separate filters are used for baby milk, ordinary milk, cream, etc., and they are thoroughly cleansed and sterilised daily. The milk, after filtration, runs into cans or bottles—ordinary milk in green bottles, infant milk in white—the bottles are then placed in baskets and packed in ice ready for conveyance in horse or hand carts to the customers throughout the city. The amount of ice used by the company is said to be about 3,000 tons a year. Our visit commenced at the somewhat unusual hour of 10 p.m. on Sunday night—the hour at which the milk for next morning's distribution is received. Nevertheless, despite the unusual hour, Mr. Busck, the managing-director, and Mrs. Busck, who had been informed of our intending visit, with kind intent were there ready to explain in detail the Company's procedure in supplying the inhabitants with pure milk from healthy cows. During our visit the night staff of white-costumed, immaculately clean and healthy-looking employés, male and female, were busily engaged in receiving, weighing, filtering, and bottling the milk to be ready for next morning, and a very interesting and busy scene they presented.

The procedure at the Danish Dairy Company's establishment, which we visited at mid-day, is very different. Here, after sampling the milk as received and testing it with respect to acidity, temperature, etc., it is filtered, sterilised by raising the temperature momentarily to 90° C., gradually cooled and then bottled ready for sale. At both establishments a very important part of the procedure is the thorough cleansing and sterilisation of empty milk vessels. The vessels are first drained of any remaining milk, washed with cold water, then washed with hot soda water, scrubbed by a revolving brush, washed with lime water, rinsed with filtered cold water, steamed, and dried ready for use.

The general impression made upon us was that the inhabitants of Copenhagen are unusually well served in their milk supply, and we venture to think that though the Copenhagen milk supply is a subject not strictly included in our inquiry, this digression relating to our visit to these dairies may not be deemed quite irrelevant.

Apart from the excellent regulations on milk hygiene so briefly outlined, these companies merit high commendation for employing in every-day practice with greater stringency than the law requires those measures described above which are designed to prevent milk tuberculosis in children, and which deserve the widest emulation.

OSTERTAG'S METHOD.

Before summarising the results of our visit we think there should be placed before you a brief account of what is being done in North Germany to suppress bovine tuberculosis. In the provinces of Schleswig Holstein, Saxony, Brandenburg, Pommerania, East Prussia, etc., what is know as Ostertag's method is in operation. This has been devised by Professor Ostertag, of Berlin, with a view to securing a gradual reduction of tuberculosis in bovines by the comparatively inexpensive process of eliminating all cases of open teuberculosis from dairy herds.

We desired to obtain at first hand reliable information respecting this procedure. As it was possible to get this at Keil and Hamburg on our way home we thought that the opportunity should not be lost, and accordingly we called at the laboratory of Professor Bugge at the Agricultural Institute, Kiel, and at the Hygienic Institute, of which Professor Dunbar is the head, at Hamburg.

Professor Ostertag's method is based on the fact that every case of tuberculosis originates from infection thrown off by an open or infectious case of the disease. In conviction of this he has devised his method for the early diagnosis and immediate separation of such open cases, and believes that in this way he can, to a large extent, prevent infection of the healthy and limit the spread of the disease.

The open or dangerous cases are those of advanced tuberculosis of the lungs and air passages, tuberculosis of the udder, urino-genital organs and intestines, that is to say, those cases in which there are open tuberculous lesions in organs with means of external communication. It is only such cases and no other that can transmit the infection. Professor Ostertag lays great weight on the fact that in the majority of cases of tuberculosis in cattle the disease is limited to situations from which infection cannot be thrown off, and that such cases are for the time being at least not dangerous.

In the pamphlets which have been issued advocating the adoption of this method it is stated that the dangerous tuberculous animals only amount to about 2½ per cent. of the herd.

As the object of Ostertag's procedure is the elimination of infecting cattle from among the healthy the degree of success which attends his measures depends upon the extent to which it is possible in every-day practice to diagnose dangerous cases immediately they occur. It has to be admitted that the real difficulty lies in ascertaining precisely when a non-infectious or non-dangerous case becomes an open or infectious one. This is more difficult than distinguishing between infected and free animals by means of tuberculin. The tuberculin reaction, so accurate in capable hands in differentiating between infected and uninfected cattle, is of no assistance in distinguishing dangerous from non-dangerous cases. It simply indicates the existence of disease and gives no information as to its extent. The few rare cases of advanced tuberculosis in which the reaction fails are not a source of much difficulty, as these are ones which can, as a rule, be diagnosed by clinical examination with certainty.

In Ostertag's method reliance is placed on conjoint veterinary inspection and bacteriological investigation. The herd is submitted annually to a careful clinical veterinary examination of each animal. Soon after this inspection a mixed sample of the herd's milk is taken and sent for bacteriological examination. Further specific examination of any animal is undertaken whenever for any reason that is necessary. As stated above, the recognition of dangerous animals in the more advanced stages of the disease is often not very difficult, and as a rule in these cases the clinical examination will suffice. In all other suspected cases where the condition cannot be positively decided by clinical examination resort is made to bacteriological methods. Samples of milk (preferably the last milk), udder tissue, sputum, or other excretions, are taken by the veterinary surgeon from suspected cows, and sent to an accredited bacteriological laboratory for examination. The samples are specially examined for living tubercle bacilli, which, when proved to be present, is positive evidence of the nature of the case. In this way the existence of infectious cases is positively ascertained.

For the purpose of giving effect to Ostertag's method arrangements have been made between the Department of Agriculture and the various Agricultural Societies for the voluntary systematic veterinary inspection of herds and the bacteriological examination of specimens from suspects.

Laboratories at which, under this agreement, the bacteriological examination of specimens is now systematically undertaken have been established at Konigsberg, Stettin, Berlin, Halle, Kiel, and Rotterdam.

The various Agricultural Societies have arranged that their members who subscribe for the purpose shall have their herds inspected in accordance with the method above described at special terms. Under this agreement the owner is obliged to sign a declaration that he will isolate any animal immediately after it is certified to be suffering from open tuberculosis; he is also reminded that he must slaughter it or sell it to be slaughtered at the earliest possible moment. The earlier it is slaughtered the better, as the less will be the ultimate loss. The owner is under the further necessary obligation of thoroughly cleansing and disinfecting his premises.

As a general routine procedure all farmers are urgently recommended to keep the calves apart from their mothers and to feed them on boiled milk; also to prohibit the common reprehensible practice of giving to young pigs the milk of diseased cows. These precautionary measures to prevent tuberculosis of the young are deemed of the greatest importance owing to the high susceptibility of calves and young pigs, and the great danger of tuberculous milk.

With a view to making Ostertag's method and the arrangement made for giving effect to it as widely known as possible, the various Agricultural Societies have issued handbills fully setting forth Professor Ostertag's contentions and recommendations, and specifying the price contributing members will be charged under the above agreement. The cost to members is as follows :—

Entrance fee of 5 marks for herds up to 25 in number.

Entrance fee of 10 marks for herds above 25 in number.

A yearly fee of 50 pfg. for each animal up to 50 and 25 pfg. for each animal over 50.

Fee for bulls over six months 2 marks.

The lowest fee for one herd is 10 marks.

Certificates are given to the farmers certifying the results of the examinations. We had an opportunity of seeing certain of these. They distinguished: (1) animals highly infectious, signifying whether proved (*a*) by clinical examination, or (*b*) by bacteriological investigation; (2) animals about which there remained a doubt and with respect to which further observation was necessary; and (3) non-dangerous animals.

We obtained from the Keil Laboratory a statement of the results of the work in Schleswig Holstein given below :—

Year.	Number of animals examined.	Number of animals affected with infectious tuberculosis.	Number of animals affected with lung tuberculosis.	Number of animals with udder tuberculosis.	Number of animals with uterine tuberculosis.
1903–4	2,425	63 (2·8%)	65	1	2
1904–5	6,527	135 (2·1%)	130	3	2
1905–6	11,000	213 (1·9%)	186	22	2
1906–7	23,278	451 (1·96%)	426	30	2

It is obvious that much real good can be effected on Ostertag's lines. Its being a voluntary measure is no doubt against it, and while it remains voluntary the extent of its adoption will probably not be great. At the same time it is a distinct step forward, and on the farms where it is in operation it may confidently be expected to somewhat reduce the prevalance of the disease. It will also probably help to educate public opinion up to the point at which a compulsory measure will be possible.

Apart from any limitation due to its optional character, Ostertag's method lies under the disability that it is practically impossible to recognise each case the moment it becomes infectious. It is probable that an animal may be intermittently infectious for some time without being suspected, and it is quite possible that one may be continuously infectious for a time before either the owner or the inspector becomes aware of it, and yet in the meantime be infecting others. The extensive prevalance of unsuspected tuberculosis revealed by tuberculin in well-cared-for herds from which all recognised wasters are systematically eliminated points with a considerable degree of certainty to infection in this way.

In our opinion Ostertag's method, to be really effective, requires to be compulsory, and to be supplemented by the use of tuberculin. Unless all the infected are first segregated from the free, it is clearly impossible to effectively guard against infection of the healthy.

VISIT TO HOHENBUCHEN MODEL DAIRY FARM.

When at Hamburg, through the kindness of Professor Dunbar, we had the privilege of inspecting Mr. Lippert's large model dairy farm at Hohenbuchen. The herd consisted of over 200 fine, healthy-looking, tubercle-free (as evidenced by tuberculin test) dairy cows. All were spotlessly clean, standing in rows on plentiful straw beds. The tail of each was attached by a string to a wire extended above the cows; this suspends the tail two or three inches above the ground when the cow is lying, and so prevents soiling.

The cow-sheds had glazed brick walls and imperviously-surfaced mangers, floors, and gutters, and each standing had a covered water trough with separate water supply. There was an electric light installation, also a good supply of cleansing water, and adequate cubic space, light and ventilation.

The clean condition of cows and sheds, together with the systematic rejection of the fore milk, careful washing of cows' udders, and attendants' hands, and the other precautions taken at milking to secure absolutely clean milk, presented a striking object lesson as to how a pure milk can be obtained.

The milk is immediately cooled, strained, and otherwise dealt with on the lines of the Copenhagen Milk Supply Company, then conveyed in double-walled vans to Hamburg, where it is sold as tubercle-free nursery milk.

In addition to visiting this farm we had the opportunity of discussing the whole question of the prevention of cattle tuberculosis with Professor Dunbar, and subsequently with the officer who is charged with the supervision of the milk supply at Hamburg.

GENERAL CONCLUSIONS.

As a result of the information given us in Denmark, and from what we saw there, we are able to set out some general conclusions :—

1. Bang's method has proved itself in Denmark during the past sixteen or seventeen years to be a practicable and economical method of ridding herds of dairy cattle of tuberculosis.

2. We consider it to be a method which may equally well be introduced into this country with a probability of even better results ensuing than have been met with in Denmark.

3. The method is somewhat slow in operation, but has the advantage of not being costly, and of causing little or no disturbance to the trade of the milk producer. (A warning is necessary against the indiscriminate slaughter of cows reacting to tuberculin on account of the cost which such slaughter occasions.)

4. The difficulties met with in practice are neither numerous nor serious, and apart from those relating to accommodation and the labour involved, they are likely

mainly to arise from the want of appreciation of the fact that tuberculosis is an infectious disease, spread like other infectious diseases in a number of ways.

RECOMMENDATIONS.

We are so strongly impressed with the necessity of doing something in this country to limit the amount of tuberculosis that we take this opportunity of making certain suggestions.

Recognising that no action can be satisfactory which is not of a general character, and applicable to the whole country, we feel that Government action is necessary, probably on the lines we have described as being in existence in Denmark. As a preliminary measure we suggest that in the interest of the stock-owners themselves and of the human population, two methods should be brought into operation :—

1. The scheduling of all cases of open tuberculosis in cattle under the Contagious Disease (Animals) Acts. This will bring inspection to every herd, and will be the means of eliminating uniformly the worst of the infecting cattle ; and

2. The offering of tuberculin and veterinary assistance to those farmers who undertake to carry out the necessary precautions on the lines set out on page 3 et seq. of this report, and which were recommended by the Royal Commission.

Pending the introduction of a Government Bill very good results could, we think, be obtained by Birmingham, and at very little cost to the Corporation, if dairy farmers supplying milk to the City were offered the necessary tuberculin and veterinary advice on the lines set out in the Report of the Medical Officer to the Health Committee on May 11th, 1908.

We desire to acknowledge the great assistance we received from Michael Pearman, Esquire, an expert in dairy farming, who volunteered to accompany us, and whose judgment was always valuable and helpful.

Your Committee have already expressed to Professor Bang its great appreciation of the exceptional services he has rendered; no amount of trouble appeared to be too great for him.

To Mr. Markeberg, of Copenhagen, to Professor Dunbar, of Hamburg, and Professor Bugge, of Kiel, our most grateful thanks are due.

We are,

Gentlemen,

Your obedient Servants,

(Signed)—

JOHN CHARLES DEXTER,

Deputy Chairman of the Health Committee.

JOHN ROBERTSON, M.D.,

Medical Officer of Health.

JOHN MALCOLM, F.R.C.V.S.,

Veterinary Superintendent.

APPENDIX I.

THE COUNCIL HOUSE,
BIRMINGHAM,
March 21st, 1908.

SIR,

TUBERCULOSIS AND THE MILK SUPPLY.

A conference was held at the Town Hall, Manchester, on Friday, February 28th, of delegates representing the Public Health Committees of the Cities of Liverpool, Manchester, Birmingham, Leeds, and Sheffield in regard to the danger to man of milk containing the living infection of tuberculosis.

Each of the above cities has had by reason of local Acts of Parliament considerable experience in the examination of samples of dairy milks for this infection. The result of this experience may be briefly stated by saying "*that the milk in about* 10 *per cent. of the churns sent into these towns contains the living infection of tuberculosis.*"

From experience elsewhere it is almost certain that this high proportion is exceeded in many districts.

The Report of the Royal Commission on Tuberculosis issued in January, 1907, states that "there can be no doubt that in a certain number of cases the tuberculosis occurring in the human subject, especially in children, is the direct result of the introduction into the human body of the bacillus of bovine tuberculosis; and there can also be no doubt that in the majority at least of these cases the bacillus is introduced through cows' milk. Cows' milk containing bovine tubercle bacilli is clearly a cause of tuberculosis, and of fatal tuberculosis in man."

With this important statement, and the knowledge that in their own towns the amount of infected milk was large, the conference decided to approach the Government with a view to getting effective steps taken to eradicate bovine tuberculosis.

The conference felt much strengthened in urging adequate preventive measures by the knowledge that any steps which will effectively deal with tubercle-infected milk will at the same time benefit all consumers of milk in the direction of ensuring a cleaner supply. And again, they feel that the direct benefit to farmers and butchers in preventing loss due either to the reduced value of the stock or to the seizure of tubercular meat intended for human food will be an important one.

The Conference passed the following resolution :—

> "That having regard to the experience of the five towns whose delegates have conferred on this subject, and also to the return recently made to the House of Commons at the request of Dr. Rutherford, a representation be made to the Presidents of the Local Government Board and the Board of Agriculture and Fisheries with a view to inducing these Boards to take effective steps to enforce uniformly throughout the country proper and suitable inspection of dairies and cowsheds, and for regulating the construction of such dairies

> and cowsheds so as to ensure cleanliness and suitable hygienic conditions; and further, that the Government be respectfully asked to include in their prospective legislation dealing with milk, clauses calculated to bring about the eradication of tuberculosis from bovines within a measureable period of years."

It is intended to present this resolution to both the Local Government Board and the Board of Agriculture.

The Conference felt that the subject is of much importance to every town, and therefore requested that your Authority be communicated with in order that you may take steps either by memorial or otherwise to urge the present Government to deal effectively with this important subject, and that you may also ask your Members of Parliament to help in every possible way.

I am,

Yours faithfully,

THOMAS FLETCHER,

Chairman of the Conference
and Chairman of the Health Committee
of the Corporation of Birmingham.

APPENDIX II.

LAW IN REGARD TO COMBATING CATTLE TUBERCULOSIS.

AMALIENBORG,

March 26th, 1898.

WE, Christian IX., by God's Grace, King of Denmark, etc., make known that the Rigsdag has passed the following law, which we have ratified and assented to :—

1.—A sum of 100,000 crowns, which is entered in the annual budget of the Chancellor of the Exchequer, shall be put at the disposal of the Minister of Agriculture for helping stock owners who wish to make use of tuberculin as a diagnostic for combating tuberculosis in cattle. The test of tuberculin shall be tried on the animals according to the rules fixed by the Minister of Agriculture. The subsidy will only be granted to owners who guarantee to keep the animals found healthy by the test apart from the animals which are suffering from tuberculosis, or which have not yet undergone the test with tuberculin.

Moreover, the Minister of Agriculture shall have, under this Act, the right to use a portion of the above mentioned sum for the purpose of helping cattle-breeding associations wishing to test special animals, and also for helping agricultural associations wishing to test with tuberculin the cows belonging to workmen.

Any owners who do not fulfil the obligations, which they have undertaken, to keep the animals found by test to be healthy apart from the portion of the herd found to be suffering from tuberculosis, or that has not yet undergone the test, must refund to the Chancellor of the Exchequer the subsidy received by them.

The requests of the owners or of cattle-breeding associations who wish to test their stock under this law, must be made through agricultural societies, and the requests will be then handed over to the Minister of Agriculture.

2.—The importation of cattle from abroad must be effected only through the routes which have been fixed by the Minister of Agriculture. Immediately after importation, the animals will be put in a special enclosure for quarantine, where they will be tested with tuberculin by the veterinary police surgeons according to the rules fixed by the Minister of Agriculture. This test will be made at the latest on the fifth day after the arrival of the animals. After the test the animals which have not reacted will be put at the disposal of the owner, and the animals which have reacted will be either sent back or taken at once to a public slaughter-house, where they will be slaughtered under the direction of the veterinary police surgeons.

The expenses incurred in providing the sheds for the quarantine and for the tests with tuberculin will be paid by the Government, whereas the other expenses will be paid by the importer.

The regulations contained in this section and in the preceding Section 1 shall be also available for any other diagnostic measures which veterinary science may discover in the war against bovine tuberculosis whenever such shall have been authorised by the Minister of Agriculture.

3.—The quarantine and the test with tuberculin may be omitted in the case of animals imported for slaughter. Such animals will be taken immediately to a public slaughter-house after having been branded.

The Minister of Agriculture may, however, permit the animals imported for slaughter to be taken, immediately after they have been branded, to a cattle market, where they shall be housed at a sufficient distance from other cattle in accordance with the instructions of the veterinary police surgeon. From such place they shall be taken straight to a public slaughter-house.

The cattle for slaughter referred to in this section shall be killed at the latest on the tenth day following the day of their arrival in the country.

4.—The Minister of Agriculture shall issue the necessary regulations for the branding of imported animals.

5.—Cows suffering from tuberculosis of the udder shall be killed. The slaughtering shall take place under the control of the veterinary police surgeon, or in a public slaughter-house. As an indemnity† for the slaughtered animal the owner shall receive a sum corresponding to a quarter of the value of the meat of the animal, and this value shall be fixed according to the current market prices. Moreover, for the portion of the meat which has been found unfit for human food by the veterinary surgeon, the owner shall receive another indemnity of half the value of the meat seized, and this value will also be fixed according to the current market prices. The portion of the meat found fit for human food will be put at the disposal of the owner.

The indemnity will be paid by the State.

6.—It is illegal for dairies to deliver milk or buttermilk for animals' food which has not been heated up to at least 85° Centigrade* (=185 Fahrenheit). Exception may be made to this rule when an accidental circumstance has prevented the heating, but the fact must then be communicated to the person who receives the milk.

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† Since altered. See page 25. * Since altered to 80°.

When cleaning the centrifuge the material adherent to the sides must be burned.

7.—It is illegal to import from abroad either milk or buttermilk if the Minister of Agriculture decides that there is not sufficient or satisfactory proof that these have been heated to a temperature of at least 85° Centigrade. Under special conditions, however, the Minister of Agriculture has authority to dispense with this prohibition.

8.—The control over the execution of this law is given to veterinary inspectors, to custom-house officers, to inspectors of factories, and to inspectors of butter and margarine, acting under the instructions of the Minister of Agriculture.

9.—Offences against Sections 2, 3, 6, and 7 of this law will be prosecuted in the police court, and will be punished with fines of from ten to 200 crowns. In the cases mentioned in Sections 6 and 7 the prohibited produce will be confiscated and heated to the prescribed degrees mentioned in these sections. The sum realised by the sale will be placed in the treasury of the town of Copenhagen, and if outside Copenhagen the sum will be put in the box in aid of the poor.

10.—This law comes into force on the 1st April, 1898, except as regards the provisions of Sections 2, 3, and 4, which begin on the 1st June, 1898, and the provisions of Section 6, which come into force on June 1st, 1899. Any motion for revising the law must be addressed to the Rigsdag before the end of the year 1902.

APPENDIX III.

SUPPLEMENT TO THE SANITARY MEASURES FOR COPENHAGEN WITH REGARD TO THE REGULATIONS AS TO DEALING IN MILK, &c.

1. All milk which is sold in the City, as well as all places where milk, which is intended for sale in the City, is kept, used, or sold, shall be under the inspection of the Sanitary Authority, and the special regulations relating to them shall be strictly carried out.

The term "Milk" in these Regulations comprises also cream, in so far as the provisions are applicable to the latter article.

2. No person shall, without previous notice to the Sanitary Inspector, sell milk in the City, nor import any milk into the City for the purpose of sale. Notice must be given of the removal of a milk business, as well as the establishment of branches.

Owners of milch cows in Copenhagen shall forthwith give notice to the Sanitary Inspector whenever an attack of contagious disease, such as tuberculosis, occurs in their herd. They shall further obtain from the Copenhagen Sanitary Authority, and keep exhibited, copies of the abstract of the Sanitary Regulations relating to cow-keeping, together with a copy of these Regulations.

4. Cow's milk, with the exception hereinafter mentioned, can only be sold as "fresh milk," "half skimmed milk," and "skimmed milk." Milk shall only be sold as

"fresh milk" from which there has not been taken any part of its natural ingredients, and the fatty contents of which are at least 2.75 per cent. Adding skimmed or half-skimmed milk to fresh milk precludes the said milk from being sold as "fresh milk," even if the fatty contents are not thereby reduced below 2.75 per cent.

Milk may be sold as "skimmed milk" from which a greater or less part of its natural fatty substance has been taken.

The term "half-skimmed milk" may be used when the fatty substances are at least 0.75 per cent.

5. Milk sold under the term "infants' milk" must be fresh milk which, besides satisfying the requirements stated in Section 4, has been directly after milking cooled to 12° Centigrade or under, and the fatty contents of which are at least 3 per cent. Furthermore, milk which is sold under the definition "infants' milk" shall be taken exclusively from cows which

(1) Within one year previously have been subjected to the tuberculin test with negative results, and

(2) For at least fifteen days previously upon veterinary examination have been found to fulfil the provisions in respect to sanitary condition, feeding, and cleaning, laid down by the Sanitary Authority in the general rules.

Every seller of infants' milk is bound on demand to make the Sanitary Authority acquainted with the source from whence the milk sold by him as "infants' milk" is obtained, and he shall, particularly when so required by the Sanitary Inspector, prove by production of veterinary certificate, that the Regulations provided by Section 1 and 2 have been complied with.

Whenever the Sanitary Authority does not find the veterinary certificate produced to be satisfactory, the Authority may require the dealer in infants' milk to comply with such further conditions as appear necessary for ensuring that the regulations relating to infants' milk may be fulfilled in a satisfactory manner.

By payment blank forms of certificates are obtained on application at the office of the Sanitary Inspector.

Infants' milk must only be sold in air-tight closed receptacles of clear or lightly coloured glass.

6. "Fresh milk," "half-skimmed milk," or "skimmed milk," together defined as "Pasteurised milk" shall, previous to satisfying the provisions stated in Section 4, have been heated up to at least 85° Centigrade*, and immediately after cooled down with a cooling apparatus to 8° Centigrade or less. Under the name "sterilised milk" must only be sold milk which has been sterilised according to a method approved by the Sanitary Authority. Pasteurised and sterilised milk must only be sold in closed completely air-tight vessels of clear or lightly-coloured glass, upon which respectively, the dates of pasteurising or sterilising and the name of the pasteuriser or steriliser are clearly indicated.

The vessels shall, before being filled up, either be sterilised or cleansed in a strong solution of soda or lime water.

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* Since altered to 80° Centigrade.

7. The term "child's milk mixture" (for which in so far as they relate to the mixing of serviceable milk, the regulations mentioned under "infants' milk," in Section 5 are in force) is applied to milk which is allowed to be sold in bottles mixed with water and sugar. An accurate indication of the ingredients and constituents of the mixture must be printed on the label of the bottle.

The mixture shall always be pasteurised.

8. Butter (churned) milk, curdled milk, preserved milk, and the like, must be declared to be such at the time of sale. The same applies to milk of other animals than cows.

9. All milk shall be strained through a close strainer immediately after milking, and be further handled with care and cleanliness. Every milk-producer shall be answerable in this respect, or, in so far as the warranty cannot be binding upon him, then the respective purveyor or dealer. All objects and appliances with which milk comes in contact shall be kept properly clean.

10. It is forbidden to sell milk—

which in colour, smell, taste, or appearance differs from the ordinary sort;

which comes from cows which have recently calved, and whose milk is not yet serviceable for boiling;

which comes from cows suffering from obvious tuberculosis , anthrax, symptomatic anthrax, hydrophobia, jaundice, inflammation of the udders, pyæmia and septicæmia, inflammation from poisoning, foot and mouth disease, cow-pox in advanced stage, severe diarrhœa, or other disease attended with fever, or from cows which are being treated inwardly or outwardly with medicaments which are likely to pass into the milk and affect its condition in an injurious manner ;

which is mixed with water, or ice, or with preservatives, such as boric acid (antiseptic), salicylic acid, or other substances which are regarded by the Sanitary Authority as injurious to health, or with other extraneous matter (see, however, Section 7) ;

which contains dirt or uncleanness of any kind.

Milk which after standing two hours precipitates a visible sediment will be considered as unduly contaminated.

In order to secure the observance of these Regulations the Sanitary Authority may at any time demand a statement from whence milk which is sold in Copenhagen has been obtained, and may, when they think it desirable, require from the respective dealers the production twice monthly of the veterinary certificate as to the sanitary condition of the cows, their cleaning, and feeding, according to the general established Regulations of the Sanitary Authority.

11.—In milk shops, at which milk of the kinds named in Section 4 is sold, every purchaser shall be provided with the necessary notification of what kind of milk he receives. The notification shall be in distinct capital letters at least one inch in size, and the purveyor shall, as far as possible, so contrive that the notification is so placed as to be conspicuous to the public.

When the milk is sold in bottles they shall be of clear or light coloured glass. The indication of the contents, with the vendor's name, shall be conspicuously exhibited and marked in a lasting manner on the side of the bottle, or on the stopper.

The same applies to milk which is intended for disposal here in the City.

Descriptions of milk other than those named in these Regulations are forbidden, on receptacles and bottles as well as in advertisement placards, unless the Sanitary Authority in every instance gives its consent thereto.

In conveying milk to the City, and in storing and selling it in the City, the dealer may not use any measure made of wood, or untinned copper, brass or zinc, nor any rusty receptable, nor any metal receptacle containing lead-enamelling which is cracked or broken apart, nor any receptacle of clay and the like in which there are crevices, nor any damaged glass ware, nor any covered-over receptacle of such a nature as to injure the milk or cause curdling.

Vessels for carrying milk shall be provided with tightly-closing lids, which shall be fastened to them with chains.

All measures employed in milk dealing shall be provided with suitable handles, so that any contact of the milk with the hands in measuring out shall be avoided.

Receptacles in which milk is sent out, or stored, or from which it is sold must not be applied to any other use.

Paper must not be used in the tightening of lids, nor any guttapercha containing lead or any other unclean or injurious material. Gauze or linen must only be used once.

Purveyors of milk using carts on which are also carried yeast, dripping, or such like, may only supply these articles in tightly-closed receptacles.

It is forbidden to convey milk or receptacles intended for milk along with dung or in uncleansed dung carts.

12. Places in the city in which it is intended that milk shall be disposed of, stored, dealt with, or sold, shall be daily ventilated and carefully cleansed.

Where the floor is of planks and not covered with linoleum or other such-like material which is impervious to moisture, it shall be varnished, and the openings between the planks shall be filled up with putty. The floor shall be cleansed daily with a damp cloth. Once a week the floors, doors, and panels shall be carefully cleaned, and the windows rubbed.

Where the walls and ceilings are not composed of marble or other stone, material, glass, or the like, or painted with oil colour, they shall be whitewashed or lime-coloured at least twice yearly. With respect to walls and ceilings which can be washed this shall be done at least four times yearly.

Dry sweeping in such places must not be done

In every place where milk which is intended to be disposed of in the City, shall be stored, dealt with, or sold, there shall be placed a water-spittoon.

No other goods must be dealt in at the same place as milk except bread, cakes, honey, groats, butter, margarine, dripping, eggs, sodawater, and beer in bottles, with sugar goods from closed receptacles. Mangling, laundry, or other similar work must not be carried on in the same place where milk is dealt in.

The place must not be used as a dwelling or night lodging, nor be in direct communication with places which serve as night lodgings, nor with other places which are used as dwellings, unless between these and the milk department an air-tight door is placed, which must not be kept open. Cellars which have an opening to a drain must not be used for keeping, dealing in, or selling milk.

The Regulations contained in this paragraph do not apply to places where milk exclusively is sold and is drawn off from air-tight closed receptacles, nor to places where there is no drawing off or pouring out.

13. When any person who is employed in milking, selling, or dealing in milk, or who lives in connection with a milk supply, becomes affected with symptoms of illness which resemble any acute infectious disease (including typhoid, scarlatina, diphtheria, or other acute throat complaint, inflammation of the brain, erysipelas, cholera), or with any serious chronic infectious complaint (including lung disease), a doctor shall at once be called in, and if he so directs the illness shall be as soon as possible notified to the Sanitary Authority, who may then require that the sick person be removed from the place in question.

No person who is suffering from a spreading or infectious skin disease, or has large foul sores or bandages on the hands or face, and no person who is suffering from any acute infectious fever must be employed in milking, dealing in, or selling milk. Cleanliness of apparel and person will be required from everyone who is employed in milk businesses or in sale of milk.

14. For a breach of the Regulations which affect personal behaviour, besides the person in question, the proprietor of the business, and, according to circumstances, likewise the deliverer of the milk or milk purveyor are also answerable when the breach occurring can be laid to his charge. In so far as the milk is not sold in closed, but in the deliverer's sealed or lead provided receptacles, the seller is answerable that the milk he is selling corresponds with the description under which it is sold.

15. A copy of these Regulations shall be hung in a conspicuous place in every milk store. On application to the Third Division of the Police of Copenhagen copies of such Regulations may be obtained free of charge.

16. The Rules in Section 12 relating to the regulation of places of sale and their condition come into force one year after the confirmation of such Rules, and the rest of the Rules a half-year after their confirmation.

Ministry of Justice, the 3rd May, 1904.

BULLETIN No. 2.

The
Hannah Dairy Research Institute

Reactors in Tuberculin-Tested (Licensed) Herds

BY

ALEXANDER B. FOWLER, B.Sc. (Agric.)

AND

NORMAN C. WRIGHT, M.A., Ph.D.

PRINTED BY

AIRD & COGHILL, Ltd., 24 DOUGLAS STREET, GLASGOW, C.2

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The authors desire to express their appreciation of the willing assistance given them throughout this inquiry by the owners of licensed herds and by County Veterinary Inspectors.

They also desire to record their thanks to the Scottish Certified and Grade A (T.T.) Milk Producers' Association for a grant towards the cost of the issue of this Bulletin.

PREFACE

BY

T. Drummond Shiels, Esq., M.C., M.B., M.P.,

Parliamentary Under Secretary of State for the Colonies, and Chairman of the Research Grants Committee of the Empire Marketing Board.

I have pleasure in writing this introduction to an account of what I regard as a valuable investigation into a matter of great public interest and importance.

During recent years rapid progress has been made in the establishment of tuberculin-tested herds. This progress has been accelerated by the institution of special grades of milk which are produced and sold under official licence. Unfortunately, the demand for such graded milk has failed to keep pace with the supply, a fact which is largely due to the ignorance of the public—and even of the medical profession—of the conditions under which the milk is produced.

The issue of this Bulletin is therefore opportune. The Bulletin deals only with one phase of the subject, namely, the extent to which licensed tuberculin-tested herds are in fact free from infection. This aspect is, however, an extremely important one: not only because of its intimate relationship with public health, but also in view of its close connection with farming practice.

The Bulletin provides for the first time an authoritative statement of the incidence of infected stock in a representative group of tuberculin-tested herds. The full details are available in the following pages. But I would emphasise here that the outstanding feature revealed by the collected figures is the very small proportion of infected animals in the herds investigated, and the negligible risk of infection to those who consume milk which is produced under the stringent precautions incumbent on the owners of licensed tuberculin-tested herds. In reaching these important conclusions, the authors of the Bulletin have made a valuable contribution to the subject.

It is, however, obvious that, if tuberculin-tested herds are to obtain the full confidence of the potential consumer of graded milk, infection on licensed farms must be entirely eliminated. The authors have therefore gone a step further in their investigations, and have attempted, by means of personal visits to individual farms, to determine the major sources through which infection may be contracted in a herd.

In spite of the difficulties inherent in such a method of investigation, the authors have, by a careful analysis of all available evidence, been able to arrive at certain important conclusions. These conclusions have not only resulted in the formulation of eminently practical recommendations, but have opened up the path to fresh investigations into the sources of infection and the elimination of disease.

It must, however, be emphasised that such conclusions are tentative: the collection of empirical information from admittedly questionable sources can never take the place of accurately controlled laboratory or field experiments. Many significant contributions to science, and particularly to the applied sciences of medicine and agriculture have, however, had their origin in the exhaustive collection and the painstaking analysis of information secured in practice.

The well balanced presentation of the evidence relating to the various sources of infection, and the originality of thought which lies behind many of the suggestions which are put forward, leads one to hope that the authors may be given an early opportunity to confirm and to extend their findings under more strictly controlled conditions.

In view of the recognised importance of Milk as a food, it is essential that it should be made safe, and we must welcome every effort towards that end. The Empire Marketing Board and the Medical Research Council have made possible certain other investigations into the tuberculous infection of milk which are now proceeding in Scotland. The various scientific and administrative bodies in Scotland are co-operating in every way possible. It is for the Press and those with knowledge of the subject to see that information regarding this fundamental food product is made more available to the general public. The health of the people, especially of the children, and the prosperity of an important branch of agriculture are involved.

I am sure that all concerned will welcome the contribution to our knowledge of this subject which has been made by Mr. Fowler and Dr. Wright.

T. DRUMMOND SHIELS.

13*th January*, 1931.

INTRODUCTION.

IT is well recognised that the incidence of tuberculosis among dairy cows can, by appropriate means, be greatly reduced. Eradication of bovine tuberculosis has, for instance, been in progress for a number of years in Canada and in the United States, with promising results. Even in these countries, however, there appears to be considerable difficulty in effecting the complete eradication of the disease from a given area. A small percentage, either of stock or of herds, remains infected in spite of drastic measures which are taken to eliminate all sources of reinfection. The figures given in Table I. show the progressive decrease in the number of reactors in a selected area in Canada, but they illustrate at the same time the very slow elimination of infected animals in the later stage of eradication. ([1])

TABLE 1.

PROGRESSIVE DECREASE IN INFECTION IN THE FRASER VALLEY AREA, CANADA.

Date of Test.	Number of Cows.	Percentage of Reactors.
May, 1926	46,174	7.9
March, 1927	46,191	1.1
October, 1928	46,480	0.76
October, 1929	50,603	0.37

In this connection it is also suggestive that, in the United States, a maximum of one half of one per cent. of reactors is *permitted* under the "Modified Accredited Area Plan." ([2])

Elimination of the disease from Canadian and American dairy herds is facilitated by the rapidity with which sources of infection can be removed through the policy of the wholesale slaughter of reacting animals. Conditions in this country present a very different problem. In the first place, the percentage of infected stock is probably far higher. In the second place, there exists in this country no general scheme for the eradication of tuberculosis, and the responsibility for the clearing of herds rests entirely on individual owners. The difficulties are considerable. The owner has to face considerable financial loss in the initial clearing of his herd, since no Government compensation is payable for the loss of reactors; he has to contend with the risk of reinfection resulting from highly infected premises; the market from which he can purchase guaranteed tubercle-free stock is limited; and, even when he has established a free herd, he is subject to continual danger through the contamination of his stock from neighbouring farms where infection is rife.

(1) For these references see p. 46.

Published figures on this subject are scanty, and reliable data relating to the causes of infection and reinfection are meagre. The most complete figures available for an individual herd are recorded by Bowes ([3]). The figures refer to the dairy herd at Manor Farm, Garforth, and cover a period of eighteen years. At the commencement of this period (1908) the herd was tested and was found to contain 65% reactors. For the first six years no attempt was made to free the herd by the immediate sale of reactors, but young stock were isolated from their reacting mothers and were reared, as far as practicable, free from the possibility of infection. By 1915 the reactors had been reduced to about 26%, and it was decided that more active steps should be taken to get rid of the remaining infected stock. Measures were therefore taken to ensure that all reactors were sold off as soon as practicable after the test. In-calf cows were to be kept until the end of their lactation, and then sold. Reacting cows not in-calf were not to be served, but were to be fed off at the end of their lactation. This decision was immediately followed by a progressive decrease in the number of reactors, the figures for 1916 and following years being 11.8%, 5.1%, 7.8%, 8.3%, nil, 1.9%, 1.5%, nil, 9.1%, nil. The high figure at the end of this series (9.1%) was stated to be due to contact with infected bought-in cattle. Similar, but less extensive, data have been published from the University College of North Wales ([4 and 5]). These data refer to the dairy herd at the College Farm, and extend over the period Spring 1920 to Autum 1928. The initial test showed 51% of the herd to be reactors. Conditions for successful eradication were not good; there was ample accommodation for the isolation of reactors in separate buildings, but the cattle—both reactors and non-reactors—were allowed to graze together during the grazing seasons until 1925. "Clinical" cases were looked for at each test, and were at once removed from the herd, but the wholesale disposal of reactors was not feasible, owing to the necessity of keeping up the supply of milk for sale. The percentage of reactors showed, however, a progressive decrease up to 1925, when the number had been reduced to such proportions that the few remaining reactors could be entirely isolated and the sale of graded milk commenced. Subsequently there was never more than one reactor at each six-monthly test. It is interesting to note that a crop of reactors appeared among the heifers in 1925, believed to be due to the consumption of infected milk from reacting cows.

A more comprehensive set of data has been published by Liversage ([6]). The data were obtained in the course of an inquiry into the economics of the production of Grade A (Tuberculin-tested) Milk, and referred to a total of twenty-eight herds. For the details of the individual herds reference may be made to the original publication: the following forms a brief summary of the data. The average proportion of reactors on the 28 farms at the first test was 27%, the proportion on individual farms varying from 75% to 2%. Of the 28 farms, 23 had less than 40% reactors.

At the second test the proportion reacting worked out at an average of 7%—a remarkable reduction over the total of 28 herds. At subsequent tests, Liversage states that the herds reached a fairly stable condition, particularly where replacements in the herds were made entirely from home-bred stock. The average proportion of reactors after the first year's testing worked out for the 28 farms at 4% per test, or 8% per annum. Liversage draws attention, however, to certain cases where the technique of the test was questioned. Omitting these cases (limited to four farms), the average proportion of reactors was found to work out at 1.2% per test, or 2.5% per year. It may be noted here that this figure agrees closely with that found in our own work (*vide infra*).

Prior to 1923 a small number of owners of Scottish dairy herds were consistently using the tuberculin test, there being a limited sale for tuberculin-tested milk and a promising market for tubercle-free stock. In 1923 the Milk (Special Designations) Order (Scotland) came into operation, and this provided an incentive to an increasing number of producers to establish licensed tuberculin-tested herds. By the Autumn of 1923 sixteen producers had been granted licences for the sale of either Certified or Grade A (Tuberculin-tested) Milk. This number increased progressively during the ensuing years, and by 1928 there were more than ninety licensed herds in Scotland.

At this stage the movement was threatened with a serious setback. A licensed dairy herd in the south-west of Scotland, which had hitherto been relatively, if not entirely, free from reactors, was found at an official six-monthly test to have a very high percentage of reacting animals. While it had been generally recognised that sudden—and often unexplained—recurrence of infection took place in licensed herds, the magnitude of the infection in this herd (amounting to 32 animals out of a herd of 43) and its very sudden appearance after a period of comparative freedom from reactors, raised serious doubts in the minds of a number of owners of licensed herds.* The existence of such doubts was recognised by the Scottish Board of Health, who made the following comment in their subsequent Annual Report (7) :—

> "It is perhaps natural that when, after a herd has become established as tubercle-free, a large proportion of the animals are discovered at a subsequent test to be reactors, the producer should at first ascribe the cause to factors over which he has

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* "At the September meeting of the Central Executive Committee of the National Farmers' Union of Scotland, Mr. John Speir declared that there was very widespread dissatisfaction regarding the test administered for the purpose of ascertaining whether tuberculosis was present in dairy cattle. A recent case in Lanarkshire, where a very large percentage of a fine dairy herd had been declared to be reactors, had caused grave concern throughout the whole country and in England, and it was felt that a thorough searching inquiry into the various tests and the methods of administration was urgently called for . . . . He moved that the Union should ask the Scottish Board of Health and the Board of Agriculture for Scotland to confer with representatives of the Union with a view to instituting some suitable form of inquiry into the whole matter."—From *The Farmer and Stockbreeder*, 1928.

no control. Even the accuracy of the tuberculin test itself as a reliable indication of the presence of the disease may be impugned on various grounds, but in the cases that have been brought to light under the Order it can be said with confidence that the accuracy of the tuberculin test has been abundantly proved."

It appeared, however, that the time had arrived when an exhaustive inquiry might usefully be made by some independent body with a view to determining the frequency of the appearance of reactors in established licensed herds and, if possible, the main sources from which infection was derived.

With the co-operation of the owners of licensed herds in Scotland the Hannah Institute has undertaken such an inquiry. The detailed findings of this inquiry are set forth in the following pages.

PART I.

The Incidence of Reactors in Tuberculin-Tested (Licensed) Herds.

METHOD OF COLLECTING INFORMATION.

The scope of the inquiry was limited to licensed tuberculin-tested herds in Scotland, *i.e.*, herds producing either Certified or Grade A (Tuberculin-tested) Milk. In general, information was restricted to the first and subsequent *official* tests* as carried out by County Veterinary Inspectors. In a limited number of cases, where the herd had been tested for a number of years prior to that in which the Milk (Special Designations) Order took effect, details for the full period of testing were also included.

In collecting information, the County Veterinary Inspectors were first communicated with, and from them were obtained the names of the owners of licensed herds.† One of the authors (A. B. F.) then visited each herd personally, and obtained such information from individual owners as was available. Out of a total of one hundred and ten licensed herds, information was supplied by the owners of ninety-six. Thirteen owners could supply no information with regard to their herds. The majority of such herds belonged to landed proprietors, whose managers had left, taking the herd history with them. In only one case was information absolutely refused.

In collecting and tabulating the information thus made available, figures for the incidence of reactors in each herd were normally limited to milking stock and in-calf heifers. In a few special cases other animals were included among the reactors.

SUMMARY OF INFORMATION OBTAINED.

The full figures for the number of reactors in each individual herd are detailed in the Appendix to this report. A summary of these figures is contained in Table 2.

An examination of these summarised figures shows that the proportion of reactors in newly established herds was relatively

* Note that the preliminary or "clearing" tests were not included. The figures refer solely to tests administered after the granting of a licence.

† In Scotland the responsibility for the administration of the Milk (Special Designations) Order lies with the Local Authority. There is no central bureau where collected information of this nature is available.

TABLE 2.

Comparative Incidence of Reactors at Successive Six-Monthly Official Tests.	1st Test.	2nd Test.	3rd Test.	4th Test.	5th Test.	6th Test.	7th Test.	8th Test.	9th Test.	10th Test.	11th Test.	12th Test.
Number of herds undergoing test, -	96	88	86	75	69	61	55	42	40	26	23	16
Total number of animals tested, -	3,913	3,577	3,499	2,982	2,731	2,448	2,290	1,909	1,874	1,188	1,094	716
Total number of reactors, - -	110	87	61	40	35	27	28	15	14	4	7	0
Percentage of reactors at test, -	2·81%	2·43%	1·74%	1·34%	1·28%	1·10%	1·22%	0·79%	0·75%	0·34%	0·64%	nil
Number of reactors lost annually, per 100 head of milking stock, in successive years of testing, - -	1st year 5·3		2nd year 3·1		3rd year 2·4		4th year 2·0		5th year 1·2		6th year 0·8	

high, the figures for the first and second tests averaging at 2.81% and 2.43% respectively. This represents an average loss during the first year of official testing of five reactors per hundred head of cattle tested. This relatively high incidence of reactors is not unexpected, in view of the considerable risk of infection on premises which have recently contained infected stock. After the first year, the proportion of reactors progressively declined, until at the fifth and sixth years the annual loss was reduced to one reactor per hundred head of cattle tested. This represents the logical result of a gradual elimination of sources of infection on the farm. The reduction of the number of reactors would undoubtedly have been more rapid if the herds had been self-contained—a point which is dealt with fully in Part II. of this Report.

TABLE 3.

INCIDENCE OF REACTORS IN LICENSED HERDS AS SHOWN AT SIX-MONTHLY OFFICIAL TESTS.

Year.	Test.	Number of Licensed Herds.*	Total Number of Animals Tested.	Number of Reactors.	Percentage of Reactors.
1923	Autumn	16	716	5	0·70%
1924	Spring	23	1,094	9	0·82%
	Autumn	26	1,188	8	0·67%
1925	Spring	40	1,874	40	2·13%
	Autumn	42	1,909	26	1·36%
1926	Spring	55	2,290	38	1·66%
	Autumn	61	2,448	26	1·06%
1927	Spring	69	2,731	35	1·28%
	Autumn	75	2,982	38	1·27%
1928	Spring	86	3,499	73	2·09%
	Autumn	88	3,577	77	2·15%
1929	Spring	96	3,913	53	1·35%
1923-29,	Total Number of Tests,	- 28,221	Total Number of Reactors,	- 428	Average Percentage of Reactors at each six-monthly test. - 1·53%

* This number refers to licensed herds from which information was available. The *total* number of licensed herds in Scotland in 1929 was 110.

The same data are shown in Table 3, but in this table the reactors have been arranged according to their actual occurrence in the different years, the period covered being from Autumn 1923 to Spring 1929. It will be seen that the number of herds increased progressively from sixteen in 1923 to ninety-six in 1929. With the exception of the three earlier tests, the percentage of reactors remained roughly constant throughout this period. The small proportion of animals which reacted in 1923-24 was probably due to the influence of the comparatively large number of old-established herds (herds established prior to the issue of the Milk (Special Designations) Order), which were included in the early tests. It might be expected that these would have a comparatively low percentage of reactors, whereas, in the subsequent years, the proportion of newly established herds would be greater, and the incidence of reactors would consequently be increased.

During the whole inquiry, 28,221 official tests were recorded as having been carried out in licensed herds.* Out of this number of tests, 428 were positive, indicating a proportion of reactors of 1·53%. This represents an average annual loss of three reactors per hundred head of milking stock.

Ideally every source of infection should be eliminated in licensed tuberculin-tested herds, and the percentage of reactors should—after the initial clearing of the herd—be reduced to nil. In practice only eighteen out of the ninety-six herds investigated attained this ideal and maintained entirely tubercle-free herds.

The percentage of reactors in old-established herds has, however, been reduced to comparatively small proportions. The average figure over all herds of 3% of reactors per year certainly represents a constant, if small, loss—and a loss which we believe to be largely avoidable by the exercise of extreme care in eliminating possible sources of infection. But it gives no support for alarmist views on the prevalence of reactors in licensed herds. Further, risk of such loss does not appear to offer any real set-back to progress in the establishment of licensed herds. The figures shown in Table 3 indicate, in fact, a progressive increase in the number of producers who have recognised the value of establishing a clean herd.

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* Under the Milk (Special Designations) Order (Scotland) it is prescribed that, if at two successive six-monthly tests a licensed herd has no reactors, the subsequent tests may be carried out at twelve-months intervals so long as the herd remains free from infection. In the figures detailed in this Report, it has been necessary—for statistical purposes—to assume that one twelve-monthly test is equivalent to two six-monthly tests.

THE INCIDENCE OF REACTORS IN RELATION TO THE POSSIBLE INFECTION OF THE MILK SUPPLY.

The object of the establishment of tuberculin-tested herds is largely to eliminate any possibility of tuberculous infection of the milk supply. Where a herd is entirely free from infection, it may be assumed that the milk produced will be tubercle-free. The results detailed above indicate, however, that in most licensed herds there is a small but constant potential source of infection. How far does this potential infection form a danger to the consumers of milk from tuberculin-tested herds ?

Existing figures show that not more than 2% of reacting cows secrete tubercle bacilli in their milk. Gofton ([8]) states that, among cases of tuberculous mastitis detected in the Edinburgh abattoirs, approximately 50% were found to be suffering from generalised infection—that is, they were in an advanced stage of the disease. It would be extremely rare to find a case of generalised tuberculosis in a licensed herd, where all animals undergo a test at least once in six months.* It is apparent, therefore, that not more than 1% of those reactors which are found in licensed herds can be assumed to secrete infected milk. The actual proportion of reactors in licensed herds which might be considered as actively dangerous to the consumer works out, therefore, at 1% of 3%, or 3 in every 10,000 animals.† This figure is a maximum one, and it is very probable that the actual proportion is so small as to be practically negligible.

Such a conclusion receives strong support from a paper recently published by Wright ([9]), from which the following statement is taken :—" From 1921 to 1926 the hospitals (of Glasgow) were supplied with milk from untested herds, and, out of 923 samples examined, 28 (or 3%) were found to be infected. During the years 1927 and 1928 the hospitals were supplied with milk from tuberculin-tested herds, and, out of 550 samples examined, *not one sample was found to be infected.*"

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* But see footnote to page 14.

† Calculated on the 1928 cow population, this indicates that there is, each year, not more than one dangerously infected animal among the whole of the licensed tuberculin-tested herds in Scotland.

PART II.

Sources of Infection in Tuberculin-Tested (Licensed) Herds.

The primary object of the inquiry was to ascertain the incidence of reactors in licensed herds. The results have shown that a number—small but constant—of reactors is found in the majority of licensed herds in the country.

The figures so far detailed would be of very limited value unless an indication was also made of the main sources from which reactors may become infected. It is only as a result of such information being available that measures can be recommended which will lead to the elimination of all avoidable losses.

METHOD OF COLLECTING INFORMATION.

Opportunity was taken during the personal visits to individual farms, referred to in Part I., to collect information on the possible sources of infection. For this purpose data of two kinds were collected. In the first place, information of a general character was sought: for instance, details of the fencing (single or double) and of the water supply (private or common); particulars of the condition of neighbouring stock, especially in fields adjacent to the owner's grazing parks; and the past history of the farm itself in relation to possible infection. In the second place an effort was made to trace the possible sources from which each individual reactor might have contracted infection.

It was obviously a task of extreme difficulty to obtain trustworthy evidence with regard to individual cases. Many of the reactors had been disposed of some years previously, and reliance had to be placed on the memory—and often merely on the impressions—of individual owners. The latter willingly communicated all the information which they had available, but this was not infrequently scanty and of questionable value.

A further difficulty arose when an attempt was made to ascertain the *primary* source of infection from which a reactor had contracted the disease. Frequently the available evidence indicated a number of sources from which infection might have been derived. An illustration of this difficulty is provided in the following details with regard to the reactors in one herd:—

Farm 35. Cases 70-95.—The premises here were badly infected. The farm was also surrounded on two sides by "flying" stock belonging to dealers, and on the third side by a nondescript lot of grazing cattle suckling calves.

At the first test there were four reactors, all commercial stock. No further details were available with regard to these animals.

At the second test there were four reactors. These animals had been bought-in through an auction mart and tested. They reacted at their first official test.

At the next test there were again four reactors, all of which had been bought-in through the auction mart and tested. It was not known whether they had previously passed any official tests.

At the fourth test there were six reactors, all from a similar source.

At the fifth test there were nine reactors. Three were home-bred heifers, but these had been grazed with un-tested stock. Two were home-bred cows which had already passed at least one official test, but they had been in the same byre as several of the above reactors. The remaining four were bought-in animals, three of which were known to have stood the test for over two years.

At the sixth test two home-bred cows, which had consistently passed the test for three years, reacted when tested by the double intradermal and ophthalmic methods. The previous method of testing was, however, not known.

The multiple sources of infection on this farm are at once apparent. The bought-in stock would carry infection with them, and spread the disease by direct contact with other stock. The premises were badly infected, and the presence of reactors on the farm added the risk of infected pastures. The farm was single fenced, and this allowed contact with neighbouring stock also probably highly infected. Finally, it is implied (though definite information is not available) that the two animals at the sixth test reacted following a change in the method of testing. The difficulty of allocating a definite source of infection for each individual reactor is therefore obvious. The important point, however, is that in every case *at least one source of infection was found to exist*, and that by suitable precautions all sources of infection could have been eliminated.

The instance just quoted is an extreme one as regards both the number of reactors and the multiple source of infection. In the great majority of cases it has been possible, by the careful sifting of available evidence, to indicate with some degree of certainty the primary source of infection. In the following pages detailed evidence is provided in regard to over four hundred and fifty reacting animals, and an attempt is made to allocate the primary source of infection in each case. Admittedly the evidence is fragmentary in some cases, and in others it is subject to varying interpretation according to the stress which is laid on one point or another. But the mass of information—taken as a whole—offers convincing evidence of the main sources from which infection is liable to take place.

SPECIFIC SOURCES OF INFECTION.

INFECTION FROM BOUGHT-IN STOCK.

The introduction of bought-in stock—stock which are supposedly tubercle-free *but which are in fact infected*—forms by far the most frequent cause of the occurrence of reactors in tuberculin-tested herds.

The danger of introducing such stock into licensed herds without adequate safeguards has already been stressed by several authors. Bowes (3) recorded a sudden increase in the number of reactors in the Garforth Herd, following the purchase of stock required to replace a number of poor yielding cows. Four of the bought-in cows, which had passed the test on entering the herd, reacted at the subsequent annual test, while a fifth animal, which had been purchased with a clean certificate, also reacted at the test. Begg and Weir (10) quote several instances of animals which were purchased for tuberculin-tested herds after being certified as tubercle-free, and which subsequently reacted at official tests. Buxton (11) calls attention to the not infrequent appearance of infection in animals which have been purchased for inclusion in tuberculin-tested herds, which have been duly certified as having passed the test, and which have been found to react at the first test after purchase.

The latter authors stress the fact that there exists, in the very early stages of infection, a so-called latent or pre-sensitive period during which the tuberculin test is inadequate to diagnose infection. The factors affecting the length of this pre-sensitive period are little understood. The period appears to vary in individual animals (*), and to be largely dependent upon the mode of infection. Calmette (12) quotes a number of authorities on this subject, but points out that the results of individual investigators are much at variance owing to the different conditions under which each worked. The maximum pre-sensitive period recorded by Calmette was just over eight weeks. Begg and Weir (loc. cit)., as a result of a wide experience in the testing of licensed herds, estimate the pre-sensitive period to be considerably longer than this, though they point out that, in arriving at any conclusion, the possibility of any unrecognised infection being contracted in the intervening period must always be kept in mind.

It appears therefore that the test *alone* does not provide a final and absolute guarantee of freedom from infection : it is also essential to ensure that the animal has been free from contact with other infected stock for a reasonable period. This fact indicates that the most stringent precautions are necessary in selecting stock for introduction into a tuberculin-tested herd. Otherwise there is a serious risk that the purchased animal, though certified as a non-reactor, may react at a subsequent test : and, further, that it may convey infection to the free herd.

Evidence obtained during the present inquiry justifies us in placing strong emphasis on this point. A large number of indi-

* Resistance to infection appears to be an important factor in this connection. Calmette states that "it seems evident that tuberculin produces a reaction as soon as a follicular tuberculous lesion has formed or as symbiosis is established between the bacilli and the lymphatic cell phagocytes." If this assumption is correct, we should expect the least resistant animal to exhibit the longest pre-sensitive period. A highly susceptible animal will therefore form a two-fold danger in a tuberculin-tested herd ; it will contract infection more readily, and it will defy attempts to diagnose such infection in the early stages of the disease.

vidual illustrative cases are detailed below, but the general effect of the policy of purchase from external sources is strikingly demonstrated in Table 4. In this Table comparisions are made of the sources of the stock in thirty-six herds. Eighteen of these have remained consistently free from reactors since their official testing commenced ; the remaining eighteen contain the highest individual numbers of reactors found in the course of the inquiry. The

TABLE 4.

COMPARISON OF HERDS HAVING THE LOWEST AND HIGHEST NUMBERS OF REACTORS.

Group I. Herds which have consistently remained free.			Group II. Herds having the highest total number of reactors.			
Number of Animals in Herd	Years Tested (*)	Source of Stock (†)	Number of Animals in Herd	Years Tested ‡	Total Number of Reactors	Source of Stock
48	2	**HB**	106	6 (10)	49	BI
38	4	**HB**	28	4	29	BI
76	6 (11)	**HB**	50	2	23	BI
7	1	BI‡	50	5	19	BI
38	2	**HB**	40	4	18	BI
12	4	**HB**	90	5	16	BI
20	1	**HB**	40	5	16	BI
28	6 (9)	**HB**	40	6 (16)	16	BI
26	3	**HB**	80	2	13	**HB**
38	1	—	40	4	13	BI
30	3	**HB**	20	2	12	BI
21	5	**HB**§	38	3	10	BI
103	6	**HB**‖	35	5	10	BI
20	4	**HB**	33	2	8	BI
30	6 (7)	**HB**	20	6	7	BI
32	1	BI	65	1	7	BI
40	6	**HB**	38	2	7	BI
27	6 (16)	**HB**	80	5	7	BI

sources of stock have been designated either as "wholly home-bred" or as "home-bred *and* bought-in." It will be seen that the stock in the consistently free herds is, with three exceptions, wholly home-bred: the three excepted herds have not been tested for more than one year, and already one of them has since been reported as no longer free. On the other hand, the herds

* The total period of tuberculin-testing is indicated in brackets; the plain figure indicates the period during which licence has been held.

† HB indicates "wholly home-bred"; BI indicates "home-bred *and* bought-in."

‡ A reactor has been reported in this herd subsequent to the completion of the inquiry.

§ A great many reactors were found before a licence was obtained, due to purchase through an auction mart. Home breeding commenced as soon as the herd was cleared, and no re-infection occurred subsequently.

‖ Original stock was bought-in, but the number of reactors prior to the issue of the licence was unknown. All believed to be home-bred since issue of licence.

with a high incidence of reactors have, with only one exception, been supplied at one time or another with purchased stock.

With regard to individual cases, a total of one hundred and fifty have been traced as bought-in animals which carried infection with them. For convenience, the case histories of these reactors have been classed into five groups: first, animals bought-in through auction marts; second, animals purchased at dispersal sales; third, animals purchased with clean certificates; fourth, animals bought-in from tuberculin-tested herds; and fifth, animals obtained from other miscellaneous sources.

(1) Animals bought-in through Auction Marts.

The following twenty-eight animals were bought-in through auction marts, and reacted at their first official test.

Case 11.—This cow had previously passed official tests (double intradermal) for two years. She had never been near a reactor. She was sold through an auction mart, but returned to the owner as being light in one quarter within one month. At the following official test she was the only cow in the herd to react.

Case 30.—A bull bought through an auction mart as having passed the double intradermal test privately. He was never in contact with reacting cattle after arrival at the new farm, but reacted at his first official test. Private test took place in spring; official test in autumn of the same year.

Case 51.—Was bought-in as a tested cow through an auction mart. She was said to have passed the test (test unknown). She reacted on her first official test (double intradermal).

Case 106.—This farm had been clear for two years. A bull was bought-in through an auction mart, specified as "tested," though originating from a non-tested herd. He reacted at the first test.

Case 135.—This heifer had been bought through an auction mart as an un-tested cow. She passed the subcutaneous test at the hands of the owner's private veterinary surgeon twice. She reacted at her first official double intradermal test.

Cases 198-209.—Twelve animals all bought through an auction mart. Four were purchased as tested cattle, and eight were from tuberculin-tested herds. All reacted at their first official tests (subcutaneous).

Cases 295-298.—Four cows, all bought through an auction mart, and tested by a private veterinary surgeon. They showed no reaction six weeks after arrival, but reacted four months later on a re-test.

Case 315.—A bull which was bought at a bull sale as "tested." He was originally from an un-tested herd, and had only been on the tested farm for two months when he reacted. On slaughter he was found to be suffering from generalised tuberculosis.

Case 318.—This animal was bought through an auction mart, with a clean certificate and from a tuberculin-tested herd. The herd from which she came was not in fact free from reactors. She had only been in her new herd for three weeks when she reacted.

Case 364.—This cow was bought-in through an auction mart as "tested." She reacted at her first official test.

Cases 369-370.—Two cows bought through auction marts. They were both from tuberculin-tested herds. Both reacted at their first test after arrival.

Case 451.—This heifer was bought through an auction mart with a clean certificate. She had been allowed to stand there for two days before being sold. She reacted at her first test in the new herd.

Case 452.—This young bull was bought from a tuberculin-tested herd as having passed the test at an auction mart bull sale. In the meantime he had been at the premises of an un-tested herd. He reacted at his first test.

The following fourteen animals were bought-in through auction marts, and reacted at their second official tests.

Cases 121-127.—These seven animals were bought-in through an auction mart and tested privately. They passed their first official tests, but reacted at their second.

Cases 185-186.—These two cows were bought-in through an auction mart. They passed their first test (subcutaneous) but failed at their second (subcutaneous and ophthalmic).

Cases 227-228.—These two animals were bought-in through an auction mart as having passed the test. They reacted on their second tests (subcutaneous and ophthalmic) after passing the first.

Cases 231-232.—Both these cows were bought-in as " tested " through an auction mart. Both passed their first tests, but at the second, one was doubtful and the other reacted (subcutaneous and ophthalmic).

Case 254.—This cow was bought as " tested " through an auction mart. She passed one official test, but failed at her second (both subcutaneous).

The following four animals were also bought through auction marts, and subsequently reacted.

Case 458.—This cow was bought through an auction mart with a clean certificate. She reacted on the new farm (? first test), and was found on slaughter to be suffering from widespread tuberculous lesions.

Case 233.—This cow was bought-in through an auction mart as " tested." She passed two official tests, but reacted at her third. She had, however, been in contact with other bought-in animals which had reacted at the previous test.

Case 234.—An exactly similar case, except that she reacted at her fourth official test, passing the first three tests satisfactorily. She had also been in contact with reactors.

Case 255.—This cow was bought as " tested " through an auction mart. She passed three tests, but reacted at her fourth. She had, however, been in contact with reactors.

(2) Animals purchased at Dispersal Sales.

The following eight animals were purchased at dispersal sales, and reacted at their first or second official tests.

Case 27.—This cow was bought at a dispersal sale of a tuberculin-tested herd. She was passed by a private veterinary surgeon (tests said to be subcutaneous, double intradermal, and ophthalmic). At her first official test she was doubtful, and on re-test, after isolation, she reacted.

Case 43.—A cow bought-in at a dispersal sale of alleged tested cows (test unknown). She reacted at her first official test.

Cases 144-146.—Three cows bought at a dispersal sale as tested by a private veterinary surgeon. They reacted at their first official test (double intradermal and ophthalmic used at both tests).

Cases 408-409.—Two heifers which had been bought at a dispersal sale of tested cattle. They were tested and passed by the owner's private veterinary surgeon, but reacted at their first official test.

Case 16.—This animal was bought at a dispersal sale of tested cows. She was tested by the County Inspector a week after entering the new herd, when she passed the double intradermal and ophthalmic tests. She reacted at her second official test. There has been no reactors on this farm at the previous test.

(3) Animals purchased with Clean Certificates.

The following twelve animals were purchased with clean certificates, but reacted at their first official test.

Cases 210-211.—These two animals were bought privately with clean certificates. They both reacted at their first official test (subcutaneous).

Cases 218-223.—These six animals were all bought-in from a dealer, and had clean certificates. They all failed at their first official test eighteen months later • (subcutaneous and ophthalmic). (*Note.*—This farm had previously been used for a beef herd, and had always been troubled with reacting cattle).

Case 240.—This animal was bought-in privately with a clean certificate. She was tested by a private veterinary surgeon, using the double intradermal method. She reacted at her first official test, using the same method.

Case 261.—This bull, which had been bought from an un-tested herd, came with a clean certificate from a private veterinary surgeon. He reacted on his first official test (subcutaneous used in both tests).

Cases 357-358.—One cow was bought-in with a clean certificate; she was bought privately from an un-tested herd. The other was bought privately from a tuberculin-tested herd. They were stall mates. Both reacted at their first official tests.

The following four animals were purchased with clean certificates, but reacted at their second official test.

Case 39.—This cow was bought-in with a clean certificate. She was tested on arrival by the County Inspector, and passed. She reacted two months later. (Double intradermal test used in both instances.)

Case 163.—This cow was bought from an un-tested herd, but with a clean certificate. She passed the first official test, but failed at the second (subcutaneous and ophthalmic at both tests).

Cases 190-191.—Two cows bought-in with clean certificates. They both gave doubtful reactions on their first test, and reacted on their second. Tests employed were subcutaneous and ophthalmic.

(4) Animals bought-in from Tuberculin-tested Herds.

The following six animals were bought from tuberculin-tested herds, and subsequently reacted.

Case 38.—This animal was bought from a tuberculin-tested herd with a certificate from the County Inspector. She was not therefore tested when she came. She was put into a single stall, but reacted at her first official test. (It is suggestive to note that the herd from which she was bought lost its licence shortly after this owing to its large number of reactors.)

Cases 47-48.—These two cows were bought from a tuberculin-tested herd. Both were old cows, and were bought privately. They reacted on their first official test (double intradermal).

Case 260.—This heifer was bought privately from a tuberculin-tested herd. She failed at her first official test (subcutaneous). (This heifer was secured from the same herd as Case 38 above.)

Case 263.—This heifer was bought privately from a tuberculin-tested herd which was, however, frequently troubled with reactors. She reacted at her first official test.

Case 455.—This cow was bought privately from a tuberculin-tested herd. She was said to have passed the double intradermal test one month prior to purchase. She reacted on her first official test (double intradermal). On *post mortem* she showed widespread tuberculous lesions of long standing.

(5) Animals obtained from Miscellaneous Sources.

The following eighty-one animals were bought-in from miscellaneous sources, and subsequently reacted at official tests.

Case 7.—This was a bought-in cow which had passed the private veterinary surgeon's subcutaneous test. She reacted at her first official double intradermal test.

Case 8.—This was a bought-in cow which was stated never to have been in contact with a reactor. She passed the subcutaneous test when treated privately, but reacted at her first official double intradermal test.

Cases 25-26.—These animals were bought-in as tested stock, and passed the subcutaneous test when tested by a private veterinary surgeon. They reacted at their first official double intradermal tests.

Case 35.—This was a bought-in cow which had never been near a reactor on the new farm, since she stood in a single stall. She passed the subcutaneous test when tested privately, but reacted at her first official double intradermal test.

Cases 103-105.—These three animals were bought-in as un-tested calves from an un-tested herd. They all ultimately reacted at their first official test.

Case 109.—This young bull was bought and tested privately. He was never near reacting animals and was never kept inside, but he had been run along with heifers, all of which had passed the test. He failed at his first official test.

Cases 111-120.—These ten animals were bought-in from a large un-tested herd. They were stated to have passed the test when bought. They all reacted at their first official test on the new farm.

Case 134.—This heifer had been bought along with three others, two of which had reacted on their first test and had not been allowed to enter the herd. She had passed two tests, one on her original farm and once on purchase. She reacted at the next official test.

Case 192.—This cow had been purchased through a dealer, and had passed the test twice subsequent to purchase. She reacted at her next test. She was never known to have been in contact with a reactor on the new farm. (Tests employed, subcutaneous and ophthalmic on each occasion.)

Case 258.—This was a bull bought privately. He was stated to have passed the test, but reacted within one month and was returned to the vendor.

Case 262.—This heifer was bought-in as having passed the test by a veterinary surgeon. She was a doubtful reactor at her first official test (subcutaneous) and was failed.

Case 264.—A bought-in cow from an un-tested herd. She was bought privately as having passed the test. She reacted at her first official test (subcutaneous and ophthalmic).

Cases 265-266.—These two cows were imported from England. They both passed one test after arrival, but reacted to the second test. They were standing in different parts of the byre, and (with Case 267) were the only reactors at the time.

Case 267.—A bought-in cow, which passed one test after arrival. She reacted at the second test.

Case 308.—This cow was bought privately as "tested." She was bought in July, and reacted in the following April. She had been placed in an entirely new byre, and was never near a known reactor at the new farm.

Case 309.—This cow was bought through a dealer as "tested." She passed her first official test, but reacted at her second. She had been standing stall mate to Case 308 above.

Case 310.—This cow was bought privately as "tested" in July, but reacted in September of the same year.

Case 311.—This heifer was bought privately from a tuberculin-tested herd which was itself free from reactors. She was bought in July and reacted in September. A puzzle.

Case 312.—This cow was bought from an un-tested herd, but was stated to have passed the test. She passed her first test two months later, but reacted at the second test six months later. She had been grazed with two reactors for two weeks before being housed.

Case 317.—A bought-in calf, which reacted at her first official test on being introduced into the milking herd. No further details.

Cases 324-325.—These were two cows bought-in from an unknown source. No information was available with regard to previous tests.

Case 356.—This cow had been tested privately by a private veterinary surgeon (test employed, unknown). She reacted in her first official test shortly afterwards (double intradermal method).

Case 361.—This was an old cow which had been bought-in privately as having passed the test. Tests employed, subcutaneous and ophthalmic. She reacted at her first official double intradermal test.

Cases 362-363.—These two animals were bought-in as un-tested heifers. They were passed by the owner's private veterinary surgeon. They passed official tests for two years, and then reacted.

Case 391.—This was a bought-in cow from an unknown source. No information was available with regard to previous tests.

Case 399.—This was a bought-in bull (source unknown). He had passed the test before entering the herd, and had also passed the first test in the herd, but he reacted at his second test.

Case 371.—A bought-in cow which gave a doubtful reaction at her first test. It was not known whether she had previously been tested.

Case 417.—An un-tested cow, which had been bought-in suckling a calf. She reacted at the first test.

Case 434.—A bought-in heifer which reacted at her first test.

Case 454.—This was a bought-in cow, source unknown. She passed two tests, but failed at her third.

Cases 147-162.—These sixteen animals failed over a period of five years. They were bought-in as un-tested cattle from Ireland. They were tested, and, having passed, were introduced into the herd. They reacted over the period stated, though no information could be given as to the number of tests which any individual animal had passed.

Cases 164-182.—These were a similar group of nineteen un-tested cattle which had been imported from Ireland, and passed an initial test. They all reacted within a period of two years.

Case 460.—An un-tested Irish heifer, which reacted at her first official lest.

Summary of Evidence of Infection from Bought-in Stock.

Many of the above cases appear at first sight to invite serious criticism either of the tuberculin test itself or of the technique of the veterinary surgeons administering the test. A more careful study of individual cases indicates, however, that such criticism is hardly justified. In weighing the detailed evidence, due emphasis must be laid on the possibility of infection having been contracted either subsequent to the qualifying tuberculin test, or at such a short period before the test that infection was in the pre-sensitive stage (*i.e.*, not recognisable by the tuberculin test). In the great majority of cases such a possibility of infection does, in fact, exist.

The risk of infection to animals which pass through an auction mart is strikingly illustrated by Case 11 (page 20), while the subsequent cases provide ample evidence of the dangers of purchase through an open market. Again, in several instances (see cases 38, 260, and 263, page 22) animals have been purchased from tuberculin-tested herds which themselves are not free from infection, and such animals have subsequently reacted in the new herd. All these are clear-cut examples of the purchase of actively infected stock.

Instances of the purchase of animals which are in the pre-sensitive stage of infection (see page 18) are numerous, though perhaps not so convincing. Direct proof that such animals were in fact infected, in spite of their failure to react to the tuberculin test, cannot of course be produced; but the trend of evidence in a large number of cases indicates that such an assumption is justifiable. The length of the pre-sensitive period varied in individual cases. Thus in Case 39 (page 22) it was short—not more than two months. On the other hand, in the series of fourteen cases on page 21 (Cases 121 to 254), it extended to at least six months, since all the animals in these cases passed their first official test after purchase and reacted at their second. A still longer period is implied in Cases 233, 234, and 255, but it should be pointed out that in these cases the possibility of an intervening infection cannot be ruled out.

Perhaps the most striking instances of the danger of unrecognised (pre-sensitive) infection are to be seen in Cases 147 to 182 (page 24). On the farms where these cases occurred it was the practice to purchase a large number of imported animals from un-tested sources, and to test all of them. Reactors were discarded, but the non-reactors were drafted into the herd. These non-reactors had therefore been in close contact with reactors just prior to their qualifying test, and thus had ample opportunity of picking up infection. They passed the test in their pre-sensitive stage, but the final results to the herds into which they were drafted were disastrous. In one herd sixteen such animals reacted over a period of five years; in another, nineteen reacted over a two-year period. It is impossible to condemn too strongly such a method of purchasing stock for inclusion in tuberculin-tested herds.

The failure of the test to diagnose infection in the above cases was due to the fact that the animals tested were in the pre-sensitive stage of infection. Three cases of an opposite character are recorded (Cases 315, 455, and 458, pages 20, 23, and 21). In each of these cases the animal was shown on slaughter to have widespread tuberculous lesions. Such an animal may lose the power to react to tuberculin owing to the breakdown of its defensive mechanism consequent on a chronic state of infection,* but it will be a dangerous source of infection to the herd into which it is drafted. Fortunately, in the majority of such cases, clinical examination of the animal would reveal the infection, so that the danger from such cases is quite limited.

To summarise this section, it is only necessary to emphasise once more the cardinal fact that failure to react to the tuberculin test is no absolute criterion of freedom from infection : *it is equally essential, in purchasing animals for inclusion in tuberculin-tested herds, to have adequate knowledge of their past histories and of the conditions of the farms from which they were secured.* If any blame is to be attached to members of the veterinary profession, it is not that they have erred in their methods of administering the test, but that they have, in providing clean certificates for individual cows, neglected to ascertain the possibility of the presence of an early stage of infection which the test itself is inadequate to diagnose.

INFECTION THROUGH CONTACT WITH INFECTED STOCK.

Infected stock may come into contact with animals in tuberculin-tested herds in three ways : they may have been present on the farm prior to the initial issue of the licence ; they may be introduced into the herd by purchase (see previous section) ; or they may have access over boundary fences.

Those which come under the last category may be in an advanced stage of the disease, and may thus be an obvious source of infection. On the other hand, animals which are bought-in are seldom in an advanced stage of infection, and will present an apparently healthy appearance. The healthy appearance of an animal can, however, never be taken as an indication that the animal is incapable of spreading infection. So-called " open " cases of tuberculosis are not limited to those which can be recognised by clinical examination : such evidence as is available indicates rather that a considerable number of apparently healthy animals may excrete tubercle bacilli from infected organs. Savage ([13]), for instance, quotes a number of authorities who have found virulent tubercle bacilli in the milk of animals with apparently healthy udders, while Stenhouse Williams and Hoy ([14]) draw attention to the

* The following quotation is taken from a paper by Buxton ([11]) :—" . . . . the body tissues of an infected animal throw out, as a means of defence, substances which break down the tuberculin formed by the organisms of which they are the unwilling host. In the case of animals whose response in this direction is vigorous and whose body cells are putting up a fine defence to the invader, these substances or " lysins " can cope with the additional tuberculin used for the test. In the case, however, of poor, weakly, extensively infected animals, the body cells have made all the response of which they are capable and are too tired, too jaded, to respond to any further stimulus which the tuberculin employed in the test might call forth."

possible excretion of infected dung by cows which are to all appearances healthy. In their own work [15] they found that, out of 185 samples of dung from apparently healthy cows, 35 (or 18 per cent.) gave positive results on guinea-pig inoculation. The presence of infected stock in a tuberculin-tested herd—even though the infection is of recent origin—may thus lead to a spread of the disease among the free stock.

In the present inquiry a total of one hundred and four cases have been traced to infection through contact with infected stock. These cases have been classed into four groups: first, infection by general contact; second, infection from bought-in stock; third, infection from a stall-mate; and fourth, infection from neighbouring un-tested cattle.

(1) Infection by General Contact.

The following fifty-five animals reacted to the test after being in contact with infected stock in the herd.

Case 6.—A five-year-old cow which had been in contact with reactors while cleaning-up the herd. She passed the first official test, but reacted at the second.

Cases 9-10.—These were two home-bred heifers which had been in contact with two recent reactors for a short time. They had passed the subcutaneous test privately, but reacted at their first official double intradermal tests.

Case 33.—This cow had been a doubtful reactor when tested by the owner's private veterinary surgeon. At the same test there had been a number of reactors discarded. She reacted at her official test. First test, subcutaneous; second test, double intradermal.

Cases 96-101.—These six heifers had been outwintered together. One of them was found to be suffering from a swelling on the jaw, which was later discovered to be tuberculous. The remainder had been feeding out-of-doors with this infected animal, all feeding from small wooden boxes. They were all home-bred. Five reacted at their first test, and the sixth at her second.

Cases 132-133.—These were two home-bred cows which had passed their first official test. They had both been in contact with a reactor, and themselves reacted at the following test.

Cases 137-143.—Four of these animals had passed the test for two years. They subsequently reacted. As far as could be ascertained, they had been in close contact with other reacting cattle at the previous test. At the following test the remaining three reacted.

Cases 187-189.—These three animals—two cows and a bull—had passed the test for two years. They subsequently reacted. As far as could be ascertained they had been in contact with reactors at the previous test. They were slaughtered and all three showed tuberculous lesions in the lungs.

Cases 330-342.—These thirteen animals were all part of the original farm stock. They had all been in contact with previous reactors. They passed one official test (subcutaneous), but reacted when tested by the double intradermal method.

Case 379.—This was an old cow which had already passed subcutaneous and intradermal tests. She had been grazing with a reactor and subsequently reacted.

Cases 400-403.—These four reactors were all home-bred. The only information which could be obtained was that they had been in contact with reacting cattle prior to the test.

Case 422.—This was an old cow which had passed several subcutaneous tests. She reacted at her first double intradermal test. She had been in contact with two reactors prior to the test.

Cases 435-441.—These seven reactors (four positive and three doubtful) had all been in contact with reacting cattle. No further details available.

Cases 443-446.—Two of these animals had been in contact with reactors at the test prior to that at which they themselves reacted. The remaining two had been in contact with the first two, and reacted at the following test.

Cases 447-450.—These four animals had been passed by the owner's private veterinary surgeon. They had, however, been in contact with reactors at that test. They reacted at the official test (two positive, two doubtful).

Case 457.—This animal had been in contact with reactors at the test prior to that at which she reacted. She was always a bad " doer," but had passed the test on several occasions.

Special Case 31.—This cow had passed the subcutaneous, double intradermal and ophthalmic tests on several occasions at official tests. There had been no other reactors on this farm for several years, and she was never known to have been in contact with a reactor. Nevertheless she finally reacted. The only source of infection appears to be the presence of two reacting bulls on the farm, although these were kept in nominal isolation.

(2) Infection from Bought-in Stock.

The following eleven animals reacted after being in contact with bought-in stock.

Cases 193-197.—These five animals were home-bred and reacted at their first official test. They had all been in contact with bought-in animals which also reacted at this test.

Cases 212-214.—These were three home-bred cows which reacted at their first official test. They had all been in contact with bought-in reactors.

Cases 224-225.—One was an old cow which had passed the test several times on this farm ; the other was a cow which had been bought at a dispersal sale. Both animals reacted after they had been pasturing with animals which had been bought-in eighteen months previously and which had remained on the farm for this period before reacting to their first test.

Case 319.—This cow had been bought-in through a dealer two years previously, but had passed three official tests. She reacted after grazing with a bought-in reactor.

(3) Infection from a Stall-Mate.

The following ten animals reacted after standing in neighbouring stalls to reactors.

Case 2.—This cow had passed the subcutaneous test five times at the hands of the private veterinary surgeon. She reacted at her first official double intradermal test. Prior to this test she had stood stall-mate to a reactor.

Case 4.—This was an old cow which had given a doubtful reaction six years previously, when tested by the subcutaneous method. She was isolated and drafted back into the herd after a re-test. She passed her first double intradermal test, but reacted at the subsequent test. She had, however, stood stall-mate to a reactor.

Case 34.—This animal had passed the subcutaneous test privately. She reacted at her first official double intradermal test. At the previous test she had been standing stall-mate to a reactor.

Case 37.—This was a cow bought-in from a dealer. She had passed the test both before and after purchase, and had also passed one official test. She was standing in next stall to a reacting cow, and reacted at the subsequent test.

Case 184.—This was a home-bred cow which had passed the test privately. At that time she was stall-mate to a cow which reacted at the private test. She reacted at the following test.

Case 215.—This was a home-bred heifer. She had stood next to a reacting cow, and reacted at her first official test.

Case 365.—There had been no reactors on this farm for a good number of years. A bought-in cow stood stall-mate to a home-bred cow, and both reacted at the following test.

Case 442.—This animal was bought-in as an un-tested heifer, but had twice passed the test. She stood stall-mate to a reactor at one test, and reacted herself at the next.

Case 453.—This was an old bull which had passed the test for several years. A young bull, bought-in through an auction mart, was put into the next box but reacted at his first test. There was only a wooden partition between the two boxes, and there were cracks in the wall. The old bull reacted at the following test, and on slaughter was found to have tuberculous lesions in the bronchial tubes.

Case 456.—This was a home-bred cow which had passed several tests. She stood stall-mate to a bought-in reactor, and herself reacted at the next test.

(4) Infection by Contact with Neighbouring Stock.

The following thirty-four animals reacted after being in contact with neighbouring un-tested cattle.

Case 17.—This heifer had passed the test in March, when officially tested by the double intradermal and ophthalmic methods. On re-test in November she reacted to both tests. She was the only reactor out of a group which were summer grazed. While at grass she was constantly jumping into a field containing neighbour's un-tested stock. Single-fenced farm.

Cases 235-236.—These were two animals from the original farm stock. They both reacted after three years' clear tests, but they had been grazing next to a dealer's stock just prior to reacting. Single-fenced farm.

Case 259.—This was a home-bred cow which had passed all official tests for four years. She was the only reactor among the herd at the time. Neighbouring cattle from an un-tested herd were constantly trespassing during the grazing season. Single-fenced farm.

Cases 326-328.—There had been no reactors in this herd for two years. These three were out of a group of fourteen animals which had been summered at grass away from home. They had been in contact with un-tested cattle while at grass. The three reactors had passed the test in April, but reacted in December of the same year. (Subsequently the remaining eleven were disposed of as they showed signs of infection.)

Cases 343-355.—These thirteen animals reacted over a period of two and a half years. They were all original farm stock. The only source of infection which could be traced was by contact over a fence bordering a field in which piners were grazing. (Note, however, that seven of these animals passed the subcutaneous test in early tests, but ultimately reacted when tested by the double intradermal method.) Single-fenced farm.

Cases 380-390.—These eleven reactors (including four doubtful) were all home-bred. All had passed at previous tests. The suspected source of infection was the presence of dealer's cattle in neighbouring fields. The farm has since been double-fenced, and has been clear for one year.

Case 414.—A bought-in cow from a certified herd. She passed the test on arrival, but reacted at her second test. The only possible source of infection appeared to be contact with neighbouring un-tested cattle. The farm, however, was double-fenced.

Case 418.—This farm had been tested for several years without reactors. This animal was a home-bred heifer, which reacted at her first test. *Post mortem* examination confirmed infection. The source of infection was apparently contact with dealer's flying stock in neighbouring fields. Single-fenced farm.

Case 459.—This heifer had never been housed, was home-bred, and was never known near a reactor in the herd. She reacted at her first test. Contact with neighbouring un-tested stock was possible. The farm was single-fenced.

Summary of Evidence of Inspection through Contact with Infected Stock.

Several of the above cases provide conclusive evidence that contact with infected stock may lead to the introduction of the disease into tuberculin-tested herds. In particular, Cases 96-101 (page 27) and Case 453 (page 29) illustrate infection which may be spread within the herd itself, while Case 17 (page 29) provides a striking example of infection contracted through contact with neighbouring un-tested stock.

Other cases are less convincing, particularly many of those classed in the "general" group (pages 26 and 28). It cannot be denied that the inference of infection by contact has, in some instances been drawn rather from the elimination of other possible sources of infection than from direct proof of the actual source indicated in the individual case histories. It is, however, suggestive that the great majority of animals dealt with in this section were home-bred, that, in general, they had passed the test on several occasions prior to infection, and that the herds from which they were drawn were those which had previously been relatively free from reactors. These facts indicate that the source of infection was adventitious rather than inherent in an infected condition of the premises. In this connection it should be pointed out that by far the greater proportion of reactors revealed infection only after they had been in contact with infected animals from an *external* source—either from bought-in stock or from cattle in neighbouring un-tested herds. But even if one assumes that the source of infection was not necessarily that implied in the case histories, the available evidence does indicate at least one possible source of infection—and of avoidable infection.

With regard to individual cases, the instances of reactors among stall-mates forms an instructive commentary on the danger of reacting cattle even in the very early stages of infection. From the information supplied in these cases, one is forced to the conclusion that an animal which has but recently contracted the disease may form a vehicle for the infection of other stock which are in continued close contact with it. Incidentally Case 31 (page 28), though not in itself conclusive, provides some evidence that even the presence of a reacting bull may lead to infection in a clean herd.

The most striking individual group of reactors is that in which infection is due to contact with neighbouring un-tested stock (page 29). If the case histories of these reactors are examined, it will be seen that, out of a total of thirty-four animals investigated, thirty-three were from farms which were single-fenced, while only one case occurred among herds which were double-fenced. The value of double-fencing is confirmed by an examination of the relative proportion of reactors occurring on single-fenced and double-fenced farms. These proportions work out as follows :—

	Number of Farms.	Number of Tests.	Number of Reactors.	Percentage of Reactors.
Single-fenced,	70	20,859	356	1.7%
Double-fenced,	26	7,362	72	0.9%

The double-fenced farms show a reduction of nearly 50 per cent. in the proportion of reactors as compared with single-fenced farms.

To summarise this section, it may be stated that contact with reacting animals has been shown to be a fruitful source of infection in tuberculin-tested herds. Such infection may take place either by contact within the herd (for instance, through the purchase of supposedly free, but actually infected, stock), or from an external source (for instance, through contact with neighbouring un-tested cattle). By appropriate measures the danger from these sources of infection can be greatly reduced, if not entirely eliminated.

INFECTION FROM CONTAMINATED PREMISES.

In the previous section stress was laid on the fact that apparently healthy cattle may excrete virulent tubercle bacilli in their fæces. It is therefore apparent that the premises of any tuberculin-tested herd *may* become infected, either prior to the issue of the licence (*i.e.*, when the herd is being initially cleaned) or at any time when reactors are present in the herd. Again, it is possible for animals from tuberculin-tested herds to have access to infected premises if they are at any time moved temporarily either to unlicensed premises or to pastures in which un-tested stock have been grazing.

It is common knowledge that buildings which have been occupied by reacting cattle must be thoroughly disinfected before they can be safely used for the accommodation of tubercle-free stock. Little information is, however, available in regard to the degree of infectivity of such infected premises. The fact that tuberculin-tested cattle could, until recently, be exhibited at cattle shows side by side with un-tested stock, and that they can still be accommodated and sold in public auction marts, indicates the existence of a widespread belief that temporary contact is unlikely to lead to infection. Similarly, little account has so far been taken *in practice* of the possibility of free animals contracting the disease by grazing on infected pasture.

What evidence is there to show that infection from these sources can, in fact, take place ?

Extensive experiments have been carried out by Stenhouse Williams and Hoy ([21]) in order to determine the viability of bovine tubercle bacilli under certain farm conditions. These workers have demonstrated that the bacilli may be found alive and active for at least twelve months in naturally infected dung, and in artificially infected dung for a period of at least two years. This indicates that dung, either allowed to lie in the byre or stored in manure heaps for ultimate disposal on the land, will remain a virulent source of infection for a surprisingly long period. Experiments with liquid manure showed that the organism was capable of remaining active for a period of at least four months. Stenhouse Williams and Hoy carried out a further series of experiments to determine the viability of tubercle bacilli on pasture land. Under the ordinary conditions prevailing in the South of England they showed that the bacilli could remain alive and virulent for a period of at least four months in dung exposed on pasture land during the winter. In the spring live bacilli were demonstrated after two months, but not after three months ; in the summer after two months ; and in the autumn after four months' exposure. They point out that the length of the period depends largely on the conditions which happen to exist. For instance, the bacilli remained alive and virulent in dung exposed on pasture land for a period of four months in the summer, provided that it was protected from direct sunlight. In the autumn, when the patch of dung was protected, as far as possible, from worm and insect life, the bacilli were present and active at the end of six months. They point out that the presence of sheds, shelters, or overhanging trees, or even of long grass, may have a material effect in prolonging the period during which the tubercle bacilli remain active. There are no other investigations directly comparable to those carried out by Stenhouse Williams and Hoy. But their experiments provide conclusive proof of the *potential* danger of infected dung—whether in the byre or on pasture grass—as a source from which the disease may be contracted. How far, in practice, can this be shown to be an *actual* danger ?

In the present inquiry a total of fifty-four cases have been traced, indirectly or directly, to infection from contaminated premises. These cases have been classed into three main groups : first, infection from building ; second, infection from pastures ; and third, infection contracted at cattle shows.

(1) Infection from Buildings.

The following twenty-six animals were infected through being housed in infected byres.

Case 1.—This cow was bought-in as a calf and reacted as a three-year-old after passing two previous tests. She had been standing in a previous reactor's stall, and this appears to be the only possible source of infection—though it was stated that the stall had been disinfected.

Case 36.—This was a bought-in cow from a tested herd. She had passed all tests in her original herd, and had passed the first test in the new herd, but reacted at the second. She had been standing in a former reactor's stall.

Case 110.—An old bull which had been tested as a yearling. He reacted as a five-year-old. He had occupied the same box as a previous reactor. It was, however, stated that the box had been disinfected and creosoted.

Cases 359-360.—Both of these reactors had passed the test on several occasions, but they had been placed in previous reactors' stalls. They reacted at the subsequent test.

Cases 420-421.—Both these reactors were standing in stalls which had previously been occupied by reactors. No other source of infection was known.

