NOTE:—The Investigation was carried out at the instance of a Joint Committee of the East and West Ridings of Yorkshire, to whom these results are being submitted, and by whom they will be published shortly.

THE SOURCES OF CONTAMINATION

OF THE

MILK-SUPPLY.

THESIS

Presented for the M.D. Degree,

BY

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OBJECT AND SCOPE OF THE INVESTIGATION.

The investigation was undertaken with the object of determining, if possible (*a*) upon whom,—the farmer,* the dairyman or the consumer—the responsibility for the greatest contamination of milk lies, and (*b*) the chief sources, and nature of the contamination at the cowshed, during railway transit, at the retailer's premises, and at the consumer's house.

The investigation commenced in March, 1907, and continued for a year, till February, 1908.

INTRODUCTORY AND HISTORICAL.

The investigation of the points and modes of contamination of the Milk Supply is all-important with a view to its prevention and control. This control is all the more important and difficult, having regard to the enormous quantities of milk which are brought, often very long distances, into the towns and cities. The approximate amounts, for instance, coming daily into the County Boroughs of Leeds, Sheffield, Bradford, Hull and Rotherham, concerned in the investigation, compared with the amounts produced in them, are as follows :—

	Total.	Produced in.	Imported.		Average Distance.	Longest Distance.
			By Road.	By Rail.		
	Gallons.	Gallons.	Gallons.	Gallons.	Miles.	Miles.
Leeds	16,000	6,860	4,910	4,230	13	65
Sheffield	20,000	6,000	7,500	6,500	17	100
Bradford	10,500	6,000	1,500	3,000	13	46
Hull	8,430	3,100	3,000	2,330	?	270
Rotherham	3,000	1,500	1,370	130	5	20
	57,930	23,460	18,280	16,190		

The chief outside sources of supply of the County Boroughs in the Ridings are :—Bradford and Leeds, West Riding; Hull, with the exception of 338 gallons daily from Derbyshire, the East Riding; Rotherham, 130 gallons daily from Derbyshire, the remainder from the West Riding; and Sheffield, 8,000 gallons from Derbyshire, 5,600 from the West Riding, and 400 from the North of England.

Milk, as is well known, is one of the most readily contaminated of food stuffs, and has many opportunities of undergoing contamination. The greater the distance it has to travel the greater the risk. The question of modes of contamination is an easy one, but great difficulty is experienced in the determination of the amount, especially when one considers the number of persons handling it before it reaches the consumer. Treatises on the subject are few, and no attempt seems to have been made to determine whether the farmer, dairyman, or consumer plays the chief part in that contamination of the ordinary milk supply, which is well known to exist. Indeed, after a prolonged search, records only of two researches bearing upon the matter have been found. The investigators in these cases were Delépine and Newsholme, and their work was in connection with the causation of epidemic diarrhœa, with the object of discovering whether the disease was due to farm or home pollution of the Milk Supply.

Delépine examined a large number of samples of milk, testing the virulence by the inoculation of animals. His investigation extended over a number of years, and its scope and results may be gathered from the following words, contained in his report: "My results do not exclude infection at the home of the consumer, or during transit from the farm, but they indicate that infection at the farm, or through vessels infected at the farm and used by the farmer for the storage and carriage of milk, must be of paramount importance. None of the milk I have examined had been exposed to any influence attributable to a consumer's home. It will be noticed that a large proportion of the samples of milk obtained from cans at railway stations or at the farms is already infectious before it reaches the consumer; also the degree of noxiousness acquired through infection is proportional to the length of time the milk has been kept, and the temperature which it has been exposed to, before it reaches the consumer."

He is also of opinion that diarrhœa is due to the organisms of the colon group found in the milk at the cowshed. This opinion he bases, not on any extended observation with isolation and identification of these organisms, but on the *toxicity* of the milk when inoculated into animals. It must be borne in mind, however, that though these organisms may be virulent to animals by inoculation, it does not entitle one to conclude that they are virulent to man in the same way by ingestion in milk.

* By farmer is meant a producer of milk.

With Delépine's views, Newsholme, the other investigator, is not in accord, attaching little importance to infection at the cowshed. While not denying the possible origin of some serious epidemics of diarrhœa through pollution at the farm of a single milk supply, he is of opinion that the origin of sporadic cases of diarrhœa is in the milk which has been exposed to pollution by infective dust during storage at the house of the consumer.

In this position the question of farm and home pollution stands, and although the causation of epidemic diarrhœa does not enter into the present investigation, since it had some bearing on the matter, the isolation with identification, as far as possible, of all colon-like organisms which are likely to be blamed for causing diarrhœa, has been carried out in samples taken both at the cowshed and at the consumer's house.

The absence of investigations in the directions indicated, is doubtless due to the fact that the proof of contamination and its extent is beset with many difficulties. Milk is exposed to varying temperatures which affect the multiplication of the organisms present when it first leaves the cowshed. Milk is an excellent food material for these organisms, which multiply very rapidly under favourable conditions of temperature. In winter, the warm milk cools quickly, but in summer it may be cooled or warmed, depending on the temperature of the atmosphere and the exposure of the milk to the atmospheric conditions. If it were possible experimentally to imitate exactly the variations in temperature in the case of a duplicate milk-can sealed to prevent contamination, then the amount of pollution of the original can might be estimated. This, however, is impracticable, first because of the labour involved; secondly because the number of samples which could be treated in this way would be small; lastly, the milk in transit may undergo sudden and unforseen variations of temperature, for example, by being transferred from one can to another, or in other ways impossible to imitate in the experimental sample.

It might be thought that the best way to detect additional contamination would be by identifying all the species of bacteria in the milk at the different stages of transit, and noting if any species are found at one stage which were not present at a former one. This method would be not only laborious, but fallacious, since the organisms might escape detection at the time of contamination owing to the smallness of their numbers, and become apparent later only when they had multiplied owing to exposure to conditions favourable for growth. After some consideration and the rejection of several methods, it was determined to carry out the following investigations, and for the reasons given :—

I. The estimation of the total number of organisms per cubic centimetre in the samples taken at various points of transit, and in various control samples, to determine the number of organisms added at different stages.

II. The estimation of the sediment in milk taken at the cowshed, and at the point where it is supplied to the consumer, to ascertain if any increase occurs in the amount, in transit.

III. The estimation of the number of bacilli enteritidis sporogenes (Klein) at each stage of transit, to note if these organisms are added at any point.

IV. The estimation of the number of glucose fermenting bacteria and streptococci at each stage, to determine the increase due to contamination during transit.

V. The identification of the various species of glucose fermenting bacteria to determine if any new species are added at various points of transit of the milk.

The consideration of the results may be divided into five sections, according to these heads. In these sections will be noted and discussed the experiments undertaken to show how pollution of the milk takes place by the organisms or sediment mentioned.

In carrying out the work, the greatest care had to be exercised to prevent the introduction of fallacies, special precautions, for example, being taken in connection with the collection of samples.

Two inspectors from each district were thoroughly instructed in the proper method of sampling with bacteriological care. These two men were always present at the taking of the samples, and the one acted as a check on the other. Four sets of samples were taken, namely at the cowshed, the railway station, the street or dairy, and the consumer's house, and the same milk was sampled throughout, no admixture being allowed with that from which the first sample was taken. The samples were taken from the mixed milk of each cowshed when ready for transport. The Inspectors usually stayed overnight at the place where the farm was situated. In the morning they went to the farm, took the samples, and, returning on the train by which the milk-cans travelled, afterwards followed the milk to the retailer, and then to the consumer, to collect the other samples. Sampling of an afternoon milking was carried out on similar lines. This entailed great work on the Inspectors, especially when, as often happened, they were required to travel long distances. They carried out the work very efficiently, however, and it was only rarely that any fault could be found with the bacteriological care exercised. Where suspicion of extraneous contamination at the hands of the Inspectors was suspected, the samples were not used. This was considered very necessary to prevent mis-interpretation of the results. Particulars regarding each sample taken were entered by the Inspector on forms of which copies are found on page 112.

The cowsheds from which the milk was taken were "picked" in order to show the effects of various conditions on the milk, sanitary and insanitary buildings both being visited. The object being to procure the samples from the milk under the ordinary conditions, no warning was given to the farmer or dairyman, and no suggestions likely to lead to departures from the routine were offered.

Delépine's apparatus was used for the collection of the samples. In this a cylindrical copper case encloses a copper dipper with which the sample is taken, and from which it is poured into the sample bottle, which is then placed in the dipper. The sample bottle was of 75 cc. capacity, with wide mouth, and was provided with a rubber stopper. The stopper was fitted with a glass centre piece, by which it might be held and so prevent contamination of the part which comes in contact with the milk. The accompanying photograph shows the bottle with its stopper, and the other parts of Delépine's apparatus. The whole of this apparatus before use was sterilized by steam under pressure at 130° C., for half an hour.

After the sample was taken, the case and its contents were placed in an ice-box and kept there till the laboratory was reached. The ice-box keeps the milk at a temperature of 2° C. Owing to the long distances to be travelled, the samples often remained in this box for over twelve hours. To determine if any change takes place at this ice-box temperature, on several occasions the bacterial content of fresh milk at the cowshed was compared with that of the same sample kept in the ice-box for various lengths of time. Gelatine plates incubated at 20° C., for 72 hours, were used, and the results are shown in the following table :—

	Fresh Milk.		Iced Milk.		
Samples.	Number of bacteria per cc.	Time at which plates made.	Number of bacteria per cc.	Time at which plates made.	Duration of icing.
A.	20,000	10 a.m.	23,300	2 p.m.	4 hours
B.	13,800	5 p.m.	13,400	3 p.m. next day	22 hours
C.	18,000	5 p.m.	20,500	5 p.m. next day	24 hours
D.	10,250	5 p.m.	9,000	11 a.m. next day	18 hours
E.	4,600	5 p.m.	4,100	11 a.m. next day	18 hours

The count, it will be noted, in three cases is slightly less, and in two a little greater, but the variations are so slight that they may be disregarded, and the length of time the samples were kept discounted in the bacterial estimations.

As temperature has a great influence on the bacterial content of the milk, it is important to remember that the summer of 1907 was unusually cold, and one unfavourable to any germs contained in milk. For comparison, the following are the average maximum and minimum temperatures for the four quarters of the year 1907, with those of the years 1901-2-3-4-5 and 6, taken at the Philosophical Hall, Leeds, and supplied by the Medical Officer of Health for Leeds.

Average Maximum and Minimum Temperatures.

	Jan. to Mar.		Apr. to June		July to Sept.		Oct. to Dec.		Annual Aver.	
	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.
1901	45.78	36.56	59.49	43.41	65.63	50.44	50.00	41.52	55.13	42.95
1902	49.03	38.55	60.47	44.49	65.66	50.68	48.44	38.51	55.90	43.06
1903	44.49	34.97	61.31	45.88	69.00	52.44	50.02	38.99	56.21	43.07
1904	47.68	37.54	61.70	45.62	76.58	53.07	50.01	39.73	56.74	43.99
1905	46.36	35.92	61.06	44.73	69.51	52.91	50.51	41.36	56.86	43.73
1906	46.67	36.71	60.80	44.83	67.48	51.91	49.80	40.02	56.17	43.36
1907	46.23	34.87	58.74	44.91	66.33	50.97	50.60	41.58	55.48	43.08

It will be seen that in the quarter April to June, the maximum for 1907 was less than in the last six years, the lowest in those six years being .75 higher, and highest 2.06 higher; in the quarter July to September, the maximum, though greater than in the years 1902 and 1903 by about .7, was less than in the last four years, the lowest in these years being 1.15 higher and the highest 3.18 higher. The average maximum temperature for the three months October to December was higher than in the previous years, having been .09 above the highest and 2.16 above the lowest in these years.

During the summer of 1907, from June till the end of September, the milk samples were examined for preservatives systematically by Dr. C. Crowther, Lecturer in Agricultural Chemistry, Leeds University. After September, if after bacteriological examination their presence was suspected, a similar examination was made. In every case the result was negative.

CULTURE MEDIA AND TECHNIQUE.

For the estimation of the total bacterial content of the first samples agar and gelatine were employed. For the later work agar alone was used, the gelatine having become contaminated by an organism of the Subtilis group, the destruction of which called for sterilization of the medium by exposure to a temperature which interfered with its setting properties.

The media were standardized to +10. Agar was incubated in all cases for 48 hours at 37° C., and gelatine at 20° C. for 72 hours, but in speaking of bacterial counts those referred to, unless otherwise stated, are the counts on gelatine or agar at 20° C., which are in nearly all cases greater than those on agar at 37° C.

The milk to be examined was of necessity in every case diluted. Two sets of flasks, one containing 9 cc., the other 99 cc. sterile water were employed, and in these, dilutions varying according to the source and history of the specimen, from 1 cc. (one cubic centimetre) to $\frac{1}{1,000,000}$ cc. (one millionth of a cubic centimetre) were made.

No less amount than .5 cc. was used of any dilution in making inoculations, the results, when a less amount was used, proving inaccurate. Three gelatine plates and three agar plates were made from each milk. Three different dilutions were used for each of the three plates, and the average of the number of colonies growing on each set of three was taken.

SECTION I.

The estimation of the total number of organisms per cubic centimetre in the samples taken at various points of transit and in the various control samples to determine the number of organisms added at different stages.

The stages understood are—1, the cowshed; 2, the railway station; 3, the street; 4, the retailer's premises; and 5, the consumer's house; and under these five heads the subject may be considered.

I. THE COWSHED.

If the bacterial counts of the samples taken at the cowsheds are considered, the outstanding feature, it will be found, is the great variations in the numbers of the organisms present. These reached from 5,000 per cc. the lowest, to 1,048,000 per cc. the highest, the average being in the cold months 74,830 and in the warm 88,260 per cc. Freudenreich, working in Berne, has found 10,000 to 20,000 bacteria per cc. on an average, in milk taken fresh at the cowshed; while Knopf, in Munich, found as many as 60,000 to 100,000 per cc. The cause of these variations is undoubtedly the differences in the conditions under which the milk is produced. For the consideration of these conditions it is convenient to group the samples in Table I. according to their bacterial content, A., those containing under 15,000 being classed as good; B., those under 50,000, as fair; C., those under 100,000, as bad; and those over 100,000 as very bad. This classification was made and the number taken to be permissible for milks of various qualities on the results of a series of experiments. It is not suggested as a permanent standard, but is employed merely for convenience and simplicity in making the report.

EFFECT OF SITUATION.—Of the total number of samples, 24, obtained from town cowsheds:—

25	per cent.	fall	into	group	A.
50	,,		,,		B.
12.5	,,		,,		C.
12.5	,,		,,		D.

Of the total, 49, from country cowsheds:—

4.1	per	cent.	fall	into group	A.
44.9	,,		,,		B.
24.5	,,		,,		C.
26.5	,,		,,		D.

These figures show that town milks are more likely to have smaller bacterial counts than country milks.

EFFECT OF CLEANLINESS OF THE UDDER.—Of the number of cases, 46, in which the inspectors reported the udders to be clean :—

15.2	per cent.	fall into	group	A.
56.5	,,		,,	B.
13.0	,,		,,	C.
15.2	,,		,,	D.

Of those reported dirty, 27 :—

3.7	per cent.	fall into	group	A.
29.6	,,		,,	B.
33.3	,,		,,	C.
33.3	,,		,,	D.

It is quite evident from these results that there is a relationship between dirty udders and high bacterial content.

EFFECT OF THE CONDITION OF THE COWSHED.—Out of the 75 cowsheds visited, 38 or 50.6 per cent. were found to have good or fair lighting and ventilation, 29 or 38.6 per cent. were badly lighted and ventilated, while 8 or 10.6 per cent. had no light or ventilation except when the doors were open. As showing the effect of insufficient lighting and ventilation of the cowshed on the bacterial content, it is interesting to note that :

Of the total number of sufficiently lighted and ventilated cowsheds, 36 :—

16.7	per cent.	are in	group	A.
58.3	,,		,,	B.
11.1	,,		,,	C.
13.9	,,		,,	D.

Of those insufficiently lighted and ventilated, 37 :—

5.4	per cent.	are in	group	A.
35.1	,,		,,	B.
29.7	,,		,,	C.
29.7	,		,,	D.

It is difficult to find the true explanation of the effect of the lighting and ventilation of the cowshed upon the milk. It may be, however, that the darkness favours dirtiness of the cows, etc., or that such cowsheds are rented by a class of farmer who is either ignorant of, or careless in regard to the proper method of producing a clean milk. It is not suggested that want of light and air always imply a high count. Two samples in group A, Nos. 11 and 25, show that in badly ventilated cowsheds milk with low bacterial counts can be produced, while 9 samples in groups C. and D., Nos. 30, 34, 55 and 69, and 33, 36, 40, 51 and 60, show that milk from well lighted and ventilated cowsheds may have high bacterial counts.

In discussing this point, Leighton, who has carried out some interesting observations in regard to the bacterial content of milk from certain cowsheds, says, " It has been observed that costly stables and expensive equipment are not indispensable for procuring clean milk and low bacterial counts. It is also true that the possession of all these does not insure the best results." The above results are to a certain extent in agreement with this conclusion.

EFFECT OF SEASON.—If the samples taken in the warm months of the year, from the beginning of May till the end of September, are considered, it will be found that of the total number, 33 :—

6	per cent.	fall into	group	A.
57.5	,,		,,	B.
18.2	,,		,,	C.
18.2	,,		,,	D.