Cases 46 and 49.—One of these was a home-bred heifer which gave a doubtful reaction at her first test. The other was also a home-bred heifer which had passed her first test, but had reacted at her second. The farm was badly infected, as shown by the number of reactors at the original private tests.

Case 52.—After eighteen months of clear testing on this farm, one home-bred heifer, which had passed one official test, reacted. There had, however, been a large number of reactors at the private test carried out eighteen months previously, and, while this animal had not been in contact with any of the reactors, it is assumed that she contracted infection through being housed in infected premises.

Cases 58-60.—One of these animals was a home-bred cow which had passed her first official test but had reacted at her second. She was the only animal to react at this test. A year previously the farm had, however, been badly infected, there being 50 per cent. of reactors. A year after this animal had reacted, two other home-bred animals gave doubtful reactions. They had never been near a reactor except for the above animal.

Cases 241-253.—A herd, which had previously been tested, moved to a new farm which was known to have been badly infected with tuberculosis. At the first official test five animals reacted. At the next five more reacted, one of which had been doubtful at the previous test but passed on re-test. At the following, three further animals reacted, two being stall-mates.

(2) Infection from Pastures.

The following twenty-one animals reacted after grazing on infected pastures.

Cases 28-29.—These were two bought-in animals, which were purchased from a tuberculin-tested herd which itself had never had a reactor. They had passed three official tests on their new farm. They were put to graze on pastures previously grazed by bought-in reactors. At the next test they reacted.

Cases 304-307a.—Thirty-one heifers were sent for grazing to a sheep farm some distance from the tuberculin-tested premises. They were put into an outlying 90 acre field and twenty-five of them remained in this field until they were brought in for testing in October. The remaining six were, at the request of a neighbouring farmer, grazed in a smaller field, as the grass in this field was getting too long for sheep. At the following test the twenty-five animals grazed in the larger field passed, but five out of the six grazed in the smaller field reacted. The cause of the infection was carefully examined, and the only solution which could be found was as follows :—No cattle had grazed on the small field for at least six years, but at the previous autumn the field was given a heavy dressing of farmyard manure. This manure was chiefly derived from a byre occupied by three or four cows. One of these was found to be clinically tubercular, and all reacted to the tuberculin test. Since this date thirty heifers had been grazed on the larger field every year, but no other reactor has been found.

Cases 63-69.—Three of these animals had passed the test for three years. They were removed from one tested farm to start up a herd at another farm. They subsequently reacted. The owner stated that he was troubled by dogs and birds, which carried slaughter-house offal on to his pastures. (But note that the farm buildings had been occupied by un-tested stock.) At the following test there were three doubtful reactors, but these were passed on re-test. No information is available as to whether they were disposed of. At the next test there was one reactor—a home-bred cow which had passed the test on several previous occasions.

Cases 372-376.—These five reactors were known to have been in contact with reactors which had been failed at the test more than a year previously. The owner attributed infection to the presence of slaughter-house offal which was carried on to his land by gulls.

Cases 397-398.—These two young bulls reacted after they had been grazing in a meadow which was watered by sewage from a tuberculosis sanatorium.

(3) Infection Contracted at Cattle Shows.

The following seven animals reacted after returning from exhibition at cattle shows.

Case 3.—This animal had passed the subcutaneous test on several occasions when tested privately, but reacted at the first official test (double intradermal). She had been exhibited at a cattle show prior to the official test.

Case 19.—There had been no reactors in this herd for five years. A heifer which had never been in calf, and which had passed an official test as a yearling, was exhibited at a cattle show. She reacted to the test ten months later.

Cases 44-45.—These two animals had been bought at a dispersal sale. They had passed one official test. One reacted on return from the London Dairy Show, and the other on return from the Royal Show, where it was alleged that she had been standing next to reactors.

Cases 61-62.—These were two home-bred heifers. One reacted after being exhibited at the Highland Show at Stirling, and the other after being exhibited at the same show at Dumfries.

Case 377.—This animal was one of the original farm stock, and had passed the test on several occasions. She was exhibited at a cattle show, and subsequently reacted in the same year. She was the only animal which had reacted in this herd for a number of years. There have been no reactors since.

Summary of Evidence of Infection from Contaminated Premises.

It is extremely difficult to indicate with any degree of certainty the exact mode of infection of animals which react after being housed in contaminated premises. The disease may have been spread by manurial contamination, either of the buildings or the pastures; it may have been contracted through the use of a common water supply or of infected feeding troughs; or it may, in fact, have been due to contact with reactors at a previous test but have remained undetected in its pre-sensitive stage.

In seven of the instances quoted above (Cases 1 to 421, pages 32 and 33), infection was limited to single stalls which had previously been occupied by reactors. In the remaining eleven cases recorded in the first group (Cases 46 to 253, page 33), the source of infection was indefinite, but the evidence was sufficient to show that at least one source of infection did, in fact, exist.

The evidence of infection from the manurial contamination of pastures is convincing. Cases 304-307a (page 33) provide a clear-cut example of such infection, and confirm, under practical conditions, the carefully controlled experiments of Stenhouse Williams and Hoy. On the other hand, the alleged infection from slaughter-house offal (Cases 63-69 and 372-376, page 34), must be accepted with reserve; these cases furnish an interesting *possible* source of infection, but they are complicated by the fact that other sources of contamination were known to exist.

Cases 397 and 398 (page 34), in which infection was assumed to be due to the contamination of pastures by sewage from a tuberculosis sanatorium, are unique. Undoubtedly such infection is possible. Several authors ([16 and 17]) have demonstrated the presence of active tubercle bacilli in the effluents from septic tanks, and it is particularly interesting that Cummings, Davies, and Acland ([18]) have recognised the danger of such a source of infection in relation to grazing.* It is unfortunate that, in the single case recorded in the present inquiry, it was not possible to obtain infected material from the reactors, so that the type of tubercle bacilli—human or bovine—might have been ascertained.

There remain the seven cases in which infection was apparently contracted at cattle shows. These are of special importance in view of the recent Circular issued by the Ministry of Health, which makes compulsory the provision of separate accommodation for tuberculin-tested stock at agricultural shows. Only one recorded case has been found in the literature in which infection was attribued to contact with un-tested stock exhibited at cattle shows. This case formed the subject of a letter addressed to the British Medical Journal ([19]) by the Medical Officer of Health for the States of Guernsey, from which the following quotation is taken:—"Until 1906, tuberculosis was apparently unknown amongst Guernsey cattle, but it was then introduced by cattle re-imported after having been to England for exhibition." The seven cases traced during the course of the present inquiry confirm the danger of infection of tested stock at cattle shows, and justify the policy of excluding such animals from exhibition unless precautions are taken to ensure their satisfactory isolation from un-tested stock.

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* The following quotation is taken from the paper by Cummings, Davies, and Acland:—" It is thought advisable to place these findings on record since it is believed that some hospitals for the tuberculous may dispose of the sludge of septic tanks on land used for gardens or grazing; a form of disposal which must be regarded as questionable in view of the above results."

MISCELLANEOUS AND MULTIPLE SOURCES OF INFECTION.

The following sixty-three reactors may have contracted infection from several sources.

Cases 268-294.—For a number of years this farm had had a very large number of reactors, as revealed at the tests carried out by the owners' private veterinary surgeon. The premises were therefore probably heavily infected. Cases 268-284 were equally divided between home-bred and original purchased stock. All these animals reacted, though it was not possible to ascertain whether they were all tested officially. The remaining ten reacted at the subsequent official test.

Cases 121-131, 183-183a, 237-239, 313-314, 320-323, and **425-433.**—These twenty-four animals all formed part of the original stock at various farms. They all reacted at their first official test. No further information is available.

Cases 14-15.—These two cases occurred on a farm which had shortly before been badly infected. One of the reactors was a cow which had been bought-in with a clean certificate. The other had been bought-in from a tuberculin-tested herd. Both cows had passed two official tests (intradermal), but both reacted at their third test. They were stall-mates.

Case 136.—This was an old cow which had on several occasions passed both the subcutaneous and intradermal tests. She had been in contact with reactors (of which there were 50 per cent. at the first official test) and had also been grazed with reacting heifers. In the year that she reacted she had been exhibited at a cattle show, and had been housed for a night in a dealer's premises. She reacted two months later, but only after an attack of rheumatism.

Case 50.—This was a bought-in cow from a tuberculin-tested herd. She passed the double intradermal test once after arrival at the new farm. She had never been near a known reactor, but had been put into a byre which had been occupied by reactors three months previously. (It was stated that the byre had been disinfected.) She subsequently reacted. This cow was also suffering from Johne's disease.

Cases 299-303.—Case 299 had given a doubtful reaction to the subcutaneous test in 1925. She showed no temperature rise after a double dose six weeks later, nor at any subsequent half-yearly test until autumn 1928. She reacted at this date and was at once slaughtered. She was found to be suffering from marked Johne's disease, while an old incapsulated tuberculous lesion was found to have broken down in the lung. Cases 300-303 were home-bred and had never been away from the farm. They had, however, been in contact with un-tested cows in an adjacent field which belonged to a neighbouring farm. Two of them, when tested, were negative to the ophthalmic but positive to the subcutaneous and double intradermal tests; on slaughter, tuberculous lesions were found in the pharynx and mediastinal glands. The remaining two were negative to the ophthalmic and doubtful to the double intradermal tests, but with the subcutaneous test gave definite rises in temperatire of from 2½° to 3° F. The temperature curves were not, however, typical, both showing a very sudden fall. On slaughter, no tuberculous lesions could be found. All four of these animals were found to be suffering from marked Johne's disease.

In the following three cases, infection was only revealed after difficult calving.

Case 20.—This cow had been tested five times and had passed the test on each occasion. She had been bought-in to the herd, but had remained free for two years. She subsequently reacted after a difficult calving at which she had retained her cleansing.

Case 21.—This was a home-bred cow which had passed the test five times. She ultimately reacted after a difficult calving at which she had retained her cleansing.

Case 32.—This was a home-bred cow which had passed the test. She failed subsequently after a difficult calving at which she was not cleansed properly.

Comments.

The bulk of these cases have occurred among original farm stock. Cases 268-294 provide a typical example of the infective conditions on a farm which is in the process of " cleaning-up "—conditions which may often lead to the appearance of reactors at the first official tests. Twenty-four similar cases are also recorded (Cases 128-433).

Case 299 is of special interest. She had reacted at an early test, but had subsequently passed for three years. On her final reaction she was slaughtered, and *post mortem* examination revealed the breakdown of an old incapsulated tuberculous lesion. The possibility of a temporary loss of reactivity following the enclosure of the disease within a wall of fibrous tissue has been noted by Buxton ([11]), who comments on the danger of allowing an animal which has once given a positive reaction to re-enter the herd. It is impossible to forecast when such an animal will again become actively infectious owing to the breakdown of the protective wall, and it therefore forms a permanent danger to the free herd. As Buxton points out, an animal which has once failed to pass the test should be ruthlessly excluded from a tuberculin-tested herd. Cases 20, 21 and 32 demonstrate that infection may in some cases only become apparent after severe strain, *e.g.*, difficult and unsatisfactory calving.

In addition to these instances of miscellaneous and multiple sources of infection, the twenty-six animals which reacted on farm 35 (page 15) should be included under this general heading, bringing the total for the section to eighty-nine cases.

ANOMALOUS TUBERCULIN TESTS.

It has been pointed out in a previous section of this report that certain apparent anomalies in the results of the tuberculin tests are due to the existence of a pre-sensitive period in the disease—a period during which the test is inadequate to diagnose infection. A limited number of cases has, however, been traced in which the test has yielded genuine anomalous results—results which are definitely due either to inherent defects in the method of testing or to faulty technique.

In five cases animals passed the subcutaneous test, but subsequently reacted at their first double intradermal test.

Case 40.—This was an old cow which had passed the subcutaneous test when tested by a private veterinary surgeon, but reacted on her first double intradermal test.

Case 216.—This animal had passed the subcutaneous test for three years. She reacted at her first double intradermal test. She died, following udder infection, shortly afterwards, but *post mortem* examination failed to reveal microscopic infection.

Cases 229-230.—Two animals which had been bought-in through the open market two years previously. Both passed the subcutaneous test during the entire period, but both reacted at their first double intradermal test.

Case 413.—This was the only reactor in the herd. She had passed the subcutaneous and ophthalmic tests, but subsequently reacted at her first double intradermal test.

In two cases, animals reacted to the official double intradermal test, but subsequently passed the subcutaneous test.

Case 5.—This bull stirk was stated to have been in contact with a known reactor. He reacted at his first official double intradermal test. He was sold and tested as a bull, when he was stated to have passed the subcutaneous test. He has continued to pass this test.

Case 102.—This was an old cow which gave a doubtful reaction to the double intradermal test. She was re-tested by the subcutaneous method and passed. Six months later she again gave a doubtful reaction to the double intradermal test, and was disposed of.

In two cases, animals reacted to the subcutaneous test, but subsequently passed the double intradermal test.

Case 18.—This animal gave a doubtful reaction to the official subcutaneous test. She was removed to another farm and has continued to pass the double intradermal test ever since.

Case 217.—This was an old cow which had passed the subcutaneous test successfully on several occasions. She then suddenly reacted to this test, but, when isolated and re-tested, she passed both the subcutaneous and double intradermal tests.

In seven cases, animals reacted at official tests, but were subsequently passed at private tests.

Case 22.—This animal had been outwintered with known reactors as a heifer. She had subsequently passed five official double intradermal and ophthalmic tests. She finally reacted to the double intradermal, but not to the ophthalmic test. She was at once re-treated by the owner's private veterinary surgeon, and passed both tests. She was, however, sold to a dealer and allowed to mix with un-tested cattle.

Cases 23-24.—These animals were from the same group as Case 22. When failed, they reacted to the double intradermal, but not to the ophthalmic tests. They were at once tested by the owner's private veterinary surgeon and passed both tests. They were sold into a clean herd on a different part of the country, where they are known to have passed official tests successfully.

Case 41.—This bull reacted at an official double intradermal test. He was later re-treated by the owner's private veterinary surgeon, employing the same test, and passed by him. The bull was exported, and has continued to pass the test ever since.

Case 329.—This cow had passed the official subcutaneous test twice, but reacted on her third test. She was subsequently re-tested by the owner's private veterinary surgeon, employing the same test, and was passed by him.

Cases 415-416.—These were two animals bought-in from a tuberculin-tested herd, where there had never been a reactor. They passed one official test, but reacted at their second. They were sold to a neighbouring farmer and re-tested by his private veterinary surgeon, when they passed.

In four other cases, anomalous tests were reported.

Case 53.—This animal gave a doubtful reaction, and was isolated. On a re-test she was stated to have passed, and she again passed six months later. At the official test about two months later she again gave a doubtful reaction, and was disposed of. All tests employed were double intradermal.

Case 410.—This was a home-bred heifer which reacted and was isolated. On a re-test she passed, and was re-drafted into the herd. She has continued to pass the test.

Cases 411-412.—This herd had been clear for a number of years of private and official testing. Two home-bred cows reacted at an official double intradermal test. The County Veterinary Inspector had only diagnosed one as a reactor, but agreed with the owner, when it was pointed out to him that the other was also a reactor. Both animals were re-tested officially by the same method, and showed no reaction whatever. They had meanwhile also been tested by the owner's private veterinary surgeon, using the subcutaneous test, and had been passed by him.

Comments.

The introduction of the double intradermal tuberculin test has placed in the hands of the veterinary surgeon a diagnostic method which is very generally held to be more sensitive than either the subcutaneous or the ophthalmic tests. Buxton and MacNalty ([20]), summarising the collected experience of a number of veterinary surgeons, record that out of 835 animals which showed no reaction to the subcutaneous test, 116 reacted when tested by the double intradermal method.

Taking such results into consideration, it is not surprising to find that a considerable number of the animals recorded in this inquiry reacted to the double intradermal test although they had previously passed the subcutaneous test. In all, forty-seven such cases were traced. Of these cases, forty were complicated by the possibility of intervening infection, and have therefore been included in the previous sections of this Report. The remaining seven (Cases 40 to 102, pages 37 and 38), however, provide fairly clear-cut illustrations of the difference in sensitivity between the two tests.

The subcutaneous test is not only subject to error by reason of its relatively low sensitivity: it may, under certain conditions, indicate infection when the rise in temperature is in fact due to some other cause (for instance, where the animal under test has contracted a bad chill). Two such instances are recorded (Cases 18 and 217, page 38).

Case 53 (page 39) probably represents the result of intermittent re-activity, one instance of which (Case 299, page 37) has already been discussed. Such an animal forms a constant potential danger to a clean herd.

In the remaining nine cases detailed in this section no definite explanation of the anomalous results is available. Three possibilities which cannot be ruled out are the use of unreliable tuberculin, faulty technique, and careless interpretation (see Cases 411 and 412, page 39). Such cases are naturally a source of concern to owners of tuberculin-tested herds, since they represent losses in stock which are entirely outwith the owner's control. Fortunately such cases account for less than two per cent. of the total number of reactors traced in this inquiry.

SOURCE OF INFECTION NOT TRACED.

There is a total of twenty-nine cases in which it has been impossible to indicate any source of infection. In twelve of these cases there is insufficient information available to determine the source of infection ; in the remaining seventeen cases, no source of infection has been traced in spite of full details being provided.

(1) Insufficient Information available.

Case 42.—This animal gave a doubtful reaction at an official test, and was stated to have reacted on a re-test. No further information was available.

Cases 107-108.—These two cows had passed three official tests (method of testing unknown) but failed ultimately to the double intradermal and ophthalmic test. No further information was available.

Case 316.—A home-bred heifer which reacted at her first test. No further information was available.

Cases 392-396.—Three of these were home-bred animals, the remaining two were of unknown origin. Four of these animals gave doubtful reactions, and the fifth a definite reaction. No further information was available.

Case 419.—A home-bred heifer which reacted at her first test. No further information was available.

Cases 423-424.—Two doubtful reactors about which there was no further information.

(2) Inability to Trace any Source of Infection.

Cases 12-13.—One was a two-year-old heifer which reacted at her first official double intradermal test. There had been no reactors on this farm for several years, and the source of infection is unknown. The other was a four-year-old cow which reacted at the subsequent test. She had previously been passed twice at official tests (double intradermal and ophthalmic). She has since been re-tested and reacted to the subcutaneous test.

Cases 54-57.—These were young stock, and were all doubtful reactors. They had never been in the byre. Four years previously there had been a number of reactors on this farm. There had been no reactors for at least two years.

Case 226.—A three-year-old heifer which was never near a known reactor. She reacted at her first test. No source of infection could be traced.

Cases 256-257.—Two home-bred heifers which reacted at their first tests (double intradermal and ophthalmic). They had never been in contact with reactors on the farm, and no source of infection could be traced.

Cases 366-368.—These three animals all reacted to the subcutaneous test. They were original farm stock, and had previously passed several tests. They all stood separately throughout the byre.

Case 378.—This farm had been clear for two years of official testing. The reactor was a young home-bred heifer, and she reacted on her first double intradermal test. *Post mortem* verified the test. No source of infection was traced.

Cases 404-407.—One of these was a bought-in cow from a tuberculin-tested herd, but she had been bought some years previously. All four had passed the test on several occasions. They had not been in contact with a reactor for more than a year.

Comments.

The small number in this group is perhaps its outstanding feature. This point is emphasised when it is born in mind that, of the twenty-nine cases recorded, twelve lacked sufficient evidence to determine a source of infection : it is possible—if not probable—that with fuller information the cause of infection in these twelve cases might have been traced.

GENERAL SUMMARY OF SOURCES OF INFECTION.

A summary of the evidence relating to individual sources of infection has been included in each of the groups above : it only remains therefore to recapitulate in a concise form the main conclusions reached in the inquiry.

In Table 5 the major sources of infection are briefly summarised.

TABLE 5.

SUMMARY OF SOURCES OF INFECTION.

Source of Infection.	Number of Reactors.		Percentage of Reactors allocated to each source.
Infected animals among bought-in stock, - -	157	34·0%	Percentage in which an avoidable source of infection has been traced, 89·25%
Infection by contact with infected stock, - - -	113	24·5%	
Infection from contaminated premises, - - - -	54	11·5%	
Miscellaneous and multiple sources of infection, -	89	19·25%	
Anomalous tuberculin tests, -	20	4·5%	Percentage in which infection may have been outwith the control of the owner, 10·75%
Source of infection not traced,	29	6·25%	
	462*	100%	

It will be seen that, out of a total of 462 reactors whose case histories have been investigated, 413 (or practically ninety per

* This number is higher than that recorded in Part I., since it includes young stock and stock not introduced into the milking herd.

cent.) have contracted infection from sources which must be considered avoidable. In the remaining 49 cases, in which infection is indicated as being outwith the control of the owner, there are included nine instances of anomalous tests in which the reliability of the subcutaneous method is questioned, and 12 cases in which the source of infection could not be traced through lack of information. It therefore appears that, out of a total of 462 cases investigated, only 28 (or six per cent.) remain entirely unexplainable, while in over 91 per cent. it is possible to advance a reasonable explanation for the appearance of infection.

We are well aware that in a number of cases the evidence is not convincing. The allocation of an individual source of infection is not easy, and in many instances it has been necessary to decide somewhat arbitrarily the primary cause of the appearance of the disease. *Such arbitrary decisions do not, however, in any way invalidate the main conclusion that practically 90 per cent. of the reacting animals have contracted infection from avoidable sources.*

Recommendations for the adoption of measures to eliminate these sources of infection are contained in Part III. of this report.

PART III.

Recommendations.

In order to eliminate the main sources of infection in tuberculin-tested herds, we recommend that the following measures should be adopted :—

ESTABLISHMENT OF THE HERD.

The successful establishment of a tuberculin-tested herd depends largely on the rate at which reactors can be eliminated. The adoption of a three-monthly test in place of a six-monthly test during the initial stages of clearing, and for a limited period subsequent to the issue of the licence, would ensure a rapid displacement of infected stock from the herd, and would limit the period during which tubercle-free animals were in contact with such infected stock.

THE PURCHASE OF STOCK,

We strongly recommend that tuberculin-tested herds should be maintained exclusively by home breeding. It must be recognised, however, that there are occasions when a sudden demand for milk may necessitate the purchase of stock from external sources. In such a case the following precautions should be taken :—

(*a*) No purchase should be made in the open market, and owners should on no account buy-in cattle from untested or doubtful herds. (See definite recommendation in footnote* below.)

(*b*) Where an animal is bought-in with a clean certificate, the certifying veterinary surgeon should be instructed to ascertain the history of the animal and the conditions on the farm from which it is purchased, in addition to applying the tuberculin test.

(*c*) Precautions should be taken to ensure that the animal is protected from infection in transit. On arrival at the new premises, it should be at once isolated and retained in isolation until it has passed *three* official tests. These tests should be carried out (1) on arrival, (2) three months after arrival, and (3) six months after arrival.†

* One of the difficulties of the owner of a tuberculin-tested herd is to know where he can safely purchase tubercle-free stock. This difficulty could be overcome by the formation of an association for the co-operative buying and selling of tuberculin-tested stock. We would suggest that this agency might be undertaken by the existing Scottish Certified and Grade A (T.T.) Milk Producers' Association.

† The following precautions are made compulsory in the United States under the "Accredited Herd" Plan :—"In accordance with the accredited herd rules, no cattle may be brought on the premises where a herd is in the process of accreditation until such animals have passed at least one tuberculin test. These animals must be kept separate from the herd until they have passed a second test, which is applied in not less than 60 days or more than 90 days, at which time they may be added to the herd." [2]

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PRECAUTIONS ON THE FARM.

The following precautions should be taken to prevent the spread of infection on the farm itself :—

(*a*) Drastic disinfection should be carried out in any premises which have been occupied by reactors.*

(*b*) Animals known to have been in continued close contact with a reactor (for instance, stall-mates) should, if possible, be isolated until the next official test.

(*c*) Manure from infected premises should not be spread on pastures. It should preferably be used on arable fields, or, if this is impracticable, on fields which are to be cut for hay. In the latter case the hay should be given a maximum exposure to the sun, and the fields should not be used during the same season for grazing. It is similarly undesirable that fields which have been occupied by reactors should be used for grazing the tubercle-free stock.

(*d*) All boundary fences separating the farm from fields in which neighbouring un-tested stock are likely to graze should be double-fenced.

(*e*) It is undesirable to keep un-tested bulls for service in tuberculin-tested herds.

PRECAUTIONS IN EXHIBITING CATTLE.

Cattle for exhibition at agricultural shows should be provided with accommodation separate from that occupied by un-tested stock † Precautions should be taken to ensure that the animals are protected from infection in transit.

THE ADMINISTRATION OF THE TEST.

We strongly recommend that one uniform test should be adopted for use in both official and private testing. In this connection the double intradermal tuberculin test appears to be of outstanding merit as a diagnostic agent. Accompanying uniformity in the method of testing, it is desirable to ensure the adoption of a uniform technique and the use of a standardised tuberculin. In interpreting the results of the test, animals should be classed either as " reactors " or as " non-reactors." The term " doubtful reactor " should be eliminated, and all doubtful cases should be classed as " reactors."

* Liberal treatment with disinfectants is not sufficient. The infected premises should first be thoroughly cleaned out. The whole internal surface of the buildings should then be sterilised with the flame of a blow-lamp, and all holes and cracks in the buildings should be cemented up. The premises should then be thoroughly treated with a strong disinfecting solution. Care should be taken to disinfect all feeding-troughs, drinking bowls, etc.

† This practice is now assured by the Circular, recently issued by the Ministry of Health, which makes compulsory the provision of separate accommodation for animals from licensed herds.

Final Summary.

1. An inquiry has been undertaken into the incidence of reactors in tuberculin-tested (licensed) herds in Scotland, and into the sources of infection from which such animals contract the disease.

2. Over the six-year period, 1923 to 1929, 28,221 official tests were recorded and 428 reactors found. The average proportion of reactors was therefore 1.52 per cent., representing a loss of 3 reactors per 100 head of milking stock per year.

3. An examination of the number of reactors at successive six-monthly official tests showed that the loss during the first year amounted to 5 reactors per 100 head, falling to 1 reactor per 100 head by the fifth and sixth years.

4. In discussing the relation of the incidence of reactors in tuberculin-tested herds to the possible infection of the milk supply, it is shown that not more than 3 in every 10,000 animals in such herds can be considered as actively dangerous. Calculated on the 1928 cow population, this indicates that there is, each year, not more than one dangerously infected animal among the whole of the licensed tuberculin-tested herds in Scotland.

5. An examination of the sources from which reactors in tuberculin-tested herds may contract infection was made by means of a thorough investigation of the case histories of 462 reactors. The proportion of reactors infected from individual sources worked out as follows :—

Infected bought-in stock, - - -	34.0%
Infection through contact with other reactors or un-tested stock, - -	24.5%
Infection from contaminated premises and pastures, - - - - - -	11.5%
Miscellaneous and multiple sources of infection, - - - - - -	19.25%
Anomalous tuberculin tests, - - -	4.5%
Source of infection not traced, - -	6.25%

The individual sources of infection are discussed in detail. It is pointed out that less than 10 per cent. of the reactors contracted infection from sources outwith the control of the owner of the herd, the remaining 90 per cent. of cases being avoidable if due precautions had been taken.

6. A number of recommendations are made by means of which the various sources of infection may be eliminated.

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APPENDIX.

Number of Reactors in Individual Herds at Successive Six-Monthly Official Tests.

Farm No., -	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Size of Herd,	48	38	35	57	20	40	20	60	40	28	40	41	27	76	62	45	33	40	7	30	—	40	—	38	12	30	20	90
No. of Reactors at 1st Test,	0	0	0	0	0	0	4	1	2	0	0	0	0	0	0	0	4	0	0	1	No information available.	0	No information available.	0	0	0	Commenced Autumn, 1929.	0
2nd Test,	0	0	0	0	0	2	0	0	0	1	0	–	2	0	0	0	3	0	–	0		0		0	0	2		0
3rd Test,	0	0	1	0	0	0	0	1	0	1	0	–	0	0	0	0	1	1	–	0		0		–	0	0		0
4th Test,	–	0	0	3	0	0	0	0	0	0	0	–	1	0	0	1	–	0	–	–		0		–	0	0		1
5th Test,	–	0	0	0	0	0	0	0	–	0	0		3	0	0	0	–	1	–	–		1d		–	0	0		0
6th Test,	–	0	0	2	0	–	1	–	–	0	0	–	0	0	0	0	–	0	–	–		0		–	0	0		0
7th Test,	–	0	0	0	0	–	0	–	–	–	0	–	0	0	0	0	–	–	–	–		0		–	0	–		1
8th Test,	–	–	0	0	0	–	–	–	–	–	0	–	–	0	0	–	–	–	–	–		0		–	–	–		0
9th Test,	–	–	0	0	2	–	–	–	–	–	0	–	–	0	0	–	–	–	–	–		2		–	–	–		0
10th Test,	–	–	–	0	2	–	–	–	–	–	1	–	–	0	0	–	–	–	–	–		0		–	–	–		0
11th Test,	–	–	–	0	0	–	–	–	–	–	0	–	–	0	1	–	–	–	–	–		–		–	–	–		0
12th Test,	–	–	–	0	0	–	–	–	–	–	0	–	–	0	0	–	–	–	–	–		–		–	–	–		–

APPENDIX—*Continued.*

Farm No.,	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
Size of Herd,	28	58	26	—	38	50	28	38	25	50	—	38	66	80	80	40	90	35	50	30	45	40	30	32	20	21	42
No. of Reactors at 1st Test,	0	1	0	No information available.	0	3	4	0	0	10	No information available.	4	1	0	0	3	2	0	7	0	3	0	0	1	4	0	5
2nd Test,	0	0	0		–	3d	4	5	0	4		2	–	1	0	0	4	0	4	2	–	0	0	0	0	0	–
3rd Test,	0	2	0		–	1	4	4	3	3		1	–	1	0	–	1	0	4	0	–	0	0	0	8	0	–
4th Test,	0	0	0		–	–	6	1	1	–		–	–	0	0	–	2	1	4	0	–	3	0	0	–	0	–
5th Test,	0	–	0		–	–	9	–	–	–		–	–	–	4	–	0	0	0	0	–	0	0	0	–	0	–
6th Test,	0	–	–		–	–	2	–	–	–		–	–	–	0	–	0	–	0	–	–	2d	–	–	–	0	–
7th Test,	0	–	–		–	–	–	–	–	–		–	–	–	3	–	0	–	0	–	–	0	–	–	–	0	–
8th Test,	0	–	–		–	–	–	–	–	–		–	–	–	0	–	6	–	0	–	4	0	–	–	–	0	–
9th Test,	0	–	–		–	–	–	–	–	–		–	–	–	0	–	1	–	0	–	–	0	–	–	–	–	–
10th Test,	0	–	–		–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	0	–	–	–	–	–
11th Test,	0	–	–		–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	0	–	–	–	–	–
12th Test,	0	–	–		–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	0	–	–	–	–	–

APPENDIX—*Continued.*

Farm No.	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
Size of Herd,	80	35	12	20	—	22	40	80	14	—	103	30	105	82	—	106	23	—	42	35	40	45	20	24	40	10
No. of Reactors at 1st Test,	0	6	0	0	No information available.	0	0	5	1	No information available.	0	0	2	0	No information available.	5	1	No information available.	2	0	4	0	0	0	0	0
2nd Test,	0	0	2	0		0	3	5	1		0	0	2	0		4	3		0	1	0	0	0	11	2	0
3rd Test,	0	2	0	1		0	1	3	0		0	0	0	0		4	1		0	1	0	0	0	0	0	3
4th Test,	0	0	0	1		0	—	—	1		0	0	—	0		10	—		0	1	0	0	1	2	0	0
5th Test,	0	0	0	1		0	—	—	0		0	0	—	0		0	—		2	0	0	0	0	0	7	—
6th Test,	0	1	2	0		0	—	—	0		0	0	—	0		0	—		0	0	2	3	0	0	2	—
7th Test,	0	0	—	—		2	—	—	2		0	0	—	0		0	—		0	0	0	0	0	0	1	—
8th Test,	0	1	—	—		0	—	—	0		0	0	—	1		4	—		0	—	0	0	—	0	2	—
9th Test,	3	0	—	—		0	—	—	—		0	1	—	3		0	—		0	—	0	0	—	0	2	—
10th Test,	—	—	—	—		—	—	—	—		0	0	—	—		0	—		—	—	—	0	—	—	—	—
11th Test,	—	—	—	—		—	—	—	—		0	0	—	—		1	—		—	—	—	0	—	—	—	—
12th Test,	—	—	—	—		—	—	—	—		—	—	—	—		0	—		—	—	—	—	—	—	—	—

APPENDIX—*Continued.*

Farm No.,	82	83	84	85	86	87	88	89	90	91	92	93	94	95
Size of Herd,	20	20	30	30	30	32	34	—	—	30	—	40	—	65
No. of Reactors, at 1st Test,	0	2	0	0	0	0	0	No information available.	No information available.	2	No information available.	0	No information available.	3
2nd Test,	0	3	0	1	0	–	0			0		0		–
3rd Test,	0	0	5	0	0	–	0			0		0		–
4th Test,	0	0	0	0	0	–	0			0		0		–
5th Test,	0	0	0	0	0	–	1			0		0		–
6th Test,	0	0	–	0	0	–	1			0		0		–
7th Test,	0	1	–	0	0	–	11			2d		0		–
8th Test,	–	1	–	0	–	–	0			0		0		–
9th Test,	–	0	–	0	0	–	0			0		0		–
10th Test,	–	0	–	0	0	–	0			0		0		–
11th Test,	–	–	–	0	0	–	–			2		3		–
12th Test,	–	–	–	0	0	–	–			–		0		–

Farm No.,	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
Size of Herd,	32	35	32	40	—	35	40	20	40	40	40	—	40	26	27
No. of Reactors, at 1st Test,	0	0	0	0	No information available.	0	0	1	0	10	2	No information available.	4	0	0
2nd Test,	0	0	0	1		0	0	0	0	6	2		0	1	0
3rd Test,	0	0	1	2		0	0	0	0	0	0		0	0	0
4th Test,	0	0	0	0		0	0	0	0	0	0		0	0	0
5th Test,	3	0	0	0		1	0	0	0	1	0		1	0	0
6th Test,	0	2	0	1		0	0	0	2	1	0		3	0	0
7th Test,	0	0	0	0		0	0	0	0	0	0		5	0	0
8th Test,	–	0	–	0		0	0	–	0	–	0		–	0	0
9th Test,	–	0	–	0		0	0	–	0	–	0		–	0	0
10th Test,	–	0	–	–		0	0	–	1	–	0		–	–	0
11th Test,	–	0	–	–		0	0	–	0	–	0		–	–	0
12th Test,	–	0	–	–		0	–	–	0	–	–		–	–	0

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EXTRACT

FROM THE ANNUAL REPORT OF THE

MEDICAL OFFICER

OF

THE LOCAL GOVERNMENT BOARD

For 1908-09.

REPORT ON

INVESTIGATIONS IN THE PUBLIC HEALTH LABORATORY OF THE UNIVERSITY OF MANCHESTER UPON THE PREVALENCE AND SOURCES OF TUBERCLE BACILLI IN COWS' MILK;

BY

SHERIDAN A. DELÉPINE

(Director of the Public Health Laboratory and Professor of Comparative Pathology and Bacteriology, University of Manchester).

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SYNOPSIS.

INTRODUCTION.

THIS report deals with experiments conducted privately by me between 1892 and 1908, and with official work carried out in my laboratory between the years 1896 and 1908 for the Public Health Departments of Manchester, Salford, Liverpool, Sheffield, Derby, Bristol, Blackburn, Blackpool, Burton-on-Trent, and a few other places.

It is, however, chiefly concerned with the work done for the Manchester Authority. This work was of considerable magnitude as compared with that done for all the other authorities, and the attempt made by the Manchester Sanitary Authority towards the purification of the town milk supply is probably the most important and successful of its kind.

Whatever value this report may have is in great part due to the readiness with which the medical officers of health and the veterinary surgeons engaged in the work have supplied me at all times with the information and material which I needed in the course of my investigations.

To Dr. Niven and his able assistants I am specially indebted in that respect. It will also be observed that but for the public spirited interest which the Manchester Sanitary Committee have taken in the milk question, the records upon which this report is based would have been considerably reduced.

The report was prepared in pursuance of an instruction from the Local Government Board (June 4th, 1908) asking me to present the result of my investigations on the prevalence and sources of tubercle bacilli in cows' milk. It is in great part based upon observations and experiments made in the Public Health Laboratory of the University of Manchester, in connection with the examination of 7,000 samples of milk.

A discussion of the relations between human and bovine tuberculosis, or of the share taken by cows' milk in the production of tuberculosis in man, would therefore be out of place in this statement, which, for the same reasons, cannot be burdened with the literature of the subject.

When I took up this investigation in 1892 very little was known regarding the prevalence of tubercle bacilli in cows' milk and the value of methods of detection. In dealing with the work done in my laboratory between 1892 and 1908 I therefore have, *firstly*, to discuss the experimental work which led me to adopt certain methods for the detection of tubercle bacilli in cows' milk; and, *secondly*, to deal with the results obtained by the use of these methods in connection with the administrative work of sanitary authorities. With the exception of Diagram III., which I have prepared from data obtained in Aberdeen, all the tables, diagrams and maps are based upon my own observations; the photographs of organs have been taken from dissections prepared by myself.

PART I.

I.—Methods used for the Detection of Tubercle Bacilli.

The presence of tubercle bacilli in tuberculous products may be ascertained by three methods:—

1. The microscopical method.
2. The cultivation method.
3. The inoculation or experimental method.

The cultivation method is uncertain, more especially when tubercle bacilli are associated with other organisms.

The microscopical and the inoculation methods are at present the only ones suitable for serial work.

A.—*Microscopical method.*

In cases of advanced tuberculosis of the udder, the bacilli may be so abundant in the secretion that their presence can easily be demonstrated in the minutest drop of that fluid. When disease of the udder is less advanced the bacilli may be so scanty and unequally distributed that many drops of milk have to be examined before a few bacilli are found.

When the tuberculous milk of one cow is mixed with the milk of many cows, as is usually the case with the milk supplied to the consumer, the detection of tubercle bacilli by the direct examination of the milk is frequently so difficult as to be impracticable.

When milk is centrifugalised in tubes, a large proportion of the bacilli are thrown to the bottom of the tube with the cells and extraneous products, or carried by the cream towards the opening of the tube. *They are therefore much more abundant in the sediment and in the cream* than in an equal quantity of the unseparated milk. The sediment is more suitable for microscopical examination than the cream. In milk containing a fair number of tubercle bacilli it is comparatively easy to demonstrate their presence by preparing films with part of the sediment, and staining these films according to the method described (at page 376) in Part II. of this report. Bacilli may, however, be numerous enough to cause infection and yet too scanty to be found in every drop of sediment examined. The sediment obtainable from 40 cc. ($1\frac{3}{8}$ ozs.) of *mixed milk* (including the milk of a diseased udder) frequently measures 40 to 60 cubic millimetres. It is difficult to examine under the microscope in a single preparation more than one or two cubic millimetres of sediment. If there were only two bacilli in the sediment of 40 cc. of milk it would often be necessary to examine at least 10 to 15 preparations before one of these bacilli was discovered. The preparation and examination of each film would take, on an average, from 20 to 30 minutes. In some cases nearly the whole sediment would have to be examined before the bacilli were found. If no bacillus was found in the sediment of one ounce of milk this would be no proof that no bacilli could be found in another ounce. In routine work it is impracticable to devote so much time to the examination of one sample of milk, and it is usual to examine only one or two films. The presence of 10 to 15 bacilli (in 40 cc. of milk) may therefore be easily overlooked. It is not unusual for a tuberculous cow to yield eight quarts of milk a day, and I have known cases in which the quantity reached 18 quarts. A tuberculous cow might therefore produce milk containing daily from 3,200 to 10,800 bacilli without these being certainly detected by the microscopical method. But as the bacilli are not equally distributed in the milk, and are often in small groups of 5, 10, 20 or more, a much greater number may escape notice than the above calculations would lead one to believe.

Various methods have been proposed with the object of obtaining a greater concentration of the bacilli than can be obtained by simple centrifugalisation, but in my experience these methods have not proved serviceable.

The microscopical method cannot be relied upon for the examination of mixed milk, but, by adopting certain devices, described at page 375 in Part II. it is capable of yielding useful results in connection with the examination of the unmixed milk of single cows.

B.—*Inoculation method.*

The inadequacy of the microscopical method led me to study in 1892 how the more delicate inoculation method could be used in routine work for the detection of tubercle bacilli.

I inoculated various kinds of animals in different parts of the body with several kinds of tuberculous and other products, and with various quantities of pure cultures of tubercle bacilli and I came to the conclusion that, for the purpose I had in view, guinea-pigs were the most suitable animals. Subcutaneous inoculation on the inner aspect of the hind leg at the level of the knee with matter containing an extremely small number of bacilli produces rapidly in the guinea-pig typical lesions, the extent and distribution of which are of great value in determining the degree of virulence of, or number of bacilli in, the products. Subcutaneous inoculations in other parts of the body, or intraperitoneal injections yield much less definite or comparable results.

The results of experimental inoculation of two guinea-pigs killed respectively 19 days and 111 days after inoculation with tuberculous products of moderate virulence are shown in Figs. 1, 2 and 3. Both animals had been inoculated on the inner aspect of the left leg at the level of the knee, care being taken to inject the material under

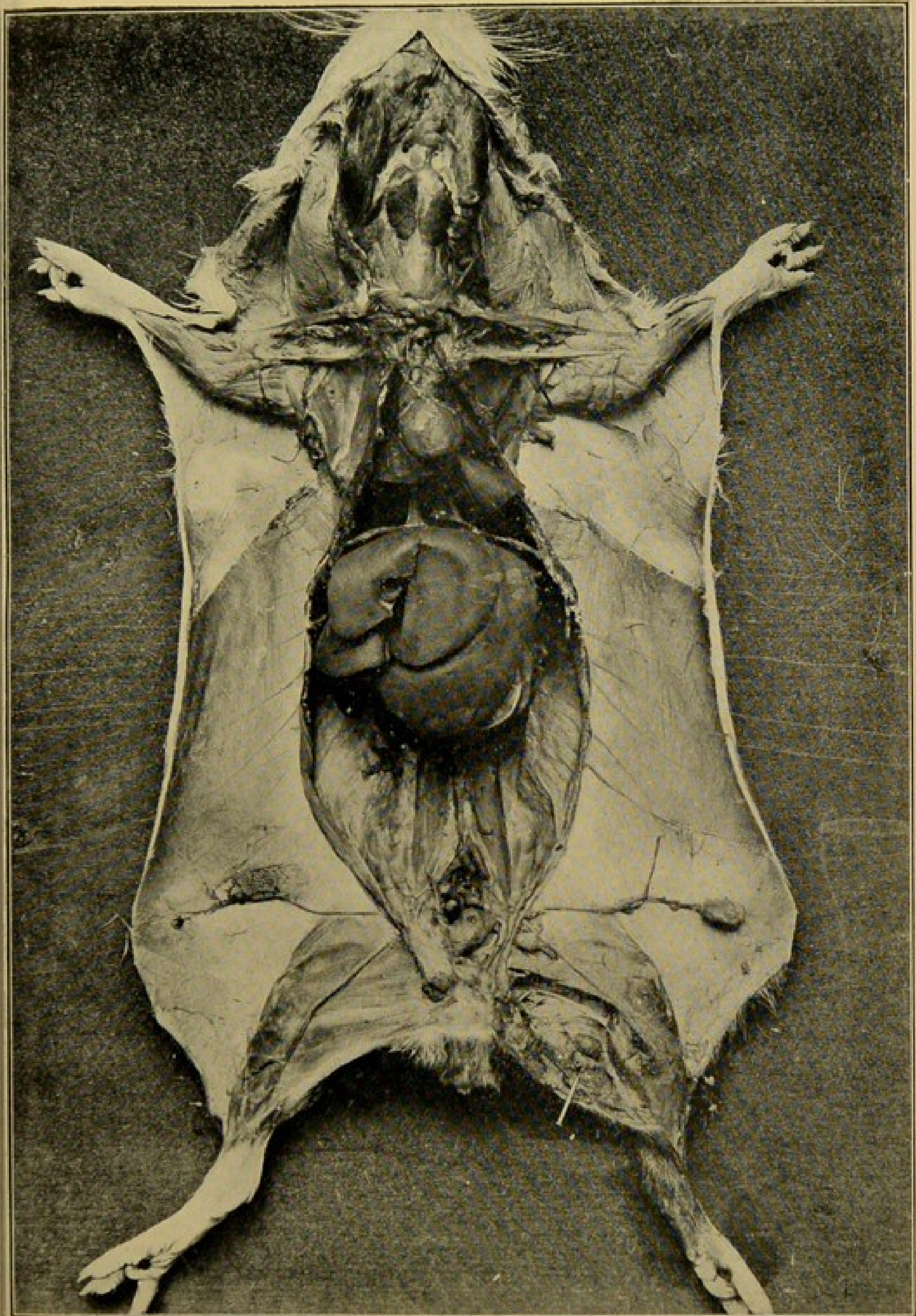


FIG. 1.

Guinea pig inoculated subcutaneously on the inner aspect of the left leg at the place indicated by a pin. Killed 19 days after inoculation. Popliteal, left superficial and deep inguinal glands, and (to a slight extent) sublumbar glands on the left side of the body enlarged and tuberculous. The corresponding glands on the right side were normal.

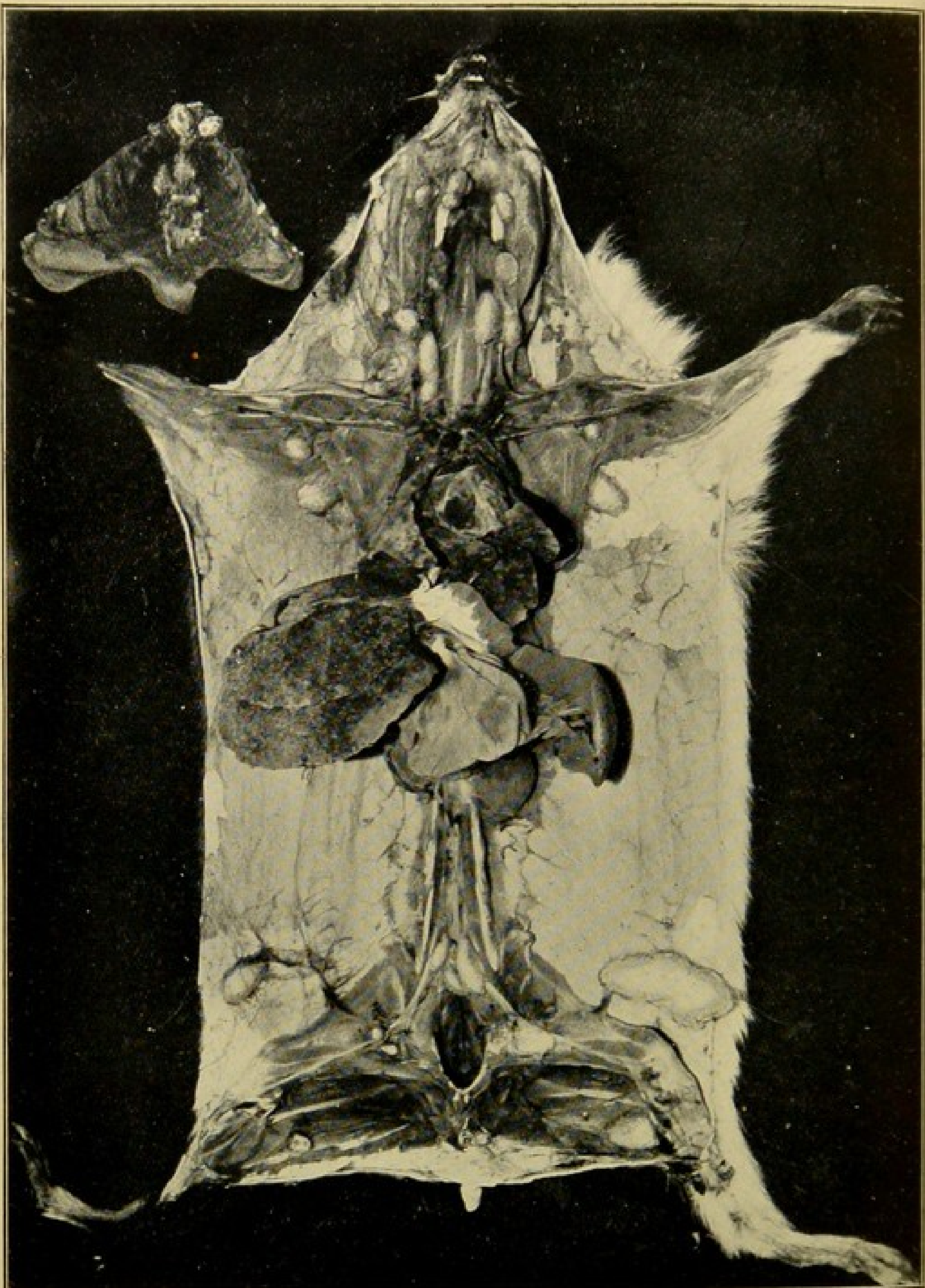


FIG. 2.

Guinea pig inoculated subcutaneously on the inner aspect of the left leg, at the same level as the guinea pig represented in Fig. 1. Killed 111 days after inoculation. All the lymphatic glands exposed by the dissection on both sides of the body are tuberculous, those connected with the left leg (seat of inoculation) are much larger and in a more advanced state of caseation and fibrosis than those connected with the right leg.

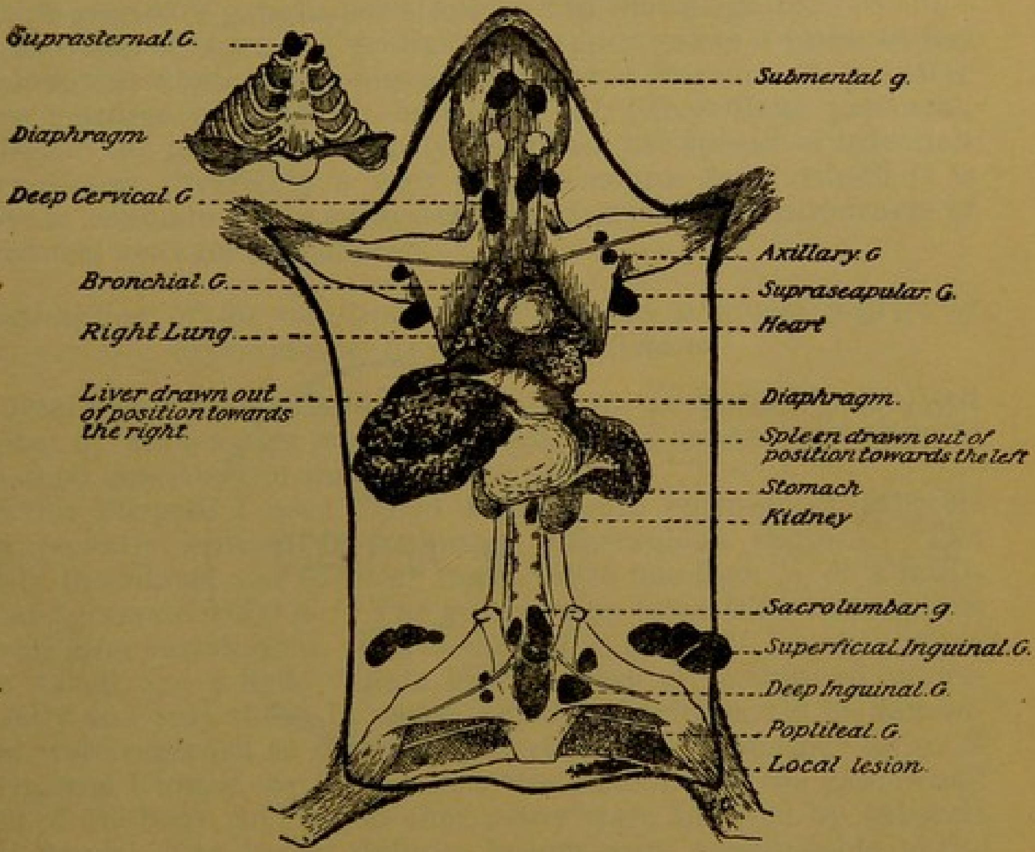


FIG. 3.

Diagram of dissected guinea pig represented in Fig. 2.

The tuberculous glands and tuberculous lesions in the viscera are printed black

the skin, without injuring the subjacent muscles. In the first guinea-pig (Fig. 1) the lesions are limited to the subcutaneous tissue and four groups of lymphatic glands (the popliteal, superficial, inguinal, deep inguinal and sacro-lumbar) on the same side of the body as the seat of inoculation. In the second guinea-pig (Fig. 2) all the lymphatic glands exposed by dissection are distinctly tuberculous, not only those in the neighbourhood of the seat of inoculation, *i.e.*, on the left side of the body and behind the diaphragm, but also those in the thorax, neck, head and fore limbs on both sides of the body, and the popliteal, inguinal and sacro-lumbar glands on the right side of the body. In Fig. 3, which is a diagrammatic key to the photograph of the second guinea-pig (Fig. 2), all the tuberculous glands have been painted black, as well as the tuberculous lesions of the lungs, liver and spleen. The names of the most important lymphatic ganglia or groups of ganglia are also given in that diagram.

On the basis of some 90 preliminary experiments I came to the conclusion that when guinea-pigs are inoculated with minute quantity of pure cultures of tubercle bacilli, or of tuberculous products, according to the method previously described, the spread of infection follows almost invariably a very definite course from which it is possible to estimate fairly accurately the degree of infectiousness of the products used for inoculation.

C.—*Estimation of the virulence of tuberculous products, degrees of experimental tuberculous infection.*

To obtain standards suitable for comparison purposes I inoculated a number of guinea-pigs weighing from 7 to 8 ounces according to the method described in the preceding section.

For this purpose I used blood serum pure cultures of tubercle bacilli recently isolated from human tuberculous sputum. The quantity inoculated was in every case a little less than $\frac{1}{20}$ of a milligramme (gramme 0·00005). The guinea-pigs were killed at various intervals after inoculation, then dissected and all the lesions visible to the naked eye noted. These lesions were all examined microscopically and only those in which tubercle bacilli could be demonstrated were regarded as certainly tuberculous. In another series of experiments I tested by inoculation the state of all the glands and organs of the body, and found that many were invaded by tubercle bacilli several days before definite lesions were recognisable to the naked eye. (These early stages of invasion cannot be conveniently utilised for diagnostic purposes.) Lesions recognisable by the naked eye were found to occur in various tissues or organs in the following order. (The position and names of each gland are given in Fig. 3.)

First week.—Subcutaneous tissue at seat of inoculation, adjacent popliteal gland.

Second week.—Superficial and deep inguinal glands, sacro-lumbar glands, retrohepatic gland, spleen (*i.e.*, all the lymphatic glands behind the diaphragm on the inoculated side the retrohepatic gland, and the spleen).

Third week.—Liver, bronchial glands, lungs (the lung lesions are often indistinct).

Fourth week.—Lungs (distinctly), suprascapular, deep and superficial cervical glands (*i.e.*, the lymphatic glands in front of the diaphragm, on both sides of the body, the axillary and cubital glands are however seldom clearly affected at that stage).

Fifth and following weeks.—The invasion of the lymphatic glands in front of the diaphragm becomes more complete and the lymphatic glands behind the diaphragm and on the *side not inoculated* become gradually affected beginning with the superficial inguinal gland.

As lesions appear in new organs, the older lesions increase in extent, passing through stages of necrosis, caseation, fibrosis, &c. At first the organs affected increase considerably in size, but after a time they show a tendency to contraction owing to the production of fibrous tissue and absorption of degenerated products.

When the quantity of tubercle bacilli is increased it is usually found that the rate of invasion is more rapid and the lesions more extensive. This however is not always the case, and bacilli which have been cultivated for many generations outside the body often lose their virulence more or less completely although they continue to grow luxuriantly. The same differences are observed in morbid products, the infectivity of which is not always proportional to the number of bacilli demonstrable by the microscopical method nor distinctly related to their source. (The Value of Experimental Tuberculosis in Diagnosis, "British Medical Journal," 1893.)

The extent and distribution of the tuberculous lesions in an inoculated animal are determined by six factors :—

1. The number of bacilli.
2. The virulence of the bacilli.
3. The time which has elapsed since infection.
4. The resistance of the animal to infection.
5. The seat of inoculation and
6. The amount of damage done to the tissues at the time of inoculation.

For purposes of comparison some of these factors may be more or less successfully reduced to constants by suitable precautions. The differences produced by time can be eliminated by examining the animals after a constant interval of time.

The resistance of the animal can be made as constant as possible, by using animals of the same race, age and weight, and keeping them previous to, and after, inoculation under identical conditions. It is obvious that in practice one is obliged to be satisfied with conditions which are only approximately similar. The seat of inoculation and the amount of damage done to the tissues can be made practically constant by due attention to details.

The only two factors which are necessarily variable are the number of bacilli and their virulence.

When one has to deal with pure cultures of tubercle bacilli it is fairly easy to estimate the number by counting the bacilli in an aliquot part of a weighable quantity of culture. Whatever care is taken only rough estimates of numbers can be obtained. The number of bacilli being approximately known it is then possible to estimate roughly their virulence.

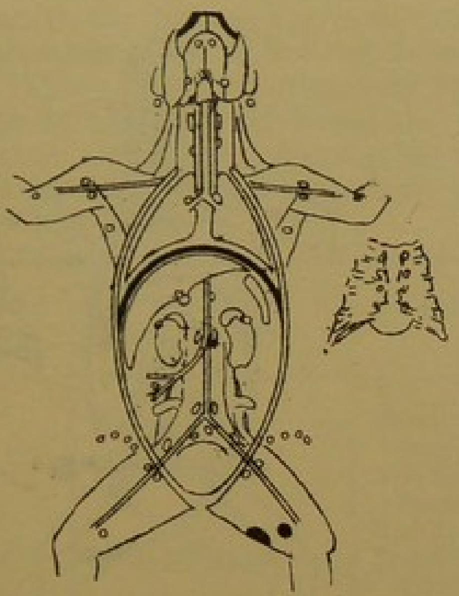
With regard to morbid products the estimation of the number of bacilli presents great difficulties, and the figures obtained are liable to considerable and unavoidable errors.

If the virulence of tuberculous products or of cultures of tubercle bacilli obtained from the same organs in the same kind of animals was constant, the quantity of bacilli could be readily estimated by the effects produced by the inoculation of equal amounts of material. Known facts do not, however, support the view that tubercle bacilli obtained from the same organ of the same kind of animal have a constant virulence, and this supposition cannot be accepted as a basis of comparison between individual cases.

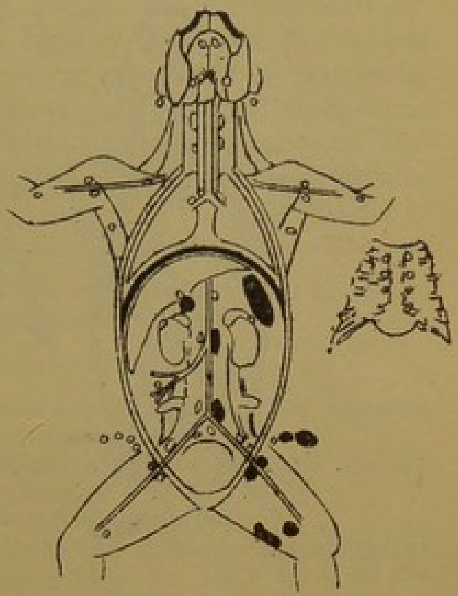
When, however, the average results of a set of several hundred inoculations, made with equal quantities of the same kind of tuber-

Fig. IV.

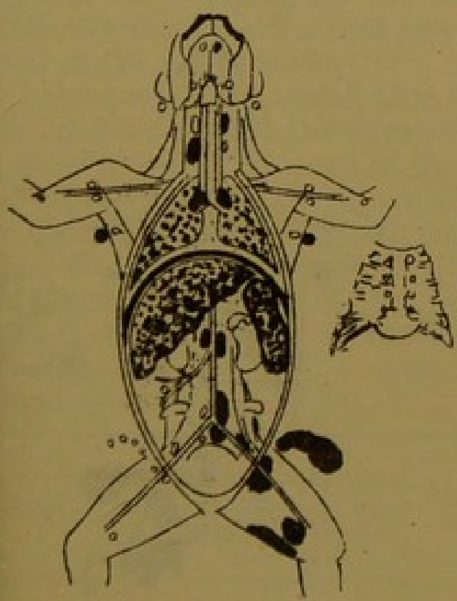
4 Guinea Pigs inoculated with equal small quantities of Tuberculous matter on the inner aspects of the left leg at the level of the knee. To show diagrammatically the 4 most characteristic stages or degrees of Tuberculous Infection. For names of parts see Fig 3. (Tuberculous lesions, black.)



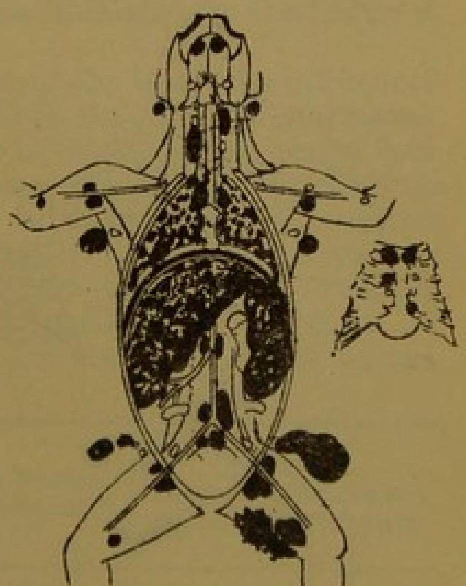
1ST DEGREE.



2ND DEGREE.



3RD DEGREE.



4TH DEGREE.

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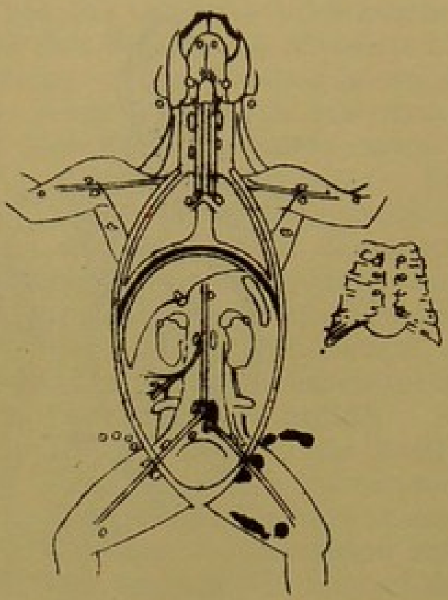
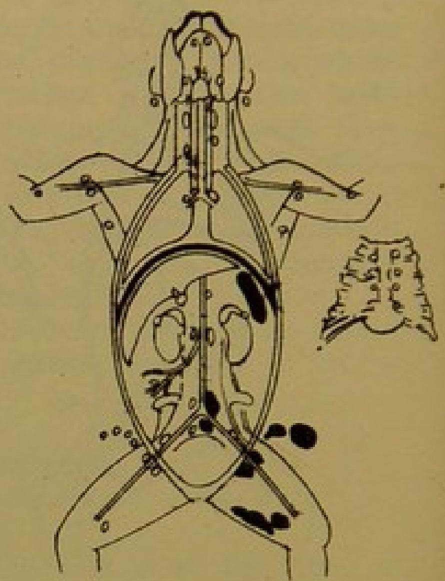
FIG V.

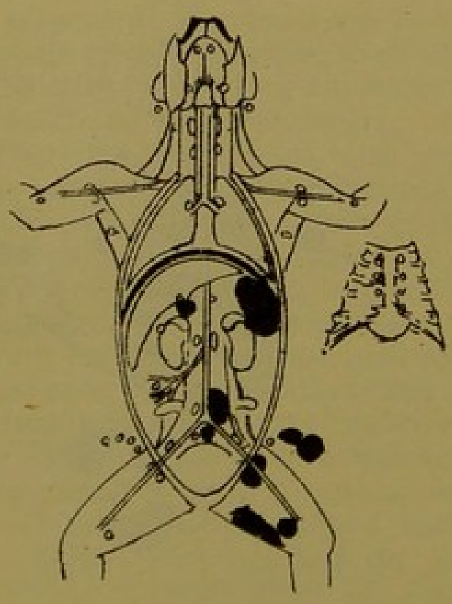
Tuberculous lesions produced in 15 days in 4 Guinea pigs inoculated with various quantities of the same milk on the inner aspect of the left hind leg at the level of the knee. (Tuberculous lesions, black.) For names of the organs, see Fig. 3.



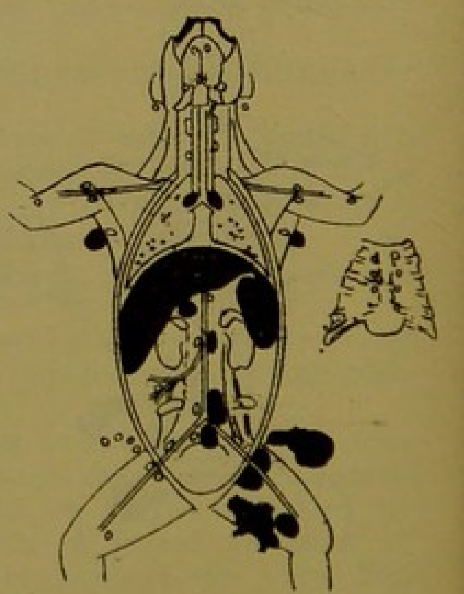
A. 0·0002 GRAMME.



B. 0·002 GRAMME.



C. 0·02 GRAMME.



D. 0·2 GRAMME.

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culous product are compared with those of another set of inoculations made under the same conditions, it is reasonable to assume that, all the other factors being the same, the differences between the average results will in all probability be due to differences in the number of tubercle bacilli.

With the object of simplifying records and making comparisons easier I have subdivided the development of experimental tuberculous lesions in the guinea-pig into four stages which are determined by the number and situation of tuberculous lesions *visible to the naked eye*. These stages are indicated by the lesions produced in a certain length of time by subcutaneous injection of $\frac{1}{20}$th of a milligramme of a pure culture of tubercle bacilli of moderate virulence into the inner aspect of *the left leg* at the level of the femoro-tibial articulation. (*See* Fig. 4.)

Stage or Degree.	Time after Inoculation.	Organs affected with Lesions visible in an ordinary Dissection.
1	Within 10 days ...	Subcutaneous tissue at seat of inoculation, adjacent popliteal gland in left leg.
2	10 to 20 days ...	A.—*Left ;* superficial and deep inguinal glands. Sacro-lumbar glands. B.—Retrohepatic gland and spleen.
3	20 to 35 days ...	Liver, lungs, bronchial glands, suprascapular glands, cervical glands on both sides of the body.
4	35 days and after ...	More complete invasion of the lymphatic glands in front of the diaphragm on both sides of the body. *Right*—superficial and deep inguinal glands and other glands behind the diaphragm on the right side of the body.

It is obvious that the number of stages could be considerably increased, and that this would allow of the time periods being made more definite ; four stages seem, however, sufficient for general purposes of comparison. It might, however, be advantageous to divide the second stage into two sub-stages indicated by the letters A and B in the above table.

I have previously stated that the extent of the lesions is influenced both by time and by the number of bacilli in the material inoculated. To ascertain the influence of the number of bacilli I inoculated four guinea-pigs with the sediment of equal quantities of various dilutions of a sample of milk obtained from a cow with advanced tuberculosis of the udder. At the end of 15 days I killed these four guinea-pigs and found tuberculous lesions in each. There was a distinct relation between the amount of the tuberculous milk (and, therefore, of tubercle bacilli) and the extent of the lesions as is shown by the following table and by Fig. 5.

Dilution.	Quantity of Original Milk contained in the Material inoculated.	Approximate Number of Tubercle Bacilli.	Degree of Tuberculosis observed at the end of 15 days.
	cc.		
$\frac{1}{100000}$	0·0002	At least 30 ...	2nd A. lesions small.
$\frac{1}{10000}$	0·002	" 300 ...	2nd A. to B.
$\frac{1}{1000}$	0·02	" 3,000 ...	2nd B.
$\frac{1}{100}$	0·2	" 30,000 ...	3rd lesions larger.

The differences though well marked at the end of 15 days would have been more marked if the animals had been kept three weeks instead of two. It would appear that the number of bacilli has a greater influence on the size of the lesions than on the spread of infection. Time has a greater influence on the spread.

D.—*Quantity of material used in experimental inoculation.*

The quantity of fluid injected under the skin of the leg at the level of the knee is not immaterial, too great a quantity of fluid injected rapidly causes mechanical lesions followed by more or less extensive necrosis or degeneration of tissues. On the other hand when a large quantity of fluid is injected slowly, the fluid infiltrates the tissues to a considerable distance from the seat of inoculation and the advantages of a clearly defined primary lesion are lost.

I found experimentally that the amount of fluid that can safely be injected in the selected region should not exceed 2 cc.

The injection of 2 cc. of normal milk does not appear to produce any material local or general disturbance of the health of the guinea-pig.

In testing milk for the presence of tubercle bacilli I use for inoculating each animal the sediment of 40 cc. (a little less than 1⅓ oz.) which is a smaller amount than that taken by a child daily. This amount corresponds to about one-fifth of the weight of the experimental animal. I have found that the administration to kittens, by the mouth of an amount of tuberculous cow's milk bearing to the body weight the same proportion, was generally followed by tuberculosis, even when only one dose of the milk was administered. This does not necessarily prove that a child would be infected by a proportional amount of milk, but the danger of infection must for the present be assumed. The question of the communicability of bovine tuberculosis to man is not discussed in this report.

As two guinea-pigs are inoculated with each sample of milk, the total amount of milk tested is 80 cc. (*i.e.*, less than 3 oz.). This quantity of milk is much smaller than that taken in 24 hours by an infant. If this amount of milk is found to contain virulent tubercle bacilli, danger to the child must be assumed.

E.—*Precautions necessary to avoid accidental infections.*

No other bacteria than those present in the udder and a few of those present on the teat should find access to the unmixed milk obtained from individual cows. When samples of this kind are taken the udder and teat should be clean and the veterinary inspector should milk the cow directly into a sterilized bottle.

With regard to the mixed milk sent to towns, it is obvious that it is the state of the milk contained in the milk cans that has to be investigated. This milk has been exposed to various sources of contamination at the farm and in transit. A sample taken at the railway station is, therefore, invariably contaminated, but care should be taken by the inspector not to add to the contaminations already present, and he must, therefore, collect the milk with the strict aseptic precautions which are detailed in the second part of this report (page 372). It is only by the exercise of great care in the collection of samples, that erroneous conclusions and serious administrative difficulties can be avoided.

With the object of preventing accidental infection all the inoculations should be performed so as to secure complete asepsis, and after the animals have been inoculated they should be isolated in sterilized cages, frequently cleaned. The food and water should be of good quality and clean. Accidental tuberculous infection, *i.e.*, infection not due to the presence of tubercle bacilli in the sample itself, should not occur when these precautions are taken.

Other infections than the tuberculous may however occur at times, some of these are avoidable, others are not.

Mixed cows' milk as sent to towns is almost invariably contaminated with fæcal bacteria, and if the milk is kept too long at ordinary temperature these bacteria frequently multiply to such an extent as to be capable of producing more or less severe local or general infection of inoculated animals. Among the lesions so produced the following are the most important: extensive local abscesses, extensive necrosis and ulceration, general septic infection, with peritonitis, pleurisy, pericarditis, œdema and hæmorrhage, pyæmia. A more chronic infection resembling chronic pyæmia sometimes occurs, it has been described as pseudo-tuberculosis although its resemblance to tuberculosis is superficial. It is not unfrequently also produced by intestinal infection due to the use of contaminated food. Some of these infections are so rapidly fatal that tuberculous lesions have no time to develop. During the year 1896 when I received, often from considerable distances, and during the summer, samples of milk which had not been suitably treated, about 20 per cent. of the samples of mixed milk gave rise to one or other of these complications. If the milk is refrigerated (when it has to be kept for more than 5 or 6 hours) these accidental infections rarely occur in more than 1 per cent of the cases. The methods which I have adopted to prevent these accidents are described in Part II. (pages 372 and 374).

F.—*Complications due to unavoidable concomitant infection.*

There are, however, *some forms of infection which are unavoidable*, and which may interfere with the inoculation test for tuberculosis. Concomitant infections capable of interfering with the development of tuberculosis occur extremely rarely. Among the few cases which I have specially noticed there are two of special interest. In these cases the streptococcus pyogenes was associated with the bacillus tuberculosis in the original material. Mixed suppurative and tuberculous lesions were produced, and the pus obtained from the abscesses during the life of the inoculated animal contained, side by side, the streptococcus and the bacillus. The animals recovered and when they were killed a few weeks later, no trace of tuberculous lesions could be discovered. It is therefore possible that in some cases of mixed infection the animals may recover from an early tuberculous infection and that the presence of tubercle bacilli may escape notice. Such cases are certainly of extreme rarity, more specially when the animals are examined three weeks after inoculation as is my practice.

II.—The Cow's Udder.

The udder is situated between the two thighs, and its posterior narrower part is immediately below the anus, vulva and urethra, most of its parts are accessible to the tuft of the tail when the tail is swished. In addition to the usual 4 teats, sometimes there are 2 supernumerary teats. The skin over the udder is hairy, except where it covers the teats.

The organ is composed of two halves separated by a median septum (Figs. 6 and 7), each half having a teat on each of its two quarters.

There is no distinct septum between the anterior and posterior quarters; nevertheless each quarter discharges its secretion through the corresponding teat, and one quarter may be diseased without the other quarter on the same side being affected.

The consistency of the udder varies according as the organ is full of milk or empty. When the organ is distended with milk it feels uniformly tense. When empty it feels uniformly soft, and the skin can be pushed deeply between the two halves or between the wall of the abdomen and the gland. When the udder is diseased certain of its parts may be enlarged or indurated, and these changes can usually be recognised by inspection and palpation *when the udder is empty.* There is one lymphatic gland at the posterior end of each half of the udder close to its attachment to the abdominal wall and to the inner aspect of the thigh. These glands are soft and difficult to recognise by palpation when they are normal, but when diseased they often reach a large size and may then be felt through the skin.

The glandular substance of a healthy udder between the periods of lactation has a pale greyish red colour and is almost opaque. During lactation a large number of small creamy white round or elongated or branched patches are more or less equally distributed through the substance of the organ. These spots are produced by the accumulation of milk in the acini or intralobular ducts (*see* Fig. 10 facing page 356). The intralobular ducts open into larger ducts known as lactiferous ducts which converge towards the base of the teat where they unite to form an elongated cavity continuous with a longer cavity occupying the whole length of the teat. This cavity is known as the *galactophorus sinus* or *cistern.* The cistern is emptied through a short straight tube known as the *duct of the teat* (Fig. 8) which is kept closed when the udder is not in use by a sphincter of smooth muscular fibres.

When the udder is diseased the appearance of the substance of the gland may be greatly altered. In cases of tuberculosis, there may be small or large clusters of buff yellow opaque patches of necrosed or caseous matter, some of these may be calcified, sometimes miliary tubercles are observed. In a great number of cases, there are in the midst of the organ more or less extensive patches of tissue denser, more transparent and more red, than the normal glandular tissue. There is a great tendency to the production of fibrous tissue, and in advanced cases the glandular tissue may be almost entirely replaced by fibrous tissue, in such cases the walls of the ducts are considerably thickened and the cistern may be more or less completely obliterated (Fig. 9). In the early stages the parts of the udder which are affected are larger than usual and feel nodulated. As the disease advances the enlargement and induration increase, but in the later stages there may be absorption of degenerated tissues, contraction of fibrous tissue and the udder may be considerably reduced in size.

When the udder is tuberculous the mammary lymphatic gland is generally considerably enlarged and tuberculous. Among the effects of tuberculosis of the udder the desquamation of the epithelial cells lining the acini and ducts of the affected parts is of special interest from a diagnostic point of view. Cells derived from the gland are found in comparatively small numbers in the milk from normal udders, but when the udder is diseased these cells increase considerably in number.* This is not special to tuberculosis, other forms of

* These epithelical cells are much altered and have been frequently mistaken for leucocytes.

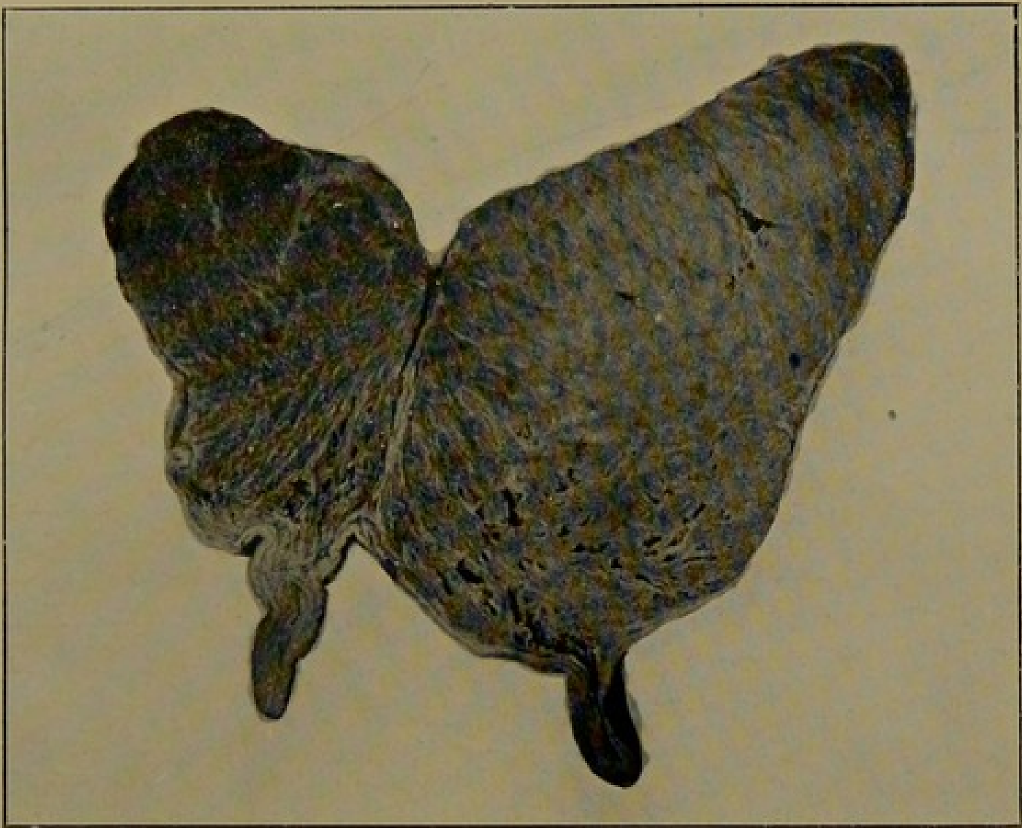


FIG. 6.

Transverse section through the posterior quarters of the udder of a tuberculous cow (Birch Hall cow) seen from the back.

Showing the considerable enlargement of the right hind quarter and the alterations in the appearances of the glandular tissue owing to extensive caseation of the greater part of the quarter. The appearance of the glandular tissue of the left hind quarter is nearly normal.

Section made after complete hardening of the organ, and therefore quite flat and not showing the effects of unequal contraction of tissues.

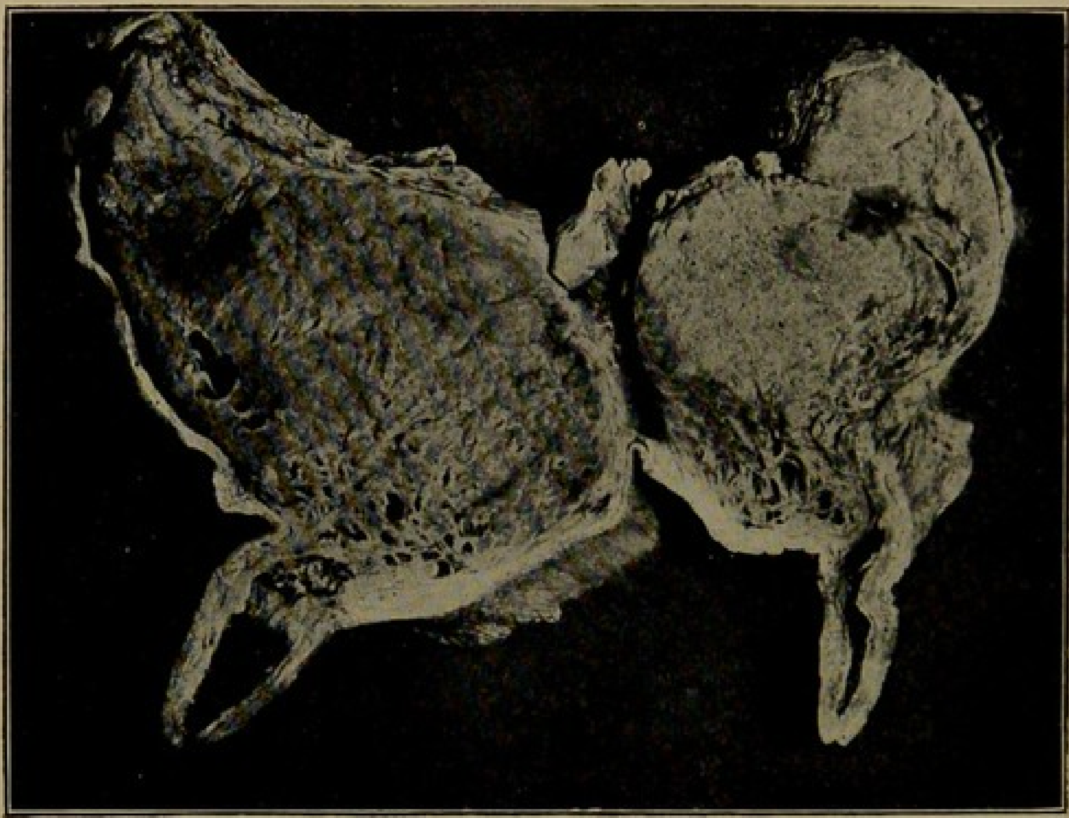


FIG. 7.

Transverse section through the anterior quarters of the udder of a tuberculous cow (Birch Hall cow) seen from the front.

Both quarters are diseased, but the right is much more affected than the left quarter. The cistern of the right teat was distended with curdy-looking matter, of which a small quantity is seen in the upper part of the cistern; this matter was teeming with tubercle bacilli.

Section made before hardening, the unequal contraction of the fibrous tissue, of the normal and of the diseased glandular tissues have rendered the surface uneven; this renders some of the differences between diseased and normal parts more obvious.

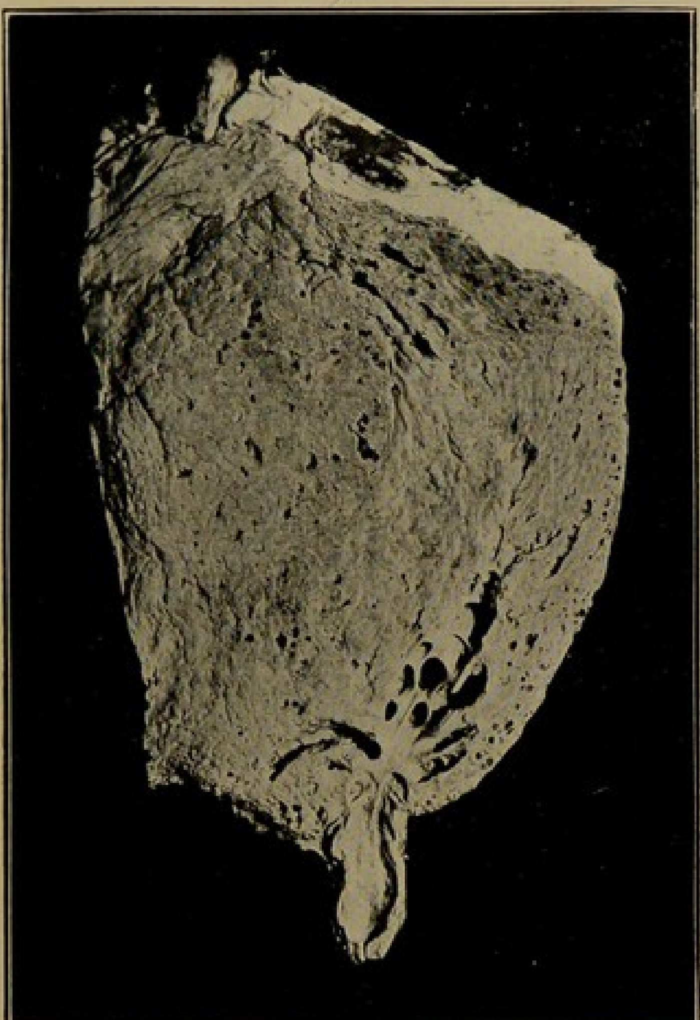


FIG. 8.

Antero-posterior section through the right hind quarter of a tuberculous cow. 12 years old. The udder was healthy and large.

The photograph shows the cistern continuous with the cavity of the teat and the short straight duct of the teat through which the milk escapes from the teat.

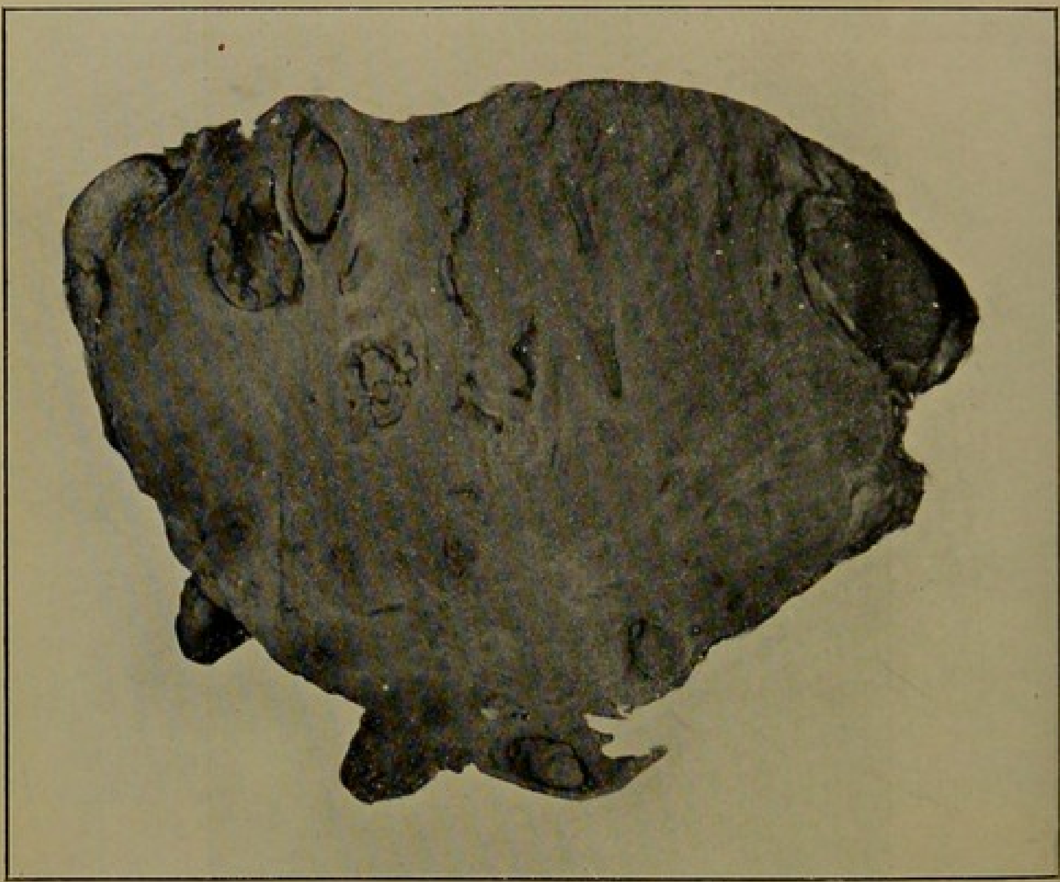


FIG. 9.

Antero-posterior section through one half of a tuberculous udder also affected with catarrhal mastitis. The ducts are considerably distended with muco-purulent material in which very few tubercle bacilli were found. The glandular tissue is almost entirely replaced by fibrous tissue. The cavity of the teat almost entirely obliterated by fibrous tissue. The mammary lymphatic gland is considerably enlarged and tuberculous.

mastitis produce a similar increase of cells. Caseous debris, mucous plugs, fibrinous masses may also be found in the milk. Sometimes tuberculosis is complicated by other infections giving rise to catarrhal or suppurative mastitis, in such cases tuberculous lesions are liable to be overlooked. An example of such a case is shown on Fig. 9.

A good cow often yields from 12 to 14 quarts of milk in 24 hours, some cows give even more milk. In the districts supplying Manchester the average yield is about 8 quarts. Tuberculosis does not cause in its early stage any diminution in the quantity or apparent quality of the milk. I have had under close observation a cow the udder of which was in a fairly advanced state of tuberculosis, and which gave for over 2 months from 7 to 8 quarts of creamy looking milk containing a large number of tubercle bacilli. I have known of another cow with early tuberculosis of the udder that yielded 18 quarts of tuberculous milk in the day. I have also records of a number of cases in which the quantity of tuberculous milk yielded by tuberculous cows was normal or above the normal. When a cow is milked the milker usually sits on a low stool on the right side of the animal, he places the milk pail which has generally a wide opening, between his knees, and steadies the cow by pressing his head against the right flank of the animal, very nearly above the opening of the milk pail. He then takes hold of one teat with each hand and squeezes the milk out of each teat alternately. During this operation the cow is often restless, swishes its tail, kicks, and not unfrequently defæcates and micturates. It is obvious, therefore, that during the operation of milking the milk is exposed to many sources of contamination, more especially when the milker, the cow, and the stable are not clean. The opening of the teat duct is frequently covered with dirt, and the duct itself is more or less contaminated. The first milk drawn, or *fore milk*, is therefore liable to be more contaminated than the rest. The milker generally leaves a little milk in the udder, this *after milk*, or "*strippings*" as it is called, contains a large number of cells. By a kind of massage or manipulation of the udder it is often possible to obtain a few ounces of milk from an udder which appears to have been milked dry, and this milk is particularly rich in cells, and sometimes in morbid products which have been dislodged by the manipulation of the organ.

III.—Sources of the Tubercle Bacilli found in Cow's Milk.

A. *The possible sources of tubercle bacilli* in cow's milk are numerous, they can be classified as follows :—

The secretions or dejecta of the tuberculous cow producing the milk, or of cows kept in the same shed.

1. The muco-purulent *discharges from the respiratory passages*, specially in cases of advanced tuberculosis of the lungs and respiratory passages.
2. The *alvine discharges* where there is disease of the intestinal tract or passage of tuberculous discharges from the respiratory passages into the œsophagus. The dung becomes a serious source of infection when tuberculosis of the intestine causes severe diarrhœa, as it frequently does in the latter stages of the disease.
3. The *urine*, more specially when there is advanced tuberculosis of the kidneys and urinary passages.