On considering the total number 40, obtained in the cool months, October to April, it is found that :—

15	per cent.	fall into	group	A.
37.5	,,		,,	B.
22.5	,,		,,	C.
25	,,		,,	D.

These percentages show that milks showing the smallest bacterial contents are more likely to be obtained during the cool months of the year.

TABLE I.

GROUP A (under 15,000).					GROUP B (under 50,000).				
Sample No.	Bacterial Content.	Source.	Cleanliness of Udders.	Lighting and Ventilation of Cowshed.	Sample No.	Bacterial Content.	Source.	Cleanliness of Udders.	Lighting and Ventilation of Cowshed.
1	13,500	Town	Clean	Good	2	22,416	Town	Clean	Bad
3	5,660	,,	,,	,,	6	27,500	,,	,,	,,
4	11,330	,,	,,	,,	9	21,500	Country	Dirty	Good
5	8,610	,,	,,	,,	10	34,080	,,	Clean	,,
8	5,000	Town	Clean	Good	12	42,400	Country	Clean	Good
11	7,360	,,	,,	Bad	14	23,300	,,	,,	,,
25	7,100	Country	Dirty	,,	15	37,500	,,	,,	,,
31	12,800	,,	Clean	Good	16	35,000	,,	,,	Bad
					17	27,300	Country	Clean	Good
					18	27,250	,,	,,	,,
					19	17,800	,,	,,	,,
					20	31,750	,,	Dirty	Bad
					21	27,000	Country	Dirty	Bad
					22	17,000	,,	Clean	,,
					23	26,000	,,	,,	,,
					24	47,000	Town	Dirty	,,
					26	21,250	Town	Dirty	Good
					27	16,600	Country	,,	Bad
					28	26,660 (Agar)	,,	Clean	Good
					29	17,500 (Agar)	,,	,,	,,
					35	34,000	Town	Clean	Good
					43	36,000	Country	,,	Bad
					45	33,000	,,	,,	Good
					46	29,600	Town	Dirty	Bad
					52	36,000	Country	Clean	Good
					54	28,300 (Agar)	,,	,,	Bad
					57	20,000	,,	,,	Good
					63	24,500 (Agar)	Town	,,	,,
					64	42,300	Town	Clean	Good
					67	40,600	,,	Dirty	Bad
					72	23,000	,,	Clean	Good
					73	20,000	,,	,,	,,
					74	20,000	Country	Clean	Good
					75	36,000	Town	,,	,,
Total Samples 8	Average Content 8,920	25% of Town 4.1% of Country Milks	15.2% of Clean Udders 3.7 of Dirty	16.7% of Well Ventilated Places 5.4% of Badly	Total Samples 34	Average Content 28,530	50% of Town 44.9% of Country Milks	56.5% of Clean Udders 29.6% of Dirty	58.3% of Well Ventilated Places 35.1% of Badly

TABLE I. *continued.*

GROUP C (under 100,000).					GROUP D (over 100,000).				
Sample No.	Bacterial Content.	Source.	Cleanliness of Udders.	Lighting and Ventilation of Cowshed.	Sample No.	Bacterial Content.	Source.	Cleanliness of Udders.	Lighting and Ventilation of Cowshed.
7	85,130	Country	Dirty	Bad	13	117,100	Country	Dirty	Bad
30	60,000	,,	Clean	Good	33	192,250	,,	Clean	Good
32	65,600	,,	,,	Bad	36	142,600 (Agar)	Town	,,	,,
34	92,400	Town	,,	Good	37	1,048,000	Country	,,	Bad
38	97,000	Country	Dirty	Bad	39	146,000	Country	Clean	Bad
41	80,500	,,	Clean	,,	40	129,000 (Agar)	,,	,,	Good
44	78,000	,,	Dirty	,,	42	330,000	,,	Dirty	Bad
48	67,000	,,	,,	,,	49	197,300	,,	,,	,,
53	63,500	Country	Dirty	Bad	50	289,600	Country	Clean	Bad
55	87,000	Town	Clean	Good	51	137,500	,,	Dirty	Good
56	52,000	Country	,,	Bad	59	164,000	Town	Clean	Bad
62	62,000 (Agar)	,,	Dirty	,,	60	380,000	,,	Dirty	Good
66	62,600	Country	Dirty	Bad	61	157,000 (Agar)	Country	Dirty	Bad
68	66,500	Town	,,	,,	65	194,000	,,	,,	,,
69	98,000	Country	,,	Good	70	116,000	,,	,,	,,
					71	107,000	,,	,,	,,
Total samples 15	Average content 74,480	12.5% of Town 24.5% of Country Milks	13% of Clean 33.3% of Dirty Udders	11.1% of Well Venti- Places 29.7% of Badly	Total samples 16	Average content 240,450	12.5% of Town 26.5% of Country Milks	15.2% of Clean Udders 33.3% of Dirty	13.9% of Well Venti- lated Places 29.7% of Badly

That the bacterial content would be greater in the summer, owing to the contamination from the milk cans, which "sour" more readily in the warm than in the cold months, owing to the great multiplication of bacteria, is almost to be expected. But if contamination in this manner is less in the winter months, it is compensated for by the contamination which occurs from the manure and dirt on the cows which are then kept indoors, and are dirtier than in summer. Certain experiments recorded later go to prove this.

From what has gone before, it will be seen that the situation of the cowshed, whether in the town or country, the condition of the cows, whether clean or dirty, and the condition of the cowshed as to light and ventilation, all produce an effect upon the milk. It must, however, be borne in mind that all these conditions are often found together. As a result of the position in the country, and want of supervision, the two latter may occur, and as a result of the bad light and ventilation, want of cleanliness of the cows, etc., may follow.

It is difficult to say in the case of each sample what at the cowshed has been the source of these organisms. There are a number of factors, of greater or less importance, at work, and it is only on the closest examination that all these factors can be made out. Some of the information collected by the Inspectors having been obtained second-hand, certain sources of pollution have probably therefore not been noted. For this reason comparison of samples exposed apparently to similar conditions has in certain instances been impossible, and no satisfactory conclusion could be drawn. This is markedly seen in the case of the mode of cleaning of the milk cans. Nevertheless, the influences of the various factors have been determined by experiments, and may be considered with reference to the following heads :—

(1) The Cow (*a*) Interior of Udder;
(*b*) Exterior of Udder.

(2) The Milker (*a*) Hands and dress.
(*b*) Wet and dry milking.

(3) The air of cowshed.

(4) The milk pails and cans.

(5) Milk coolers.

(6) Milking machines.

(1) THE COW (*a*) INTERIOR OF THE UDDER.—This raises the question: What is the bacterial content of milk as it is drawn from a normal udder? By normal udder is meant one which does not show any sign of disease.

Diseased conditions of the udder do not enter into the present investigation, but two cases recorded by the Inspectors show the absolute disregard for the consumer displayed by some farmers. In one case, a cow, giving at each milking three gallons of milk, which was mixed with the rest of the milk from the cowshed, was seen by the Inspectors to be very ill. The farmer had not stopped to consider the effect of this illness on the milk. On being spoken to by the Inspectors, the cow's condition being so evident, he consented to have her killed, when she was found to be extensively affected with tuberculosis. In another case, a cow was found to be "suffering from some condition of the udder, there being blood in the milk. The milk from the cow was allowed to stand to settle, and then it was poured in with the rest of the milk except the settlings." Another striking case is worth recording. A cow was suspected, by those in charge, of being infected with tuberculosis, as it was very ill and had a cough, and it was considered advisable to isolate it from the rest in the cowshed. One quarter of her udder was enlarged, and the milk drawn from it was watery and tinged with blood. Despite the suspicion of tuberculous disease, the milk from the enlarged quarter was given to pigs, and that from the other three-quarters was sold for human use in the raw condition. This cow, on being killed ten days later, was found to be extensively affected with tuberculosis.

It is generally agreed that milk as secreted is sterile, but when the milk passes to the lower ducts and the cistern, it becomes contaminated with organisms which have passed in from the teat and have there multiplied during the intervals of milking (Moore, Ward, Bolley and Simon).

To determine the bacterial content of milk issuing from the teat, a series of experiments was undertaken in which the foremilk, the midmilk, and the strippings were each examined. In order to exclude the possibility of extraneous contamination taking place, the following precautions were exercised.

The udder, teats and flanks of the cows were washed with soap and water, then washed with clean boiled water and a sterile cloth and left moist. The flask to receive the milk was held as near the teat as possible with the neck horizontal to prevent the entrance of organisms. The milk was drawn by the writer in the ordinary way, the hand having first been thoroughly washed.

		Agar 37° C. 48 hrs.	Agar 20° C. 72 hrs.	
A	Foremilk	2,000	30	per cc.
	Midmilk	320	3	,,
	Strippings	256	4	,,
B	Foremilk	33	15	,,
	Midmilk	1	3	,,
	Strippings	3	—	,,
C (A repeated)	Foremilk	2,668	27	,,
	Midmilk	800	5	,,
	Strippings	448	3	,,
D (B repeated)	Foremilk	38	18	,,
	Midmilk	12	7	,,
	Strippings	3	1	,,
E	Foremilk	89	33	,,
	Midmilk	23	4	,,
	Strippings	15	8	,,
F	Foremilk	4,000	720	,,
	Midmilk	2,432	544	,,
	Strippings	2,970	240	,,
G	Foremilk	6,000	240	,,
	Midmilk	3,548	13	,,
	Strippings	2,824	6	,,
H	Foremilk	160	380	,,
	Midmilk	24	16	,,
	Strippings	86	86	,,
K	Foremilk	1,280	1,920	,,
	Midmilk	800	992	,,
	Strippings	42	34	,,
L	Foremilk	480	200	,,
	Midmilk	180	192	,,
	Strippings	100	90	,,

The foremilk is the first 25 cc. drawn from the teat, and what is called midmilk was taken when milking was half done. The last milk taken from the udder is known as the strippings.

Samples at a later date of the foremilk from different quarters of the same cows were taken and examined with the following results.

The letters (*a*), (*b*), (*c*), (*d*) represent the different quarters of the udder. Samples (*b*), (*c*) and (*d*) of each were taken on the same day. Samples (*a*) were taken and examined a short time before.

		a	*b*	*c*	*d*	
A	Agar 37° C.	2,668	30	20	30	per cc.
	Agar 20° C.	27	420	50	40	,,
B	Agar 37° C.	33	800	1,600	2,016	,,
	Agar 20° C.	15	1,056	1,920	1,920	,,
E	Agar 37° C.	89	5,760	232	3,648	,,
	Agar 20° C.	33	640	100	3,840	,,
F	Agar 37° C.	4,000	5,600	4,032	296	,,
	Agar 20° C.	720	52	4,800	200	,,
G	Agar 37° C.	6,000	5,960	3,552	108	,,
	Agar 20° C.	240	6,528	5,568	30	,,
H	Agar 37° C.	160	14	8	14	,,
	Agar 20° C.	380	14	16	14	,,
K	Agar 37° C.	1,280	24	68	188	,,
	Agar 20° C.	1,920	12	60	162	,,
L	Agar 37° C.	480	30	280	320	,,
	Agar 20° C.	200	18	320	288	,,

These results show that there are great differences in the bacterial content of the milk from different cows and also in milk from different quarters of the same cow. Moore found 7,200 and 8,400 bacteria per cc. in the first milk and 546 and 504 in the last milk, while Schultz found 97,000 in the foremilk, 9,000 in the midmilk, and 500 in the strippings.

Harrison in his experiments got greater foremilk counts. This may have been due to the fact that a smaller amount of milk was taken than in the present instance. He also examined the milk coming after the foremilk with the following results, which show the great decrease in the bacterial content when the first coming milk is excluded.

Number of Bacteria per cc. in Milk.

Foremilk	26,070,	25,630,	38,420,	18,110,	54,800,	32,700
	43,520,	27,830,	18,500,	29,400,	45,630,	48,700
Milk after removal of Foremilk	1,246,	1,150,	1,430,	3,420,	1,560,	890
	2,575,	4,820,	3,270,	1,285,	1,350	

From the results of the writer's experiments it is evident that there exists no constant relationship between the number of organisms on plates incubated at 37° C. and the number on plates kept at 20° C. In some cases the count in the latter is much less, in others the same, and in others is much greater. This will depend on the organisms which gain entrance to the milk ducts. Again there may be a marked difference between the foremilk and the midmilk bacterial content. For instance, Sample A shows a marked reduction from 2,000 to 320, while Sample F shows a reduction which is not so marked, from 4,000 to 2,432. In only one case was a negative result obtained, namely in B, where the "strippings" plate at 20° C. showed no growth. On the plate kept at 37° C. there were, however, three colonies. Thus in no case has sterile milk been obtained. It is interesting to note that cows H and L, which show the smallest number of organisms in the milk from all quarters, were only 4 years old, and each had calved 7 days previously, the others were all older and had been in milk some months.

Backhaus and Appel have shown that it makes little difference on the bacterial content of the foremilk whether the intervals between the milkings are moderately long or very long.

To find if the completeness of the milking process had anything to do with the bacterial content of the milk, two experiments were carried out, Cow E, one which had a large bacterial count in three quarters, was thoroughly "stripped," and Cow K was left "proud" at each milking for two days, before the samples were taken from each quarter. The following results were obtained on examination :—

		a	b	c	d
E.	Agar 37° C. ..	80 ..	9,000 ..	120 ..	60
	Agar 20° C. ..	60 ..	2,560 ..	120 ..	40
K.	Agar 37° C. ..	150 ..	254 ..	27 ..	66
	Agar 20° C. ..	20 ..	164 ..	40 ..	44

On comparing the results of these samples with the above of former samples from the same cows, in the case of E there is found a decrease in three-quarters, but in one a great increase, and in the case of K, there is a large increase in one quarter, and a decrease in the other three. In the first examination of the foremilk from Cow E, the average from all quarters was 2,432, and in the second 2,312, and in the first from Cow K, the average was 390, and in the second 124. There is therefore a slight reduction in the first instance, and in the second, where one would expect an increase, there is a decrease. So far as this experiment goes, it must be concluded that the completeness of the stripping has no influence on the bacterial content of the milk.

The results of these experiments agree with those of Schultz, von Freudenreich, Boeckhout and de Vries, and Burr and others who, after using the most careful precautions, have been unable to obtain sterile milk. They are at variance with those of Swithinbank and Newman, and Eyre, who have recorded successful attempts at obtaining a milk quite free from organisms. It must be remarked, however, that Swithinbank and Newman used the milking-tube.

Henderson, Moore and Ward, who have each examined the udders of newly killed animals, have found that organisms are invariably present in the cistern and ducts, and also maintain with the former observers that milk drawn, no matter how carefully, from the udder, always contains bacteria.

Putting aside the question whether or not sterile milk can be obtained, the above experiments show that in practice, with the most careful precautions, milk as it comes from the cow contains a variable number of bacteria, and often even a large number. The lowest average of the foremilk from all quarters of a single cow is 49 (Cow H), and the highest 3,905 (Cow G). It must be borne in mind, however, that the average of the whole milk from all quarters would be much less.

Owing to the high bacterial content of the foremilk, as demonstrated better possibly in Harrison's than in the present investigation, it is advisable to discard the milk which is first drawn from the teat if it is desired to obtain the purest milk for consumption. The loss entailed by doing so is very slight, as the first drawn milk is always very poor in butter fat. It is only necessary to discard the first "draw" from the teat.

(*b*) Exterior of Udder.—This is a fruitful source of contamination. When one considers the condition of many of the cows providing milk for the market, it is not surprising that gross contamination occurs. It is no uncommon thing to find the udder, flanks and haunches of milch cows plastered with manure, sometimes almost an inch thick, and quite often no attempt whatever is made at grooming. During the summer, when the cows are at grass, the manure on their haunches and udders lessens, but in the winter it is much increased, as is also the contamination of the milk as will be seen from the following experiments.

It is strange that cows which are maintained chiefly as a source of human food should be kept in such a filthy condition. In none of the 75 cowsheds were the udders ever washed at all. In three, Nos. 63, 64 and 66, or 4 per cent., the udders were rubbed with a dry cloth, while in two cowsheds, Nos. 39 and 43, the teats alone were washed. The samples from these cowsheds do not show good results owing to other factors, which were not controlled, acting in the contamination of the milk, but perhaps owing also to the cleaning not having been efficiently performed. Sometimes the milker before beginning to milk rubs over the udder with his hand. This cannot be regarded as even an attempt at cleansing, more harm than good probably resulting, since the dust and filth detached settles into the milk pail, which is placed underneath directly after the rubbing. An Inspector reported that in one case a milker performed this rubbing *after* he had placed the pail beneath the udder ready to milk, the pail thus receiving all the dust, etc. Most commonly, however, even the perfunctory dry rub with the hand is omitted, and the cow is milked whether the udder is clean or covered with dry detachable manure.

To show the contamination which actually occurs during the process of milking, certain experiments were undertaken. A number of agar plates were held under the udder during the process of milking for two minutes each. During milking there is a considerable shaking of the udder, and this dislodges the loosely adherent dirt and bacteria which drop into the pail below.

The first series of experiments was carried out during the summer, when the cows were out in the fields all day and night, and were only brought in at milking times; the second series in the winter, when the cows were confined to the sheds.