4. *Utero-vaginal discharges* in cases of tuberculosis of the genital organs.
5. The *milk* in cases of tuberculosis of the udder and possibly sometimes in cases of advanced tuberculosis without apparent tuberculosis of the udder.

Of these products *tuberculous milk is an unavoidable source of tubercle bacilli.*

The *intestinal and genito-urinary discharges* may *pass directly* into the milk pail at the time of milking, when that operation is conducted negligently, or *indirectly*, by first coating the skin covering the udder, flanks, thighs and tail of the cow; this, however, should not occur when the cow is properly kept and groomed, the milking conducted carefully, and the milk received in proper milk pails. In connection with the detection of tubercle bacilli in dung, it is important to keep in mind the fact that acid-fast bacilli, bearing some resemblance to the tubercle bacillus, may be present in large numbers in the intestinal contents of cows not affected with tuberculosis.

The discharges from the *respiratory and upper alimentary passages* may also at times pass indirectly into the milk by contaminating the cow and various articles in the stable. All these discharges retain their virulence after drying, and may be blown about in the shape of *dust* and infect the cow, the cowman, or any vessel kept in the stable. The milk may also be contaminated with bacteria including tubercle bacilli through the intermediation of flies.

The cowman and other dairy hands.

1. It has been supposed by some that *direct and dangerous tuberculous infection* of the milk is frequently caused by tuberculous dairymen, either at the farm or elsewhere. It is obvious that tuberculous men of extremely dirty habits might at times lubricate their hands with their own expectoration before milking the cows, or contaminate the milk in other ways.
2. The expectoration and other discharges from a tuberculous man may also contaminate the stable or his own clothing in the same way as the discharges from a tuberculous cow would, and thus cause *indirect contamination* of the milk.

Various farm animals other than the cow may be a source of *indirect contamination* of the milk. *Swine* are most liable to tuberculosis, but *horses*, *dogs* and *cats* should not be ignored as possible, though rare, sources of tubercle bacilli. Various poultry birds are also very liable to the disease, *i.e.*, *turkeys*, *geese*, *ducks*, *hens*, &c.

The *dairy vessels* may become infected, not only when kept in the stable, but when handled by dirty or tuberculous dairy hands, or "cleaned" with water highly polluted with the drainage of infected stables.

Of all these sources of infection some are *unavoidable, constant and generally massive*, others are *avoidable, accidental, and are generally slight.*

B.—*The udder as a source of infection of the milk.*

The tuberculous udder is now, as was always my opinion, rightly considered to be by far the most important source of tuberculous milk. This view is corroborated by the experience gained during the past 14 years in connection with the Manchester supply with regard to the degree of infectivity of samples of milk and the lesions found post-mortem in the tuberculous cows from which the sample had been obtained.

Between 1895 and 1900 the inoculation of guinea-pigs with the milk of tuberculous cows produced in a large proportion of cases very considerable tuberculous lesions. The udders of the cows that had produced these virulent samples were extensively diseased. During the past few years very few of the milk samples produced extensive lesions, and in many cases the experimental lesions were recognised with some difficulty. This change has been associated with a much greater rarity of clear lesions of the udder; the majority of the advanced cases had been eliminated during the previous years. Owing to frequent testing and inspection it is now practically impossible for tuberculosis of the udder to reach the advanced stages which were at first frequently observed. Advanced cases are, however, still found occasionally in farms that are inspected for the first time, although farmers begin to realise the importance of not keeping on their farms cows with diseased udders or in a state of advanced tuberculosis.

The work of detection of tuberculous lesions by ordinary veterinary examination has therefore become more difficult, but this is in part compensated by the greater skill which the veterinary surgeons have gained by experience.

The number of tubercle bacilli excreted by a tuberculous udder is considerable and at times enormous.

In order to ascertain directly how much milk might be infected by a tuberculous udder I took some of the milk from an udder in a state of advanced tuberculous mastitis, diluted it with various quantities of cows' milk free from tubercle bacilli, and inoculated a series of guinea-pigs with the various dilutions.

The results of these inoculations have been given on page 347 and in Fig. 5 from which it will be seen that one part of the tuberculous secretion was capable of infecting 100,000 parts of sound milk. I regret not to have pushed the dilution further, for the result of the microscopical examination indicated that this milk diluted 1,000,000 times would probably have still been capable of infecting guinea-pigs.

At the time when the udder becomes first diseased there is no diminution in the amount of secretion. Many of the cows which we had to condemn were considered exceptionally "good milkers" by the farmers. It is not unusual for a cow, the milk of which contains a large number of tubercle bacilli, to yield eight, nine or more quarts of apparently excellent milk in a day. The milk of one such cow may therefore be sufficient to infect the milk of a very large herd when the diseased and sound milk are mixed together.

This experiment shows the degree of delicacy to which the inoculation test may be brought. The power which a single cow with a tuberculous udder has to infect a large quantity of milk has been clearly proved by the fact that when it was found at the laboratory that the mixed milk from a farm was capable of producing tuberculosis, the veterinary surgeon was able in the majority of cases to discover a cow with tuberculous udder in the herd.

C.—Other sources of infection than the tuberculous udder.

Of the other sources of infection which I have enumerated it is obvious that the *tuberculous fæcal and genito-urinary discharges of the cow* are the most important, either *directly*, when the cow defæcates and the loose fæces produce abundant splashings while milking is going on, or *indirectly*, owing to the udder, flanks, legs and tail being coated with tuberculous dung which may fall into the milk pail when the udder is handled, the cow steadied by the head of the milker, or the cow swishes its tail.

The dung may contain a large number of tubercle bacilli. It must, however, be admitted that when the cow is properly groomed and handled, and when the milkman is clean and takes a moderate amount of care, the amount of excreta entering the milk pail accidentally must be extremely small. Even when the cow, milkman, and stable are dirty the comparatively small amount of infectious matter introduced in this way is diluted with the milk of several cows and ultimately the number of tubercle bacilli derived from the dung is exceedingly small when compared with the number derived from the udder.

This source of infection, in my experience becomes chiefly important when the tuberculous lesions have become fairly extensive and in such cases the udder is also very frequently affected.

With regard to the *other discharges from the cow* the chances of direct infection of the milk are slight, and the probable amount of indirect infection is very small, when compared with that derived from the udder. The same may be said of tubercle bacilli derived from the *milkman and various farm animals.* Even in the event of human expectorations finding their way accidentally into the milk, the number of tubercle bacilli introduced in this way would be exceedingly small when compared to the number of bacilli that may be derived from a tuberculous udder.

IV.—Experimental Evidence regarding the Chief Source of Tubercle Bacilli in Cows' Milk.

When beginning my work on milk in Manchester, my first observations were directed towards ascertaining to what extent tuberculosis of the udder was the source of the milk found to be tuberculous. My earlier results were summarised in the Journal of Comparative Pathology, June—September, 1897; thus the milk of 24 tuberculous cows was distributed as follows: 10 cows *certainly suffering from some form of mastitis* (tuberculous or not) produced tuberculous milk in five instances, or 50 per cent.; 9 cows whose udders, judging by the characters of the milk, were possibly affected with some form of mastitis produced tuberculous milk in 1 case, or 11 per cent.; and 5 *tuberculous cows with healthy udders* produced no tuberculous milk.

During the period 1896–1901, 505 cows kept on farms producing tuberculous milk showed *evidence of some udder disease.* Of this number 50 only within my knowledge were tested with tuberculin, with positive result in 38 cases, negative in 10 cases, and doubtful in 2 cases. A bacteriological examination of the milk of these 50 cows gave the following results: Of the 38 cows reacting positively to tuberculin 8, or 21 per cent. had tuberculous milk, the non-reacting 12 cows did not give milk producing tuberculosis on inoculation.

The udders of seven of the tuberculous cows which had been found to give milk that had not produced tuberculosis in inoculated animals were examined, post-mortem, and I found them to be *free from naked eye or microscopical tuberculous lesions.* Guinea-pigs inoculated with portions of these udders did not contract tuberculosis.

I also examined five of the udders of tuberculous cows that had given milk producing tuberculosis in inoculated animals, and found *in each of these udders tuberculous lesions visible to the naked eye or under the microscope*, and in all cases tubercle bacilli were found in the lesions.

It may now be accepted that tuberculosis of the udder is the main source of tuberculous milk.

V.—Difficulty of Detecting Early Tuberculous Lesions of the Udder by Inspection and Palpation Alone.

For some time after the onset of tuberculosis in the udder, the lesions are so slight that even an experienced veterinary surgeon may have great difficulty in deciding whether the udder is diseased or not. From an administrative point of view this difficulty is most inconvenient, and we have, therefore, paid special attention to it. I need only refer to four cases inspected by Mr. Lloyd. The mixed milk supplied by three farms having been found tuberculous, these three farms were inspected, but no tuberculous udder could be discovered, the mixed milk of these three farms was again tested bacteriologically and still found to be tuberculous. Mr. Lloyd inspected again these farms, and after a very lengthy examination he discovered in each a cow showing slight signs of disease of the udder, *but in none were the symptoms at all typical of tuberculosis.* A sample of milk was taken from each of these cows, and each of the three samples produced tuberculosis in the experimental animals.

In another case Mr. Lloyd took a sample of milk from a cow suffering from advanced pulmonary tuberculosis, the udder appearing to be free from disease at the time. I found that the milk contained tubercle bacilli; Mr. Lloyd visited the same farm five weeks after his first visit and detected slight induration of one of the hind quarters of the udder. Two weeks later he examined the cow again and found the induration more marked. He then took a separate sample of milk from each teat and sent those samples to me. Of these four samples only one produced tuberculosis, and this was the sample taken from the diseased quarter.

I have records of several other instances of the same kind, which it is unnecessary to enumerate here. I will simply relate in detail the observations and experiments which I made during the year 1908 upon a tuberculous cow which I kept in my own stable for nearly four months. I obtained this cow for the purpose of repeating a number of experiments and observations which I had made before 1897. There was perfect concordance between the 1908 results and those obtained before 1897.

VI.—Changes observed in the Udder and the Milk of a Tuberculous Cow in the course of Four Months (*Birch Hall cow*).

Towards the end of August Mr. Brittlebank found for me a cow suffering from tuberculosis of the udder. From the examination which he made of the animal at the farm, he was of opinion that this cow had tuberculous lesions of the left lung and of the right posterior quarter of the udder, he had some doubts about the state of the right anterior quarter, and thought that the left half of the udder was sound. I bought this cow and had it brought to a stable at my house. For purposes of reference I will call this animal the "Birch Hall cow."

On September 10th, i.e., some two weeks after the cow had been first inspected at the farm, Mr. Brittlebank and I examined her carefully and we observed that, in addition to the lesions previously noticed, the right anterior quarter of the udder had become clearly involved :

The right half of the udder was distinctly larger than the left half, the difference was most marked after the cow had been milked. The state of each of the quarters was as follows (Fig. 11 A).

Right posterior quarter, considerably enlarged, projecting downward and backward beyond the corresponding quarter on the left side, generally indurated, irregularly nodulated hard mass felt in the anterior part of the quarter in front of the base of the teat.

Right anterior quarter, slightly larger than the left anterior quarter, softer than the right posterior quarter, an ill-defined patch of induration felt by pressing the hand between the anterior parts of the two halves of the udder. The right anterior quarter although clearly abnormal was very much less affected than the right posterior quarter.

Left posterior and anterior quarters, nothing abnormal detected.

The amount of milk yielded by the cow at that time was 7 to 8 quarts in 24 hours, there was no marked difference between the amount obtained from the right and from the left half of the organ. The milk had the appearance of good creamy milk. The results of the bacteriological examination of the milk are given in the table at page 359.

It will be sufficient to state here that the only visible difference between the samples of milk obtained from each of the four quarters was that the milk of the two right quarters had a slight brownish tinge. This slight colouring of otherwise normal looking milk is not observed only in tuberculous mastitis but also in various other forms of mastitis. Tubercle bacilli could easily be detected in the milk of the two right quarters by the microscopical method. *Two tubercle bacilli* were found after long search in four milligrams of sediment from the *milk of the left anterior quarter*. The guinea pigs inoculated with the milk of the two right quarters and of the left anterior quarter contracted tuberculosis. The milk of the left posterior quarter had no effect.

On September 26th.—A complete examination of the cow was again made 16 days after the second examination and about one month after the first (by Mr. Brittlebank). The cow was in fairly good condition, its coat was glossy, but the animal was thin and coughed occasionally. The physical signs of pulmonary disease were more marked. The right side of the udder was considerably enlarged (see Fig. 11 B) and both right quarters were much indurated and nodulated. An ill defined nodule or patch of induration could now be felt in the depth of the left anterior quarter close to the abdominal wall. The left posterior quarter appeared to be normal. The amount of milk yielded at one milking by the

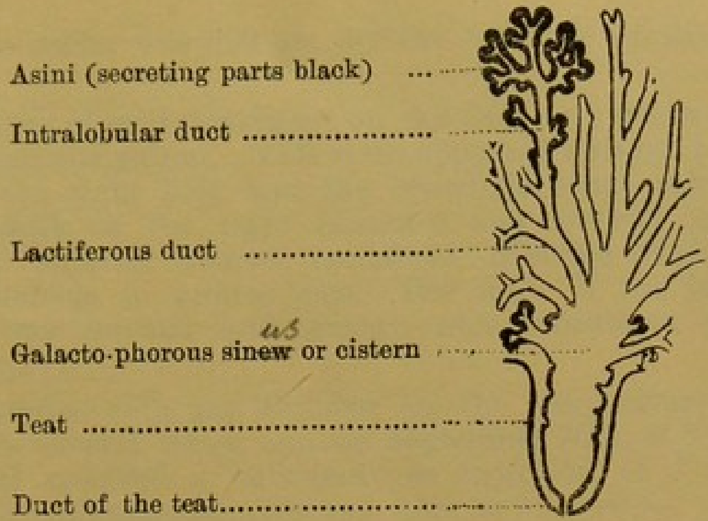


FIG. 10.

Diagram of the essential parts of a cow's udder.

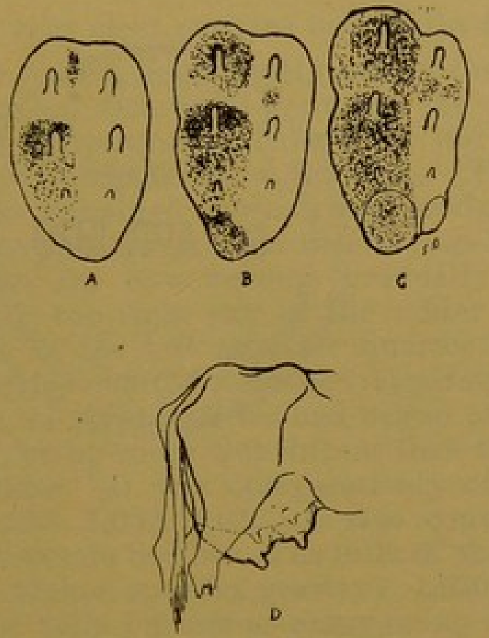


FIG. 11.

Udder of the "Birch Hall" cow. Changes observed between September 10th and December 28th.

A.—Udder seen from below, anterior part above in sketch. September 10th. Right side distinctly larger than left.

B.—Udder seen from below, anterior part above in sketch. September 26th. Right side much longer, right mammary lymphatic gland very large and distinctly felt.

C.—Udder seen from below, anterior part above in sketch. December 28th. Considerable enlargement and nodulation of right side. Mammary lymphatic glands much enlarged.

D.—Udder seen from the right side, to show enlargement of right half and bulging of each quarter above the teat. The dotted line indicates approximately the size of the left half of the udder.

Parts which felt indurated during life are indicated by stippling.

right half of the udder was 500 ccs., by the left half of the udder 1250 ccs.

The total amount of milk produced on the 24th was about 4 litres or a little less than one gallon. This milk appeared normal, but that obtained from the right half had the brownish tinge previously noticed. The milk of the right posterior and anterior quarters and of the left anterior quarter contained tubercle bacilli and produced tuberculosis in guinea pigs. The milk of the left posterior quarter was normal and guinea pigs inoculated with it remained healthy.

Between September 28th and October 1st, the temperature of the animal was taken several times, and on September 30th, at 9 o'clock p.m., the animal received a subcutaneous injection of 3 ccs. of tuberculin. The temperatures observed were as follows :—

September	28th	9 a.m.	101° 6.	
„	29th	„	101° 4.	
„	30th	„	101° 4.	
„	„	9 p.m.	102° 2	Tuberculin injected.
October	1st	6.30 a.m.	103° 2.	
„		7.30 „	104° 4.	
„		8.30 „	105°.	

There was therefore a very clear positive tuberculin reaction.

Samples of milk were taken immediately before the injection of tuberculin and at 9 a.m. on October 1st during the height of the tuberculin reaction. The injection of tuberculin did not seem to produce any effect upon the virulence of the milk. The milk from the left posterior quarter remained normal, and produced no effect when injected into guinea pigs (see table of results page 359). During the month of November the cow became gradually weaker and coughed more frequently, the right side of the udder continued to enlarge, and the lesions in the left anterior quarter became more distinct. The left posterior quarter remained apparently free from disease. The milk from the right quarters had begun to be distinctly altered early in October, being more translucent than the milk from the left half of the udder. It was comparatively of low specific gravity : 1,028, 1,029, 1,030, 1,032, 1,033 ; it also contained a large number of cells and of tubercle bacilli. The milk of the left anterior quarter had a slightly higher specific gravity : 1,030, 1,032, 1,032, 1,032 ; it contained many cells but not so many on an average as the right quarters, tubercle bacilli were much more scanty and not always demonstrable by the microscopical method.

The milk of the left posterior quarter had the highest specific gravity : 1,035, 1,031, 1,035, 1,035 ; it contained fewer cells than the milk of the other quarters, and up to the beginning of October never contained any tubercle bacilli. The examination of the milk was unfortunately interrupted during the months of November and December.

At the beginning of December the cough became very troublesome, and the cow began to suffer from violent diarrhœa which became rapidly fœtid. There were many tubercle bacilli in the fluid fæces. The secretion of milk stopped and it was with difficulty that Mr. Brittlebank was able to obtain a few ounces of a yellow serous looking fluid, full of whitish flocculent masses from each of the two right quarters. He could not obtain any secretion from the left quarters.

On December 24th the cow was slaughtered and a post-mortem examination was made by Mr. Brittlebank, who found advanced tuberculous lesions of the lungs, thoracic and mesenteric glands. On examination of the intestine I found extensive superficial ulcers or erosions which had not the usual characters of tuberculous ulcers. There were many tubercle bacilli in the débris and mucus covering the floor of these ulcers. The right side of the udder was about three times as large as the left side.

The right posterior and the right anterior quarters were both in the same state, bulging externally, anteriorly and posteriorly above the teat, and projecting considerably downwards, backwards and forward beyond the corresponding quarters on the left side (Fig. 11, C and D). Both felt very hard and nodulated. The left anterior quarter though generally soft contained several indurated patches. The left posterior quarter was small and soft.

In sections of the right quarters hardly any trace of normal glandular tissue could be recognised, the normal tissues had been replaced by clusters of rounded or oval or branched patches of pale yellow opaque material, in which the original arrangement of the acini could be at places recognised. These yellow opaque patches were separated by more translucent pink, reddish yellow strands, containing an excess of fibrous tissue.

In the left anterior quarter, there were only few comparatively small pale yellow patches surrounded by a zone of translucent pink connective tissue.

In the left posterior quarter beyond a slight increase of the opacity of some parts of the glandular tissue no lesion suggesting tuberculosis could be found.

In the cistern of both right teats there was an accumulation of yellowish opaque coagulated looking material, in which tubercle bacilli were very abundant, there was also a large accumulation of the same kind of material in the ill-developed cistern of the right supernumerary teat (behind the ordinary right posterior teat) this material contained a large number of tubercle bacilli.

The mammary lymphatic glands on both sides were tuberculous, but the right was several times larger than the left and contained large caseous masses. All the lesions previously described when examined microscopically were found to contain tubercle bacilli, and to be the seat of diffuse tuberculous lesions. Giant cells and giant cell systems were very few. The chief interest of this case (apart from the evidence which it gives as to the amount of infection that may be derived from a single cow) is in the clear connection observed between the lesions of the udder and the infectiousness of the milk. The milk from the three quarters which were diseased was invariably found infectious. The milk of the sound quarter remained free from bacilli for at least one month, even during the height of the tuberculin reaction. For some time before death there were signs that this quarter was beginning to undergo some change, for there was an increase of cells in its secretion. Unfortunately the cow became rapidly worse, and when an attempt to obtain milk from this quarter was made the secretion had ceased.

The results of the complete examination of samples of milk collected between September 10th and December 24th are summarised in the table of results of 38 experimental inoculations which I performed between the same dates (p. 359).

Results of 38 experimental inoculations made in the course of 3 months and 19 days with the milk of a tuberculous cow with tuberculous udder, kept under observation by the author. (Birch Hall cow.)

Reference No.	Date.	Nature of Sample.		Naked-eye characters of the Milk.	Reaction.	Specific Gravity.	Cream per 100.	Sediment per 100,000.	Inoculation test for tubercle bacilli.		Average degree for time (standard).	Remarks.
									No. of days after inoculation.	Degree of tuberculosis.		
		A.—Whole Udder.										
7474A	10–IX.	Whole milk of udder mixed.	Cream only used for inoculation.	Normal, creamy looking.	Alk., slight	1,034	5·3	14·	21	2nd	2nd	The cow was yielding 8 quarts of milk at the time.
7475A	”	Ditto	Sediment only.	Ditto	”	”	”	”	38	4th	3rd to 4th	The lesions produced by the cream were quite as extensive as those produced by the sediment. The local lesions produced by the cream were more marked. The absorption of the cream was slow.
7474B	”	Ditto	Cream only	Ditto	”	”	”	”	32	4th	4th	
7475B	”	Ditto	Sediment only.	Ditto	”	”	”	”	19	2nd	2nd	

Continuation.

Reference No.	Date.	Nature of Sample.		Naked-eye characters of the Milk.	Reaction.	Specific Gravity.	Cream per 100.	Sediment per 100,000.	Inoculation test for tubercle bacilli.		Average degree for time (standard).	Remarks.
									No. of days after inoculation.	Degree of tuberculosis.		
		B.—LEFT HALF OF UDDER.										
7505A	26–IX.	Milk of the 2 quarters mixed.	Sediment used for inoculation.	Normal, creamy looking.	—	—	10·6	25·	27	2nd to 3rd	3rd	
B	"	Ditto	Ditto	Ditto	—	—	—	—	79	4th, advanced.	4th, advanced.	
7529	1–X.	Ditto	Ditto	Ditto	Amphot.	1,037	6·	8·75	32	0	—	Milk taken 11 hours after injection of tuberculin, temperature of cow being 105° F.
		C.—RIGHT HALF OF UDDER.										
7504A	26–IX.	Milk of the 2 quarters mixed.	Sediment used for inoculation.	Milk slightly more translucent than normal, and having a slight brownish tinge. It was nevertheless very creamy.	—	—	9·1	110·	20	2nd	2nd	

B		Ditto	Ditto	Ditto	—	—	—	—	26	4th	3rd	
7528	1–X.	Ditto	Ditto	Ditto	Amphot.	1,035	6·8	52·5	31	4th	3rd	Milk taken 11 hours after injection of tuberculin, the temperature of the cow being 105° F.
		D.—LEFT POSTERIOR QUARTER.										
7477A	10–IX.	*Cream* only used for inoculation.		Normal looking, creamy.	Alk., slight	1,035	15·9	11·	123	0	4th, advanced or death.	
B	10–IX.	*Sediment* only used for inoculation.		Ditto	—	"	"	"	285	0	"	
7508A	28–IX.	*Fore milk* only, ditto ...		Ditto	—	1,031	5·3	24·	267	0	"	
B	"	*After milk* only (strippings), ditto.		Ditto	—	"	15·2	24·	27	0	3rd	
7520	30–IX.	*Fore, middle, and after milk*, mixed.		Ditto	Amphot.	1,035	12·9	37·5	73	0	4th, advanced.	Before injection of tuberculin (temperature of cow 102·2° F.).
7525	1–X.	Ditto		Ditto	"	"	13·6	17·5	14	0	2nd	11 hours after injection of tuberculin, when the temperature was 105° F.
		E.—LEFT ANTERIOR QUARTER.										
7478A	10–IX.	*Cream* only used for inoculation.		Normal, creamy.	Alk., slight	1,032	20·5	30·	97	4th, advanced.	4th, advanced.	
B	"	*Sediment*, ditto		Ditto	"	"	"	"	45	4th, beginning.	4th, more advanced.	
7509A	28–IX.	*Fore milk*, ditto		Ditto	—	1,030	4·5	90·	92	4th, advanced.	"	

Continuation.

Reference No.	Date.	Nature of Sample.	Naked-eye characters of the Milk.	Reaction.	Specific Gravity.	Cream per 100.	Sediment per 100,000.	Inoculation test for tubercle bacilli.		Average degree for time (standard).	Remarks.
								No. of days after inoculation.	Degree of tuberculosis.		
		E.—LEFT ANTERIOR QUARTER—*cont.*									
7509B	28–IX.	*After milk*, only used for inoculation.	Normal, creamy.	Alk., slight	1,030	19·	105·	26	2nd	3rd	This guinea-pig was suffering from accidental gastro enteritis due to infected food.
7521	30–IX.	*Fore, middle, and after milk*, mixed.	Ditto	Amphot.	1,032	9·8	35·	62	4th, early.	4th, advanced.	Before injection of tuberculin (temperature 102·2° F.).
7524	1–X.	Ditto	Ditto	"	"	11·4	60·	21	3rd	3rd	11 hours after injection of tuberculin (temperature105°F.).
		F.—RIGHT ANTERIOR QUARTER.									
7476A	10–IX.	*Cream* only used for inoculation.	Creamy - looking, but colour brownish.	Alk., slight	1,029	22·8	150·	33	4th, advanced.	"	
B		*Sediment*, ditto	Ditto	—	—	—	—	31	"	"	
7507A	28–IX.	*Fore milk*, ditto	Ditto	—	1,028	3·8	105·	22	"	2nd to 3rd	
B		*After milk*, ditto	Ditto	—	—	9·8	50·	23	"	"	
7523	30–IX.	*Fore, middle, and after milk*, ditto.	Ditto	Amphot.	1,033	9·1	92·5	22	3rd, early	3rd, early	Before injection of tuberculin (temperature 102·2° F.).

7527	1–X.	Ditto	Ditto	,,	1,030	16·7	85·	22	3rd, early	3rd, early	11 hours after injection of tuberculin (temperature 105°F.).
	28–XII.	All the secretion obtainable.	Yellow, serous-looking with flakes.	Alk.	1,028	0	858·	—	—	—	Tubercle bacilli very abundant in the secretion. (No inoculation.)
		G.—Right Posterior Quarter.									
7475A	10–IX.	*Cream* only used for inoculation.	Creamy, brownish colour.	,,	1,029	15·2	105·	32	4th, very advanced.	3rd	
B	,,	*Sediment*, ditto	Ditto	—	—	—	—	35	4th, advanced.	,,	
7506A	28–IX.	*Fore milk*, ditto	Ditto	—	1,028	5·3	120·	26	,,	,,	
B	,,	*After milk*, ditto	Ditto	—	—	9·8	105·	26	,,	,,	
7522	30–IX.	*Fore, middle, and after milk*, mixed.	Ditto	Amphot.	1,030	9·8	105·	24	4th, early	,,	Before injection of tuberculin (temperature 102·2° F.).
7526	1–X.	Ditto	Ditto	,,	1,032	11·4	60·	21	3rd to 4th	2nd to 3rd	11 hours after injection of tuberculin (temperature 105°F.).
2034A	28–XII	Secretion diluted 100 times	Yellow, serous-looking fluid with whitish flakes suspended in it.	Alk.	1,028	0	1122·	15	early 3rd	early 2nd	Quantity actually inoculated corresponding to— $\frac{1}{5}$th of one cubic centimeter of milk 0·2 cc.
2035A	,,	Ditto 1,000 ,,	Ditto	,,	,,	,,	,,	,,	2nd, advanced.	,,	$\frac{1}{50}$th ditto 0·02 cc.
2036B	,,	Ditto 10,000 ,,	Ditto	,,	,,	,,	,,	,,	early 2nd	,,	$\frac{1}{500}$th ditto 0·002 cc.
2037A	,,	Ditto 100,000 ,,	Ditto	,,	,,	,,	,,	,,	beginning 2nd.	,,	$\frac{1}{5000}$th ditto 0·0002 cc.

VII.—Apparent Relation between the Amount of Cells and extraneous Products found in Samples of Mixed Milk and the Pathogenic Properties of the Milk.

As the presence of tubercle bacilli in milk may in some cases be attributable to the introduction of extraneous dirt, it seems desirable to complete these general remarks by referring to the relation which the presence of cells, dirt, and other extraneous products appeared to have to the pathogenic properties of milk. I presented to the Manchester Sanitary Committee a report upon this subject in the early part of 1908. The following statements are taken from that report.

Although my original method for estimating the amount of sediment is not so accurate as my new one described in the second part of this report, it is sufficient for general puposes of comparison.

I have explained how a part of the bacteria, cells, and various products, in other words dirt, were separated from each sample of milk by centrifugalisation. This sediment, when examined microscopically, was found to consist chiefly of :—

1. *Cells* derived from the internal parts of healthy or diseased udders.
2. *Hairs and cells* derived from the skin of the milker, or of the cow or other farm animals.
3. *Wool, cotton, and other fibres* from the clothing of the milker, or from strainers and other articles.
4. *Vegetable and mineral matter* derived—
   (*a*) *From food, dung, litter*, or other kinds of dirt clinging to the skin of the cow or the hands of the milker ;
   (*b*) *From the dust or splashings* in the cow-sheds, or dirt adhering to dairy vessels, when these are not properly cleaned ;
   (*c*) *From the water* used for cleaning the cans and other dairy vessels.
5. *Animalcules, moulds, algae, bacteria* derived from the food, litter, water (used to clean dairy vessels or other purposes), possibly also from the hands and clothes of dirty milkers, and from cows or other farm animals, including cats and dogs.
6. *Pathogenic organisms* derived from diseased cows, dairy hands, polluted water, dust, etc.

It seemed to me that the amount and character of the sediments separated from samples of unseparated milk collected at the farms (or at railway stations on their arrival from the farms) would be greatly influenced by the state of the cow-sheds and dairies.

I paid, therefore, special attention to the amount of sediment separated from each sample of milk received in the laboratory.

The amount was *roughly* estimated by measuring the diameter of the deposit formed in the closed hemispherical end of tubes of uniform diameter which were used for centrifugalising the milk. Taking the average of the last 10 years as my basis, I have come to the conclusion that milk yielding a sediment having a diameter of—

less than ...	7 m.m.	was clean ;
„ „ ...	9 „	was as clean as could be expected under average circumstances ;
„ „	9–10 „	was of doubtful cleanness ;
more than	10 „	was dirty ;
„ „	13–20 „	was very dirty or contained an excessive amount of cells or inflammatory products indicating disease of the udder.

This classification is quite arbitrary, and could not be used for administrative purposes, but is quite sufficient for purpose of comparison.

The weight of slime per gallon corresponding to the various diameters of the sediments may be *approximately* estimated as follows :—

6– 8 m.m.—at least		10 grains per gallon.			
9–10	„	„	20	„	„
11–12	„	„	30	„	„
13–20	„	„	80	„	„

To control these figures, I obtained in 1900 the slime separated (at a dairy) from 15 gallons of average country milk. This material was kindly supplied to me by Mr. Hailwood. The weight of this slime was 304·45 grains, *i.e.*, about 20 grains per gallon. Milk containing this amount of slime generally yielded in the laboratory a sediment measuring 9–10 m.m.

Between the years 1896–1900 the average amount of slime arriving daily in 40,000 gallons of milk may be calculated as follows :—

					grains.
179	samples at	10 grains	per gallon	... ...	1,790
218	„	20 „	„	... ...	4,360
45	„	30 „	„	... ...	1,350
12	„	80 „	„	... ...	960
454					8,460

$$\frac{8,460 \times 40,000}{454 \times 7,000} = 106 \text{ lbs. of slime.}$$

The amount of slime arriving daily was, therefore, about 106 lbs., or 1 ton in 20 days. (On the supposition that the daily supply was about 40,000 gallons.)

In 1906 the amount of slime in the same quantity of milk had been reduced to 79 lbs.

Some of the constituents of slime are natural cellular products, which are not of an objectionable nature. From the observations made in my laboratory it appears difficult to obtain regularly milk containing less than seven grains of sediment per gallon. Admitting this to be the irreducible minimum, it is possible to estimate roughly the *unnecessary and objectionable amount of slime* imported daily. Before 1900 this objectionable slime amounted to 66 lbs. daily; in 1906 it had been reduced to 39 lbs.

Between 1896 and 1900 over 60 per cent. of the milk samples examined gave sediments measuring 9 m.m. or more; in other words only 40 per cent. of the milk appeared to be clean.

In 1906 the milk had improved considerably; over 68 per cent. of the milk gave sediments below 9 m.m., and could, therefore, be classed as clean milk.

The diminution in the number of milk yielding sediments of 13 m.m. and over, and which, according to the scale adopted, were classed as very dirty, was even more marked. Between 1897 and 1900 not less than 2·6 per cent. of the samples belonged to this group, while in 1906 the percentage had fallen down to 0·5, *i.e.*, the number of very dirty samples had fallen from 5 to 1.

The results obtained are summarised in Table B. and Diagram II. In this diagram all the lightly shaded part above the black line indicates the relative quantity of clean milk during the 10 years; the darker shaded parts under the black line show the relative amount of milk of doubtful cleanness; the black portion represents milk which contained much dirt or an excessive number of cells, presumably derived from diseased udders.

This great diminution in the amount of dirt may, I think, be taken as conclusive evidence that during the last 10 years a very marked improvement has taken place in the state of cows and cow-sheds. It is obvious that if the milk had been treated at a dairy before the taking of the samples, the amount of dirt in the milk would not have had the meaning attached to it here. The samples collected at the railway stations came directly from the farms and, except for the usual straining, had not been freed from a great part of the slime by centrifugalisation.

Milk contractors are now in the habit of "cleaning," by centrifugalisation or filtration the milk arriving from the farm. But centrifugalisation cannot be trusted for the removal of dangerous bacteria. I have explained previously (page 343) that many bacteria, cells and other light particles remain in the cream. Therefore, artificially cleaned milk is not equal in safety to milk clean from the first. Before reaching the contractor the milk is almost invariably strained at the farm, but only the gross impurities are partly removed by straining.

The strainer is often a source of bacterial contamination. The pouring of milk through the layer of dirt on the surface of the strainer causes the displacement of finer particles, including the bacteria clinging to the grosser particles.

Although there is no constant relation between the amount of dirt and the pathogenic properties of milk, when individual cases are considered, there is, on the contrary *a distinct average correlation between the amount of dirt and the pathogenicity of untreated milk.* This is shown not only with regard to tuberculosis, but also in connection with other lesions which are liable to occur in inoculated animals.

I have classified roughly all the lesions which were observed in the course of this investigation into five groups, which are indicated in Table A. and Diagram 1. From these it will be seen that in 1897 and 1898 not less than 45 per cent. of the samples produced some kind of lesion (including tuberculosis), whilst in 1906 the percentage had fallen to 14·4 (including tuberculosis). In 1897–8, 3·6 per cent. of the samples produced severe septicæmic lesions rapidly fatal; since 1902 no sample of this kind has been received.

Diagram I. shows better than Diagram II. the great improvement which has taken place in the Manchester milk supply during 10 years of close sanitary supervision. All the portions of the diagram above the black line correspond to the *milk which was proved by actual experiment to be free from noxious properties*, and, therefore, could be considered wholesome. Only 54 per cent. of the milk belonged to that category in 1897–8; in 1906 the amount of wholesome milk had risen to 84·7 per cent. The milk capable of producing serious lesions (including tuberculous lesions), which in 1897–8 amounted to 20·8 per cent., had in 1906 been reduced to 7·4 per cent.

Table A.

Results of Inoculation of Guinea Pigs with the Sediment obtained from 40 cc.'s of Milk in each case.

Manchester.—*Unseparated Mixed Milk taken at Railway Stations and other places away from the Farm*—i.e., *Milk such as would have been supplied to the contractor or the consumer in Town. In this table of gross results control samples are included.*

Year.	Group I. Normal.		Group II. Chronic.		Group III. Sub-acute.		Group IV. Acute.		Group V. Tuberculous.		Actual Number of Specimens Examined.	Remarks.
	Actual Number.	Per cent.	Actual Number.	Per cent.	Actual Number.	Per cent.	Actual Number.	Per cent.	Actual Number.	Per cent.		
1897–8	60	54·5	27	24·5	—	—	4	3·6	19	17·2	110	Group I.—Normal—No lesions observed attributable to milk.
1900	243	70·5	50	14·5	10	2·9	2	0·6	39	11·3	344	Group II.—Chronic—Evidence of various forms of inflammation, not fatal or very slowly fatal and clearly attributable to milk.
1901	329	75·0	64	14·6	3	0·7	—	—	42	9·5	438	Group III.—Sub-acute—Various lesions attributable to milk, and fatal to one or both animals from 4 to 10 days after inoculation.
1902	292	68·0	78	18·4	15	3·5	2	0·47	36	8·5	423	Group IV.—Acute—Lesions attributable to milk and fatal to one or both animals within 3 days.
*1903	303	69·4	70	16·0	9	2·0	—	—	54	12·3	436	Group V.—Tuberculous lesions.
1904	331	76·7	53	1[illegible]·2	5	1·1	—	—	42	9·7	431	
1905	633	82·8	58	7·5	12	1·5	—	—	61	8·1	764	
1906	601	84·7	50	7·0	6	0·8	—	—	47	6·6	704	
											3,650	

* During this year a number of farms which had not previously been inspected were included in the operations.

Table B.

Amount of Sediment separated by Centrifugalisation.

Manchester.—*Unseparated Mixed Milk taken at Railway Stations, or at other places away from the Farm.*

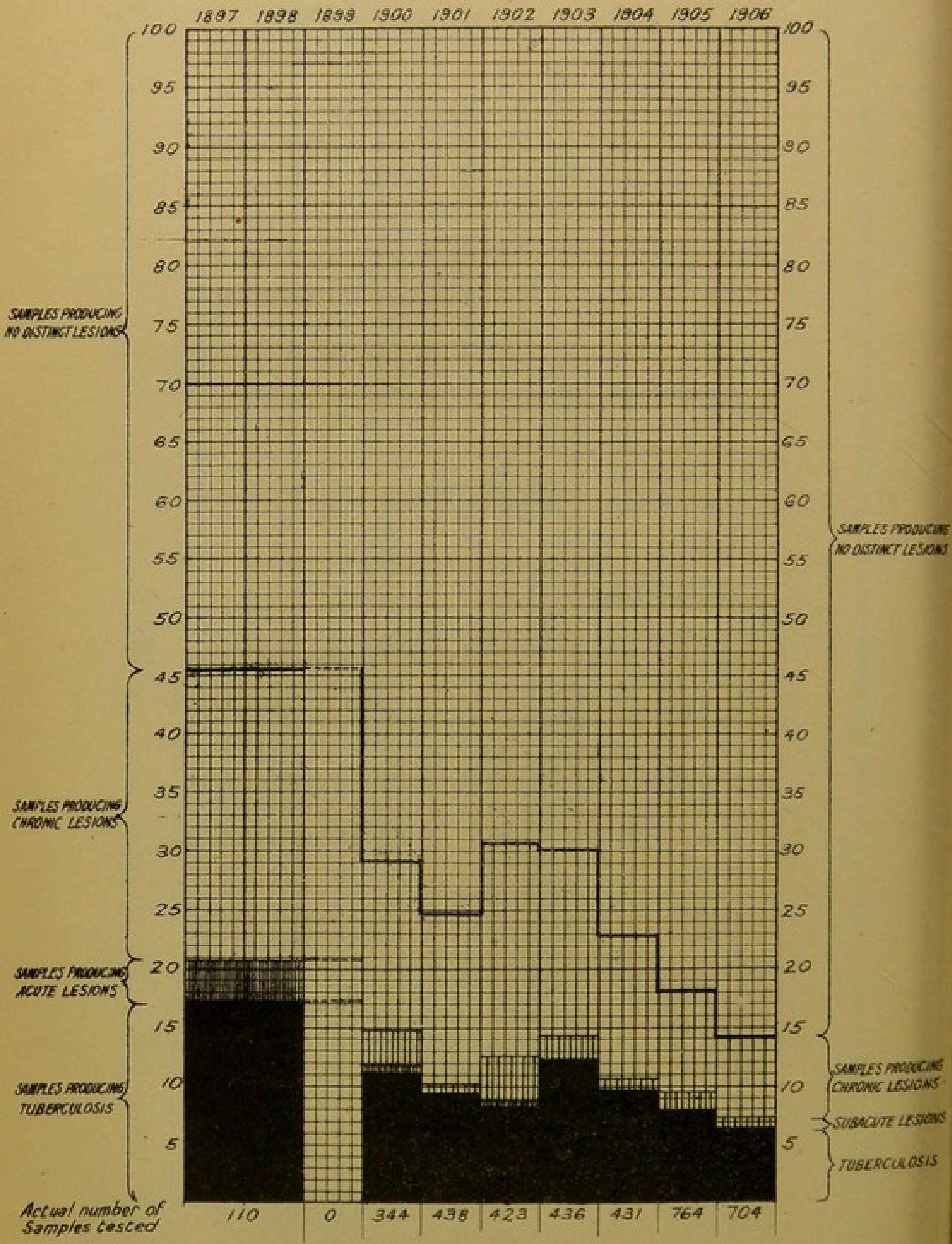
Years	Clean Milk.				Doubtful.		Milk contained marked excess of Dirt or Abnormal Products.				Total.
	Under 7 mm.		7–8 mm.		9–10 mm.		11–12 mm.		13–20 mm.		
	Actual Number.	Per cent.	Actual Number.	Per cent.	Actual Number.	Per cent.	Actual Number.	Per cent.	Actual Number.	Per cent.	
1896–1900	19	4·2	160	35·2	218	47·9	45	9·9	12	2·6	454
1901–1902	186	21·5	325	37·7	280	32·5	53	6·1	17	1·9	861
1903–1904	164	18·9	295	34·0	326	37·5	57	6·5	15	1·7	867
1905	190	24·8	276	36·1	242	31·6	49	6·4	7	0·9	764
1906	185	26·2	296	42·0	188	26·7	31	4·4	4	0·5	704
											3,650

The numbers indicating the amount of sediment show only the relative amount. The absolute amount of sediment is not given in this table.

Diagram I.

3650 Samples of Mixed Milk collected at Railway Stations in Manchester during the 10 Years 1897-1906. (inclusive).

Classified according to the effects produced in inoculated animals.



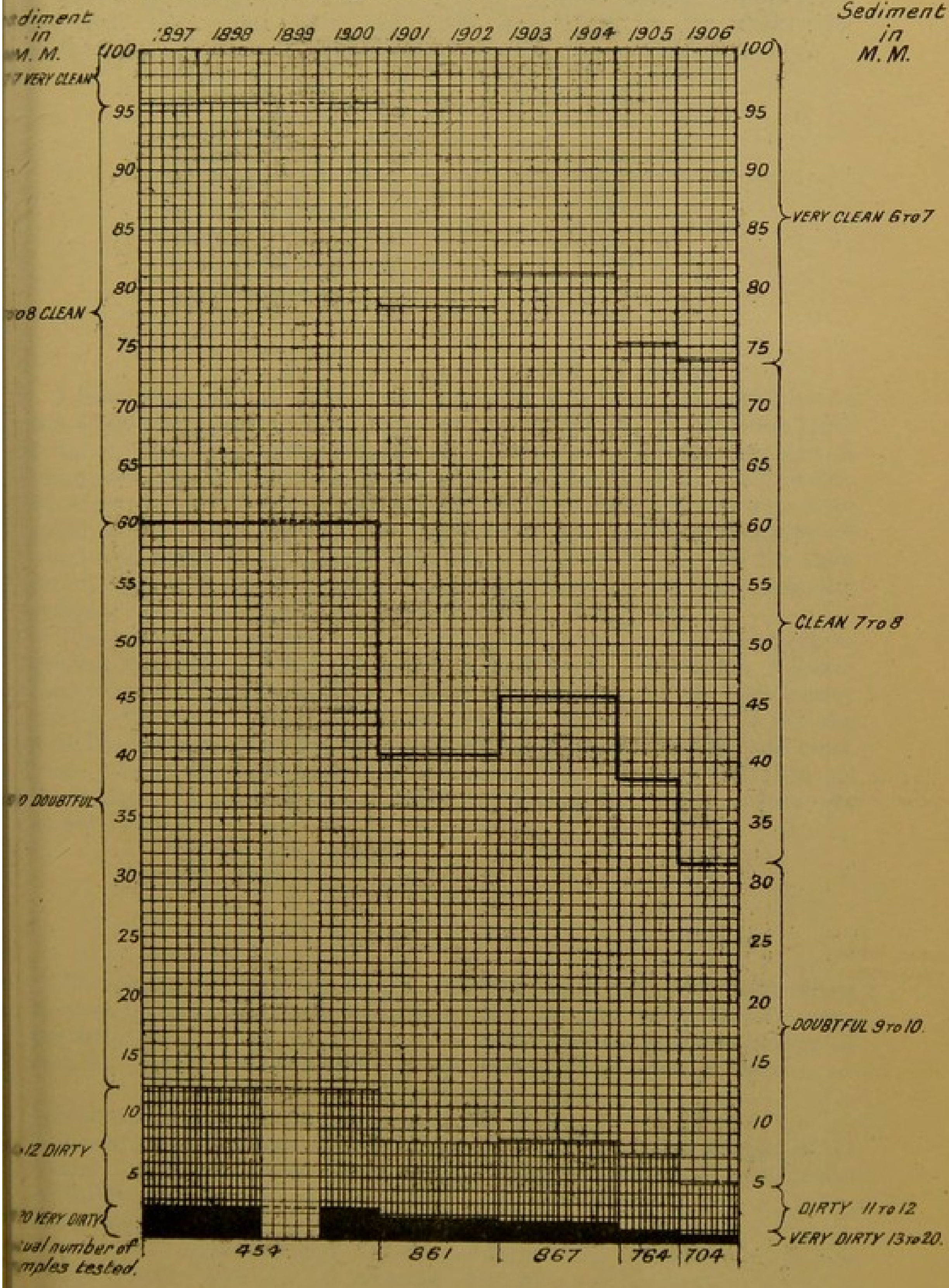
3/12. Wt 13002 . 24 1375 . 10/09.

Weller & Graham, Ltd Litho, London

Diagram II.

650 Samples of Mixed Milk collected at Railway Stations. Manchester during the 10 Years 1897–1906. (inclusive)

Classified according to the amount of Sediment. (Dirt and Cells)



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PART II.

Results of the Examination of 7,000 Consecutive Samples of Milk for the Detection of Tubercle Bacilli.

I.—Source of the Samples; Number of Samples Available for Investigation Purposes.

The 7,000 samples of milk tested at the Public Health Laboratory between the years 1896 and 1908 were sent by the following authorities:—

Manchester...	—	5,443
Salford	296	
Blackburn	161	
Derby	260	
Sheffield	116	
Burton-on-Trent	314	
Bristol	77	
Various other places	306	
Spoilt samples	27	
	—	1,557
Total ...		7,000

I have avoided any selection of samples, and taken from my books the 7,000 samples that have been sent consecutively to me since 1896. I have, however, been obliged to exclude 82 of these samples as unsuitable for the purpose of this report. Their unsuitability is due in most cases (67 per cent.) to the incompleteness of the data supplied at the time the samples were sent, and the impossibility of obtaining accurate particulars at a later date; in some cases the tests failed to give definite results owing to accidents; in a few cases the samples were unsuitable for the application of any test.

The samples excluded owing to accidents may be taken as representing administrative or experimental failures. Of these failures less than half were due to accidents occurring in the laboratory (chiefly the early death of the two animals inoculated). Of all the suitable samples reaching the laboratory not more than 0·20 per cent. were wasted owing to experimental accidents. After excluding all the unsuitable samples the number remaining for consideration are as follows:—

Manchester samples	5,388
Other samples	1,530
	6,918

The samples sent in small numbers and intermittently from various places are of interest only for general purposes of comparison, and cannot be used in an investigation of the meaning of results. After the exclusion of these 306 samples there remain

6,614 samples

which can be safely utilised for careful study.

These samples were obtained from 2,079 farms in the course of 11 years. The number of cows kept on these farms may be estimated as follows:—

Manchester supply	1,385 farms	Average No. of cows per farm 19·5	Total ...	27,032
Other places	694 „	Average No. of cows per farm 18·0	„ ...	12,492
	2,079			39,524

The number of farms and of cows that have been tested in connection with the Manchester milk supply is about two-thirds of the total number tested for all authorities. The number of samples examined for the Manchester authority is more than three-quarters of the total number of samples sent by all authorities. Table VII. and Table VIII., in which the results obtained are given year by year, show that the inspection work has been pursued more steadily in Manchester than elsewhere, and also that the area from which the Manchester milk came corresponds closely with the milk producing areas of the other authorities (with the exception of the Bristol area). For these various reasons, and also owing to the fact that I have been in very close touch with the work of the Manchester Medical Officer of Health and veterinary inspectors, I will consider in greater detail the results obtained in Manchester, and use the figures relating to other areas for purposes of general comparison.

II.—General Outline of the Administrative Aspect of the Work.

A.—*Farms outside the City boundaries.—Administration of the Milk Clauses of the Manchester General Powers Act*, 1899.

A recent account of the working of the Milk Clauses from the administrative point of view is given in the "Report on the Health of the City of Manchester, 1907," by Dr. James Niven (page 160).

No changes have been made since 1899, and most of the preliminary administrative work done between 1896 and 1899, *i.e.*, before the passing of the Manchester Milk Clauses, was conducted on the same lines. There has, however, been a gradual improvement in the arrangements for the taking of samples, which, since 1901, have been most carefully systematised so as to secure general and frequent supervision of the whole area of supply. The collection of samples and the inspection of farms are conducted as follows. Samples of milk are obtained at the railway stations, or elsewhere within the city, by the Food and Drugs Inspectors. These samples are submitted to bacteriological examination. All samples found to cause tuberculosis are followed to their source at the farm by the medical officer of health (or his representative) and the veterinary surgeon.

The veterinary surgeon examines all the milk cows on the farm, and takes separate samples of milk from cows having diseased or suspicious udders. These samples are examined bacteriologically, and when the milk of a cow is found to be tuberculous this is taken as proof that the udder is tuberculous. The farmer is required by the medical officer of health to isolate the affected cow and at the same time is advised to have the animal slaughtered in the presence of the veterinary surgeon of the corporation. This advice is followed in a great number of cases, and opportunity is thus obtained not only to remove dangerous cows but also to control the value of the bacteriological tests.

It sometimes happens that the farmer disposes of one or more cows in the interval between the taking of samples and the completion of the bacteriological examination. When this has taken place the veterinary surgeon attempts to trace the movements of any cow that has been removed from the farm. In this he is not always successful, owing to farmers frequently sending the suspicious cows to farms that are not under the administrative control of Manchester.

When none of the samples obtained from udders showing evidence of some form of mastitis resembling tuberculous mastitis are found by bacteriological examination to be tuberculous, further mixed samples are taken either at the railway station or at the farm, and if the mixed milk remains infectious a further inspection of the farm is made. Unmixed samples are again taken and examined bacteriologically.

At first the finding of udders yielding tuberculous milk was sometimes very slow, and in such cases I advised the dividing of the herd into groups of cows varying in number according to the size of the herd, a mixed sample being taken from each group. It was generally found that one of the groups yielded tuberculous milk, and it became then usually easier to find the infective cow or cows. This method has not been used of late in Manchester but it has proved useful in other places. The final step consists in taking one or more samples of the mixed milk of the farm or shippon after the cow or cows with tuberculous udders have been isolated or eliminated. If these control samples are proved by bacteriological examination to be incapable of producing tuberculosis the farm is considered, for practical purposes, to be free from sources of tuberculous infection of the milk *for the time being.*

B.—*Farms within the City Boundaries.*

The cow-sheds within the city are usually inspected without the preliminary examination of a mixed sample of milk. When inspection, palpation of the udder, and other signs do not allow the veterinary surgeon to determine whether an udder is tuberculous or not, a sample of the milk from the suspected udder or quarters is taken for bacteriological examination. During the years 1896 to 1901 inclusive, the cows in nearly all the Manchester cow-sheds were tested in this way. Since then very few samples have been tested bacteriologically, except in 1905, when a fairly large number of mixed samples were taken of the milk supplied by Manchester farms that had not previously been tested bacteriologically. Since then the farms have been controlled by veterinary inspection, and only occasional unmixed samples taken to clear the nature of suspicious cases. The cows kept in the city cow-sheds are frequently replaced, and are on an average much younger than those kept in many country farms; tuberculosis of the udder is therefore much less likely to occur in the city than in the country.

III.—Working Staff.

The success of the work has depended :—

1st. On Dr. Niven's excellent administrative arrangements for the systematic supervision of the milk supplying area and the removal of infectious cases.

2nd. On the special veterinary knowledge and tact of Messrs. Jas. King, Alfred Holburn (1896, 1897, 1898), J. S. Lloyd (1899–1900), and Mr. J. W. Brittlebank (1901–1908) who have successively acted as veterinary surgeons to the corporation.

3rd. On the accuracy of the bacteriological results.

I conducted myself between 1892 and 1895 all the experimental work upon which, in 1895, I based the methods which have been used since then. The examination of samples of milk was also at first carried out entirely by myself, but after the administrative and laboratory work had been fully co-ordinated I secured the co-operation of several of my assistants in succession. A great part of the bacteriological work has in this way been done by Dr. E. J. Sidebotham, and later by Dr. A. Sellers, who have made under my direction a great number of inoculations and *post-mortem* examinations of inoculated animals.

A fairly large number of *post-mortem* and microscopical examinations have been made for me in early days by Dr. F. J. H. Coutts. Dr. J. R. Carver and Dr. F. C. Moore have also examined microscopically four to five hundred milk sediments. Before any part of the work was transferred to any of my assistants we worked jointly until the results obtained by us were in perfect agreement. As there has been no change in the methods I adopted in 1895 the results obtained at the present time are strictly comparable with those obtained in 1895.

IV.—Collection of Samples and of Data relating to them.

The collection of samples entirely free from accidental contamination is obviously essential to success.

A.—*Collecting apparatus.*

The inspector is provided with collecting apparatus which I have designed specially for the purpose. This apparatus consists of :—

(1) A glass bottle (8 to 10 ozs. capacity) with an indiarubber stopper.

(2) A tinned copper milk scoop, with long handle, shaped like the milk measures used by milk men.

(3) A copper metal case enclosing the scoop and bottle.

The bottle, stopper, scoop and copper case are cleaned and then sterilized by steam under pressure at the laboratory. The inspector has strict instructions not to open the case till the moment when he wants to use it, and to close it again immediately after taking a sample. The stopper must not be allowed to come in contact with any unsterilized object. It is usually deposited in the lid of the sterilized case while the bottle is being filled.

B.—*Collection of mixed milk.*

The Food and Drugs Inspector is instructed to include in a test sample some of the milk contained in the various milk cans coming from a shippon or farm. Care is taken to prevent the admission of any dirt when the milk cans are opened. The milk in each can is stirred up with the sterilized milk scoop, the inspector being careful not to allow his hand to come in contact with the milk. Obviously it would be difficult and inadvisable to stir thoroughly the whole of the milk contained in a milk can, and I have often found samples containing a marked excess of cream, indicating imperfect admixture, this however does not materially affect the results of the bacteriological examination.

During the first years I had the temperature of the milk taken at the time of collection and at the time of arrival at the Laboratory. For this purpose a thermometer was attached to the stopper of the sample bottle. Since 1901 this step has been omitted as sufficient information had previously been obtained.

C.—*Collection of unmixed milk.*

Samples of unmixed milk are collected by the veterinary surgeon at the time of his visit to the farm. The greatest care is taken to avoid the admixture with the milk of dirt from any source. Skilled veterinary inspectors milk the cow direct into the bottle. Those with less practice may milk the cow into the sterilized scoop or case and transfer the milk into the bottle. *None of the dairy vessels are used for this work, nor is the milkman allowed to take the sample or to handle the collecting apparatus.* In dealing with cases of early tuberculosis of the udder, in which lesions are so slight that they are difficult to recognise by palpation, it is usually preferable to collect the last milk known as *strippings* in which cells and tubercle bacilli are usually more numerous than in the fore and middle milk.

D.—*Collection of data.*

Immediately after taking a sample of mixed milk at a railway station or elsewhere, the inspector fills the form which I supply for the purpose, and of which a facsimile is reproduced here.

N.B.—After entering on this label all the information obtainable, the sample of milk should be sent to the **Director of the Public Health Laboratory, Manchester,** without the slightest delay. If an interval of more than six hours must elapse between the time of milking and the time of arrival of the sample at the Laboratory, the bottle containing the sample should be packed in ice. Suitable refrigerators may be obtained by application at the Laboratory.

Milk collected at Railway Stations, or other places away from Farm.

Name of station or place .... No. on Lab. Case.........
Name of farm......................................of farmer...
Situation of farm ....
Probable time of milking...
Railway station nearest to farm...
Destination of Milk..
State of milk can.. ....Size............gallons. No. on Can...............
Temperature of milk..
Has the sample been collected in such a way as to avoid accidental contamination?......
Date of collection...
Signature of Inspector................................Authority.......................................

For samples of milk collected at the farm I supply another form for the use of the veterinary surgeon.

N.B.—After entering on this label all the information obtainable, the sample of milk should be sent to the **Director of the Public Health Laboratory, York Place, Manchester,** without the slightest delay. If an interval of more than six hours must elapse between the time of milking and the time of arrival of the sample at the Laboratory, the bottle containing the sample should be packed in ice. Suitable refrigerators may be obtained by application at the Laboratory.

Milk collected at Farm or Dairy.

No. on Lab. Case.........
Name of farm... ....of farmer...
Situation of farm...
Mixed milk. { State of shippon ....
No. of cows in shippon...
Unmixed milk. { Description of cow, or No. of reference ....
State of cow ....
General evidences of disease ....
State of the udder...
Result of tuberculin test..
Quantity of milk yielded in 24 hours ....
Date of Collection of sample.......................................A.M.........................P.M.
Time of milking ....A.M.........................P.M.
Has the sample been collected in such a way as to avoid accidental contamination?......
Signature of Inspector ....Authority...

By means of these forms I have been able to follow closely the progress of the work done and of the results obtained. It was, however, not always possible to obtain all the information required at the time when the samples were collected. Whenever this was the case the missing particulars were obtained by the Veterinary Surgeon during his subsequent visits to the farms. All samples not sufficiently documented have been discarded.

E.—*Forwarding the samples to the Laboratory.*

When the inspector can arrange to deliver the sample at the Laboratory within a few hours of the time of collection, no further precaution is needed than to keep the metal case securely closed until delivery. If the milk cannot reach the Laboratory within four or five hours in the summer or ten hours in winter, the collector is directed to place the sample cases in a small portable refrigerator in which cooling is obtained without the bottles being soiled by melted ice. The refrigerator which I supply for the purpose is of the same type as one which I have used since 1893 for the sending of samples of water to a distance.*

When the samples cannot be examined immediately on arrival at the Laboratory they are kept in a refrigerating chamber at a temperature below 4° C. until they are examined.

V.—Examination of Samples at the Laboratory.

A.—*Preliminary examination.*

The reaction and specific gravity of each sample are taken and any abnormal appearances noted. (The temperature was also taken during the first years.)

The milk is then centrifugalised. For this purpose I use tubes measuring 14 cm. (5½ inches) in length and 2·2 cm. (⅞ inch) internal diameter. The bottom of these tubes is hemispherical and they have two marks indicating the level reached respectively by 2 cubic centimetres and 40 cubic centimetres of fluid.

Two of these tubes are filled up to the 40 ccm. mark with the milk contained in one sample bottle, 80 ccm. (or 2·81 ounces) of each sample are therefore used for the test.

The milk is centrifugalised in these tubes for 15 minutes, the speed of the centrifugal machines (diameter 17 inches) ranging between 2,000 and 3,000 revolutions per minute.

At the end of that time the cream should form a compact layer, so dense that (when the milk is not very abnormal) the tube can be turned upside down without any spilling of fluid. A dense sediment ("slime" of dairymen) is formed at the bottom of the tube to which it adheres so firmly that the supernatant fluid can be entirely removed without the sediment being displaced. In the case of mixed milk this sediment never covers the whole of the hemispherical bottom of the tube and its amount can be roughly estimated by measuring the diameter of the segment occupied by the deposit. The unmixed secretion obtained from diseased udders frequently yields a sediment so bulky that it may fill the whole bottom and rise in the tube to a height of ½ to 4 or more centimetres.

For the purpose of measuring more accurately the amount of sediment, I have of late years used tubes which I designed

* Bacteriological Survey of "Surface Water Supplies," *Journal of State Medicine London, 1898.*

for the purpose. These tubes measure 11·5 cm. in length, the internal diameter of the upper two-thirds is 1·5 cm. that of the lower one-third is reduced to 2 mm. in some, 3 mm. or 4 mm. in others. The narrow part of the tube is calibrated and graduated, the intervals between the divisions corresponding to 5 cubic millimetres. The lower end of these tubes is open and ground flat.

When the tube is used the lower opening is closed by a hemispherical glass bead, the flat surface of which is ground. This bead is fixed to the tube by covering its flat surface with a thin layer of hot gelatine and pressing it firmly against the lower ground end of the tube. The capacity of these tubes is 15 cubic centimetres. This quantity of milk yields on centrifugalisation enough sediment for purposes of mensuration. When the sediment is scanty 40 cc. or 50 cc. of the milk are centrifugalised in larger tubes of the same shape, or in the ordinary tubes. When the latter are used the milk is centrifugalised as usual, then the cream and separated milk are removed, the sediment, mixed with 15 ccs. of normal saline solution, is transferred to one of the small graduated tubes and centrifugalised again. When the amount of sediment is large, the milk should be diluted before centrifugalisation. The speed of the centrifugal machine is gradually increased until it reaches 3,000 revolutions per minute, at the end of 15 minutes the sediment has separated into several distinct layers, the deepest one containing most of the mineral matter and larger particles of extraneous matter, the more superficial layer being mostly composed of cells and bacteria. The various parts of the sediment can be studied by removing the fluid above it and the bead at the bottom of the tube. The sediment can then be driven out of the tube on to a slide where it forms a cylindrical mass easily analysed. By means of these tubes it is therefore possible not only to estimate with fair accuracy the total amount of sediment, but also to recognise by simple inspection the relative amount of *extraneous matter* which is generally black, grey, greenish or brownish in colour, and of *cellular products* which have usually a creamy, buff yellow, or pinkish (when blood stained) colour and are opaque or translucent. The same elements may be to a certain extent be recognised in the sediments obtained in the larger tubes where they form concentric zones, but owing to their being spread over a larger surface they form thinner less distinct layers. The narrow tubes have allowed me to detect tubercle bacilli by the microscopical method much more frequently than I had been able to do when I used only the large tubes. When dealing with a set of samples of unmixed milk I have been able to detect tubercle bacilli microscopically in 4 out of 10 samples, the remaining 6 samples being found by inoculation to be free from tubercle bacilli. With the large tubes I have seldom been able by the microscopical method to find tubercle bacilli in more than 50 or 60 per cent. of the samples.

This fact is of some importance as, in the event of direct inspection of farms being adopted, as a primary step, the microscopical method might be used to reduce considerably the number of inoculations which up to lately have been found necessary in order to secure accurate results.

To remove the cream and separated milk so as to obtain the sediment by itself the cream is loosened from the sides of the tube and aspirated through a tube ($\frac{1}{8}$-inch diam.) connected with a receiving flask from which the air is exhausted by means of an air pump; the separated milk is then removed in the same way until there remain only 2 cubic centimetres of it with the sediment at the bottom of the tube.

I have also used with advantage for the same purpose, centrifugalising tubes the lower part of which, containing the sediment, could be separated from the body of the tube after centrifugalisation.

By tilting the tube the surface of the sediment is exposed and, with a sterilized platinum loop, about 2 milligrammes of the superficial layer of the sediment are taken and spread on a cover glass. One microscopical film is prepared in this way from each of the 2 tubes used for each sample.

After removing this small fraction of the sediment the tube is thoroughly shaken so as to mix the sediment with the small amount of separated milk left with it. The mixture is drawn from each tube into a hypodermic syringe. One syringe, recently sterilized by steam under pressure, is used for each sample. One guinea-pig is inoculated with the contents of each syringe.*

B.—*Microscopical examination.*

The two films when dry are placed in a covered capsule containing equal parts of absolute alcohol and ether, in which they are kept for at least 2 hours, after which the capsule is placed in a dish of water previously brought to a temperature of 80° to 90° C. The mixture of absolute alcohol and ether boils at once, and after 10 to 15 minutes of this treatment the cover glasses are removed from the hot mixture and washed with absolute alcohol.

The films are then stained for tubercle bacilli with carbol fuchsin according to the Ziehl-Neelsen method.

By adopting these precautions very clear preparations are obtained, and no difficulty is caused by acid fast bacilli.

Since 1884 several thousand films have been examined in this way by myself or my assistants and I have known of one instance only in in which an acid-fast bacillus had been mistaken for the tubercle bacillus by a worker who had probably neglected some of the precautions indicated above. and had not paid sufficient attention to the morphological features of the organism, which were clearly different from those of the tubercle bacillus. The reliability of this method of microscopical examination has been amply proved by the results of the inoculation of guinea-pigs. Over 100 samples of milk in which the presence of tubercle bacilli had been demonstrated by the microscopical method produced *without exception* tuberculosis in guinea-pigs inoculated with them.

Unfortunately the failure to find tubercle bacilli by the microscopical method does not prove that a sample of *mixed milk* is safe, and about 50 per cent. of the tuberculous samples would have been overlooked had the routine microscopical examination alone been relied upon. With regard to *unmixed milk* better results may easily be obtained by the special method which I have previously described.

C.—*Inoculation Test.*

Two guinea-pigs weighing from 7 to 10 ozs. (smaller and larger guinea-pigs may be used, but the best results are given by animals of the size indicated above) are inoculated each with the sediment obtained from 40 cc. of milk mixed with 2 cc. of the separated milk in the way which I have previously described. This material is injected subcutaneously on the inner side of the left hind leg, the puncture is made at the level of the femoro-tibial articulation, with aseptic precautions. The two animals inoculated

* For more details see "The Examination of Cows' Milk for the Detection of Pathogenic Properties," *Journal of Comparative Pathology, 1897.*

with one sample are then kept in a recently sterilized zinc cage which is placed in a clean, well-lighted, and well ventilated animal house. The animals are well cared for and regularly fed, the cages are cleaned every day or every other day.

When the precautions previously described are strictly observed, accidental deaths are of great rarity and the inoculations have no appreciable effect on the health of the guinea-pigs unless the milk contains pathogenic organisms. Acute inflammatory lesions are of great rarity even when the milk has been obtained from diseased udders (tuberculous or not).

With milk which has not been properly handled and in which bacteria have been allowed to multiply under the influence of long keeping and high temperature, early inflammatory lesions often rapidly fatal are frequent*, and sometimes interfere with the diagnosis of tuberculosis by causing the death of the animals before the tuberculous lesions have become distinct. When tubercle bacilli are moderately abundant in the milk, enlargement of the popliteal and superficial inguinal lymphatic glands close to the seat of inoculation can often be recognised from the 8th to the 10th day, and if the animal is killed it is fairly easy to demonstrate the presence of tubercle bacilli in these glands (Figs. 1, 2, and 3). (By the inoculation method it is even possible to show that the popliteal gland is usually infected before the end of the 4th day.) When tubercle bacilli are few the lymphatic gland lesions may not be obvious before the end of the 2nd or 3rd week. It has therefore become my practice in order to give uniformity to the procedure and to obtain comparable results to kill the experimental animal at the end of the third week. Very little is gained by waiting longer, for the distinction between various races of tubercle bacilli is not the object of these inoculations.

With regard to milk containing an extremely small number of bacilli that are often very unequally distributed, it is clear that the presence of these bacilli could be detected with certainty only if a greater quantity of milk and a greater number of guinea-pigs than those employed for the purpose of the ordinary routine tests were used.

Besides tuberculous lesions, the milk is capable of producing some other chronic lesions to some of which the name of *pseudo-tuberculosis* has been given. Pseudo-tuberculosis has been erroneously supposed to be a serious cause of error. No experienced pathologist could mistake in the guinea-pig such lesions for true tuberculous lesions, and when the precaution which I have invariably taken of confirming each diagnosis by a demonstration of tubercle bacilli in the lesions occurring in the experimental animal is adopted even an experimenter with scanty pathological experience could not make any mistake.

VI.—Record of Work and Results.

The working of the various methods which have been previously described is made clear by the following reproduction of two pages of my laboratory books which show how a summary record has been kept of all the examinations made since 1896.

---

* The results of the examination of 45 samples of mixed milk collected in 1896 without special precautions were as follows :—

Samples producing no noxious effects or only transient trivial lesions ...	17
Samples producing local irritation, but no general infection	17
Samples producing intense local irritation and general infection ...	8
Samples producing tuberculosis	3

A.—*Records of the examination of two samples of milk, obtained from one farm,* (1) *mixed milk obtained at a railway station,* (2) *unmixed milk obtained at a farm.*

(Record 1).

No.—*3773 M/C. Can 36.*	Sanitary Authority—*Manchester.*
Name of Collector, *D. Hickman.*	Date of arrival of sample—*23/3/1906.* hour *2* a.m. p.m.
Address if necessary	Date of collection " " " " hour *7* a.m. p.m.
	Time of milking " —*23/3/1906.* hour *5* a.m. p.m.

A. Milk collected at Farm or Dairy.

Name of farm of farmer

Situation of farm

Mixed Milk—

State of shippon or shippons

No. of cows in shippon

Unmixed Milk—

Description of cow, or No. of reference

State of cow

Evidences of disease

Result of tuberculin test

Quantity of milk yielded in 24 hours

B. Milk collected from cans at railway stations or other places away from the farm.

Name of station, or place—*Longsight Station.*

Name of farm—*T. O. H.* of farmer—*H. W.*

Situation of farm—(*Map XXI. 84. M. 51.*)—*Prestbury.*

No. of miles from Manchester Station

Railway station nearest to farm

Destination of milk—*W. C., Ardwick Terrace.*

State of milk can—*Clean.* Temperature of milk

Characters of Milk on arrival at the Laboratory.

Colour—*Normal.*	*Microscopical Examination of Sediment.*
Reaction—*Amphoterous.*	Foreign bodies
Sp. Gr.—*1031.*	Cells Leucocytes
Cream—*15 mm.*	Microbes
Sediment—*11 mm.*	Tubercle bacilli

Additional Information.

References :—

Inoculation Book

Laboratory Book

Special Book—*M.B. 5156–5157.*

Photographs

Result of Inoculation + (*20/4/1906*).

No.—*5063*

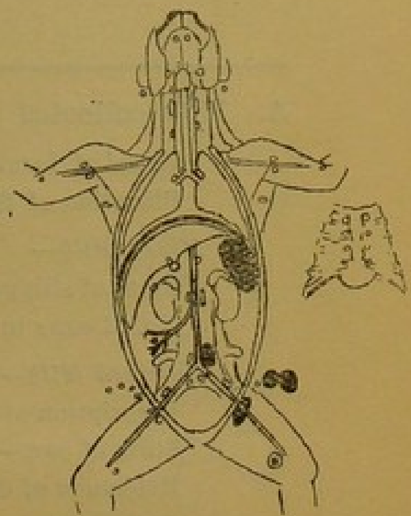
F. Weight a.m.—*8 ozs.*
Weight p.m.—*8.*

A.

Date of inoculation—*23/3/1906.*
No. of hours after collection—*About 10.*
Part inoculated—*Left hind leg.* quantity—*2 cc.*
Symptoms
Apparent cause of death—*Killed by chloroform.*
Date of death—*18/4/1906.* No. days after inoc.—*26.*
Date p.m.—*18/4/1906.*

Local lesion—*None noticeable.*

Popliteal gland	Right—*Normal.*	Left—*Enlarged, partly caseous.*	
Superficial inguinal g.	id. ,,	id. ,, ,, ,,	
Deep inguinal g.	id. ,,	id. ,, ,, ,,	
Sublumbar g.	id. ,,	id. ,, ,, ,,	
Retro hepatic g.	,,	Bronchial g.	
Mesenteric g.	,,	Sternal g.	
Renal g.	,,	Cervical g.	
Liver	,,	Peritoneum	
Spleen—*Enlarged, a few tubercles.*		Pleura	
Lungs—*Normal.*		Pericardium	



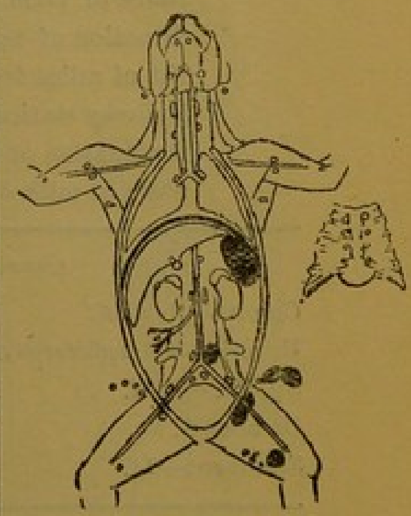
M. Weight a.m.—*7 ozs.*
Weight p.m.—*8.*

B.

Date of inoculation—*23/3/1906.*
No of hours after collection—*About 10.*
Part inoculated—*Left hind leg.* quantity—*2 cc.*
Symptoms
Apparent cause of death—*Killed by chloroform.*
Date of death—*18/4/1906.* No. days after inoc.—*26.*
Date p.m.—*18/4/1906.*

Local lesion—*Small caseous masses.*

Popliteal gland	Right—*Normal.*	Left—*Enlarged, partly caseous.*	
Superficial inguinal g.	id. ,,	id. ,, ,, ,,	
Deep inguinal g.	id. ,,	id. ,, ,, ,,	
Sublumbar g.	id. ,,	id. ,, ,, ,,	
Retro hepatic g.	,,	Bronchial g.	
Mesenteric g.	,,	Sternal g.	
Benal g.	,,	Cervical g.	
Liver	,,	Peritoneum	
Spleen—*Enlarged, a few tubercles.*		Pleura	
Lungs—*Congested.*		Pericardium	



Lesions examined microscopically.	Results.
A.—Popliteal gland (left)	*Tubercle bacilli found.*
Superficial inguinal gland (left) ...	,, ,, ,,
B.—Popliteal gland (left)	,, ,, ,,
Superficial inguinal gland (left) ...	,, ,, ,,
Lesions from which cultures made.	

(Record 2).

No.—*3843 M/C. Can 39.* Sanitary Authority—*Manchester.*

Name of Collector—*J. W. Brittlebank.* Date of arrival of sample—*26/4/1906.* hour a.m. p.m. *Refrigerator.*

Address if necessary Date of collection „ —*25/4/1906.* hour *11* a.m. p.m.

Time of milking „ — *ditto.* hour *11* a.m. p.m.

A. Milk collected at Farm or Dairy.

Name of farm—*T. O. H.* of farmer—*H. W.*

Situation of farm—(*Map XXI. 84. M. 51.*)

Mixed Milk—

State of shippon or shippons—*Fair.*

No. of cows in shippon—*10* (*on farm, 61*).

Unmixed Milk—

Description of cow, or No. of reference—*Red cow, shed 6, last on left.*

State of cow—*Fair condition.*

Evidences of disease—*Udder, left hind quarter indurated and enlarged, right hind quarter indurated.*

Result of tuberculin test

Quantity of milk yielded in 24 hours—*?*

B. Milk collected from cans at railway stations or other places away from the farm.

Name of station, or place

Name of farm of farmer

Situation of farm

No. of miles from Manchester Station

Railway station nearest to farm

Destination of milk

State of milk can Temperature of milk

Characters of Milk on arrival at the Laboratory.

Colour—*Normal.*	*Microscopical Examination of Sediment.*
Reaction—*Amphoterous.*	Foreign bodies—*Very few.*
Sp. Gr.—*1034.*	Cells—*Very abundant.* Leucocytes—
Cream—*7.*	Microbes—*Few.*
Sediment—*11.*	Tubercle bacilli—*None found.*

Additional Information.

References :—

Inoculation Book

Laboratory Book

Special Book—*M.B. 5063.*

Photographs

Result of Inoculation+ (*22/5/1906*). No.—*5157*.

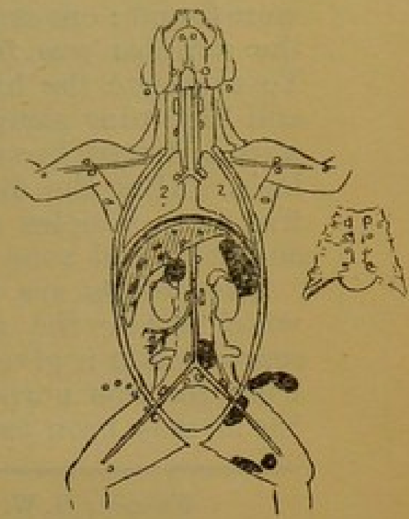
F. Weight a.m.—*8 ozs.*
Weight p.m.—*6*.

A.

Date of inoculation—*27/4/1906*.
No. of hours after collection—*52*.
Part inoculated—*Left hind leg*. quantity—*2 cc.*
Symptoms
Apparent cause of death—*Killed by chloroform*.
Date of death—*21/5/1906*. No. days after inoc.—*24*.
Date p.m.—*21/5/1906*.

Local lesion—*Caseous abscess*.

Popliteal gland Right—*Normal*.	Left—*Enlarged, caseous*.	
Superficial inguinal g. id. ,,	id. ,, ,,	
Deep inguinal g. id. ,,	id. ,, ,,	
Sublumbar g. id. ,,	id. ,, ,,	
Retro hepatic g.—*Enlarged,*	Bronchial g.—*Normal*.	
Mesenteric g. *opaque*.	Sternal g. ,,	
Renal g.	Cervical g. ,,	
Liver—*A few small tubercles*.	Peritoneum ,,	
Spleen—*Enlarged, a few tubercles*.	Pleura ,,	
Lungs—*Doubtful*.	Pericardium ,,	



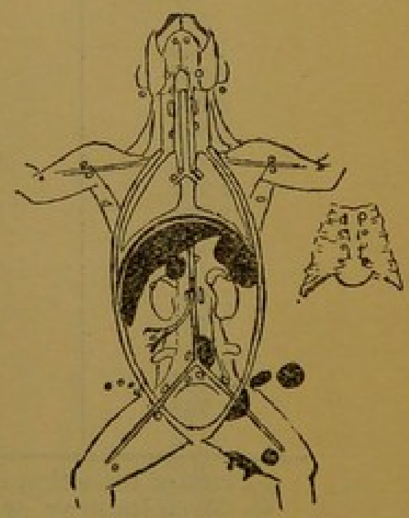
F. Weight a.m.—*?*
Weight p.m.—*4 ozs.*

B.

Date of inoculation—*27/4/1906*.
No. of hours after collection—*52*.
Part inoculated—*Left hind leg*. quantity—*2 cc.*
Symptoms
Apparent cause of death—*Killed by chloroform*.
Date of death—*21/5/1906*. No. days after inoc.—*24*.
Date p.m.—*21/5/1906*.

Local lesion—*Ulcer*.

Popliteal gland Right—*Normal*.	Left—*Enlarged, caseous*.	
Superficial inguinal g. id. ,,	id. ,, ,,	
Deep inguinal g. id. ,,	id. ,, ,,	
Sublumbar g. id. ,,	id. ,, ,,	
Retro hepatic g.—*Enlarged,*	Bronchial g.—*Normal*.	
Mesenteric g. *opaque*.	Sternal g. ,,	
Renal g.	Cervical g. ,,	
Liver—*Tuberculous*.	Peritoneum ,,	
Spleen— *Ditto*.	Pleura ,,	
Lungs	Pericardium ,,	



Lesions examined microscopically.	Results.
A.—Local lesion	*Tubercle bacilli found*.
Superficial inguinal gland	,, ,, ,,
B.—Local lesion	,, ,, ,,
Superficial inguinal gland	,, ,, ,,
Lesions from which cultures made.	

These two records show that on the 23rd of March, 1906, a sample of milk, coming from a farm situated in the Prestbury district, and at which 61 cows were kept, was found at the laboratory to be tuberculous. On the 27th of April the farm was visited by the veterinary surgeon. In a shippon which was in fair condition, and in which ten cows were housed, two cows with indurated udders were found; one sample was taken from each of these cows. One of the samples was found at the laboratory to produce tuberculosis. To complete the history of this farm I may say that between 1896 and 1900 nine samples of mixed milk had been taken at a railway station, tested bacteriologically and found not to produce tuberculosis. After the discovery and elimination of the tuberculous cow five more samples of mixed milk were taken during the years 1906 and 1907, and none of these were found to produce tuberculosis.

The results are further summarised at my laboratory in cards which allow the state of each farm to be followed closely. A reproduction is given here of the contents of one of the cards which I use for this purpose. The card selected refers to the farm which has already been used as an example.

Farmer: H. W. *County:* Cheshire. *Map:* XXI. 84.
Farm: T. O. H. *District:* Macclesfield. M. 51.

Number in Milk Book.	Place of Collection.* R. F. C.	Date of Collection.	Result.**	Number of Cows.†
92	R.	22.7.1897	—	
519	R.	2.2.1900	—	46
523	R.	2.2.1900	—	
1,514	R.	23.5.1901	—	34
2,337	R.	8.10.1902	—	
2,967	R.	23.10.1903	—	
3,383	R.	27.6.1904	—	
3,731	R.	30.12.1904	—	
4,287	R.	7.7.1905	—	
5,063	R.	23.3.1906	+	61
5,156	C.	27.4.1906	—	10
5,157	C.	27.4.1906	+	10
5,345	R.	23.7.1906	—	
5,760	R.	29.11.1906	—	
5,979	R.	21.2.1907	—	40
6,454	R.	11.7.1907	—	40
6,765	R.	14.10.1907	—	

* Place of collection is indicated as follows:—
R. = Railway, or place outside the farm.
F. = Farm, when the sample represents the milk of more than one cow.
C. = One cow only.
** + = Tubercle bacilli found.
— = Tubercle bacilli not found.

† Number of cows means (*a*) in the case of mixed or railway samples the total number of cows in the farm or section of the farm from which the milk found at the railway station is derived; (*b*) in the case of samples taken at the farm the number of cows in the shippon in which the suspected cows are housed.

B. Map used for studying the distribution of inspected farms and of the farms found tuberculous.

In order to ascertain the distribution of tuberculous cows, I divided into one square inch areas an ordnance map (one inch to the mile) of the whole area supplying milk to Manchester and

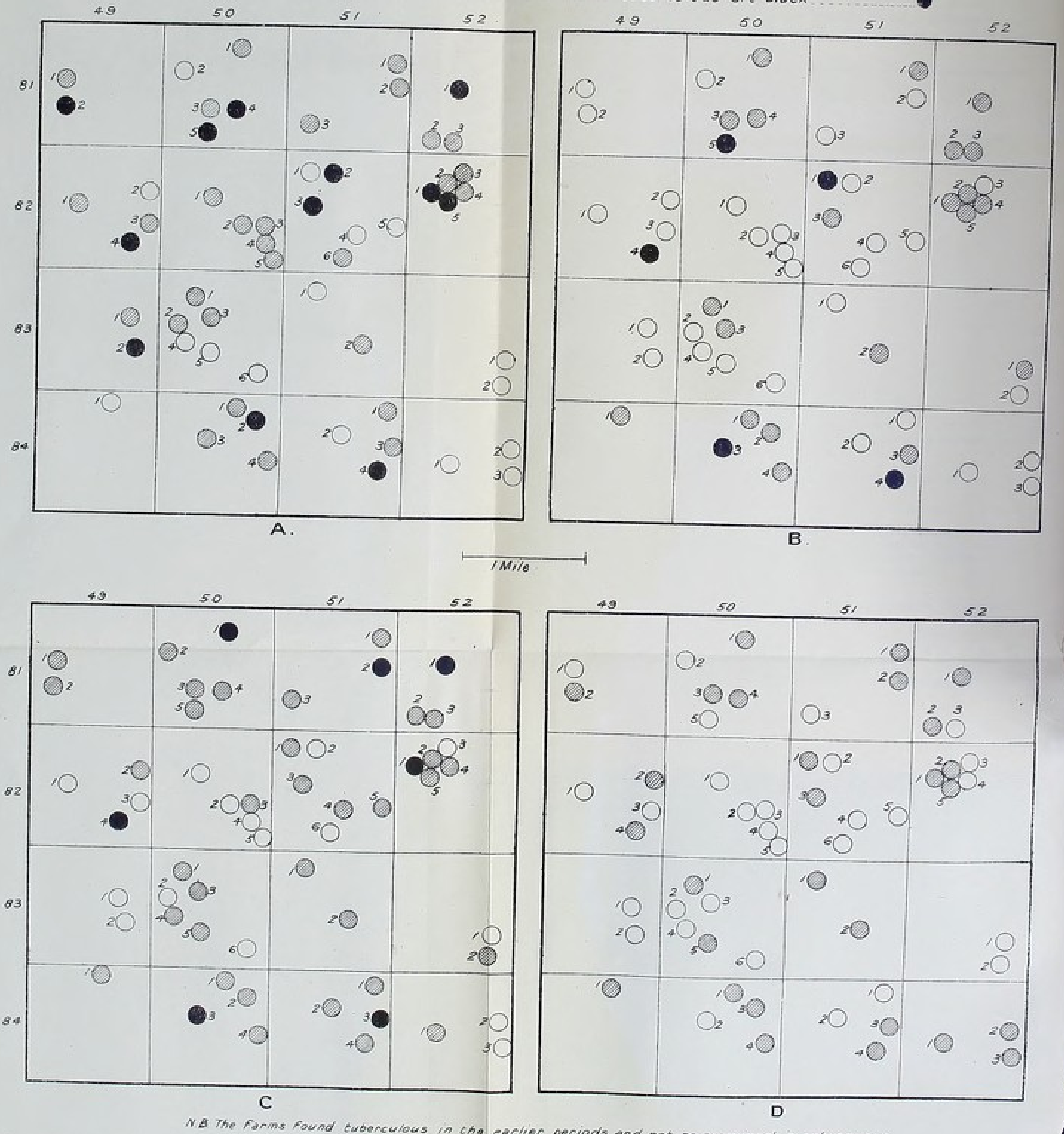
Fig. 12.

One 16-Square-Mile Area (XXI. M.)

Showing the Results of the Inspection of the Farms Supplying Milk to Manchester during the 12 Years 1896 – 1907 (inclusive)

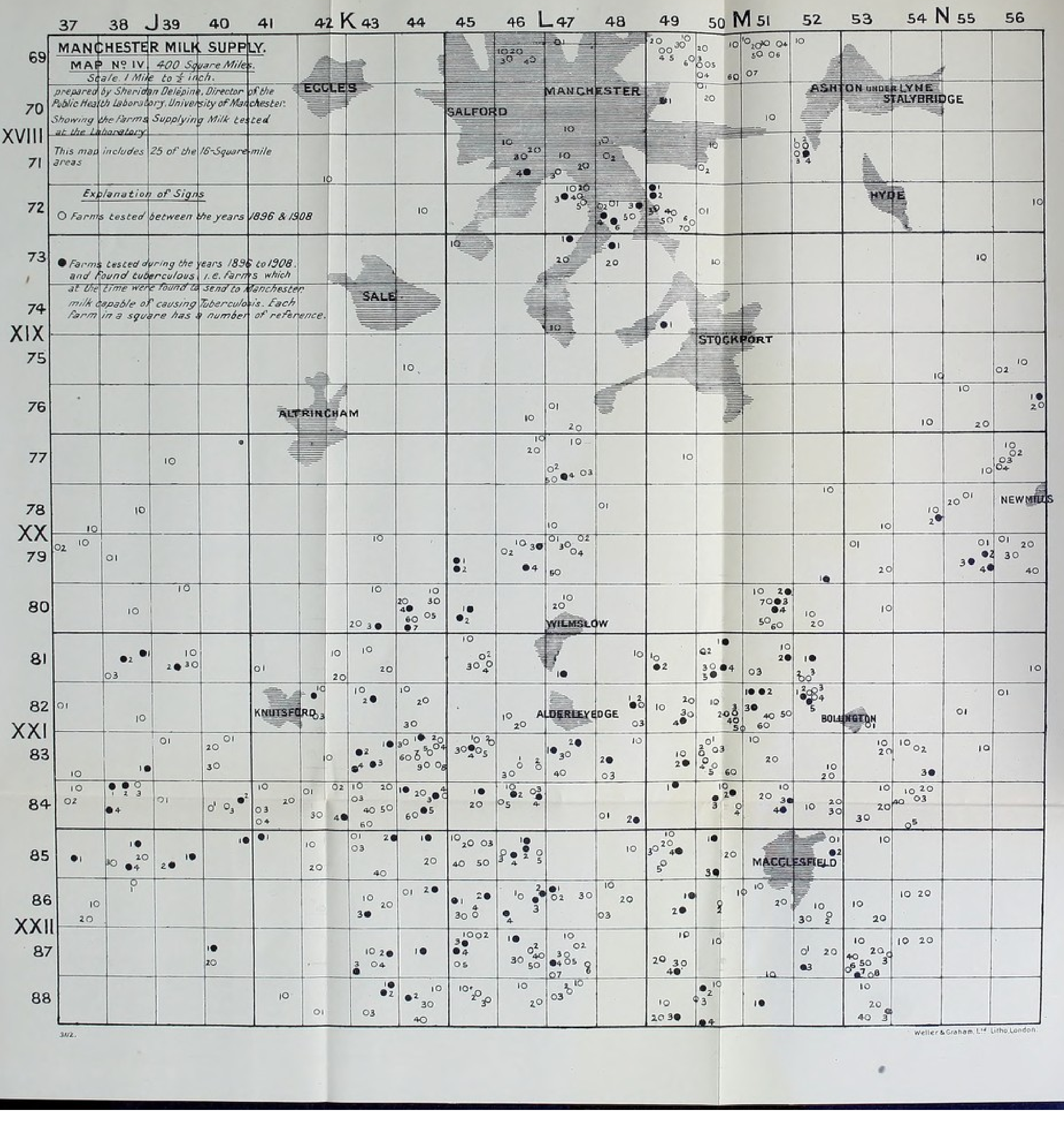
Divided into 4 periods A. 1896 – 1902 _ B. 1903 & 1904.
C. 1905 & 1906 _ D. 1907.

The position of the farms is indicated by a numbered ring.
The farms inspected during each period are tinted grey.
The farms inspected during each period and found tuberculous are black.