The Agar plates after exposure were incubated for four days at 20° C. The area of each plate is about one-ninth that of a 12 inch plate. Thus, by multiplying the following results by 9 the number of organisms falling every two minutes into the milk pail is obtained. Milking usually takes from 6 to over 15 minutes.

SERIES I. SUMMER. ALL COWS OUT.

I.	1st	exposure	2 minutes	..	576	colonies.
II.	1st	,,	,,	..	596	,,
III.	1st	,,	,,	..	240	,,
	2nd	,,	,,	..	200	,,
IV.	1st	,,	,,	..	408	,,
V.	1st	,,	,,	..	480	,,
	2nd	,,	,,	..	320	,,
VI.	1st	,,	,,	..	380	,,
VII.	1st	,,	,,	..	512	,,
	2nd	,,	,,	..	688	,,
			Average	..	440	

A few days afterwards, the same conditions prevailing, Cows I., II. and VII. had their udders and flanks brushed and then washed with a clean cloth, which had been boiled, and boiled water. The above experiments were then repeated with the following results :—

I.	1st	exposure	2 minutes	..	140	colonies.
	2nd	,,	,,	..	160	,,
II.	1st	,,	,,	..	160	,,
	2nd	,,	,,	..	140	,,
VII.	1st	,,	,,	..	240	,,
	2nd	,,	,,	..	180	,,
			Average	..	170	

As the figures show, the improvement following washing was most marked. Plates placed in the passage in the cowshed at the same time for five minutes gave counts of from 168 to 300.

In the second series of experiments, performed during the winter, when all the cows were inside, the duration and method of exposure of the following plates were the same, but a variety of observations was made.

SERIES II. WINTER. COWS INDOORS.

1. Three cows were left dirty and had no treatment before milking. The counts were as follows :—

I.	1st	exposure	2 minutes	..	over 5,000	colonies.
	2nd	,,	,,	..	Similar.	,,
II.	1st	,,	,,	..	4,800	,,
III.	1st	,,	,,	..	about 5,120	,,
	2nd	,,	,,	..	,, 3,840	,,
			Average	..	4,752	

2. Three cows had their udders and flanks brushed and the plates were held underneath during milking. The counts were :—

IV.	1st	exposure	2 minutes	..	1,000	colonies
	2nd	,,	,,	..	800	,,
V.	1st	,,	,,	..	2,400	,,
VI.	1st	,,	,,	..	2,560	,,
	2nd	,,	,,	..	2,000	,,
			Average	..	1,752	

3. Four cows had their udders and flanks brushed and then washed with soap and boiled water, then with clean boiled water and a clean cloth and left moist. The plates held below the udder as above gave the following results :—

V.	1st exposure	2 minutes	..	180	colonies.
	2nd ,,	,,	..	200	,,
VI.	1st ,,	,,	..	260	,,
	2nd ,,	,,	..	180	,,
VII.	1st ,,	,,	..	320	,,
	2nd ,,	,,	..	288	,,
VIII.	1st ,,	,,	..	260	,,
IX.	1st ,,	,,	..	160	,,
	2nd ,,	,,	..	240	,,
X.	1st ,,	,,	..	320	,,
	2nd ,,	,,	..	128	,,
		Average	..	230	

4. In three cases the udders were dried after washing, and gave the following results :—

IV.	1st exposure	2 minutes	..	336	colonies.
	2nd ,,	,,	..	264	,,
XI.	1st ,,	,,	..	448	,,
	2nd ,,	,,	..	800	,,
XII.	1st ,,	,,	..	416	,,
	2nd ,,	,,	..	400	,,
		Average	..	444	

On considering the above results, there is found a very great increase in the number of organisms falling on the plates when the cows are living indoors in winter as compared with the number when the cows are living outside in summer. The above experiments were all carried out in the cowshed whither the cows had been brought to be milked. The cow, therefore, contributes less to the contamination of the milk when living in the open air. The explanation lies in the fact that the cows get their udders soiled with the manure deposited on the cowshed floor when living indoors, a contamination which they escape when lying on the grass. Simple brushing has the effect of reducing the number of bacteria falling on the plates, but a reduction is very markedly seen when the udders are washed and when left moist. In three cases where the udders were dried, the numbers of bacteria were greater than in cases where the udders were left moist. When there is a little moisture on the hairs, the bacteria cling to the moist surface and are less readily dislodged. The surface, however, should not be dripping wet, as then the drops of water are apt to fall into the milk and contaminate it.

It is commonly urged by the farmer that washing lessens the milk secretion. That this is not so is proved by Eckles, who carried out certain experiments which show that, when the animal is accustomed to the treatment, no noticeable effect is produced either in the quantity of milk or of butter-fat. Again, it may be said that the cows would be liable to cold as a result of the washing, but such is not the case. These experiments lasted several months in winter and during all this time six cows were washed twice daily, and often also all the twenty cows in the shed without any harm resulting. The operation of washing should, however, be properly carried out. Clean boiled water should be used and clean cloths which have also been boiled.

A striking example of how not to do it was brought to the notice of the writer. At a certain cowshed, the cows were washed regularly and looked as clean as possible to the naked eye, but when plates were held underneath the udders during milking, the following results were obtained :—

Cow A.	1st exposure	2 mins.	..	1,600	colonies.
	2nd ,,	,,	..	2,000	,,
	3rd ,,	,,	..	1,800	,,
Cow B.	1st ,,	,,	..	2,000	,,
	2nd ,,	,,	..	1,000	,,
	3rd ,,	,,	..	1,700	,,
Cow C.	1st ,,	,,	..	1,440	,,
	2nd ,,	,,	..	1,404	,,
		Average	..	1,618	

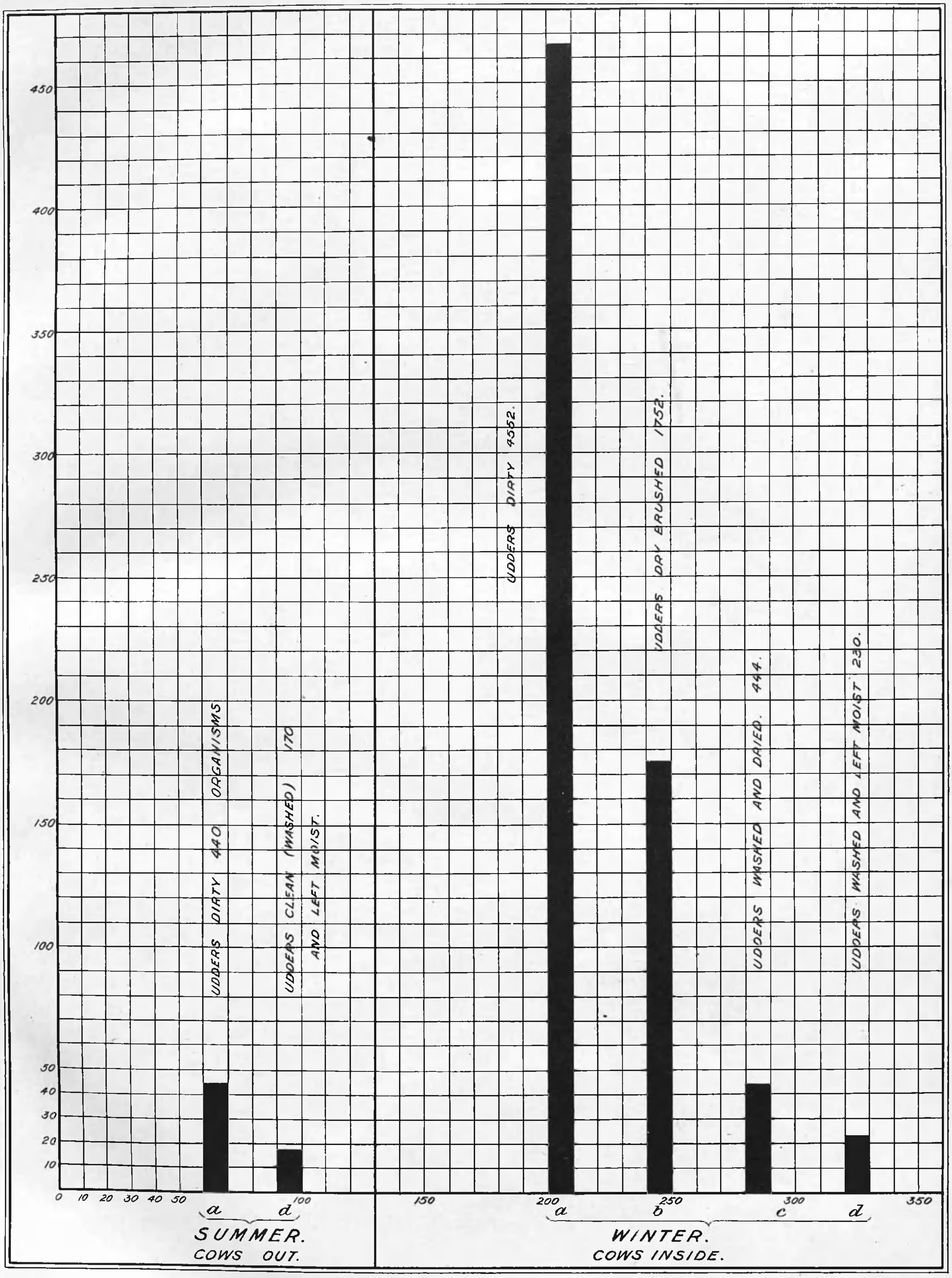


CHART I.