N.B. The farms found tuberculous in the earlier periods and not re-examined in subsequent years had ceased sending milk to the town.

8112. Wt 13002. 24. 1450. 10/09.
Weller & Graham, Ltd. Litho. London.


MANCHESTER MILK SUPPLY.
MAP Nº IV. 400 Square Miles.
Scale. 1 Mile to ½ inch.
prepared by Sheridan Delépine, Director of the Public Health Laboratory, University of Manchester.
Showing the Farms Supplying Milk tested at the Laboratory.
This map includes 25 of the 16-Square-mile areas
Explanation of Signs
○ Farms tested between the years 1896 & 1908
● Farms tested during the years 1896 to 1908, and found tuberculous, i.e. farms which at the time were found to send to Manchester milk capable of causing Tuberculosis. Each farm in a square has a number of reference.
ECCLES
SALFORD
MANCHESTER
ASHTON UNDER LYNE
STALYBRIDGE
HYDE
SALE
STOCKPORT
ALTRINCHAM
NEW MILLS
WILMSLOW
KNUTSFORD
ALDERLEY EDGE
BOLLINGTON
MACCLESFIELD
Weller & Graham, Ltd Litho. London.

several other places. The area of each of these squares is, therefore, one square mile. Each of these areas can be identified by two numbers, one of these numbers indicates the distance in miles of the square from the west border of the districts represented on the map and the other number indicates the distance, also in miles, from the north boundary of the map. For the purpose of grouping the farms into larger areas, the map is also divided into latitudinal zones four miles broad, the width of each of these zones corresponds to that of four of the *one-square-mile areas*. Each of these zones is numbered on the map by Roman figures. Four miles zones perpendicular to the former are also indicated in the map by capital letters. In this way the map is divided not only into one-square-mile areas, but also into *sixteen-square-mile areas* which are designated by Roman figures and capital letters. *See* Map IV.

I have given a number to all the farms situated in each one-square-mile area (*see* Fig. 12). It becomes thus possible to indicate exactly the position of each farm in a skeleton map. I have used such a map for the purpose of arranging the records according to the position of the farms.

By this method it is possible to study the distribution of tuberculosis in areas of equal size, a thing which I found impossible to do by means of the usual sub-divisions of the counties into districts of unequal size and very irregular shape.

This kind of map may be conveniently used to show how the testing and inspection of the farms have been conducted year by year, and to record the results obtained. An example of this is given in detail in the map of one 16-square-mile district reproduced here (Fig. 12), and in which each of the farms inspected during the 11 years is indicated by a small numbered ring. The farms inspected each year are tinted grey, and those found tuberculous, black.

C. Detailed table of results obtained in connection with one sixteen-square-mile area.

The detailed tables of results in which the work done between 1896 and 1908 is summarised are so bulky that they cannot be reproduced in this report. I will, therefore, reproduce here only a small section of these tables dealing with the 16-square-mile area XXI. M., the map of which is reproduced in this report. This area is situated in Cheshire, north of Macclesfield. In it, during the 11 years, 57 farms have been supplying Manchester (*i.e.*, more farms than in any other 16-square-mile area). The number of cows in the farms inspected was about 1,022, or a few less than in the area XXII. L., in which there were 1,077 cows distributed among the 50 inspected farms. The proportion of tuberculous farms was above the average, but below that observed in several other areas. Unusual difficulties were experienced in clearing some of the farms from tuberculosis. In the section reproduced here, the names of the farms and farmers have been omitted, but the farms can be identified by the numbers referring to their position on the map.

TABLE I.

Results of the Examinations of Samples of Milk obtained from Farms situated in the Area XXI. M.

Explanation of signs.—This table is concerned with a little less than $\frac{1}{24}$th of the farms dealt with by the Manchester authority.

The results of bacteriological examination of samples of mixed milk collected at the railway stations or at the farms are given above the line (position of the numerator), the results of the examination of the unmixed milk of individual cows are given below the line (denominator) thus :—

$\frac{\circ\ \circ\ +}{+\ \circ}$	means :	Two mixed samples not tuberculous, one mixed sample tuberculous (railway samples).
		Milk of one cow tuberculous, milk of another cow not tuberculous (individual cows samples).

The order in which the samples have been taken in the course of each year is indicated by oblique lines, thus :

$+ \;/\; \overset{F}{+} \;\backslash\; \circ$	which means :	Tuberculous railway sample taken before visit to the farm.	Mixed sample taken at the farm, at the same time as the unmixed ; found tuberculous	Railway sample taken after visit to the farm and removal of diseased cow; not tuberculous.
$/\ \circ\ +\ \backslash$			Visit to the farm after the taking of the first railway sample—one cow giving non-tuberculous milk ; one cow giving tuberculous milk.	

F above the sign corresponding to a mixed sample, indicates that the mixed sample was taken at the farm.

Table I. shows that five small farms which were inspected before 1901 have not been inspected since ; this is due to the fact that milk has ceased to come to Manchester from these farms. The same may be said of eight other farms which have not been inspected since 1902 or 1903. On the other hand some 12 farms have been inspected for the first time since 1905. There remains more than one-half of the farms that have each been inspected from 4 to 16 times during the whole period. In comparing the state of the district at the beginning and at the end of the period of 12 years it is necessary to keep account of these facts, but, inasmuch as the farms tested each year were supplying Manchester with milk at the time, the results are comparable as regards the quality of the milk supply at various times.

D.—Amount of milk infected by tuberculous cows.

To obtain a general idea of the amount of tuberculosis that has been dealt with in each area, I have summed up for each area the results obtained during the whole period of twelve years. Whether the contamination of the milk was due to the presence of one or of several diseased cows in the herd, or to any other cause, the mixed milk from that farm was infectious. The amount of tuberculous milk reaching town is, therefore, not proportional to the number of infecting cows, but to the size of the herds to which they belong.

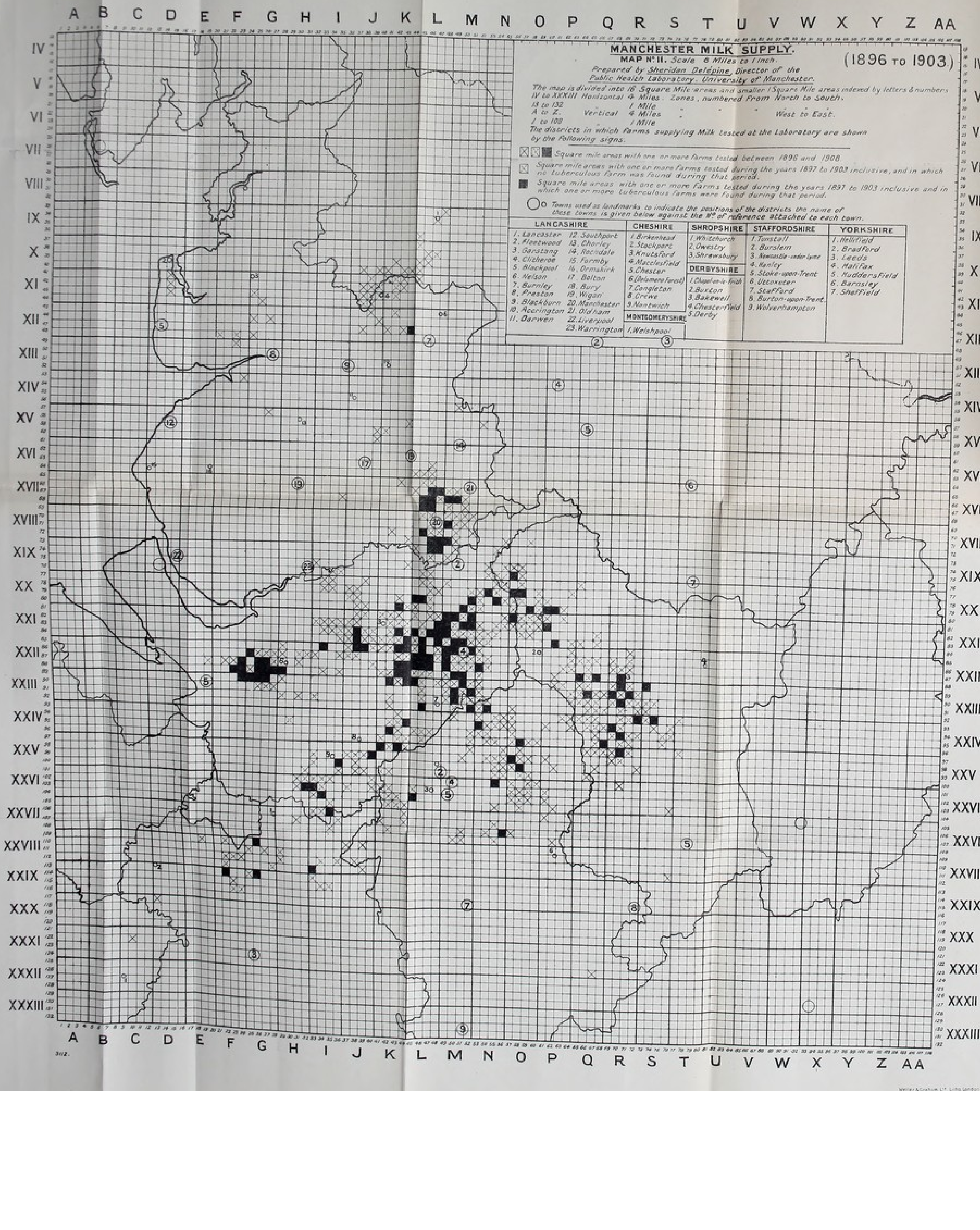
An estimate of the amount of tuberculous milk produced at one time or another within an area can therefore be made by adding together the number of cows kept in the various tuberculous farms. It is unfortunately impossible to ascertain for how long the farm had produced tuberculous milk when the fact was detected.

TABLE I. RESULTS OF THE EXAMINATION OF SAMPLES OF MILK OBTAINED FROM 57 FARMS SITUATED IN THE AREA XXI. M.

References to maps: 50 Mile Area No.	Farm No.	1896–1900	1901	1902	1903	1904	1905	1906	1907	Railway Samples: Total	Railway Samples: +	Farm Samples: Total	Farm Samples: +	No. of Cows on Tuberculous Farms	No. of Cows on All Farms
89.49	1			OO			O	O		4					22
	2 A B	+		O				O	O	4	1			14	14
" 50	1	O	O	OO	OO	O	OO	+/OO +/+ O	O	13	2	3	1	30	30
	2						O	O		2					14
	3	O	O	OOO	O	OO	O	O	OO	12					19
	4	+/OOO+OO	O F	+O	O		O		O	7	2	6	1	24	24
	5	O+/+ /O	+/O+OO O	OOO	O+/+	O	O	OO		14	4	6	2	12	12
" 51	1	O		O	O		O	O	OOO	8					12
	2 A B	O					O	+/++	O	4	1	2	2	8	8
	3 A B	O					O			2					25
" 52	1	OOOO	OO	+/+O	OO	OO	O	OO+/OOO	O	16	2	5	1	27	27
	2	O	O	OO	OO			O	OO	9					12
	3			OO	O		O	O		5					12
82.49	1	O								1					10
	2						O	O	O	4					9
	3	OOO	OO	O						6					10
	4	++/O+OO	OO	OO	+/O O		+/+O		O	10	4	7	2	27	27
" 50	1	O								1					14
	2	O								1					10
	3	O	O	O/OO O			O			5		2			14
	4	OO	O							3					14
	5	O	O	O						3					23
51	1				O+/+		O	O	O	5	1	1	1	34	34
	2	O		+/O						2	1	1		18	18
	3	+OO	OO	O	OO	O	O	OO	O	13	1			17	17
	4						O			1					12
	5							OO		2					13
	6	O								1					10
" 52	1 A B	+O	O	O+/O+	OO			+/OO+ OO	O	11	3	5	2	18	18
	2			OO	O		O		O	5					12
	3	O								1					10
	4	O	OO	OO		OO	O	O		9					20
	5	OO		+ /+O OO	OO		O	O	O	10	1	2	1	12	12
83.49	1		O							1					8
	2	+/F + /+O								2	2	2	1	13	13
" 50	1			OO	OO	O		O	OOO	9					13
	2	OOO	O							4					17
	3	O			O		O			3					14
	4						O			1					17
	5							O	O	2					13
	6						O			1					10
" 51	1						O		O	2					19
	2	O	OO		O	O	O	O	O	8					15
" 52	1				OO					2					13
	2							O		1					22
84.49	1	O	O	OO	OO		O	O	OO	10					25
" 50	1	OOOO	O	OOO	OO	OO	O	O	OOO	17					18
	2 A B	O	OO	O+/+O	OOOO	OO	OOOO	O	OO	18	1	2	1	16	16
	3		O		O	+/O +/OOO OO	O	+/O+O O		9	3	7	1	23	23
	4 A B	O	O	O	O	OO	O		O	8					28
" 51	1	O	O				O			3					20
	2						O			1					30
	3	OOO	O	O	O	OO	O	+/O+ OO	OOO	15	1	2	1	61	61
	4	OO	F +/++ O	O	O	O+/OO O		O	O	12	3	4	2	38	38
" 52	1							O	O	2					14
	2								O	1					20
	3								OO	2					18
TOTALS FARMS	57	O — 29; + — 7	O — 23; + — 3	O — 21; + — 6	O — 22; + — 3	O — 12; + — 2	O — 32; + — 1	O — 23; + — 6	O — 28; + — 0	328	33	57	19	392	1022

For explanation of signs see opposite.

had produced



MANCHESTER MILK SUPPLY.
MAP No. II. Scale 8 Miles to 1 inch.
(1896 to 1903)
Prepared by Sheridan Delépine, Director of the Public Health Laboratory, University of Manchester.
The map is divided into 16 Square Mile areas and smaller 1 Square Mile areas indexed by letters & numbers
IV to XXXIII Horizontal 4 Miles. Zones, numbered from North to South.
13 to 132 1 Mile
A to Z. Vertical 4 Miles West to East.
1 to 108 1 Mile
The districts in which farms supplying Milk tested at the Laboratory are shown by the following signs.
Square mile areas with one or more farms tested between 1896 and 1908
Square mile areas with one or more farms tested during the years 1897 to 1903 inclusive, and in which no tuberculous farm was found during that period.
Square mile areas with one or more farms tested during the years 1897 to 1903 inclusive and in which one or more tuberculous farms were found during that period.
Towns used as landmarks to indicate the positions of the districts the name of these towns is given below against the No. of reference attached to each town.
LANCASHIRE
1. Lancaster 2. Fleetwood 3. Garstang 4. Clitheroe 5. Blackpool 6. Nelson 7. Burnley 8. Preston 9. Blackburn 10. Accrington 11. Darwen 12. Southport 13. Chorley 14. Rochdale 15. Formby 16. Ormskirk 17. Bolton 18. Bury 19. Wigan 20. Manchester 21. Oldham 22. Liverpool 23. Warrington
CHESHIRE
1. Birkenhead 2. Stockport 3. Knutsford 4. Macclesfield 5. Chester 6. (Delamere Forest) 7. Congleton 8. Crewe 9. Nantwich
MONTGOMERYSHIRE
1. Welshpool
SHROPSHIRE
1. Whitchurch 2. Oswestry 3. Shrewsbury
DERBYSHIRE
1. Chapel-en-le-Frith 2. Buxton 3. Bakewell 4. Chesterfield 5. Derby
STAFFORDSHIRE
1. Tunstall 2. Burslem 3. Newcastle-under-Lyme 4. Hanley 5. Stoke-upon-Trent 6. Uttoxeter 7. Stafford 8. Burton-upon-Trent 9. Wolverhampton
YORKSHIRE
1. Hellifield 2. Bradford 3. Leeds 4. Halifax 5. Huddersfield 6. Barnsley 7. Sheffield
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z AA
IV V VI VII VIII IX X XI XII XIII XIV XV XVI XVII XVIII XIX XX XXI XXII XXIII XXIV XXV XXVI XXVII XXVIII XXIX XXX XXXI XXXII XXXIII
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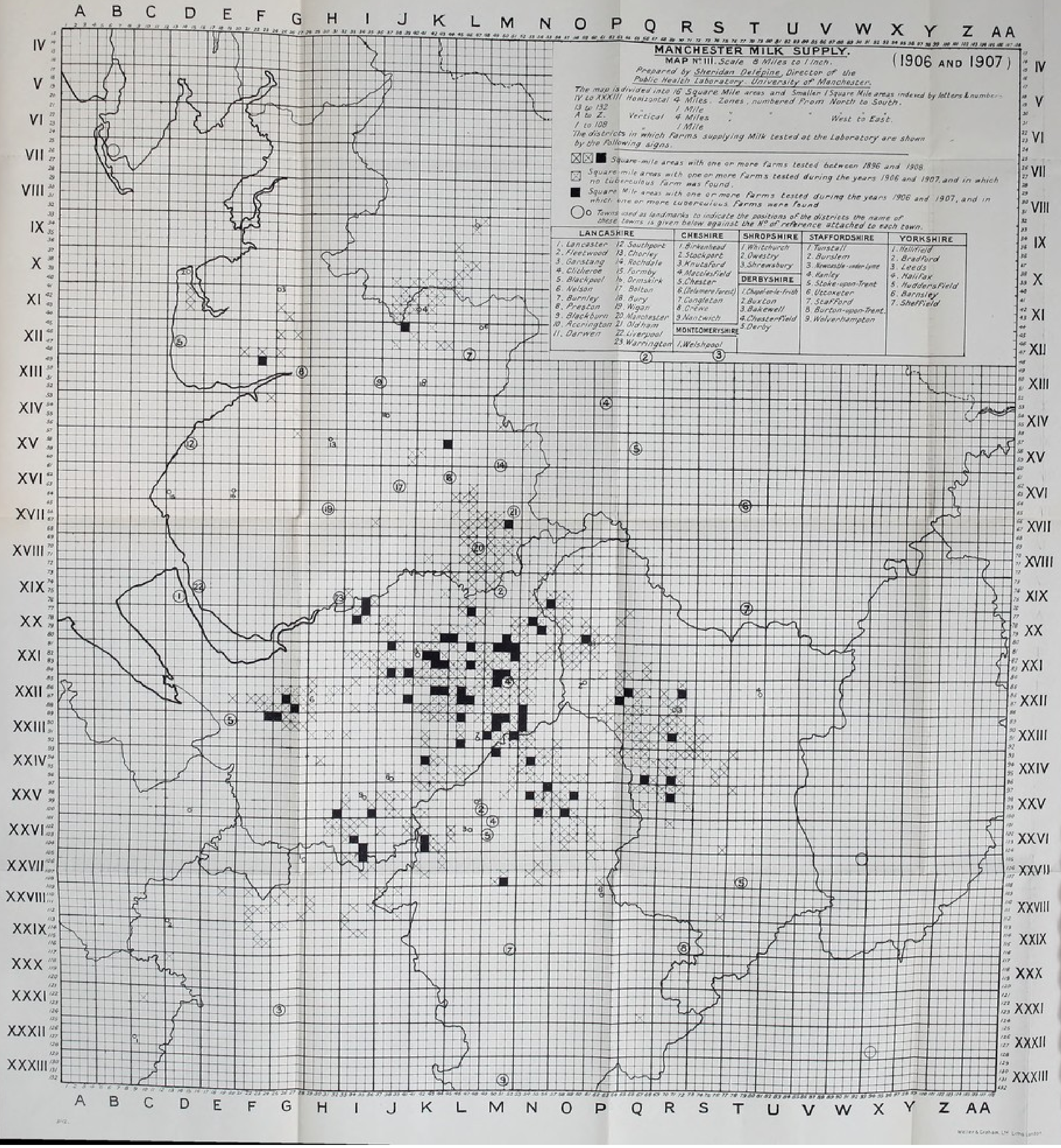
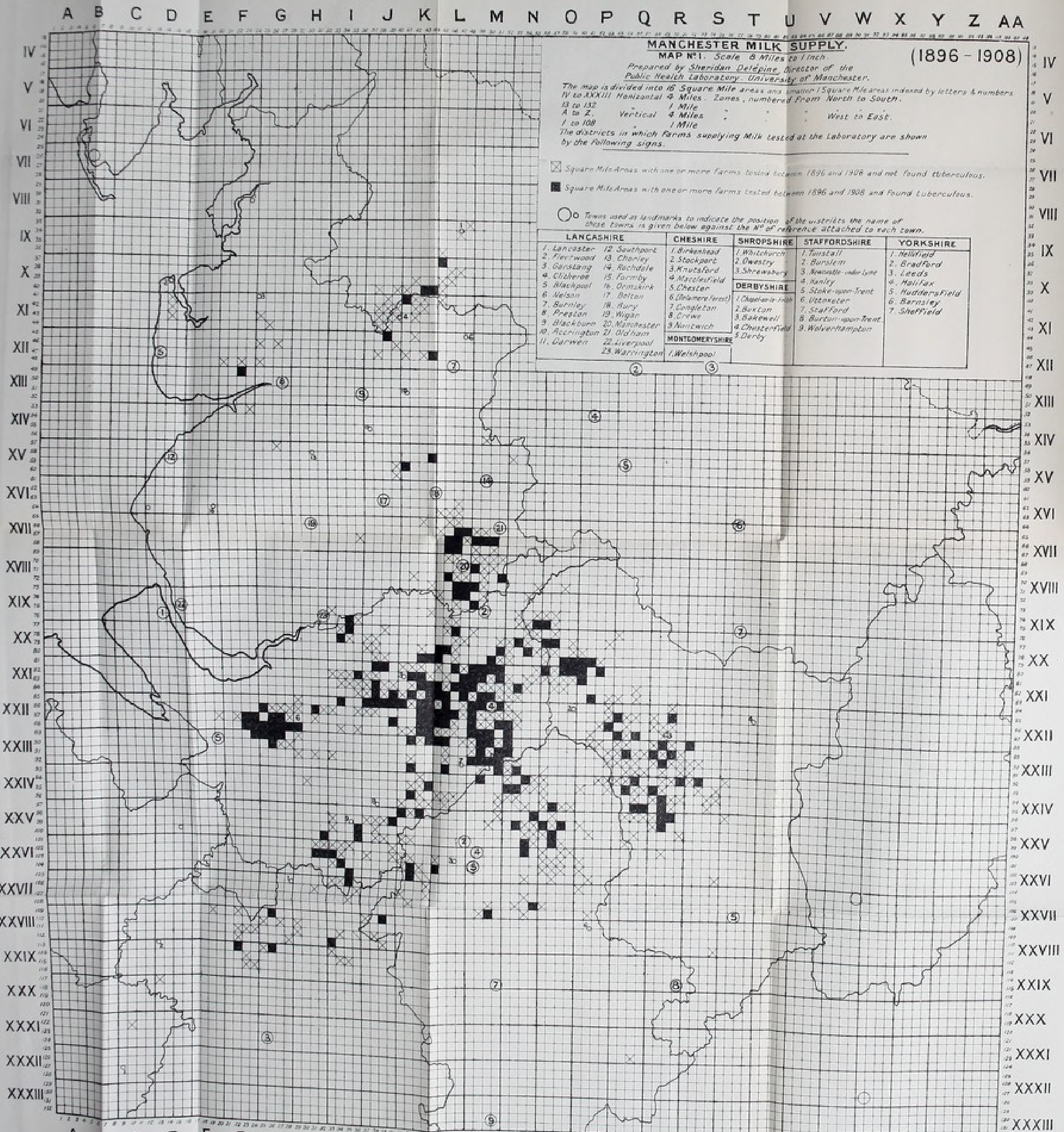

MANCHESTER MILK SUPPLY.
MAP No. III. Scale 8 Miles to 1 Inch.
(1906 AND 1907)
Prepared by Sheridan Delépine, Director of the Public Health Laboratory. University of Manchester.
The map is divided into 16 Square Mile areas and Smaller 1 Square Mile areas indexed by letters & numbers
IV to XXXIII Horizontal 4 Miles. Zones, numbered From North to South.
13 to 132 " 1 Mile
A to Z. Vertical 4 Miles " " " West to East.
1 to 108 " 1 Mile
The districts in which Farms supplying Milk tested at the Laboratory are shown by the Following signs.
Square-mile areas with one or more farms tested between 1896 and 1908
Square-mile areas with one or more Farms tested during the years 1906 and 1907, and in which no tuberculous farm was found.
Square Mile areas with one or more Farms tested during the years 1906 and 1907, and in which one or more tuberculous Farms were found
Towns used as landmarks to indicate the positions of the districts the name of these towns is given below against the No. of reference attached to each town.
LANCASHIRE
1. Lancaster
2. Fleetwood
3. Garstang
4. Clitheroe
5. Blackpool
6. Nelson
7. Burnley
8. Preston
9. Blackburn
10. Accrington
11. Darwen
12. Southport
13. Chorley
14. Rochdale
15. Formby
16. Ormskirk
17. Bolton
18. Bury
19. Wigan
20. Manchester
21. Oldham
22. Liverpool
23. Warrington
CHESHIRE
1. Birkenhead
2. Stockport
3. Knutsford
4. Macclesfield
5. Chester
6. (Delamere forest)
7. Congleton
8. Crewe
9. Nantwich
MONTGOMERYSHIRE
1. Welshpool
SHROPSHIRE
1. Whitchurch
2. Oswestry
3. Shrewsbury
DERBYSHIRE
1. Chapel-en-le-frith
2. Buxton
3. Bakewell
4. Chesterfield
5. Derby
STAFFORDSHIRE
1. Tunstall
2. Burslem
3. Newcastle-under-Lyme
4. Hanley
5. Stoke-upon-Trent
6. Uttoxeter
7. Stafford
8. Burton-upon-Trent.
9. Wolverhampton
YORKSHIRE
1. Hellifield
2. Bradford
3. Leeds
4. Halifax
5. Huddersfield
6. Barnsley
7. Sheffield
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z AA
IV V VI VII VIII IX X XI XII XIII XIV XV XVI XVII XVIII XIX XX XXI XXII XXIII XXIV XXV XXVI XXVII XXVIII XXIX XXX XXXI XXXII XXXIII


MANCHESTER MILK SUPPLY.
MAP No. 1. Scale 8 Miles to 1 Inch.
(1896 - 1908)
Prepared by Sheridan Delépine, Director of the Public Health Laboratory. University of Manchester.
The map is divided into 16 Square Mile areas and smaller 1 Square Mile areas indexed by letters & numbers
IV to XXXIII Horizontal 4 Miles. Zones, numbered from North to South.
13 to 132 " 1 Mile
A to Z. Vertical 4 Miles " " " West to East.
1 to 108 " 1 Mile
The districts in which farms supplying Milk tested at the Laboratory are shown by the following signs.
Square Mile Areas with one or more farms tested between 1896 and 1908 and not found tuberculous.
Square Mile Areas with one or more farms tested between 1896 and 1908 and found tuberculous.
Towns used as landmarks to indicate the position of the districts the name of these towns is given below against the No. of reference attached to each town.
LANCASHIRE
1. Lancaster
2. Fleetwood
3. Garstang
4. Clitheroe
5. Blackpool
6. Nelson
7. Burnley
8. Preston
9. Blackburn
10. Accrington
11. Darwen
12. Southport
13. Chorley
14. Rochdale
15. Formby
16. Ormskirk
17. Bolton
18. Bury
19. Wigan
20. Manchester
21. Oldham
22. Liverpool
23. Warrington
CHESHIRE
1. Birkenhead
2. Stockport
3. Knutsford
4. Macclesfield
5. Chester
6. (Delamere Forest)
7. Congleton
8. Crewe
9. Nantwich
MONTGOMERYSHIRE
1. Welshpool
SHROPSHIRE
1. Whitchurch
2. Oswestry
3. Shrewsbury
DERBYSHIRE
1. Chapel-en-le-Frith
2. Buxton
3. Bakewell
4. Chesterfield
5. Derby
STAFFORDSHIRE
1. Tunstall
2. Burslem
3. Newcastle-under-Lyme
4. Hanley
5. Stoke-upon-Trent
6. Uttoxeter
7. Stafford
8. Burton-upon-Trent
9. Wolverhampton
YORKSHIRE
1. Hellifield
2. Bradford
3. Leeds
4. Halifax
5. Huddersfield
6. Barnsley
7. Sheffield

In Table II. I have attempted to give a synoptical summary of the number of farms, number of cows, and percentage of cows the milk of which was rendered infectious by the presence of tubercle bacilli. Each of the squares in this table represents a 16-square-mile area. In each square the number of farms is given in the left upper angle, the total number of cows in those farms in the right upper angle, the number of cows, the milk of which was infected, per cent of the total number of cows on the inspected farms, is given below the other two numbers. This synopsis shows that tuberculosis was very widely distributed, but was very much more prevalent in certain limited districts than in others. This table refers to the Manchester milk supply only.

E.—Distribution of tuberculous farms.

Map I. shows the extent of the area (2,096 square miles) from which Manchester draws its milk supply. Each square mile area in which one or more tuberculous farms have been found during the 11 years is marked black.

Map II. shows the areas containing farms which were inspected before 1903, and the number found tuberculous.

Map III.; the areas containing farms which were inspected during the years 1906 and 1907 and those found tuberculous. In each of these maps the areas inspected are indicated, and those in which one or more tuberculous farms have been discovered are black. Several years have been grouped in order to obtain periods during which most of the farms in each district have been inspected. These maps demonstrate the considerable reduction that has taken place in the number of areas in which dangerous cows have been found during the 11 years.

F.—Number of tuberculous farms and cows in various regions and in various years.

To obtain this information I have divided the whole supply area into 11 latitudinal zones, defined in Table III. which gives in a condensed form the results analysed in the long tables not published in this report, but of which a small section has been reproduced in Table I.

(*a*) *Number of farms tested and found tulerculous during the 11 years.*

During the whole period of 11 years 1,385 farms have been tested. Of these 294 have been found to send tuberculous milk to Manchester on one or more occasions. In other words 21·2 per cent. of the farms supplying Manchester during the 11 years have, *at one time or another*, supplied tuberculous milk. It is difficult to estimate for how long the supply was infected each time that the presence of tubercle bacilli in the milk was detected, so that it is not possible to calculate exactly the amount of tuberculous milk sent to Manchester by these farms, but the amount must have been considerable.

(*b*) *Presence of cows with tuberculous udders on tuberculous farms.*

Of these 294 farms, 276 have been inspected once or several times during the period, and in 190 (or 68·4 per cent.) of the inspected farms the cow or cows to which the infection of the milk was due have

TABLE II.

Number of farms, number of cows on these farms, with the number of cows the milk of which was found to be infected with tubercle bacilli, in each of the 16-square-mile areas.

—	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	N.	O.	P.	Q.	R.	S.	T.
IX.									3/45 0								
X.							2/47 0	5/86 42·9	**11/198 6**								
XI.	3/65 0			3/65 0			**12/266 0**	**13/288 3·7**	2/41 0								
XII.			2/27 0	3/62 0			6/120 15·8	4/82 32·8									
XIII.			1/48 100														
XIV.			1/20 0							1/10 0							
XV.				1/13 0			5/72 0	5/130 30			1/20 0						
XVI.									4/59 0								
XVII.						1/12 0		1/13 0	**54/901 20**	**21/295 13·5**							
XVIII.								2/30 0	**25/468 27·3**	**37/441 13·6**	1/9 0	1/12 0					

XX.						**9/153 19·5**	**7/174 0**	**10/155 35·1**	**23/401 34·1**	**11/175 44·5**	**21/341 18·4**	**23/392 17**	**11/155? 33·5?**	2/20? 0			
XXI.						**16/334 12·8**	**24/567 46·3**	**47/982 29·1**	**36/668 32·9**	**57/1022 38·3**	**18/277 6·1**	**27/444 21·8**	**17/277 31·7**	3/43 0			
XXII.		1/45 0	**18/560 53·9**	**36/981 41·7**	**9/230 43·2**	**6/191 17·2**	**13/239 61·5**	**28/515 48·9**	**50/1077 38·4**	**36/762 40·8**	**19/284 11·6**		**9/153 7·1**	**22/337 28·4**	**11/208 18·2**		
XXIII.			2/52? 80·7?	**12/324 62**	3/56 0	1/48 0		9/137? 48·9?	**10/218 23·3**	**45/1030 43·6**	**17/256 28·5**		6/78 0	**25/400 15**	**29/549 35·5**	8/111 13·5	
XXIV.					1/120 0			**14/290 38·6**	8/139 0	6/95 21	**21/409 27·1**	**15/288 8·3**	5/91 0	**22/460 33**	**31/555 22·7**	**9/154 29·8**	1/10 0
XXV.					1/44 100	**6/154 42·2**	**12/239 66·9**	7/144 32·6		3/46? 0	**16/321 24·6**	**16/266 37·5**	2/49 0	6/99 0	**16/326 25·1**		1/12 0
XXVI.					**7/218 29·8**	**12/315 45**	3/39 0	**13/295 14·6**	2/54 97·4		4/73 31·5	**12/195 0**	3/45 0		1/30 0		1/10? 0
XXVII.					1/9 0	**8/302 35**		4/104 0		5/101 19·8	4/122? 56·5?	3/74 0	2/42 0				
XXVIII.		1/24 0	5/136 0	4/83 14·4	2/37 0	3/94 40·4										4/135 31·1	
XXIX.																	
XXX.								*a b* *c*									

a/b *c*	Explanation of the arrangement of the figures in each square:—

(*a*) Number of farms tested in each 16-square-mile area.
(*b*) Total number of cows in these farms.
(*c*) Number of cows, the milk of which was infected at one time or another, per cent. of the total number.
(The dark figures are in squares in which more than 150 cows were housed.)

been found. All these cows had tuberculous udders. After the elimination of these cows the milk of the farm almost invariably lost its infective properties. In 86 (or 31·6 per cent.) of the farms inspected the infecting cow had not been found up to the end of 1907.* This was in many cases proved to have been due (as I will show later) to removal of a diseased cow. The testing of samples and inspection have generally had the effect of causing the rapid disappearance of tubercle bacilli from the milk, *even when the diseased cows have escaped discovery.*

(*c*) *Number of cows on infected farms and amount of milk tested.*

The number of cows kept in the 1,385 farms was about 27,032, or an average of 19·5 per farm for the 11 years. The number of cows in farms the mixed milk of which was found to produce tuberculosis was 7,669. This figure is based upon data collected by the Veterinary Surgeons, at the time of their visits to infected farms, and may be accepted as accurate for all practical purposes.

The milk of 28·3 per cent. of all the cows supplying milk to Manchester has therefore *at one time or another* contained enough tubercle bacilli to produce tuberculosis in experimental animals. This figure is obviously not applicable to any single year.

(*d*) *Number of tuberculous farms at various times during the 11 years.*

In comparing various periods it was necessary to deal with a fairly large number of cows for each period. In order to get figures of comparable magnitude I have been obliged to group together all the farms tested during the years 1896 to 1900. The number of farms tested in each of the years 1896, 1897, 1898 was too small to reduce sufficiently the effects of hazard, and permit the results obtained during each of these years to be compared with those obtained in the following years. The actual state of the farms in 1896 was worse than the figures relating to the four years 1896 to 1900 indicate. (Samples of mixed milk were not examined during 1899.)

The number of farms tested and found tuberculous between 1896 and 1908 was as follows :—

Year.	Number of farms tested.	Number of farms tuberculous.	Number of farms tuberculous per cent. of farms tested.
1896–1900 (four years)	427	72	16·8
1901	368	44	11·9
1902	348	41	11·7
1903	339	44	12·9
1904	331	38	11·4
1905	571	48	8·4
1906	555	48	8·6
1907	549	40	7·2

The number of tuberculous farms has therefore been reduced by more than one-half.

* The infecting cows were in a few cases found during the year 1908. *See* page 406.

TABLE III.—MANCHESTER MILK SUPPLY 1896–1908.

Farms tested each year at the Laboratory by the examination of samples of milk collected at railway stations or at the farms found to supply tuberculous milk.

Latitudinal Zones from North to South. Each roman figures indicates one of the 4 miles broad latitudinal zones. Each capital letter indicates a 16-square-mile area. (*See* Maps.)	Area in square miles over which the farms are spread.	1896–1900. Farms tested for the 1st time. Total No. tested.	1896–1900. No. found tuberculous.	1901. Farms tested for the 1st time. No.	1901. No. found tuberculous. +	1901. Total No. of farms tested during the period. Total No	1901. No. found tuberculous. +	1902. Farms tested for the 1st time. No. tested.	1902. No. tuberculous. +	1902. Total No. of farms tested. No. tested.	1902. No. tuberculous. +	1903. Farms tested for the 1st time. No. tested.	1903. No. tuberculous. +	1903. Total No. of farms tested. No. tested.	1903. No. tuberculous. +	1904. Farms tested for the 1st time. No. tested.	1904. No. tuberculous. +	1904. Total No. of farms tested. No. tested.	1904. No. tuberculous. +	1905. Farms tested for the 1st time. No. tested.	1905. No. tuberculous. +	1905. Total No. of farms tested. No. tested.	1905. No. tuberculous. +	1906. Farms tested for the 1st time. No. tested.	1906. No. tuberculous. +	1906. Total No. of farms tested. No. tested.	1906. No. tuberculous. +	1907 (a few 1908). Farms tested for the 1st time. No. tested.	1907 (a few 1908). No. tuberculous. +	1907 (a few 1908). Total No. of farms tested. No. tested.	1907 (a few 1908). No. tuberculous. +	Summary of results during the 12 years 1896 to 1908. Farms tested or inspected. Total No. of farms.	Farms found to supply tuberculous milk. No. of tuberculous farm.	Tuberculous farm per cent. of total.	Total farms inspected. No.	No. in which tuberculous udder found.	Per cent.	Number of cows in farms tested. Total No. (average No. of cows per farm is given below the total No.).	No. of cows on farms supplying tuberculous milk.	Per cent.	Total No. of samples tested at the Laboratory.
IX. L ... ... / X. J, K, L ... ... / XI. D, G, K, L ... ... / XII. F, G, J, K	192	5	—	0	—	0	—	11	1	11	1	4	—	8	—	12	3	18	3	13	1	30	1	17	—	39	—	7	—	39	1	69	6	8·6	6	3	50·0	1,392 (20·15)	105	7·5	190
XIII. F ... ... / XIV. F, M ... ... / XV. G, J, K, N ... ... / XVI. L ... ... / XVII. I, K, L, M	192	55	8	2	—	19	1	0	—	2	—	3	—	3	—	4	—	5	1	13	—	18	1	15	1	22	2	4	—	20	1	96	14	14·5	14	9	64·2	1,593 (16·59)	313	19·6	209
XVIII. K, L, M, N, O ... / XIX. I, K, L, M, N, O ...	176	44	9	3	—	14	3	2	1	4	1	1	—	2	—	9	1	10	1	28	1	34	2	6	1	16	2	2	—	8	—	95	15	15·7	15	11	73·3	1,439 (15·4)	334	23·2	196
XX. I, J, K, L, M, N, O, P, Q ...	144	30	8	18	2	33	5	6	1	30	4	5	—	17	—	4	—	19	1	33	3	60	8	14	—	55	4	7	1	51	8	117	27	23·0	26	13	50·0	1,966 (16·8)	483	24·5	485
XXI. I, J, K, L, M, N. O, P, Q ...	144	81	14	21	3	71	10	19	—	73	9	26	2	86	9	15	3	59	10	52	4	147	9	14	1	120	12	17	—	135	5	245	57	23·2	50	38	76·0	4,614 (18·8)	1,417	30·4	1,266
XXII. E, F, G, H, I, J, K, L, M, N, O, P, Q, R.	224	105	18	34	3	94	11	26	2	91	8	18	4	87	20	21	3	92	11	23	4	125	17	21	—	111	8	10	—	105	8	258	76	29·5	73	49	67·1	5,582 (21·6)	2,162	38·3	1,326
XXIII. F, G, H, I, K, L, M, N, P, Q, R, S.	192	40	6	29	4	58	8	23	7	57	9	20	2	58	4	17	1	57	8	17	1	66	5	9	1	55	6	12	2	64	9	167	44	26·3	39	25	64·1	3,259 (19·5)	1,154	38·4	709
XXIV. H, K, L, M, N, O, P, Q, R, S, T.	176	28	3	25	3	38	4	18	1	38	3	14	—	48	5	15	1	41	3	10	—	42	2	16	—	59	4	7	1	50	2	133	20	15·0	19	13	68·4	2,611 (19·6)	591	22·6	460
XXV. H, I, J, K, M, N, O, P, Q, R, T.	176	21	3	11	—	18	—	3	1	10	1	6	3	14	4	9	—	14	—	5	—	18	1	21	4	42	7	10	—	33	2	86	16	18·5	15	11	73·3	1,700 (19·7)	432	25·4	251
XXVI. H, I, J, K, L, N, O, P, R, S	160	10	3	9	—	11	—	7	1	13	1	10	1	13	2	2	—	10	—	11	1	25	2	3	1	23	2	6	—	27	2	58	10	17·2	10	9	90·0	1,274 (21·9)	325	25·5	179
XXVII. H, I, K, M, N, O, P ... / XXVIII. E, F, G, H, I, J, S ... ... / XXIX. F, G, I ... ... / XXX. XXXI. D, C, Q	112 / 112 / 48 / 48	8	—	9	1	12	2	16	3	19	4	2	—	3	—	3	—	6	—	4	—	6	—	9	—	13	1	10	1	17	2	61	9	14·7	9	9	100·0	1,602 (26·2)	353	22·0	117
Totals for the whole area supplying milk to Manchester.	2,096	427	72	161	16	368	44	131	18	348	41	109	12	339	44	111	12	331	38	209	15	571	48	145	9	555	48	92	5	549	40	1,385	294	21·2	276	190	68·8	27,032 (19·5)	7,669	28·3	5,388
No. of tuberculous farms per cent. of farms inspected during each yearly period.		16·8		9·9		11·9		13·8		11·7		11·0		12·9		10·8		11·4		7·1		8·4		6·2		8·6		5·4		7·2		Samples about which full particulars could not be obtained.									45
No. of farms that had been previously inspected and No. of those found tuberculous.						207	28			217	23			230	32			220	26			362	33			410	39			457	35	Total No. of samples tested for the Manchester Authority.									5,443
Percentage of tuberculous farms in this group.						13·5				10·5				13·9				11·7				9·1				9·5				7·6											

(*e*) *Recurrence of infection on certain farms.*

The infected farms have required close supervision. In Table IV. I have arranged the results of the tests in two groups so as to show first, the proportion of tuberculous farms among those tested for the first time each year; second, the results obtained in connection with farms which had been previously tested. The second group includes, therefore, all the farms which had to be frequently inspected because they had been found badly infected, or appeared specially liable to infection.

The *first group* contains (*a*) all the farms tested for the first time between 1896 and 1900 when things were at their worst; (*b*) farms tested for the first time after 1900 when farmers had become acquainted with the work done by the Corporation.

It will be seen that after excluding the results of the first years of inspection, the proportion of tuberculous farms has generally been a little higher among the farms previously inspected than among the farms inspected for the first time. In both groups a very marked and steady improvement is clearly shown.

TABLE IV.

Manchester Milk Supply, 1896–1908.

Farms tested each year.—1. Tested for the first time; 2. tested again after having been previously tested.

(In each case the actual number of farms found to supply tuberculous milk is given, as well as the number of tuberculous farms per cent. of the number of farms tested.)

—	First group.			Second group.		
	Farms tested for the first time.			Farms previously tested.		
	Number of farms tested.	Number found tuberculous.	Per cent.	Number of farms retested each year.	Number found tuberculous.	Per cent.
1896–1900	427	72	16·8	—	—	—
1901	161	16	9·9	207	28	13·5
1902	131	18	13·8	217	23	10·5
1903	109	12	11·0	230	32	13·9
1904	111	12	10·8	220	26	11·7
1905	209	115	7·1	362	23	9·1
1906	145	9	6·2	410	39	9·5
1907	92	5	5·4	457	35	7·6
	1,385	159	11·4	—	—	—

Total number of tests following a first test	2,103
„ „ first tests...	1,385
„ „ times the 1,385 farms were tested among them ...	3,488
Number of times farms were found tuberculous	291

(g.) *Unequal distribution of tuberculosis.*

A notable feature relating to the distribution of tuberculosis is brought out by Table III., as well as by Maps I., II., and III.

Tuberculosis is most prevalent in Zone XXII., which includes a large proportion of Cheshire farms and a comparatively small number of Derbyshire farms. *North of this zone* the proportion of tuberculous farms, though lower, is still high in Zones XXI. and XX., in which the farms are mostly Cheshire farms. Further north the proportion of tuberculous farms becomes much smaller, until in districts north of Burnley the percentage of tuberculous farms is reduced to less than one-third of that recorded in connection with Zone XXII. *South of Zone XXII.* there is also a marked reduction in the proportion of tuberculous farms, notwithstanding the fact that there are a few badly infected areas, but these are limited in extent. The reduction is not so marked as in the north. Mr. Brittlebank has informed me that in the districts where tuberculosis is most prevalent, there are many old farms, that much of the cattle is bred on the premises, and that the proportion of old cows is great.

In my opinion, based upon a considerable amount of evidence, these conditions favour infection and the extension of tuberculous lesions to the udder; possibly they are sufficient to account for the frequent infection of the milk in these districts.

(h.) *Gross results of the examination of samples of milk.*

To complete this brief statement I have prepared tables giving the results of the examination of milk coming to Manchester from various counties. The fact that an equal number of samples of the milk supplied by each farm has not been taken each year does not appear to affect the main results, which are in close agreement with those I have previously recorded regarding the number of tuberculous farms.

Mixed milk arriving in Manchester from various counties between 1897 *and* 1908, *showing for each year number of samples examined, number found tuberculous, and percentage.*

(4,380 *samples taken at railway stations.*)

County.	1897.			1898.			1900.			1901.			1902.			1903.			1904.			1905.			1906.			1907.			1908.			Total.		
	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tu erculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.
Cheshire	40	4	10·0	59	12	20·3	228	32	14·0	277	32	11·5	248	25	10·0	296	37	12·5	256	26	10·1	487	47	9·6	397	30	7·5	461	30	6·5	4	—	—	2,753	275	9·9
Derbyshire	2	2	100·	5	1	20·	82	3	3·5	103	5	4·8	126	9	7·1	82	7	8·5	103	13	12·6	125	6	4·0	111	6	5·4	83	3	3·6	1	—	—	823	55	7·5
Staffordshire.. ..	—	—	—	—	—	—	40	4	10·	47	2	4·2	32	1	3·2	39	6	15·3	37	1	2·7	56	4	7·1	109	8	7·3	91	8	8·9	2	—	—	453	34	7·5
Lancashire	1	—	—	—	—	—	4	1	25·0	2	—	—	8	1	12·5	11	1	9·0	15	1	6·6	70	2	2·8	54	2	3·7	57	2	3·5	1	—	—	223	10	4·5
Yorkshire	—	—	—	—	—	—	2	—	—	—	—	—	4	—	—	1	—	—	11	2	18·1	15	1	6·6	25	—	—	23	—	—	2	—	—	83	3	3·6
Shropshire	—	—	—	—	—	—	2	—	—	11	4	36·3	6	2	33·3	1	—	—	3	—	—	3	—	—	8	1	12·5	7	—	—	—	—	—	41	7	17·0
Wales and various..	2	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	4	—	—
Totals	45	6	13·3	65	13	20·0	358	40	11·1	440	43	9·7	424	38	8·9	430	51	11·8	425	43	10·1	757	60	7·9	704	47	6·6	722	43	5·9	10	—	—	4,380	384	8·7

Table V. shows :—

1st. *The actual number of samples of mixed milk examined yearly.* (These samples represent closely the milk actually supplied to the Manchester consumers.)

2nd. *The counties* from which the milk came.

3rd. The *number of samples found tuberculous.*

The number of samples examined during each of the years 1897 and 1898 is unfortunately too small for comparison. By throwing these two years together one gets a total of 110 samples, 19 of which were tuberculous, *i.e.*, 17·2 per cent.

No mixed samples were taken in 1899. The percentage of tuberculous samples for each of the 10 years is as follows :—

	Per cent.
1897–1898	17·2
1900	11·1
1901	9·7
1902	8·9
1903	11·8
1904	10·1
1905	7·9
1906	6·6
1907	5·9

It will be noticed that these figures agree closely with those relating to the number of tuberculous farms during the same periods. The reduction in the amount of tuberculous milk supplied to Manchester can therefore be fairly attributed to the reduction in the number of tuberculous farms. I have previously shown that the reduction in number of farms producing tuberculous milk was mostly, if not entirely, due to the *elimination of cows with tuberculous udders.*

Table V. also shows that the great bulk of the Manchester milk supply comes from Cheshire, and that the proportion of tuberculous samples was greatest in connection with that county. There has, however, been a great improvement in the milk coming from that source.

Table VI. deals with samples of unmixed milk. This table shows that of the 940 samples taken from udders which were thought by the veterinary surgeon to be possibly tuberculous, only 242 yielded milk capable of producing tuberculosis. This fact is particularly significant and should not be lightly dismissed.

TABLE VI.

Unmixed milk taken at the farms from cows with suspected udders.

(940 *samples.*)

County.	1896.			1897.			1898.			1899.			1900.			1901.			1902.		
	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.
Cheshire ..	—	—	—	—	—	—	—	—	—	—	—	—	86	23	26·7	85	23	25·9	59	20	33·8
Derbyshire..	—	—	—	—	—	—	—	—	—	—	—	—	12	1	8·3	12	2	16·6	16	7	43·7
Staffordshire	—	—	—	—	—	—	—	—	—	2	—	—	13	3	23·0	10	1	10·0	1	1	100·
Lancashire..	7	—	—	17	3	17·6	3	—	—	17	3	17·6	31	4	12·9	55	7	12·7	5	1	20·
Yorkshire ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Shropshire..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	1	25·0	14	3	21·4
Various ..	—	—	—	2	2	100·	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals ..	7	—	—	19	5	26·3	3	—	—	19	3	15·7	142	31	21·8	166	34	20·4	95	32	33·6

County.	1903.			1904.			1905.			1906.			1907.			1908.			Totals.		
	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.
Cheshire ..	47	20	42·5	53	10	18·8	75	21	28·0	83	25	30·1	72	19	26·3	3	—	—	563	161	28·5
Derbyshire..	11	4	36·3	20	5	25·0	17	1	5·8	19	3	15·7	6	2	33·3	—	—	—	113	25	22·1
Staffordshire	9	4	44·4	—	—	—	7	3	42·8	18	4	22·2	18	7	38·8	—	—	—	78	23	29·4
Lancashire..	1	—	—	8	2	25·	7	2	28·5	5	1	20·	3	1	33·3	—	—	—	159	24	15·0
Yorkshire ..	—	—	—	4	1	25·0	2	1	50·0	—	—	—	—	—	—	—	—	—	6	2	33·3
Shropshire..	—	—	—	—	—	—	—	—	—	—	—	—	1	1	100·	—	—	—	19	5	26·3
Various ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	100·
Totals ..	68	28	41·1	85	18	21·1	108	28	25·9	125	33	26·4	100	30	30·0	3	—	—	940	242	25·7

In Table VII. *the total number of samples collected at the railway stations or at the farms is given with the results* of the examination. This table is given to facilitate the comparison of the results obtained in connection with the Manchester supply with those obtained in connection with other supplies as recorded in Table VIII.

TABLE VII.

General summary of the results of the examination of all the samples of milk received from the Manchester authority between 1896 *and* 1908.

—	1896.			1897.			1898.			1899.			1900.		
	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.
Railway samples	—	—	—	45	6	13·3	65	13	20·0	—	—	—	358	40	11·1
Farm samples...	—	—	—	—	—	—	38	5	13·1	44	3	6·8	12	6	50·0
Individual cows samples.	7	—	—	19	5	26·3	3	—	—	19	3	15·7	142	31	21·8

TABLE VII.—*continued.*

—	1901.			1902.			1903.			1904.			1905.		
	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.
Railway samples	440	43	9·7	424	38	8·9	430	51	11·8	425	43	10·1	757	60	7·9
Farm samples...	23	4	17·3	1	—	—	—	—	—	1	—	—	1	1	100·
Individual cows samples.	166	34	20·4	95	32	33·6	68	28	41·1	85	18	21·1	108	28	25·9

TABLE VII.—*continued.*

—	1906.			1907.			1908.			Totals.		
	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.	Total number of samples examined.	Number tuberculous.	Per cent.
Railway samples	704	47	6·6	722	43	5·9	10	—	—	4,380	384	8·7
Farm samples...	3	2	66·6	—	—	—	—	—	—	123	21	17·0
Individual cows samples.	125	33	26·4	100	30	30·0	3	—	—	940	242	25·7
Total ...	...	...	...	...	...	..	...	...	...	5,443	—	—

TABLE

General Summary of the results of the examination of samples of
from various authorities

—	Total number of farms tested.	Number found tuberculous.		1896–1900.			1901.			1902.			1903.		
				Total number examined.	Number tuberculous.	Per cent.	Total number examined.	Number tuberculous.	Per cent.	Total number examined.	Number tuberculous.	Per cent.	Total number examined.	Number tuberculous.	Per cent.
Blackburn	82. Average No. of cows per farm, 21.	9	R	—	—	—	3	0	0	3	1	33·3	4	0	0
			F	2	0	0	1	0	0	4	2	50·0	5	1	20·0
			C	5	2	40·0	5	0	0	4	0	0	3	0	0
Bristol	74. Average No. of cows per farm, 25.	4	R	50	2	4·0	16	1	6·2	2	0	0	—	—	—
			F	3	1	33·3	4	0	0	—	—	—	—	—	—
			C	—	—	—	—	—	—	—	—	—	—	—	—
Burton-on-Trent ..	117. Average No. of cows per farm, ?	19	R	—	—	—	—	—	—	—	—	—	—	—	—
			F	—	—	—	—	—	—	—	—	—	—	—	—
			C	—	—	—	—	—	—	—	—	—	—	—	—
Derby	155. Average No. of cows per farm, 16.	20	R	—	—	—	73	9	12·3	7	1	14·2	—	—	—
			F	—	—	—	28	4	14·2	—	—	—	—	—	—
			C	—	—	—	26	2	7·6	—	—	—	—	—	—
Salford	164. Average No. of cows per farm, ?	24	R	115	14	12·1	—	—	—	22	3	13·6	55	4	7·2
			F	—	—	—	—	—	—	—	—	—	—	—	—
			C	26	5	19·2	—	—	—	5	4	80·0	5	0	0
Sheffield	102. Average No. of cows per farm, ?	12	R	1	—	—	—	—	—	—	—	—	—	—	—
			F	7	—	—	—	—	—	—	—	—	—	—	—
			C	19	1	5·2	—	—	—	—	—	—	—	—	—
Various .. .. .. Counties of Linlithgow, Westmoreland, Lancashire, Cheshire, Yorkshire, Nottinghamshire, Warwickshire, Gloucestershire.	—	—	R	83	5	6·0	20	0	0	11	3	27·2	7	1	14·2
			F	12	2	16·6	2	0	0	4	0	0	6	0	0
			C	41	11	26·8	7	0	0	6	2	33·3	4	1	25·0
Total number of farms, excepting Various.	694. Average No. of cows per farm, based on available returns, 18.			364	43	11·7	185	16	8·6	68	16	23·5	89	7	7·8
Mixed samples only .. (Yearly totals and percentages.)				249	21	8·2	112	10	8·9	45	8	17·7	66	5	7·5

R = Railway stations samples. F = Farm mixed

VIII.

mixed and unmixed milk received at the Public Health Laboratory (1896–1908). (1,557 *samples.*)

1904.			1905.			1906.			1907.			Mixed milk collected at railway station or in road.			Mixed milk collected at the farm.			Unmixed milk from individual cows.			Total number of samples of milk examined.
Total number examined.	Number tuberculous.	Per cent.	Total number examined.	Number tuberculous.	Per cent.	Total number examined.	Number tuberculous	Per cent.	Total number examined.	Number tuberculous.	Per cent.	Total number examined.	Number tuberculous.	Per cent.	Total number examined.	Number tuberculous.	Per cent.	Total number examined.	Number tuberculous.	Per cent.	
2	0	0	13	0	0	30	0	0	19	2	10·5	74	3	4·0							
10	1	10·0	2	0	0	2	0	0	16	2	12·5				42	6	14·3				
4	2	50·0	8	2	25·0	5	0	0	11	1	9·1							45	7	15·5	161
—	—	—	—	—	—	—	—	—	—	—	—	68	3	4·4							
—	—	—	2	0	0	—	—	—	—	—	—				9	1	11·1				
—	—	—	—	—	—	—	—	—	—	—	—							—	—	—	77
30	6	20·0	37	4	10·8	29	7	24·1	44	3	6·8	140	20	14·2							
11	0	0	44	2	4·5	26	1	3·8	17	2	11·7				98	5	5·1				
25	5	20·0	23	4	17·3	16	8	50·0	12	4	33·3							76	21	27·6	314
—	—	—	—	—	—	—	—	—	84	10	11·9	164	20	12·1							
—	—	—	—	—	—	—	—	—	10	1	10·0				38	5	13·1				
—	—	—	—	—	—	3	0	0	29	7	24·1							58	9	15·5	260
18	2	11·1	9	0	0	29	2	6·8	—	—	—	248	25	10·0							
—	—	—	—	—	—	—	—	—	—	—	—				—	—	—				
5	1	20·0	—	—	—	7	1	14·2	—	—	—							48	11	22·9	296
—	—	—	—	—	—	46	5	10·9	23	1	4·3	70	6	8·5							
—	—	—	3	2	66·6	1	1	100·0	1	0	0				12	3	25·0				
—	—	—	5	3	60·0	4	3	75·0	6	1	16·6							34	8	23·5	116
7	0	0	12	2	16·6	13	0	0	23	2	8·6	176	13	7·3							
—	—	—	—	—	—	—	—	—	6	0	0				30	2	6·6				
6	0	0	13	1	7·6	9	1	11·1	14	2	14·2							100	18	18·0	306
118	17	14·4	171	20	11·6	220	29	13·1	315	38	12·0	940	90	9·5	229	22	9·6	361	74	20·4	1,530
														Unsuitable samples						..	27
																					1,557
57	8	14·0	71	6	8·4	147	14	9·5	193	18	9·3	940	90	9·5							

samples. C = Cows unmixed samples.

i.—Gross results of the examination of samples of milk for various authorities.

Table VIII.—*The results of the examination of* 1,530 *samples of milk received from Salford, Blackburn, Bristol, Burton-on-Trent, Derby, Sheffield, and several other places in England and Scotland* cannot be compared in detail with those obtained in connection with the Manchester supply.

1. The *number of samples* examined each year for each authority is not sufficient for statistical purposes.

2. The *work was not conducted continuously* nor according to the same plan in each place through the whole period, and I had not the means, which were afforded to me in Manchester, of comparing accurately the results of the veterinary inspection of the farms with those obtained at the Laboratory.

The *samples of mixed milk represent for each district or group of districts, the milk sold to the consumer.*

The results of the examination of unmixed milk do not indicate the state of the milk supply but of the cows individually tested.

The discovery of tuberculous udders is influenced by two important factors, viz.:—

1. The frequency of advanced and easily detected lesions; 2, the skill of the Veterinary Inspector. The skill of the Veterinary Inspector is indicated less by the number of diseased udders which he detects than by the number of tuberculous farms which become free from tuberculosis after the removal of the infected cows which he has selected for bacteriological examination and which are ultimately proved to be tuberculous by the experimental tests.

It is to the mixed milk only that I will refer in the following remarks.

Some of the towns entered in Table VIII. are supplied by the same districts as, or by districts contiguous to, those supplying Manchester.* The *Salford* milk supply area coincides very closely with the Manchester area. A fairly large number of farms send milk to both towns.

Blackburn is supplied by districts which also supply Manchester and Salford, and I have previously shown that the milk coming to Manchester from that part of Lancashire is much freer from tubercle bacilli than the milk produced in other districts.

Derby takes its milk mostly from the southern part of Derbyshire, an area which is contiguous with the part of the county supplying Manchester and Salford.

Sheffield is supplied by the southern parts of the West Riding of Yorkshire, and the northern half of Derbyshire; this area is contiguous with that supplying Manchester.

Burton-on-Trent gets most of its milk from parts of Staffordshire, which also supply Manchester.

The *Bristol* milk area is quite distinct from the preceding ones, and is situated in Gloucestershire and Somersetshire.

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* It is obvious that my remarks are based only upon what has come within my knowledge through the examination of samples sent to my Laboratory.

k.—Comparison of the results obtained in various places.

Although the samples of mixed milk received from these various places during the 11 years were comparatively few in number, they have yielded results which are not without interest, as is shown by the following figures.

TABLE IX.

Results of the examination of samples of mixed milk collected in various towns.

Town.	A. 11 years. No. of mixed milk samples examined in 11 years.	A. 11 years. No. tuberculous—per cent., average for 11 years.	B. 2 years, 1906–7. No. of samples examined in 1906–7.	B. 2 years, 1906–7. No. found tuberculous—per cent., 1906–7.
Blackburn	74	4·0	49	4·0
Sheffield	70	8·5	49	8·1
Derby (1901–8)	164	12·1	84	11·8
Burton-on-Trent (1904–8) ...	140	14·2	73	13·6
Bristol	68	4·4	No examinations.	
Salford	248	10·0	29	6·8
Manchester	4,380	8·7	1,426	6·3
Various counties* from Scotland to the south of England.	176	7·3	36	5·5

* The figures relating to this group cannot be compared with those above. During the first few years the samples came chiefly from the neighbourhood of Manchester; in the last two years the samples have come chiefly from districts where tuberculosis was less prevalent.

These figures are in agreement with those obtained in connection with the Manchester supply and which show that in the zone including Cheshire and Derbyshire, tuberculosis was very prevalent during the period under consideration, north and south of that zone the disease was much less prevalent, except in limited districts such as the one from which Burton-on-Trent obtains its supply. The same figures also show that the well sustained and very systematic effort made by Manchester to purify its milk supply has been more effectual than the work done in other places. It must be noticed that the figures given in the above table do not show the actual improvement which has taken place in the course of the 11 years, but only how much the average of the last 2 years is below the average for the last 11years. As the number of yearly samples taken in Manchester during the last 6 years was very much greater than during the previous 6 years, and as a great improvement had already taken place at the end of the first 6 years, it is clear that the Manchester average for the 11 years given above is lower than if an equal number of samples had been taken each year.

The effect of the working of the Manchester clauses is better shown by comparing the state of the milk supplied from the same (or contiguous) districts to Manchester and to other towns during the last two years. (Two years are taken in order to obtain a sufficient number of samples in certain cases so as to reduce errors.)

TABLE X.

Samples of mixed milk coming from various districts, collected in Manchester and four other towns, in 1906 and 1907, and the number found tuberculous per cent. of the number of samples tested at the Laboratory.

Milk-supplying Counties.	Town supplied.	Samples of Mixed Milk tested in 1906 and 1907. No.	Samples of Mixed Milk tested in 1906 and 1907. Number found tuberculous, per cent.
Lancashire	Manchester	111	3·6
	Blackburn	49	4·0
Derbyshire	Manchester	194	4·6
	Derby	84	11·9
Derbyshire and Yorkshire (adjacent districts).	Sheffield	69	8·6
Staffordshire	Manchester	165	7·2
	Burton-on-Trent ...	73	13·7

These figures indicate, first, that even where tuberculosis was not very prevalent, as in the Blackburn district, efficient supervision has brought about a sensible reduction in the amount of tuberculous milk supplied to Manchester.

Second, that where tuberculosis was very prevalent the proportion of tuberculous milk supplied to Manchester has been reduced to nearly half of what it has in other towns supplied by the same or contiguous districts.

VII.—*A.* Evidence obtainable as to the Source of Tubercle Bacilli from the Bacteriological Examination of the Milk and the Inspection of the Farms.

To estimate the value of this evidence it is necessary to realise that there are very few, if any, herds in this country free from tuberculosis. There are a few farms which are kept free by periodical testing, elimination of tuberculous animals, and non-admission of reacting cattle, but these farms are so few that they do not materially affect the general state of things.

One can say without exaggeration that there are very few herds of more than 10 cows that do not include one or more tuberculous cows. This general statement is partly based upon information which I have received from various quarters respecting the results obtained with regard to several herds tested with tuberculin. It is also based upon the personal experience which I gained in 1897, 1898, and 1899, while testing experimentally the value of tuberculin by means of four small herds (two in Lancashire and two in Cheshire). The total number of cows or heifers tested was 128; the animals giving a positive reaction were slaughtered and examined post mortem. It was found that 37, *i.e.*, 30 per cent., of these cows were tuberculous. The percentages for each farm were respectively

100 per cent., 32 per cent., 17 per cent., and 25 per cent. On comparing these results with those obtained, shortly after, in Aberdeen, I found that there was a remarkable agreement. 240 heads of cattle were tested with tuberculin before being slaughtered at the abattoir. Among these animals were 137 heifers or cows, of which 52, or 37 per cent., were found tuberculous. Very similar results were obtained by the same method as far back as 1891 by Lydtin in the Duchy of Baden. This observer found that out of 110 head of cattle 37 were tuberculous. There is a remarkable agreement in the results obtained in these three places so distant from each other. These results would almost justify one in assuming that one out of every three cows is tuberculous, but taking account of the unequal distribution of the disease, and of the effect of age (*see* page 395), it seems safer not to assume a greater proportion than the one I have assumed for purposes of argument.

I can therefore say, without exaggeration, that out of the 1,385 farms inspected on behalf of the Manchester authority there were probably at least 1,300 with tuberculous cows, and to exclude any fear of exaggeration we may reduce this number to 1,000; it is safe to assume that on each of these farms there were, on an average, several tuberculous cows. The milk supplied by these farms has frequently been tested bacteriologically, with the result that 294 of them were found to supply tuberculous milk. In consequence of this 276 farms were inspected, and in 190 of them the veterinary surgeon, *with the help of the bacteriologist*, was able to discover one or more cows with tuberculous udders. After the removal of those cows the milk generally ceased to produce tuberculosis in guinea-pigs when examined on one or more occasions afterwards.

Probably in the majority of cases, the milk was tuberculous owing to the presence on the farm of a cow or cows with tuberculous udders. There remained, however, a fairly large number of cases (a little less than one-third of all tuberculous farms) where the source of infection could not be established in this simple fashion, and in order to obtain more information about this doubtful group I have classified the farms belonging to it according to the results of the bacteriological tests and of the visits of inspection. I then asked Mr. Brittlebank to furnish me with the history of all the farms in relation to which the results did not seem to have been satisfactory or clear.

The classification of results which I adopted for the purpose of clearing the obscure points, or to test the value of the results, will be made clear by a reference to the detailed record of results given in Table I. (page 383).

B. Analysis of the Results of Bacteriological Examinations.

Table I., as has been previously explained, shows the results of the examinations of milk made each year in connection with each farm. All the results relating to one farm are entered on one line; the order in which the samples have been taken at the railway station and at the farm, as well as the results of the examination, are indicated as explained at page 384.

The 16-square-mile area to which this section of the table corresponds (XXI. M.) was one of the most difficult to deal with, and I have selected it as giving good examples of nearly all the combinations of events that have been observed during the 12 years in the various districts dealt with. The results obtained may be classified as follows :—

* *Evidence indicating the reliability of bacteriological examinations and the importance of tuberculous udders as source of tubercle bacilli.*

1. *Repeated examinations of railway samples with uniform negative results.*

A. Repeated examinations at short intervals during the same year. (Example, Table I. 84/50 (2*a*. *b*.) $\underline{0\,0\,0\,0}$ 4 samples in 1903 and in 1905, each.)

The milk of a number of farms was tested more than once *in the same year* with negative results :

Twice in great many cases.
Three times in about 79 cases.
Four ,, ,, 10 ,,
Five ,, in 1 case.
Six ,, in 2 cases.

B. Repeated examinations in the course of several consecutive years.

There were over 72 farms which gave invariably negative results once and usually twice a year for at least five consecutive years. In a much greater number of cases similar results were obtained for two, three, or four consecutive years.

C. The value of the above results was controlled in connection with 17 farms in the following way. The railway samples having given negative results, the farm was visited and samples of unmixed milk taken from all the cows which showed signs of some disease. The results of the examination of the unmixed milk agreed with those obtained with the mixed milk (.$\frac{0\,0\,0}{0\,0\,0\,0}$ No example in Table I.). In some cases the samples were taken simultaneously at the railway station and at the farm.

2. *Simultaneous examination of mixed milk and of unmixed milk from the same farm with positive results.* (Example, Table I. 84/51

(4) $\frac{+}{\ }╱\frac{+}{+\,+}╲\frac{0}{\ }$ 1901.) I have some 20 records of this kind. They show, as well as the controls in negative cases, that it is possible to estimate the state of a herd by the examination of mixed samples of milk.

3. *Railway samples of mixed milk being found tuberculous the farm is visited, and at least one cow with tuberculous udder is found among those with diseased or suspicious udders.* (Example, Table I.

82/52 (1*a*. *b*.) $\frac{+}{\ }╱\frac{\ }{0\,0\,+}╲\frac{0\,0}{\ }$ 1906.) This sequence was observed in the case of 190 out of the 276 farms visited, *i.e.*, in 68·8 per cent. of the cases.

Sometimes the tuberculous cow was not found at the first visit and the railway milk remained tuberculous. A cow with tuberculous udder was found and removed on the second or third visit; the railway milk was afterwards found free from tubercle bacilli.

(Example, Table I. 81/50 (1) $\frac{+}{} \Big/ \frac{}{0\ 0} \Big\backslash \frac{+}{} \Big/ \frac{}{+} \Big\backslash \frac{0}{}$

1906.) I have records of some 16 occurrences of this kind.

From the above evidence it follows that the appearance of tubercle bacilli in the milk of a herd was associated, on the occasions when the examinations were made, in at least 68·8 per cent. of the cases, with the presence of one or more cows with tuberculous udders in the herd.

There must have been *many tuberculous cows in herds yielding milk free from tubercle bacilli*, and the milk from these herds must have been exposed to various other chances of tuberculous infection. Yet several examinations, sometimes at very short intervals, failed to show in such cases any clear evidence of intermittent infection.

** *Evidence regarding cases in which the source of infection of the milk was not discovered.* (Example, Table I., 84/50 (3)

$\frac{+}{} \Big/ \frac{}{0} \Big\backslash \frac{+}{} \Big/ \frac{}{0\ 0\ 0} \Big\backslash \frac{0\ 0}{}$ 1904.)

There were 86 farms (31·1 per cent.) in which the veterinary inspector was unable to find the cow or cows producing tuberculous milk. In 80 of these cases (although the cause of infection had not been detected) the visit of inspection was followed by *disappearance of tubercle bacilli from the mixed milk.* The other six cases belong to a group of farms which I will discuss when dealing with continued infection. I have no further information regarding 20 of these farms, either because Mr. Brittlebank could not obtain any reliable data or because the farmers refused absolutely to give him any information (this occurred in three cases only). This leaves 60 cases for investigation, and from the histories obtained by Mr. Brittlebank I have been able to classify them as follows :—

1. The farmer had *sold one or more cows between the day of collection of the railway sample and that on which the farm was visited.*

This was found to have certainly taken place in 32 cases. In six of these the farmer admitted that he had sold a cow with a diseased udder shortly before the visit.

In five the cow was diseased, but no information was available regarding the state of the udder.

In 21 the state of the cow could not be ascertained.

In addition to these 32 cases, there were eight more cases of farmers or dealers who were constantly buying or selling cattle. Sale was going on at three of these farms at the time of the veterinary visit. There were therefore, in all probability, 40 out of the 60 farms in which the composition of the herd had altered by the removal of cows between the taking of the railway sample and the visit to the farm. Cows that were admittedly diseased had been removed from 11 of these farms.

2. *The farmer had sent to town milk purchased from a neighbouring farm.*

This was fully established in five cases, and had probably occurred in others.

In three out of the above five, the purchased milk came from a farm where a cow with tuberculous udder was found.

3. *There was a tuberculous udder on the farm but this had not been found before the end of the period under investigation.*

In four cases the cow with tuberculous udder was found in 1908.

In one case samples were taken from suspicious cows and these samples gave negative results on being examined bacteriologically, but there was another cow with advanced tuberculosis and indurated udder, from which no milk could be obtained at the time. In Mr. Brittlebank's opinion the udder of that cow was certainly tuberculous and had, previous to the visit, been the source of infection.

4. *In* 10 *instances the farmer denied having sold any cow or bought any milk* from his neighbours, but in no less than three of these cases there was ground for not accepting the information as correct.

Of the 60 cases investigated there are several which should have been included among those in which the infection of the milk had been clearly traced to a tuberculous udder.

	Cases.
Late discovery of the udder	5
Obtaining tuberculous milk from a neighbouring farm where there was a cow with tuberculous udder	3
	8

It is almost certain that the selling of cows between the collection ot a railway sample and the visit to the farm accounts in many cases for the disappearance of tubercle bacilli from the milk on the second occasion; this had taken place certainly in 32 cases, and almost certainly, in eight more cases, giving a total of 40. In two more cases milk had been purchased from a neighbour, but as the state of the cows on the neighbouring farm was not ascertained, it is not possible to say what was the cause of infection.

The source of tubercle bacilli in 50 of the cases in question was therefore :—

	Cases.		Per cent.	
Certainly a cow with tuberculous udder either on the farm or on a neighbouring farm in ...	8	or	13·3	
In all probability a cow with tuberculous udder in	11	„	18·3	31·6
Probably a cow removed from the farm in	29	„	48·3	
Possibly a cow on a neighbouring farm in	2	„	3·3	51·6
	50	„		83·2

This leaves only 10 cases entirely unexplained or 16·7 per cent. The 86 cases in which the cause of infection of the milk was not found in the usual way may be therefore divided proportionally to this percentage as follows :—

Cases in which the cause of infection was certainly or almost certainly a diseased udder	say	27
Cases in which the cause was probably a diseased cow	„	44
Cases in which the infection has remained without explanation	„	15
		86

By introducing these figures into the general statistics the following estimates are obtained :—

Farms producing tuberculous milk and in which tuberculous udders were found directly ...	190	
Farms producing tuberculous milk and in which tuberculous udders were found late or indirectly	27	
		217
Farms producing tuberculous milk and in which there were probably tuberculous udders ...		44
Farms producing tuberculous milk and in which nothing has been found to explain infection ...		15
		276

This gives the following general percentages :—

	Per cent.
Tuberculous udders the cause of infection ...	78·6
Tuberculous udders probably the cause of infection	16·
Nothing definite found to connect infection with the state of the cow	5·2
	99·8

If, instead of averaging the results obtained in connection with the whole supply area one takes into consideration only those obtained in the 16-square-mile areas, in which the number of farms *inspected* exceeded five and where, therefore, the number of farms and cows was sufficiently large to form a satisfactory basis for a statistical investigation, a striking difference is revealed between the farms which were sufficiently close to Manchester to permit of rapid inspection, and those less accessible. This difference is brought out in Table XI.

Table XI.

Effects of the Distance of the Farm upon the Results of Inspection.

Proportion of tuberculous cows with tuberculous udder found in each of the 16-square-mile areas in which the number of farms inspected numbered five or more (17 "*16-square-mile areas*").

Reference to the 16-square-mile areas.	Total number of farms sending milk to Manchester.	Aggregate number of cows on these farms.	Number of farms inspected.	Number of farms on which tuberculous udders were found.	Number of farms with tuberculous udders, per cent. of farms inspected.
XVII. L ...	42	721	8	7	87·5
XVIII. L ...	25	468	5	4	80·
XX. L ...	23	401	7	6	85·7
XXI. J ...	24	567	7	4	57·1
K ...	47	982	11	7	63·6
L ...	36	668	8	8	100·
M ...	57	1,022	15	14	93·3
Farms within 16 miles of Manchester averages.	(254)	(4,829)	(61)	(50)	(82·)
XXII. F ...	18	560	7	3	42·8
G ...	36	981	12	9	75·
J ...	13	239	6	5	83·3
K ...	28	515	11	8	72·7
L ...	50	1,077	13	10	76·9
M ...	36	762	12	5	41·6
XXIII. G ...	12	324	6	3	50·
M ...	45	1,030	13	8	61·5
R ...	29	549	8	5	62·5
XXIV. Q ...	22	460	5	3	60·
Farms more than 16 miles from Manchester.	(289)	(6,497)	(93)	(59)	(63·)
General Totals	543	11,326	154	109	Over 70·

N.B.—Manchester is situated in the latitudinal zones XVII. and XVIII. at the place where they are crossed by the longitudinal zones L and M. It is clear that the proportion of cases in which the veterinary surgeon was able to discover cows with tuberculous udders on farms sending tuberculous milk to Manchester is greater in connection with the farms which were easy of access and could be inspected rapidly, than with the other farms.

It does not appear desirable for the present to attempt to push the analysis of these cases further. Two facts, however, remain clear, viz. :—

(1) The occurrence of tubercle bacilli in milk sent to town was due to the presence of tuberculous cows with tuberculosis of the udder in about three-fourths of the cases.

(2) The farmer must have had in most of the remaining cases some knowledge of the probable source of infection, for after he had possibly become acquainted with the fact that his milk was being tested the tubercle bacilli disappeared. The frequency of this occurrence renders accidental coincidence improbable.

Diagram III.

[?]cidence of Tuberculosis in Cattle of various Ages.

Author's analysis of the results obtained in Aberdeen on the basis of Tuberculin tests and post-mortem examinations.

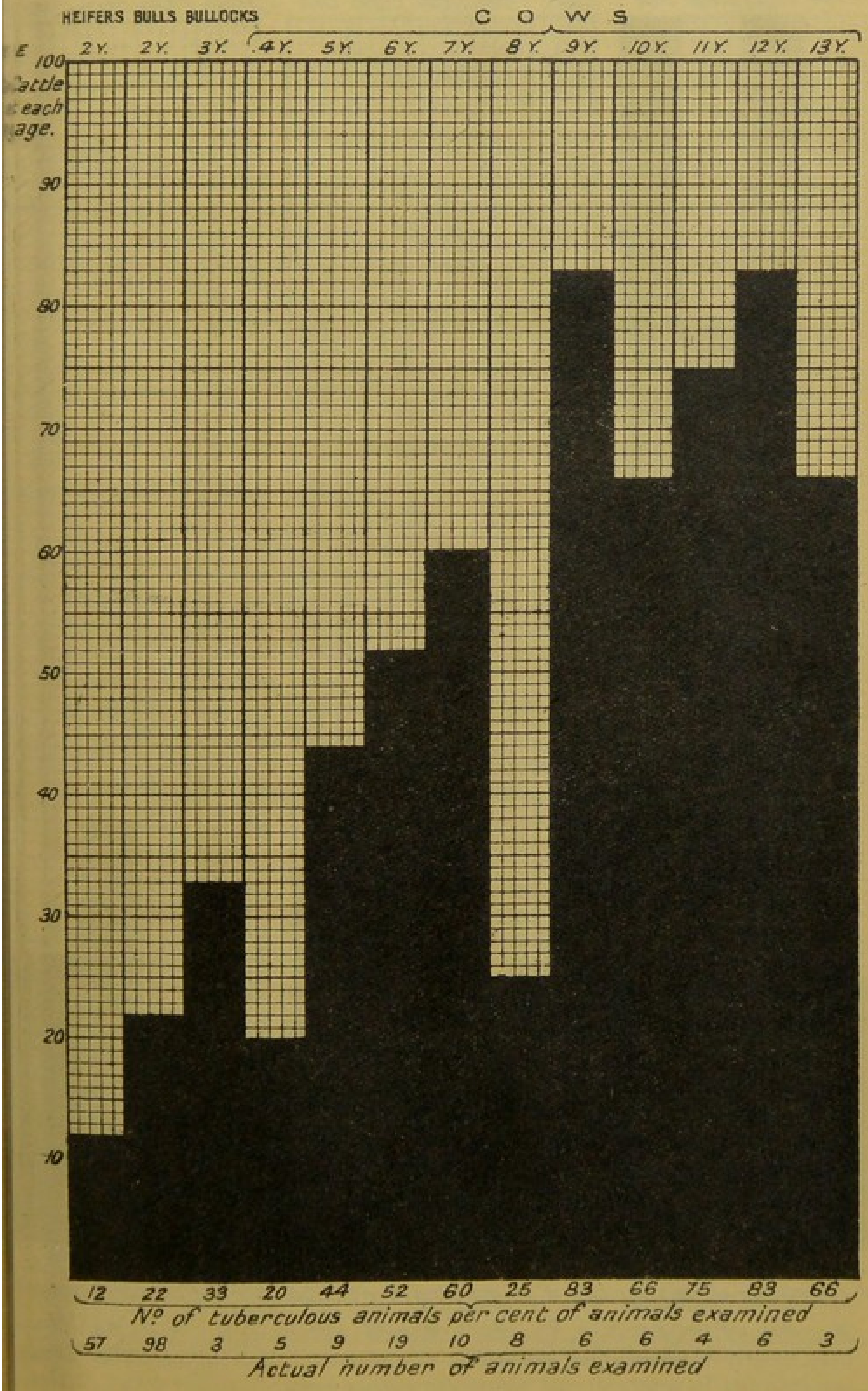
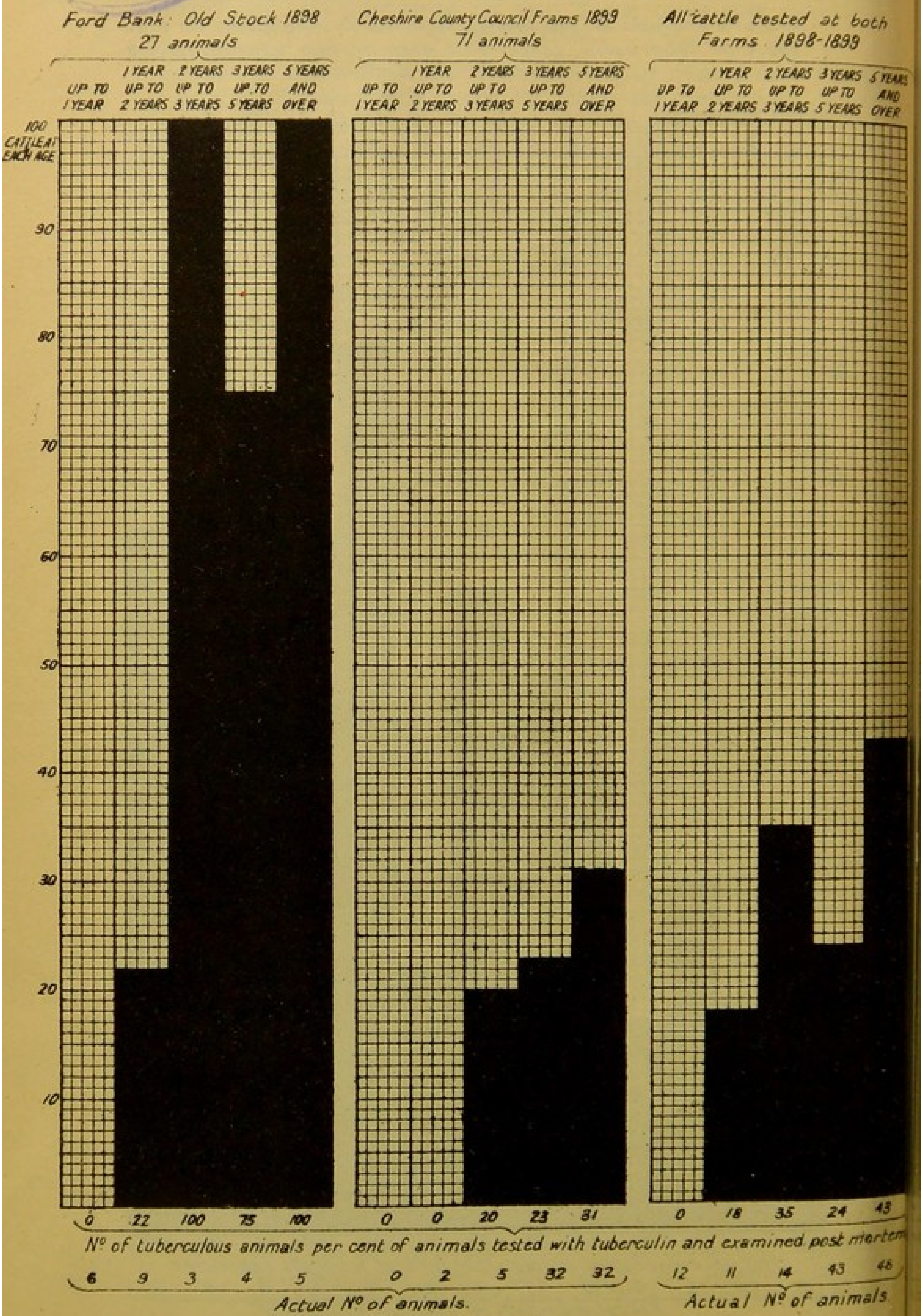


Diagram IV.

Incidence of Tuberculosis in Cattle at Various Ages.

(2 small herds) 128 animals.



Weller & Graham, Ltd Litho, London

With regard to the source of the tubercle bacilli in 5·2 per cent. of the cases it would not be safe to say that the source was not the udder and *must therefore be one of the other causes previously mentioned.* I have already pointed out that in nearly one-third of these cases Mr. Brittlebank had reasons to doubt the truth of the information given to him regarding the movements of the cows or the source of the milk.

⁂ *Persistence of tubercle bacilli in the milk of some farms under supervision.*

In all the cases which have been discussed so far, whether the source of infection of the milk was discovered or not, the results of supervision were satisfactory. There have, however, been instances of failure, apparent or real. In about 38 of the farms inspected during the 12 years the railway milk was found repeatedly tuberculous. This sometimes happened for 2, 3, or 4 years in succession. More frequently there was an interval of one or more years between the occurrences. The information which I obtained from Mr. Brittlebank regarding these farms suggests that the persistent infection of the milk was, in the majority of cases, due to errors on the part of the farmer.

The conditions observed in connection with these farms may be roughly grouped as follows :—

	Farms.
Many old cows kept on the farm (in several cases all the stock had been reared on the farm)	16
Bad housing, inferior stock, premises dirty	8
Frequent buying and selling, stock changing frequently	3
Buying at low prices any class of cow	2
Change of tenants and of herd	3
Purchase of cows apparently good, but found tuberculous shortly afterwards	2
Taking suspicious cow from another farm	1
No explanation (in two cases the tuberculous cows were young)	3
	38

It would appear therefore that the most important cause of difficulty was the presence on the farms of old milk cows. Many of these cows were undoubtedly tuberculous, and as they became older they, one after the other, developed lesions of the udder as the disease advanced.

The frequency of tuberculosis in aged cows is well known, and is made evident by Diagram III. based on statistics collected in Aberdeen in 1899 by J. MacLauchlan Young and J. I. Walker, and Diagram IV., which is based on statistics collected by myself in Manchester during the years 1898–1899. The two investigations were quite independent, and were made to ascertain the value of tuberculin in diagnosis, but I have utilised them here to determine the age incidence of tuberculosis.

The buying of new cattle or changes in the composition of the herds introduce difficulties which, from an administrative point of view, are serious, and indicate the necessity of close, frequent and skilful supervision. This cause accounts for 10 cases of recurrence

Bad housing, inferior stock and dirt, which were noticed in eight cases, cannot account in themselves for tuberculous infection, but they undoubtedly favour its spread and render supervision and the application of preventive measures more difficult.

⁂ *Sudden appearance of tubercle bacilli in the milk supplied by farms that had been supervised for several years and had always supplied milk free from tuberculosis.*

The unexpected appearance of tubercle bacilli in the milk produced on farms under supervision and which for several years had supplied non-tuberculous milk was due to circumstances very similar to those which caused recurrence of infection on certain farms. The special conditions observed were as follows :—

	Farms.
Old cows kept (in most of these farms an old cow was found with a tuberculous udder)	26
Cows purchased and found tuberculous soon after purchase	3
Frequent buying and selling, stock changing frequently	2
Bad housing, inferior stock, dirty premises	3
Tuberculous udder unintentionally overlooked by farmer	1
No definite information (in one case the diseased cow was young. In some instances close breeding for high milking was supposed to be of importance by the farmer)	15
	50

In the great majority of cases a cow with tuberculous udder was found, and with very few exceptions the cow was an old one.

This group of cases shows specially the value of *constant supervision* and good administrative methods. The fact that milk coming from these farms had been free from tuberculosis was no guarantee that tuberculosis might not occur at any moment. This was to be expected, for there were undoubtedly many tuberculous cows on these farms. There was a probability of the farmers buying from time to time a tuberculous cow, for they are nearly all adverse to the use of tuberculin, which is the only reliable test for the diagnosis of early tuberculosis.

⁂ *Farmers who have ceased sending milk to Manchester.*

The number of farmers who have ceased sending milk to Manchester since the milk clauses came into operation, is not considerable.

Fourteen have ceased although their milk had not been found tuberculous. Eighteen have ceased after the milk had been found tuberculous. In four cases the supply was discontinued owing to removal or death. This list is probably not complete, but is sufficient to show some of the effects of the work done in Manchester. One of the farmers included in this list had to cease owing to a compulsory order. The others as far as I know ceased voluntarily, and probably send their milk elsewhere, or, as two of them did, took to cheese making.

Before concluding this report I desire to express my great indebtedness to various gentlemen who have supplied me with the information which I required in order to complete the data relating to samples of milk examined in my laboratory. I wish specially to mention here the valuable assistance which I have received from Dr. C. H. Tattersall of Salford, Dr. W. J. Howarth of Derby, Dr. H. Scurfield of Sheffield, Dr. D. S. Davies of Bristol, Dr. J. M. Cowie of Burton-on-Trent. I have in several places alluded to Dr. James Niven's important share of the work done in Manchester, and to the assistance I have frequently received from Mr. Jas. King, Mr. A. Holburn, Mr. J. S. Lloyd and Mr. J. W. Brittlebank, who have successfully acted as veterinary inspectors for Manchester. To the work done by various members of my laboratory staff I have referred in the text. I wish, however, to acknowledge more specially the considerable help which I have received from Dr. E. J. Sidebotham and Dr. A. Sellers.

General Summary and Conclusions.

1. Between the years 1896 and 1908, 5,320 samples of mixed milk coming from 12 different counties have been tested bacteriologically at the Laboratory, and 474 of these samples have produced tuberculosis in experimental animals. In other words, 8·9 per cent. of the mixed milk (*i.e.*, milk as supplied to consumers) contained a sufficient number of tubercle bacilli to produce tuberculous infection.

2. A certain proportion of the milk coming from each of the counties was tuberculous. No region appeared to be entirely free from bovine tuberculosis, but the extent to which the milk was affected varied considerably according to the region from which it came. The differences were considerable. The proportion of tuberculous samples coming from North Lancashire, the North Western districts of Yorkshire, and the parts of Gloucestershire and Somersetshire supplying Bristol, was on an average for the 12 years from 4 to 4·4 per cent.

The proportion for Cheshire was ... ... 9·9 per cent
„ „ „ Derbyshire „ from 7·5 to 12·1 „
„ „ „ Staffordshire „ „ 8·9 „ 14·2 „

These figures are not based upon the examination of equal numbers of samples in each case, but they are nevertheless significant.

3. Their significance is made clearer by the fact that the Manchester Sanitary Authority has, by means of the Manchester Milk Clauses, succeeded in reducing the amount of tuberculous milk supplied by one of the most infected counties from 16·1 per cent., which was the proportion in 1897–1898, to 6·5 per cent. in 1907. The great prevalence of bovine tuberculosis in certain districts is therefore clearly due to avoidable or preventable causes.

4. It is now generally accepted that so far as man is concerned, the chief danger connected with bovine tuberculosis is due to the presence of tubercle bacilli in cow's milk.

It is obviously desirable from every point of view to eradicate completely bovine tuberculosis. Unfortunately agriculturists have not, as a rule, fully realised the necessity of dealing with this problem. But as bovine tuberculosis is a serious danger to the health of man, it is the duty of the Public Health Authorities to prevent the distribution of milk capable of conveying tuberculosis.

5. The evidence summarised in this report shows clearly that the milk becomes certainly infectious when tuberculous lesions are present in the udder.

6. In cases of tuberculosis without *clear* affection of the udder there may also be occasional infection of the milk. There is a difference of opinion as to whether the appearance of tubercle bacilli in the milk is evidence of the onset of mammary lesions, or may occasionally be entirely unconnected with mastitis. There is however no difference of opinion as regards the danger of infection of the milk in all cases of advanced tuberculosis; in such cases the udder is either diseased or liable to become diseased at any moment.

7. Lesions of the udder were found in one or more of the cows on at least three-fourths of the farms supplying tuberculous milk to Manchester.

8. That tuberculous udders were not found more often was, in all probability, due to the slowness of bacteriological methods, or to the distance of farms from the administrative centre which prevented rapid administrative action. This, not unfrequently, allowed the farmer to remove one or more tuberculous cows from his farm. There are good reasons to believe that this had taken place at 16 per cent of the farms supplying tuberculous milk.

9. The general outcome of the facts collected by me during the 11 years under consideration is that the infection of the milk was—

Certainly or almost certainly due to tuberculosis of the udder at... ...	78·6 per cent. of the farms.
Probably due to tuberculosis of the udder at	16·0 " " "
Possibly due to tuberculosis of the udder or to other sources of infection at	5·2 " " "

10. Although it is difficult to deny the possible danger of other sources of infection it is clear that tuberculous infection of the milk is in a very high proportion of the cases due to tuberculosis of the udder. It is also obvious that all cows in a state of advanced tuberculosis are potentially dangerous on account of their special liability to tuberculosis of the udder and of the infectiousness of their dejecta. Under the present conditions the proportion of tuberculous animals among cattle of more than four years is considerable.

11. These facts are of value from an administrative point of view, for since *the presence in our herds of a large number of tuberculous cows* is tolerated, it is important to have the means of discovering when these cows are actually, or potentially, dangerous to human health.

12. Tuberculosis of the udder can be detected with great accuracy by a combination of veterinary inspection of the cows and of bacteriological examination of the milk obtained from udders showing signs of disease, more specially enlargement and induration. It is unfortunately impossible for the most experienced veterinary surgeon to distinguish, by inspection and palpation, tuberculous mastitis from all other forms of mastitis. It is also practically impossible for the veterinary surgeon, unaided, to discover by ordinary inspection early tuberculous lesions of the udder.

The Manchester records show that out of 940* udders which veterinary surgeons of exceptional experience and ability thought might possibly be affected with tuberculosis, only 242 were proved by bacteriological examination actually to be tuberculous. In my opinion, the evidence recorded in this report shows that the bacteriological results, when obtained by suitable methods, are reliable. These results were controlled time after time by post-mortem examinations of condemned cows, and by the state of the mixed milk after the removal of condemned cows.

The accuracy needed for the purposes of public health administrative work can therefore be obtained only by a combination of skilful veterinary inspection and bacteriological examination.

13. In order to determine the farms requiring inspection it has been found necessary in administering the Manchester Milk Clauses to examine bacteriologically the mixed milk supplied by each farm. The bacteriological testing of mixed milk is, unfortunately, a slow process. Simple microscopical examination yields a certain proportion of trustworthy positive results, but negative results cannot be relied upon. The inoculation method, which gives much more accurate results, involves a delay of 10 to 20 days, and this delay appears to have been taken advantage of by some farmers, who, apparently being warned by the sampling of their milk, have removed suspicious cows from their farm before the visit of the veterinary inspector.

14. This defect, though a serious one, has not prevented the Sanitary Authority of Manchester from obtaining, by skilful administration, a considerable improvement in the milk supply. A reference to Table III. will show that while during the years 1896–1900, 16·8 per cent. of the farms supplying milk to the town were tuberculous, the number had fallen to 7·2 per cent. in 1907.

The fact that similar results have not been obtained in other towns, is I think due chiefly to lack of continuity in the work, probably in part due to financial reasons. The work done in Manchester has been of considerable magnitude; it has been continued steadily for over 12 years and has involved a considerable amount of expenditure on the part of the town, and of labour on the part of the Medical Officer of Health, the Bacteriologist, and the Veterinary Surgeon.

15. Notwithstanding the measure of success obtained in Manchester in the course of 11 years, it is obvious that better results might have been obtained if diagnosis of tuberculosis of the udder, or the discovery of cows producing tuberculous milk could have been effected more rapidly. This appeared to me so important that I have considered carefully whether the bacteriological methods might not be improved. After many attempts I have not succeeded in finding a method of microscopical examination by which it would be possible to prove with certainty that *samples of mixed milk* collected at railway stations were entirely free from tubercle bacilli. On the other hand I have satisfied myself that, by taking certain precautions, *it is generally possible by the microscopical method to determine rapidly whether tubercle bacilli are present or not in the unmixed milk obtained direct from the cow.*

* It is only fair to say that in some of these cases the suspicion was very slight, and that in a few other cases the samples of milk were taken for the purpose of gaining experience. I think, however, that I can say without fear of exaggeration that *not more than one-third* of the udders which on inspection appeared to be possibly affected with tuberculosis, were on bacteriological examination proved to be actually tuberculous.

On the basis of a somewhat limited experience I have come to the conclusion that it is possible by this means to detect tubercle bacilli in the unmixed milk of more than 90 per cent. of the cows that yield tuberculous milk capable of infecting guinea pigs.

The cases that would escape if this method was used could be detected by submitting the samples giving negative results to the usual inoculation test.

16. The chief objection that may be offered to this microscopical method is that, as there would be no preliminary testing of railway samples, *all the farms* would have to be inspected periodically, and this would require a greater staff of veterinary inspectors than is needed under the present system. This, however, apart from the cost, would be an advantage, for the results obtained would be better than those obtainable at present. (The examination of mixed milk would still have to be carried out from time to time for purposes of control.)

Primary inspection of the farms could not, however, be carried out without additional powers.

17. One of the facts brought out by the work done in Manchester, requires some consideration. Some farmers who supplied tuberculous milk to Manchester have, after this had been discovered, ceased sending their milk to the town, and now send it elsewhere or use it to make cheese. Occurrences of this kind indicate the necessity of strict control of the milk supply of *every district*.

18. So long as the presence of tuberculous cows, and more specially of aged tuberculous cows, is tolerated in our herds, a certain amount of tuberculous infection of the milk supply is inevitable. The elimination of cows with tuberculous udders undoubtedly removes the most material and dangerous source of infection, *but it is only after the milk has become infectious* that these cows are detected. *Frequent inspection* is therefore indicated under the present system of control.

19. Preventive methods based upon the state of the milk or of the udder cannot give results equal in value, either from an agricultural or from a public health point of view, to those that could be obtained by methods having for object the *eradication of bovine tuberculosis.* The latter, though more costly at first, would yield more permanent benefits, and finally be less onerous.*

20. Measures having for object the control of milk supplies, to be efficient must be carried out uninterruptedly year after year, very systematically and over fairly *extensive continuous areas.*

* As this aspect of the question is not discussed in the report, I must refer the reader to a paper bearing upon it, in the "Transactions of the British Congress on Tuberculosis," State Section. Vol. II., pp. 235–282. London. 1902.

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LA MÉTHODE LOEWENSTEIN

APPLIQUÉE AU SANG DES BOVIDÉS

La recherche des bacilles de KOCH (Bacillus tuberculosis typus bovinus) dans le sang des bovidés tuberculeux par la méthode LOEWENSTEIN.

Compte rendu des expériences exécutées pour la fondation nommée ci-dessus par

O. BOSGRA. vétérinaire à Groningen.
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rédigé par

C. F. VAN OIJEN.

Professeur de la Faculté de médecine-vétérinaire à l'université d'UTRECHT.

Prof. Dr. D. A. DE JONG
29-4-1865 30-5-1925

Prof. Dr. D. A. de Jong-Stichting te Utrecht.

Beheerders hebben de eer U hierbij, de eerste onder de auspicien der Stichting tot stand gekomen publicatie, aan te bieden.

Namens de Stichting voornoemd,

de secretaris-penningmeester

Dr. H. J. VAN NEDERVEEN.

Het doel der te Utrecht gevestigde Stichting is, de bevordering van de studie der Vergelijkende Ziektekunde, waaronder wordt verstaan de leer der bij mensch en dier gemeenschappelijk voorkomende ziekteprocessen. Zij tracht dit doel te bereiken door het doen verrichten van proefondervindelijk onderzoek.

De Stichting werd opgericht op 7 Juni 1929 door vrienden en leerlingen van wijlen Prof. Dr. D. A. de Jong — in leven o.m. Hoogleeraar in de Vergelijkende Pathologie aan de Rijks-Universiteit te Leiden —, die daardoor de nagedachtenis van dezen geleerde meenden te eeren op een wijze, welke geacht mag worden het meest met zijn denkbeelden overeen te stemmen. Tot dit doel werd een inzameling gehouden, waardoor een stamkapitaal en toezeggingen van een aantal jaarlijksche bijdragen werden bijeengebracht. Onder deze laatsten neemt die van de Maatschappij voor Diergeneeskunde een vooraanstaande plaats in.

Het beheer der Stichting is opgedragen aan vijf personen te weten: een vertegenwoordiger der Maatschappij voor Diergeneeskunde; thans Dr. H. J. van Nederveen, te 's Gravenhage.
een vertegenwoordiger der Nederlandsche Maatschappij tot bevordering der Geneeskunst; thans Prof. Dr. R. de Josselin de Jong te Utrecht;
een vertegenwoordiger der Faculteit der Veeartsenijkunde der Rijks-Universiteit te Utrecht; thans Prof. C. F. van Oijen te Utrecht;
en twee door de hiergenoemden aangewezen personen; thans Dr. J. J. F. Dhont te 's Gravenhage en Prof. W. C. de Graaf te Utrecht.

Voorzitter der Stichting is thans Dr. J. J. F. Dhont, Laan van N.O. Indië 94 's Gravenhage, terwijl Dr. H. J. van Nederveen, Neuhuyskade 61 's Gravenhage de functie van Secretaris-Penningmeester bekleedt.

Bijdragen voor de Stichting kunnen worden gestort op de postrekening van laatstgenoemde No. 105194 onder vermelding van het doel, waarvoor de storting geschiedt.

Fondation

Prof. Dr. D. A. de Jong-Stichting. Utrecht.

Pays-Bas.

Les Directeurs ont l'honneur de vous présenter respectueusement le premier fascicule des Annales de la Fondation.

Pour la Fondation,

Dr. H. J. VAN NEDERVEEN,
Secrétaire-trésorier.

La Fondation, située à Utrecht, a été créée pour favoriser, par moyen de recherches expérimentales, la Pathologie Comparée, c'est à dire, l'étude des maladies communes aux hommes et aux animaux.

La Fondation date du 7 Juin 1929. Elle a été formée par les amis et les élèves de feu le Prof. Dr. D. A. de Jong, — de son vivant e.a. Professeur de Pathologie Comparée à l'université de Leyden — pour honorer la commémoration de ce savant d'une manière, qui concorde tout à fait avec les principes du maître. On an réussi à fonder un capital au moyen d'une collecte et on nous assura plusieurs dotations annuelles. Parmi celles ci, la „Maatschappij voor Diergeneeskunde" (Société pour favoriser la science vétérinaire) occupe une place préponderante.

La Fondation est dirigée par cinq personnes c.a.d.

un représentant de la Maatschappij voor Diergeneeskunde; actuellement le Dr. H. J. van Nederveen, La Haye.

un représentant de la „Maatschappij tot bevordering der Geneeskunst" (Société des médicins); actuellement le Prof. Dr. R. de Josselin de Jong, Utrecht.

un représentant de la faculté de médecine-vétérinaire de l'Université d'Utrecht; actuellement le Prof. C. F. van Oijen, Utrecht.

et deux personnes nommées par les délégués déjà mentionnés; actuellement le Dr. J. J. F. Dhont, La Haye et le Prof. Dr. W. C. de Graaff à Utrecht.

Le Président de la Fondation est le Dr. J. J. F. Dhont, Laan van N.O. Indië 94, La Haye, tandis que le Docteur H. J. van Nederveen, Neuhuyskade 61, La Haye est chargé de la fonction de Secrétaire-trésorier.

On peut verser une souscription pour la Fondation sur le Compte postal No. 105194 du docteur van Nederveen en mentionnant le but du versement.

Stiftung:

Prof. Dr. D. A. de Jong-Stichting. Utrecht. Holland.

Der Ausschuss beëhrt sich hiermit die erste Ausgabe der Stiftung ergebenst zu überreichen.

Mit vorzüglicher Hochachtung,

Dr. H. J. VAN NEDERVEEN,
Schrift- und Kassenführer.

Zweck der Stiftung „Prof. Dr. D. A. de Jong-Stichting", ist, die Förderung der vergleichenden Pathologie, d.h. des Studiums der gemeinsamen Krankheiten des Menschen und der Tiere, durch Veranlassung von geeigneten experimentellen Untersuchungen.

Der Sitz der Stiftung ist Utrecht. Sie wurde am 7. Juni 1929 von Freunden, Verehrern und Schülern dem Gedächtnis des verstorbenen Professors Dr. D. A. de Jong, — Prof. der vergleichenden Pathologie an der Universität zu Leiden, — zu Ehren errichtet, und zwar in einer Weise, die ganz im Sinne des verstorbenen Forschers lag. Es wurde ein Stammkapital aufgebracht und laufend werden jährliche Beiträge gezeichnet. So wird u.a. eine beträchtliche Summe jedes Jahr von der „Maatschappij voor Diergeneeskunde" (Gesellschaft für Veterinär-Medizin) entrichtet.

Der geschäftsführende Ausschuss der Stiftung wird gebildet von

einem Delegierten der „Maatschappij voor Diergeneeskunde" z.z. Dr. H. J. van Nederveen, 's Gravenhage.

einem Delegierten der „Nederlandsche Maatschappij tot bevordering der Geneeskunst" (Verein Holländischer Ärzte) z.z. Prof. Dr. R. de Josselin de Jong, Utrecht.

einem Delegierten der veterinär-medizinischen Facultät der Universität Utrecht z.z. Prof. C. F. van Oijen, Utrecht und

zwei Personen, die durch die obengenannten Vertreter gewählt werden; z.z. Dr. J. J. F. Dhont, 's Gravenhage und Prof. Dr. W. C. de Graaf, Utrecht.

Vorsitzender ist z.z. Dr. J. J. F. Dhont, Laan van N. O. Indië 94, 's Gravenhage: Kassen- und Schriftführer Dr. H. J. van Nederveen, Neuhuyskade 61, 's Gravenhage.

Schenkungen sind der Stiftung über das Postscheck-Konto No. 105194 des Herrn Dr. van Nederveen, unter Mitteilung des Bestimmungszweckes zuzuleiten.

Foundation

Prof. Dr. D. A. de Jong-Stichting Utrecht.

Holland.

The Board of Directors presents the first volume, publised by the Foundation.

With Compliments.

By order,

Dr. H. J. VAN NEDERVEEN,

Honorary secretary-traesuror.

The object of the Foundation, establised in Utrecht, is to promote the Study of Comparative Pathology, by which is to be understood the knowledge of diseases, which men and animals have in common.

To attain this purpose it causes experimental investigations to be executed.

The Foundation was erected June 7th 1929 by friends and pupils of the late Prof. Dr. D. A. de Jong — in lifetime a.o. professor in Comparative Pathology at the University of Leyden — this being as they thought the proper way for honoring the commemoration of this learned investigator most in agreement with his ideas.

A stock fund and a number of annual subscription were collected, amongst the latter the contribution of the Maatschappij voor Diergeneeskunde (Veterinary Association) is a prominent one.

The Board of the Foundation consist of:

the representative of the Veterinary Association; at present Dr. H. J. van Nederveen, The Hague.

the representative of the „Nederlandsche Maatschappij tot bevordering der Geneeskunst (Medical Association of Holland); a.p. Prof. Dr. R. de Josselin de Jong, Utrecht.

the representative of the Veterinary Faculty of the University of Utrecht; a.p. Prof. C. F. van Oijen, Utrecht.

two scientists, invited by those already mentioned; a.p. Dr. J. J. F. Dhont The Hague and Prof. Dr. W. C. de Graaf, Utrecht.

Chairman to the Foundation is Dr. J. J. F. Dhont, 94 Laan van N.O. Indië, The Hague, whilst Dr. H. J. van Nederveen, 61 Neuhuyskade, The Hague is acting as honorary secretary-treasurer.

Contributions to the Foundation may be paid by transferring them on the postal account of the latter (No. 105194), mentioning the proper purpose of the remittance.

INTRODUCTION.

Plus de cinquante années sont déjà passé depuis la découverte du bacille de la tuberculose par ROBERT KOCH mais, malgré des recherches très nombreuses, l'influence réciproque entre ce bacille et l'animal atteint de cette maladie est encore presque tout à fait inconnue. Même la présence ou l'absence de ce microörganisme dans les organes, indemnes à l'examen macroscopique, reste un véritable mystère.

Cette ignorance de la mode de diffusion dans le corps des bacilles de KOCH est causé en premier lieu par la culture difficile et lente, que nous observons en transmettant ces bacilles d'un tissu vivant dans un milieu de culture artificiel.

Toutes les observations sur la présence du bacille de la tuberculose dans les organes tout à fait normaux méritent donc notre attention et surtout de telles observations sur le sang, le „tissu'', d'une fonction si spéciale. Que de questions sur la propagation du proces tuberculeux dans le corps et sur la possibilité de l'excrétion de ces bacilles par plusieurs organes sont reliées à l'apparition — plus ou moins fréquente — des bacilles de KOCH, dans le sang des animaux ou bien des hommes tuberculeux.

Ces réflexions déclarent facilement la grande importance qu'on a attribuée aux observations de LOEWENSTEIN (publiées depuis 1929), qui constatait le virus de cette maladie dans le sang d'un grand percentage des personnes tuberculeuses.

Je dépasserais les limites de cet ouvrage en énumérant toutes les publications de cet auteur et encore plus en ajoutant tous les efforts d'autres expérimentateurs pour affirmer ces observations. Un résumé complet en est donné en langue hollandaise par le Dr. A. J. GERVER, intitulé : „Kweeken van Tubercelbacillen uit bloed'' Thèse Amsterdam 1932.

La plupart des auteurs n'obtenaient pas les résultats remarquables de LOEWENSTEIN ; même ceux qui travaillaient sous la direction de celui-ci et qui appliquaient la méthode aux individus indiqués par lui.

On se doutait enfin de la véracité du docteur L. La dénégation des résultats d'autrui est bien facile ; mais plus d'une fois l'évolution de la science a été retardée par une opinion injuste sur des découvertes des plus importantes. Il faut qu'une recherche tout à fait sérieuse et complète doive précéder le jugement final.

Chez l'homme cette recherche rencontre plusieurs obstacles presque insurmontables ; c'est pourquoi je supposais qu'une telle investigation chez les animaux pourrait rendre des résultats très précieux.

On trouvera dans ce travail le récit des expériences de messieurs les vétérinaires O. BOSGRA, maintenant à Groningen et P. J. VAN ENDT (Utrecht), exécutées dans les dernières années sous ma direction. Ces expériences ont abouti à des résultats bien curieux.

Nous avons taché de répondre à la question :

„Est-il possible d'affirmer la présence des bacilles de la tuberculose dans le sang des bovidés tuberculeux par la méthode de LOEWENSTEIN?"

Nous considérons comme „bacille de tuberculose", toute modification de ce microörganisme qui produit des cultures dans les milieux artificiels de caractère spécifique et se montrant pathogène pour les animaux d'expérience.

On ne s'occupait pas de la forme spéciale de ce virus, qui se manifestait ainsi dans le sang.

La résolution de cette question devrait être précédée de quelques recherches d'ordre technique et dans le cours de ce travail il semblait favorable d'étendre les expériences à d'autres espèces que les bovidés (cobayes, lapins).

LITTERATURE.

Les méthodes à démontrer la présence des bacilles de la tuberculose dans le sang sont les suivantes :

1. Recherche microscopique des frottis du sang.
2. Inoculation chez des cobayes.
3. Cultures sur milieu artificiel.

Quoique seulement les méthodes nommées sub. 3 n'appartiennent à notre terrain, un résumé très bref des résultats obtenus par les deux autres est très instructif.

RECHERCHE MICROSCOPIQUE.

HEINRICH MAMMAN. — Ueber den Nachweis von Tuberkelbazillen im stromenden Blute und seine praktische Bedeutung; Thèse Leipzig. 1911.

En négligeant les détails techniques je fais remarquer, que le sang fut traité par l'acide acétique et par l'antiformine; enfin le résidu fut suspendue dans la ligroine. Il y avait des bacilles dans le sang d'un cheval, d'un veau, de six vaches et de quatre boeufs (total 12 sur 15 animaux.)

Dr. R. BROLL. — Ueber das Vorkommen und den Nachweis von Tuberkelbazillen im stromenden Blute lungen-tuberkulöser Rinder; Berliner Tierärztl. Wochenschrift 1909, No. 49.

L'auteur examinait le sang de deux vaches à peu près de la même manière que MAMMAN, c. a. d., de chaque animal cinq échantillons. Chez une vache il trouvait les bacilles acido-résistants dans tous les échantillons, chez l'autre seulement dans deux.

Je ne tâcherai pas de résumer complètement la littérature de la recherche microscopique des bacilles de KOCH dans le sang. Si ces observations mentionnées plus haut ne se basent pas sur des défauts de la technique on pourrait conclure que les bacilles de la tuberculose se trouvent très fréquemment dans le sang.

INOCULATION CHEZ DES ANIMAUX D'EXPÉRIENCE.

Un revue détaillée des ouvrages sur la recherche des bacilles de KOCH dans le sang par l'inoculation des cobayes a été donnée par le Dr. G. R. R. WILLEMS intitulée: „Een onderzoek naar het voorkomen van virulente tubercelbacillen in het vleesch van tuberculeuze slachtdieren", thèse Utrecht 1932.

Je cite de ce travail les observations suivantes:

MULLER et ISHIWARA (Zentralblatt für Bakteriologie 1914, T. 74, P. 393.) signalent parmi 22 animaux examinés dix cas positifs, en premier lieu chez les animaux portant de grandes lésions caséeuses, ou bien des lésions miliaires, dans les organes parenchimateux.

BONGERT. (Archiv für Hygiène T. 69) a démontré des bacilles dans le sang de cinq bovidés en examinant trente vaches et 3 porcs. Il inoculait des lapins et des cobayes.

HÄUTLE. (Thèse, München 1914) examinait le sang retenu post mortem du coeur de 25 bovidés, sans résultat positif.

SIEBINGER. (Thèse, München 1914) trouvait des bacilles de la tuberculose dans le sang artériel de sept animaux sur dix cas et chez cinq de ces animaux aussi dans le sang véneux.

Ces observations sont contradictoires, mais on en tire la conclusion, que la présence des bacilles de la tuberculose dans le sang des bovidés n'est pas rare.

CULTURES SUR TERRAINS ARTIFICIELS.

Les recherches par moyen de cultures sur terrain artificiel sont encore peu nombreuses. Je n'ai trouvé que les suivantes:

a. Cobayes.

DREYER et VOLLEN. (The Lancet May 1931 p. 1012) infectaient 182 cobayes, par la voie subcutanée, intrapéritoneale ou intravéneuse et retrouvaient par moyen de culture les bacilles de la tuberculose dans le sang receuilli au coeur-droit chez 160 animaux (88 %). En sensibilisant les animaux pour l'infection de la tuberculose par un traitement spécial, les auteurs trouvaient des bacilles de KOCH dans le sang sur 96 % des cas.

FRIEDA ABT. (Schweizerische Medizinische Wochenschrift, 7 Nov. 1931) inoculait 41 cobayes avec un virus tuberculeux très virulant; chez 28 de ces animaux les bacilles avèraient dans le sang. Sur 9 cobayes inoculès avec des matières suspectes provenant d'hommes tuberculeux les bacilles ont été retrouvés dans le sang de deux.

Les meilleurs résultats ont été obtenus en inoculant le terrain artificiel avec du sang pur sans aucun traitement préalable. L'auteur nie l'influence défavorable de l'haemoglobine sur le développement des cultures et propage le traitement à l'acide acétique ou à l'acide sulfurique de très faible concentration.

Les cultures ont été obtenues du sang veineux des animaux intra vitam. ou bien du sang provenant de la moitié droite du coeur après l'autopsie.

CICELY WEATHERALL. (The Lancet May 7, 1932) rapporte des recherches analogues en utilisant le terrain préparé par DREYER et VOLLEN (l. c.); elle receuillait seulement une culture primaire en examinant le sang de 63 cobayes.

ALFRED EIDHER. (Wiener Tierärztl. Monatschrift, 1 Juli 1932).

Quatres cobayes sont infectés par des bacilles du type bovine, trois parmi eux donnent des cultures provenant du sang; après incubation des éprouvettes pendant six semaines. Chez deux cobayes infectés avec des bacilles du type humain le résultat est analogue.

b. Animaux divers.

EIDHER (l. c.) raconte une expérience avec deux chiens dont l'un montrait une réaction positive à la tuberculine.

Douze journées après l'inoculation du terrain on reconnait une colonie de bacilles acido-résistant.

L'auteur examinait ensuite deux chats, l'un avec tuberculose de la peau et du poumon, l'autre avec „métritis et entéritis''. Onze journées resp. trois semaines aprés l'inoculation des milieux nutritifs les colonies se montraient.

EIDHER prenait du sang dans le coeur d'un singe (Macacus Rhesus), infecté depuis quelque temps par des bacilles de tuberculose (type bovine). L'opération fut exécutée chez l'animal en narcose.

Les cultures sur les terrains artificiels et l'inoculation du sang chez un cobaye démontraient la présence des bacilles de KOCH. La culture rendait tuberculeux un cobaye inoculé.

Le sang obtenu du coeur à l'autopsie d'un lémurien infecté auparavant par des bacilles de la tuberculose (type bovine) donnait une culture positieve au bout de sept semaines; le sang veineux provenant d'un autre atteint de la tuberculose en donnait une au bout de trois semaines.

c. Bovidés.

EIDHER l. c. rapporte le résultat négatif avec le sang veineux de 26 bovidés atteints d'une grave tuberculose.

Je rappelle les détails d'ordre technique suivants.

Traitement du sang avec le citrate de sodium, puis avec l'acide acétique où bien l'acide sulfurique, ensuite inoculation du résidu contenant beaucoup d'haemoglobine sur les terrains de LOEWENSTEIN, d'une part avec le „rouge du Kongo'', d'autre part avec le „vert malachite''.

Chez d'autres échantillons l'auteur provoquait l'hemolyse avec de l'eau stérélisée et traitait le sédiment ensuite avec l'acide sulfurique. Citons le passage suivant:

„Von den vier Rindern, von denen zwei als Schlachtbefund Lungen-
„tuberculose, eines Perlsucht und eines Eutertuberculose zeigten, war
„nach zwei Monaten die Blutkultur von dreien mikroskopisch positiv.
„Die ersten Kolonien zeigten sich nach sechs Wochen.

„Die mit den gezüchteten Stämmen intraperitoneal geimpften Meer-
„schweinchen zeigten nach drei Wochen bei ihrer Tötung generalisierte
„Tuberkulose.''

Les illustrations de cet ouvrage ne prouvent pas tout à fait la nature tuberculeuse des lésions rencontrées chez les cobayes inoculés des cultures du sang. Inoculation en série n'a pas été exécutée. La valeur de ces observations reste donc quelque peu douteuse. Néamoins, ce travail est le seul qui se rapporte à la recherche des bacilles de KOCH dans le sang des bovidés par la méthode LOEWENSTEIN; donc il faut y donner toute attention.

d. Volaille.

SILBERSCHMIDT. (Inaug. Dissert. Leipzig 1931) a publié des recherches détaillées sur la présence des bacilles de tuberculose aviaire dans le sang des poules. Le sang fut traité par le citrate de sodiom et l'acide acétique, puis inoculation du sédiment sur les terrains de LOEWENSTEIN et de PETRAGNANI. Une autre partie du sédiment fut exposée à l'acide sulfurique (15 % pendant deux ous trois minutes); inoculation sur les terrains artificiels identiques. Incubation à 37° C.

L'auteur retrouvait les bacilles „aviaires" dans le sang de sept (28 %) sur 25 poules, qui montraient une réaction positive à la tuberculisation. Neuf poules mortes de tuberculose gardèrent toutes des bacilles dans le sang. Remarquons que l'auteur examinait aussi des frottis de sang à la microscope et trouvait en deux cas des bacilles acido-résistants.

Ajoutons enfin le résultat positif de la culture du sang provenant du coeur d'un faisan et de celui du sang, obtenu par phlébotomie chez deux poules sur six.

Il semble donc que le bacille de la tuberculose aviaire se trouve fréquemment dans le sang des oiseaux tuberculeux.

Un traitement complet de ces recherches chez l'homme se trouve dans le travail de G. S. Wilson intitulé „Tuberculous Bacillaemia". Medical Research Council; Special Report Series No. 182 London. Published by His Majesty's Stationery Office 1933.

TECHNIQUE SPECIALE.

a. Terrain de culture.

LOEWENSTEIN a modifié plus d'une fois le terrain spécial utilisé dans ses recherches; ces adversaires tirent de cette variabilité un argument défavorable pour l'auteur.

Nous nous sommes bornés à la formule dans la Deutsche Medizinische Wochenschrift 1930, No. 24 page 1010 répétée ci-dessous.

Faites une solution de

Mono-phosphate de potassiom.	0.4 %
Sulphate de magnesiom.	0.04 %
Citrate de magnesiom	0.1 %
Asparagine	0.6 %
Glycerine.	2.— %

On ajoute à 120 cc de cette solution 6 grammes d'amylum de pomme de terre et on stérilise pendant deux heures au bain marie. Après refroidissement jusqu'à 50° C. quatre oeufs entiers et 10 cc d'une solution de 2 % du „rouge du Congo'' sont additionnés. Collez la mixture par le gaze et faîtes coaguler à 80° C. dans des éprouvettes en couches obliques, comme le serum de LOEFFLER.

Après la stérilisation on verse dans chaque éprouvette une demie cc. d'eau distillée stérilisée pour augmenter la quantité de l'eau condensée. Cette quantité est nécessaire pour entretenir une humidité suffisante du terrain pendant l'incubation prolongée. Ensuite une incubation préalable à 37° C. pendant 4 journées est obligatoire pour contrôler la stérilité des terrains.

Pour obtenir une surface des couches limpide et uniforme il est nécessaire de mettre les éprouvettes dans l'appareil à coagulation à froid et de chauffer ce dernier lentement.

b. Traitement à l'acide sulfurique.

LOEWENSTEIN, imitant HOHN e. a. s'est servi de la propriété bactéricide de l'acide sulfurique pour éliminer les microörganismes banales dans les matières à prouver, en considérant que les bacilles de la tuberculose sont résistant jusqu'à un certain degré à cet acide. Il est impossible de reviser ici la littérature complète sur ce „traitement à l'acide''.

Je me permets de signaler le résumé détaillé de ces ouvrages élaborés par mon collaborateur le Dr. J. VAN WOERDEN, intitulé: „De primaire cultuur van den Bacillus tuberculosis, typus bovinus en hare diagnostische waarde'' (Thèse Utrecht 1931).

Cet cuvrage nous rend la conviction, que la concentration de l'acide appliqué et la durée du traitement sont de première importance.

Pour la recherche des bacilles de KOCH dans le lait, où l'on peut supposer des bacilles du type bovine la concentration de 0.5 N ($\pm$ 1.5 % vol.) et la durée du traitement de 20 minutes sont à préférer.

Evidemment, nous nous sommes servis de cette documentation pour le traitement du sang.

c. Examination de la viande — respectivement du suc de viande selon la méthode VAN WOERDEN — WILLEMS.

Dans le cours de nos recherches nous étions obligés de prouver la présence des bacilles de la tuberculose dans la viande des animaux atteints de cette maladie. La technique des auteurs nommés plus haut a été employée.

En voici une description abrégée.

Après stérilisation de la surface d'un morceau de viande par la flamme le centre est coupé en cubes d'environ 1 cM^3, en opérant avec des instruments stériles.

Enveloppés dans une toile stérilisée les morceaux sont comprimés dans une presse à viande stérilisée.

De 500 gr. de viande on obtient ainsi à peu près 40 cc de suc. Celui-ci est filtré par une couche d'agar-agar en utilisant la méthode d'EIJCKMAN. (Nederlandsch Tijdschrift voor Microbiologie en Hygiène 1927. T. 2. No. 2.) Cette méthode se décrit ainsi:

Un filtre en porcelaine (dimension 10—14 cm.) est monté, par moyen d'un bouchon en caoutchouc, sur une bocal portant un tuyeau à robinet. On couvre le filtre d'un papier à filtrer, humide (SCHLEICHER No. 591—575) et ensuite d'une couche de 3 mm. d'agar-agar 3 % solidifié. Un anneau de verre d'une dimension d'environ un centimètre plus petit que le filtre en porcelaine est placé sur l'agar-agar. L'espace entre le bord du filtre et l'anneau est rempli d'agar-agar pour éviter la diffusion du filtrat sans qu'il ne passe une couche de cette substance.

L'appareil doit être stérile. Le suc de viande est versé sur le filtre. Par moyen d'une pompe on vide le bocal jusqu'à un vacuum de 2 cm. de mercure. On ferme le robinet du tuyeau, et on transporte l'appareil dans la chambre froide pour éviter la souillure des microörganismes banales dans l'agar-agar.

Au bout de 24 heures le suc a passé l'agar-agar. Tous les microbes, donc aussi les bacilles de KOCH sont retenus par l'agar-agar. Une couche superficielle de celui-ci est émulsionée dans quelques gouttes d'acide sulfurique ($\frac{1}{2}$ N. pendant vingt minutes). On ajoute un peu d'eau destillée stérile et on fait centrifuger.

Alors le sédiment est prêt à l'inoculation sur des terrains artificiels ou bien chez des sujets soumis à l'expérience.

d. Prélèvement des échantillons du sang.

Nous avons pris les échantillons du sang avec des précautions de stérilité aussi complètes que possible, pour éviter toute contamination, soit avec des microbes banales, soit avec des bacilles de tuberculose se trouvant dans le milieu embiant de l'animal.

Le mode d'opération chez les animaux malades est le suivant:

Après transportation de l'animal des l'étable en plein air, nous avons coupé les poils à l'endroit de la phlébotomie, lavé la peau, que nous avons desinfectée à l'alcohol et à la teinture d'iode. Ensuite une canule stérile a été implantée dans la veine.

Chez nos petits sujets soumis à l'expérience nous avons tondu la peau, après le lavage et puis nous avons stérilisé le terrain. Le sang a été récolté dans des flacons stériles contenant une solution de 1 % de citrate de sodiom.

Remarquons que nous avons toujours injecté nos cultures chez les veaux etc. à l'un des côtés du cou et que nous avons exécuté la phlébotomie à l'autre. Il est donc impossible que l'échantillon de sang ait été contaminé par des bacilles de tuberculose se trouvant à proximité de l'endroit de l'injection. Le traitement à l'acide sulfurique des sédiments semble prèsque superflu pour éviter les cultures impures dans nos tubes à essaye, parce que la matière à inoculer est stérile d'origine. Nos expériences simultanées avec

1. le sédiment du sang inaltéré
2. le sédiment après traitement à l'acide sulfurique (0.5 N.)
3. le même après traitement à l'acide sulfurique (15 %) prouvent que nos précautions contre une infection indésirable ont été efficaces.

Les échantillons de sang pris dans les diverses cavités du coeur exigeaient des précautions spéciales.

Dès la mort de l'animal, les artères et les veines principales du coeur ont été barrées et ensuite on a enlevé le coeur du corps.

Après flambage de la surface nous avons exécuté l'incision et nous avons receuilli le sang à l'aide d'une pipette stérile.

RECHERCHES PREALABLES.

Il est douteux qu'un terrain artificiel, construé pour les bacilles du type humain soit aussi favorable pour ceux du type bovine, se trouvant dans le sang des bovidés tuberculeux.

En considérant la littérature et les résultats d'autres expériences, exécutées dans notre laboratoire, BOSGRA a conclu que la glycérine a une influence défavorable sur le développement des colonies des bacilles de tuberculose du type bovine et entreprit de comparer l'efficacité du terrain de LOEWENSTEIN d'une part glycériné et d'autre part sans glycérine. Les souches de notre collection du bacille de KOCH ne pouvaient pas servir à ces expériences, parce qu'elles s'étaient déjà plus ou moins adoptées aux terrains glycérinés. L'étude de cette question se fait au moment de la transplantation des bacilles du tissus vivant aux terrains artificiels.

Nous nous sommes servis pour ce but des lésions tuberculeuses dans les poumons de quelques bovidés, qui ne contiennent que très rarement des microörganismes banales, autres que les acidorésistentes. Le traitement à l'acide sulfurique dilué, (0.5 N.) pendant une demi-heure, se montrait suffisant pour éliminer cette contamination non-désirée. Auparavant la présence des bacilles de KOCH était controlée par la recherche microscopique (ZIEHL NEHLSEN).

L'examen à la microscope des terrains de LOEWENSTEIN sans glycérine (L. S. G.) signala des bacilles acido-résistants 5—8 jours après l'inoculation, l'examen macroscopique relevait la présence de ces colonies au bout de 10—16 jours. Sur le terrain de LOEWENSTEIN glycériné nous n'avons observé des colonies que 21 à 42 jours après l'inoculation des tubes à essai. Les différentes souches ne montraient pas toutes une abbréviation de l'incubation tellement accentué. On pourrait parler de souches plus ou moins résistantes à l'influence de la glycérine.

Mais de toutes ces expériences, dont nous ne pouvons pas faire une description détaillée, nous avons l'opinion, que la recherche des bacilles de tuberculose dans les lésions tuberculeuses du poumon des bovidés se fait en général plus vite en usant le terrain non glycériné.

On peut supposer qu'il en soit de même pour la recherche de ces bacilles dans le sang. Pour cette raison nous nous sommes servis dans les expériences décrites ci-dessous du terrain de LOEWENSTEIN non glycériné.

CHANGEMENTS DIVERS DU TERRAIN ARTIFICIEL.

L'examen du Lait.

Remarquons, que les recherches mentionnées ci-dessus offraient une occasion spéciale pour étudier d'autres changements du terrain de LOEWENSTEIN proposés par différents auteurs.

Nos études se sont étendues sur les suivantes:

1. Terrain de LOEWENSTEIN non glycériné (viz. ci-dessus).
2. ,, ,, ,, préparé avec des jaunes d'oeufs (suppression du blanc).
3. Terrain de LOEWENSTEIN préparé avec de l'acide citrique.
4. ,, ,, ,, ,, ,, des oeufs de canard au lieu d'oeufs de poule.

Les oeufs à jaunes foncés se montraient favorables dans le travail de HOHN; les oeufs de canard ont tous le jaune de couleur bien prononcée.

Aucun de ces changements n'a prouvé une amélioration.

Ajoutons que le terrain de LOEWENSTEIN non glycériné nous a aussi servi à la recherche des bacilles de tuberculose dans le lait. Le résultat de l'examen à la microscope du sédiment d'un certain échantillon de lait étant négatif, les bacilles acido résistants se montraient au bout de quatre semaines dans nos éprouvettes au terrain non glycériné Beaucoup d'autres expériences ont affirmé cette observation, mais elles forment un chapitre spécial, que nous ne voulons pas traiter ici en détail. Le résumé suivant suffira.

Le terrain de LOEWENSTEIN non glycériné se montrait un milieu de culture très propre à la découverte des bacilles de KOCH dans le lait et dans d'autres matières tuberculeuses, provenant d'animaux atteints de cette maladie.

Probablement ce terrain sera aussi efficace pour la recherche de ces bacilles dans le sang.

Traitement du sang — et par conséquent aussi des bacilles qu'il contient — préalable à l'inoculation du terrain de culture.

Le traitement des matières tuberculeuses et du sédiment du lait se bornait à l'imhibition à l'acide sulfurique et l'inoculation des éprouvettes. La centrifugation nous sert à faire accumuler les microörganismes rares dans le sédiment, mais en centrifugeant du sang les corpuscules blancs et rouges s'accumulent aussi dans le sédiment volumineux; ainsi la concentration des bacilles dans cette matière ne sera pas très élevée. Il est donc nécessaire de modifier le sang par l'hémolyse pour obtenir dans un sédiment aussi concentré que possible les microorganismes présents.

Notre mode de travail se décrit ainsi:

1. Dès la phlébotomie, une solution de citrate est ajoutée au sang pour éviter la coagulation.
2. Addition de l'acide acétique (0.5 %) pour obtenir l'hémolyse.
3. Centrifugation (3.000 tours par minute pendant 15 minutes).
4. Lavage du sédiment à l'eau distillée, centrifugation répétée.
5. Traitement à l'acide sulfurique (0.5 N. pendant 20 minutes).
6. Lavage à l'eau distillée et centrifugation répétés une ou deux fois.
7. Inoculation des tubes à l'aide d'une pipette stérilisée.

Quelques auteurs sont d'avis que l'hémoglobine retarde le développement des bacilles de tuberculose; pour satisfaire à cette objection le sédiment fut traité à plusieurs reprises à l'acide acétique pour éliminer les dernières traces de cette matière. Mais à la fin de nos recherches nous avons résolu, que le traitement à l'acide acétique prolongé est aussi funeste au développement des colonies. Ce qu'on peut gagner en éliminant l'hémoglobine, se perd par le traitement à l'acide, et surtout l'influence défavorable de l'hémoglobine ne nous semble que très faible.

Au commencement de nos recherches — tous ces détails étant encore inconnus — mon collaborateur BOSGRA a appliqué la méthode de LOEWENSTEIN au sang de quelques bovidés tuberculeux sans autre modification que la suppression de la glycérine.

Le sang, le sédiment et à plus forte raison aussi les bacilles qui s'y trouvaient furent traités au citrate, à l'acide acétique et sulfurique. Après coup il est évident que ce traitement rigoureux ne rendait pas des cultures florides. Une fois de plus je voudrais attirer l'attention aux recherches de VAN WOERDEN. (l. c.) montrant, qu'une augmentation minimale de la concentration de l'acide sulfurique, ou bien de la durée du traitement sont à la fois très défavorables au développement des cultures, surtout dans les cas ou le lait ne contenait que de très rares bacilles.

Évidemment ces considérations s'appliquent aussi à la recherche de ces bacilles dans le sang.

MELANGES DE SANG ET D'UNE CULTURE DE BACILLES DE TUBERCULOSE.

Pour nous orienter sur la tâche à accomplir, nous avons résolu de mêler des échantillons de sang avec des bacilles de KOCH. Une émulsion de ces bacilles a été diluée à titre de $^1/_{10}$; $^1/_{100}$; $^1/_{1000}$ etc. jusqu'à $^1/_{10^8}$, et 5 cc de ces émulsions diluées ont été ajoutées à 20 cc de sang défibriné.

Puis ces échantillons furent traités conformément à la description du chapitre précédent.

Toutes les éprouvettes infectées par le „sang à l'émulsion $^1/_{10}$'' montraient au bout de cinq semaines de belles colonies de bacilles acido-résistants, il y en avait aussi dans un tube de la série „sang à l'émulsion $^1/_{1000}$''.

Nous attribuons ce résultat irrégulier au traitement prolongé à l'acide acétique. Des circonstances imprévues nous ont obligés de laisser les échantillons pendant toute la nuit dans cet acide. Mais ce procédé nous a prouvé que notre technique nous permet de retrouver ces bacilles dans le sang infecté.

PREMIERE SERIE DE BOVIDES TUBERCULEUX.

Résultats négatifs.

Grâce à la collaboration du Prof. Dr. WESTER et du Dr. BEIJERS, des échantillons de sang ont été pris chez quelques vaches tuberculeuses, se trouvant à la clinique médicale de la Faculté de Médecine Vétérinaire.

Je remercie bien sincèrement ces collègues de leur contribution active à ces expériences. Nous avons choisi des animaux, souffrant de grave tuberculose chez lesquels des bacilles acido-résistants se montraient à l'examen microscopique du lait, ou bien de l'urine.

Cette série se compose de treize spécimens.

Après le traitement du sang mentionné ci dessus nous avons inoculé pour chaque échantillon simultanément des éprouvettes au terrain de LOEWENSTEIN (non glycériné) et deux cobayes. (Inoculation sous cutanée de ces derniers à la région inguinale). Les tubes et les cobayes ont été observés au moins pendant huit semaines, dans la majorité des cas plus longtemps. L'autopsie des cobayes exécutée plus de huit semaines après l'inoculation ne montrait aucune lésion tuberculeuse. Tous ces animaux se trouvaient dans une santée parfaite. Le résultat fut donc tout à fait négatif.

A cet époque le vétérinaire BOSGRA dut quitter mon laboratoire pour une autre situation préférable, il transmit sa tâche au vétérinaire P. J. VAN ENDT. L'affirmation des résultats de LOEWENSTEIN semblait alors bien douteuse.

Premier résultat positif chez des animaux inoculés.
Les cultures de LOEWENSTEIN restent négatifs.

La multitude des opérations avec le sang, préalable à l'inoculation des éprouvettes nous semblait tout à fait désavantageuse à un résultat positif et nous obligeait d'essayer d'autres méthodes plus simples.

BOSGRA venait d'excécuter l'expérience suivante:

Une vache tuberculeuse (tuberculose contagieuse de la mammelle, du poumon et des reins) fut saignée d'une veine jugulaire. Après addition d'une solution de citrate, le sang fut divisé en quatre parties d'environ 30 cc. Deux de ces parties furent traitées conformément à la règle ordinaire, le sédiment a été inoculé à deux cobayes.

Des deux autres parties nous avons attendu d'abord la précipitation des globules rouges et blancs, nous avons fait écouler le sérum et nous avons receuilli ensuite, à l'aide d'une pipette, la couche superficielle de la précipitation contenant les cellules blanches, accompagnées de quelques globules rouges. Inoculation de cette couche à deux autres cobayes.

Un troisième couple de cobayes a été inoculé avec le reste, c. a. d. les globules rouges des dernières portions.

Les premiers et les derniers animaux restèrent parfaitement sains et ne montrèrent à l'autopsie aucune trace de tuberculose.

Chez les cobayes, inoculés de la couche des globules blancs se trouvaient les lésions suivantes:

„Glande lymphatique inguinale (Lymph. inguin. superficiale) tuméfiée, contenant une masse caséeuse

„Glande lymphatique iliacale tuméfiée

„Glande portale tuméfiée

„Une petite nodule dans la rate.''

L'examen microscopique de toutes ces lésions prouvait leur nature tuberculeuse, grâce aux jeunes tubercules très distincts portant des bacilles acido-résistants.

Cette expérience n'est pas complète ni indiscutable.

En dehors de ce résultat, nous sommes seulement en possession de l'histoire clinique de cette vache, l'animal lui-même était sorti de la clinique, sans qu'il nous fût possible de faire l'autopsie à l'abattage. L'inoculation de la matière suspecte des lésions de nos cobayes chez d'autres animaux d'expérience, a été suprimée; leur caractère contagieux n'est donc pas tout à fait prouvé.

Cependant cette observation a eu une influence définitive pour la continuation des recherches. Elle prouvait l'existance des bacilles de tuberculose dans le sang d'un animal tuberculeux. En considérant l'efficacité de la méthode de LOEWENSTEIN, appliquée à l'examen du lait et à d'autres matières tuberculeuses, un pareil résultat avec le sang semblait possible.

VAN ENDT a tâché d'abord d'améliorer la technique en supprimant le traitement rigoureux à l'acide avant l'inoculation. Pour ce but une modification liquide du terrain de LOEWENSTEIN fut divisée par lui. La mixture de la solution des sels et des oeufs etc. nommée page 11 ne fut plus échauffée jusqu'à la coagulation mais traitée d'une stérilisation fractionée (chauffage à 55° C. trois fois pendant une heure).

Plusieurs fois l'inoculation des terrains solides a été accompagnée de tels inoculations dans la modification soluble, soit avec le sang pur, soit avec le sédiment traité aux acides. Après l'incubation de huit jours d'autres terrains spéciaux ont été infectés par quelques gouttes des cultures „LOEWENSTEIN liquides''. Au bout de trois semaines l'examination macroscopique de ces cultures secondaires démontrait des cultures de bacilles acidorésistants. En comparant ces derniers avec les cultures originales sur „LOEWENSTEIN solide'' elles ne se montraient pas plus florides ni plus nombreuses. Il n'y avait pas une réduction appréciable de la durée de l'incubation.

D'autres terrains artificiels, comme celui de PETRAGNANI et de BESREDKA ont été examinés simultanément. Le „BESREDKA'' ne donnait pas des résultats encourageux, le „PETRAGNANI'' rendait de temps en temps des cultures aussi remarquables que le „LOEWENSTEIN''. Mais ce dernier nous semblait préférable, sans qu'il y eût une grande différence entre ces deux.

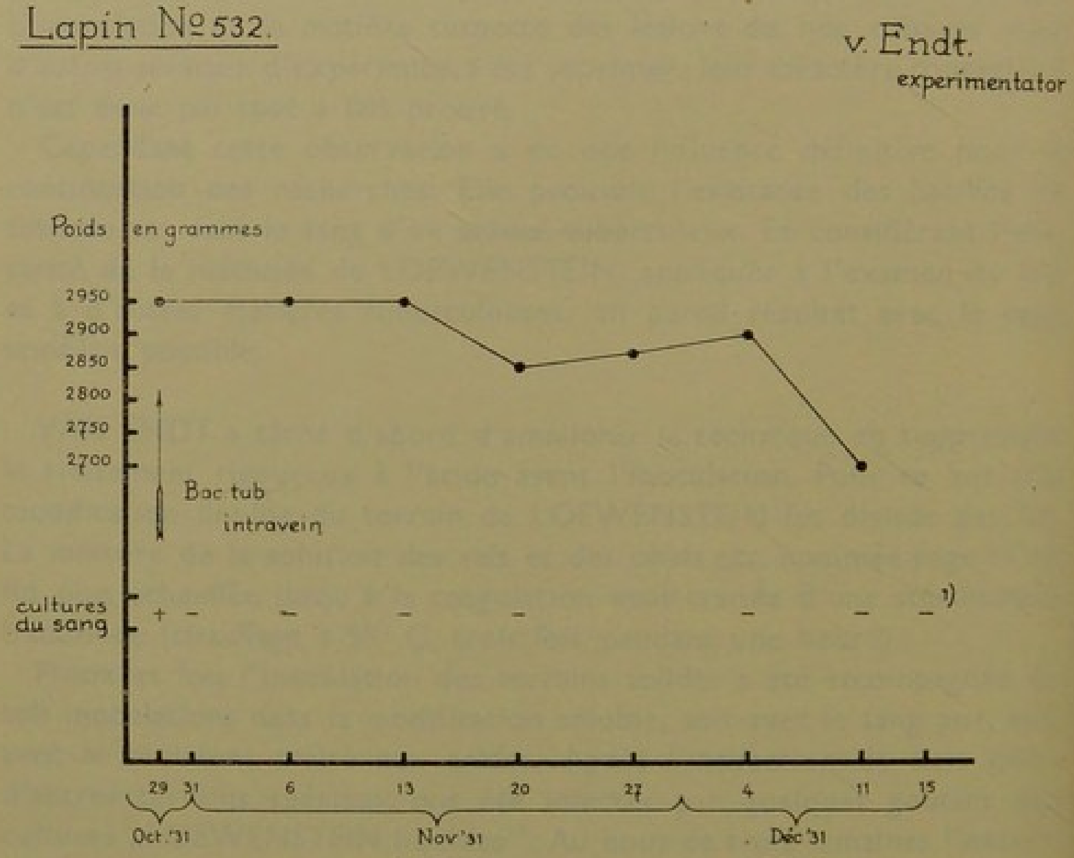
Enfin nous ne nous sommes pas bornés à l'examen des bovidés, nous avons étendu nos recherches à d'autres animaux.

L'EXAMEN DU SANG DES PETITS ANIMAUX D'EXPERIENCE.

a. Lapins.

Le lapin No. 532 reçut à la veine marginale de l'oreille gauche une cc. d'une émulsion de bacilles de tuberculose (souche H Z No. 19). Cette souche a été cultivée au terrain de LOEWENSTEIN non glycériné, d'une lésion tuberculeuse, du poumon d'une vache Le lapin mourut au bout de 48 jours, l'autopsie montrait des lésions tuberculeuses des poumons; du foie et de plusieurs glandes lymphatiques. La rate surtout était criblée de petits nodules de caractère tuberculeux; les reins ne montraient que quelques lésions plus grandes.

No 1



Tubercules miliaires

Poumon + Foie + Rate + + Rein +

[1]) sang coeur droit

Huit échantillons du sang, obtenus par phlébotomie et un autre receuilli post mortem dans le coeur ont été examinés. La première expérience fut exécutée dix minutes après l'inoculation des bacilles. Quelques gouttes du sang sont transportées dans une éprouvette contenant du terrain de LOEWENSTEIN forme liquide; inoculation avec cette culture sur des terrains „LOEWENSTEIN solide'' au bout de huit jours. Six semaines après ceux-ci montraient une culture peu floride de bacilles acido-résistants. Evidemment les microörganismes originaire de ce culture faisaient partie de la culture inoculée.

L'expérience ne prouve pas du tout, qu'un lapin tuberculeux porte les bacilles de cette maladie dans le sang.

Remarquons que la souche a été cultivée sur le terrain „LOEWENSTEIN solide'', les bacilles s'étaient donc déjà adoptés à ce milieu arti-

Lapin 532. TABLE No. 1.

Date	Origine du sang	Traitem. du sang.	Cultures inoculées	Transport		Résultat.
29/10/32 10 min. p. inj.	Veine de l'oreille gauche.	Aucun.	L. liq.	7/10	L. sol. L. sol. L. sol.	négatif négatif **positif**
31/10 2 jours p. inj.	idem	idem	L. sol. L. liq. Besredka	 9/11 9/11	 L. sol. L. sol.	négatif negatif negatif
6/11 8jours p. inj.	idem	citrate ac. acét. ½ %	L. sol. L. sol. L. liq. L. liq. Besredka	 19/11 19/11	 L. sol. L. sol.	négatif negatif infecté négatif négatif
13/11 15 j. p. inj.	idem	idem	L. sol. L. sol. L. liq. L. liq.	 20/11 20/11	 L. sol. L. sol.	négatif négatif négatif négatif
20/11 22 jours p. inj.	idem	idem	L. sol. L. sol. L. sol.			infecté infecté infecté
4/12 36 j. p. inj.	idem	idem	L. sol. L. sol. L. sol. L. liq.	 11/12	 L. sol.	négatif négatif négatif négatif
11/12 43 j. p. inj.	idem	idem	L. sol. L. sol. L. sol.			négatif infecté infecté
15/12 47 j. p. inj.	coeur droit	Aucun	L. sol. L. sol.			négatif infecté

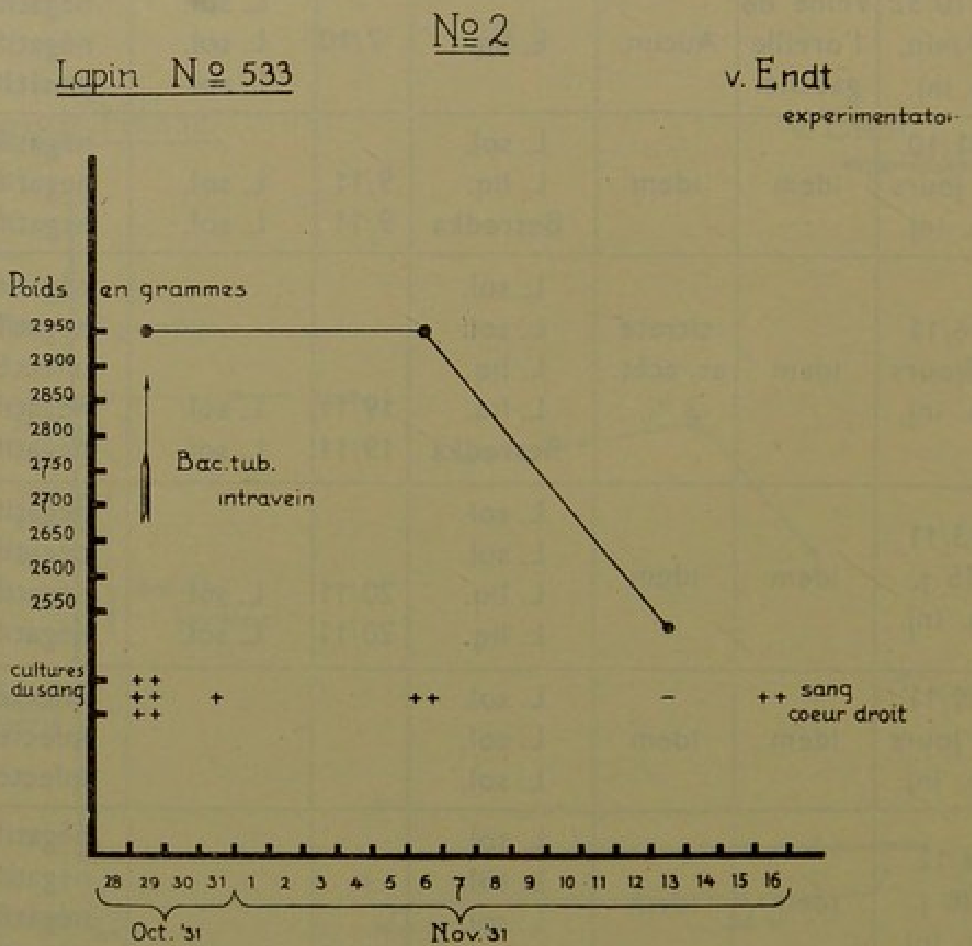
ficiel. L'expérience est analogue à celle du sang mêlé d'une culture „en vitro" (voir page 16), mais dans celle ci le mélange a été fait dans les artères et dans les veines d'un animal vivant.

Cependant le résultat indiqua le mode d'opération à suivre, le succès étant obtenu en inoculant du sang, inaltéré.

Le diagramme No. I et la table No. I donnent un résumé de toutes les cultures préparées avec le sang de cet animal.

Lapin No. 533.

Injection d'une cc. d'émulsion de bacilles de tuberculose dans la veine marginale de l'oreille droite. (Souche H Z No. 18). Cette souche a été cultivée du sédiment d'un échantillon de lait sur le terrain „LOEWENSTEIN solide".. Le sédiment fut traité pendant 15 minutes à l'acide



Tubercules miliaires

Poumon + + Foie + Rate +

sulfurique 0.5 N. Probablement ces bacilles ne se sont pas seulement accomodés à ce milieu artificiel, mais ils possèdent aussi une résistance appréciable contre l'acide sulfurique. Remarquons que le lait, dans lequel des bacilles acidorésistants se montraient à l'examen microscopique, venait de la vache No. I (voir page 43).

L'inoculation avec ce sédiment au terrain LOEWENSTEIN procurait des cultures florides au bout de six jours.

A l'autopsie, — l'animal mourut 17 jours après l'inoculation, — on trouvait une grave tuberculose des poumons (c. a. d. d'anciennes lésions à côté de nodules miliaires) accompagnée de quelques nodules tuberculeuses de la rate.

Lapin 533. TABLE No. 2.

Date	Origine du sang	Traitem. du sang	cultures inoculées	Transport		Résultat
			L. sol.			**Positif** 15 j. [1]
29/10/32	Veine de			7/11	L. sol.	**Positif** 41 j.
10 min	l'oreille	Aucun	L. liq.	7/11	L. sol.	**Positif** 41 j.
p. inj.	gauche			7/11	L. sol.	**Positif** 45 j.
			Besredka	7/11	L. sol.	**Positif** 36 j.
			L. liq. 1	7/11	L. sol.	**Positif** 45 j.
31/10			L. sol.			**Positif** 26 j.
2 j.	idem	idem	L. liq.	7/11	L. sol.	négatif
p. inj.			Besredka	7/11	L. sol.	négatif
			L. sol.			**Positif** 41 j.
6/11		citrate	L. sol.			**Positif** 41 j.
8 j.	idem	Ac. acét.	L. sol.			négatif
p. inj.		½ %	L. liq.	13/11	L. sol.	négatif
			Besredka	13/11	L. sol.	négatif
13/11			L. sol.			négatif
15 j.	idem	idem	L. sol.			négatif
p. inj.			L. liq.	20/11	L. sol.	négatif
			L. liq.	20/11	L. sol.	négatif
16/11			L. sol.			**Positif** 31 j.
18 j.	coeur	aucun	L. sol.			**Positif** 31 j.
p. inj.	droit		L. liq.	23/11	L. sol.	négatif
			L. liq.	23/11	L. sol.	négatif

La cachexie de l'animal fut très accentuée. Le diagramme No. 2 et la table No. 2 nous montrent tous les détails des inoculations exécutés avec le sang de ce lapin.

Cinq échantillons ont été examinés; au bout de dix minutes, deux jours, sept et quatre jours, succédant à l'inoculation et enfin à l'autopsie.

---

[1]) 15 j. veut dire : 15 journées après l'inoculation.

Toutes les séries avéraient la présence des bacilles de KOCH, à l'exception de l'avant dernière, qui restait négative.

Un tube au terrain „LOEWENSTEIN solide'' ensemencé avec du sang inaltéré (receuilli dix minutes p. i. du lapin No. 533) fut positif au bout de quinze jours. Dans plusieurs autres séries l'inoculation des tubes au „LOEWENSTEIN liquide'', ou bien au „milieu de BESREDKA'', a été suivi par la transplantation sur le terrain de LOEWENSTEIN solide. Cependant les cultures d'origine „LOEWENSTEIN liquide'' poussaient plus vite que celles venant du „BESREDKA''.

La durée de l'incubation de ces dernières variait de quatre à huit semaines; une éprouvette dans laquelle on a répandu quelques gouttes d'un tube au „LOEWENSTEIN liquide'' démontrait des colonies visibles au bout d'une semaine.

L'inoculation de quelques tubes au terrain „LOEWENSTEIN solide'' avec du sang inaltéré (receuilli à l'autopsie dans le coeur de ce lapin) désignait des colonies au bout de 31 jours.

Nous avons rencontré beaucoup de difficultés en prouvant le caractère spécifique des bacilles de ces dernières souches et de celles de la première série. Une partie seulement des spécimins de ces colonies démontrait des bacilles acido-résistants. Ceux appartenant à l'émulsion injectée possédait cette qualité sans exception. Pour prouver l'identité des bacilles obtenus du sang avec celle du virus spécifique de la tuberculose, l'inoculation d'un animal susceptible de cette maladie semblait indispensable. (Cobaye No. 541). Cet animal mourut de la tuberculose généralisée (voir ci-dessous). Les bacilles obtenus dans le sang du lapin furent donc de vrais bacilles de tuberculose.

L'expérience du lapin No. 533 prouva l'apparition des bacilles de tuberculose dans le sang au bout de dix minutes, deux, sept, et dix-sept jours après l'inoculation expérimentale.

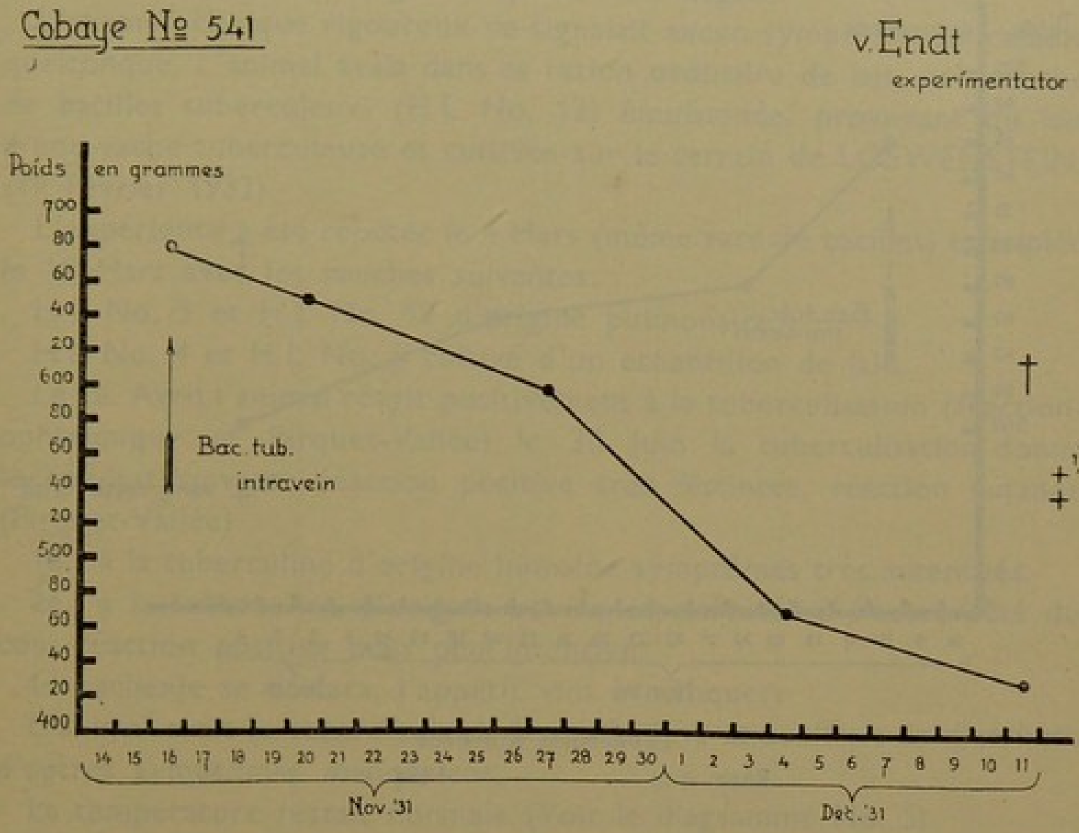
b. Cobayes.

Le cobaye No. 541 subit une injection d'une émulsion de bacilles de tuberculose, provenant du sang du lapin No. 533 et receuilli dix minutes après l'inoculation de cet animal avec une souche H L 19 émulsionée. Au bout d'une incubation de 26 jours, l'abcès, formé à l'endroit de l'injection s'ouvrit. Le pus renfermait des bacilles acido-résistants.

Après la mort du cobaye (26 jours post injectionam) l'autopsie relevait la tuberculose miliaire du foie, de la rate, accompagnée de tuberculose des glandes lymphatiques iliacales (médiales et latérales) du côté de l'injection.

Nous receuillîmes à cautères aseptiques et à l'aide d'une pipette stérilisée du sang dans le coeur droit et répandîmes ce sang inaltéré dans deux éprouvettes au terrain „LOEWENSTEIN solide''. Au bout de sept jours déjà, on constata plusieurs colonies de bacilles acido-résistants. (voir le diagramme No. 3).

No 3



[1]) sang coeur droit

Le cobaye No. 538 a été soumis à l'injection d'une émulsion dan; la région de l'hypogastre. Les bacilles de tuberculose provenaient du sang de la vache No. 1. (Voir page 43).

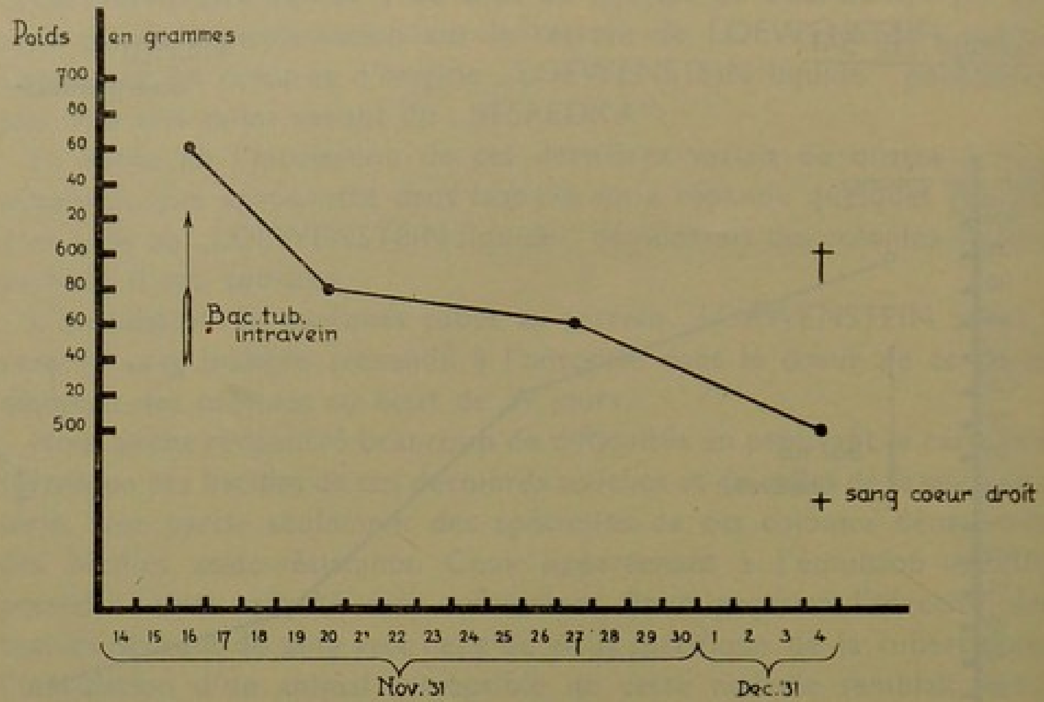
Le petit rongeur mourut au bout de 19 jours. Voici l'autopsie: A l'endroit de l'injection se trouve un abcès ouvert, portant des bacilles acido résistants bien développés. La rate et le foie tuméfiés montrent plusieurs nodules miliaires. Les glandes lymphatiques régionales à l'endroit de l'injection (Lgl. iliacae médiales, et Lgl. sacrales) sont atteintes.

Deux tubes du terrain „LOEWENSTEIN solide" reçoivent quelques gouttes du sang, pris dans le coeur droit, à l'aide d'une pipette stérilisée. Plusieurs colonies de bacilles acido-résistants apparaissent au bout de quinze jours. (Comparer le diagramme No. 4). La substance de la rate inoculée au cobaye No. 544 provoqua chez cet animal la tuberculose des poumons du foie et de la rate (Autopsie 18—1—32).

Les bacilles receuillis du sang du cobaye No. 538 sont donc de vrais bacilles de tuberculose.

No 4

Cobaye No 538 v. Endt.
experimentator.



Tubercules miliaires

Rate ++ Foie ++

L'EXAMEN DU SANG DES VEAUX SOUMIS A L'INFECTION EXPERIMENTALE.

Le Veau No. 2, âgé de deux mois, race pie noire Friso-Hollandaise, masculin, tuberculiné par moyen de l'ophthalmo réaction et de celle de Pirquet-Vallée ne réagissait qu'au sens négatif.

L'examen clinique rigoureux ne signalait aucun symptôme de maladie quelconque. L'animal avala dans sa ration ordinaire de lait, une souche de bacilles tuberculeux. (H L No. 12) émulsionée, provenant du lait d'une vache tuberculeuse et cultivée sur le terrain de LOEWENSTEIN. (19 Février 1932).

L'expérience a été répétée le 4 Mars (même race de bacilles) et triplée le 18 Mars avec les souches suivantes:

H L No. 3 et H L No. 19 d'origine pulmonaire.

H L No. 4 et H L No. 5 cultivé d'un échantillon de lait.

Le 1e. Avril l'animal réagit positivement à la tuberculisation (réaction-ophtalmique et Pirquet-Vallée) le 30 Juin la tuberculisation donna le résultat suivant: réaction positive très distincte, réaction cutanée (Pirquet-Vailée).

1e. à la tuberculine d'origine humaine symptômes très accentués.

2e. à la tuberculine d'origine bovine et exécutée à l'autre côté du cou, réaction positive mais peu intensive.

La cachexie se déclara, l'appétit vint à manquer.

L'animal avait le ventre relevé, les poils durs et souffrait de diarrhée; d'autres symptômes manquaient.

La température restait normale (Voir le diagramme No. 5).

On préleva des échantillons de sang 4 à 5 heures après l'ingestion des bacilles tuberculeux pour vérifier l'opinion de quelques auteurs, que ceux-ci dépassent la muqueuse de l'intestin à la fin de ce délai. L'examen du sang a été répété hebdomadairement plus tard avec des intervalles plus longs.

La série des terrains artificiels se composait pour l'examen de chaque échantillon:

1e. des terrains de LOEWENSTEIN non glycérinés formes „solide" et „liquide".

2e. du terrain de PETRAGNANI.

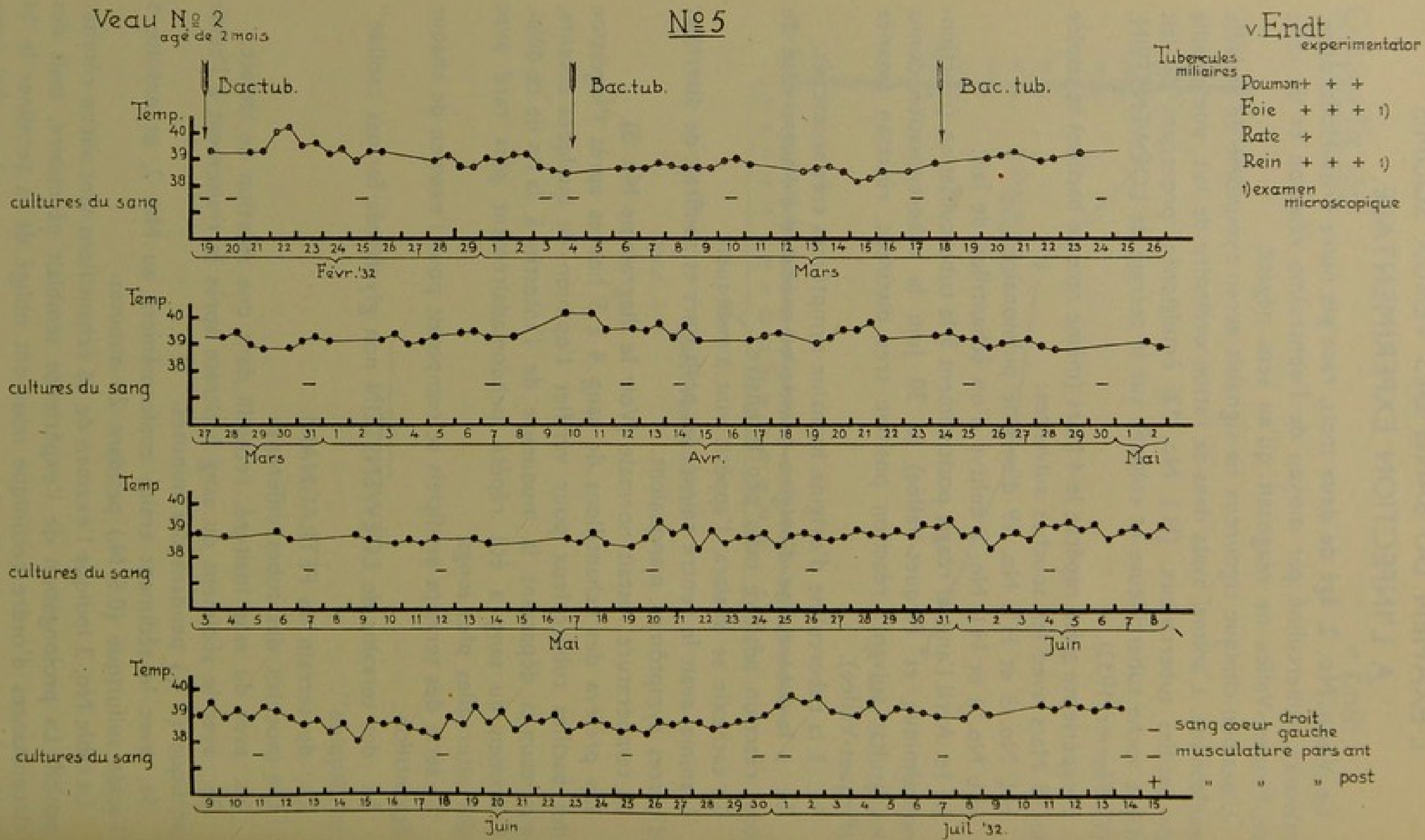
On inoculait des tubes différents.

1e. avec du sang inaltéré, receuilli dans une solution de citrate.

2e. avec le sédiment du sang à citrate après le traitement à l'acide acétique (5 %) pendant dix minutes.

3e. avec le sédiment traité conformément au No. 2, et ensuite à l'acide sulfurique (0.5 N.) pendant 20 minutes.

La table No. 3 indique l'examen de 26 échantillons sans aucun résultat positif. La prolongation de l'expérience semblait nécessaire, mais des circonstances d'ordre technique nous ont obligé de la terminer le 14 Juillet. Le récit détaillé de l'autopsie se trouve au procès verbal (voir


Veau N° 2
agé de 2 mois
N° 5
v. Endt
experimentator
Bac.tub.
Bac.tub.
Bac. tub.
Temp.
40
39
38
cultures du sang
Févr. '32
Mars
Avr.
Mai
Juin
Juil '32.
Tubercules miliaires
Poumon + + +
Foie + + + 1)
Rate +
Rein + + + 1)
1) examen microscopique
— sang coeur droit gauche
— — musculature pars ant
+ " " " post

eau No. 2.

e	Traitem. du sang	Cultures inoculées	Transp.		Résultat
32 .i.	Citrate	L. sol. L. liq. Pétragn.	12/3	L. sol. Pétr.	négatif négatif négatif
	Citrate ac. acét. 0,5%	L. sol. 2 L. liq. Pétragn. 2	12/3	L. sol. Pétr.	négatif négatif négatif
	Citrate ac. acét. 0,5% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. liq. Pétragn. 2	12/3	L. sol. Pétr.	négatif négatif négatif
	Citrate	L. sol. L. liq. Pétragn.	12/3	L. sol. Pétr.	négatif négatif négatif
	Citrate ac. acét. 0,5%	L. sol. 2 L. liq. Pétragn. 2	12/3	L.sol. Petr.	négatif négatif négatif
	Citrate ac. acét. 0,5% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. liq. Pétragn. 2	12/3	L. sol. Pétr.	négatif négatif négatif
	Citrate	L. sol. L. liq. Pétragn.	12/3	L. sol. Pétr.	négatif infecté négatif
	Citrate ac. acét. 0,5%	L.sol. 2 L. liq. Prétagn. 2	12/3	L. sol. Pétr.	négatif infecté négatif
	Citrate ac. acét. 0,5% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. liq. Pétragn. 2	23/3	L. sol. Pétr.	négatif infecté négatif
	Citrate	L. sol. Pétragn.			négatif infecté
	Citrate ac. acét. 0,5%	L.sol. 2 Pétragn. Pétragn.			négatif négatif infecté
	Citrate ac. acét. 0,5% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L.sol. 2 Pétragn. Pétragn.			négatif négatif infecté
.i.	Citrate	L.sol. Pétragn.			négatif négatif
	Citrate ac. acét. 0,5%	L. sol. 2 Pétragn. Pétragn.			négatif négatif infecté
	Idem ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 Pétragn. 2			négatif négatif
	Citrate	L. sol. L. liq. Pétragn.	17/5	L. sol. Pétr.	négatif négatif infecté négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. liq. Pétragn. 2	17/5	L. sol. Pétr.	négatif négatif infecté négatif
	Idem ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 Pétragn. 2			négatif négatif
	Citrate	L. sol. Pétragn.			négatif négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 Pétragn. 2			négatif négatfi
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 Pétragn. Pétragn.			négatif négatif infecté
	Citrate	L. sol. L. liq. Pétragn.	17/5	L. sol. Pétr.	négatif infecté infecté
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. liq. Pétragn. 2	17/5	L. sol. Pétr.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. liq. Pétragn. 2	17/5	L. sol.	négatif infecté négatif

TABLE No. 3. Vena Jugul. sinistra.

Date	Traitem. du sang	Cultures inoculées	Transp.		Résultat
31/3	Citrate	L. sol. Pétragn.			négatif négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. liq. Pétragn. 2	17/5	L. sol.	négatif infecté négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. liq. Pétragn. 2	17/5	L. sol. Pétr.	négatif négatif infecté négatif
7/4	Citrate	L. sol. L. liq. Pétragn.	17/5	L. sol. Pétr.	négatif négatif infecté négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. liq. Pétragn. 2	17/5	L. sol. Pétr.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. liq. Pétragn. 2	17/5	L. sol. Pétr.	négatif négatif négatif
12/4	Citrate	L. sol. Pétragn.			négatif négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. liq. Pétragn. 2	17/5	L. sol. Pétr.	négatif négatif infecté infecté
	Idem ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 Pétragn. 2			négatif infecté
14/4	Citrate	L. sol. L. liq. Pétragn.	17/5	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. liq. Pétragn. 2	17/5	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. L. sol. L. liq. Pétragn. 2	17/5	Pétr.	infecté négatif négatif négatif
25/4	Citrate	L. sol. L. liq. Pétragn.	17/5	L. sol. Pétr.	négatif infecté négatif négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. liq. Pétrang.	17/5	L. sol.	infecté infecté négatif
	Idem ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 Pétragn.			négatif négatif
30/4	Citrate	L.sol. L. liq. Pétragn.	17/5	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 Pétragn. Pétragn.			négatif infecté négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. liq. Pétragn.	17/5	L. sol. Pétr.	négatif négatif infecté négatif
7/5	Citrate	L. sol. L. liq. Pétragn.	30/5	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. liq. Pétragn. 2	30/5	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 IL. iq. Pétragn. Pétragn.	30/5	L. sol.	négatif négatif négatif infecté

Date	Traitem. du sang	Cultures inoculées	Transp.		Résultat
12/5	Citrate	L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif négatif négatif
	Citrate ac. acét. ½ %	L. sol. 2 L. liq. Pégtran. 2	23/6	L. sol.	infecté négatif négatif
	Citrate ac. acét. ½ % ac. sulf. ½ N. ½ h.	L. sol. L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif infecté négatif négatif
20/5	Citrate	L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif infecté négatif
	Citrate ac. acét. ½ %	L. sol. 3 L. liq. Pétragn.	23/6	L. sol.	négatif négatif infecté
	Citrate ac. acét. ½ % ac. sulf. ½ N. ½ h.	L. sol. 3 L. liq. Pétragn.	23/6	L. sol.	négatif négatif infecté
26/5	Citrate	L. sol.* Pétragn.			négatif négatif
	Citrate ac. acét. ½ %	L. sol. L. sol. 2 Pétragn.			infecté négatif négatif
	Idem ac. sulf. ½ N. ½ h.	L. sol. 3 Pétragn.			négatif négatif
4/6	Citrate	L. sol. L. liq. Pétragn.	23/6	L. sol.	infecté infecté négatif
	Citrate ac. acét. ½ %	L. sol. 3 L. liq. Pétragn.	23/6	L. sol.	négatif négatif négatif
	Citrate ac. acét. ½ % ac. sulf. ½ N. ½ h.	L. sol. L. sol. 2 L. liq. Pétragn.	23/6	L. sol.	infecté négatif négatif négatif
11/6	Citrate	L. sol. L. liq. Pétragn.	4/8	L. sol.	infecté négatif négatif
	Citrate ac. acét. ½ %	L. sol. 3 L. liq. Pétragn.	4/8	L. sol.	infecté négatif infecté
	Citrate ac. acét. ½ % ac. sulf. ½ N. ½ h.	L. sol. 3 L. liq. Pétragn.	4/8	L. sol.	infecté négatif infecté
18/6	Citrate	L. sol. Pétragn.			infecté négatif
	Citrate ac. acét. ½ %	L. sol. 3 Pétragn.			infecté négatif
	Citrate ac. sulf. ½ N. ½ h.	L. sol. 3 Pétragn.			infecté négatif
25/6	Citrate	L. sol. L. liq. Pétragn.	4/8	L. sol.	infecté négatif infecté
	Citrate ac. acét. ½ %	L. sol. 3 L. liq. Pétragn.	4/8	L. sol.	infecté négatif négatif
	Citrate ac. acét. ½ % ac. sulf. ½ N. ½ h.	L. sol. L. sol. 2 L. liq. Pétragn.	4/8	L. sol.	négatif infecté négatif négatif

Date	Traitem. du sang	Cultures inoculées	Transp.		Résul
30/6	Citrate	L. sol. L.liq. Pétragn.	4/8	L. sol.	infect négat négat
	Citrate ac. acét. ½ %	L. sol. L. sol. 2 L. liq. Pétragn.	4/8	L. sol.	infect négat négat négat
	Citrate ac. acét. ½ % ac. sulf. ½ N. ½ h.	L. sol. 3 L. liq. Pétragn.	4/8	L. sol.	négat négat négat
1/7	Citrate	L. sol. L. liq. Pétragn.	4/8	L. sol.	négat négat négat
	Citrate ac. acét. ½ %	L. sol. L. sol. 2 L. liq. Pétragn.	4/8	L. sol.	infect négat négat infect
	Citrate ac. acét. ½ % ac. sulf. ½ N. ½ h.	L. sol. L. sol. 2 L. liq. Pétragn.	4/8	L. sol.	infect négat négat infect
7/7	Citrate	L. sol. L. liq. Pétragn.	4/8	L. sol.	négat négat négat
	Citrate ac. acét. ½ %	L. sol. 2 L. sol. L. liq. Pétragn.	4/8	L. sol.	infect négat négat négat
	Citrate ac. acét. ½ % ac. sulf. ½ N. ½ h.	L. sol. 3 L. liq. Pétragn.	4/8	L. sol.	négat négat négat
14/7	Citrate	L. sol. L. liq. Pétragn.	4/8	L. sol.	négat négat infect
	Citrate ac. acét. ½ %	L. sol. L. sol. 2 L. liq. Pétragn.	4/8	L sol.	infect négat négat négat
	Citrate ac. acét. ½ % ac. sulf. ½ N. ½ h.	L. sol. L. sol. 2 L. liq. Pétragn.	4/8	L. sol.	infect négat négat négat
14/7 coeur droit	Citrate ac. acét. ½ %	L. sol. L. sol. 2 Pétragn.			infect négat négat
	Idem ac. sulf. ½ N. ½ h.	L. sol. 3 Pétragn.			négat négat
14/7 coeur gauche	Citrate ac. acét. ½ %	L. sol. L. sol. 2 Pétragn.			infect négat négat
	Idem ac. sulf. ½ N. ½ h.	L. sol. Pétragn.			infect infect

l'annexe page 57) rédigé gracieusement, — comme tous les autres — par le Prof. Dr. SCHORNAGEL, directeur de l'institut de l'anatomie pathologique. Je remercie chaleureusement mon collègue ainsi que monsieur le vétérinaire J. H. TEN THIJE pour leur concours effectif.

La fin de l'expérience se constituait en cultures du sang prélévé du coeur droit et du suc de viande de la partie thoracique et de la cuisse; celles ci exécutées conformément à la technique VAN WOERDEN-WILLEMS (Voir page 12).

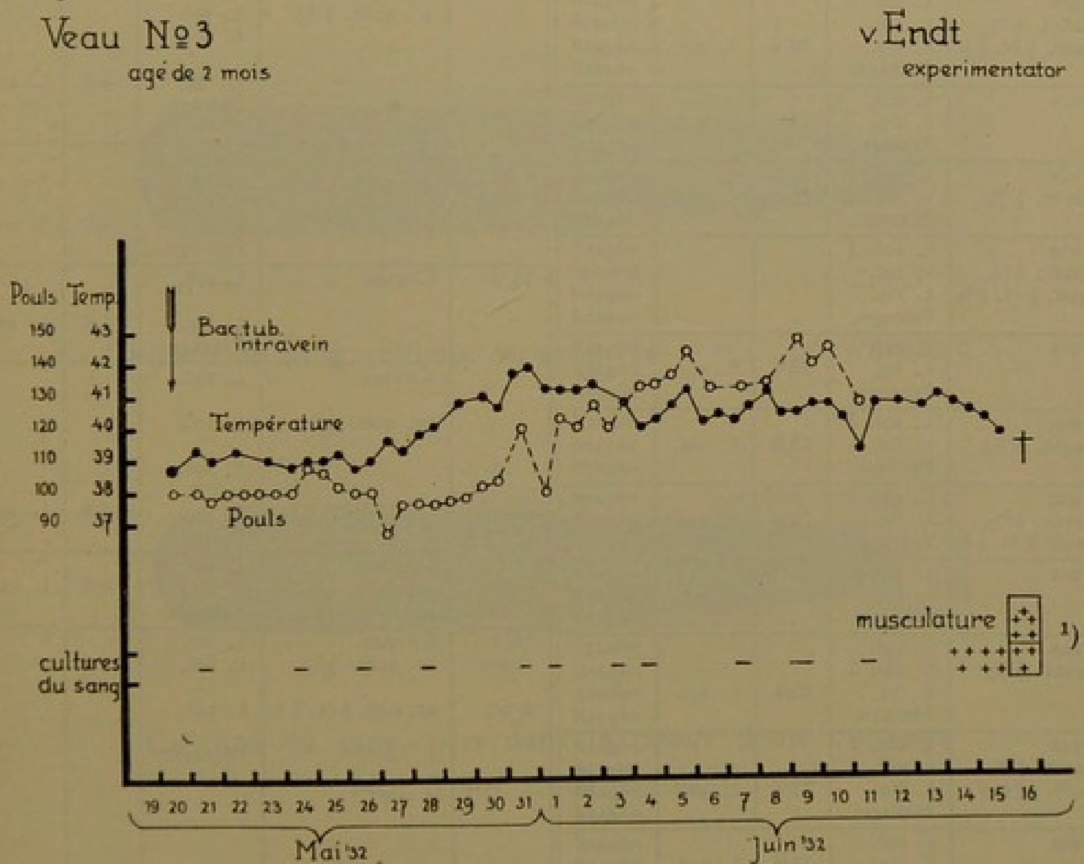
L'examen microscopique des poumons du foie et des reins montrait des nodules tuberculeuses miliaires; les cultures des glandes mésentériques renfermaient des bacilles acido-résistants. Pour terminer, une culture du suc de viande de la cuisse présentait des bacilles tuberculeux.