Showing the average number of bacteria falling on Agar plates held underneath the udder during milking in Summer when the cows are out and in Winter when inside.

(*a*) Udders dirty.

(*b*) Udders dry brushed.

(*c*) Udders washed and dried.

(*d*) Udders washed and left moist.

These results were obtained from cows which were out all day in summer and did not compare favourably with the plates seen above from cows kept under the same conditions, but not washed. The exposures were therefore repeated, and gave results much higher, namely :

Cow A.	1st exposure 2 mins.	..	1,808	colonies.
	2nd ,, ,,	..	1,888	,,
	3rd ,, ,,	..	2,752	,,
Cow B.	1st ,, ,,	..	3,264	,,
	Average ..	..	2,428	

On enquiry, it was found that for washing all the cows, one cloth was used which afterwards was washed in cold water and allowed to lie damp in a condition suitable for the growth of organisms, and used again. The process of cleansing adopted simply consisted in washing first the manure from the haunches, thus soiling the cloth. and then plastering on the udders an invisible layer of dirt and bacteria, which on milking, fell off and contaminated the milk. Unfortunately, the influence on the milk was not ascertained as the milk was mixed with other milk produced under different conditions. The pollution in this case was made much worse by the improper method of washing, being from two to sixteen times as much as when the udders were not washed at all.

By using several cloths and exercising a little care in boiling them, pollution by means of the cloths should not occur. The udder and lower part of the belly should be brushed, and then washed. The haunches need not be washed. This should be in addition to the usual grooming of the cows, which ought always to be done. The grooming in summer when the cows are out will not take up much time, as they keep themselves clean, but in winter it will take longer. It has been found by experiment that one man in winter can keep twenty cows in a clean condition by devoting a single hour a day to the work; of course this is only after they have been thoroughly freed from the manure on their haunches, the removal of which may take some days at first.

It may be objected that the operation of washing takes up too much time. Practical experience shows otherwise, as two men can wash 10 cows thoroughly in half an hour, and, as illustrated in a case below, when pushed for time, one man can do it in the same time, perhaps not so thoroughly, but without apparently influencing the bacterial content of the milk to any extent. The cost of one man for an hour, or two men for half an hour does not add much to the cost of a gallon of milk. If the cost of a man for an hour be taken as 4d. (a fair figure), and the quantity of milk produced by 10 cows is 15 gallons, it will be found the additional cost per gallon of milk is about a farthing.

In addition to the organisms falling from the udder, as shown above, very often large pieces of manure are detached and drop into the milk pail when the udder is not cleaned. It is quite common to find large particles of manure floating on the top of the milk before it is filtered or strained.

An idea of the amount of manure which gets into the milk in large particles is obtained by considering the following estimations: On two separate days the milk from a cowshed where the cows were in a dirty condition, was passed through a piece of muslin. The deposit (chiefly manure) was washed off afterwards into distilled water, this water was then filtered through filter paper, which was then dried with the deposit and weighed. On the first day, the quantity of milk strained was 12 gallons, and on the second, 14 gallons. In the former amount the deposit weighed 2.005 grams and in the latter 1.415. Taking 4.5 as the number of litres in a gallon, the weight of deposit per litre was .037 grams in the one, and .022 grams in the other.

It must be noted that this is not all the dirt, a certain amount escaping the muslin mesh. The finer particles passing through constitute what may be termed "sediment" and will be considered later.

To show the bacterial contamination by means of manure the content of fresh and old cow-dung was estimated. All these samples were taken in winter, when the cows were indoors.

Fresh Manure, which had only lain in the cowshed for 1 or 2 hours :—

		Agar 37° C. 48 hrs.		Agar 20° C. 4 days.
Sample I.	Bacteria per gram	725,000	..	632,000
Sample II.	,,	3,500,000	..	2,373,000
Sample III.	,,	8,430,000	..	5,063,000
Sample IV.	,,	1,258,000	..	693,000

Samples I. and IV. were from cows fed on hay only, the others, II. and III., were from cows having oats and oilcake, and show that the more highly nitrogenous the food the higher the number of bacteria voided.

Old Manure, cut off from the hardened faeces sticking to the udder and side of legs of the cows :—

	Agar 37° C. 48 hrs.	Agar 20° C. 4 days.
Sample I. Bacteria per gram	66,368,000	.. 1,435,000,000
Sample II. ,,	185,000,000	.. 1,235,000,000
Sample III. ,,	13,050,200,000	.. 7,821,200,000
Sample IV. ,,	8,649,300,000	.. 3,743,590,000

The fresh manure samples contained from 632,000 to 5,063,000 bacteria per gram, while the old manure contained from 1,235,000,000 to 7,821,000,000 per gram, taking the growth at 20° C.

The manure adhering to the hair of the cow is kept warm and the organisms finding the temperature favourable multiply rapidly. Seldom if ever does fresh manure gain entrance to the milk pail; it is the old manure containing an enormous number of organisms which enters the milk and causes pollution.

If we calculate the amount of contamination when 2 grams of manure containing 1,235,000,000 organisms (the smallest of the above counts) is mixed with 12 gallons or 54 litres of milk, as in the above case, there is found to be added 22,870 per cc. organisms per cc. of milk. Fortunately the large pieces of manure are removed by straining before they are all dissolved in the milk, but part undoubtedly is dissolved and grossly pollutes the fluid.

At this point it seems well to remark that in the minds of some farmers there is a mistaken idea in regard to straining and the manurial pollution. The writer remonstrated with farmers on two occasions for having their milk disgustingly polluted with manure, large particles of which were floating on the top of the milk in the milk pail. The one said, " Oh, we use the ' Ulax ' filter, it removes everything," and the other " We use three strainers to remove it." They are not aware that these filters, however efficient they may be for removing particles of dirt, cannot remove the bacteria previously washed out of the manure, the coarse debris and vegetable particles only being kept back. The above experiments show the importance of excluding excrement from the milk. This can easily be done by grooming the cows and washing the udders afterwards.

To show the effect of such treatment on the bacterial content of the milk, some experiments were undertaken upon a herd of cows kept in one cowshed. Before proceeding to describe these, however, a passing reference may be made to the work of two foreign observers, Willem and Miele. After taking the minutest precautions these workers were able to obtain milk containing from 2 to 5 organisms per cc., the milk being drawn in the usual way. The milking was done in a special place which was kept aseptic. Great care was taken with the cows which had the udders and teats washed with soap and boiled water, or with an antiseptic solution.

It is difficult to believe that even with the greatest precautions such favourable results can always be obtained. Certainly with most of the cows dealt with here which gave high bacterial counts even in the strippings, drawn directly into a flask, it would be impossible. The two cows H. and L., which were young and had recently calved, might give results approaching the above, but even in their case there is doubt.

In the present investigation the object in view has not been to obtain milk as free as possible from bacteria, but to determine what bacterial content one might reasonably expect when the milking is carried out by the farmer using reasonable precautions as to grooming and washing. The details and results of the experiments may be stated as follows :—

1. Five cows had their udders dry brushed and washed and left moist, and the foremilk was rejected. The samples of the milk were found to contain the numbers of bacteria noted below :—

	Agar 37° C.	Agar 20° C.
Cow I. ..	480 per cc.	.. 320 per cc.
Cow II. ..	580 ,,	.. 640 ,,
Cow III. ..	280 ,,	.. 680 ,,
Cow VI. ..	340 ,,	.. 370 ,,
Cow VII. ..	420 ,,	.. 350 ,,
	Average ..	472