Résumons:

Dans le cas du veau No. 2 des lésions tuberculeuses miliaires manquaient à l'autopsie, mais se démontraient à l'examen microscopique des organes. Le suc de viande renfermait des bacilles tuberculeux. Les cultures du sang restèrent tous négatifs.

Le veau No. 3, né dans l'étable de l'institut servit à l'expérience suivante:

№ 6



Tubercules miliaires

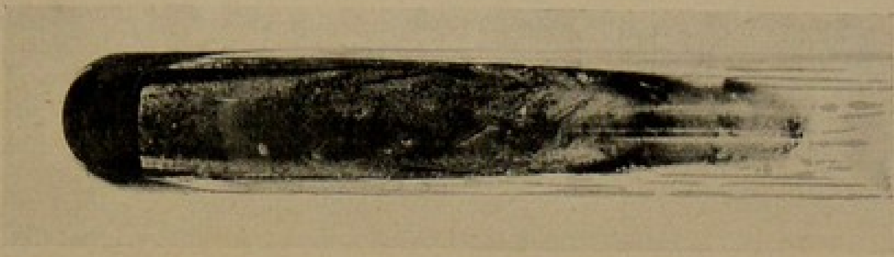
Poumon + + +　　Foie + + +　　Rate + + +　　Rein + + +

1) Sang coeur droit.

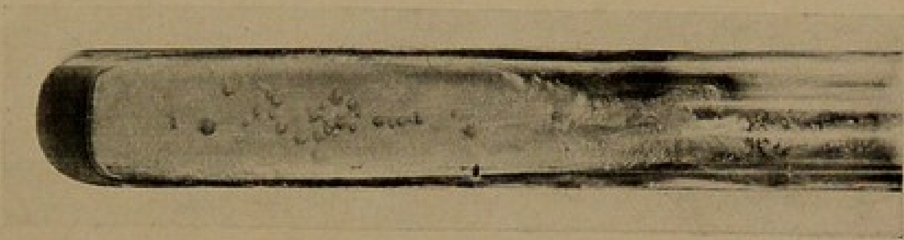
Date	Traitem. du sang	Cultures inoculées	Transp.		Résultat
21/5	Citrate	L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 3 L. liq. Pétragn.	23/6	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif infecté négatif négatif
24/5	Citrate	L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif infecté négatif négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif infecté négatif négatif
26/5	Citrate	L. sol. Pétragn.			infecté négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 3 Pétragn.			négatif négatif
	Idem ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 3 Pétragn.			négatif négatif
28/5	Citrate	L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif infecté négatif
	Citrate ac. acét. $\frac{1}{2}$ %	L. sol. 3 L. liq. Pétragn.	23/6	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif infecté négatif négatif
31/5	Citrate	L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif infecté négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 3 L. liq. Pétragn.	23/6	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. sol. L. liq. Pétragn.			négatif infecté négatif négatif
1/6	Citrate	L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 3 L. liq. Pétragn.	23/6	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 3 L. liq. Pétragn.	23/6	L. sol.	négatif négatif négatif
3/6	Citrate	L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif négatif négatif
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. L. sol. 2 L. liq. Pétragn.	23/6	L. sol.	infecté négatif infecté négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif infecté négatif négatif
4/6	Citrate	L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif négatif infecté
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif infecté négatif négatif
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. L. liq. Pétragn.	23/6	L. sol.	négatif infecté négatif

Date	Traitem. du sang	Cultures inoculées	Transp.		Résul
7/6	Citrate	L. sol. L. liq. Pétragn.	4/8	L. sol.	néga néga infec
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. liq. Pétragn.	4/8		néga néga néga
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 3 L. sol. L. liq. Pétragn.	4/8	L. sol.	néga infec néga infec
9/6	Citrate	L. sol. L. liq. Pétragn.	4/8	L. sol.	néga néga infec
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 2 L. sol. L. liq. Pétragn.	4/8	L. sol.	néga infec néga infec
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. sol. L. liq. Pétragn.	4/8	L. sol.	néga infec néga infec
11/6	Citrate	L. sol. L. liq. Pétragn.	4/8	L. sol.	néga néga infec
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. 3 L. liq. Pétragn.	4/8	L. sol.	néga néga infec
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 3 L. liq. Pétragn.	4/8	L. sol.	néga néga infec
14/6	Citrate	L. sol. L. liq. Pétragn.	4/8	L. sol.	infec néga néga
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. L. sol. L. sol. L. liq. Pétragn.	4/8	L. sol.	néga infec posit 57 j néga posit 57 j
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 2 L. sol. L. liq. Pétragn.	4/8	L. sol.	infec posit 45 j néga néga
15/6	Citrate	L. sol. L. liq. Pétragn.	4/8	L. sol.	posit 52 j. néga néga
	Citrate ac. acét. $\frac{1}{2}$%	L. sol. L. sol. L. sol. L. liq. Pétragn.	4/8	L. sol.	posit 44 j. posit 44 j. posit 52 j. néga infect
	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. 3 L. liq. Pétragn.	4/8	L. sol.	infec néga infec
16/6 coeur droit	Citrate ac. acét. $\frac{1}{2}$% ac. sulf. $\frac{1}{2}$ N. $\frac{1}{2}$ h.	L. sol. L. sol. L. sol. Pétragn.			infect positi 60 j. positi 60 j. positi 51 j.

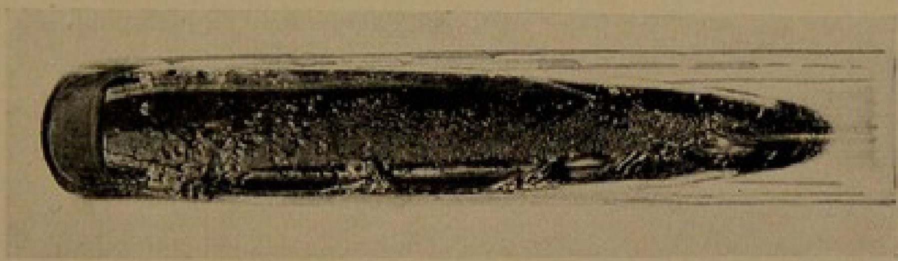
BACILLUS TUBERCULOSIS



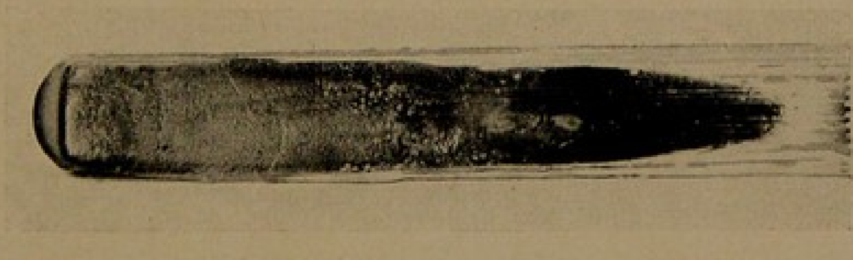
Culture du sang veineux du veau No. 1 sur „Loewenstein"



Culture du sang veineux du veau No. 1 sur „Petragnani"



Culture du sang veineux du veau No. 3 sur „Loewenstein"



Culture du sang, pris dans le coeur droit du veau No. 3 sur „Loewenstein"

L'animal ne présente à l'examen clinique rigoureux aucun signe de maladie. La réaction à la tuberculine (réaction ophtalmique et Pirquet Vallée) est négative. On choisit pour mode d'infection la voie intraveineuse en injectant une émulsion de culture, obtenue du coeur du lapin No. 533, cultivée sur le terrain LOEWENSTEIN non glycériné.

L'animal vécut encore vingt-sept jours après l'inoculation. Rappelons les symptômes cliniques suivants: respiration accélerée dès l'onzième jour p. i. — l'auscultation révélait le bruit d'inspiration vésiculaire accentuée — et diarrhée intermettante. Le diagramme No. 6 représente la fréquence du pouls et la température quotidienne.

Citons le procès-verbal de l'autopsie (voir page 57). Tuberculose miliaire, forme acute et grave, des poumons du foie de la rate et des reins, accompagnée de tuberculose caséeuse prononcée des glandes lymphatiques bronchiales.

La table No. 4 contient les détails de l'examen de treize échantillons de sang pris au cours de 27 jours. Le traitement du sang et les inoculations sont conformes à ceux de la série précédente (Veau No. 2). Seulement on ajoutait des inoculations avec du sang pris dans le coeur droit après la mort de l'animal, avec du suc de viande d'une partie orale et d'une partie coudale de l'animal et avec de la substance de quelques glandes lymphatiques.

Nous rencontrons les résultats positifs suivants:

A. Examen du sang.

1. Échantillon prélèvé deux jours avant la mort. Inoculation du sédiment non traité à l'acide sulfurique.

Une culture de „LOEWENSTEIN non glycériné".

Une culture de PETRAGNANI.

2. Échantillon prélevé le jour précédant la mort. Inoculation du sédiment conforme au No. 1.

Trois cultures de „LOEWENSTEIN non glycériné".

3. Échantillon pris à l'autopsie. Inoculation du sédiment traité à l'acide sulfurique.

Une culture de PETRAGNANI.

B. Examen des glandes lymphatiques.

Lymphagl. cervical. superficial. Une „LOEWENSTEIN nonglycérinée.

Une PETRAGNANI.

Lymphagl. iliaca interna dextra. Deux cultures LOEWENSTEIN nonglycérinées.

Une culture PETRAGNANI.

Lymphagl. iliaca interna sinistra.
Une PETRAGNANI.

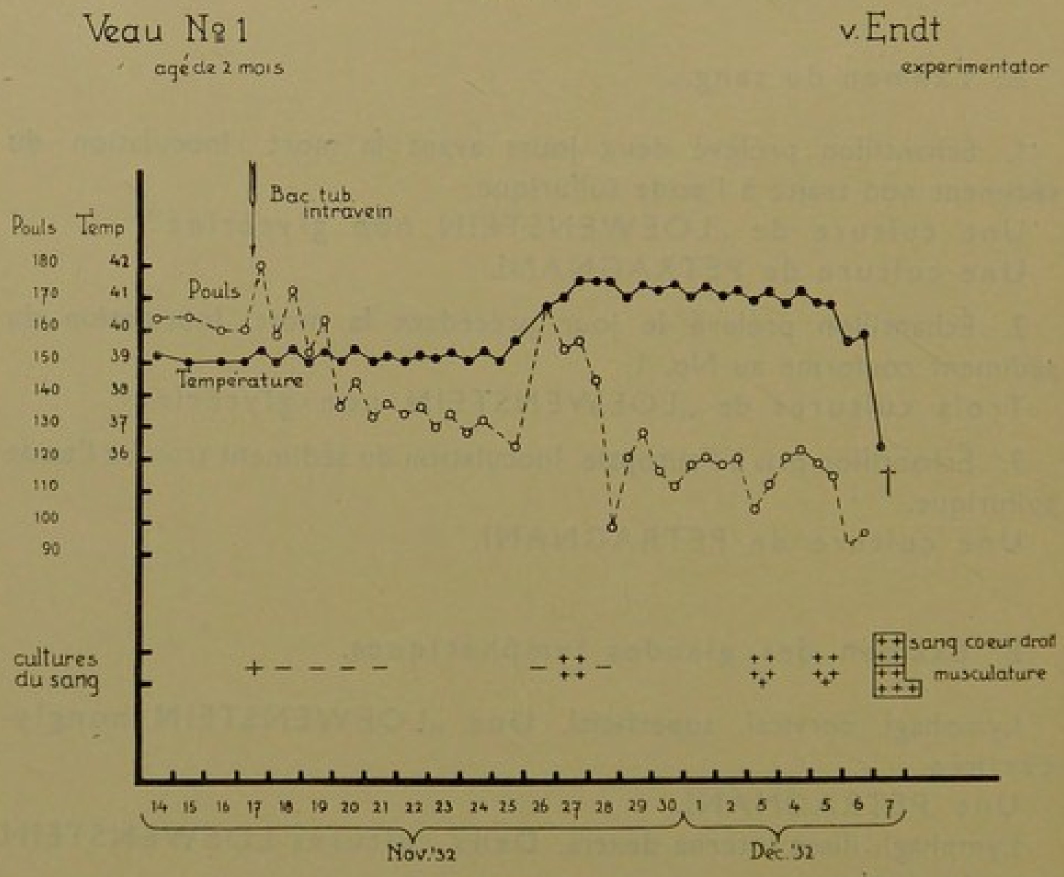
Remarquons que la nature spécifique des bacilles obtenus du sang le 15-6-32, a été prouvée par l'inoculation au cobaye No. 608. L'autopsie de l'animal, abattu au bout de vingt jours, signalait la tuberculose du foie et de la rate (controlé à l'examen microscopique); à l'endroit de l'injection se trouvait un abcès contenant des bacilles acido-résistants.

RESUME.

Dans notre expérience de veau No. 3, le délai entre l'inoculation et l'apparition des bacilles dans le sang comptait 26 jours; ceux ci se présentaient aussi dans le sang les deux jours consécutifs; au dernier desquels l'animal sucomba.

Le veau pie No. 1 féminin acheté à l'âge d'environ trois mois, de race Friso-Hollandaise jouissait d'une santé parfaite à l'examen clinique rigoureux. Elle réagissait au sens négatif à la tuberculisation (réaction ophtalmique et Pirquet Vallée) L'injection de dix cc. d'émulsion

№7



Tubercules miliaires

Poumon + + + + Foie + + + + Rate + + + + Rein + ?

de bacilles de KOCH se fit à la veine jugulaire (souche HL No. 18, identique à celle de l'expérience „Lapin No. 533") Ces bacilles ont été cultivés du lait de la vache No. 1 (Voir page 43).

L'animal souffrait beaucoup et amaigrissait. Les poumons étant atteints en premier lieu le veau toussait fréquemment et suffoqua. Le diagramme No. 7 porte la fréquence du pouls et la température quotidienne.

Cette dernière s'éleva au neuvième jour et se maintint jusqu'au dix-neuvième à ce même niveau, puis elle s'abassa jusqu'au moment de la mort. Mentionnons du procès-verbal de l'autopsie (voir annexe page 58) la grave tuberculose des poumons du foie et de la rate. Ces organes portaient tous des nodules miliaires à côté d'autres lésions plus anciennes. Les reins ne renfermaient que des nodules sub-miliaires, constatés à l'examen microscopique.

/eau No. 1. TABLE No. 5. Vena jugul sinistra.

te	Traitem. du sang	Cultures inoculées	Transp.		Résultat
11	Citrate	L. sol. 3 L. liq.	 25/11	 L. sol.	négatif négatif
	Citrate ac. acét. ½%	L. sol. L. sol. L. sol. L. liq.	 25/11	 L. sol.	négatif **positif** **61 j.** négatif négatif
11	Citrate	L. sol. 3			négatif
	Citrate ac. acét. ½%	L. sol. L. sol. 2			négatif infecté
11	Citrate	L. sol. L. sol. 2			infecté négatif
	Citrate ac. acét. ½%	L. sol. 3			négatif
11	Citrate	L. sol. 3			négatif
	Citrate ac. acét. ½%	L. sol.			infecté
11	Citrate	L. sol. 3			négatif
	Citrate ac. acét. ½%	L. sol. 2 L. sol.			négatif infecté
11	Citrate	L. sol. 3			négatif
	Citrate ac. acét. ½%	L. sol. L. sol. 2			négatif infecté
11	Citrate	L. sol. 3			négatif
	Citrate ac. acét. ½%	L. sol. 4			infecté
	Citrate	L. sol. L. sol. 2			**positif** **72 j.** négatif
	Citrate ac. acét. ½%	L. sol. L. sol. L. sol.			**positif** **72 j.** infecté négatif
	Citrate ac. acét. ½% ac. sulf. ½ N.	L. sol. L. sol. L. sol.			**positif** **72 j.** **positif** **72 j.** négatif
	Citrate	L. sol. 2			négatif
	Citrate ac. acét. ½%	L. sol. 2 L. sol.			négatif infecté

Date	Traitem. du sang	Cultures inoculées	Transp.		Résultat
3/12	Citrate	L. sol. L. liq.	 7/1	 L. sol.	négatif négatif
	Citrate ac. acét. ½%	L. sol. L. sol. L. sol. L. liq. 2	 7/1	 L. sol. 2	infecté **positif** **64 j.** **positif** **64 j.** négatif
	Citrate ac. acét. ½% ac. sulf. ½ N.	L. sol. L. sol. L. sol. L. liq. 2 L. liq.	 7/1 7/1 7/1	 L. sol. 2 L. sol. L. sol.	**positif** **64 j.** infecté négatif négatif **positif** **44 j.** **positif** **(10 j.)**
5/12	Citrate	L. sol. L. liq.	 7/1	 L. sol.	négatif négatif
	Citrate ac. acét. ½%	L. sol. L. sol. L. sol. L. liq. 2	 7/1	 L. sol. 2	**positif** **58 j.** **positif** **58 j.** infecté négatif
	Citrate ac. acét. ½% ac. sulf. ½ N. ac. sulf. ½ N.	L. sol. L. sol. L. sol. L. sol. L. liq. 2 L. liq.	 7/1 7/1 7/1	 L. sol. 2 L. sol. L. sol.	**positif** **56 j.** **positif** **61 j.** négatif négatif négatif négatif **positif** **43 j.** **(10 j.)**
7/12 coeur droit uit R. hart.	Citrate ac. acét. ½% ac. sulf. ½ N.	L. sol. L. sol. L. sol. L. liq. L. liq.	 7/1 7/1 7/1	 L. sol. 2 L. sol. L. sol.	**positif** **60 j.** **positif** **70 j.** **positif** **60 j.** négatif négatif **positif** **42 j.** **(10 j.)**

La recherche s'étendait à onze échantillons de sang; les trois premiers ont été prélevés successivement au bout d'une, de six et de 24 heures après l'injection, les autres avec des intervalles d'un — jusqu'à quatre jours. La table No. 5 contient les détails de toutes les cultures sur le terrain LOEWENSTEIN non glycériné formes „solide'' et „liquide''.

On inoculait:

1e. avec du sang à citrate, sans aucun traitement.

2e. avec le sédiment du sang à citrate, exposé à l'acide acétique et lavé à l'eau distillée.

Les bacilles de tuberculose ont été cultivés dans le sang prélevé une heure après l'inoculation et aussi dans les échantillons receuillis 10, 16, 18 et 20 jours p.i. Le dernier a été pris post mortem dans le coeur droit. Notons la fièvre appréciable qu'indique le diagramme No. 7 à tous ces jours.

L'incubation des cultures positives comptait à peu près dix semaines. Quelques gouttes des terrains liquides, transportées un mois plus tard sur des terrains solides, offraient au bout d'une semaine des cultures visibles à l'oeil. Le suc de viande, préparé conformément à la méthode VAN WOERDEN-WILLEMS (voir page 12) a été inoculé au terrain de LOEWENSTEIN forme liquide. La transplantation sur les terrains „LOE-WENSTEIN solide'' et „PETRAGNANI'' a été effectuée au bout de cinquante jours.

Après un délai de dix jours l'un et l'autre montraient des cultures visibles à l'examen microscopique. Le cobaye No. 606 — inoculé d'une culture du sang, qu'on venait de prendre dans le coeur de notre veau — mourut au bout d'un mois, souffrant de tuberculose du foie, des poumons et de quelques glandes lymphatiques. (Lgl. iliacae médiales) Donc ces bacilles originaires du sang, sont des vrais bacilles tuberculeux.

Résumons les résultats des expériences avec les veaux en soulignant, que nous avons réussi à cultiver à plusieurs reprises des bacilles dans le sang. L'expérience échouait quand les bacilles étaient introduits par la voie digestive.

Mais ces observations ne sont pas applicables aux animaux souffrant d'une tuberculose spontanée. Voici les arguments qui s'y opposent.

1e. Les bacilles inoculés, s'étant développés sur le terrain de LOE-WENSTEIN, s'étaient déjà accoutumés à ces conditions spéciales. Présumable il y a chez les animaux tuberculeux des races de ces bacilles, qui ne se développent point sur ce terrain. Le résultat négatif ne prouve donc pas du tout l'absence des bacilles dans le sang.

2e. Le mode d'infection (par voie intraveineuse en usant une dose très forte de bacilles) ne se présente pas en réalité. L'apparition des bacilles dans le sang des animaux soumis à l'expérience ne prouve point la présence de ceux ci dans le sang des animaux tuberculeux après infection spontanée.

D'autre part ces observations et surtout celles de l'expérience avec le veau No. 1 sont d'une totalité parfaite et soutiennent notre confiance dans la méthode; en démontrant le valeur du terrain de LOEWENSTEIN non glycériné.

Les cultures obtenus chez les animaux d'expériences nous forcent à continuer avec beaucoup d'intérêt la recherche des cas de tuberculose spontanée.

L'EXAMEN DU SANG DES ANIMAUX SOUFFRANT DE TUBERCULOSE SPONTANEE.

Deux modes d'opération se recommandent pour cette recherche. Plusieurs animaux ayant de graves lésions tuberculeuses entrent dans la clinique, mais à cause de la chance minimale de guérison, ou de l'inclination à une aggravation de cette maladie, les animaux sont menés à l'abbattoir dès que la diagnose a été dressée. En général la durée d'observation de ces animaux ne compte que quelques jours. Des obstacles d'ordre technique empêchent dans la majorité des cas une étude approfondie des détails concernant la forme spéciale des lésions tuberculeuses.

Observons que seulement les procès verbaux des autopsies rendent la valeur spéciale aux observations positifs ou négatifs des cultures.

C'est pour cela qu'il vaut mieux acheter de tels animaux tuberculeux et poursuivre les examinations du sang ainsi que les recherches cliniques en complêtant ces données par l'autopsie de chacun des cas.

Nous avons travaillé des deux manières.

A. La recherche du sang des animaux, se trouvant dans la clinique pour les maladies internes. Nous avons receuilli du sang de la veine jugulaire chez une nouvelle série de vaches tuberculeuses. L'inoculation des terrains se faisait conforme page 15, c. à. d. on répandait.

1e. le sang à citrate, sans aucun traitement quelconque.

2e. le sédiment du sang à citrate, après le traitement à l'acide acétique (0.5 %).

3e. Le sédiment traité comme au numéro 2 et puis à l'acide sulfurique (0.5 N.).

Les terrains employés sont ceux de LOEWENSTEIN non-glycérinés formes „solide'' et „liquide''.

L'un de ces animaux, agé d'environ deux ans, souffrait de la tuberculose des glandes lymphatiques rétrophargingéales; les autres de la tuberculose des poumons forme contagieuse.

L'examen microscopique des crachats prouvait la présence des bacilles acido-résistants.

L'examen du sang a été répété chez deux de ces animaux, mais .... tous nos efforts restèrent sans résultat positif.

Malgré notre succès auprès des petits animaux soumis à l'expérience et auprès des veaux notre but semblait encore inaccessible. Heureusement une expérience d'inoculation chez un cobaye nous indiqua la voie à suivre.

Il s'agit de l'examen du sang d'une vache nommée Z. Citons les détails suivants.

Examen clinique. Status praesens. L'animal, agé de 5 ans a les poils morts, la peau tendue, et se montre bien souffrant.

Pouls 120, Température 40,8° Respiration 40. Les muqueuses visibles sont injectées. L'animal tousse d'un toux faible; L'auscultation du poumon droit ne présente rien d'anormal, celle du poumon gauche fait entendre un sifflement vésiculaire surtout près du coeur.

Le sputum renferme plusieurs bacilles tuberculeux. Les systèmes artériels et veineux et le système digestif sont indemnes, l'urine contient beaucoup de bacilles de KOCH et aussi de l'albumen (Réaction ESBACH 0.1 %). Les quartiers antérieurs de la mammelle sont tuméfiés et endurcis, l'excrétion contient une multitude de bacilles tuberculeux. La glande lymphatique supramammaire droite est tuméfiée.

La grave tuberculose de la mammelle nous fit supposer, que le sang veineux, revenant de cet organe, contiendrait des bacilles de KOCH. Nous avons exécuté la phlébotomie de la veine principale de la mammelle (Vena abdomina subcutanea). La série des substances inoculées sur le terrain de LOEWENSTEIN se compose des suivants:

1e. le sédiment du sang à citrate, traité à l'acide acétique.

2e. le sédiment traité conforme au No. 1 et ensuite à l'acide sulfurique. (0.5 N.) pendant quinze minutes.

3e. le sédiment traité conforme au No. 1 et ensuite à l'acide sulfurique (5.5 N. = 15 %) pendant cinq minutes.

4e. le sédiment traité conforme au No. 1 et ensuite à l'antiformine ($7\frac{1}{2}$ %) pendant une minute.

Les cobayes No. 513 et 514 ont été soumis à l'injection d'une partie du sédiment, obtenu conforme au No. 1e, contenant les corpuscules blancs de six cc. de sang.

Au bout de sept semaines une tube de la seconde série contenait des cultures de bacilles non acido résistants. Nos expériences du Lapin No. 533 rendaient nécessaire l'inoculation de cette culture chez un cobaye, pour prouver le caractère spécifique de ces bacilles (cobay No. 533). Le poids de l'animal ne diminuait point. L'autopsie après l'abattage au bout de 19 semaines révélait quelques follicules tuméfiés de la rate et les poumons un peu anormale à l'examen macroscopique. L'examen microscopique de ces organes démontra, que ces lésions ne furent pas de la tuberculose. Les bacilles cultivés étaient donc d'un caractère non-spécifique.

Cependant l'un des cobayes (No. 514) mourut au bout de 15 semaines l'autopsie prouvait la tuberculose miliaire des poumons, controlée à l'examen microscopique. Le cobaye No. 513 n'indiquait après l'abattage aucun signe de tuberculose.

La preuve est faite (cobaye 514) que le sang provenant de la mammelle tuberculeuse de cette vache renferme quelquefois des bacilles tuberculeux, probablement peu nombreux.

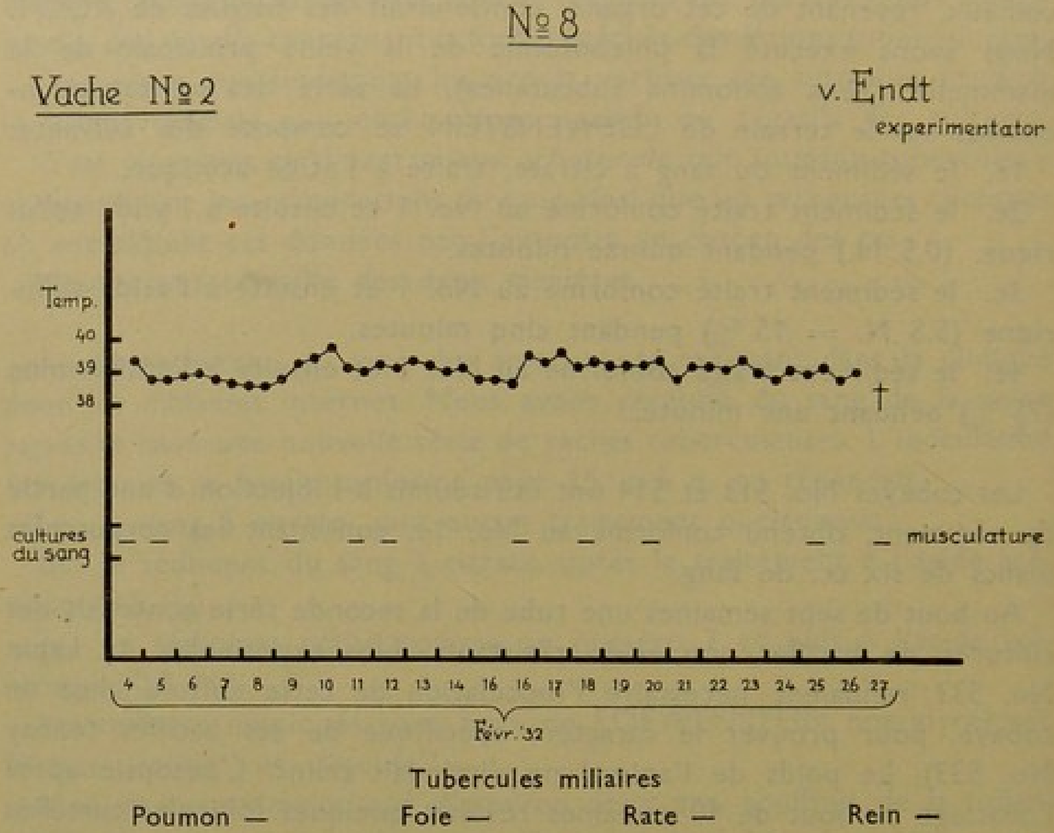
Cette observation, faite à l'aide de vivisection, restait à répéter au moyen des cultures au terrain spécifique de LOEWENSTEIN.

B. L'EXAMEN DU SANG DES VACHES ACHETEES POUR CE BUT SPECIAL.

a. La recherche des échantillons pris au moyen de phlébotomie de la veine jugulaire.

Commencons par citer les expériences avec le sang de la vache No. II.

Description clinique. La vache agée de cinq ans, race Friso-Hollandaise, couleur-pie-noir, présente à l'examen clinique: Pouls 78, Température 39°; Respiration 24, Dermatitis scabiosa.



La vache tousse très fort, la respiration démontre le type costo-abdominal. On ne peut receuillir qu'une très petite quantité de sputum mucsopurulent, ou l'on trouve des bacilles tuberculeux. L'auscultation relève à droite et à gauche des bruits de respiration accentués. La matière fécale, liquide et fétide, contient des oeufs de Distomum hepaticum et des bacilles acido-résistants (des bacilles de KOCH?). L'animal est plein mais ne présente aucune anomalie du système génital; il n'y a entre autres pas de tuberculose de la mammelle.

La température varie entre 38,6° et 39,7°, donc il n'y a pas de fièvre (Voir le diagramme No. 8). La vache mourut au bout de 24 jours. Le procès-verbal de l'autopsie (Voir page 59) mentionne, que le foie, la rate, la mammelle, ainsi que les glandes lymphatiques appartenant à ces organes ne présentent pas d'affections tuberculeuses, ni à l'examen macro- ou microscopique.

On trouve aux poumons une pneumonie tuberculeuse étandue accompagnée de plusieurs tubercules caséeux ou liquéfiés, de la grandeur d'un pois. D'autres tubercules ayant la grandeur d'une tête d'épingle ont été répandus dans le tissus le long des cours des bronches, qui portent dans leurs muqueuses de tels tubercules. A la recherche microscopique on signale beaucoup de bacilles tuberculeux. A côté de ces affections des poumons on trouve la tuberculose de l'intestin (notamment des ulcères à l'iléum).

Les glandes mésentériques ne montrent, même à l'examen microscopique aucune altération tuberculeuse.

Cette description brève des altérations morphologiques ne suggère pas du tout la probabilité d'une diffusion de bacilles dans le système artériel ou veineux.

Cependant on ignora ces détails au temps du séjour de l'animal dans notre étable et l'examen des échantillons de sang fut continué avec régularité neuf fois dans un délai de 24 jours.

Nous receuillîmes du sang de la veine jugulaire gauche et nous inoculâmes les substances suivantes:

a. le sang inaltéré, en ajoutant une solution de citrate.

b. le sédiment du sang à citrate après traitement à l'acide acétique (0.5 %).

c. idem idem en ajoutant le traitement à l'acide sulfurique (0.5 N.).

Les séries des terrains artificiels se composaient des tubes de LOEWENSTEIN formes „solide'' et „liquide'' et du terrain de PETRAGNANI.

Au bout d'un certain temps quelques gouttes du terrain „liquide'' ont été transportées dans des tubes au terrain „solide''. La table No. 6 renferme tous les détails de ces inoculations.

A la fin de l'expérience des cultures ont été dressées avec du suc de viande (préparé conforme à la méthode VAN WOERDEN-WILLEMS) et avec la matière de plusieurs glandes lymphatiques. Toutes ces cultures restèrent négatives.

Ces travaux minutieux aboutissant à un résultat négatif, n'ont pas été exécutés en vain, parce que le résultat de l'examen bactériologique est parfaitement en harmonie avec celui de l'examen anatomo-pathologique. Une différence entre ces deux — voir des preuves incontestables à la recherche anatomo-pathologique d'une diffusion des bacilles par la voie artérielle et un résultat négatif de toutes les cultures — aurait été beaucoup plus décourageante, presque au point de refuser la continuation des recherches.

D'autre part nous avons conclu par ces expériences que l'examen en bloc des animaux se trouvant dans la clinique donnerait une quantité énorme de travaux inutiles. La chance d'un résultat positif nous semble minimale, tandis que la méthode n'eut pas été contrôlée avec du sang contenant des bacilles de tuberculose.

Une sélection rationelle des cas nous sembla nécessaire.

Vache No. 2. TABLE No. 6. Vena jugal sinistra.

Date	Traitem. du sang	Cultures inoculées	Transp.		Résultat
4/2	Citrate	L. sol. L. liq. Pétragn.	12/2	L. sol. Pétragn.	négatif négatif négatif négatif
	Citrate ac. acét. ½%	L. sol. L. sol. L. liq. Pétragn. 2	12/2	L. sol. Pétragn.	négatif infecté négatif infecté négatif
	Citrate ac. acét. ½% ac. sulf. ½ N. 2 h.	L. sol. 2 L. liq. Pétragn. Pétragn.	12/2	L. sol. Pétragn.	négatif infecté infecté négatif infecté
5/2	Citrate	L. sol. L. liq. Pétragn.	10/3	L. sol. Pétragn.	négatif négatif infecté négatif
	Citrate ac. acét. ½%	L. sol. 2 L. liq. Pétragn. 2	10/3	L. sol. Pétragn.	négatif négatif infecté négatif
	Citrate ac. acét. ½% ac. sulf. ½ N. 20 min.	L. sol. L. sol. L. liq. Pétragn. 2	10/3	L. sol. Pétragn.	négatif infecté infecté infecté négatif
9/2	Citrate	L. sol. L. liq. Pétragn.	10/3	L. sol. Pétragn.	négatif négatif infecté négatif
	Citrate ac. acét. ½%	L. sol. L. sol. L. liq. Pétragn. 2	10/3	L. sol. Pétragn.	négatif infecté négatif négatif négatif
	Citrate ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. 2 L. liq. Pétragn. 2	10/3	L. sol. Pétragn.	négatif infecté négatif négatif
11/2	Citrate	L. sol. L. liq. Pétragn.	12/3	L. sol. Pétragn.	négatif négatif négatif négatif
	Citrate ac. acét. ½%	L. sol. 2 L. liq. Pétragn. Pétragn.	12/3	L. sol. Pétragn.	négatif infecté infecté négatif infecté
	Citrate ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. 2 L. liq. Pétragn. 2	12/3	L. sol. Pétragn.	négatif négatif infecté négatif
12/2	Citrate	L. sol. L. liq. Pétragn.	12/3	L. sol.	négatif infecté infecté
	Citrate ac. acét. ½%	L. sol. L. sol. L. liq. Pétragn. 2	12/3	L. sol.	négatif infecté infecté négatif
	Citrate ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. 2 L. liq. Pétragn.	12/3	L. sol.	négatif infecté négatif
	Aucun	L. sol. L. liq. Pétragn.	12/3	L. sol. Pétragn.	infecté négatif infecté infecté
16/2	Citrate	L. sol. L. liq. Pétragn.	12/3	L. sol. Pétragn.	négatif négatif négatif négatif
	Citrate ac. acét. ½%	L. sol. 2 L. liq. Pétragn. 2	12/3	L. sol. Pétragn.	négatif infecté négatif négatif
	Citrate ac. acét. ½% ac. sulf. ½ N. 20 min.	L. sol. 2 L. liq. Pétragn. 2	12/3	L. sol. Pétragn.	négatif négatif négatif négatif
18/2	Citrate	L. sol. L. sol. Pétragn.	12/3	L. sol. Pétragn.	infecté infecté négatif négatif
	Citrate ac. acét. ½%	L. sol. 2 L. liq. Pétragn. 2	12/3	L. sol. Pétragn.	infecté négatif négatif négatif
	Citrate ac. acét. ½% ac. sulf. ½ N. 20 min.	L. sol. 2 L. liq. Pétragn. 2	12/3	L. sol. Pétragn.	négatif négatif infecté négatif
	Citrate Sérum	L. liq. 2 Pétragn.	12/3	L. sol. 2	négatif négatif
20/2	Citrate	L. sol. L. liq. Pétragn.	16/3	L. sol. Pétragn.	infecté négatif négatif infecté
	Citrate ac. acét. ½%	L. sol. 2 L. liq. Pétragn. Pétragn.	16/3	L. sol. Pétragn.	infecté négatif négatif infecté négatif
	Citrate ac. acét. ½% ac. sulf. ½ N. 20 min.	L. sol. 2 L. liq. Pétragn. 2	16/3	L. sol. Pétragn.	négatif négatif infecté infecté
25/2	Citrate	L. sol. Pétragn.			infecté négatif
	Citrate ac. acét. ½%	L. sol. L. sol. Pétragn. 2			négatif infecté négatif
	Idem ac. sulf. ½ N. 20 min.	L. sol. 2 Pétragn. 2			négatif négatif

Le sang de la veine jugulaire vient de passer les capillaires des organes de la tête, dans lesquels on ne peut pas supposer plusieurs affections tuberculeuses d'où émanent des bacilles. Ces bacilles entrant dans le sang en sortant d'autres organes du corps, seront filtrés dans les capillaires du poumon. Il est donc invraisemblable que le sang de cette veine contienne le virus recherché.

Par contre mon collaborateur BOSGRA avait déjà proposé l'examen du sang affluant d'un organe quelconque gravement atteint de la tuberculose.

Pour cela nous avons acheté deux vaches souffrant de tuberculose de la mammelle. Les bacilles de KOCH ont été signalés dans le lait par moyen du microscope et par des cultures. La phlébotomie a été exécutée dans la veine principale de la mammelle (Vena abdomina subcutanea) [1]. Chez une de ces vaches nous receuillîmes aussi du sang de la veine jugulaire.

b. L'examen du sang de la veine principale de la mammelle.

Vache No. 1. BOSGRA nota les observations cliniques suivantes: L'animal a été très mal nourri; l'appétit lui manque. On trouve à l'examen microscopique de l'excrétion de la mammelle — dont la quantité est réduite — beaucoup de bacilles tuberculeux. La température surmonte 40.3° à plusieurs reprises. A la fin du séjour dans notre étable (12 jours) l'animal est tellement faible qu'il ne peut plus se tenir debout.

Cinq échantillons de sang ont été receuillis, le dernier une quart d'heure avant la mort. L'abatage a été exécuté par la coupure des veines et des artères principales du cou.

Citons le procès-verbal de l'autopsie (voir page 60):

Tuberculose grave des poumons, de la matrice et de la mammelle. L'examen microscopique de ces organes avère l'abscence des nodules miliaires.

La tuberculose se montra chez cet animal d'un type spécifique nommé par les auteurs allemands „strahlige Verkäsung (Dégénération caséeuse en forme de stries). Ce caractère spécial a été rencontré aussi dans les lésions tuberculeuses de la mammelle et des glandes lymphatiques supramammaires.

La table No. 7 indique le résultat de toutes les cultures inoculées avec le sang de la vache No. 1. Notons celles du sang artériel (Art. carotis) dressées au dernier jour de l'expérience et donnant un résultat négatif.

Le sang a été traité au citrate, à l'acide acétique et à l'acide sulfurique (0,5 N. ou bien 1,5 N.); dans quelques expériences l'acide sulfurique a été remplacé par l'antiformine. Quelquefois les globules blancs ont été séparés des autres substances du sang et traités ensuite à l'acide acétique etc.

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[1]) Cette veine, se continuant dans la Vena thoracica interna n'existe pas chez l'homme; chez la vache elle est très facile à atteindre.

Vache No. 1. TABLE No. 7. Vena abdomina subcutanea.

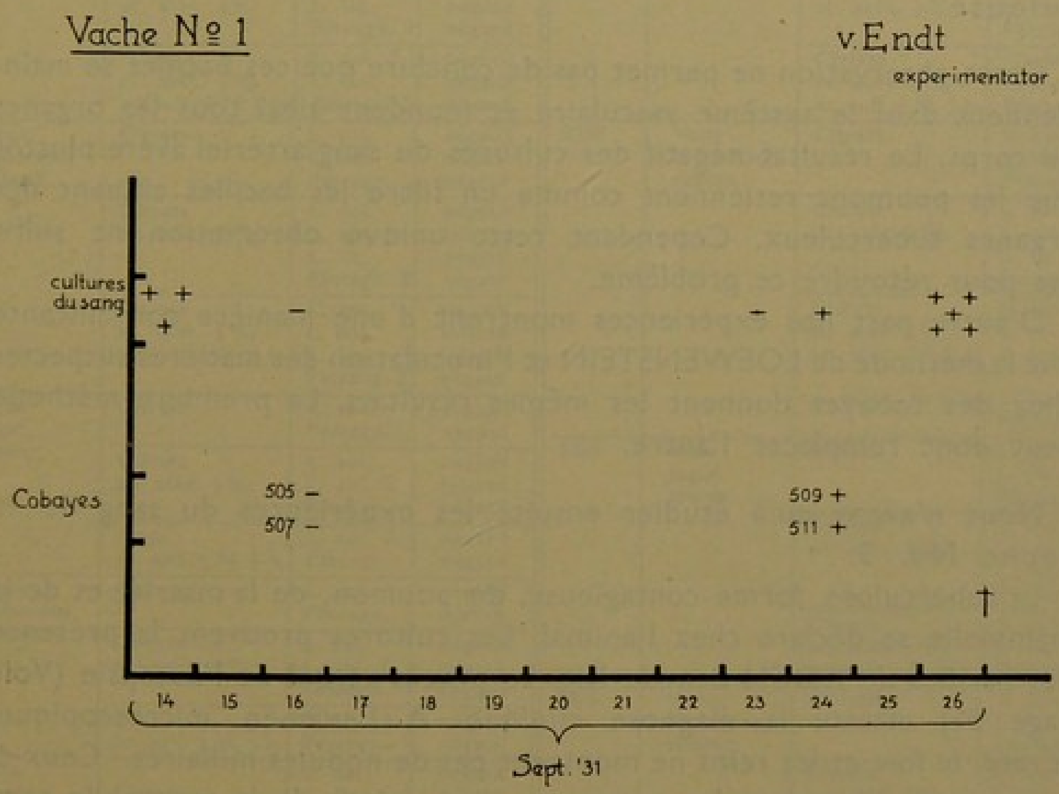
Dates	Traitement du sang	Cultures inoculées	Résultat
14/9	Citrate Ac. acét. ½ N. Ac. sulf. ½ N. 15 min.	L. sol. L. sol. Besredka	**positif 63 j.** **positif 82 j.** négatif
	Citrate Ac. acét. ½ N. Ac. sulf. ½ N. 15 min.	L. sol. L. sol. Besredka	**positif 83 j.** négatif négatif
	Citrate, centrifuger, serum pipetté Ac. acét. ½ N. Ac. sulf. 15 % 5 min.	L. sol. Besredka	négatif négatif
	Citrate, centrifuger, sérum pipetté Ac. acét. ½ %. Ac. sulf. ½ N. 15 min.	L. sol. Besredka	négatif infecté
	Citrate, centrifuger, sérum pipetté Ac. acét. ½ %. Antiformine 15 % 15 min.	L. sol. Besredka	infecté infecté
16/9	Citrate Ac. acét. ½ % Ac. sulf. 15 % 5 min.	L. sol. L. sol. Besredka	négatif négatif infecté
	Citrate, ac. acét. ½ % Antiformine 15 % 15 min.	L. sol. Besredka	négatif infecté
	Citrate, centrifuger, sérum pipetté Ac. acét. ½ %. Ac. sulf. 15 % 5 min.	L. sol. Besredka	négatif infecté
	Citrate, centrifuger, sérum pipetté Ac. acét. ½ %. Antiformine 15 % 15 min.	L. sol. Besredka	cassé négatif
	Citrate, centrifuger Ac. acét. ½ %. Antiformine 15 % 1 min.	**cobaye 505** **cobaye 507**	négatif négatif
23/9	Centrifuger, sérum pipetté Ac. acét. ½ %	L. sol. 2 Besredka Besredka	négatif négatif infecté
	Centrifuger, sérum pipetté Ac. acét. ½ %. Ac. sulf. 15 % 5 min.	L. sol. Besredka	négatif négatif
24/9	Citrate, ac. acét. ½ % (2 %) Ac. sulf. 15 % 15 min.	L. sol. Besredka Besredka	négatif négatif infecté
	Citrate Ac. acét. ½ % (2 ×) Ac. sulf. 15 % 5 min.	L. sol. L. sol. Besredka Besredka	**positif 119 j.** négatif négatif infecté
	Citrate Ac. acét. ½ %	**Cavia 509** **Cavia 511**	**positif 91 j.** **positif 90 j.**
26/9	Citrate Ac. acét. ½ % (2 ×) Ac. sulf. ½ N. 15 min.	L. sol. L. sol. Besredka 2	**positif 61 j.** négatif négatif
	Citrate Ac. acét. ½ % Ac. sulf. 15 % 5 min.	L. sol. L. sol. Besredka 2	**positif 61 j.** **positif 61 j.** négatif
art. carotis dextra	Citrate, ac. acét. ½ % Ac. sulf. ½ N. 15 min.	L. sol. 2 Besredka 2	négatif négatif
	Citrate, ac. acét. ½ % Ac. sulf. 15 % 5 min.	L. sol. 2 Besredka 2	négatif négatif

Les terrains inoculés se composaient de tubes de LOEWENSTEIN et de ceux de BESREDKA.

Nous avons cultivé des bacilles tuberculeux, dans les séries suivantes: (Voir le diagramme No. 9).

1. Examen de l'échantillon du 14-9-31. (Les deux séries suivantes restèrent négatives 16-9 et 23-9).
2. Examen de l'échantillon du 24-9.
3. Examen de l'échantillon du 26-9.

N° 9



Tubercules miliaires

Poumon + +   Foie + +   Rate +   Rein +

Simultanément aux cultures des cobayes ont été inoculés avec le sédiment des échantillons du 16-9 et du 24-9; le résultat de ces expériences est conforme à celui des cultures c. à. d. Le 16-9, les cultures restèrent négatives, les cobayes ne souffrirent pas de tuberculose.

Le 24-9, une culture étant positive, les cobayes No. 509 et 511 ont contracté la tuberculose générale.

Rappelons, que la culture du 24-9 n'a pas été reconnue positive qu'au bout d'une incubation de 4 mois.

L'incubation prolongée des cultures est donc indispensable.

Ajoutons que cette culture nous causa beaucoup de difficultés, une partie des bacilles se montra acido-résistants, les autres manquèrent cette qualité spécifique. L'inoculation du cobaye No. 538 fournit la preuve que ces microorganismes furent en vérité des Myco-baterium tuberculosae (Voir page 22 cobaye No. 538). La perte temporaire de la faculté de l'acido-résistance a été signalé plusieurs fois par d'autres auteurs. Les limites de ce travail ne me permettent pas d'étudier cet phénomène à fond.

Notons que les cultures du sang pris dans le coeur droit, et du suc de la matière des glandes lymphatiques ont été malheureusement supprimés.

Résumons l'expérience de la vache No. 1. Nos recherches prouvent que des bacilles tuberculeux se trouvent à plusieurs reprises dans le sang des veines d'une mammelle tuberculeuse.

Cette observation ne permet pas de conclure que ces bacilles se maintiennent dans le système vasculaire et inondent ainsi tous les organes du corps. Le résultat négatif des cultures du sang artériel avère plustot que les poumons retiennent comme un filtre les bacilles affluant des organes tuberculeux. Cependant cette unique observation ne suffit pas pour résoudre ce problème.

D'autre part nos expériences montrent d'une manière convaincante que la méthode de LOEWENSTEIN et l'inoculation des matières suspectes chez des cobayes donnent les mêmes résultats. La première méthode peut donc remplacer l'autre.

Nous n'avons qu'à étudier ensuite les expériences du sang de la vache No. 3.

La tuberculose, forme contagieuse, du poumon, de la matrice et de la mammelle se déclare chez l'animal. Les cultures prouvent la présence des bacilles de KOCH dans le lait. Le procès-verbal de l'autopsie (Voir page 61) atteste la diagnose clinique. A l'examen microscopique, la rate, le foie et les reins ne montrent pas de nodules miliaires. Ceux-ci se trouvent bien dans les poumons. Les lésions de la mammelle sont moins florides que celles de la mammelle, de la vache No. I; le tissue est endurci. Les glandes lymphatiques suppramammaires montrent des lésions tuberculeuses caséeuses, surtout dans les Sinus superficiels renfermant beaucoup de bacilles tuberculeux.

Les échantillons du sang ont été traités conforme à la description page 15. La table No. 8 présente le résumé de toutes les inoculations.

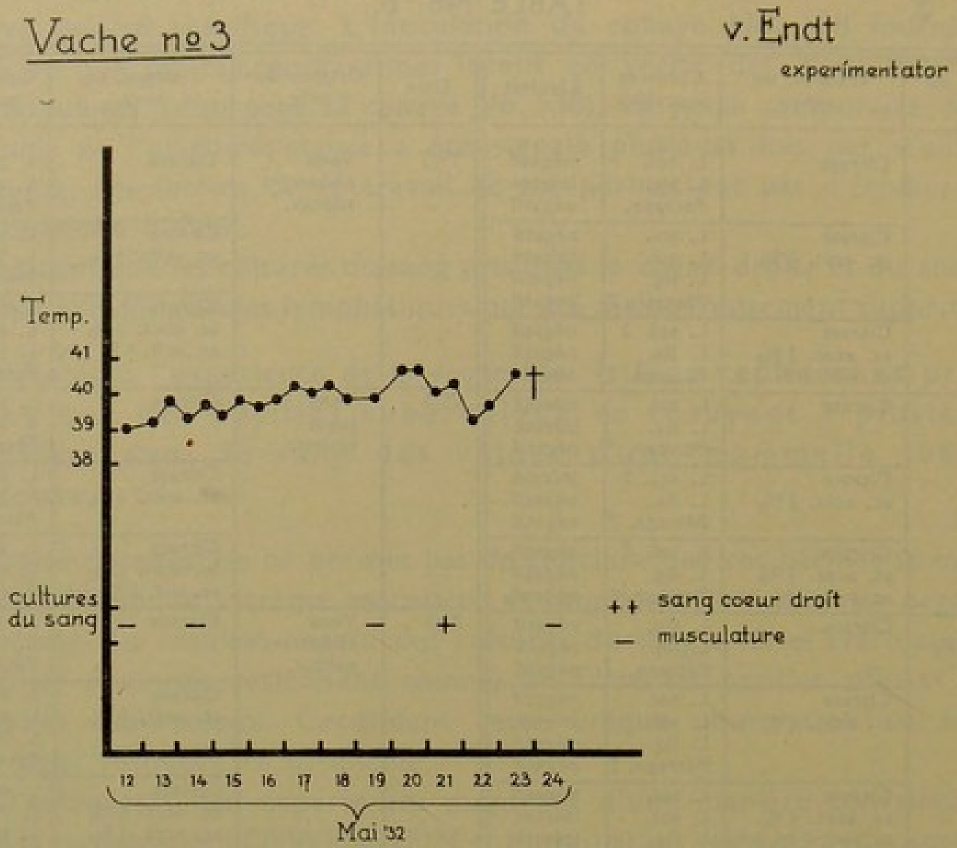
La vache resta dans notre institut pendant 12 jours; nous receuillîmes six fois des échantillons du sang, dont cinq fois simultanément dans la veine jugulaire et dans la veine principale de la mammelle (Voir diagramme No. 10).

Seulement l'échantillon du 21/5, pris dans la veine de la mammelle fournit une culture positive, sur le terrain de LOEWENSTEIN (solide) ache No. 3. TABLE No. 8.

Date	Origine du sang	Traitem. du sang	Cultures inoculées	Résultat
		Citrate	L. sol. L. liq. Pétragn.	négatif infecté négatif
		Citrate ac. acét. ½%	L. sol. L. sol. L. liq. Pétragn. 2	négatif infecté négatif négatif
		Citrate ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. 2 L. liq. Pétragn. 2	négatif négatif négatif
	Vena jugul. sinistr.	Citrate	L. sol. L. liq. Pétragn.	infecté infecté négatif
		Citrate ac. acét. ½%	L. sol. 2 L. liq. Pétragn. 2	infecté négatif négatif
		Citrate ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. 2 L. liq. Pétragn. 2	négatif négatif négatif
	Vena abdomina subcut.	Citrate	L. sol. L. liq. Pétragn.	négatif négatif négatif
		Citrate ac. acét. ½%	L. sol. L. sol. L. liq. Pétragn. 2	négatif infecté négatif négatif
		Citrate ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. L. sol. L. liq. Pétrang. 2	négatif infecté infecté négatif
	Vena jugul. sinistr.	Citrate	L. sol. Pétragn.	négatif négatif
		Citrate ac. acét. ½%	L. sol. L. sol. 2 Pétragn.	négatif infecté négatif
		Idem ac. sulf. ½ N. ½ h.	L. sol. 3 Pétragn.	négatif négatif
	Vena abdomina subcut.	Citrate	L. sol. Pétragn.	négatif infecté
		Citrate ac. acét. ½%	L. sol. L. sol. 2 Pétragn.	négatif infecté négatif
		Idem ac. sulf. ½ N. ½ h.	L. sol. 3 Pétragn.	négatif négatif
	Vena jugul. sinistr.	Citrate	L. sol. L. liq. Pétragn.	négatif négatif négatif
		Citrate ac. acét. ½%	L. sol. 2 L. sol. L. liq. Pétragn.	négatif infecté négatif négatif
		Citrate ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. 3 L. liq. Pétragn.	négatif infecté infecté

Date	Origine du sang	Traitem. du sang	Cultures inoculées	Résultat
19/5	Vena abdomina subcut.	Citrate	L. sol. L. liq. Pétragn.	négatif négatif négatif
		Citrate ac. acét. ½%	L. sol. 3 L. liq. Pétragn.	négatif négatif négatif
		Citrate ac. acét. ½% ac. sulf. ½ B. ½ h.	L. sol. 2 L. sol. L. liq. Pétragn.	négatif infecté négatif négatif
21/5	Vena jugul sinistr.	Citrate	L. sol. L. liq. Pétragn.	négatif infecté négatif
		Citrate ac. acét. ½%	L. sol. 3 L. liq. Pétragn.	négatif négatif négatif
		Citrate ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. 3 L. liq. Pétragn.	négatif négatif négatif
21/5	Vena abdomina subcut.	Citrate	L. sol. L. liq. Pétragn.	infecté négatif négatif
		Citrate ac. acét. ½%	L. sol. 2 L. sol. L. liq. Pétragn.	négatif infecté négatif infecté
		Citrate ac. acét. ½% ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. 2 L. sol. L. sol. L. liq. Pétragn.	négatif **posit. 84 j** **positif 84 j.** négatif négatif
23/5	Vena jugul. sinistr.	Citrate	L. sol. L. liq. Pétragn.	négatif négatif négatif
		Citrate ac. acét. ½%	L. sol. 2 L. sol. L. liq. Pétragn.	négatif infecté infecté négatif
		Citrate ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. 3 L. liq. Pétragn.	négatif infecté négatif
23/5	Vena abdomina subcut.	Citrate	L. sol. L. liq. Pétragn.	négatif négatif négatif
		Citrate ac. acét. ½%	L. sol. 3 L. liq. Pétragn.	négatif négatif négatif
		Citrate ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. 3 L. liq. Pétragn.	négatif infecté négatif
23-24/5	coeur droit	Citrate	Pétragn.	**positif 75 j.**
		Citrate ac. acét. ½%	L. sol. L. sol. 2 Pétragn.	**positif 122 j.** négatif négatif
		Citrate ac. acét. ½% ac. sulf. ½ N. ½ h.	L. sol. L. sol. 2 L. liq. Pétragn.	**positif 122 j.** négatif infecté **positif 110 j.**

№ 10



Tubercules miliaires

Poumon ++ Foie — Rate — Rein —

après une incubation de quantre-vingt-quatre jours!! Conforme à ce résultat les cultures inoculées avec le sédiment du sang pris dans le coeur droit le 23/5 se montrèrent positives.

Remarquons les cultures suivantes positives:

1e. un tube au terrain de Pétragnani (inoculation du sang à citrate, incubation 75 jours)

2e. un tube au terrain de LOEWENSTEIN (inoculation du sédiment traité à l'acide acétique, incubation 122 jours)

3e. un tube au terrain de LOEWENSTEIN et un autre au terrain de PÉTRAGNANI. (inoculation du sédiment traité à l'acide sulfurique; incubation 122 jours)

La dernière culture a été inoculée chez le cobaye. No. 609. L'autopsie prouva la tuberculose d'une glande lymphatique. (Lgl. illiaca médiales dextra)

Résumé. On a trouvé des bacilles tuberculeux dans le sang de la veine principale de la mammelle et dans le sang pris au coeur droit (p.m.) d'une vache No. 3, souffrant de grave tuberculose de la mammelle.

Les bacilles manquèrent dans le sang de la veine jugulaire.

EPILOGUE.

La table No. 9 montre les détails de toutesles cultures positives de nos expériences. On compte 54 cultures positives, douze de celles-ci sont originaires des animaux souffrant de tuberculose spontanée. De ces douzes cultures, huit ont été cultivées du sang prélevé de l'animal vivant au moyen de phlébotomie, les quatre autres résultent de la recherche du sang pris à l'autopsie du coeur droit.

Nous avons réussi deux fois à d'affirmer le résultat positif des cultures par l'expérience au moyen de vivisection d'un cobaye.

En observant exclusivement les échantillons du sang à résultat positif des cultures on trouve que:

1e. l'inoculation du sang inaltéré donne un résultat positif dans tous les cas.

2e. l'inoculation du sang à citrate seulement dans trois cas sur huit.

3e. l'inoculation du sédiment de sang à citrate, traité à l'acide acétique dans huit cas sur neuf.

4e. l'inoculation du même sédiment traité ensuite à l'acide sulfurique dans treize cas sur quinze.

Le traitement à l'acide sulfurique nous semble donc aussi favorable que celui au citrate-aceté acétique; notons cependant que le premier traitement produit l'avantage que les infections banales sont écartées.

La table No. 10 renferme le résumé des résultats des terrains différents, seulement les échantillons donnant des cultures positives ont servi de base à cette table.

Les meilleurs résultats ont été obtenus en usant le terrain de LOEWENSTEIN sang glycérine, forme „solide" ($\pm$ 60% des tubes inoculés avec des matières contenant des bacilles tuberculeux montrent des colonies). Le terrain de PETRAGNANI ne donne que 45% de cultures positives. Le terrain de LOEWENSTEIN forme „liquide" n'est pas préférable; admettons que le nombre absolu des tubes de ces dernières catégories et trop limité pour former un opinion finale.

TAB

Espèce d'animal	Mode d'infection	Date	Origine du sang	Période après l'infection	Espèce d culture
Lapin (532)	intraveineuse	29/11	Veine auriculaire	10 min.	L. liquid puis L. so
Lapin (533)	,,	29/10	,,	10 ,,	L. sol.
					L. liquid
					L. liquid Besredk
	,,	31/10	,,	2 jours	L. sol.
	,,	6/11	,,	8 ,,	L. sol.
					L. sol.
	,,	16/11	coeur droit	18 ,,	L. sol.
					L. sol.
Cobaye (541)	subcutanée	16/11	coeur droit	26 ,,	L. sol.
					L. sol.
Cobaye (538)	,,	16/11	,,	19 ,,	L. sol.
Veau (III)	intraveineuse	20/5	Vein. jug.	25 ,,	L. sol.
					Pétragn
					L. sol.
				26 ,,	L. sol.
					L. sol.
					L. sol.
					L. sol.
			coeur droit	27 ,,	L. sol.
					L. sol.
					Pétragn
Veau (I)	intraveineuse	17/11	Vein. jug.	une heure	L. sol.
				10 jours	L. sol.
					L. sol.
					L. sol.
				17 ,,	L. sol.
					L. sol.
					L. sol.
					L. liquid
					L. liquid
				19 ,,	L. sol.
					L. sol.

9.

tif après jours	Traitement de la matière à inoculer.
8 j.	Du sang inaltéré a été récolté dans le terrain de L. liquide.
55 j.	Du sang inaltéré.
11 j.	,, ,, ,,
55 j.	,, ,, ,,
66 j.	,, ,, ,,
66 j.	,, ,, ,,
11 j.	sédiment; citrate, acide acét. 0,5 %.
11 j.	,, ,, ,, ,, 0,5 %.
11 j.	du sang inaltéré.
11 j.	,, ,, ,,
77 j.	,, ,, ,,
77 j.	,, ,, ,,
44 j.	,, ,, ,,
77 j.	sédiment; citrate, acide acét. 0,5 %.
77 j.	,, ,, ,, ,, 0,5 %
55 j.	,, ,, ,, ,, 0,5 % ac. sulf. 0,5 N. $\frac{1}{2}$ h.
22 j.	du sang à citrate.
44 j.	sédiment; citrate, acide acét. 0,5 %.
44 j.	,, ,, ,, ,, 0,5 %.
22 j.	,, ,, ,, ,, 0,5 %.
0 j.	,, ,, ,, ,, 0,5 %, ac. sulf. 0,5 N. $\frac{1}{2}$ h.
j.	,, ,, ,, ,, 0,5 %, ,, ,, 0,5 N. $\frac{1}{2}$ h.
j.	,, ,, ,, ,, 0,5 %, ,, ,, 0,5 N. $\frac{1}{2}$ h.
j.	du sang à citrate.
j.	sédiment; citrate, acide acét. 0,5 %.
j.	,, ,, ,, ,, 0,5 %, ac. sulf. 0,5 N. $\frac{1}{2}$ h.
j.	,, ,, ,, ,, 0,5 %, ,, ,, 0,5 N. $\frac{1}{2}$ h.
j.	sédiment; citrate, acide acét. 0,5 %.
j.	,, ,, ,, ,, 0,5 %.
j.	,, ,, ,, ,, 0,5 %, ac. sulf. 0,5 N. $\frac{1}{2}$ h.
j.	,, ,, ,, ,, 0,5 %, ,, ,, 0,5 N. $\frac{1}{2}$ h.
j.	,, ,, ,, ,, 0,5 %, ,, ,, 0,5 N. $\frac{1}{2}$ h.
j.	,, ,, ,, ,, 0,5 %.
j.	,, ,, ,, ,, 0,5 %.

TABLE No.

Espèce d'animal	Mode d'infection	Date	Origine du sang	Période après l'infection	Espèce de culture
Veau (I)			Vein. jug.	19 jours	L. sol.
					L. sol.
					L. liquide
			coeur droit	21 ,,	L. sol.
					L. sol.
					L. sol.
					L. sol.
Vache (S.)	Infection naturelle		Veine jugulaire		cobaye
Vache (Z.)	Infection naturelle		Vena abdomina subcut.		cobaye
Vache (I)	Infection naturelle	14/9	Vena abdomina subcut.		L. sol.
					L. sol.
					L. sol.
		24/9			L. sol.
					cobaye
					cobaye
					L. sol.
		26/9			L. sol.
					L. sol.
Vache (III)	Infection naturelle	21/5	Vena abdomina subcut.		L. sol.
		24/5	coeur droit		Pétragna
					L. sol.
					L. sol.
					Pétragna

L. sol. = terrain de LOEWENSTEIN solide sans glycériné.
L. liquide = terrain de LOEWENSTEIN liquide sans glycériné
BESREDKA = terrain de BESREDKA.
PÉTRAGNANI = terrain de PÉTRAGNANI.

NTINUEE

tif après jours	Traitement de la matière à inoculer.
556 j.	sédiment; citrate, acide acét. 0,5 %, ac. sulf. 0,5 N. $\frac{1}{2}$ h.
651 j.	,, ,, ,, ,, 0,5 %, ,, ,, 0,5 N. $\frac{1}{2}$ h.
413 j.	,, ,, ,, ,, 0,5 %, ,, ,, 0,5 N .$\frac{1}{2}$ h.
660 j.	sédiment; citrate, acide acét. 0,5 %, ac. sulf. 0,5 N. $\frac{1}{2}$ h.
660 j.	,, ,, ,, ,, 0,5 %, ,, ,, 0,5 N. $\frac{1}{2}$ h.
660 j.	,, ,, ,, ,, 0,5 %, ,, ,, 0,5 N. $\frac{1}{2}$ h.
412 j.	,, ,, ,, ,, 0,5 %, ,, ,, 0,5 N. $\frac{1}{2}$ h.
.. 64—66	sédiment; citrate, acide acét. 0,5 %.
.. 514	,, ,, ,, ,, 0,5 %.
33 j.	sédiment; citrate, acide acét. 0,5 %, ac. sulf. 15 % 5 min
22 j.	,, ,, ,, ,, 0,5 %, ,, ,, 15 % 5 min
33 j.	,, ,, ,, ,, 0,5 %, ,, ,, 15 % 5 min
59 d.	,, ,, ,, ,, 0,5 %, ,, ,, 15 % 5 min
.. 509	,, ,, ,, ,, 0,5 %.
.. 511	,, ,, ,, ,, 0,5 %.
11 j.	,, ,, ,, ,, 0,5 %, ac. sulf. 0,5 N. 15 min.
11 j.	,, ,, ,, ,, 0,5 %, ,, ,, 15 % 5 min.
11 j.	,, ,, ,, ,, 0,5 %, ,, ,, 15 % 5 min.
44 j.	,, ,, ,, ,, 0,5 % ,, ,, 0,5 N. 1 h.
55 j.	du sang à citrate.
22 j.	sédiment; citrate, acide acét. 0,5 %.
22 j.	,, ,, ,, ,, 0,5 %, ac. sulf. 0,5 N. $\frac{1}{2}$ h.
00 j.	,, ,, ,, ,, 0,5 %, ,, ,, 0,5 N. $\frac{1}{2}$ h.

TABLE No. 10.

Espèce d'animal	Data	L. sol.		L. liq.		Pétragnani		Besredka	
		Inoc.	pos.	Inoc.	pos.	Inoc.	pos.	Inoc.	pos.
Lapin 532	29/10			1	1				
Lapin 533	29/10	1	1	2	2			1	1
	31/10	1	1	1				1	
	6/11	3	2	1				1	
	16/10	2	2	2					
Cobaye 541	11/12	2	2						
Cobaye 538	4/12	2	1	1					
Veau III	14/6	3	1	1		1	1		
		3	1	1		1			
	15/6	1	1	1		1			
		3	3	1		1			
	16/6	3	2			1	1		
Veau I	17/11	3	1	1					
	27/11	3	1						
		3	1						
		3	2						
	3/12	3	2	2					
		3	1	2	1				
	5/12	3	2	2					
		3	2	2	1				
	7/12	3	3	2	1				
Vache I	14/9	2	2						
		2	1					1	
		2	1					1	
	24/9	2	1					2	
	26/9	2	1					2	
		2	2					2	
Vache III	21/5	3	1	1		1			
	24/5	1				1	1		
		3	1			1			
		3	1	1		1	1		
		71	42	25	6	9	4	11	1
	pos. circa		60 %		24 %		45 %		9 %

RECAPITULATION GENERALE.

1. En usant la méthode LOEWENSTEIN il est possible, de cultiver des bacilles tuberculeux dans le sang de certains animaux tuberculeux. Cette méthode donne des résultats aussi précis que l'inoculation des matières suspectes chez des cobayes. La suppression de la vivisection nous permet une recherche beaucoup plus universelle.

Donc, la méthode LOEWENSTEIN forme un progrès appréciable de la technique de laboratoire.

2. En appliquant la méthode LOEWENSTEIN au sang affluant d'un organe tuberculeux (mammelle) on a cultivé maintes fois des bacilles de KOCH. Ces expériences prouvent clairement, ce qu'on a supposé jusqu'aujourd'hui à l'égard de la diffusion de ces bacilles dans le corps des animaux tuberculeux en se basant sur les affections morphologiques.

3. Seulement chez les animaux infectés expérimentalement on a retrouvé au moyen de la methode LOEWENSTEIN les bacilles tuberculeux dans le sang de la veine jugulaire. Dans un cas de tuberculose spontanée la présence de ces bacilles dans le sang jugulaire a été prouvée au moyen de l'inoculation du cobaye.

4. On a cultivé sur le terrain de LOEWENSTEIN, des bacilles de KOCH dans le sang du coeur droit d'un lapin, de deux veaux et d'une vache. Chez une autre vache le résultat de cette expérience resta négatif, conforme aux lésions trouvées à l'autopsie.

Les résultats positifs affirment les observations de DREIJER auprès des cobayes et sont en rapport avec ceux de GERVER auprès de l'homme. Nos recherches concernant les veaux et la vache cependant sont tout à fait originales.

5. La septicémie générale, causée par des bacilles de tuberculose, — que LOEWENSTEIN suppose être fréquente parmi les hommes, — ne se montra pas chez les animaux domestiques tuberculeux.

D'autre part la présence de ces bacilles, limitée à certains endroits du système vasculaire est plus fréquente chez les animaux, qu'on a supposé jusqu'aujourd'hui.

6. La méthode LOEWENSTEIN est propre à la recherche de plusieurs questions se portant à la diffusion des bacilles de la tuberculose dans le corps et à l'excrétion de ces bacilles par plusieurs organes.

HOMMAGES.

A la fin de ce travail je veux rendre hommage à mes colaborateurs BOSGRA et VAN ENDT. Le dévouement infatigable de ce dernier, même dans des conditions difficiles, a été de la plus grande valeur pour aboutir au succès aussi complet, que je viens de dècrire. Monsieur VAN ENDT a bien mérité de cet ouvrage.

Messieurs les directeurs de la fondation „Prof. Dr. D. A. DE JONG-Stichting'', permettez moi de vous remercier de l'amabilité avec laquelle vous avez rempli tous mes voeux.

J'espère que ces expériences formeront la première d'une série de travaux utiles, exécutés sous vos auspices bienveillants.

Permettez-moi aussi de rendre hommage à feu le Professeur Dr. D. A. DE JONG, l'auteur qui a introduit dans notre pays la recherche expérimentale de la tuberculose d'une manière si scientifique.

Dédions-lui ce travail avec tous nos respects.

Utrecht 1933. C. F. VAN OIJEN.

PROCES VERBAL DE L'AUTOPSIE No. 1.
(Reg. No. B. 7083) 4-7-32.

Veau No. II. Infection par voie buccale avec des bacilles de tuberculose.

L'animal est assez maigre. Les glandes lymphatiques mésentériques sont gonflées à cause d'une tuberculose de caractère caséeux, accompagnée d'autres tubercules encore jeunes.

Des ulcères tuberculeux (environ 15) se trouvent dans la partie distale de l'intestin grêle, les plaques lymphatiques de PEYER en portent aussi. Quelques uns de ces ulcères ont le fond caséeux. Le duodenum indique quelques endroits suspects de tuberculose.

Les glandes lymphatiques et mandibulaires renferment des lésions identiques, à celles des glandes mésentériques. L'examen macroscopique des poumons ne démontre aucun signe de tuberculose, la surface des sections ne porte que quelques endroits suspects.

La rate est un peu tuméfiée, les follicules sont agrandis.

Les reins sont de couleur anémique.

L'intestin grêle indique un catarrhe; tuméfaction et rougeur locale de la muqueuse, exsudation mucopurulente. Le gros intestin est normal, le contenu trop liquide.

Gastrite catarrhale. Quelques tubercules hyalins sur le péritoine. La plèvre costale et l'épiploon sont endurcis par une prolifération aspécifique du tissu fibrillaire.

Examen microscopique.

Tuberculose miliaire, du poumon, du foie et des reins.

PROCES VERBAL DE L'AUTOPSIE No. 2.
(Reg. No. B. 7055) 16-6-32.

Veau No. III. Infection intraveineuse de bacilles de tuberculose.

L'animal est en mauvaise condition.

Les poumons sont très volumineux et criblés de nodules hyalins de la dimension d'une tête d'épingle, quelques uns ont le centre non-transparant et sont entourés d'une zône hyperémique. Tuberculose miliaire aiguë des poumons.

Les glandes lymphatiques bronchiales et médiastinales sont tuméfiées, la surface des sections est granuleuse et d'une couleur blanche-grisâtre.

Paralysis cordis. La rate n'est pas gonflée. Tuméfaction modérée du foie. Tuberculose miliaire du foie, les nodules ressemblent à ceux des poumons. La glande portale est tuméfiée et montre le même aspect que les glandes bronchiales.

Les reins sont agrandis, quelques nodules blancs-grisâtres de la dimension d'une tête d'épingle sont disséminés irrégulièrement dans le tissu. Tuberculose miliaire très aigué des reins.

La cervelle, l'intestin et les glandes mésentériques sont intactes à l'examen macroscopique.

Examen microscopique.

Poumons. Multitude de tubercules miliaires à centre caséeux contenant des cellules épithéloides et des cellules-géantes.

Reins. Tuberculose miliaire aiguè; les nodules se trouvant dans la substance corticale, se composent de cellules épithéloides et de cellules géantes et contiennent beaucoup de bacilles.

Les glandes lymphatiques bronchiales indiquent à leur périférie une nécrose caséeuse, mais à l'examen microscopique on trouve aussi des cellules épithéloides typiques et quelques cellules-géantes.

Le foie. De petits nodules miliaires, contenant plusieurs cellules géantes et de rares bacilles de tuberculose se trouvent surtout dans le tissu fibrillaire périportale.

La rate. Criblée de petits tubercules, renfermant plusieurs cellules géantes — dont quelques uns montrent la régrestion centrale —, et quelques bacilles de tuberculose.

PROCES VERBAL DE L'AUTOPSIE No. 3.
(Reg. No. B. 6824) 7-12-31.

Veau No. I.

L'animal âgé d'environ deux mois est assez bien nourri. Les poumons, pesant 3.6 K.G., sont dilatés, oedémateux et criblés de nodules blancs-grisâtres, hyalins, juste visibles.

D'autres nodules de la dimension d'une tête d'épingle indiquent la nécrose caséeuse centrale.

Tuberculose miliaire aiguë des poumons.

Les glandes bronchiales et médiastinales sont tuméfiées; leur substance corticale est oedémateuse et montre une nécrose caséeuse, quelque fois du type „strahlige Verkäsung''.

La rate gonflée porte d'innombrables tubercules jeunes.

On observe dans le foie partout des nodules gris et hyalins de la dimension d'une pointe d'épingle.

Examen microscopique.

Poumons. Plusieurs petits nodules de pneumonie tuberculeuse. Les alvéoles renferment des leucocytes et des cellules épithéloides. Au milieu de ces nodules la nécrose a commencé. Il y a plusieurs bacilles acido-résistants.

A quelques endroits les bronches ont été corrodés par le tissu tuberculeux, causant la desquamation de l'épithélium de la muqueuse.

Le foie. Parsemé de petits tubercules, situés irrégulièrement dans les lobules, quelque fois dans le tissu fibrillaire périportale. La nécrose est prépondérante, les cellules épithéloides typiques manquent; on observe beaucoup de bacilles de tuberculose.

La rate. Parsemé de petits tubercules à nécrose centrale; on reconnaît quelques cellules épithéloides.

Reins. Inflammation chronique fibrillaire locealisée dans de petits nodules de la substance corticale; prolifération du tissu fibrillaire. D'autres nodules inflammatiores, au caractère aigu, renferment quelques cellules épithéloides. (tubercules?).

PROCES VERBAL DE L'AUTOPSIE No. 4.
(Reg. No. B. 6927) 27-2-32.

Vache No. II. Tuberculose des poumons, forme contagieuse.

L'animal âgé de huit ans est très mal nourri. Dermatite scabieuse prononcée des jambes et du cou.

Poumons. Emphysème alvéolaire, interstitiel et sub pleural. Emphysème médiastinale. Des tubercules, de la dimension d'un pois, caséeux ou liquéfiés et purulents, se trouvent dans la partie postérieure des lobes principaux. D'autres tubercules ont la dimension d'une tête d'épingle. Diffussion du procès par voie bronchique. Broncho-pneumonie du lobule cardiaque du poumon.

Extension des bronches; les bronches renferment de la matière muqueuse; la surface de la muqueuse, d'une couleur rouge-foncée est granuleuse à cause des lésions nombreuses, parmi desquelles on observe des tubercules de la dimension d'une tête d'épingle. La muqueuse de la trachée a le même aspect.

On trouve quelques tubercules caséeux de la dimension d'un pois sur la plèvre costale à côté de petits flocons fibrillaires spécifiques.

Dans les glandes bronchiales se trouvent quelques tubercules caséeux et calcifiés de la dimension d'une tête d'épingle; dans les glandes médiastinales quelques nodules, caséeux et calcifiés mais plus grands.

Le coeur est paralysé, le ventricule droit est dilaté, sa paroi musculaire est mince et spacieuse. On trouve des pétéchies sous l'épicardium le long des sillons longitudinaux et coronaires.

La rate n'est pas distinctement tuméfiée, les follicules sont visibles et rangés irrégulièrement.

Le foie. Distomatose chronique des tubes biliaires, cirrhose de la partie gauche.

Reins tuméfiés; on observe de petits nodules blancs grisâtres (des Infarct's calcifiés ?).

La muqueuse de l'estomac indique des follicules tuméfiés. Le contenu de l'intestin est mucopurulent. Tuberculose de la muqueuse de l'intestin grêle, se manifestant par de nombreux ulcères à circonférence tuméfiée.

A l'examen macroscopique et microscopique les glandes mésentériques ne démontrent pas de lésions tuberculeuses.

PROCES VERBAL DE L'AUTOPSIE No. 5.
(Reg. No. B. 6728) 26-9-31.

Vache No. I. Tuée en agonie.

Les glandes mammaires de la vache jeune et maigre sont tuméfiées et endurcies, surtout les quartiers postérieurs.

Tuberculose chronique et universelle du quartier droit postérieur, avec nécrose caséeuse prononcée. La glande supramammaire — d'une dimension de deux poings — est très fortement reliée au tissu mammaire. Elle indique une tuberculose caséeuse, montrant un dessin gyreux; la matière tuberculeuse étant localisée dans les sinus de la glande.

Mammite tuberculeuse des parties inférieures du quartier gauche postérieur; les tubercules sont opaques, la nécrose caséeuse est moins prononcée, que dans les nodules du quartier droit postérieur. La glande supramammaire gauche est moins altérée que l'autre; les lésions sont localisées dans le tissu de la périphérie. Les glandes illiacales internes ont la dimension d'un poing; les altérations correspondent à celles des glandes supramammaires.

Les tubercules récents du péritoine sont localisés surtout dans la région antérieure et ne mesurent que quelques millimètres. Sur quelques parties de la plèvre et du péricarde on observe du tissu granulaire spécifique.

Les poumons sont emphysémateux; pneumonie tuberculeuse étendue mais récente, dispersion lobulaire montrant le dessin des bronches. Des complexes tuberculeux, de la dimension d'un poing et se composant de petits lobules entièrement caséeux, se trouvent dans la région postérieure des lobes principaux. Les bronches ont été obturées à plusieurs endroits par des masses purulentes jusqu'à la bifurcation de la traché.

Les glandes bronchiales et médiastinales sont tuméfiées, la surface des sections ressemble à du lard, la nécrose va commencer (couleur terne on ne trouve que quelques nodules caséeux.).

Tractus intestinalis; quelques ulcères récents dans l'intestin grêle. Les glandes mésentériques portent des nodules caséeux de quelques centimètres, la matière caséeuse est striée et d'une couleur blanche grisâtre (strahlige Verkäsung?).

Tuberculose totale de la muqueuse des cornes de la matrice avec beaucoup d'exsudat. Tuberculose diffuse des tubes de Gaertner avec perforation du vagin, les oviductes sont intacts, ainsi que les glandes ovariennes.

Les reins. La surface de quelques renculi s'est retirée et porte quelques tubercules. Le procès a déjà atteint la partie centrale; dégénération caséeuse. La substance corticale ne contient que des tubercules solitaires dubieux.

La rate n'est pas gonflée, quelques follicules irréguliers; pas de tubercules à observer.

Le foie, pas de tuberculose, distomatose chronique mais légère; des tumeurs d'un aspect spéciel sont répandues dans le tissu. („cavernomata'', se composant de cellules spécifique du foie).

Athéromatose modéré de l'endocardium de l'oreillette gauche. Les glandes lymphatiques de la carcasse ne présentent pas de lésions tuberculeuses.

Les glandes lymphatiques des poumons indiquent une nécrose caséeuse aiguë et diffuse. La cervelle est intacte.

PROCES VERBAL DE L'AUTOPSIE No. 6.
(Reg. No. B. 7029) 24-5-32.

Vache No. III.

L'animal est mal nourri.

Tuberculose du péritoine localisée dans la partie pelvienne. Des agglomérations tuberculeuses, caséeuses d'une épaisseur d'un cm. sont situées sur le rumen, sur la paroi gauche du ventre et sur la surface pariétale de l'épiploön, accompagnées de granulations hyperémiques dans lesquelles se trouvent des tubercules miliaires. Tuberculose de la plèvre; des granulations qui forment des tumeurs circonscris hyperémiques contenant des tubercules minuscules, sont accompagnées de quelques tubercules à piques de la dimension d'un pois.

Poumons oedémateux, emphyséme alvéolair, interstitiel et subpleural. On trouve dans les lobes principaux:

1e. des tubercules caséeux de la dimension d'un pois, se composant de plusiers nodules tuberculeux miliaires. (La dispersion est du type bronchogène).

2e. de très beaux tubercules miliaires solitaires, aigus, à peine visible, quelques uns hyalins, d'autres à centre déjà terne.

Le contenu des bronches est muqueux, leurs parois indiquent quelques nodules caséeux.

Les glandes bronchiales et médiastinales sont tuméfiées; nécrose caséeuse, calcification.

La rate un peu gonflée la pulpe est amollie.

Le foie; dégénération parenchymateuse, distomatose chronique et légère, des tubes billiaires.

Les reins sont tuméfiés, quelques nodules blancs-grisâtres, de la dimension d'une tête d'épingle. Dans le rein droit un abcès tuberculeux de la dimension d'un oeuf de pigeon; nécrose caséeuse de la substance centrale. La matrice est tuméfiée; nécrose caséeuse générale de la muqueuse, surtout à l'endroit des „carunculae".

Les oviductes sont tuméfiés et nécrosés au centre (Infection de la matrice via les oviductes?). Les tubes de GAERTNER ont l'épaisseur d'un crayon, nécrose molle centrale Tuberculose mammaire, surtout de la moitié droite et du quartier gauche postérieur. Le tissu est endurci, de couleur blanc-grisâtre et granuleux. La région ventrale démontre plusieurs nodules caséeux de forme bizarre.

Les glandes supramammaires sont tuméfiées. La substance de la périphérie se compose d'un tissu granuleux blanc-grisâtre et proéminent; on observe quelques nodules à l'aspect terne. Le même procès moins étendu s'observe dans les glandes illiacales internes. Il y a un catarrhe de l'intestin.

Examen microscopique.

Il fut impossible de découvrir des tubercules miliaires dans la rate, le foie et les reins.

Les poumons sont criblés de tubercules miliaires régressifs; des tubercules se trouvent aussi dans la muqueuse des bronches. On observe beaucoup de bacilles de tuberculose, même des bacilles libres dans le contenu des bronches.

Glandes supramammaires. Tuberculose caséeuse, surtout dans les sinus superficiels; peu de cellules spécifiques; les bacilles de tuberculose abondent.

ZUSAMMENFASSUNG.

Untersuchungen von Rinderblut mittels der Methode Loewenstein zum Nachweis von Tuberkelbazillen.

Die allgemeine Septikaemie mit Tuberkelbazillen, welche Loewenstein beim Menschen sehr oft gefunden haben soll, wurde bei Rindern und bei kleinen Versuchstieren nicht angetroffen. Andererseits wurde die Anwesenheit solcher Bazillen an bestimmten Stellen des Gefässsystemes häufiger vorgefunden als man bis jetzt angenommen hat . Verfasser und seine Mitarbeiter haben durch Anwendung des Verfahrens nach Loewenstein Tuberkelbacillen gefunden :

a. In dem von einem tuberkulösen Organ (Euter) abfliessenden venösen Blut,

b. in dem Blut aus der Jugular-Vene bei experimentell infizierten Tieren,

c. in dem rechten Herzblut letzterer Tiere und in einem Fall spontaner Tuberculose,

d. in dem Fleischsaft mehrerer Tiere.

Die Methode ergibt genau dieselben Ergebnisse wie der Tierversuch mit Meerschweinchen. Sie ist als eine wertvolle Verbesserung der Versuchsmethoden anzuerkennen, welche besonders anzuwenden ist beim Studium der Verbreitung der Tuberkelbazillen über den Tierkörper und der Ausscheidung dieser Bazillen durch die verschiedenen Organe.

SUMMARY.

Tuberculous bacillaemia in animals : cultivation from the blood by the technique described by Loewenstein.

Tuberculous bacillaemia — which Loewenstein describes as a frequent phenomenon in man — could not be detected in cows and smal rodents.

Local infection in definite parts of the vasculair system has been demonstrated in a higher number of cases than generally will be admitted. The author and his collaborators, following the technique inaugurated by Loewenstein detected tuberkel bacillae

a. in the venous blood, leaving a tuberculous organ (e.g. the udder of the cow),

b. in the blood extracted from the Vena Jugularis in animals after experimental infection,

c. in the blood extracted from the hart of those animals and in one case of spontaneous tuberculosis,

d. in the meat juice from several animals.

The method prooved to be as reliable as the injection of suspected materials in guiny-pigs. It must be recognised as a notable progress in laboratory technique especially in studying problems regarding the dissemination of tubercle bacilli through the animal body and their excretion by different organs.

BULLETIN

OF THE

Canadian Tuberculosis Association

SUPPLEMENT

CONTAINING

FOUR CONTRIBUTIONS ON BOVINE TUBERCULOSIS

PRESENTED TO THE

Ottawa Medico-Chirurgical Society, National Museum, Ottawa, December 20, 1929

The papers, two in number, were delivered by Dr. Campbell Laidlaw, Physician, Ottawa, and Dr. R. Marguerite Price, Bacteriologist, University of Toronto. The discussion was opened by Dr. Hilton, Director of the Health of Animals Branch, Federal Department of Agriculture and Dr. R. E. Wodehouse, Executive Secretary, Canadian Tuberculosis Association.

DR. J. G. RUTHERFORD AND BOVINE TUBERCULOSIS

By Dr. Campbell Laidlaw

Mr. President, Ladies, and Gentlemen: First of all let me express my appreciation at having been asked to take part in this evening's program.

Although it was with diffidence that the invitation was accepted, the preparation of a paper was undertaken less reluctantly, for the reason that it seemed to afford an opportunity for treating of the subject "Bovine Tuberculosis," in such fashion as to convey a brief, commemorative sketch of the life and work of one who made a contribution of outstanding value in connection with this disease. I refer to the originator and first incumbent of the post of Veterinary Director General of Canada —the late Dr. J. G. Rutherford, a man who brought into being what is now one of the most conspicuously efficient sanitary services in the world; a gentleman, by the way, who was intimately known to many of you and who, on several occasions, appeared before this society as a favourite guest.

Having once embarked on my project as at first contemplated, it occurred to me to ask Dr. Oskar Klotz, Professor of Pathology at the University of Toronto, if he would be good enough to put me in touch with some of the most reliable sources of information regarding Bovine Tuberculosis. He at once referred me, with enthusiasm, to Dr. R. M. Price, of his Department, citing her knowledge of the disease in its human form as quite unique and of superior worth, a knowledge largely acquired through extensive scientific research. It immediately struck me, then, that instead of presuming to pass on to you the garnered data and opinions of authorities, the needs of the situation would best be served by arranging, if possible, for one of these, viz, Dr. Price herself, to speak to you direct. This, with unwarranted modesty, she kindly consented to do, and so she will shortly address us on phases of the problem as it relates to infection in children.

Accordingly, as you will be glad to know, my own observations on the subject of the evening will be merely introductory in character, and by way of indicating some of the salient features in the career of a great Scottish-Canadian.

John Gunion Rutherford, C.M.G., D.V.Sc., H.A.R.C.V.S., fifth son of the Rev. Robt. Rutherford, M.A., and Agnes Gunion, was born on Christmas Day, 1857, at the Manse, Mountain Cross, Peebleshire. He was one of a family of six sons and two daughters, of whom only two are still living; Mrs. Elspeth Brotherston, of Edinburgh, widow of a Presbyterian minister, and Walter Rutherford, prominent among British Electrical Engineers, who maintains consulting offices in London and Calcutta.

Besides the last named and the subject of this memoir, other sons of this family achieved distinction also: William, a graduate in the Classics of Balliol College, Oxford, who took Holy Orders, became Dean of Westminster School, and rose to fame as one of the foremost Greek Scholars of his generation, and George, a noted Mining and Marine Engineer, who, after work of national importance at Cardiff was murdered by Chinese bandits while occupying a responsible position with a British-Chinese corporation near Shanghai.

Very early in life John G. Rutherford showed a natural aptitude and love for learning and these, together with studious habits, private tuition of a high order, and a course at the Glasgow High School, laid for him a cultural foundation of unusual soundness. However, his youthful inclination for a way in life (unlike that of his father and the distinguished William), lay in another direction than that of the Humanities. From boyhood it had been his intention to acquire all the knowledge he could about domestic animals and farming. Thus, after leaving school, we find that he had become attached as a student on the celebrated live stock farm at Phillipshaugh, in Ayreshire.

A brief sojourn amid the new surroundings further stimulated his ambition and, contrary to the wish of his father, he left for Canada at the early age of seventeen to work his way through the Ontario Agricultural College at Guelph. Of this Institution he was one of the earliest and most brilliant students, graduating at the head of his year. Later, he attended the Ontario Veterinary College, leaving it in 1879 as the Gold Medallist.

While yet a student he had spent a considerable time at Bow Park Farm, near Brantford, under John Hope, one of the leading Shorthorn authorities in America, and soon after graduation he went to the United States, where for two years he was in charge of one of the largest breeding and racing establishments on the continent.

Returning to Canada in 1884 the youthful Veterinary Surgeon settled in practice at Portage la Prairie, Manitoba, where he also engaged in stock breeding.

Almost immediately he was appointed a Veterinary Inspector for the province of Manitoba, and in the following year he was called to serve during the Rebellion as Veterinary Staff Officer with the North West Territories Field Force. In 1892 he became member for Lakeside in the Manitoba Legislature, and after sitting in that House for four years he was elected, in 1897, to represent the constituency of MacDonald in the Federal Parliament, where he occupied a seat until 1900.

In 1887 Dr. Rutherford had married Edith Boultbee, of Portage la Prairie. His widow and three daughters survive him.

While as yet a young practitioner, his only son died at the age of six months of Tabes Mesenterica. This event, it has been said, inspired the father to dedicate himself anew to a great task; that fight against Bovine Tuberculosis in which he had enlisted himself as a student and which he now determined to wage with all the vehemence of his nature.

After devoting much time for many years to an intensive study of this animal plague, his utterances concerning it had come to be regarded as so authoritative that in 1901 he was appointed by the Dominion Government as a special inspector for the purpose of investigating tuberculosis in cattle, as it related to British herds, and also for the testing in Great Britain of cattle consigned to Canada.

During the period of his special service abroad his views on tuberculosis attracted widespread attention, his ideas in regard to the far-reaching dangers of the disease as it occurs in animals other than the human, being regarded as radical in the extreme. Certainly they ran contrary to the overpowering weight of evidence presented by medical authorities at the International Congress on Tuberculosis held, during the same year, in London. Here no less an authority than the immortal Robert Koch made the unfortunate pronouncement that Bovine Tuberculosis need not be regarded as a serious menace to human health.

Of this circumstance Dr. Rutherford at a later time remarked:—

"Although the views of the majority of the leading Veterinarians on this point were entirely and, as subsequent investigation has shown rightly, at variance with those of the great scientist, the latter, obtaining as he did, the almost undivided support of the medical profession, was able to sway public opinion to such an extent as largely to increase the difficulties, already sufficiently great, confronting the veterinary sanitarian."

It must have been with mingled feelings of disappointment, encouragement, and apprehension that this champion of a cause, temporarily lost, returned to Canada the following year to be invested with the responsibility of organizing a department of Veterinary Services, which was to be nation wide in its scope.

He fully realized that he must set to work in the face of a powerful foe, viz. (and to put it in his own words):—

"the lack of public confidence then existing in the ability of the Department of Agriculture to deal effectively with contagious disease among animals, as evidenced not only by its failure in attempting the control of tuberculosis, but by the steady if gradual extension of Glanders, Hog Cholera, Mange, and other maladies, which had from time to time been introduced into the Dominion."

But, undaunted by this hostile atmosphere, to say nothing of recent denouncement in high places of some of his cherished theories, this ardent pioneer rejoiced that the way had been opened for him to develop cautiously, persistently, and expansively, a great utility which would have as its objective the stamping out of animal plagues in this country.

Time will not permit more than brief mention of the many phases of activity which sprang up and matured as parts of the structure which had been envisioned at the outset by this dreamer. They represented legislative enactments and an administrative fabric which involved the initiation of entirely new policies and important reforms. Among them were included provision for the surrender by the various provinces, to Federal authority, the control of animal diseases, the establishing of biological laboratories for the investigation of animal diseases by trained Veterinary Pathologists, a bureau for the dissemination of useful information, and schemes for the improvement of Veterinary Education: to say nothing of systematized effort in other directions.

Nor must we allude more than casually to the fact that in 1906 the author of these enterprises was called upon to add to his increasing burdens by assuming the post of Live Stock Commissioner for Canada. This appointment had become necessary, and was distinctive. Only merit must count and once more the position sought the man. It placed him in control of all the work of the Department of Agriculture in connection with the development of the live stock industry throughout the Dominion, including the granting of assistance to live stock associations, the furnishing of expert judges and lectures on live stock subjects, and the general supervision of the system of national registration of pedigrees for the various breeds of domestic animals. Bringing to this added field of service special talents which had gained him an international reputation and had earned the personal admiration of his Sovereign, one need not suspect him of having fallen short of great accomplishment in this separate sphere.

But it is the purpose of this abbreviated record to focus more particularly upon this man's aims and achievements in respect to Bovine Tuberculosis. In his final report to the Minister of Agriculture he recalls his first official contact with it in these words:—

"At the time of my accession to office in 1902, I found that in Canada, as in some other countries, there existed among cattle owners, generally, and particularly among breeders of pure bred stock, a sentiment strongly antagonistic to the taking of any official action in connection with the disease."

So much for the attitude of the cattle owners. In the same report we learn the attitude of the Veterinary Director General himself from the words:—

"I was looking forward to and paving the way for an active campaign, having for its object the eradication from Canadian herds, of this destructive and dangerous disease."

The campaign was skilfully inaugurated and tactfully but vigorously prosecuted throughout his tenure of office.

It is true that for a while after he had assumed his executive powers his department met with criticism in some quarters on the ground that its attitude was not sufficiently aggresive. But Rutherford was nothing if not thorough, and his plan of action was "to make haste slowly."

He explained that before attempting to enunciate a definite policy with regard to Bovine Tuberculosis it would be necessary (and here I shall quote at length from some of his own paragraphs):—

"First, gradually to adopt such methods, official and otherwise, in dealing with tuberculosis, as would tend to convince owners and breeders of live stock that the existence of disease in their herds was not only certain to cause them serious financial loss, but constituted a grave menace to the health of themselves and their families, as well as of other human beings exposed to infection, either through direct contact with tuberculous animals or through the consumption of their products.

"Second, to develop in the minds of stock owners a feeling of confidence in the capacity of the department to furnish a veterinary sanitary service, sufficiently effective and reliable to warrant its being entrusted with a task of such magnitude. With this object in view, I decided to take up and deal successfully with the various other animal plagues existing in the Dominion, none of which, although serious enough in themselves, were to be compared in point of importance, or extent of distribution, to the disease now under consideration.

"Third, to study the disease itself and the use of tuberculin, even more carefully than I had hitherto done, and to keep a close watch on the work of such scientists as were devoting special attention to it, and particularly that of the various commissions and private investigators who were labouring to determine the validity of Koch's contention that the Bovine and Human forms of the malady might, for all practical purposes, be regarded as distinct.

"Fourth, to endeavour to unify and consolidate, in so far as this continent is concerned, the views regarding the disease held, not only by members of the veterinary profession, but by medical health officers and by those interested in the stock breeding, dairying, and packing industries, with the object of rendering possible the adoption by the various governing bodies in Canada and the United States, of reasonably uniform measures for its control and eradication."

In the year 1908 the chief of the Veterinary Services of Canada was elected President of the American Veterinary Medical Association, and shortly afterwards was called upon to present a paper on the control of the bovine form of the disease before the International Congress on Tuberculosis held at Washington.

So comprehensive was this paper, as indicating a profound knowledge of comparative pathology, intelligent grasp of scientific opinion, keen understanding of imperative needs, and breadth of optimistic vision, that it attracted more attention and favourable comment in the agricultural press of this continent and Europe than perhaps any other production of a similar nature.

In the following year the American Veterinary Medical Association heartily approved a recommendation by its retiring President for the creation of an International Commission to study the whole subject of Bovine Tuberculosis and to prepare a report embodying a practical policy for its control. Coming as it did from one who had attained a position of commanding influence, the Association not only approved the recommendation, but voted a generous sum from its own funds for the furtherance of the project.

I now quote a sentence from one of the official reports of the Department of Agriculture,—

"The members of the commission were most carefully selected and comprised a number of the most prominent veterinarians from the United States and Canada, several eminent comparative pathologists and medical health officers of both countries, as well as gentlemen representing the stock breeding, dairying, and packing interests."

Of this Commission Dr. Rutherford was made Chairman. It held many meetings at various places in both countries and its first and principal report was published as an official bulletin and widely distributed by the Departments of Agriculture of both Canada and the United States.

To outline the activities of the International Commission, the beneficent schemes evolved and their invaluable results, would require a voluminous treatise in itself.

Nor shall I endeavour to discuss the complex network of agencies, technical and otherwise, which gave it birth and which made it such a force in the protection of ourselves, our children, and our children's children. Suffice it to say that so far as Dr. Rutherford was concerned it represented, in the benefits it conferred, the fruition in large measure, of long-cherished hopes and unremitting labours.

Remembering the open antagonisms of earlier years, when as has been mentioned, cattle owners and stock breeders had disdained and resented any semblance of governmental advice or interference in their affairs, how this protagonist of a great cause must have hailed with delight their conversion, as demonstrated, e.g., in the following resolution adopted unanimously by the Canadian Live Stock Association at its convention of 1912:—

"Resolved that in the opinion of this Association it is eminently desirable that the Dominion Government should, at the earliest possible date, suggest a policy having for its object the control, and, as far as possible, the eradication of Bovine Tuberculosis, on the lines recommended in the report of the International Commission."

For ourselves it is a pleasure to reflect that, ere he had laid down the reins of office, this prophet, now honoured in all countries, had come to witness the complete rebuttal of the notable pronouncement made by Koch in 1901.

In this connection, as illustrating the boldness of his imagination, I cannot forbear to give in his own words his prediction that,

"In the near future pathologists will agree that the original source of human infection was Bovine Tuberculosis, although the disease has now, unfortunately, and largely owing to habits of life, become much more firmly established and more readily transmissable among human beings, than among other of the various non-bovine species of animals susceptible to it."

In 1912 Dr. Rutherford resigned from the Department of Agriculture, after ten years of indefatigable and conscientious work; at a time indeed, when he might well have viewed with complacency some of its major fruits. He speaks of his retirement as coincident with the moment when;

"That spirit of antagonism to official action which formerly existed had given place to a feeling of confidence and respect; when the knowledge regarding tuberculosis possessed by the general public, as well as by the veterinary profession was infinitely greater and more accurate than ever before and when it could be truthfully said that nowhere had any governmental agency been at any time more favourably situated or so well equipped for continuing the fight against Bovine Tuberculosis than that over which, for a decade, he had presided."

Shortly after severing his connection with the Government Service, Dr. Rutherford assumed the duties of Superintendent of Animal Industry and Agriculture for the Canadian Pacific Railway, with headquarters at Calgary, but time will not permit more than mere mention of the fact that he exhibited rare genius for what was required of him, in the new environment.

And now, in order to round out a narrative of exceptional public service, it is necessary to refer to other episodes in the career of this forceful personality.

While a representative from the West in the House of Commons, he had been instrumental in bringing to a practical issue the vexed questions of grain transportation and inspection, and in establishing the vastly improved conditions that now obtain. At the same time he was one of the prime movers in the agitation which actually brought about the formation of the present Railway Commission. It was natural, therefore, that in 1918 the Canadian Government should make a choice which was welcomed with enthusiasm by press and public at large, irrespective of political bias, when it recalled him to the service of the State, appointing him to an office, that of Railway Commissioner for Canada, which he adorned until the time of his death.

During his later years this victor in many a battle had become a victim of disease. It took the form of a progressive Nephritis complicated by occasional seizures of Angina Pectoris, a clinical complex which his zealous interest in biological phenomena urged him to point out as being a striking illustration of familial incidence: for already, it had taken toll of four lives among his next of kin. Nevertheless, in spite of so sore a handicap, and fully aware of its impending issue, he endured and waited with equanimity, continuing to shoulder the burden of the daily round with surprising vigour up until the last month of his life.

One beautiful summer day he arrived in Ottawa from Vancouver, and one week later, July 24th, 1923—to use words which his poetic soul had dictated when he spoke once of the last journey of another—"he passed out of this world which he had loved so much to a land beyond the stars."

Should a biography of this man be written by one capable of giving proper treatment to the mass of data available, we might reasonably expect to peruse a large and inspiring volume.

For the foundation of the mere outline now attempted I am largely indebted to Miss B. M. Bayless, who, for years, in the capacity of Private Secretary, was closely in touch with Dr. Rutherford's varied activities.

While giving this lady my best thanks for the wealth of material in the form of personal reminiscences, and published matter kindly placed at my disposal, there should also be intimated the regret that the necessarily restricted use of it has resulted in a correspondingly inadequate portrayal of a career, so ample and so fascinating.

Perhaps, however, you may not have failed to comprehend from this meagre story the significance of a life opportunely devoted to the welfare of one of the great crusades of history—the Battle against Tuberculosis.

Of its qualities of head and heart I would fain have spoken at length. Let me mention only a few of those gifts and graces still vivid on our memory:—the ready understanding of difficult problems and the fearlessness in grappling with them, the philosophic shrewdness, the sound logic in debate, the intuition in the choice of helpers, the genuine kindliness, the engaging humour, the uncompromising honesty, and the reverence for those things that are lovely and of good report.

In writing or speaking in praise of another, one is prone to err on the side of fulsome eulogy. Lest you should think me to blame in this respect I would invite your attention to a brief resumé denoting appraisals by competent judges.

We find, for example, that he was singled out by His Majesty as a person who possessed extraordinary knowledge and great personal charm. The King of Italy welcomed him to the International Institute of Agriculture at Rome as "a patron of the Sciences worthy of his warmest confidence." His associates of the Permanent International Veterinary Congress at the Hague acclaimed him as one of its ablest advocates. The Royal College of Veterinary Surgeons of Great Britain awarded him a very carefully guarded and seldom-conferred degree. The University of Toronto esteemed him as a scholar who had lent his best auspices to the advancement of Veterinary Education, and recognized in a signal manner, the fact that he had enhanced the scientific standing of his Alma Mater.

Several of Dr. Rutherford's intimate fellow workers our society is proud to welcome as its guests this evening—men who enjoy enviable places in the realm of Veterinary Science, notably among them being his one-time trusted counsellor, and now, worthy successor, Dr. George Hilton, the present Veterinary Director General of Canada; and the latter's very able lieutenant, Dr. A. E. Watson, Chief Veterinary Pathologist.

In the presence of these erstwhile colleagues, it would be unbecoming of me to do more than venture the opinion, that they admired and respected their former chief for virtues which included courtesy, a magnetic candour, unobtrusive helpfulness and a deeply ingrained sense of justice.

As for his friends many of us here to-night know that they loved him.

In conclusion let me quote two short sentences which appeared in one of the leading Scientific Journals of the United States, under the caption "Great Men of History". The excerpt is from the editor's page of "Veterinary Medicine" and is to be found in the September number, 1922. It reads thus:—

"H. G. Wells has accomplished the monumental task of naming the six great men of history with such good judgment that no argument thus far advanced even threatens to dethrone them. Here is *our* choice of the six great Veterinarians of history, any or all of whom we shall dethrone on better arguments than we can produce to retain them forever in the Hall of Fame:—Vegetius, Bourgelat, Nocard, Dieckerhopf, Percival Robinson, J. G. Rutherford."

BOVINE TUBERCULOSIS IN ITS RELATION TO INFECTION IN CHILDREN

R. M. Price, M.B.

(From the Laboratories of Pathology and Bacteriology University of Toronto)

The idea that tuberculosis in man can, in part, be traced to infection from cattle had its origin early in the nineteenth century. Klenke, in 1846, expressed his belief that milk from tuberculous cows was infectious, and that scrofuloderma in children was probably a result of such infection. Villemin, in 1865, definitely established the infectious nature of tuberculous material from man and animals by transmitting the disease to laboratory animals. From that time until 1882, when Robert Koch identified the tubercle bacillus, the etiologic agent in the disease tuberculosis, the literature contains records of many experiments illustrating the difficulties and disappointments encountered in establishing the specific cause of the disease.

The bacillus of tuberculosis was discovered before the idea of specific etiology in the form of disease producing micro-organisms had been generally accepted. Methods for determining the properties of bacteria, identifying species, and distinguishing varieties among them were in their infancy. It is natural, therefore, that the outstanding morphological, cultural, staining and biological properties of the tubercle bacillus, as recorded by Koch, should have been accepted as circumscribing the characters necessary for identification. As they appeared to be the same from man and cattle, it was generally agreed that they were identical. The statements by Klein, Villemin and Martin, that the etiology of human tuberculosis was different from bovine, did not change or modify the accepted conclusion that mammalian tuberculosis was caused by one and the same organism.

Klein, in 1883, pointed out that Koch's work did not clearly establish the identity of human and bovine tuberculosis. He himself had observed differences in the morphology of the tubercle bacillus obtained from human and bovine sources. He also observed differences in the pathogenicity of bacilli obtained from human and bovine sources for the rabbit. From these observations he concluded that "the tuberculous virus derived from human sources was not the same as that obtained from the cow."

The first step toward separating varieties among tubercle bacilli was made by two Italian observers, Rivolta and Mafucci, who, in 1892, published their observations on the avian tubercle bacillus, and pointed out the essential differences between that strain and the known mammalian variety.

Theobald Smith, in 1896, published the results of his studies upon two strains of tubercle bacilli, one recovered from a tuberculous bull, and another recovered from a pet animal, presumably infected by its tuberculous owner. It is of interest to note that upon the study of these two strains alone, Smith determined every essential difference between the human and bovine types of tubercle bacilli. In 1898 he published further evidence of the existence of the human and bovine types of tubercle bacilli. He pointed out clearly the differences of the two types, which exist in their morphology, cultural characters and virulence, especially for rabbits and calves. He also pointed out that the two types exhibit decided differences in their action on glycerin in culture media.

In the face of the growing evidence of morphological, cultural and biological differences of these two types of tubercle bacilli, little doubt was entertained as to the infectiousness of the bovine type for man. While much work was being done on the relationship of milk from tuberculous cows to the presence of tuberculosis in man, the cases of accidental infection with the bovine virus during post-mortem work, and under other conditions, was considered final evidence of the susceptibility of man for the bovine organism. The simple procedure of investigating the type of bacilli isolated from different forms of tuberculosis, and the observation of their cultural character in comparison with known cultures, and the study of their biological characteristics, as suggested by Smith, received but little attention.

Interest in this question became suddenly acute in 1901, when at the meeting of the Seventh International Congress on Tuberculosis, held in London, England, Robert Koch announced the results of his subsequent studies upon the two forms of tubercle bacilli. He stated that although the human and bovine tubercle bacilli differed morphologically, culturally and biologically, he did not believe that the bovine virus was an important factor in human infection. Thus, the differentiation of human and bovine types of tubercle bacilli made by Theobald Smith was confirmed by Koch, who put strong emphasis on the non-transmissibility of bovine tuberculosis to man. Since most of Koch's material studied was obtained from adult human sources, his views met with violent opposition from most quarters, and precipitated an enormous amount of research work. Numerous investigations followed as to the identity or non-identity of the bacillus from man and cattle, and at the same time viruses from man were

This research was carried out under a grant from the National Research Council of Canada.

investigated as to whether or not they were identical with those obtained from cattle.

Of the investigations which followed, the most outstanding work is that of the British Royal Commission, the work of the Gesundheitsamt in Berlin, and later the work of Park and Krumwiede in the United States. The resulting evidence left no doubt of the infectiousness of the bovine virus for infants and children, but in regard to adult cases of tuberculosis, the important principles of Koch's contention were corroborated.

Prior to the discovery of the tubercle bacillus, but after the infectious nature of tuberculous material had been established, there was wide diversion of opinion as to the mode of infection. The commonly accepted theory was that the etiologic agent entered through the respiratory tract. Koch supported this belief in his early work, and reaffirmed it in 1901. Chauveau, in 1888, held that the alimentary tract might be the portal of entry of the bacillus. Woodhead, in 1894, called attention to evidence of intestinal infection, especially in children. This opinion was held generally in France. Von Behring advocated not only the digestive tract as a way through which infection took place, but since it occurred so frequently in infancy and childhood, milk was in all probability the vehicle for the transmission of the disease.

The number of tubercle bacilli necessary to produce infection is important. It was believed that while a few virulent tubercle bacilli might produce tubercles, the vast amount of experimental work done in the past tends to indicate that a large number of bacilli are necessary to overcome the usual resistance of experimental animals, when tubercle bacilli are fed by mouth. There is, however, no way of determining the susceptibility of young children to this organism. Smith states that "bovine tuberculosis may be transmitted to children when the organism is overpowered by a large number of bacilli, as in milk from cows suffering from tuberculosis of the udder, or when certain unknown favourable conditions for infection exist."

It is agreed by all bacteriologists who have studied this question that it is impossible to decide on clinical signs alone, the type of mammalian tubercle infection one is dealing with. It is true, however, that human pulmonary tuberculosis is almost always due to infection with the human type of the bacillus, and that cases of primary intestinal tuberculosis are due to infection with the bovine type of the tubercle bacillus if a community is consuming infected milk. For other forms of clinical tuberculosis one can simply state that the younger the individual, the greater the probability of infection by milk consumed, and the more likely the case to be due to bovine infection.

It is now generally agreed that tuberculosis in cattle is caused by the bovine type of the tubercle bacillus only. The incidence of bovine infection in man, therefore, depends upon the amount of tuberculosis in cattle from which the milk is obtained and the amount of raw milk consumed by children. The widespread infection of cattle in Europe and America, and the presence of tubercle bacilli in their milk is recognized by all. From figures available in the literature, it appears that 30 to 50 per cent of cattle in Europe are infected. In the United States the incidence of tuberculosis in cattle is given as roughly 20 per cent. In Canada 5 per cent of cattle tested react to tuberculin.

From a study of raw market milk made in various countries, the percentage of tubercle bacilli found in milk is as follows:—

	per cent
London..	22
Sheffield..	10.4
Birmingham..	7.3
Edinburgh..	20
Berlin..	14–30
New York City..	20
Chicago..	10
Washington..	7

The incidence of bovine infection in children appears to be unusually high in Great Britain. Phillip Mitchell of Edinburgh, in a study of 72 cases of cervical adenitis in children under twelve years of age, recovered bovine tubercle bacilli in 90 per cent of his cases. John Frazer, in a study of 67 cases of bone and joint tuberculosis in children of the same age, recovered bovine strains in 62.7 per cent of cases studied. In 47 children under five years of age, he recovered bovine strains in 72.5 per cent.

The British Royal Commission investigating the prevalence of bovine infection in England and Wales, analysed 1,139 cases of tuberculosis, both in children and in adults based on reports and papers published by Eastwood and F. and A. S. Griffith. Dividing the cases studied into two age groups, their findings are as follows:—

Variety of Cases	Number of Cases	Percentage of cases infected with Bovine Bacilli: Under 5 Years of Age	All Ages
Cervical Lymph Nodes..	125	85.0% of 20 cases	48.0%
Lupus Vugaris..	140	66.0% of 50 "	51.0%
Scrofuloderma..	52	58.3% of 12 "	38.4%
Bone and Joint Tbc..	514	30.2% of 96 "	19.2%
Genito-Urinary Tbc..	21		19.0%
Tbc. Meningitis..	12		16.6%
Pulmonary Tuberculosis..	275		1.1%

Park and Krumwiede of the Public Health Laboratories, New York City, in a study of 1,220 unselected cases of tuberculosis, dividing the cases studied into three age groups, give the incidence of bovine infection as follows:—

1. Children under five years of age, 280 cases with 65 bovine strains recovered, or 23.7 per cent.
2. Children from five to sixteen years of age, 153 cases with 36 bovine strains recovered, or 23.5 per cent.
3. Adults sixteen years and over, 787 cases with 10 bovine strains recovered, or 1.2 per cent. (This group included 644 cases of pulmonary tuberculosis).

A study of 2,516 cases of various forms of tuberculosis reported in the literature up to 1914, and compiled by Wang of the University of Edinburgh, gives perhaps the most comprehensive idea of the amount of bovine tuberculosis in man existing in Western Europe, British Isles and the United States. He found that, dividing the cases into three age groups, the incidence of bovine infection is as follows:—

1. Children under five years of age, 614 cases with 199 bovine strains recovered, or 32.4 per cent.
2. Children five to sixteen years of age, 591 cases with 171 bovine strains recovered, or 28.9 per cent.
3. Adults sixteen years and over, 1,311 cases with 38 bovine strains recovered, or 2.9 per cent.

These observers conclude that the excessive amount of bovine infection in surgical tuberculosis in children is due to the large amount of tuberculosis in cattle with its subsequent milk infection, and the common practice of feeding infants and children in Great Britain, and to a degree in the United States, on raw cow's milk.

In France, on the other hand, bovine infection in man is very uncommon. Although tuberculosis in cattle is extremely prevalent there, the custom of boiling milk, for purely economic reasons, is universal, thus eliminating this type of infection in children. Burnet, of the Pasteur Institute, did not recover a single bovine strain among the 89 strains of tubercle bacilli he isolated from various forms of surgical tuberculosis in children.

During the years of the war, 1914 to 1918, but few bacteriological examinations were made for the type of tubercle bacilli in human cases. Since then the majority of reports have come from Great Britain, and these tend to indicate that the percentage of bovine infection remains high.

The analysis of the results of bateriologic examinations of the large number of cases of medical and surgical tuberculosis outlined, indicates that in adults infection with the bovine type of the tubercle bacillus is comparatively uncommon. The small number of cases reported are probably residual childhood infection; whereas in children, particularly in the group under sixteen years of age, it is the cause of considerable infection. It is of interest to note that tissue localization of the bovine tubercle bacillus is peculiar, the lungs being practically immune. The glandular and abdominal types of infection appear to predominate, pointing very strongly to the alimentary route of infection. The mortality rate in such cases of tuberculosis is lower than in other types of the disease.

Up to the present, as far as we are aware, no studies have been made in Canada indicating the incidence of bovine infection in children, nor have accurate figures indicating the frequency with which tubercle bacilli appear in raw market milk.

For the past three years, under the auspices of the National Research Council of Canada, we have been carrying out a study upon the incidence of bovine infection in children in one of the districts of Canada. The district with which we have dealt is the Toronto area, where city regulations demand the pasteurization of milk, but to which, however, there is a migration of sick individuals from outlying districts seeking treatment in the various city hospitals. By co-operation with these hospitals, and in particular with the co-operation of the Hospital for Sick Children, we have been enabled to study a considerable number of tuberculous children from whom we have obtained material for the purpose of determining the type of infection. Besides this, we have also had the opportunity of obtaining contact with a number of children living in towns and villages of Ontario.

Up to the present, we have recovered 237 strains of tubercle bacilli from 193 children studied, all under fourteen years of age. All these strains have been identified by laboratory means as to type. Both medical and surgical cases have been studied, and the group is comprised of the following types of cases:

Tuberculosis of Bones and Joints
Renal Tuberculosis
Tuberculous Meningitis
Tuberculous Adenitis
Tuberculosis of the Tonsils
Tuberculosis of the Adenoid
Pulmonary Tuberculosis
Pleurisy with Effusion

Of the 237 strains identified, 197 were recovered from 167 children, which proved to be of the human variety, and 40 strains recovered from 26 children were of bovine origin.

The 197 strains of tubercle bacilli of human type were recovered from medical and surgical cases of tuberculosis. We made no particular attempt to isolate organisms from cases of frank pulmonary tuberculosis. We have, however, studied a number of laryngeal swabs obtained from children suffering from generalized tuberculosis. A number of positive swabs were obtained in this manner.

In the greater proportion of the cases from whom the human variety of the tubercle bacillus was recovered, a history of contact to open human tuberculosis was obtained. A number of our cases of surgical tuberculosis studied, showed a varying degree of pulmonary or tracheo-bronchial tuberculosis, demonstrable on physical examination or by X-ray. All these children reacted to tuberculin.

Forty strains of tubercle bacilli of bovine variety were recovered from 26 different patients. With the exception of one case, none of the children in this group showed evidence of pulmonary involvement, on physical examination or by X-ray. There was no history of contact to open tuberculosis. There was, however, invariably a history of the children having been fed on raw cow's milk. This group, without exception, reacted to tuberculin.

SUMMARY OF A STUDY UPON THE INCIDENCE OF BOVINE INFECTION IN CHILDREN

	Number	Human Type	Bovine Type
Bone and Joint Tuberculosis..	75	72	3
Tuberculous Meningitis..	42	41	1
Renal Tuberculosis..	20	18	2
Pulmonary Tuberculosis..	19	18	1
Tuberculosis of Lymph Nodes (Cervical and Mesenteric)..	21	6	15
Tuberculosis of the Tonsils..	9	6	3
Tuberculosis of the Adenoid (Pharyngeal Tonsil)..	5	4	1
Tuberculous Pleurisy..	2	2	0

Analysis of Bovine Strains

Up to the present, we have recovered 40 strains of tubercle bacilli of bovine origin, obtained from 26 different patients, as follows:—

Tuberculous Meningitis	1
Three strains recovered— (a) Cerebro-spinal Fluid. (b) Meninges. (c) Mesenteric Glands.	
Generalized Tuberculosis, including Pulmonary Tuberculosis, infant 15 months of age..	1
Two strains recovered— (a) Sputum. (b) Mesenteric Glands.	
Tuberculosis of Knee Joint..	1
Tuberculosis of Shoulder Joint..	1
Renal Tuberculosis..	2
Six strains recovered— (a) Urine Rt. Kidney. (b) Urine Lt. Kidney. (c) Urine Bladder.	
Tuberculous Mastoiditis..	1
Two strains recovered— (a) Mastoid Process. (b) Cervical Lymph Nodes.	
Tuberculous Adenitis..	15
Twenty-one strains recovered.	
Tuberculous Tonsillitis..	3
Tuberculosis of the Adenoid..	1

Summary of Histories of Illustrative Cases

Case No. 1. K.D., age 2 years. Admitted to the Hospital for Sick Children from Kitchener, Ont., with a clinical diagnosis of Tuberculous Meningitis. At autopsy an extensive mesenteric tuberculosis was found. There was no evidence of pulmonary disease. Cultures recovered from the cerebro-spinal fluid, meninges and mesenteric glands, all yielded tubercle bacilli of typical bovine variety. Upon enquiry, this boy had practically all his life been fed on raw cow's milk. It is of interest to note in connection with this case that milk submitted for examination from the Kitchener district to the Provincial Board of Health laboratories, Toronto, prior to the introduction of pasteurization, yielded tubercle bacilli in three out of four samples examined.

Case No. 2. M.S., age 15 months, of foreign parentage. Died of generalized tuberculosis, including pulmonary tuberculosis. Cultures obtained from the sputum by means of a laryngeal swab, and mesenteric glands obtained at autopsy, both yielded organisms of the bovine variety. As far as could be ascertained, this infant was artificially fed, but no definite history concerning the source of milk could be obtained.

Case No. 3. E.P., age 8 years. Admitted to the Hospital for Sick Children from Point-au-Baril, with a clinical diagnosis of Tuberculosis of the Right Knee Joint. As far as could be ascertained, there was no contact to open tuberculosis. This boy had always been fed on raw milk of the district. The strain recovered from the pus aspirated from the knee joint was of typical bovine variety.

Case No. 4. N.W., age 9 years. Admitted to the Hospital for Sick Children from Haileybury, Ont., with a clinical diagnosis of Healed Pott's Disease and Tuberculosis of the Right Shoulder Joint. This boy was born in England and came to Canada when two years of age. At the age of two and one-half years he developed Pott's Disease, from which he apparently made a good recovery. Two years prior to admission to the hospital, he began to complain of pain in the right shoulder, which was clinically diagnosed as tuberculosis. Physical examination and X-ray failed to reveal any evidence of pulmonary disease. This boy had been fed on raw milk from a mixed herd, which was later believed to be tuberculous. Pus aspirated from the right shoulder joint yielded tubercle bacilli of typical bovine variety.

Case No. 5. A.B., age 12 years. Admitted to the Hospital for Sick Children with a clinical diagnosis of Bilateral Renal Tuberculosis and tuberculous Cystitis. There was no history of contact to open tuberculosis, nor is there any evidence of tuberculous lesions in other organs than the kidneys and bladder. Culture repeatedly isolated from the urine from both ureters and bladder yielded tubercle bacilli of bovine variety. This child was born in England and came to Canada five years ago. During her residence in England she was fed on raw cow's milk.

Case No. 6. M.McC., age 10 years. Admitted to the Hospital for Sick Children from Mono Mills, Ont., with a clinical diagnosis of Bilateral Renal Tuberculosis and Tuberculous Cystitis. Her symptoms dated back six months prior to admission. There was no history of contact to open tuberculosis. Physical examination and X-ray failed to reveal evidence of active pulmonary disease. Cultures isolated from the urine from both ureters and bladder were of bovine variety. Upon enquiry, it appeared that this child had all her life lived on a farm, and had been fed raw milk from a mixed herd. The father, who owns the herd, stated that three years previously he had purchased two pure bred cows which he kept in the herd for one year, but as they did not seem to thrive and appeared ill, he disposed of them.

Case No. 7. J.D., age 11 years. Admitted to the Hospital for Sick Children from Scarboro (a suburb of Toronto) with a clinical diagnosis of Tuberculous Cervical Adenitis and Mastoiditis. Two strains of tubercle bacilli recovered from this patient, one from the lymph nodes and the other from the mastoid process, were of bovine variety. This case is of interest, in as much as he is one of a group of cases under treatment in the surgical clinic of the Hospital for Sick Children from that neighbourhood. All these children, suffering from various forms of surgical tuberculosis, chiefly tuberculous cervical adenitis and tonsillitis, came from the same neighbourhood, almost the same street, supplied by one dairy, distributing unpasteurized milk. A sample of milk submitted for examination yielded tubercle bacilli of bovine origin, both in smear and on guinea pig inoculation.

Case No. 8. R.S., age 7 years. Admitted to the Hospital for Sick Children from Lakeview Beach, Ont., with a clinical diagnosis of Tuberculous Cervical Adenitis. There was no history of contact to open tuberculosis. There was no evidence of tuberculosis elsewhere. This boy had all his life been fed on raw cow's milk. The tubercle bacilli recovered were of typical bovine variety.

Case No. 9. F.McL., age 8 years. Admitted to the Hospital for Sick Children with a clinical diagnosis of Tuberculous Cervical Adenitis. This lad was born in Scotland, and came to Canada one year prior to admission to the hospital. He, however, had had enlarged glands for two and one-half years. From the history of this boy, it appears that he had, more or less, all his life been fed on raw milk, or milk which had been heated, but not boiled. Unfortunately, the glands removed at operation were lost. A tonsillectomy was done at the same time, and one of the tonsils, both on section and guinea pig inoculation proved tuberculous. A typical bovine strain of tubercle bacilli was recovered from this source.

Case No. 10. E.S., age 7 years. Admitted to the Hospital for Sick Children from Exeter, Ont., with a clinical diagnosis of Tuberculous Cervical Adenitis. This child had always been fed on raw milk from the town dairy. The strain recovered from the glands removed at operation was of typical bovine variety.

Case No. 11. J.W., age 5 months. Admitted to the Hospital for Sick Children from Maple, Ont., with a clinical diagnosis of Tuberculous Cervical Adenitis. There was no history of contact to open tuberculosis, and no evidence of tuberculosis elsewhere. This infant had been breast fed for two months, and for three months prior to admission to the hospital had been fed on raw milk from a mixed herd. The father, who owns the herd, admitted that one animal in the herd had had a chronic cough and showed progressive loss of weight. This animal, it would appear, had also tuberculosis of the udder, but it was slaughtered before it could be examined. The organism recovered from the cervical lymph nodes removed at operation, was of typical bovine variety.

Case No. 12. A.McA., age 18 months. Admitted to the Private Patients' Pavilion, Toronto General Hospital, from Georgetown, Ont., with a clinical diagnosis of Bilateral Tuberculous Cervical Adenitis. This child, for nine months prior to admission to the hospital, had been fed on raw milk from a mixed herd. Pus aspirated from the glands, and the glands removed at operation, yielded tubercle bacilli of bovine variety. This child made an uneventful recovery.

Case No. 13. S.K., age 18 months. Admitted to the Hospital for Sick Children from Markham, Ont., with a clinical diagnosis of Tuberculous Peritonitis. This child was breast fed for twelve months, and for six months prior to admission to the hospital had been fed on raw milk from a mixed herd. Repeated aspirations of the peritoneal cavity failed to yield any fluid. A small tuberculous gland removed from the angle of the left jaw yielded tubercle bacilli of bovine variety. There was in this instance no history of contact to open tuberculosis, and no evidence of pulmonary involvement on physical examination or by X-ray.

Case No. 14-15. J.G., age 6 years. Admitted to the Hospital for Sick Children with a clinical diagnosis of Chronic Tonsillitis and Mastoiditis. Both tonsils and adenoid removed at operation yielded tubercle bacilli of bovine origin. Two years previously this patient had tuberculous cervical glands removed. For one year previous to his first operation (1926), he had lived in Scarboro, and had been fed on unpasteurized milk of the district.

Case No. 16-17. J.D., age 11 years. Admitted to the Hospital for Sick Children from Scarboro with a clinical diagnosis of Tuberculous Tonsillitis, Cervical Adenitis and Mastoiditis. Typical bovine strains of tubercle bacilli were recovered from the mastoid process and tonsil and cervical glands.

Case No. 18. E.R., age 8 years. Admitted to the Hospital for Sick Children from Scarboro, with a clinical diagnosis of Tuberculous Cervical Adenitis and Chronic Tonsillitis. The tonsils removed at operation yielded tubercle bacilli of bovine variety. This child had, at intervals, been fed on raw milk of the district.

Case No. 19. M.S., age 8 years. Admitted to the Hospital for Sick Children with a clinical diagnosis of Tuberculous Cervical Adenitis. There was no history of contact to open tuberculosis. Physical examination and X-ray of chest failed to reveal evidence of pulmonary disease. The organism recovered from the glands removed at operation was of typical bovine variety. When this child was an infant she lived in Newtonbrook, Ont., and the family had their own cows. The milk she took was boiled for the first year, but was given later in the raw state. One of the cows from which the milk was obtained was in poor health and apparently suffering from tuberculosis.

Case No. 20-21. M.D., age 7 years. Admitted to the Hospital for Sick Children from Todmorden, Ont., with a clinical diagnosis of Tuberculous Cervical Adenitis and Tonsillitis. The glands were large, matted and fluctuating, and inoperable. Pus aspirated from the glands and the tonsils removed at operation yielded tubercle bacilli of bovine variety. Upon enquiry, it appeared that the father, a farmer, owned a mixed herd of fourteen head of cattle. As this patient had all her life been fed on raw milk from this herd, the father was informed that the child probably contracted her tuberculous infection from that source. At his own expense, the father had a veterinary surgeon tuberculin test his herd; it was found that thirteen out of the fourteen cows reacted to tuberculin. He then disposed of his herd, and the autopsy revealed extensive tuberculosis in most of the animals slaughtered; two of the animals were so grossly diseased that their carcasses were condemned.

Summary and Conclusions

It will be noted that in our studies upon the nature of tubercle bacilli isolated from children, we have identified 237 strains of tubercle bacilli recovered from both medical and surgical cases of tuberculosis. Of these, 197 strains recovered from 167 children proved of human variety, and 40 strains recovered from 26 children proved of bovine origin.

In the majority of the cases from which the human type of tubercle bacillus was recovered, a history of contact to open pulmonary tuberculosis was obtained, and in a number of our surgical cases there was evidence of tracheobronchial or pulmonary tuberculosis, demonstrable on physical examination or by X-ray. All these children reacted to tuberculin.

Forty strains of bovine tubercle bacilli were recovered from twenty-six patients in our series, the oldest being a patient twelve years of age, and the youngest an infant of five months. In all the cases investigated, a direct relationship with infected milk was demonstrated. In the majority of the cases, the milk relationship could not be demonstrated by complete laboratory means, though the history in every instance indicated that the child had been fed on raw milk. Wherever possible, we endeavoured to obtain milk for bacteriologic examination and guinea pig inoculation. In two of our series studied, we were able to demonstrate tubercle bacilli in the milk.

It is of interest to note that the bovine tubercle bacilli isolated were recovered from various regions and materials, namely, cerebrospinal fluid, meninges, bones and joints, tonsils, adenoid tissue, lymph nodes, and in one instance, from the sputum. Of these regions, the lymph glands, particularly those of the neck, were the most common sites of infection. Frequently associated with the tuberculous cervical adenitis was a tuberculous tonsillitis.

All these children, without exception, came from districts in regions where pasteurization of milk was not carried out. None of these children, with the exception of one case, showed any evidence of pulmonary or tracheobronchial tuberculosis, demonstrable either on physical examination or by X-ray, the evidence pointing to the alimentary route of infection.

From this limited study upon the incidence of bovine infection in children in this community, it would appear that:—

1. Bovine tuberculosis is a factor in childhood infection in rural Canada, and in areas where pasteurization of milk is not carried out. The incidence of bovine infection in such areas is probably greater than we are aware of.

2. Milk is the vehicle for the transmission of the disease. However, as the incidence of tuberculosis in cattle is estimated as being lower in Canada than in Europe and the United States, so too do we find a lesser incidence of bovine infection in children.

3. Tissue localization of the tubercle bacillus of bovine variety is peculiar for certain regions of the body, the lungs being practically immune.

4. In the Toronto District, where pasteurization of milk has been in practice since 1915, not a single case of bovine infection has been found in children who have been brought up on the pasteurized milk of that district.

5. If we may be allowed to draw conclusions in terms of percentage incidence of bovine infection as illustrated in this study, 13·4 per cent of tuberculosis in children, leading to operation, disablement and disfigurement, and

occasionally leading even to death of the child, is preventable, and can be easily controlled by the simple means of proper pasteurization, or boiling of milk.*

The President, Dr. R. K. Paterson, asked Dr. George Hilton, Veterinary Director General of Canada, to open the discussion.

Dr. HILTON: It is, I assure you, a great privilege to open a discussion upon such an important subject as that of the transmissibility of bovine tuberculosis to the human being.

Permit me at the outset to congratulate Dr. Price upon the presentation of such an interesting review over such a long period of the researches of scientists in their endeavour to incriminate, or to eliminate the bovine tubercle bacillus, as a cause of tuberculosis in man, and also for her excellent report of the very laudable and painstaking investigation and study by herself and co-workers of the incidence of bovine infection in children in the Toronto district.

Practical scientific work of this kind is invaluable and it is much more convincing than many books of theoretical argument.

I am not a research worker as my activities for many years have been limited to an association with the administration of policies for the control and eradication of contagious diseases of live stock.

As there has been in recent years an unprecedented demand for the control of bovine tuberculosis, it may be of interest to you if I outline briefly the progress that has been made in this connection. It has not by any means been a path of roses, as the human element is an important factor in work of this kind.

From a business standpoint the prevalence of bovine tuberculosis has far reaching effects not only on agriculture but also on many commercial enterprises, especially the meat and dairy industries.

Unlike many other diseases tuberculosis is not a self limiting malady, but if unchecked by energetic control, or eradication measures continues to spread steadily.

Long before the question of the transmissibility of bovine tuberculosis to the human subject was definitely settled it was realized that the control of bovine tuberculosis was a problem of supreme economic importance to cattle owners individually and collectively, and that it was an important factor from a public health viewpoint.

It has always been only too apparent that progress in the control of this disease depended to a great extent upon public opinion, and it has consequently been necessary to adopt policies accordingly.

The first control measures were adopted in 1896 and consisted of the free testing of herds with tuberculin. It was soon necessary to consider the marking of reacting cattle to prevent their sale to unsuspecting purchasers. In 1903 an act was passed providing for the compulsory marking of all cattle reacting to official tests by punching the letter "T" through the right ear.

*See References, page 15.

Sound educational propaganda and the demonstration of convincing lesions in the carcases of reactors gradually resulted in a greater demand for the test.

With a view to encouraging this demand the supervised herd plan was adopted in 1905. Under this plan any owner could place his herd under the supervision of the Department by signing an agreement to observe the Department's requirements. The herds were tested free of charge by veterinarians employed by the Government and every effort was made to eradicate the infection and to maintain these herds free from tuberculosis.

While little progress was at that time being made in the control of this disease the continued publicity of the Department's policy gradually awakened the interest of the general public.

With the inauguration of the Meat Inspection Service in 1907 further convincing proof of the existence of this disease in our food producing animals resulted in the public giving more thought to the soundness and wholesomeness of what they consumed. A greater agitation for the suppression of the disease from a public health viewpoint followed, and there was a demand for a safer milk supply.

Seven years later, or in 1914, the Municipal Tuberculosis Order was passed. This policy was adopted with a view to assisting municipalities to obtain their milk supply from tubercle-free herds.

This order applied only to municipalities and it was the first policy requiring compulsory slaughter of reactors and the payment of compensation for tuberculosis.

You will note that a period of over thirty years elapsed before it was considered feasible to pass an order providing for the slaughter of tuberculous cattle. It was, however, soon apparent that even the Municipal Order was at that late date premature, as it was necessary two years later to amend it, in order that municipalities might have the option of accepting milk from untested herds, provided it was properly pasteurized.

With the order so amended many municipalities took advantage of it, but it was soon found that satisfactory progress was not being made in the control of bovine tuberculosis under its provisions. The order nevertheless served a very useful purpose in that apart from its benefits from a public health viewpoint it was a means of educating the public and resulted in a much increased demand for milk from tuberculin tested cattle.

With a more favourable public sentiment it was possible in 1919 to adopt a definite and more particular plan for the eradication of the disease in individual herds.

This policy is known as the Accredited Herd Plan and under its provisions all reactors are slaughtered and compensation is paid. With a view to encouraging live stock owners to maintain tuberculosis-free herds, herds under this plan passing two annual clean tests, or three semi-annual ones, are accredited and the owners receive certificates to that effect. It is a very popular plan, and there are at the present time nearly 4,500 fully accredited herds in this country, containing approximately 135,000 cattle, and in addition thereto there are nearly 1,500 herds under the process of accreditation.

As the number of accredited herds increased there was a persistent demand on the part of the stockmen for more progressive control measures.

As experience had already shown that tuberculosis could be eradicated in individual herds, there was every reason to believe it could also be effectively controlled in definite areas with even better prospects of maintaining them clean.

In 1922 it was decided to endeavour to control the disease by the area plan. Under this plan all cattle in a specified territory are systematically tested at suitable periods, all reactors are slaughtered and compensation is paid.

This plan has proven to be the most practical and economical method for the control of bovine tuberculosis. It permits of organized systematic work and enables the testing of the greatest possible number of cattle in a given period.

There are at the present time nine of these areas in this country with over 800,000 cattle. One of these areas comprises the Province of Prince Edward Island, another the Province of Nova Scotia, with the exception of Cape Breton. There are two areas in Ontario and one area in each of the other provinces with the exception of Alberta.

In the areas in which more than one general test has been conducted the percentage of infection has been materially reduced.

In one area, with approximately 52,500 cattle, an initial infection of 7·9 per cent has been reduced in a five year period to 0·4 per cent. The compensation cost was reduced from a little over $150,000 to approximately $10,000. In another area, with approximately 46,000 cattle, and with a similar initial infection of 7·9 per cent we have been able to reduce the infection in a two year period to 0·76 per cent. The compensation cost was reduced from approximately $124,200 to approximately $14,000.

The highest initial infection has been found in two separate extensions to one of our areas. One of these extensions comprises three counties. There are approximately 61,000 cattle in these three counties, and at the initial test 13,397 of these animals reacted, or 19·8 per cent. In view of the unusually high infection special attention was paid to this area, and in a year's period we were able to reduce this infection from 19·8 per cent to ·88 per cent, and the compensation cost was reduced from $444,600 to approximately $19,000.

The other extension comprises two counties and a portion of two others. There are approximately 59,000 cattle in this territory, and at the initial test 11,600 of these cattle reacted, or 19½ per cent. We are at the present time conducting another test of these cattle, and with 40,000 cattle tested the infection has been reduced to ·9 per cent. With not more than 1,500 cattle to test, it is not at all probable that this reduction will be changed. The compensation cost has been reduced from approximately $400,000 to $12,500.

It is interesting to note that with practically a similar number of cattle in two separate districts, with a similar incidence of infection, practically the same reduction has been made in the percentage of infection in a similar period.

One of the lowest initial infections was found in the Province of Prince Edward Island. With approximately 94,800 cattle not more than 0·59 per cent reacted. A second test was conducted four years later and the percentage of infection was reduced to 0·15 per cent. The compensation cost was reduced from approximately $14,500 to approximately $5,000.

With approximately 192,000 cattle in the Province of Nova Scotia not more than 2·2 per cent reacted, but a second general test has not so far been conducted.

We have found that the initial tests are the costly ones, as over 80 per cent of the compensation paid is incurred in the first tests, and definite progress is made as soon as these tests are completed, reactors slaughtered and the premises cleansed and disinfected.

The cleaning up of these areas of infection has a marked influence in the control of tuberculosis in Canada as a whole, and with our present knowledge it is the only plan by which the natural spread of the disease may be overcome and the ultimate cost of eradication lessened.

We have tested with tuberculin, under our various policies, a total of approximately one and a half million cattle, or a little over one-eighth of the total number of cattle in the Dominion, at least once, and many of them more frequently, and we have removed by slaughter more than 127,000 reactors. A post-mortem examination has been made of each of these carcases and the records are on file in our head office.

Last year our Meat Inspection Division condemned as fit only for fertilizing purposes 14,312 carcases of tuberculous cattle, or in other words 715 carloads, which would make fourteen train loads with fifty cars per train.

This represents not only the loss of the carcases, but also a serious waste of time and money in the raising and feeding of such a large number of cattle.

Even with the comparatively low incidence of this disease in the Dominion our economic losses are serious and they will assuredly increase if we relax our efforts to control this disease.

Fortunately the demand for this work is now so great that our progress is limited only by the available staff and the amount of money voted for this purpose.

The progress which has been made is due very largely to an enlightened public opinion, as it has been quite apparent that public interest in the control of bovine tuberculosis increases as the work progresses.

The menace of this disease to the human being is constantly discussed in the districts in which the testing of cattle is in progress, and this subject has a strong popular appeal.

There is no doubt that the human health factor has been responsible for much of the support given to our work in the control of bovine tuberculosis.

It is, I assure you, very gratifying to realize that in our efforts to control this disease in cattle, we are assisting the medical profession to wage war against this disease in the coming generation of this country.

The discussion was then thrown open to the whole meeting.

Doctor R. E. Wodehouse, Secretary, Canadian Tuberculosis Association: Mr. Chairman, may I be permitted to extend to our Medical Society the congratulations of the Canadian Tuberculosis Association upon our having been favoured with the visit of this distinguished laboratory research worker, Dr. Price, to contribute a paper on her work in regard to: "The Aspects of Bovine Tuberculosis Infection in Children."

I consider the splendid study reported by Dr. Price, and the other work proceeding in the laboratory with which she is associated, to be second in importance only to that carried on by Dr. Griffiths of the University of Cambridge, England, and this on account of its detailed epidemiological study in connection with the patients before death and with their home surroundings and source of food supply previous to entering hospital.

Having said this much in my official capacity, may I now discuss the papers as a member of our Medical Society without conveying anything but unofficial personal views.

There has been a unique drama proceeding in Canada during the last few years. You will recall that Dr. Hilton, in conveying to you information as to the progress of the many schemes in the different provinces for testing cattle for the presence of tuberculosis and eliminating the positive reactors, stated there had been little work* done under his department in Alberta. The Alberta cattle owners principally led by the ranchers who produce for beef purposes have, I understand, always been opposed to adopting this system for ridding their herds of tuberculosis and when the vaccination against tuberculosis was announced as a result of the work of Calmette and Guerin in Paris, this group immediately seized upon this as a solution of their situation and they interested their Provincial Government, who in turn had a research undertaken by the Provincial University and this eventually came under the financial assistance of the National Research Council through its Sub-Committee on Tuberculosis.

At the same time or before, similar studies were being made in the Research Laboratories of the Health of Animals Branch of the Federal Department of Agriculture, Ottawa, under the supervision of Dr. E. A. Watson. (The work in the University of Alberta was under the direction of Dr. Rankin). Many members of our Society present know Dr. Rankin and are of the same opinion as myself in regard to his integrity and sincerity of purpose which is absolutely unimpeachable. We also are familiar with Dr. Watson and we know of his sterling worth and will not allow anything to influence our judgment in appraising the value of any reports by either of these workers of studies made under their direction.

The two studies were carried out on a total of over 300 calves and in addition other smaller animals, and were the largest research studies along this line probably made anywhere in the world. The methods utilized were not exactly the same in detail and the findings were not entirely in accord. Dr. Rankin made the statement in Ottawa last December that vaccination by the B.C.G. vaccine, which is a living tuberculosis organism with an attenuated virulence, did produce in the animals inoculated a positive reaction to the ordinary tuberculin skin tests. *Now this is the important point I wish you to appreciate.*

Doctor Klotz announced at the same meeting, as the result of work carried on by the group working under him in Toronto of which our present distinguished speaker of the evening is one, *that finally and positively any animal, human or otherwise, giving a positive reaction to the tuberculin test could have demonstrated in it a pathological condition resulting from tuberculosis infection* provided the laboratory doing the work had a capable, careful personnel and sufficient money and inclination to insist on search of the tissues, obtained in post mortem, for the microscopic presence of this pathological condition. *Now this is the second important point.*

I think it necessarily follows that B.C.G. establishing a positive reaction to tuberculin must at the same time and in the same animal establish the presence of a pathological condition in keeping with Dr. Klotz' announcement. Therefore, I am inclined to hold the opinion along with Dr. Watson's findings that the injection of a living virus, although attenuated, as in the B.C.G. vaccine, in view of our present knowledge, is not a safe procedure or one to be permitted either in the animal or in the human. This opinion seems to be

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*M.T.O. (Municipal Tuberculin Orders) operate in Banff, Calgary and Edmonton. There are 98 herds (as well) in Alberta tested under the Health of Animals Branch of the Federal Department of Agriculture. This is the smallest provincial program in Canada.

eld at least by the British authorities, in so ar as humans are concerned, and is concurred in by Petroff of Saranac and other laboratory workers, in spite of the fact that in France well over 100,000 babies have been inoculated with this living virus in recent years during their first week of life.

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I desire to express my sincere thanks to Professor Oskar Klotz for his supervision throughout the course of these studies, and for much valuable advice and helpful criticism received from him.

I wish also to express my thanks to Dr. R. I. Harris, of the Surgical Division, Hospital for Sick Children, Toronto, whose interest and co-operation have made this work possible, and the Medical, Surgical and Laboratory Divisions of the Hospital for Sick Children, for courtesy and co-operation in clinics, wards and laboratories of the hospital.—R. M. Price.

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Report of a Special Committee
appointed by the
People's League of Health Inc.
to make

A Survey of Tuberculosis of Bovine Origin in Great Britain

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12, STRATFORD PLACE :: :: LONDON, W.1

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KNOWLEDGE IS THE ONLY ARMOUR OF DEFENCE OF WHICH WE CANNOT BE ROBBED BY AN ENEMY

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12, Stratford Place,
London, W.1.

To His Majesty King George V. :

May it please Your Majesty :

I have the honour to inform Your Majesty that The People's League of Health, of which Your Majesty is the Patron, is now ready to present the Report of the Special Committee formed in February, 1930, to undertake a Survey of Tuberculosis of Bovine Origin in Great Britain.

In laying the Report before Your Majesty, I would point out that in making this Survey, The People's League of Health has had the privilege of being associated with The Royal College of Physicians, The Royal College of Surgeons and The British Medical Association, all of which bodies appointed representatives to serve upon the Committee.

I venture to think that not the least important of the findings of the Committee are those which refer to the economic aspect of Tuberculosis in cattle, the eradication of which is so earnestly desired and yet, at present, entails great losses to the Farming Industry and expense to the Nation, in compensating those farmers whose cattle have to be destroyed.

It is felt that the Recommendations contained in the Report will be of special interest to Your Majesty, seeing that they are directed towards the improvement of the health of Your Majesty's subjects, more particularly of young children to whom Tuberculosis is communicated through the agency of infected milk.

I have the honour to be

Your Majesty's Obedient Servant.

(*Signed*) Olga Nethersole,

Founder and Honorary Organiser.

January 18th, 1932.

INTRODUCTION.

At an Extraordinary Meeting of the Medical and Science Councils of the People's League of Health, of which His Majesty The King is the Patron, convened at its Headquarters, 12, Stratford Place, London, W. 1, on February the 4th, 1930, the subject of Tuberculosis of Bovine Origin and the spread of infection from cattle to human beings, was brought to the special attention of the Members by the Founder and Honorary Organiser, Miss Olga Nethersole, R.R.C.

The Chairman, the late Mr. E. B. Turner, F.R.C.S., was reminded that during the Pure Food Campaign, which had been carried on by the League since it commenced its activities in 1919, the recognition of the value of Milk as a " *Protective* Food " had been repeatedly urged. At the First International Health Conference, held at the British Empire Exhibition in 1924, Professor J. C. Drummond, D.Sc., F.I.C., Professor of Bio-Chemistry, University College, London, and Member of the Science Council of the People's League of Health, in a paper read in the Food Section brought forward the subject of " Protective Foods " and " The Place of Milk in the National Dietary ". In dealing with the nutritive value of milk, which he pointed out was directly dependent upon the food of the lactating animal, Professor Drummond had stressed the need for special attention being given to the ration of such cows, particularly in winter, when they were not out at pasture. He further stated that it had been shewn experimentally that supplementing the winter rations of milch cows with foods rich in vitamin, such as cod liver oil, might be of great dietetic value by increasing the quality of the milk, whereby the health of the nation would benefit to an appreciable degree.

The Honorary Organiser stated that she had reminded the meeting of these facts because Professor Drummond was unable to be present, but that he had empowered her to say that he was in full sympathy with the object of the meeting, and that if a Special Committee was appointed to consider the problem, he would be willing to serve upon it. She further said that she herself ventured to believe that the lack of resistance shewn by dairy and other cattle and young calves to tuberculosis, and probably to other diseases, arose from poor nutrition due to a faulty and inadequate diet.

After a number of speakers had expressed their opinions, it was recognised that there were available no accurate statistics for England, Scotland and Wales relating to human Tuberculosis of Bovine Origin, and that the losses to industry from this disease could not therefore be reliably estimated. The meeting considered the subject of sufficient importance to warrant the undertaking of a special study. After a further free expression of opinion, it was decided that the People's League of Health should appoint a Special Committee to make a Survey of the existing conditions regarding tuberculosis of bovine origin in Great Britain.

The object of this investigation was to collect the necessary facts so as to bring to bear upon this important subject more light than was then available. The Committee was to arrive at a considered opinion regarding the sources and the treatment of this form of tuberculosis, and to suggest methods that might be employed for its prevention and eradication. If it was deemed necessary, the Committee was to recommend additional legislative measures, and was finally to lay before His Majesty's Government a Report of its Findings.

This action on the part of the People's League of Health is yet another step in its campaign for safeguarding the people's food from impurities and adulteration, which has been one of the most important directions of its activity since the League came into being in 1919. A notable example is the Government's action in regard to the New Regulations governing Food Preservatives [as set out in Statutory Rules and Orders, 1925, Number 775, Paragraph 69755, dated August 4th, 1925], which victory the People's League of Health helped in no small way to bring about.

Letters endorsing this latest work undertaken by the League were received from the Rt. Hon. Neville Chamberlain, P.C., M.P., the Rt. Hon. Lord Moynihan, K.C.M.G., C.B., M.S., F.R.C.S., the Rt. Hon. the Earl of Iveagh, C.B., C.M.G., the Rt. Hon. Viscount Astor, Major the Hon. J. J. Astor, M.P., Lord Bledisloe, P.C., K.B.E., who prior to his taking up the Governorship of New Zealand had accepted the office of Vice-President, the Rt. Hon. Walter Guinness, D.S.O., M.P., Sir Gomer Berry, Bt., J.P., the Rt. Hon. Lord Luke, the Rt. Hon. Lord Waring, the Rt. Hon. Viscount Burnham, C.H., G.C.M.G., and the Rt. Hon. Viscount Leverhulme.

On page 42 will be found the names of those Universities, Departments, Institutions, and individuals who have conferred with the Committees upon the subject of the League's Enquiry. It will be seen that the efforts of the League to moderate the ravages of Bovine Tuberculosis have been recognised by the Royal College of Physicians of England, the Royal College of Surgeons, and the British Medical Association, all of which bodies have given it valuable support by appointing their representatives to serve upon the Committees.

The financial help rendered to the League by Lord Iveagh for the making of the Survey is hereby gratefully acknowledged.

Additional Meetings Preliminary to the Formation of the Main Committee.

At a meeting held on March 24th, 1930, the various aspects of the problem were discussed by the following members of the Medical and Science Councils of the League, and by other well-known authorities :—

Sir Robert Armstrong-Jones, C.B.E., M.D., D.Sc., F.R.C.S., F.R.C.P., Lord Chancellor's Visitor in Lunacy.
Dr. P. Manson-Bahr, D.S.O., F.R.C.P., M.R.C.S., Consulting Physician to the Colonial Office and Crown Agents for the Colonies.
Dr. John Buchan, M.O.H., Bradford.
The late Prof. W. E. Dixon, F.R.S., M.D., D.Sc., D.P.H., Reader in Pharmacology in the University of Cambridge and Assessor to the Regius Professor of Physic.
Dr. W. E. Gye, National Institute for Medical Research, Farm Laboratories.
Dr. William Hunter, C.B., M.D., F.R.C.P., F.R.S.E., Representing the Royal College of Physicians.
Dr. Johnstone Jervis, M.O.H., Leeds.
Professor J. C. Grant Ledingham, C.M.G., F.R.S., F.R.C.P., D.Sc., Director, Lister Institute.
Professor Dame Louise McIlroy, D.B.E., M.D., D.Sc., Professor of Obstetrics, Gynæcological Unit, London School of Medicine for Women.
Dr. A. A. Mussen, M.O.H., Liverpool.
Dr. A. S. M. Macgregor, O.B.E., M.O.H., Glasgow.
Dr. Nathan Raw, C.M.G., M.D., B.S., F.R.C.S.E., M.R.C.P.
The late Mr. E. B. Turner, F.R.C.S.
Sir Pendrill Varrier-Jones, M.A., M.R.C.S., Medical Director, Papworth Village Settlement.
Dr. R. Stenhouse Williams, M.B., C.M., D.Sc., L.R.C.P., L.R.C.S., Director of The National Institute for Research in Dairying, Reading.
Dr. W. M. Willoughby, M.O.H., City of London.
Professor Georges Dreyer, C.B.E., M.D., F.R.S., Professor of Pathology, University of Oxford.
Mr. C. H. Fagge, F.R.C.S., L.R.C.P., M.B., M.S., Representing The Royal College of Surgeons of England.
Professor F. T. G. Hobday, C.M.G., F.R.C.V.S., F.R.S.E., Principal, The Royal College of Veterinary Surgeons.
Dr. Alfred Salter, M.P., J.P., B.S., M.R.C.S., L.R.C.P., D.P.H.
Dr. W. G. Savage, B.Sc., D.P.H., M.O.H., Somerset.
Dr. Gordon Tippett, M.R.C.S., L.R.C.P.

Dr. H. B. Brackenbury, M.R.C.S., L.R.C.P., LL.D. London, Chairman of Council of the British Medical Association, attended the meeting unofficially, and referred to the Association's attitude towards the People's League of Health as having been very friendly in the past.* There was a desire to help the work of the League in every way; and there had been occasions, as at the 97th annual meeting of the British Medical Association held at Manchester in 1929, when the two organisations were associated in matters of interest to the public generally.† The official attitude of the British Medical Association to this new work which the League was inaugurating would be considered, he said, by the Council the following week.‡

All those who attended this meeting were invited to serve upon the League's Bovine Tuberculosis Committee and agreed to do so.

* As was evident when members of the British Medical Association joined a deputation from the League to the Minister of Health on the subject of the effect of Noise on the Health of the Community, December 4th, 1928.

† The Founder and Honorary Organiser of the People's League of Health was a Vice-President of the Sociological Section of this meeting.

‡ Dr. C. O. Hawthorne, LL.D., F.R.C.P., was subsequently appointed to represent the British Medical Association upon the League's Special Committee of Enquiry.

General Committee.

The following were the members of the General or Parent Committee as finally constituted :—

The Hon. Mrs. Adams, President of and Representing the Central Council of Milk Recording Societies.

* Sir Robert Armstrong-Jones, C.B.E., M.D., D.Sc., F.R.C.S., F.R.C.P., Lord Chancellor's Visitor in Lunacy.

Lieut.-Colonel J. W. Brittlebank, C.M.G., F.R.C.V.S., late Chief Veterinary Officer, Manchester.

* Dr. John Buchan, M.O.H., Bradford.

Wilfred Buckley, Esq., C.B.E.

Prof. J. B. Buxton, Department of Animal Pathology, University of Cambridge.

Dr. Louis Cobbett, M.A., F.R.C.S., F.R.C.P., Cambridge.

‡ Dr. C. M. Connan, B.S., M.O.H., Bermondsey.

Sir William Dampier, Secretary, Agricultural Research Council.

The late Prof. W. E. Dixon, F.R.S., M.D., D.Sc., D.P.H., Reader in Pharmacology in the University of Cambridge and Assessor to the Regius Professor of Physic. (Deceased 16–8–31.)

Prof. Georges Dreyer, C.B., M.D., F.R.S., Professor of Pathology, University of Oxford.

* Prof. J. C. Drummond, D.Sc., F.I.C., Professor of Bio-Chemistry, University College, London.

* C. H. Fagge, Esq., F.R.C.S., L.R.C.P., M.B., M.S., Representing The Royal College of Surgeons of England.

Prof. Leonard Findlay, M.D., D.Sc.

W. Hill Forster, Esq., Representing the Central Chamber of Agriculture.

* *Member of the Medical and Science Councils of the People's League of Health.*
‡ *Denotes in an advisory capacity.*

Capt. E. Freeth, Representing the National Federation of Dairymen's Associations.

Prof. S. H. Gaiger, Department of Veterinary Pathology, Liverpool University.

Arthur Gofton, Esq., F.R.C.V.S., Chief Veterinary Inspector, City of Edinburgh.

* Dr. W. E. Gye, National Institute of Medical Research.

Dr. Somerville Hastings, M.S., M.R.C.S., L.R.C.P., M.P. for Reading.

* C. O. Hawthorne, M.D., LL.D., D.Sc., F.R.C.P., Representing the British Medical Association.

Prof. F. T. G. Hobday, C.M.G., F.R.C.V.S., F.R.S.E., Principal, Royal Veterinary College.

‡ Sir F. Gowland Hopkins, P.R.S., D.Sc., M.B., M.R.C.P., L.R.C.S., LL.D., F.I.C., Professor of Bio-Chemistry, University of Cambridge.

* William Hunter, C.B., M.D., LL.D., F.R.C.P., Representing the Royal College of Physicians of London.

Harold Jackson, Esq., Chairman of the Central Council of Milk Recording Societies.

*‡ Dr. J. Johnstone Jervis, M.O.H., Leeds.

G. C. Jones, A.C.G.I., F.I.C., F.C.S., Representing the Amalgamated Master Dairymen, Ltd.

*‡ Sir Robert Jones, Bt., K.B.E., C.B., F.R.C.S., D.Sc.

* Prof. J. C. Grant Ledingham, C.M.G., F.R.S., F.R.C.P., D.Sc., Director of the Lister Institute.

*‡ Colonel P. S. Lelean, C.B., C.M.G., F.R.C.S., D.P.H., Director, Usher Institute of Public Health, University of Edinburgh.

* Dr. T. J. Mackie, D.P.H.

* Prof. Dame Louise McIlroy, D.B.E., M.D., D.Sc., Professor of Obstetrics and Director of the Gynæcological Unit, London School of Medicine for Women.

*‡ Dr. A. S. Macgregor, O.B.E., M.O.H., Glasgow.

James Macintosh, Esq., Representing the British Dairy Farmers' Association.

‡ Prof. J. J. R. MacLeod, F.R.S., Professor of Physiology, Aberdeen University.

Lieut.-Colonel C. Maddock, C.I.E., M.D., F.R.C.S.E., D.P.H., Representing the Certified and Grade A Milk Producers' Association.

G. P. Male, Esq., M.R.C.V.S., President, Royal College of Veterinary Surgeons.

*‡ Dr. P. Manson-Bahr, D.S.O., F.R.C.P., M.R.C.S., Consulting Physician to the Colonial Office and Crown Agents for the Colonies.

Dr. F. Minett, D.Sc., M.R.C.V.S., Royal Veterinary College.

* Dr. A. A. Mussen, M.O.H., Liverpool.

* Dr. T. G. Nasmyth, M.D., D.Sc., D.P.H., F.R.C.P., F.R.C.S., Representing the Highland and Agriculture Society of Scotland.

Thomas Neame, Esq., "Certified Milk" Producer.

Dr. John Boyd Orr, D.S.O., M.C., M.A., D.Sc., Rowett Research Institute, Aberdeen.

* Dr. Nathan Raw, C.M.G., B.S., F.R.C.S., M.R.C.P., Lord Chancellor's Visitor in Lunacy.

* Dr. M. B. Ray, D.S.O., Save the Children Fund.

* *Member of the Medical and Science Councils of the People's League of Health.*

‡ *Denotes in an advisory capacity.*

* Sir John Robertson, C.M.G., O.B.E., LL.D., M.D., D.Sc., Birmingham.

Dr. Wm. Robertson, F.R.C.P., M.O.H., Edinburgh.

Jas. Sadler, Esq., O.B.E., Secretary of the Cheshire Chamber of Agriculture.

Dr. A. Salter, J.P., B.S., M.R.C.S., L.R.C.P., D.P.H., M.P., West Bermondsey.

H. G. Sanders, Esq., M.A., School of Agriculture, University of Cambridge.

* Dr. W. G. Savage, B.Sc., D.P.H., M.O.H., Somerset.

Dr. Gordon Tippett, M.R.C.S., L.R.C.P.

The late Mr. E. B. Turner, F.R.C.S.

P. B. Tustin, Esq., F.R.San.I., Representing the United Dairies, Ltd.

Sir Pendrill Varrier-Jones, M.A., M.R.C.S., Medical Director, Papworth Village Settlement.

Mrs. Chalmers Watson, C.B.E., M.D.

Lieut.-Colonel Sir Archibald Weigall, K.C.M.G., Representing the Royal Agricultural Society of England.

S. R. Whitley, Esq., J.P., Reading.

* Dr. R. Stenhouse Williams, M.B., C.M., D.Sc., L.R.C.P., L.R.C.S., Director of the National Institute for Research in Dairying, Reading, Representing Agricultural Education Association.

* Dr. W. M. Willoughby, M.O.H., City of London.

The late George Wilson, Esq., D.Sc., M.R.C.V.S., Representing the Ministry of Agriculture, the Government of Northern Ireland.

* Prof. G. S. Wilson, M.D., F.R.C.P., D.P.H., Department of Bacteriology, London School of Hygiene and Tropical Medicine.

Norman C. Wright, M.A., Ph.D., Hannah Dairy Research Institute, Ayr.

Miss Olga Nethersole, R.R.C., Founder and Honorary Organiser of The People's League of Health.

Prof. David F. Fraser-Harris, B.Sc. (Lond.) M.D., D.Sc., F.R.S.E., Medical Secretary to the Committee.

* *Member of the Medical and Science Councils of the People's League of Health.*

This Committee held two meetings, the first under the presidency of the late Mr. E. B. Turner, F.R.C.S., the second under that of Dr. W. G. Savage, M.O.H. for the County of Somerset.

The powers vested in this Committee, as laid down at the extraordinary meeting of the Medical and Science Councils, held on February 4th, 1930, were as follow :—

(I.) The conducting of such investigations as, in their opinion, are deemed advisable in the carrying out of their survey and enquiry ; such investigations to include the collecting of evidence upon the following points :—

(*a*) The causes and pre-disposing causes of tuberculosis in cattle and children.

(*b*) The number of cattle infected with the tubercle bacillus.

(*c*) The number of children suffering from tuberculosis of bovine origin.

(*d*) Methods of infection and its mode of carriage to man, cattle and bird.

(*e*) The relative values of powers of resistance and of vaccines (immunization) as methods of prevention.

(*f*) The effect of pasteurisation of milk as a preventive measure.

(*g*) The effect of pasteurisation upon the nutritive value of milk regarded as "a protective" food, especially in the case of young children.

(*h*) Methods for the control and prevention of tuberculosis in cattle and bird at present in operation.

(*i*) Methods for the control and prevention of tuberculosis of bovine origin in man at present in operation.

(*j*) Legislation already in operation for its control and prevention, and how far such legislation is at present enacted.

(*k*) The need for further legislation and the enforcement of statutes.

(II.) Co-opting of additional members to serve upon the Committee.

The first meeting of the Parent Committee was held in Committee Room 12 at the House of Commons on April 30th, 1930, when the following scheme of investigation was drawn up and adopted by the Committee, which also decided to divide into two Sub-Committees for the more convenient consideration of the numerous matters referred to it. The scheme adopted was as follows :—

SCOPE OF INVESTIGATION.

Object.—To make a survey of the present situation as regards Tuberculosis of Bovine Origin in Great Britain.

Summary of the subject-matters adopted for investigation by the Committee :—

I. STATISTICAL DATA.

A. Bovine Tuberculosis.

Amount of tuberculosis in dairy stock as judged by :—

1. Reactors to tuberculin.
2. Udder cases.
3. "Open cases."

B. Human Tuberculosis of Bovine Origin.

Its amount, incidence, spread, lesions, and the vehicles of its transmission.

C. The Spread of Bovine Tuberculosis.

Its methods of transmission.
Factors affecting infection.
Natural history of tuberculosis in bovine animals.

II.

D. Methods Employed to Reduce Bovine Tuberculosis, with Evidence as to their Effects.

1. Building up of tuberculosis-free herds.
2. Elimination of all tuberculous animals.
3. Education and more hygienic environment.
4. Operation of the Tuberculosis Order.
5. Immunization.

E. Methods now Employed to Reduce the Risk of Transmission of Tuberculosis by Milk, with Evidence as to their Success.

1. "Designated milks."
2. Operation of the Tuberculosis Order (1925).
3. Systematic veterinary inspection of cows.
4. Bacteriological control.
5. Pasteurisation.

F. Executive Legislation and Administrative Measures and their Results.

Suggestions as to lines of advance, legislative and otherwise, and the formation of a scheme for the eradication of tuberculosis conveyed by milk.

The foregoing subjects were finally referred to two Sub-Committees known, thereafter, respectively as "A and B" and "C", which then entered upon their deliberations.

Sub-Committee A and B directed its attention to the statistical data as specified under heads A, B and C, in the scheme given above.

Sub-Committee C directed its attention to the subjects designated under D and E.

The subject-matters under F were reserved for the final consideration of the General Committee after the reports of the Sub-Committees had been received.

The personnel of Sub-Committee A and B* was :—

Dr. William Hunter (*Chairman*).
The Hon. Mrs. Adams.
Colonel J. W. Brittlebank.
Professor J. B. Buxton.
Dr. Louis Cobbett.
Professor J. C. Drummond.
Mr. C. H. Fagge.
Professor S. H. Gaiger.
Mr. Arthur Gofton.
Mr. Harold Jackson.
Dr. F. C. Minett.
Mr. Thomas Neame.
Mr. J. Sadler.
Mr. H. G. Sanders.
Dr. W. G. Savage.
Sir Pendrill Varrier-Jones.
Mrs. Chalmers Watson.
Dr. Norman Wright.
Dr. Stenhouse Williams.
Dr. Willoughby.
Professor G. S. Wilson.
Miss Olga Nethersole.
Professor David F. Fraser-Harris (*Medical Secretary*).

* This Committee met 4 times.

Towards the close of its investigation, Sub-Committee A and B appointed a small Sub-Committee to consider the draft report ; its personnel was :—

Professor G. S. Wilson (*Chairman*).
Professor Buxton.
Dr. Minett.
Dr. W. G. Savage.

The personnel of Sub-Committee C* was :—

Dr. C. O. Hawthorne (*Chairman*).
Mr. Wilfred Buckley.
Professor J. C. Drummond.
Captain E. Freeth.
Professor L. Findlay.
Dr. Somerville Hastings, M.P.
Professor Hobday.
Professor Grant Ledingham.
Lieut.-Colonel Maddock.
Mr. James Macintosh.
Professor J. J. R. MacLeod.
Professor Dame Louise McIlroy.
Mr. G. P. Male.
Dr. Nathan Raw.
Dr. A. Salter, M.P.
Dr. W. G. Savage.
Dr. Gordon Tippett.
Mr. P. B. Tustin.
Sir Archibald Weigall.
Mr. S. R. Whitley.
Professor G. S. Wilson.
Miss Olga Nethersole.
Professor David F. Fraser-Harris (*Medical Secretary*).

* This Committee met 9 times.

REPORT OF SUB-COMMITTEE "A AND B".

Chairman :

William Hunter, C.B., M.D., F.R.C.P., LL.D. (Edin.).

PART I.

TOTAL BOVINE POPULATION OF ENGLAND AND WALES ON JUNE 4th, 1929.

1. The figures given in Table I., taken from the Report of the Ministry of Agriculture for 1929, are introduced in order to show the magnitude of the bovine tuberculosis problem in England and Wales.

TABLE I.

CATTLE POPULATION OF ENGLAND AND WALES.

Cows and Heifers in milk	2,054,073
Cows in Calf but not in milk	293,755
Heifers in Calf	364,763
Bulls used in service	80,271
Other Cattle—	
2 years and over	918,878
1 year and under 2	1,143,640
Under 1 year	1,102,254
	5,957,594

2. Life of Dairy Cows.

A cow normally produces her first calf at from $2\frac{1}{4}$ to 3 years of age, the lower age being common for certain breeds and systems of management, and the higher age for other breeds, etc. The length of time cows remain in the milking herd (*i.e.* from the date of first calving to final disposal) has been ascertained by many workers, and some of the results are given below :—

(*a*) Mr. H. G. Sanders, working with milk recorded herds in five eastern counties in the year 1928-29, concluded that the average life of cows in these milking herds was 4.7 years.

(*b*) A Bangor (North Wales) Report gives the average life of cows in milking herds at about 4 years ; this Report states that of 260 cows :—

13 or	5.0%	of cows left the herds before their	2nd calf.
58 or	22.3%	,, ,, ,, ,, ,, ,, ,,	3rd ,,
117 or	45.0%	,, ,, ,, ,, ,, ,, ,,	4th ,,
163 or	62.7%	,, ,, ,, ,, ,, ,, ,,	5th ,,
192 or	73.8%	,, ,, ,, ,, ,, ,, ,,	6th ,,
220 or	84.6%	,, ,, ,, ,, ,, ,, ,,	7th ,,

leaving 40 or 15.4% to calve their 7th calf in herds.

(*c*) Mr. G. H. Garrod gives the following figures for " wastages " among herds in Kent :—

In 1928-29 of 1,334 cows in 50 herds, 271 or 20.3 per cent. were eliminated.

In 1929-30 of 830 cows in 32 herds, 181 or 21.8 per cent. of animals were eliminated.

The average milking life of cows may therefore be taken as between 4½ and 5 years.

PART II.

THE INCIDENCE OF BOVINE TUBERCULOSIS IN GREAT BRITAIN.

Incidence as Estimated from the Results of Tuberculin Tests.

Since no comprehensive body of statistics exists in Great Britain other than that in Dr. Savage's books, and since no extensive testing over the whole country or even over a whole county has ever been made, calculations have to be based on samples, the majority of which have not been taken at random.

Since many of these samples comprise herds belonging to the more enterprising owners who are desirous of establishing tuberculosis-free herds, it is probable that the figures tend to underestimate the true frequency of tuberculous infection amongst the general cow population.

It has been definitely ascertained both from the Ministry of Health and from the Ministry of Agriculture and Fisheries that there is no system of collation of the returns of the results of tuberculin-testing or of abattoir statistics. The returns of tuberculin tests are sent to the Ministry of Health and, being confidential, are not published.

The Sub-Committee has therefore investigated available figures with a view to arriving at a fair estimate of the amount of tuberculosis in dairy stock in this country. Conclusions have been based on the following information.

4. As the result of a special request, the Ministry of Health provided the following figures ; it will be noted that they refer only to a limited period :—

TABLE II.

REACTORS IN HERDS SUBMITTED FOR LICENCE BY THE MINISTRY OF HEALTH FOR THE PRODUCTION OF CERTIFIED AND GRADE A (T.T.) MILK.

Year.		*No. of Animals tested.*	*No. of reactors.*	*Percentage of reactors.*
1924	Tests prior to certification ..	1,195	260	21.76
1925	,, ,, ,, ,, ..	2,034	520	25.57
1926	,, ,, ,, ,, ..	2,390	417	17.45

5. Figures supplied by Colonel Maddock, dealing with 1,526 cows from 40 farms, show as a result of first test, 35.5 *per cent. reactors*. These, like those quoted in paragraph 4, were probably well-managed herds which the owners considered might be rendered tubercle-free without too great effort or expense.

6. Dr. Savage (1929) gives the following percentages of tuberculin reactors :—

TABLE III.

TUBERCULIN REACTORS IN THE NEIGHBOURHOOD OF BIRMINGHAM, 1907—1927.

Year.	*No. of Animals tested.*	*Percentage reacting.*	*Year.*	*No. of Animals tested.*	*Percentage reacting.*
1907	51	43.1	1918	72	48.6
1908	237	48.5	1919	—	—
1909	283	31.8	1920	78	16.7
1910	73	20.5	1921	30	40.0
1911	19	63.2	1922	206	36.4
1912	163	44.8	1923	52	17.3
1913	390	38.5	1924	231	50.2
1914	—	—	1925	41	4.9
1915	26	26.9	1926	—	—
1916	15	6.7	*1927	169	68.6
1917	—	—	1907–27	2,136	40.4

* Intradermal test used ; subcutaneous test mainly used in earlier years.

7. The Medical Research Council Report No. 94 (1925) gives the following tabulated results of double intradermal tuberculin testing of four herds :—

TABLE IV.

M.R.C. REPORT, 1925. No. 94.
DOUBLE INTRADERMAL TUBERCULIN TEST ON THREE PREVIOUSLY UNTESTED HERDS.

	Animals tested.	*Reacted.*	*Percentage reacted.*
Herd C.	37	18	47.6
Herd D	33	12	36.4
Herd F	104	62	59.6
Total ..	174	92	52.9

8. Professor J. B. Buxton gives the following results of 17 previously untested herds in different parts of England, extending from Devonshire to Cumberland :—

Total number of animals tested with tuberculin	661
Reacted positively	434
Percentage of positive reactors	65.66

9. Dr. Minett has recently tested three herds of the ordinary commercial type in which no effort had been made to control the disease. The results are shown in Table V.

TABLE V.

INTRADERMAL TUBERCULIN TESTING OF THREE HERDS.

Herd.	*Total Number of Animals.*	*Number of reactors.*	*Percentage reacting.*
A	75	46	61.3
B	101	40	39.6
C	89	30	33.7
	265	116	43.8

About 4 per cent. of the 265 animals gave reactions which were classed as " doubtful ". These have been included above among the reactors.

10. The average of the figures available is about 40 per cent. which the Sub-Committee feels may be regarded as a conservative estimate of the amount of tuberculosis in dairy cattle, judged from this particular standpoint.

11. In view of the high incidence of bovine tuberculosis, it would obviously be futile to recommend the immediate elimination of all reactors irrespective of whether or not they were giving tuberculous milk.

12. The Sub-Committee has had before it figures showing the incidence of tuberculosis in cattle in foreign countries, *e.g.* Japan, Sweden, and the United States of America. While these figures are interesting, the Sub-Committee is of opinion that they do not in any way help to solve the problem in this country, and therefore does not propose to quote them with the exception of those from the United States of America.

These are quoted because they are very much more favourable than the English figures, and show how it has been possible to institute an eradication campaign involving the slaughter of all reactors in the country. This campaign was started in 1917, and the figures are given for 1919, showing the low initial incidence, and the fall which has taken place during the ten years to 1929 :—

TABLE VI.

TUBERCULIN TESTS ON CATTLE IN U.S.A.

Year.	*Tested.*	*Reactors.*	*Percentage reacting.*
1919 ..	329,878	13,528	4.1
1929 ..	11,683,720	206,764	1.8

13. THE INCIDENCE OF UDDER TUBERCULOSIS.

The findings of routine inspections of cows undertaken by skilled veterinarians furnish a useful guide to the prevalence of udder tuberculosis, since special attention is invariably paid to the condition of the udder. As special inspections, *i.e.* those resulting from an examination of a herd because tubercle bacilli are found in the milk, are almost always included with the unselected examinations, the results are not those of a perfectly random sample, but the error from this source is inconsiderable.

The following are submitted :—

TABLE VII. (*a*).

UDDER TUBERCULOSIS IN COWS.

County.	*Year.*	*Cows Examined.*	*Udder Tuberculosis cases found :*	
			Number	*Percentage.*
Lanarkshire ..	1926	34,632	45	0.10
	1927	34,601	47	0.14
	1928	35,819	39	0.11
	1929	36,233	38	0.11
West Riding (Yorkshire)	1928–29	100,654	130	0.13
	1929–30	156,334	207	0.13
Cumberland ..	1927	3,025	7	0.23
	1928	9,916	7	0.07
	1929	9,915	8	0.08
	1930	16,785	18	0.11

14. The figures are reasonably consistent and show that about 0.13 per cent. of cows when inspected show evidence of tuberculosis of the udder detectable by clinical examination along with some assistance from bacteriological examination of the milk. Most of these results are from yearly or bi-annual examinations. With more frequent examinations such as are possible in city cowsheds, rather higher figures may be recorded. For example, in Liverpool town cowsheds in 1927, out of 12,148 examinations, 19 udder tuberculosis cases were detected (0.15 per cent.) ; for 1928, out of 10,613 examinations, the percentage was 0.23 ; and for 1929, out of 12,105 examinations, the percentage was 0.21. Excluded from the above figures are those cows with tuberculosis of the udder reported separately under the Tuberculosis Order and not detected by routine inspection. When these are included, the percentage is slightly increased. In Lanarkshire, for example, their inclusion brings the percentage udder figures for 1928 and 1929 to 0.17 and 0.19 respectively.

In most cases of udder tuberculosis there is a stage during which no definite clinical signs are present, although tubercle bacilli are excreted in the milk ; these cases are not included in the above figures.

15. Making allowances for these undetectable cases, we consider that the percentage of udder tuberculosis in dairy cattle can reasonably be taken as about 0.2 per cent. (1 in 500) in the country generally. The actual percentage no doubt varies somewhat in different areas depending upon such factors as the age, composition of the herds and the conditions under which they are maintained.

NOTE.—In Gloucestershire a system of veterinary inspection has been in operation since 1927, and the following results have been obtained. The figures include not only animals detected at routine inspection but those reported separately under the Tuberculosis Order ; they have therefore not been made use of in Table VII.

TABLE VII. (*b*).

Surveys.	*Year.*	*Animals Examined.*	*Udder Tuberculosis cases found.*	
			Number	*Percentage.*
1st ..	1927–28	52,131	55	0.11
2nd ..	1927–28	53,623	32	0.06
3rd ..	1928–29	44,648	29	0.07
4th ..	1928–29	42,126	15	0.04
5th ..	1929–30	45,902	21	0.05
6th ..	1929–30	44,900	20	0.05
7th ..	1930–31	44,104	21	0.05

STATISTICS RELATING TO ANIMALS SLAUGHTERED UNDER THE TUBERCULOSIS ORDER, 1925.

16. The Sub-Committee has examined various reports on the number of animals slaughtered under the Tuberculosis Order, 1925, and is of the opinion that they are of no special value for the purpose of the Committee's Report.

STATISTICS DERIVED FROM ABATTOIR EXAMINATIONS.

17. The Sub-Committee has collected the following sample figures, the majority of which relate to cows :—

(*a*) Mr. Dunlop Young, quoted by Savage, states that in the City of London abattoirs during 1924, 284 cows were slaughtered, and 28 per cent. were found to be tuberculous.

The average number of cows slaughtered annually within the City area over a period of nine years was 630, of which 33 per cent. were found to be tuberculous.

(*b*) In Edinburgh, Mr. Gofton states that during 1920-1924, 16,249 cows passed through the abattoir, and that of these 44.78 per cent. were found to be tuberculous. Very little variation was noticed from year to year.

In 1926, 3,479 cows were slaughtered, and 46.5 per cent. found tuberculous.

In 1927, 3,687 cows were slaughtered, and 42.9 per cent. found tuberculous.

In 1928, 3,793 cows were slaughtered, and 41.8 per cent. found tuberculous.

In 1929, 4,173 cows were slaughtered, and 39.4 per cent. found tuberculous.

In 1930, 3,721 cows were slaughtered, and 40.6 per cent. found tuberculous.

(*c*) The statistics of the Dublin Corporation abattoir for 1928-1930 are as follow :—

In 1928, 7,437 cows were slaughtered, and 33 per cent. found tuberculous.

In 1929, 6,866 cows were slaughtered, and 32.5 per cent. found tuberculous.

In 1930, 5,629 cows were slaughtered, and 33.1 per cent. found tuberculous.

It is stated that a large number of *old* cows were slaughtered during this period.

(*d*) At Newcastle-on-Tyne between 1922 and 1925, a careful *post-mortem* search for tuberculous lesions was made in cows slaughtered in the abattoir. Of 121 animals slaughtered, 94 (78 per cent.) were found to be tuberculous.

18. The Sub-Committee desires to point out that abattoir figures concern, as a rule, the older animals and that, as is well known, the incidence of tuberculosis in bovines increases with their age. This is shown by the following figures given by Delépine, quoted from Cobbett (1912) :—

TABLE VIII.

RELATION OF TUBERCULOSIS TO AGE IN CATTLE.

Age in Years	0–1	1–2	2–3	3–5	5–9	9–13	*Total.*
No. examined	29	68	112	51	94	25	379
Percentage Tuberculous	3.4	13.2	24.1	23.5	48.9	76.0	30.5

As further illustrating this point, Mr. Gofton gives the following figures for animals slaughtered in Edinburgh during 1928-1930 :—

TABLE IX.

PERCENTAGE OF COWS AND OTHER CATTLE FOUND TUBERCULOUS WHEN SLAUGHTERED AT EDINBURGH, 1928–30.

	No. Slaughtered.	*Percentage Tuberculous*
Calves . .	13,924	0.70
Heifers . .	2,770	7.47
Oxen . .	82,974	4.19
Bulls . .	2,164	22.59
Cows . .	11,687	40.55

NOTE.—The age of these animals is not known with certainty, but Mr. Gofton has been kind enough to provide the following information :—

(*a*) Age of heifers : 2–3 years.

(*b*) Age of oxen : Majority 2½–3 years ; minority up to 4 years.

(*c*) Age of bulls : 4–7 years ; majority probably 5–6 years.

(*d*) Age of cows : This is very uncertain. Many relatively young cows come from the local dairies at about 5–6 years of age ; from that they range up to 12, 15, or even more years.

The tuberculosis percentage for cows will be seen to be higher than in the case of younger animals, and since, no doubt, many cows suspected of tuberculosis are sent to abattoirs intentionally, the figures will be unfairly loaded and may give a false impression. Taking all the available figures, it will be seen that of 55,318 cows slaughtered, 39.5 per cent. were found on *post-mortem* to contain gross macroscopic lesions of tuberculosis.

PART III.

EVIDENCE OF PRESENCE OF TUBERCLE BACILLI IN MILK.

19. The Sub-Committee has examined the reports of a number of milk samples taken under the provisions of the Milk and Dairies Act, and also those recorded by the Ministry of Health. Some of these are given below. Many of the tables have been taken from Dr. Savage's book on " The Prevention of Human Tuberculosis of Bovine Origin ", and modified slightly to bring them up to date.

TUBERCLE BACILLI IN MILK.

TABLE X.

BULK SAMPLES COLLECTED AT THE FARMS FROM ALL THE MILK-PRODUCING COWS IN THE HERD.
SOMERSET FIGURES.

Year.	*No. of Samples examined.*	*No. T.B.+*	*Percentage T.B.+*
1926	180	4	2.2
1927	230	5	2.2
1928	273	6	2.2
1929	300	8	2.67
1930	344	8	2.3
Total 1926–1930 ..	1,327	31	2.3

TABLE XI.

TUBERCLE BACILLI IN MILK (RAW MIXED AS RECEIVED INTO THE CITY).