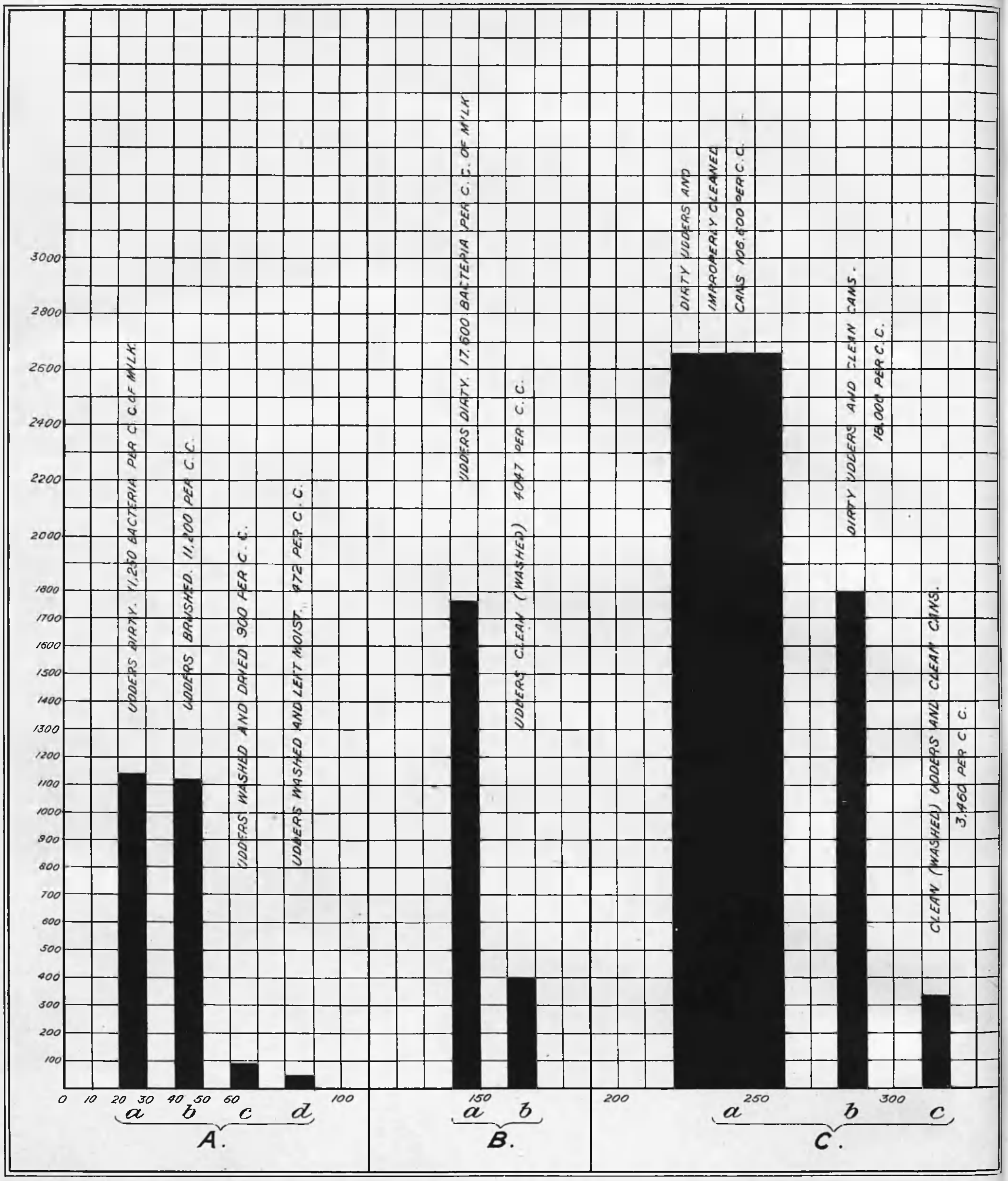


CHART II.

A. Average Bacterial Content of Milk from single cows. Cans all sterilized by steam.

(*a*) Udders dirty.
(*b*) Udders dry brushed.
(*c*) Udders washed and dried.
(*d*) Udders washed and left moist.

B. Average Bacterial Content of Milk from whole herds of ten cows. Cans steamed.

(*a*) Udders dirty.
(*b*) Udders washed.

C. Experiment at a Cowshed showing the effect of dirty cans and dirty udders on the Bacterial Content of the Milk.

(*a*) Dirty udders and improperly cleaned cans.
(*b*) Dirty udders; cans sterilized by steam.
(*c*) Clean (washed) udders and clean cans.

2. The milk from three cows whose udders had been washed and thoroughly dried contained :—

		Agar 37° C.		Agar 20° C.
Cow A.	..	800 per cc.	..	700 per cc.
Cow B.	..	750 ,,	..	1,000 ,,
Cow V.	..	650 ,,	..	1,000 ,,
		Average	..	900

3. Three cows had their udders dry brushed and their milk gave the following counts :—

		Agar 37° C.		Agar 20° C.
Cow IX.	..	6,400 per cc.	..	—
Cow X.	..	2,900 ,,	..	—
Cow IV.	..	9,500 ,,	..	11,200 per cc.

4. Two cows were left dirty, and the milk gave :—

		Agar 37° C.		Agar 20° C.
Cow VIII.	..	13,300 per cc.	..	10,700 per cc.
Cow C.	..	8,500 ,,	..	11,800 ,,
		Average	..	11,250

5. The mixed milk of the rest of the uncleaned cows in the same cowshed gave :—

Agar 37° C.	Agar 20° C.
14,500 per cc.	17,600 per cc.

NOTE.—The milk pails were all sterilized by steam.

It is apparent from the above results that the milk from cows which have their udders washed and left moist gives the lowest count, and contrasts favourably, especially with the count of milk from cows left dirty. Dry brushing does not give such a marked result. If we compare the average of the results of washed cows, viz., 472, with that of the results of the dirty cows, viz., 11,250, it is found to be about 24 times less, which is very striking.

These results are similar to those obtained by Russell, who, in a single experiment, found that when the udder of a cow was cleaned and left moist, the content of the milk was 330 bacteria per cc., while that of the milk from the mixed herd was 15,500.

A similar improvement is seen in the sediment content of the milk. Four estimations from the unstrained milk of dirty and clean cows were made, with the following results :—

			Dirty.		Washed.
Cow A.	volumes per million		70	..	10
Cow B.	,,	,,	80	..	10
Cow C.	,,	,,	80	..	7.5
Cow D.	,,	,,	60	..	7.5
Average		,,	72.5		8.7

Taking the average of these, we find that when the udders are not cleaned, the amount of dirt gaining access to the milk is about 8.3 times that entering when the udders are cleaned. In passing, it may be stated that the numbers of coliform organisms and of streptococci in the milk are less, when the udders are cleaned, but a fuller consideration of these organisms will be found at page 61.

The last experiment of this series was made with the mixed milk of all the 10 cows in the cowshed, all the udders having been washed. Counts were made on three successive days, and were as follows :—

		Agar 37° C.		Agar 20° C.
1st day	..	2,800 per cc.	..	4,130 per cc.
2nd ,,	..	2,900 ,,	..	4,600 ,,
3rd ,,	..	2,300 ,,	..	3,460 ,,
		Average	..	4,047

On the first day, the 10 cows were washed by two men in half an hour, but on the other two days, one man did the work in half an hour himself, owing to his being pushed for time, with about the same results on the one day, and better results on the other day. It is important to note that the operation of washing was carried out as mentioned in the plate experiments and was done by the ordinary cowmen at the farm, without any supervision, the men being told what to do and then left to themselves. The milk remained in the cowshed until all cows were milked, and the cans and pails were sterilized as usual by steam. These experiments show that, with care in the sterilization of the cans and washing of the udders, much can be done to reduce the bacterial content of the milk at the farm.

Park, taking similar precautions as to cleanliness and washing, obtained a similar number, 4,333, as the average of six estimations of the mixed milk from an entire herd.

The covered milk-pail has also been recommended to prevent some of the contamination from the udder. The cover is provided with a small opening about six inches in diameter, through which the milk passes into the pail, and in which may be placed a strainer of linen, flannel or sterile cotton wool. Conn states that the covered pail keeps out about 66 per cent. of the dirt which gains entrance to the ordinary wide-mouthed pail in general use.

(2) MILKER.—The usual routine in milking is for the milker to come from the field or other duty, and without preparation to sit down to milk. If he washes his hands at all he rarely does so thoroughly. If the hands are dirty the friction in milking detaches the bacteria, which fall into the milk below. The writer saw two men come from the field, where they were leading manure, and without preparation sit down to milk with very dirty hands and clothes. In very few cases are overalls used by the milker, though these prevent him from contaminating the milk with particles from his garments, which are usually dust-laden and often very much so.

In one instance, where a man had thoroughly washed his hands, and had donned a clean overall, during milking he blew his nose with his fingers, wiped them on the leg of his filthy trousers, underneath the overall, and then continued milking. Such instances of carelessness or perhaps, as these acts were performed in the writer's presence, ignorance, are not isolated cases. The following case may be quoted as an additional example of ignorance and carelessness. The writer and an inspector visited a farm for samples, and the farmer, on getting a sixpence for two small samples, spat on the coin in his hand, for luck, and then started milking again. This case was all the more important as the man was a wet milker. In addition to being disgusting, serious disease could be transmitted in this way. In only very few cowsheds are facilities in the shape of wash-basins and clean towels provided for the washing of the milkers' hands.