	BIRMINGHAM.			NEWCASTLE-ON-TYNE.		
Year.	*No. of samples examined.*	*T.B.+*	*Percentage T.B.+*	*No. of samples examined.*	*T.B.+*	*Percentage T.B.+*
1918 ..	56	3	5.4	103	3	2.9
1919 ..	37	2	5.4	169	6	3.6
1920 ..	83	8	9.6	174	11	6.3
1921 ..	200	12	6.0	165	9	5.5
1922 ..	228	8	3.5	171	12	7.0
1923 ..	298	23	7.7	178	8	4.5
1924 ..	303	26	8.6	220	7	3.2
1925 ..	681	52	7.6	372	29	8.0
1926 ..	811	71	8.8	376	15	4.0
1927 ..	899	64	7.1	376	14	3.7
1928 ..	1056	96	9.1	376	14	3.7
1929 ..	958	64	6.7	377	33	8.7
1930 ..	1699	105	6.2	—	—	—
1918–1930 ..	7,309	534	7.31	1918–29 3,057	161	5.27

TABLE XII.

TUBERCLE BACILLI IN MILK (RAW MIXED AS RECEIVED INTO THE CITY).

	Salford. All Samples.			Analysed as regards origin. Cheshire.		Lancashire.	
Year.	*No. examined.*	*T.B.+*	*Percentage T.B.+*	*No. examined*	*Percentage T.B.+*	*No. examined*	*Percentage T.B.+*
1920	264	19	7.2	83	14.4	112	2.6
1921	284	19	6.7	104	12.5	105	2.8
1922	197	10	5.1	89	9.0	76	1.3
1923	278	24	8.6	123	13.8	94	5.3
1924	265	23	8.7	256	11.1	76	8.0
1925	331	29	8.7	203	10.8	90	4.4
1926	329	22	6.7	157	8.9	152	4.6
1927	371	31	8.3	178	11.2	124	4.8
1928	466	39	8.3				
1929	463	45	9.7				
1930	530	31	5.8				
1920–1930	3778	292	7.73				
1925–1929	—	—	—	998	10.4	649	5.68

TABLE XIII.

TUBERCLE BACILLI IN MILK (RAW MIXED AS RECEIVED INTO THE CITY).

	Manchester.			Sheffield.		
Year.	*No. of country samples examined.*	*T.B.+*	*Percentage T.B.+*	*No. of samples examined.*	*T.B.+*	*Percentage T.B.+*
1920	194	29	14.9	836	59	7.0
1921	305	37	12.1	1057	88	8.3
1922	243	21	8.6	1073	80	7.5
1923	296	33	11.1	957	68	7.1
1924	253	43	9.5	966	72	7.5
1925	292	24	8.2	913	89	9.8
1926	474	49	10.3	993	64	6.4
1927	604	67	11.1	1166	92	7.9
1928	694	122	17.6	1027	65	6.3
1929	697	88	12.6	1058	78	7.4
1930	750	107	14.3	1041	77	7.4
1920–1930	4,802	620	12.91	11,087	832	7.5

TABLE XIV.

TUBERCLE BACILLI IN MILK.

		No. of samples examined.	*T.B.*	*Percentage T.B.*
London County Council..	1918—1927	16,514	870	5.3
Liverpool	1920—1930	12,763	878	6.9
Huddersfield	1926—1930	237	15	6.3
Reading	1920—1930	282	31	11.0
Cardiff	1920—1930	682	31	4.5
Hull	1925—1930	449	30	6.7
Blackburn	1920—1030	1804	37	2.1
Bristol	1920—1930	450	30	6.7
Leeds	1920—1930	878	36	4.1
Brighton	1920—1930	541	60	11.1
Glasgow	1921—1930	1702	49	2.9
Edinburgh	1918—1927	795	67	8.4
Aberdeen	1920—1930	1561	89	5.7

Taking all the figures together, the results are as follow :—

Number of samples examined.	*Number containing T.B.*	*Percentage T.B.*
69,901	4,690	6.7

20. In the collection of these figures, considerable care has been exercised to choose only those dealing with unselected samples of mixed raw milk. All of them were obtained, so far as could be gathered, by the biological method of testing ; but as this method is subject to variation in technical details from one laboratory to another, it must be borne in mind that the results in different areas are not strictly comparable. The error introduced by this variation is not likely to be a large one, but it may partly explain the unusually low figures obtained in some areas. Examination of the figures already quoted shows that no obvious reduction in the proportion of milk infected with tubercle bacilli has occurred during the last ten years ; and examination of the figures referring to several years ago (Table XV.) likewise lends no support to the idea that any marked

general improvement in the milk supply, so far as its freedom from infection with tubercle bacilli is concerned, has taken place.

TABLE XV.

PERCENTAGE OF MIXED MILK SAMPLES CONTAINING TUBERCLE BACILLI 1908—1910 (MODIFIED FROM SAVAGE).

	1908	1909	1910
Manchester	8.3	5.1	6.4
Liverpool country samples	3.3	1.8	4.1
,, town samples	2.0	0	1.4
Sheffield country samples	9.9	10.9	10.4
Birmingham	11.3	7.5	7.3
Leeds	25.3	16.4	—
London (County Council)	11.6	10.4	—

Conclusions.

21. It is estimated, on the basis of the tuberculin reaction; (*a*) that at least 40 per cent. of the cows in this country are infected with the tubercle bacillus, though only a minority of them are in an infective condition; (*b*) that about 0.2 per cent. of all cows are suffering from tuberculosis of the udder, and are therefore probably excreting living tubercle bacilli in the milk; (*c*) that about 40 per cent. of cows slaughtered in the public abattoirs show naked-eye lesions of tuberculosis; (*d*) and that a proportion of the raw market milk, varying in different parts of the country from 2 to 13 per cent., with an average figure of 6.7 per cent., contains living tubercle bacilli.

PART IV.

INCIDENCE OF TUBERCULOSIS OF BOVINE ORIGIN IN HUMAN BEINGS.

Types of Tubercle Bacilli and their Infectivity.

22. There are four types of tubercle bacilli—the cold-blooded, avian, bovine, and human—which are distinguishable by cultural, pathogenicity, and, to some extent, by serological tests.

23. Tuberculosis, as it affects man, is due to infection with the human and bovine types. No case of human infection with the cold-blooded type has been recorded, and infection of man with the avian type is so rare that it can be disregarded.

24. The human type of bacillus gives rise under natural conditions to tuberculosis in man, monkeys, pigs, dogs, and parrots; experimentally it is also pathogenic for the guinea-pig.

25. The bovine type of bacillus gives rise under natural conditions to tuberculosis in cattle, pigs, man, monkeys, horses, sheep, goats, dogs and cats ; experimentally it is also pathogenic for the guinea-pig and the rabbit. It will be seen that the bovine has a wider range of pathogenicity than the human type of bacillus.

26. Man is the natural habitat of the human type of bacillus ; though disease caused by this organism may occur under natural conditions in other animals, but the total number of cases is so small compared with those occurring in human beings, that man alone must be regarded as furnishing a reservoir for this type of bacillus.

27. The bovine type of bacillus finds a natural habitat in cattle, but it is also frequently present in man and in pigs. It is, however, chiefly from cattle that this type of organism gains access to the human body.

28. There is abundant evidence that infection of man with the human type occurs mainly by the respiratory tract. Bacilli are coughed up by patients suffering from pulmonary tuberculosis, and are expelled in the form of fine droplets during the acts of coughing, sneezing, spitting, or even loud talking. These infected droplets may be inhaled by persons in the vicinity, so that the bacilli in the droplets are deposited on the mucous membranes of the pharynx, larynx, or trachea, or may be aspirated directly into the lungs. Tubercle bacilli, present in dried sputum, may likewise be inhaled in the form of dust.

29. Infection of man with the bovine type, on the other hand, occurs almost exclusively by the alimentary tract. The chief vehicle of infection is cow's milk, and the bacilli contained in infected milk, when swallowed by man, may gain access to the tissues either through the pharyngeal mucous membrane or through the intestine. The same route is followed by the bovine tubercle bacilli present in infected meat ; although there is every reason to believe that, under modern conditions of hygienic meat, the risk of infection of man from tuberculous meat is almost negligible, compared to that from infected milk.

30. Either type of bacillus may give rise to tuberculosis in any organ in man, but, generally speaking, while the human type is responsible for both pulmonary and non-pulmonary disease, the bovine type is found chiefly in non-pulmonary lesions.

31. Milk is consumed daily mainly by the young, and the maximum incidence of tuberculosis of bovine origin is in childhood. Tuberculosis of human origin is common at all ages.

Incidence of Human Tuberculosis of Bovine Origin in England and Wales.

A. *Mortality Statistics.*

32. Since the type of the infecting organism can be determined only by bacteriological methods, it follows that our knowledge of the extent of bovine infection in man rests solely on the data accumulated by the examination of specimens of tuberculous material collected either during life or after death. The process of "typing" is arduous and time-consuming and demands considerable experience. For this reason the type of infecting organism is not usually determined as a routine, and the number of determinations that have been made is not very large. If it were desired to obtain an accurate idea of the frequency of bovine infection, it would be necessary to "type" the bacilli from every kind of tuberculous lesion in each sex, age-group, and social class. This has never been done, so that the figures available are necessarily imperfect. It is essential to bear this in mind when considering the estimates that have been based upon them.

33. The work of the Royal Commission on Tuberculosis, 1895, and of certain individual research workers, notably of Dr. A. Stanley Griffith (1929), has provided us with most of the information we possess on the type of infecting organism in tuberculosis. It is not proposed to set out this information in detail. The figures, however, can be used as a basis for estimating, from the mortality statistics published by the Registrar General, the probable frequency of fatal bovine infection in man. This has been done in Table XVI.

TABLE XVI.

DEATHS FROM TUBERCULOSIS IN 1928 (England and Wales).
CALCULATION OF BOVINE DEATHS.

	Respiratory.			Nervous System.		
Age.	*Deaths.*	% *Bovine*	*Calculated deaths of Bovine origin.*	*Deaths.*	% *Bovine.*	*Calculated deaths of Bovine origin.*
0–5 ..	393			1327	24.1	320
5–10 ..	258	1.5	18	520	20.5	152
10–15 ..	574			221		
15–20 ..	2,901	1.0	298	189	15.4	74
20 & over ..	20,673			294		
Total ..	29,799	1.06	316	2,551	21.40	546

TABLE XVI.—*cont.*

Age.	*Deaths.*	% *Bovine.*	*Calculated deaths of Bovine origin.*	*Deaths.*	% *Bovine.*	*Calculated deaths of Bovine origin.*
	ABDOMINAL.			BONES AND JOINTS.		
0–5 ..	453			28	28.6	8
5–10 ..	129	75	501	28	19.0	10
10–15 ..	86			26		
15–20 ..	132			74	4.7	33
20 & over ..	536	30	200	637		
Total ..	1,336	52.46	701	793	6.43	51
	SKIN.			LYMPHATIC GLANDS.		
0–5 ..	0			26	85.7	22
5–10 ..	0			6	62.1	4
10–15 ..	0			2	32.0	1
15–20 ..	4			9	33.3	2
20 & over ..	75	10	8	47	13.0	6
Total ..	79	10.0	8	90	40.0	36
	GENITO-URINARY.			DISSEMINATED.		
0–5 ..	2			415		
5–10 ..	4	33.3	4	169	24.6	178
10–15 ..	7			140		
15–20 ..	30	15.0	42	177	5.0	47
20 & over..	248			767		
Total ..	291	15.81	46	1,668	13.49	225
	OTHER ORGANS.					
0–5 ..	5					
5–10 ..	2					
10–15 ..	1	8				
15–20 ..	0					
20 & over..	8					
Total ..	16	8	1			

34. From Table XVII., in which the figures shown in Table XVI. are summarized, it will be noted that the calculated

bovine deaths in 1928 for all forms of tuberculosis were approximately 2,000 ; that 5.3 per cent. of all deaths were due to the bovine type ; that 23.6 per cent. of the non-pulmonary deaths were due to this type ; and that about two-thirds of the deaths due to bovine infection occurred before the age of fifteen years.

TABLE XVII.

BOVINE TUBERCULOSIS DEATHS IN ENGLAND AND WALES, 1928, SUMMARIZED. ALL AGES.

	Deaths.	*% Bovine.*	*Bovine Deaths.*
Respiratory	29,799	1.06	316
Nervous	2,551	21.40	546
Abdominal	1,336	52.46	701
Bones and Joints	793	6.43	51
Skin	79	10.0	8
Lymphatic Glands	90	40.0	36
Genito-urinary	291	15.81	46
Disseminated	1,668	13.49	225
Other Organs	16	8.0	1
All Forms	36,623	5.27	1930
Tuberculosis excluding that of respiratory origin ..	6,824	23.64	1614

BOVINE TUBERCULOSIS DEATHS IN CHILDREN UNDER 15.

	Deaths.	*% Bovine.*	*Bovine Deaths.*
Respiratory	1,225	1.5	18
Nervous	2,068	22.8	472
Abdominal	668	75.0	501
Bones and Joints	82	22.0	18
Skin	0	0	0
Lymphatic Glands	34	79.4	27
Genito-urinary	13	33.3	4
Disseminated	724	24.6	178
Other Organs	8	15.0	1
All Forms	4,822	25.27	1,219

35. These estimates, which have been compiled with considerable care, may be compared with those of previous workers. Thus Cobbett (1917) estimated that the mortality caused by infection with the bovine type was 6 per cent. Griffith (1927) put this figure at 6.9 per cent., and Savage (1929) at 5.13 per cent. These estimates are not grossly dis-similar, and it may be concluded that approximately 6 per cent. of all tuberculous deaths are due to infection with the bovine type. In other words, about 2,000 children die annually from tuberculous infection of bovine origin.

36. To show that these figures for 1928 are not exceptional, the calculated deaths of bovine origin for the ten years 1920–29 are set forth in Table XVIII.

TABLE XVIII.

TUBERCULOSIS DEATHS IN ENGLAND AND WALES, 1920—1929.

As to the proportion due to bovine infection, it is calculated that 1 per cent. of the respiratory and 23 per cent. of the non-respiratory cases in each year are of bovine origin.

Year.	*Respiratory deaths.*	*Non-Respiratory deaths.*	*Bovine Origin.*		*Calculated total deaths of bovine origin.*
			Respiratory.	*Non-Respiratory.*	
1920	32,791	9,754	328	2,249	2,577
1921	33,505	9,173	335	2,110	2,445
1922	33,919	8,858	339	2,037	2,376
1923	32,097	8,691	320	1,999	[2,319
1924	32,690	8,413	327	1,935	2,262
1925	32,382	8,005	324	1,841	2,165
1926	30,108	7,417	301	1,706	2,007
1927	31,066	7,107	310	1,635	1,945
1928	29,799	6,824	298	1,570	1,868
1929	31,425	6,565	315	1,510	1,825

B. *Notification of Tuberculosis.*

37. Tuberculosis is not necessarily a fatal disease, and mortality statistics afford, therefore, only an incomplete idea of the total amount of infection of bovine origin. In order

to supplement this information, use can be made of the notifications of tuberculosis given annually in the Registrar-General's Report. In estimating the proportion of bovine infections, it has been assumed that the same proportion holds for cases of illness as for actual deaths. This assumption is not altogether justified, since owing to the peculiar location of many bovine lesions and the usual failure of the lungs to be involved, death is probably less frequent than with infections of the human type. Figures calculated on this basis will, therefore, under-estimate the true frequency of bovine infection; they do, however, afford some indication of the amount of illness caused by this organism.

TABLE XIX.*

INCIDENCE OF BOVINE TUBERCULOSIS IN ENGLAND AND WALES AS MEASURED BY NOTIFICATION OF CASES, 1920—1929.

Year.	*Respiratory cases.*	*Non-Respiratory cases.*	*Calculated Bovine Origin.*		*Calculated total cases of bovine infection.*
			Respiratory.	*Non-Respiratory.*	
1920	61,655	15,851	617	3,646	4,263
1921	52,299	15,653	523	3,599	4,122
1922	55,798	16,178	558	3,719	4,277
1923	57,007	18,494	570	4,253	4,823
1924	57,737	18,711	577	4,302	4,879
1925	58,545	19,228	585	4,423	5,008
1926	56,212	18,608	562	4,280	4,842
1927	54,048	17,679	540	4,070	4,610
1928	53,047	17,977	530	4,135	4,665
1929	52,634	16,544	526	3,805	4,331

* The figures in this table are taken from the Registrar General's report. It will be noted that the numbers of cases increased in the year 1923. This increase was probably due to the efforts of the Ministry of Health, in whose annual report for the year 1930–31 the following statement is found —" For the years 1923—1930 inclusive, the figures include all new cases coming to the notice of the Medical Officers of Health of administrative Counties, County Boroughs, and Metropolitan Boroughs, whether as a result of notification under the Regulations or otherwise, and are not strictly comparable with the figures for previous years."

It is true that the Registrar General's statistics are compiled only from cases actually notified, but there can be little doubt that the efforts of the Ministry of Health increased the numbers of notifications from 1923 onwards.

38. From this Table it appears that at least 4,000 fresh cases of infection due to the bovine type must occur annually.

It may be remarked that, though tuberculosis is a notifiable disease, there is reason to believe that a considerable proportion of cases, particularly of the non-respiratory type, are not in fact notified. The figure 4,000 is therefore undoubtedly an under-estimate of the true frequency of bovine infection. Moreover, no mere figures can correctly indicate the extent of suffering and deformity caused by this disease.

Incidence of Human Tuberculosis of Bovine Origin in Scotland.

39. The data available for Scotland are very much scantier than those for England and Wales, and in order to avoid making estimates which may be unreliable, it is proposed to give the actual figures obtained from an examination of tuberculous lesions.

TABLE XX.

FREQUENCY OF BOVINE TYPE OF BACILLUS IN TUBERCULOUS LESIONS IN SCOTLAND. ALL AGES.

Compiled from Figures of Fraser (1913), Mitchell (1914), and Griffith (1929).

Variety of Tuberculosis.	*No. of cases examined.*	*Bovine bacilli found.*	*Percentage Bovine bacilli.*
Respiratory	468	18	3.8
Nervous	10	3	—
Abdominal	8	5	—
Bones and Joints	98	49	50.0
Lymphatic Gland	90	77	85.6
Disseminated	12	5	—
Other Organs	13	4	—

Comparison with Table XVI. indicates the greater frequency of bovine infection in Scotland than in England and Wales. Besides the much higher incidence in bone, in joint and in glandular disease, it will be noted that about 4 per cent. of cases of pulmonary tuberculosis are due to the bovine type. This is in marked contrast with the figure of 1 per cent. for England and Wales.

Diminution of Human Tuberculosis of Bovine Origin in England and Wales during the past Eighty Years.

40. Examination of Table XXI. will show that the annual death-rate from tuberculosis, both of the pulmonary and of the

non-pulmonary type, has diminished considerably during the past eighty years.

TABLE XXI.

ANNUAL MORTALITY FROM TUBERCULOSIS PER MILLION PERSONS LIVING 1851—1929.

Year.	*All forms.*	*Respiratory.*	*Non-Respiratory.*
1851–55	3638	2890	748
1856–60	3328	2663	665
1861–65	3316	2625	691
1866–70	3217	2558	659
1871–75	2956	2327	629
1876–80	2818	2141	677
1881–85	2558	1922	636
1886–90	2342	1704	638
1891–95	2138	1504	634
1896–1900	1912	1337	575
1900	1904	1337	567
1901	1807	1263	544
1902	1739	1229	510
1903	1741	1196	545
1904	1780	1228	552
1905	1634	1130	504
1906	1647	1138	509
1907	1606	1125	481
1908	1585	1099	486
1909	1524	1063	461
1910	1422	988	434
1911	1456	1035	421
1912	1361	995	366
1913	1340	958	382
1914	1345	988	357
1915	1440	1053	387
1916	1423	1046	377
1917	1479	1085	394
1918	1539	1165	374
1919	1229	918	311
1920	1123	833	290
1921	1117	845	272
1922	1107	848	259
1923	1049	798	251
1924	1039	801	238
1925	1017	788	229
1926	942	730	212
1927	952	744	208
1928	909	709	200
1929	932	738	194

41. It will be noted, however, that the fall in the non-pulmonary death-rate has been very much more marked than in the pulmonary death-rate. Thus the non-pulmonary death-rate in 1929 was only 34.2 per cent. of the death-rate in 1900, whereas the pulmonary death-rate in 1929 was 49 per cent. of that in 1900.

42. It is not proposed to discuss in detail the factors responsible for the differential fall in the death-rate. In this fall

many factors are concerned, and no one of them can be selected as predominant. The following may be mentioned :—

(*a*) Improvement in the general hygienic production of milk. There is no doubt that during the past ten or twenty years, as a result of the educational work undertaken amongst farmers, of the institution of Clean Milk Competitions, of the introduction of "grading," and of the sustained and praiseworthy efforts, in particular, of the National Institute for Research in Dairying, there has been a marked improvement in the general cleanliness of milk production. Whether there has been any corresponding decrease in the frequency with which milk is infected with tubercle bacilli, it is not possible to say with certainty. Judged from the proportion of samples infected now and twenty years ago, there is little evidence of any improvement, but it must be remembered that the biological test for tubercle bacilli in milk is a qualitative test, and will not reveal, under the conditions in which it is usually performed, any difference in the numbers of tubercle bacilli. It may well be that, even though the proportion of infected samples still remains high, the actual numbers of tubercle bacilli in market milk have actually fallen. This might take place as the result of earlier detection of cases of udder tuberculosis, which would probably result in a decrease in the heaviness of infection before an actual fall in the proportion of infected milks became apparent.

(*b*) Increase in the pasteurisation and sterilisation of milk. That pasteurisation, if adequately performed, is capable of destroying tubercle bacilli and rendering infected milk safe for consumption, there seems to be very little doubt. Striking evidence of its effect in preventing tuberculosis of bovine origin has recently been collected in Toronto by Price. Material from 207 cases of tuberculosis in children, mostly of non-pulmonary type, was examined, and the bovine type of bacillus was recovered from 26 cases. All the cases infected with the bovine type came from the country around Toronto, where the milk was mostly consumed raw ; in Toronto itself, where 99.5 per cent. of all milk sold is pasteurised, not a single case of bovine infection was found.

The extent to which pasteurisation has been responsible for the fall in tuberculosis of bovine origin in this country is doubtful. Examination of Table XXI. shows that the rate of fall in the non-respiratory tuberculosis death-rate has been increasing o late years. Thus during the 50 years 1851–1900 the death-rate fell by only 23.1 per cent.; between 1900 and 1909, however, it fell by 18.7 per cent.; between 1909 and 1919 by 32.5 per cent.; and between 1919 and 1929 by 37.6 per cent. Seeing that pasteurisation and sterilisation of milk have been operative on a big scale only during the past ten or fifteen years, it is doubtful whether they can be held chiefly responsible for the fairly rapid decline in non-pulmonary tuberculosis that has been going on for the last thirty years. More probably their influence has been to accelerate during recent years a fall which had already commenced as the result of other causes.

(*c*) Improvement in child welfare. During the past twenty years or so there has been a steady increase in the number of infants and children supervised by welfare centres. At many of these centres, care is taken to provide milk, either derived from safe herds or in a form which renders it probable that any tubercle bacilli have been destroyed. It is not unjustifiable to assume that this action has been in some measure responsible for the marked diminution in tuberculosis of bovine origin which has occurred.

Conclusions.

43. It is estimated (*a*) that about 6 per cent. of all deaths from tuberculosis are caused by the bovine type of bacillus; (*b*) that about 2,000 deaths, mostly in children, occur annually from this cause; (*c*) that at least 4,000 fresh cases of bovine infection develop each year; (*d*) and that an immense amount of suffering, invalidity and often permanent deformity is caused by this bacillus.

Signed on behalf of Sub-Committee A and B,

William Hunter.

(*Chairman*).

October, 1931.

REPORT OF SUB-COMMITTEE "C".

Chairman, C. O. Hawthorne, M.D., D.Sc., LL.D.

1. The Sub-Committee being satisfied with the evidence that milk, as at present produced and distributed, is one of the agencies through which tuberculosis is communicated to human beings, has been concerned mainly with the study of methods by which a milk-supply free from the risk of infection by the tubercle bacillus can be secured.

I. Tubercle Bacilli in Milk.

2. The obvious aim of all arrangements is the provision of a milk-supply untainted by the presence of the bacillus of tubercle. In the attainment of this end there may be difficulties, but until it is attained, preventive medicine cannot profess to be content nor the social conscience clear.

3. The suggestion is sometimes made that a slight infection with the tubercle bacillus in early life has value, through the establishment of immunity, against later and more serious invasions, and figures are quoted to show that in communities where abdominal tuberculosis in children is frequent, phthisis pulmonalis in adults is relatively rare, and *vice-versa*. Even if this statement were accurate, it could not possibly justify the haphazard distribution of the bacillus in the food supply, for such distribution must mean that many lives would certainly be sacrificed on the chance that others might receive a degree of protection, and no one can tell in advance into which of these two classes any individual child will fall. If the doctrine is true, the practical lesson is not that immunisation against tuberculosis should be left to the chance of a more or less infected milk-supply, but that this end should be reached by a definite and controlled system of prophylactic vaccination or other allied method; and up to the present no system of this order has established itself.

4. It is right to add that while a milk supply free from the bacillus of tubercle will mean a reduction of tuberculous disease in early life, it would not abolish the disease, because children, equally with adults, probably indeed more than adults, are liable to infection from human sources. Infection by the bovine

form of the bacillus would almost or altogether disappear, but not infection by the human type ; the prevention of this latter source of disease is, of course, of the highest importance, but it does not fall within the scope of this report.

5. Under the Milk and Dairies Act, 1915, it is an offence to sell for human consumption "the milk of any cow which has given tuberculous milk", or which, *inter alia*, "is suffering from emaciation due to tuberculosis or from tuberculosis of the udder or from acute inflammation of the udder". To secure a conviction, however, it has to be proved that the defendant "had previously received notice from an officer of a Local Authority, or that he otherwise knew, or by the exercise of ordinary care could have ascertained, that the cow had given tuberculous milk or was suffering from any such disease". In practice, this provision has had only a limited value (see par. 11).

II. Tuberculosis in Milk-Yielding Cows.

6. In considering the prevention of bovine tuberculosis, it is necessary to realise that two entirely distinct subjects are involved : (1) the diminution or eradication of tuberculosis in cattle, and (2) the provision of a safe milk-supply for human consumption ; failure to keep this fundamental distinction in mind leads to much confusion. The first problem is entirely a veterinary one, and should be dealt with by the Ministry of Agriculture. The second problem is essentially a medical one, and should be dealt with by the Ministry of Health. Nevertheless, measures for dealing with the two problems must overlap to a considerable extent. Hence it is desirable that the Ministry of Health and the Ministry of Agriculture should jointly agree on a plan which would embrace the two problems and lead to the maximum of administrative efficiency.

III. Measures for Diminishing the Incidence of Tuberculosis in Cattle.

7. Three groups of procedures are here considered and recommended : The first, the prophylactic vaccination of cattle, is at present only in its experimental stages. In regard to the other two measures, we desire to emphasise the primary importance of our proposals for increasing the number of herds the component animals of which are ascertained to be free, and are maintained free, from any taint of tuberculosis. This appears to us to be the only radical solution of the problem of bovine

tuberculosis. At the same time we appreciate the difficulties of the problem and the fact that progress in this direction must of necessity be slow. We therefore include the group of measures under B (see below) in the belief that the policy outlined for dealing effectively with the recognised infective cases is likely to lead to a diminution in the amount of tuberculous infection amongst cattle and to facilitate the operation of the more thorough scheme.

(A) Measures for Increasing the Number of Herds Free from Tuberculosis.

8. In 1919 the Departmental Committee on the Production and Distribution of Milk recommended that a scheme for assisting owners to build up herds of cattle free from tuberculosis should provide for: (1) "Official veterinary assistance in the work of diagnosis and eradication; (2) the issue of certificates in regard to those herds in which the necessary conditions had been complied with; (3) correlation with a system of milk grading which could provide an official guarantee, on which a milk producer could base a claim to receive a better price for tubercle-free milk."

The Ministry of Health has provided a system of milk grading since 1922, but no corresponding action has been taken by the Ministry of Agriculture to provide any kind of assistance on the lines above indicated or on any other.

The existing nomenclature applied to graded milks is unsatisfactory, and new terms which carry definite meanings to the public are required.

9. There is an urgent need for the introduction of such a scheme; and cattle breeders throughout the country would welcome some indication that the Authorities intend to assist them in the matter. The building up of tuberculin-tested herds, and the establishment of "accredited" areas have proved of great value in Canada and the United States of America, and though the problem on the other side of the Atlantic is in many ways simpler than it is in this country, the Sub-Committee is strongly of opinion that this policy is to be recommended as affording the most fruitful method of bringing about the ultimate eradication of tuberculosis from cattle.

10. It is not the desire of the Sub-Committee to recommend any scheme in detail for accomplishing this end. In recent years, schemes have been drawn up by the Scottish Conference

on Agricultural Policy (1925), by the Scottish Branch of the National Veterinary Medical Association (1930), and by the National Veterinary Medical Association of Great Britain and Ireland (1931).

In particular, the Sub-Committee would emphasise the importance of the following points: (*a*) Tuberculin, in order to ensure adequate potency and reliability, should be standardised, and its distribution and use should be regulated as in the case of substances included in the "Dangerous Drugs Act": (*b*) the methods adopted for the carrying out of the tuberculin tests should be standardised: (*c*) an official register of tubercle-free or "accredited" herds should be instituted for herds which comply with the necessary conditions (including periodical testing) of a national scheme; and owners of herds entered in this register should be allowed to use an appropriate designation.

For the full development of any such scheme, it will obviously be necessary to secure the active co-operation of the agricultural interests.

(B) Measures for the Detection and Elimination of "Open" Cases of Tuberculosis.

11. The detection and elimination of "open" cases of tuberculosis in cattle is the main object of the Tuberculosis Order of 1925 issued by the Ministry of Agriculture. This Order, according to the circular issued with it, "aims at the destruction of every cow suffering from tuberculosis of the udder or giving tuberculous milk, and every bovine animal suffering from tuberculous emaciation or suffering from a chronic cough and showing definite clinical signs of tuberculosis"; and notice of possession of any animal affected as indicated must be given by the owner or person in charge to a police constable or inspector of the Local Authority; further, a veterinary surgeon, who in his private practice detects any animal so affected, must as soon as possible notify the fact to an inspector of the Local Authority.

This Order has now been in operation for more than five years, and although considerable numbers of animals are reported and dealt with annually, the opinion is generally held that no appreciable progress has been made towards the eradication of the actual numbers of "open" cases. The main cause of this comparative failure is that the vast majority of the cattle slaughtered under the Order have acted as centres of infection for a considerable time before they were reported. No real progress can be expected until a scheme is devised and brought into action which will enlist the co-operation of the herd owner, the Local Authority, the veterinary inspector, and the bacteriologist in discovering and dealing adequately with infected "open" cases at the earliest possible moment.

An amplification of the Tuberculosis Order, 1925, or a new scheme with these objects in view, should deal specifically, amongst other points, with the following: (*a*) Owners of stock to notify suspected cases immediately; (*b*) Local Authorities to appoint experienced and preferably full-time veterinary inspectors to visit and report on all such infected cases, to take samples of milk for bacteriological examination, to apply such tuberculin tests as may be considered advisable, to see that such suspected animals are isolated from other stocks, that the milk is treated as directed, and that disinfection of premises occupied by infected stock is properly carried out; (*c*) compensation payable to the owner to be so arranged and graduated as to encourage the immediate notification of suspected cases and to penalise any undue delay; no compensation should be paid for animals which should clearly have been reported at an earlier stage of the disease; (*d*) since adequate isolation is often impossible on small farms, to enable infected animals to be isolated and controlled, Local Authorities should be empowered to establish isolation centres for the housing of infected animals; animals removed to such centres could be valued before removal, and compensation paid on the lines indicated above; (*e*) Local Authorities to adopt and pursue a definite system of bulk milk sampling and bacteriological examination as a means of discovering herds or groups of animals containing "open" cases; (*f*) the licensee of any premises registered for the slaughter of animals should be compelled to keep a register, open to inspection by the proper officers, for all their purchases, showing where obtained, from whom, and when.

The development and operation of such a scheme as is suggested above requires the goodwill of the farmer; and to assist in creating this attitude of mind, an educational campaign will be necessary to explain more fully to farmers the advantages of discovering suspicious cases at as early a stage as possible, and of recognising the importance of sound methods of housing, feeding, and management, and of adequate disinfection of premises occupied by infected stock. The veterinary inspectors could assist materially in this aspect of the work.

The Sub-Committee has given considerable attention to the above aspect of the bovine tuberculosis problem because the extension proposed is along lines already in force and because it is useful as a measure preliminary to any comprehensive scheme. At the same time the Sub-Committee points out that available evidence does not suggest that such a scheme can play a major part in materially reducing bovine tuberculosis. In paragraphs 9 and 10 the Sub-Committee has outlined the measures which must form the basis of any effective scheme to eliminate bovine tuberculosis. There are, however, grounds for believing that the policy just outlined of dealing effectively with definitely infective cases may lead to a diminution of the amount of open tuberculosis amongst cattle and enable a thorough scheme more easily to be put into operation.

The Committee has considered the question of making provision for the routine clinical examination of all dairy cows. While recognising the value of this method in detecting tuberculosis of the udder, the Committee realises that it does not reduce the amount of tuberculosis in cattle to the extent that can be obtained by other methods.

If, therefore, financial considerations necessitate a choice between veterinary inspection and a method which carries a better guarantee of eliminating tuberculosis, the Committee is of opinion that the latter procedure should be adopted. If, however, financial consideration were not of so much importance, the Committee would be glad to see veterinary inspection extended in association with a more certain method of eradicating tuberculosis, since such a combination of methods would not only reduce tuberculosis very materially, but would also assist the dairy farmers to eliminate many other diseases from their herds.

(C) Prophylactic Vaccination of Cattle.

12. Attempts have been made to secure tubercle-free cows by the immunisation of calves by a suitably prepared vaccine. Experiments towards this end are still in progress, but much research must be carried out before practical recommendations can be made. The subject is of such importance that the various vaccines available should be investigated with much greater care than has hitherto been bestowed upon them in this country ; and we are of opinion that the performance of experiments both in the laboratory and in the field to test the value of these vaccines should be actively encouraged.

Measures for Providing a Safe Milk Supply for Human Consumption.

13. The most obvious method of preventing human infection by the bovine variety of the tubercle bacillus would be to use milk supplied only by cows free from tuberculosis. In practice, however, such a course is impossible. Were all the cows reacting to the tuberculin test to be slaughtered (some 40 per cent. of the total), the immediate result would be a milk famine, while the exclusion of tuberculous infection from dairy farms would not be fully secured, and the sum necessary to compensate the owners would amount to an enormous figure. Moreover, it is certain that the majority of cows reacting positively to tuberculin yield milk free from the tubercle bacillus, while on the other hand, the test in the case of advanced disease may be negative. Wholesale slaughter of reacting cows must, therefore, be ruled out as an impracticable policy.

A further extension in this direction, and one frequently advocated, is to arrange for routine inspection of all dairy cattle by competent veterinary surgeons. Experience shows that this procedure has resulted in the detection of many infective cows, particularly those suffering from tuberculosis of the udder. This procedure is helpful if funds are available to allow it to be put into effective operation.

14. Though the radical measure just discussed is impossible, the principle of a milk-supply obtained from non-tuberculous cows has been accepted and approved by the Ministry of Health in the Milk Designations Order. During recent years there has been a slow but steady increase in the supply of milk from herds free from tuberculosis as recognised by the Ministry of Health under the Milk (Special Designations) Order, 1923.* We now recommend, in order to encourage this supply, that the operation of the Order should be modified as follows : (*a*) To the different grades of designated milks new terms or names should be given which would indicate definitely to the purchaser the nature and quality of each grade ; (*b*) the fee required by the authorities for a licence to produce designated milks should be abolished ; (*c*) the system whereby licences under the Milk (Special Designations) Order are granted should be simplified by a reduction in the number of licensing authorities.

15. At present, however, the number of herds producing "Certified" and "Grade A Tuberculin Tested" milk are so few

* For Note see opposite page.

that it is impossible to supply more than a very small proportion of the population with milk of these classes. While it is fervently to be hoped that the number of herds yielding milk free from tubercle bacilli will increase in the future, the problem to be faced at the moment is the provision of a safe milk supply to the whole human population.

* The essential requirements regarding, and differences between, the Graded Milks are shown in the following table :—

	"*Certified*" *Milk.*	"*Grade A* (*Tuberculin-tested*)."	"*Grade* A."
LICENSING AUTHORITY TO PRODUCE.	Ministry of Health.	Ministry of Health.	County Council or County Borough Council.
Ibid. TO DISTRIBUTE.	Local Sanitary Authority.	Local Sanitary Authority.	Local Sanitary Authority.
REQUIREMENTS AS TO COWS.	Must be certified free from tuberculosis by the tuberculin test.	As for "certified."	Certificate from veterinary surgeon every three months that cows are free from clinical disease; not tuberculin tested.
MILK-CONTAINERS REQUIRED.	Must be bottled on the farm and special caps provided.	Delivered to consumers in, (*a*) the bottles or the sealed containers as received from the farm; (*b*) suitable containers of not less than two gallons capacity; (*c*) bottles with the name of the dealer by whom the milk was bottled, the address of the licensed bottling establishment, the day of production and the words "Grade A Tuberculin Tested" or "Grade A" on each bottle cap.	As for "Grade A (tuberculin-tested)."
BACTERIAL REQUIREMENTS (at any time before delivery to the consumer).	Not more than 30,000 bacteria per c.c.; no coliform bacillus in 1/10 c.c.	As for "Grade A."	Not more than 200,000 bacteria per c.c.; no coliform bacillus in 1/100 c.c.
HEAT CONDITIONS.	Shall not at any time be treated by heat.	As for "Certified."	As for "Certified."

16. Though the methods just discussed for increasing the supply of milk free from tubercle bacilli, and for reducing the degree of infection in milk from tuberculous herds, might in time lead to a substantial reduction in the risk of infection, it must be realised that at the moment there are large numbers of cases of bovine tuberculosis occurring every year in human beings due to the consumption of infected milk. The immediate necessity is to prevent the occurrence of such cases. In view of the gravity of this problem, we are of opinion that all raw milk for human consumption that does not come from tuberculin-tested herds should be adequately pasteurised ; or, if this is impossible, should be sterilised or boiled.

17. Short of this attainment of the highest level, *i.e.* an absolutely tubercle-free herd, much can be done at the source to avoid infection of milk with the bacillus. The greatest danger comes from tuberculosis of the udder, especially when this exists apart from other evidence of tuberculosis and the cow appears to be in perfect health, so that without a bacteriological examination of the milk the condition may easily be overlooked.

18. Again, milk may occasionally contain tubercle bacilli from tuberculous cows even though there is not infection of the udder, and there is a further risk of milk being contaminated by fæcal and even by uterine discharges from any diseased cow in the herd.

19. One obvious aid towards safety is the tuberculin-testing of any animal *before* its admission to the herd, and this is the more important as cows are very susceptible to infection by the bovine tubercle bacillus.

20. The susceptibility of cows to infection enforces the need for all the general hygienic measures calculated to promote the health and resisting powers of the animals, while the demand for perfect cleanliness on all occasions cannot be too strongly emphasised. Useful suggestions in these directions are contained in pamphlets such as those issued by the Ministry of Agriculture and Fisheries, 10, Whitehall Place, S.W. ; The Yorkshire Milk Recording Society, York ; and the National Institute for Research in Dairying, Shinfield, Reading.

21. The present legal sanctions necessary in the public interest to enforce the conditions which would reduce to a minimum the distribution of tubercle bacilli in the general milk-supply need strengthening. Though the farmer is bound to notify certain conditions as defined in the Tuberculosis Order, 1925,

and the recognition or suspicion of tuberculosis in any cow used to provide milk for human consumption, yet such notifications are, as a matter of fact, often made only when the disease is advanced, that is, when much mischief has already been done. Prosecutions for neglect to notify have been very rare events (see Par. 11), and the provisions of the Tuberculosis Order, 1925, have not, in point of fact, proved of much practical value.

(D) Pasteurisation.

22. Before discussing Pasteurisation or any other process intended to make milk safe for human consumption by freeing it from the risk of tubercular and other infections, the Sub-Committee desires to express the opinion that none of these processes ought to be accepted as a substitute for pure and clean milk, or as compensatory for the neglect of strictly hygienic conditions in the production and distribution of milk. On the contrary, it is in these conditions that there exists the first line of defence against infection. The suggestion that want of care in the earlier stages is of less importance, seeing that later on some method of treatment will guarantee safety, is strongly to be deprecated. From the outset, the object ought to be the production of a natural supply of perfectly clean milk free from all pathogenic organisms and with a minimum, non-pathogenic, bacterial count. Even if it be held that some subsequent and supplementary treatment of the milk is advisable, the one cannot be permitted to take the place of the other. The demand is for care and cleanliness in all the stages, and certainly not less in the first than in the subsequent ones.

23. It is essential to note that by the "Pasteurisation of Milk" is meant the exposure of the milk to a temperature of not less than 145 deg. F. and not more than 150 deg. F. for 30 minutes, after which, in accordance with the regulations of the Ministry of Health, the milk must be immediately cooled to not more than 55 deg. F. If these conditions of time and temperature have not been satisfied (that is, have been either deficient or in excess) then effective pasteurisation has not been secured. Possibly the future may disclose other successful methods, and, if so, the Ministry of Health would doubtless be prepared to recognise and approve them.

24. If the processes just described are effectively conducted, pasteurisation may be relied on as an effective method of destroying tubercular and other pathogenic micro-organisms in milk.

On the other hand, the mere heating of milk for a brief period is not completely effective, and although, when so treated, milk is often described as "pasteurised", the term in such circumstances is incorrect and misleading. This remark applies equally to the so-called "flash" method of pasteurisation.

25. Under the terms of the Milk (Special Designations) Order, 1923, it is illegal to use the designation "pasteurised" in connection with the sale of milk except under the terms of a licence granted by the Minister of Health. Yet some milk that has been adequately pasteurised, and some that has been otherwise treated by heat, is now sold as "raw milk". Any milk that has been treated by any heating process should be required to be described, when offered for sale, either as "pasteurised" (under licence by the Minister of Health) or, if not pasteurised, by some officially approved designation which will indicate that it is not "raw" but has been subjected to the action of heat.

26. The question whether pasteurisation does or does not impair the food value of milk has been debated. Laboratory experiments have shown that some loss of vitamin C and changes in many of the other constituents of the milk take place. On the other hand, there is a large body of evidence contributed, among others, by physicians, by children's hospitals and by medical officers of health to the effect that in their experience pasteurised milk is a food of highly satisfactory nutritive value. The subject, however, includes certain controversial issues which will be confidently settled only by further research.

27. The use of pasteurised milk in large cities, both in this country and in the United States of America, has been followed by a reduction in the incidence of cases of human tuberculosis of bovine origin and by a diminution of epidemics of milk-borne diseases such, for example, as diphtheria, typhoid, paratyphoid fever, scarlet fever, septic sore throat, and undulant fever. The amount of evidence supporting this statement, both from this country and from the other side of the Atlantic, is considerable.

28. The existing requirements of the Milk (Special Designations) Order, 1923, make it a condition that milk sold as "certified" or as "Grade A (Tuberculin Tested)" shall not at any stage be treated by heat. In view of the value of pasteurisation as a protection against milk-borne infection, and as a means of reducing the bacterial content of milk, particularly in warm weather, it seems reasonable that provision should be made by the Minister of Health to allow milk from tubercle-free herds to

be sold either raw or pasteurised, provided that each variety be officially labelled.

29. The Sub-Committee is of opinion that the Ministry of Health should draw up Milk Regulations, which, with the approval of the Minister, could be adopted by any of the larger Local Urban Authorities, and that these Regulations should include the following: (*a*) To require that all milk sold within the jurisdiction of the Authority should either be from herds in which no animal reacts to the proper application of the tuberculin test, or has been effectively pasteurised; (*b*) to forbid the importation into the area of milk which has been treated by heat other than by the process of pasteurisation as prescribed by the Minister of Health, and to require that any milk that has been pasteurised shall be so described when offered for sale; (*c*) that there should be compulsory classification of all grades of milk sold within the area in accordance with the terms of the Milk Designations Order in force for the time being; and (*d*) that adequate supervision and control over the health of all persons engaged in the production and distribution of milk should be secured.

Before such powers are granted to any Local Authority, an enquiry into the conditions of milk production and distribution in its area should be undertaken by the Ministry of Health to ensure that the proposed regulations are suitable to the local conditions.

Conclusions.

30. While our report contains numerous recommendations to which we attach importance, we would, in particular, emphasise the following procedure for diminishing human tuberculosis of bovine origin:—

1. The basic aim is the diminution and ultimate elimination of tuberculosis amongst our herds so that cows entirely free from tuberculosis should be the sole source of milk and milk-products for home consumption (pars. 9 and 10).
2. Assistance towards this object can be attained by improving existing facilities for the elimination of infective tuberculous cattle (par. 11).
3. Measures capable of more immediate operation for protecting the public should be made available at once. Those we favour are:—

(*a*) More active aid and encouragement for milk producers to produce milk certified free from tubercle bacilli (pars. 8 and 14).

(*b*) An extension and enforcement of general hygienic measures in connection with milk (par. 12).

(*c*) Permissive powers to the larger Urban Authorities (at first restricted to these areas), after a local enquiry by the Ministry of Health, to require all milk sold within their area either to be taken from tuberculosis-free cows or to be efficiently pasteurised or treated by some other process recognised by the Ministry of Health (par. 29).

(*d*) To encourage further critical studies of the effect of any compulsory system of pasteurisation upon the nutritional qualities of milk and its influence upon the distribution aspect of the milk problem.

Signed on behalf of Sub-Committee C.

C. O. Hawthorne,

Chairman.

October, 1931.

GENERAL CONCLUSIONS.

The two reports presented summarise the findings of a large representative Committee which, working mainly through two special sub-committees, has, during the past year and a half, considered the various problems of bovine tuberculosis in great detail. For these findings the reports themselves should be consulted, all that is attempted here being a broad general summary of the position.

For several decades the medical profession as a whole, and particularly those members who are actively engaged in the Public Health Service, together with the veterinary profession, agriculturists and other persons connected with the milk-supply, have been concerned with the admitted fact that a certain amount of human tuberculosis originates through the agency of milk. This knowledge has militated harmfully in two directions, since, in addition to the serious direct loss to the community in disease and in deaths, it has led to a curtailment of the use of milk and to the neglect in some degree of its value as a food. A necessary preliminary is an accurate knowledge of the facts, and in the past these have sometimes been obscured by the circulation of statements not always in accordance with ascertained figures. A summary of the scientifically determined findings on which to base a reliable measurement of the amount of human tuberculosis of bovine origin was, therefore, necessary before any solution of the problem could be advanced. Our first report (Sub-Committee A and B) furnishes data which are the result of a careful examination of all the evidence, and which may be accepted with confidence as an accurate statement of the existing position.

The essential conclusions of the first report may be summarised as follow :—

(*a*) It is estimated, on the basis of the tuberculin reaction, that at least 40 per cent. of the cows in this country are infected with the tubercle bacillus, though only a minority of them are in an actively infective condition ;

(*b*) About 0.2 per cent. of all cows (or 1 in 500) are suffering from tuberculosis of the udder, and are therefore probably excreting living tubercle bacilli in the milk ;

(*c*) About 40 per cent. of cows slaughtered in the public abbatoirs show naked-eye lesions of tuberculosis ;

(*d*) A proportion of the raw market milk, varying in different parts of the country from 2 to 13 per cent., or having an average figure of 6.7 per cent., contains living tubercle bacilli.

(*e*) In England and Wales about 6 per cent. of all deaths from tuberculosis are caused by the bovine type of bacillus.

(*f*) About 2,000 deaths in England and Wales, mostly in children, occur annually from this cause.

(*g*) At least 4,000 fresh cases of bovine infection develop each year, an immense amount of suffering, invalidity and often permanent deformity being thus caused by this bacillus.

While the facts are serious, they do, however, suggest that the menace is a diminishing one, and that the measures already in operation have not been in vain. At the same time no one can view the present position as other than highly unsatisfactory. It has been the aim of the Committee to try to evaluate all available methods with the object of suggesting measures which offer the most practical means for reducing and, if possible, eliminating any danger of tuberculosis being spread through the agency of the milk-supply. Various procedures, all of some utility, have been put into force or advocated and their claims stressed by different experts. Obviously all are not of equal merit, and their indiscriminate advocacy hinders progress. The Committee in its second report (Sub-Committee C) has endeavoured to assess the relative utility of various proposed procedures and to present a coherent scheme.

The Committee places in the forefront that the essential object to be aimed at is a diminution and ultimate elimination of tuberculosis amongst our dairy herds, so that cows entirely free from tuberculosis should be the sole source of milk and milk-products for human consumption. All students of the subject are, however, aware that the attainment of such an aim is beset with difficulties and, at the best, can never be rapid. While, therefore, pressing for active steps along the lines indicated in the Report, the Committee considers that measures capable of more immediate operation for protecting the public should be made available at once. These are set out in the conclusions to the second Report (Sub-Committee C).

Broadly summarised, the opinion of the Committee is that the only classes of milk which can be considered safe from the risk of conveying tuberculosis are, (*a*) milk obtained from herds certified under adequate control to be free from tuberculosis, and (*b*) milk which has been subjected to efficient and controlled pasteurisation, or other approved process of heat-treatment. The former is represented by herds licensed either as " Certified " or as " Grade A (Tuberculin Tested) ", and the Committee favours steps to facilitate the extension of the number of such herds. The efficient pasteurisation of the rest of the milk-supply is beset with many technical and trade difficulties, and immediate steps to put into operation a universal scheme are not practicable. While emphasising the principle, the Committee recommends, as a first step, and as something feasible with but little delay, that, subject to a preliminary inquiry by the Ministry of Health, legal steps be taken to give permissive powers to the larger Urban Areas to require the efficient pasteurisation (or other accepted form of heat-treatment) of all milk sold within their area which is not drawn from tuberculosis-free cows. This procedure has the advantage that it can be extended without much difficulty as shown to be advisable and practicable.

The provision for the major part of the population of a milk-supply safe from the risk of containing tubercle bacilli, and, for the most part, safe from the risk of conveying other infectious diseases, will, it is anticipated, not only remove many of the dangers connected with the milk-supply but enable milk to take its rightful place as a safe and valuable food.

Signed on behalf of the General Committee,

W. G. SAVAGE,

Chairman.

October, 1931.

THE INFLUENCE OF NUTRITION UPON THE LIABILITY TO INFECTION.

Sir Frederick Gowland Hopkins, President of the Royal Society, in his advisory capacity as a member of the General Committee of Investigation of Bovine Tuberculosis in Great Britain, convened by the People's League of Health, has made the following important statement :—

> " Recent work seems to have shewn beyond all doubt that qualitative factors in the diet, whether of man or animal, play an important part in determining the resistance of individuals to bacterial infection. Especially would this seem to be true of the influence of Vitamin A. The work of Mellanby and Green on Septicæmia, that of Sherman and his co-workers, and, indeed, that of many other workers, seems to have shown conclusively that an adequate store of this Vitamin in the body definitely increases the resistance to bacterial invasion. It has been held that deficiency in this Vitamin leads to a faulty condition in mucous membranes and other epithelial surfaces, and this is why invasion becomes easier. Recent work carried out in Copenhagen has shown, however, that animals with an adequate supply of the Vitamin are more resistant than those which are deficient, even when bacilli (paratyphoid bacilli, for instance) are injected subcutaneously.
>
> " It must be admitted that at present such evidence does not relate to the tubercle bacillus in particular ; but the evidence strongly suggests that the factor of nutrition must be duly weighed in all studies of tuberculous infection, of whatever kind. Further work on this matter is, indeed, urgently called for."

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Letter from His Majesty the King to the Founder and Honorary Organiser, dated July 14th, 1926.

Privy Purse Office,
Buckingham Palace,
S.W.

DEAR MISS NETHERSOLE,

The Second General Report of the People's League of Health has been laid before the King, and His Majesty was interested to see that the very effective measures that have been devised to educate the public in the prevention of Disease have now been adopted not only in the Dominions but in most of the countries of Europe.

The colossal task of instructing the public in matters affecting their health, and in placing at their disposal the latest discoveries of science, is one that should appeal to the whole community, and the King, who has taken the greatest interest in this League since its inception, is glad to think that the admirable object of the People's League of Health has now received universal recognition.

Yours sincerely,

(Signed) F. PONSONBY.

PUBLIC SUPPORT FOR THE LEAGUE.

As the public will readily understand, if any work similar to that of this publication is to be undertaken by the League, financial aid should be forthcoming.

The League, therefore, takes this opportunity of appealing to your generous support. In order to carry out the work which it sees to be urgently necessary in health education as the basis of the prevention of disease, the People's League of Health appeals to all who have the welfare of the country at heart to render it support to the extent of the means within their power.

All donations should be sent and all cheques made payable to :—

Sir Gilbert Garnsey, K.B.E.,
The People's League of Health
12, Stratford Place,
London, W.1.

Reprinted from Canadian Public Health Journal, July, 1929

The Incidence of Bovine Tuberculosis in Children*

R. M. PRICE, M.B.

(*From the Laboratories of Pathology and Bacteriology, University of Toronto.*)

THE idea that tuberculosis in man can, in part, be traced to infection from cattle, had its origin early in the 19th century. Specific attempt at proof was first made in 1846, by Klenke, who was very emphatic in his belief that milk from tuberculous cows was infectious for children, and that scrofuloderma was a result of such infection. Villemin, in 1865, definitely proved the infectious nature of tuberculous material from man and animals by transmitting the disease to laboratory animals. With the discovery of the tubercle bacillus by Robert Koch in 1882, the similarity of tuberculous processes in man and animals was apparently settled.

The first step toward separation of varieties among tubercle bacilli was made by two Italian observers, Rivolta and Mafucci, who in 1892 published their observations on the avian strain of tubercle bacilli, and pointed out that this variety differed in many ways from the mammalian strain.

Theobald Smith, in 1896, further demonstrated that the mammalian tubercle bacillus probably comprised two distinct types, the human and bovine. He published further evidence of the existence of the bovine tubercle bacillus in 1898.

In the face of growing evidence of morphological and cultural differences of these two types of tubercle bacilli, little doubt was entertained as to the infectiousness of the bovine strain for man. While much work was being done on the relationship of milk from tuberculous cows to the presence of tuberculosis in man, the cases of accidental infection with the bovine virus during post-mortem work, and

**This research was carried on under a grant from the National Research Council of Canada.*

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under other conditions, were considered final evidence of the susceptibility of man for the bovine tubercle bacillus.

Interest in the question of the susceptibility of man to the bovine tubercle bacillus suddenly became acute in 1901, when, at the International Congress on Tuberculosis held in London, Koch announced his belief that, though the human and bovine varieties of tubercle bacilli differed, he did not believe the bovine virus was an important factor in human infection. His views met with violent opposition from most quarters, and precipitated an enormous amount of research work. Numerous investigations followed as to the identity or non-identity of the bacillus from man and cattle, and at the same time viruses from man were investigated as to whether or not they were identical with those from cattle. Various commissions were appointed to study the question, and of these, the most outstanding were the British Royal Commission, the German Imperial Commission, and the work of Park and Krumwiede in the United States. A great deal of work was done, and the resulting evidence left no doubt of the infectiousness of the bovine virus for man, though it was noted by all workers that the incidence of bovine infection varies in different countries, and that the highest incidence of bovine infection occurs in children.

It is now generally agreed that tuberculosis in cattle is caused by the bovine type of tubercle bacillus only. The incidence of bovine infection in man, therefore, depends upon the amount of tuberculosis in cattle from which the milk is obtained, and the amount of raw milk consumed by children.

The incidence of tuberculosis in cattle varies in different countries. From figures available, it appears that in some countries in Europe, as high as 50 per cent of cattle are infected. In the United States the incidence of tuberculosis in cattle is given roughly as 20 per cent. In Canada, about 5 per cent of cattle tested react to tuberculin.

The milk supply, such as is furnished in most communities in the civilized world, yields tubercle bacilli in from 6 per cent to 20 per cent of all samples examined. Park, of the New York State Board of Health, in a paper published in May, 1927, gives the incidence of tubercle bacilli in raw market milk sold in New York City as 20 per cent.

Human pulmonary tuberculosis in nearly 100 per cent of cases in adults and 99 per cent of cases in children, is caused by the organism of the human type, whereas primary intestinal tuberculosis in children is usually due to infection with the bovine type. For other forms of clinical tuberculosis, one can simply state that the younger the individual the greater is the probability of the infection through the milk consumed, and the more likely is the case to be due to the bovine type.

Park and Krumwiede of the New York State Board of Health, in a series of 1,042 unselected cases of both medical and surgical tuberculosis investigated, dividing the cases into three age groups, found the incidence of bovine infection as follows:

(*a*) Children under 5 years of age, 220 cases with 59 bovine strains isolated, or 26.8 per cent.

(b) Children from 5 to 16 years of age, 132 cases with 33 bovine strains recovered, or 25 per cent.

(*c*) Adults, 16 years and over, 689 cases, with 9 bovine strains recovered, or 1.31 per cent.

A study of 2,516 cases of various forms of tuberculosis reported in the literature up to 1914 compiled by Wang, of the University of Edinburgh, gives perhaps the most comprehensive idea of the amount of bovine tuberculosis in man existing in Western Europe, the British Isles and the United States. He found that, dividing the cases into three age groups, the incidence of bovine infection is as follows:

(*a*) Children under 5 years of age, 614 cases, with 199 bovine strains isolated, or 32.4 per cent.

(*b*) Children from 5 to 16 years of age, 591 cases with 171 bovine strains isolated, or 28.9 per cent.

(*c*) Adults, 16 years and over, 1,311 cases with 38 bovine strains isolated, or 2.9 per cent.

During the years of the war, 1914 to 1918, but few bacteriological examinations were made for the types of tubercle bacillus in human cases. Since then the majority of reports have come from Great Britain, and these show that the percentage of bovine infection remains high.

Up to the present, so far as we know, no studies have been made in Canada indicating the incidence of bovine infection in children, nor have we accurate figures indicating the frequency with which tubercle bacilli appear in raw market milk.

For the past three years, under the auspices of the National Research Council of Canada, we have been carrying out a study upon the incidence of bovine infection in children in one of the districts of Canada. The district with which we have dealt is the Toronto area, where city regulations demand a thorough pasteurization of milk, but to which, however, there is a migration of sick individuals from outlying districts seeking treatment in the various hospitals. By co-operation with these hospitals, and in particular with the Hospital for Sick Children, we have been able to study a considerable series of tuberculous children, from whom we have obtained material for the purpose of determining the type of infection.

Besides this, we have also had the opportunity of obtaining contact with a number of tuberculous children living in the towns and villages of Ontario.

Up to the present, we have recovered a total of 190 strains of tubercle bacilli from 168 children studied, all under 14 years of age. All these strains have been identified by laboratory means as to type.

Both medical and surgical cases were studied, and the group is comprised of the following types of cases:

Tuberculosis of bones and joints.
Renal tuberculosis.
Tuberculous adenitis.
Tuberculosis of the tonsil.
Tuberculosis of the adenoid.
Tuberculous meningitis.
Pulmonary tuberculosis (laryngeal swabs).
Pleurisy with effusion.

Of the 190 strains identified, 160 recovered from 148 children proved to be of the human variety, and 30 strains recovered from 20 different children were of bovine origin.

The 160 strains of tubercle bacilli of the human type were recovered from medical and surgical cases of tuberculosis. We made no particular attempt to isolate organisms from cases of frank pulmonary tuberculosis. We have, however, studied a number of laryngeal swabs obtained from children suffering from generalized tuberculosis. A number of positive swabs were obtained in this manner.

In the great majority of this group of cases studied, a history of contact to open tuberculosis was obtained. A number of our cases of surgical tuberculosis studied showed varying degrees of pulmonary or tracheo-bronchial tuberculosis, demonstrable on physical examination or X-ray. All these children reacted to tuberculin.

SUMMARY OF A STUDY UPON THE INCIDENCE OF BOVINE INFECTION IN CHILDREN

	Number	*Human Type*	*Bovine Type*
Bone and Joint Tuberculosis	*65*	*63*	*2*
Tuberculous Meningitis	*32*	*31*	*1*
Renal Tuberculosis	*26*	*25*	*1*
Pulmonary Tuberculosis (Laryngeal Swabs)	*16*	*15*	*1*
Tuberculosis of Lymph Nodes (Cervical and Mesenteric)	*16*	*4*	*12*
Tuberculosis of Tonsils	*7*	*5*	*2*
Tuberculosis of Adenoid (Pharyngeal Tonsil)	*4*	*3*	*1*
Tuberculous Pleurisy	*2*	*2*	*0*

Analysis of Bovine Strains

Up to the present, we have recovered 30 strains of tubercle bacilli of bovine origin, obtained from 20 different patients, as follows:—

Tuberculous Meningitis *1*
Three strains recovered (a) Cerebro-spinal fluid.
(b) Meninges.
(c) Mesenteric glands.

Generalized Tuberculosis, including pulmonary tuberculosis, infant 15 months of age *1*
Two strains recovered (a) Sputum.
(b) Mesenteric glands.

Tuberculosis of Knee Joint *1*

Renal Tuberculosis		*1*
	Three strains recovered (a) Urine right kidney.	
	(b) Urine left kidney.	
	(c) Urine bladder.	
Tuberculous Mastoiditis		*1*
	Two strains recovered (a) Mastoid process.	
	(b) Cervical lymph glands.	
Tuberculous Cervical Adenitis		*12*
	Sixteen strains recovered.	
Tuberculous Tonsilitis		*2*
Tuberculosis of Adenoid		*1*

Summary of Histories Available

Case No. 1. K.D., age 2 years. Clinical diagnosis—Tuberculous Meningitis. Admitted to the Hospital for Sick Children from Kitchener, Ont. At autopsy, an extensive mesenteric tuberculosis was found. There was no evidence of pulmonary disease. Cultures recovered from the cerebro-spinal fluid, meninges and mesenteric glands, all yielded tubercle bacilli of the bovine variety. This boy had practically all his life been fed on raw cow's milk.

Case No. 2. M.S., age 15 months, of foreign parentage. Died of a generalized tuberculosis, including pulmonary tuberculosis. Cultures obtained from the sputum by means of a laryngeal swab, and mesenteric glands obtained at autopsy, both yielded organisms of the bovine variety. As far as could be ascertained, this infant was artificially fed, but no definite history concerning the source of milk could be obtained.

Case No. 3. E.P., age 8 years. Admitted to the Hospital for Sick Children from Point-au-Baril, with a clinical diagnosis of Tuberculosis of the Right Knee Joint. As far as could be ascertained, there was no contact to open tuberculosis. This boy had always been fed on raw milk of the district. The strain recovered from the pus aspirated from the knee joint yielded tubercle bacilli of typical bovine variety.

Case No. 4. A.B., age 12 years. Admitted to the Hospital for Sick Children with a clinical diagnosis of Bilateral Renal Tuberculosis and Tuberculous Cystitis. There was no history of contact to open tuberculosis nor is there any evidence of tuberculous lesions in other organs than the kidneys and bladder. Cultures isolated from the urine from both ureters and bladder yielded tubercle bacilli of bovine origin. This child was born in England and came to Canada five years ago. During her residence in England she was fed on raw milk.

Case No. 5. J.D., age 11 years. Admitted to the Hospital for Sick Children from Scarboro (a suburb of Toronto) with a clinical diagnosis of Tuberculous Cervical Adenitis and Mastoiditis. Two strains recovered from this patient, one from the lymph nodes and the other from the mastoid process, both yielded tubercle bacilli of the bovine variety.

This case is of particular interest, inasmuch as he is one of a group of cases under treatment in the surgical clinic of the Hospital for Sick Children from that neighbourhood. These children, suffering from various forms of surgical tuberculosis, chiefly tuberculous cervical adenitis, came from the same neighbourhood, almost the same street, supplied by one dairy distributing unpasteurized milk. A sample of milk submitted for examination yielded tubercle bacilli of bovine origin, both in smear and on guinea-pig inoculation.

Case No. 6. R.S., age 7 years. Admitted to the Hospital for Sick Children from Lakeview Beach, Ont., with a clinical diagnosis of Tuberculous Cervical Adenitis. There was no history of contact to tuberculosis. There was no evidence of tuberculosis elsewhere. This boy had all his life been fed on raw cow's milk. The tubercle bacilli recovered were of typical bovine variety.

Case No. 7. F.M., age 8 years. Admitted to the Hospital for Sick Children with a clinical diagnosis of Tuberculous Cervical Adenitis. This lad was born in Scotland, and came to Canada one year prior to admission to the hospital. He, however, had had enlarged glands for two and one-half years. From the history of this boy, it appears that he had, more or less, all his life been fed on raw milk, or milk which had been heated but not boiled. Unfortunately, the glands removed at operation were lost. A tonsillectomy was done at the same time and one of the tonsils, both on section and guinea-pig inoculation proved tuberculous. A typical bovine strain of tubercle bacilli was recovered from this source.

Case No. 8. E.S., age 7 years. Admitted to the Hospital for Sick Children from Exeter, Ont., with a clinical diagnosis of Tuberculous Cervical Adenitis. There was no history of contact to pulmonary tuberculosis. This child had always been fed on raw milk from the town dairy.

Case No. 9. J.W., age 5 months, was admitted to the Hospital for Sick Children from Maple, Ont., with a clinical diagnosis of Tuberculous Cervical Adenitis. There was no history of contact to pulmonary tuberculosis, and no evidence of tuberculosis elsewhere. This infant had all his life been fed on raw milk from a mixed herd. The father, who owns the herd, admitted that one animal in the herd had a chronic cough, and showed progressive loss of weight. This animal, it would appear, had tuberculosis of the udder as well, but it was slaughtered before it could be examined. The organism recovered from the glands removed at operation was of typical bovine variety.

Case No. 10. A.McA., age 18 months. Admitted to the Private Patients' Pavilion, Toronto General Hospital, from Georgetown, Ont., with a clinical diagnosis of Bilateral Tuberculous Cervical Adenitis. This child, for nine months prior to admission to the hospital, had been fed on raw milk from a mixed herd. Pus aspirated from the glands, and the glands removed at operation, yielded tubercle bacilli of bovine origin.

Case No. 11. S.K., age 18 months. Admitted to the Hospital for Sick Children, from Markham, Ont., with a clinical diagnosis of Tuberculous Peritonitis. This child was breast fed for twelve months, and for six months prior to admission to the hospital had been fed on raw milk from a mixed herd. Repeated aspirations of the peritoneal cavity failed to yield any fluid. A small tuberculous gland removed from the angle of the left jaw yielded tubercle bacilli of bovine variety. There was no history of contact, and no evidence of pulmonary involvement on physical examination or X-ray.

Case No. 12-13. J.G., age 6 years. Admitted to the Hospital for Sick Children with a clinical diagnosis of Chronic Tonsillitis and Mastoiditis. Both tonsils and adenoids removed at operation yielded tubercle bacilli of bovine origin. Two years previously this lad had tuberculous cervical glands removed. For one year previous to his first operation (1926) he had lived in Scarboro, and had been fed on unpasteurized milk of the district. (See Case No. 5.)

Case No. 14. J.D. Admitted to the Hospital for Sick Children with a clinical diagnosis of Tuberculous Tonsillitis, Cervical Adenitis, and Tuberculous Mastoiditis. A typical strain of bovine tubercle bacillus was recovered from pus from the mastoid process. (See Case No. 5.)

Case No. 15. E.R., age 8 years. Admitted to the Hospital for Sick Children from Scarboro, with a clinical diagnosis of Tuberculous Cervical Adenitis, and Chronic Tonsillitis. The tonsils removed at operation yielded tubercle bacilli of bovine origin. This child has at intervals been fed on raw milk of the district. (See Case No. 5.)

Summary

It will be noted that in our studies upon the nature of tubercle bacilli isolated from children, we have identified 190 strains recovered from both medical and surgical cases of tuberculosis. Of these, 160 strains proved to be of human variety, and 30 strains, recovered from 20 different patients, proved to be of bovine origin.

In the majority of the cases from which the human type of the tubercle bacillus was recovered, a history of contact to open pulmonary tuberculosis was obtained, and in a certain proportion of our surgical cases there was evidence of tracheo-bronchial or pulmonary tuberculosis, demonstrable on physical examination or X-ray. All these children reacted to tuberculin.

Thirty strains of bovine tubercle bacillus were recovered from twenty patients in our series, the oldest being a patient twelve years of age, and the youngest an infant of five months. In most of the cases investigated, a direct relationship with infected milk was demonstrated. In the majority of the cases, the milk relationship could not be demonstrated by complete laboratory methods, though the history in many of the cases indicated that the child had received quantities of raw milk. Wherever possible, we have endeavoured to obtain milk for bacteriologic examination and guinea-pig inoculation. In one of our series of cases studied, we were able to demonstrate tubercle bacilli in the milk.

It is of interest to note that the bovine strains isolated were recovered from different sources, namely, cerebro-spinal fluid, meninges, lymph glands, mastoid process, tonsils, adenoid tissue, kidneys, and in one

instance, from the sputum. Of these regions, the lymph glands, particularly those of the neck, were the most common sites of infection.

All these children came from districts in regions where pasteurization of milk was not carried out. None of the children, with the exception of one case, showed evidence of pulmonary or tracheobronchial tuberculosis, either on physical examination or X-ray, the evidence pointing to the alimentary routes of infection.

Fom this limited study upon the incidence of bovine infection in children in this community, it would appear that:

1. Bovine tuberculosis is a factor in childhood infection in rural Canada, and in unpasteurized areas. The incidence of infection is probably far greater than we are aware of.

2. Milk is the vehicle for the transmission of the bovine tubercle bacillus.

3. Tissue localization of the bovine tubercle bacillus is peculiar to certain regions, the lungs being practically immune.

4. In the Toronto district, which is a pasteurized area, not a single case of bovine infection has been recovered up to the present.

5. If we may be allowed to draw conclusions in terms of percentage incidence from this small group of cases studied, about 12 per cent of surgical tuberculosis in children, leading to operation, disablement and disfigurement, and occasionally leading even to the death of the child, is preventable, and can be easily controlled by the simple means of pasteurization, or boiling of milk.

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BOVINE TUBERCULOSIS IN MAN

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October 11, 1915.—Since its first issue much new work has been carried out on the subject with which it deals. It has therefore been revised and brought up to date as it is felt that the subject matter is of urgent interest at the present crisis.

Note. Tuberculosis as it affects man is divided into (*a*) pulmonary tuberculosis, that is to say, tuberculosis of the lungs, "consumption," or "phthisis," and (*b*) "other forms of tuberculosis," that is to say, tuberculosis affecting any other part of the body but the lungs.

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There never was a time when it was so necessary to take stock of the nation's living possessions; never a time when it was so essential as it is now to raise healthy strains both of man and beast. Tuberculosis continues to contaminate these strains. It is true that the amount of contamination is decreasing but there still remains an enormous task to be accomplished before either physician or veterinary surgeon, farmer or social economist can rest on their oars. For the past three years a campaign against Tuberculosis has been actively waged all over the country. Curative measures, measures directed towards the alleviation of human beings already affected have been most in the public mind. Curative methods there must be: the tuberculous worker must, if possible, and as soon as possible, again assume a position of economic independence. It is not the business of this paper to discuss these methods but to bring forward the evidence of many investigators upon the important position in the whole problem of Bovine Tuberculosis in Man. No number of beds in sanatoria and hospitals will ever suffice to stamp out tuberculosis in human beings unless the sources of infection are attacked. It is not in dispute that there are two main types of the tubercle bacillus—the human and bovine. What was in dispute for some time was whether the bovine bacillus could cause disease in man.

Koch at the International Congress on Tuberculosis in 1901 startled the scientific world. He asserted that man was practically never infected by bovine tuberculosis. Subsequent research has shewn that this statement is erroneous.

Koch asserted that the infection of human beings by bovine tuberculosis is but a very rare occurrence. He estimated the extent of infection by the milk and flesh of tuberculous cattle and the butter made from their milk as hardly greater than that of hereditary transmission and he therefore did not deem it advisable to take any measures against it. It is generally admitted that the hereditary transmission of tuberculosis is an extremely rare event.

Prof. Koch based his statement upon the fact that he had been unable to produce tuberculosis in young cattle by human tuberculous material. He had conducted a series of experiments upon nineteen young cattle, attempting to infect them with human tuberculosis by feeding, by inhalation, by subcutaneous, intravenous, and intraperitoneal inoculation: in every case he had failed to produce any effect.

"None of these cattle shewed any symptoms of disease, and they gained considerably in weight. From six to eight months after the beginning of the experiments they were killed. In their internal organs not a trace of tuberculosis was found...the animals we experimented on were affected by the living bacilli of human tuberculosis exactly as they would have been by dead ones; they were absolutely insusceptible to them." "An almost equally striking distinction between human and bovine tuberculosis was brought to light by a feeding experiment with swine: six young swine were fed daily for three months with the tuberculous sputum of consumptive patients. Six other swine received bacilli of bovine tuberculosis with their food daily for the same period. The animals that were fed with sputum remained healthy and grew lustily, whereas those that were fed with the bacilli of bovine tuberculosis soon became sickly, were stunted in their growth, and half of them died. After three months and a half the surviving swine were all killed and examined. Among the animals that had been fed with sputum no trace of tuberculosis was found, except here and there little nodules in the lymphatic glands of the neck, and in one case a few grey nodules in the lungs. The animals, on the other hand, which had eaten bacilli of bovine tuberculosis had, without exception (just as in the cattle experiment), severe tuberculous diseases, especially tuberculous infiltration of the greatly enlarged lymphatic glands of the neck and of the glands from the abdomen, and also extensive tuberculosis of the lungs and the spleen."

Koch, of course, realized that to shew that cattle or pigs were not susceptible to human tuberculosis was no proof that the reverse may not occur; he therefore proceeded to discuss the evidence for human infection by cattle. As no direct experiments could be carried out he discussed indirect evidence. "It is well known that the milk and butter consumed in great cities very often contain large quantities of the bacilli of bovine tuberculosis, and unintentionally carry out the experiment which we are not at liberty to make. If the bacilli of bovine tuberculosis were able to infect human beings, many cases of tuberculosis caused by consumption of alimenta containing tubercle bacilli could not but occur among the inhabitants of great cities, especially in children. And most medical men believe that this is actually the case. In reality, however, it is not so. That a case of tuberculosis has been caused by alimenta can be assumed with certainty only when the intestine suffers first, i.e. when a so-called primary tuberculosis of the intestine is found. But such cases are extremely rare." Professor Koch then cited statistics; he said that he himself had only seen primary tuberculosis of the intestine on two occasions, that Biedert had only found it sixteen times among 3104 post-mortems of tuberculous children. "Primary tuberculosis of the intestine, especially among children, is a comparatively rare disease, and of those few cases that have been enumerated, it is by no means certain they were due to infection by bovine tuberculosis, it is just as likely that they were caused by the widely propagated bacilli of human tuberculosis." That then was Professor Koch's position—that cattle could not be infected by tubercle bacilli of human origin, and that since primary tuberculosis of the intestine in man was extremely rare, it was very improbable that man, considering his many opportunities of infection, was liable to bovine tuberculosis.

It may be said at once that the statistics quoted by Professor Koch concerning the frequency of primary tuberculosis in children do not correspond with those obtained in this country. Woodhead, Shennan, Guthrie, Still, Ashby, and Carr have published the results of the post-mortem examinations of 1161 tuberculous children; primary intestinal tuberculosis was found in 286 = 20·30 per cent.

Those who listened to Professor Koch realized the gravity of his statements. Professor Nocard pointed out that M. Chauveau had infected cattle with tuberculosis from human sources. He stated that the results of such inoculation varied very much: "in certain cases one succeeds and in more frequent cases one does not succeed." He thought failure was due to the transference of the organism from a favourable to an unfavourable soil. He also showed that there were numerous well-authenticated instances in which human beings, especially veterinary surgeons, had been "inoculated while making post-mortem examinations on tuberculous cows." "Then the disease has remained unnoticed for several months, but it has revealed itself sooner or later; its course has varied according to different circumstances, but it has finally appeared. Some of them have been cured; we have a colleague, also a veterinary surgeon in Copenhagen, who is an example of its curability. Others are dead, having watched step by step the progress of the disease from the moment of inoculation to the summit of the corresponding lung." Professor Bang pointed out that although "there is little danger of infecting cattle from tuberculous men it is not always certain that the opposite conclusion is right." "I fear Professor Koch has gone a little too far when he speaks of the non-necessity of taking measures against the tuberculosis of cattle. I fear his opinion will be rather detrimental to the work which goes on in many countries in order to procure healthy milk for the public." There is no doubt that Professor Bang was right, and that Professor Koch's statement has retarded by many years measures for the improvement of the milk-supply of this country.

Professor Sims Woodhead pointed out that Crookshank had been successful in producing tuberculosis in a calf, using the sputum of a tuberculous patient. He very wisely added that the matter was of very great importance, and "we cannot settle it by talking about it; it is only by careful experiments carried out on very definite lines that we can convince ourselves of the accuracy or insufficiency of Professor Koch's statements." He further suggested that a commission should be formed to investigate the matter. In the last fourteen years a large body of evidence has been accumulated which seems to prove that a certain proportion of tuberculosis in man is due to the bovine type of bacillus. This evidence may be divided up into two main groups, (*a*) experimental, (*b*) statistical. The experimental evidence must clearly be of two sorts: first, the proof or disproof that tuberculous material from human beings can infect cattle; and, second, that man can be infected with tubercle bacilli of the bovine type.

The Royal Commission in their Report of 1907 stated that they had studied the nature of the tuberculous material obtained from sixty cases of the disease in man. They found that the organisms obtained divided themselves into two main groups. Group I comprised fourteen strains out of the whole number which were capable of producing generalized tuberculosis in calves and rabbits. Group II consisted of forty cases; these produced a more or less localized lesion—never a generalized tuberculosis either in calves or rabbits. The remaining six cases showed characteristics which made it impossible to include them in either of the two main groups. As we are only concerned with the possible transference of bovine tuberculosis to man it is not necessary to discuss these aberrant strains. The strains belonging to Group I showed the following characteristics. In suitable doses they were able to produce generalized tuberculosis in cattle and rabbits; when grown on alkaline glycerine broth there was a slow increase of alkalinity as growth proceeded; growth on all media was slower than was the case with organisms of Group II. These results obtained with members of Group I were identical with those obtained when strains derived from cattle were used. It was quite impossible either by morphology, staining reactions, cultural reactions, or pathogenic effects to distinguish between the members of Group I derived from human sources and the tubercle bacillus as obtained from cattle. The conclusion seems inevitable that both man and cattle may be infected by the same organism. If this conclusion be true it is necessary to consider the route by which the bovine type of bacillus penetrates man and the material in which it comes. The answer to the first question is to be found in the work of many people, thus in the Report of the Royal Commission on Tuberculosis it is stated that the tuberculous material of Group I was supplied to the Royal Commission in the form of glands from the abdomen or neck; and when the details of the several cases were studied it seemed that the bacillus found an entrance into the body by way of the alimentary canal; now the spread of tuberculosis from man to man is generally held to take place mainly through the respiratory passages, but very different are the conditions determining the entrance into the human body of bacilli coming from a bovine source. The opportunities for the transmission to the body by the respiratory passages of the air-borne bacilli coming from the lungs of a tuberculous cow are insignificant compared with the abundant opportunities for the transmission to man of tubercle bacilli present in cows' milk. That infection of distant tissues may occur through the intestinal tract is seen continually in typhoid fever, in which disease the organisms taken with the food or drink may be found circulating in the blood during the first week of the disease. Calmette and Guerin, Calmette and Petit have conducted many experiments which show that infection through the intestinal tract may readily occur, and that organisms introduced into the intestinal canal may be found circulating in the blood within six hours of their introduction. It must be admitted that infection through the intestinal tract is by no means an impossible occurrence.

Later research has shown that in considering the intestinal tract, we must consider rather the whole alimentary tract including teeth and tonsils.

Stiles in a valuable paper read before the National Association for the Prevention of Consumption at Leeds in 1914 stated that "the human bacillus is inspired: the bovine bacillus is ingested. Both have access to the tonsils. In swallowing tuberculous milk the bacilli are squeezed into the little pockets of the tonsils where they multiply and then pass to the upper glands of the neck." Mitchell examined the tonsils from seventy-two such cervical glandular cases. In 37 % the tonsils shewed evidence of tuberculosis under the microscope. In twelve cases he isolated the bovine bacillus; in three the human bacillus. There is therefore good evidence to show that if the tubercle bacillus be brought in contact with the alimentary tract it can penetrate the human system and produce disease. There is only one material that passes from the cow to man in such a form and in sufficient quantity to be able to produce an appreciable amount of chronic disease. That material is uncooked milk of which we in this country probably drink more than almost any other nation in Europe. Is there any evidence that there are sufficient tuberculous organisms in milk to give rise to a constant stream of cases of bovine tuberculosis. The following table gives the figures obtained in some of the large towns:

Tubercle Bacilli in Mixed Milk Samples (Percentages). (Savage.)

	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910
Manchester	8·7	8·57	10·42	6·7	6·15	6·2	5·74	8·28	5·14	—
Liverpool, country samples	6·1	7·3	5·1	9·2	3·8	6·8	4·7	3·3	1·8	4·1
Liverpool, town samples	0·6	0·4	0·8	1·5	0·4	1·4	1·5	2·0	—	1·4
Sheffield, country samples	—	17·8	16·7	6·7	14·7	9·6	9·7	9·9	10·9	10·4
Birmingham, country samples	Prior to 1908 = 14 per cent.							11·3	7·5	7·3
Leeds, country samples...	—	—	—	—	—	—	—	25·3	16·4	—
Sunderland	—	—	—	—	—	—	2·5	7·0	7·4	3·6
London (L.C.C.)	—	—	—	—	—	—	—	11·6	10·4	—

If an average be taken of these with other large towns between 9 % and 10 % of the mixed milks are found to contain tubercle bacilli. In places in which there is inadequate veterinary inspection the proportion of infected samples is very much higher. Thus Mitchell found that in Edinburgh 20 % of the samples taken from milk on sale at the milk-shops contained living tubercle bacilli, and Stiles in his paper stated "most emphatically, that in Scotland 75 % of the surgical tuberculosis is due to infected milk." Earlier in the paper he mentioned that 50 % of his cases in the Edinburgh Children's Hospital were cases of surgical tuberculosis. Stiles based his estimate of the percentage of bovine tuberculosis upon the careful investigations by Fraser and Mitchell of the material derived from cases upon which he himself operated. There is no doubt the milk of this country does contain living tubercle bacilli. To what extent does infection take place? The answer to this question should be twofold, first the demonstration of the bovine type of bacillus in tuberculous material derived from sick persons and second if the source of the infection be milk that those who drink most milk are the worst sufferers.

The work of Park, Krumwiede, Fraser, Mitchell, Eastwood, F. Griffith and A. Stanley Griffith shows that man can be infected by the bovine type of bacillus, and that the most intense infection is amongst the chief milk drinkers. Park, Krumwiede and Fraser working with material from cases of tuberculosis obtained the following results:

	16 years and over		5–16 years		0–5 years	
	Human	Bovine	Human	Bovine	Human	Bovine
Park and Krumwiede	677	9	99	33	161	59
Fraser	—	—	14	9	12	28
	677	9	113	42	173	87

We have here a total of 1101 cases examined: of these 686 were aged 16 years and upwards; among these nine cases of bovine tubercle were found. On the other hand, amongst children 5–16 years, 155 cases were examined; of these forty-two showed the bovine type; and of 260 children under 5, eighty-seven were infected by the bovine type. Mitchell working in Edinburgh showed that of eighty cases of tuberculous infection of the glands of the neck, seventy-one were caused by the bovine type of bacillus.

A. Stanley Griffith examined material from thirty-five unselected tuberculous cases occurring in children between 0 and 12 years and found six bovine infections, twenty-eight human, and one mixed infection. It is interesting to note that all the cases of bovine infection occurred in children between 1 and 4 years, i.e. at the period when cow's milk forms the chief diet.

Eastwood and F. Griffith investigated this question from another point of view. They obtained post-mortem material from institutions within the county of London from 150 children dying from all causes between the ages of 2 and 10 years. Ninety-four showed evidence of infection with tubercle bacilli and from seventy-eight of these cultures were obtained. It is important to note that in five of these cases *cultures were obtained,* though no demonstrable lesions of tuberculosis were found. In sixty-five of the cases evidence of infection with the human bacillus was obtained: fifty-two of these infections had proved fatal ones. In thirteen of the cases evidence of infection with the bovine bacillus was obtained: nine of these had proved fatal to the children.

The investigations quoted all tend to show:

1. That a definite proportion of tuberculosis in man is due to the bovine type of bacillus, that this proportion is highest in the young (0–5), not quite so high but still very appreciable in those from 5–16. From this age period upwards it becomes a constantly diminishing factor (Park and Krumwiede).

2. That in some districts at least the proportion of bovine infection in certain types of tuberculous disease in children is very high, thus Fraser, working in Edinburgh, found the bovine type in 58 % of the cases of tuberculous disease of the bones and joints which he investigated. Mitchell also working in Edinburgh found it in 90 % of the cases of tuberculous infection of the glands of the neck.

3. That in other districts the proportion does not appear to be so high. Thus Eastwood and Griffith from seventy-eight cases obtained from institutions within the county of London found 16·7 % to be due to bovine infection. Stanley Griffith, the source of the material is not stated, found 17·6 % of bovine infection.

It would not be fair to assert on the work done either that London is better than Edinburgh or Edinburgh worse than London, since the Edinburgh work was carried out on certain specified types of tuberculous disease, bones and joints and cervical glands, whereas for the work of Eastwood, F. Griffith and A. Stanley Griffith special types of tuberculous disease were carefully avoided. It is however quite clear that a very definite proportion of tuberculous disease, at any rate in children, is due to bovine infections, and that these cases occur within the age period when the consumption of cows' milk is at a maximum. To establish the exact extent of this type of infection further investigations, such as those of Fraser and Eastwood and Griffith, are very desirable in all big centres of population. They should be undertaken on a much larger scale and always considered with a parallel examination of the milk samples. Material from purely rural districts and from some of the areas of Wales and the Isle of Man—both rural and industrial—would give most instructive results. In some rural districts the children apparently drink very little cows' milk and as infants they are mostly breast fed, frequently for excessively long periods. Investigation of the excreta of cows is also much needed. Valuable information would be obtained by the intensive study of tuberculosis in all its aspects in a village community.

The persons then who show bovine infection are those who drink most milk. Is it possible to show that partly as the result of measures to insure a much less infective milk supply the death rate from tuberculous disease other than pulmonary is falling more rapidly than the death rate from pulmonary tuberculosis? Let us consider some of the figures. Sir George Newman, Chief Medical Officer of the Board of Education, gives in his Report for 1914 a valuable table compiled by Dr T. H. C. Stevenson (p. 77). This table shows the mortality in England and Wales from all causes and from tuberculous diseases during the period 1907–14. If we take the figures for 1914 as equivalent to 100 the following facts emerge:

Death rate per 1000 *living.*

	1907	1914
1. *At all ages*		
(*a*) All causes ...	107·5	100
(*b*) Other tuberculous diseases ...	127·7	100
(*c*) Phthisis	132	100
2. *Ages* 1–5		
(*a*) All causes ...	125·6	100
(*b*) Other tuberculous diseases ...	127	100

From this we may conclude that the diminution of the death rate *at all ages* from those forms of tuberculous disease chiefly produced by milk has not been quite so great within the years under consideration as the diminution in the death rate at all ages from tuberculous disease of the lungs. If we take the period 1–5 it is seen that the fall in the death rate from all causes has not been quite so great as the fall from "other tuberculous diseases." These figures apply to England and Wales. Can it be shown that in a community where active precautions are taken to supervise the milk supply better results have been obtained.

For many years the milk supply of Manchester has been very carefully controlled and the percentage of mixed milks showing tubercle bacilli has been reduced from 17·2 % in 1897–8 to 5·14 % in 1909. Professor Delépine, who is responsible for the work, has published figures to show that the death rate from tuberculous diseases other than pulmonary tuberculosis has diminished in Manchester at a greater rate than that for all other causes and for pulmonary tuberculosis. He assumes that the improvements in general sanitation, etc. affect the general death rate, and the death rate from pulmonary tuberculosis, as much as they affect the death rate from other tuberculous diseases, and that if he can show that the reduction in the mortality from tuberculous diseases other than phthisis is proportionally greater than the reduction in the mortality from phthisis, and from all causes, it is reasonable to claim that this result is in all probability due to improvement in the milk, and the amount of that improvement may be taken as a basis for an approximate estimate of the share taken by bovine tuberculosis in the infection of human beings. Some of Professor Delépine's figures are summarized in the following tables, in which the average death rate for 1906–10 is called 100, the death rates at the other five-year periods are expressed in terms of this figure.

Manchester. (*All Ages.*)

Deaths	All causes	Phthisis	Other tuberculous diseases
1881–5	133	146	156
1886–90	136	106	161
1891–5	133	126	164
1896–1900	128	123	139
1901–5	113	117	120
1906–10	100	100	100

From these figures it would appear that there has been a greater saving of life in other tuberculous diseases than is the case in either of the other two groups; it also shows that whereas the deaths from other tuberculous diseases increased in number from 1881 to 1895, there has been a steady diminution in the last fifteen years, in fact just at that period when the active measures taken against infection might be expected to produce some effect. If we examine the statistics for the age-period 0–5, it is found that there is again a greater fall in the death rate from other tuberculous diseases than from all causes; at this age-period the deaths from pulmonary tuberculosis constitute so small a fraction of the whole as not to be comparable.

Manchester. (*Ages* 0–5.)

Deaths	All causes	Tuberculous diseases other than Pulmonary Tuberculosis
1881–90	163	193
1891–5	143	198
1896–1900	144	161
1901–5	120	127
1906–10	100	100

These statistics seem to show that where a genuine effort has been made to deal with the problem of tuberculous milk, there a definite gain is effected; they must not, however, be too literally accepted, for, apart from other outside influences, the same difficulty arises that is present in the consideration of the returns of the Registrar-General, that we do not know what proportion of deaths from other tuberculous diseases is due to the bovine type of bacillus and what to the human. On the evidence at present available from one quarter to one third is bovine. If we take it at the lowest estimate we find that the bovine type of tubercle bacillus is the cause of about one fourth of the cases of other tuberculous diseases at ages 0–16, that is to say, about 3000 deaths a year. It is usually supposed that for every death there are at least ten persons suffering from the disease. If this be so bovine tuberculosis is responsible for 30,000 cases of illness at any one time. What this may represent in monetary loss it is impossible to estimate accurately, but it will be well within the mark to say not less than £300,000 per annum. What it represents in pain and suffering and ultimate loss of earning capacity only those who have to deal with the disease can realise.

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