In 51 cases the hands of the milkers were reported as clean, 5 as having been washed; in 8 cases the hands were fairly clean; and in 16 cases the hands were shown to be dirty. In 8 cases the clothes of the milkers were reported as dirty, and in only one instance were overalls used.

So-called " Wet Milking" should never be allowed. It is a source of contamination, and the process is often disgusting to look at. The milker usually wets his hands in the milk which he first draws from the teats, and often the fingers are dipped in the milk during milking. If the hands are not thoroughly washed to begin with, he contaminates the milk in this way. During the milking process also the hands often come in contact with the milk issuing from the teat. In " dry-milking " such does not occur. Although the influence of " wet milking " on the bacterial content of the samples of milk cannot be pointed out, owing to the impossibility of excluding other contaminating factors, an idea of the pollution may be formed from the description of an example of " wet milking " given by an inspector who saw the operation when taking a sample at a cowshed. " A female milker kept dipping her fingers in the milk, which, along with the excreta on the teats caused her hands to look as though they had been dipped in treacle—they were filthy." The author has seen two exactly similar cases. Throughout the investigation six cases of wet milking have been noted. Sometimes vaseline is used as a lubricant in wet-milking, as in one case reported; but this does not prevent the milk passing on to the hands during milking, and unless both teats and hands are thoroughly clean contamination still takes place. All wet milking is objectionable, since not only is the contamination from the teats and udders likely to be increased, but the entry of infectious matters of various kinds from the hands of the milker will be facilitated and the possibility of the transmission of infectious diseases in this way cannot be overlooked.

(3) AIR OF COWSHED.—The air of a cowshed almost inevitably contains large numbers of bacteria derived from the animals and the fodder. Plates containing agar, were exposed in cowsheds for five minutes during milking with the following results, the numbers being calculated as falling on the surface of a twelve inch pail. At the end of 96 hours at 20° C. the numbers noted were found on the plates.

A	..	3,456 and 3,600.
B	..	4,500.
C	..	3,375 and 4,185
D	..	1,260
E	..	2,068 and 2,700

It is almost impossible to distinguish between the contamination due to the air and that due to the animal during the process of milking, as the dust particles from the animals pass through the air to the milk pail. Before and after milking, however, the air alone contaminates. The number of bacteria in the air at any one time varies according to the disturbances of the air, and the distribution of dust.

In many cowsheds it is customary to throw down hay to the cows just before milking. The dry dust from the hay, which is heavily laden with bacteria, is disturbed and distributed about the cowshed, and so leads to contamination of the milk. Harrison has carried out some experiments showing the increase in the number of bacteria owing to the disturbance of the dust during bedding. His results are interesting, and may be quoted. The number of bacteria deposited per minute on a surface equal to a twelve inch pail is shown. In series A the exposure was made during bedding; in B exposure was made an hour after.

SERIES A.									
16,000	..	13,536	..	12,216	..	12,890	..	15,340
19,200	..	23,400	..	27,342	..	42,750	..	18,730
SERIES B.									
438	..	610	..	820	..	715	..	1,880
2,112	..	1,650	..	990	..	1,342	..	2,370

The same may occur in the case of the shaking up of hay in feeding.

Although the contamination from the air cannot be avoided, it may be lessened by a little forethought in regard to feeding, and by taking the milk as soon as possible out of the cowshed to a properly constructed place or dairy, where the bacteria are fewer. The cows should be fed from a half to one hour before milking, or the hay should be put into the mangers a similar time before the cows are brought in for milking. The usual plan of keeping the milk standing in the cowshed until all the cows are milked is bad. At one cowshed, although the dairy is only 25 yards distant, the farmer has constructed a low wooden stand upon which the milk pails are placed and retained uncovered until half a dozen are filled, when all are carried to the dairy. During all this time, before and after the pails are filled, the organisms from the air are entering the vessels. With a little extra trouble the pails could be transferred directly after milking to the purer atmosphere of the dairy.

The influence of bad lighting and ventilation as affecting the bacterial content of the milk has already been considered. It would appear that with bad lighting and bad ventilation there is also bad management and a dirty condition of the cows, etc., influencing the bacterial content of the milk.

It is interesting to note that in the cowsheds where the air bacteria were counted, the lighting and ventilation were good. In Shed D, the provisions for lighting and ventilation were of the best description.

Carnelly, Haldane, and Anderson have shown that there is an enormous increase of bacteria in crowded and ill-ventilated places for human habitation, and it is reasonable to suppose that the same is true with regard to cowsheds. The results obtained in the experiment in the well-ventilated cowshed D tend rather to support this opinion.

To prevent this air contamination in the cowshed, it has been suggested that milking should be done always in the open air. In connection with this suggestion, the following experiments are interesting and important. Some plates were exposed in an open field 50 yards from the farm buildings to show the contamination which might take place there as compared with that in the cowshed. Again the numbers of bacteria have been calculated as falling on a twelve-inch milk pail. The plates were incubated at 20° C. for 96 hours.

A. (1) 5 mins. exposure,	18,		B. (1) 5 mins. exposure,	9.
(2) ½ hour's ,,	72.		(2) ½ hour's ,,	45.

The air is not such an important source of contamination if we calculate the number of organisms per cc. of milk. Suppose 4,500 organisms, the highest in the above experiments, fall on to a milk pail every 5 minutes, and suppose during the milking of two gallons the pail is open to the air for 20 minutes, calculating 2 gallons equal to 9 litres, the contamination due to the air amounts to only 2 organisms per cc.

For comparison with the results obtained in the cowshed, agar plates were placed in dairies or places specially built for keeping the cans at the farm, and after incubation at 20° C. for 96 hours, gave the following results:—

A. 720. B. 630. C. 180. D. 270.

A and B had coarse whitewashed walls, and C and D had glazed brick walls, which were regularly washed down. When compared with the above results in the cowshed, it is seen that it is desirable to keep the cans in a properly appointed place. Where the dairy is regularly washed every day and the atmosphere kept moist, the number of organisms is much less as in C and D. The marked contrast between the bacterial content of the air in the cowshed and that in the dairy is well seen in the photographs.

The writer is of opinion from these experiments that not much is to be gained by milking in the field. Labour is saved in milking in the cowshed, and if precautions are taken during milking not to disturb the dust by feeding, to keep the cans and pails outside the cowshed as much as possible, and to take the milk out of the cowshed as soon as drawn, to a suitable dairy or milk store, the contamination can be greatly reduced, and need only be a few organisms per cc., and these usually harmless air organisms.

(4) MILK PAILS AND RAILWAY CANS.*—These also are a fruitful source of contamination of the milk, the cans probably to a greater extent than the pails, owing to the smaller size of the latter and the ease with which they may be cleansed. In summer, more than in winter, these receptacles are responsible for contamination, the heat favouring multiplication of the organisms in the dregs always left behind in the vessels after the milk has been poured out by the retailer.

In seven instances, Nos. 17, 18, 19, 21, 22, 23 and 66 in the table, the cans were sterilized by steam, and the milk obtained from these showed great similarity in bacterial content.

17	..	27,300 per cc.	22	..	17,000 per cc.
18	..	27,250 ,,	23	..	26,000 ,,
19	..	17,800 ,,	66	..	62,000 ,,
21	..	27,000 ,,			

Samples 17 to 23 were obtained during the warmer months, while 66, which shows a greater number of organisms, was obtained in mid-winter. This comparatively high count may be due to the fact that at this cowshed the udders were in a dirty condition.

The similarity in bacterial content is apparently due to the method of cleaning the cans, the efficiency of which is constant. These samples show markedly the effect of steam sterilization in keeping the bacterial content low while the cows remain in the same condition of uncleanliness. In No. 66, while the method of cleaning the cans was the same, the pollution from the udders was increased, due to the cows living inside. The cans here were all sterilized by the dairymen, who sent back the cleaned cans to the farmer. In no cowshed was there any provision for sterilization by steam.

In all the other cases the cans were said to have been scalded. Scalding is, however, rarely properly carried out. A usual method is to pour into a large 16 gallon churn a pailful of what is called boiling, but what is usually only tepid water, which is thus suddenly cooled and which is usually poured from the vessel before there has been any prolonged action of the heat on the bacteria.

Often there is no provision for boiling sufficient water in a boiler ; and when a boiler exists, it is not always used for this purpose. The water has often to be obtained from the small kitchen boiler or kettle, which yields a quantity quite inadequate for the purpose of sterilization. The result of this is great carelessness in the cleaning of the cans, as in one instance where a single pailful of boiling water from a kitchen boiler was used for " scalding " four large cans successively. In another instance the water was got from the hot water system of the house, and although it was alleged that the water was boiling, and the cans were scalded, it was admitted that it was always possible to keep the hands in it without inconvenience. The temperature of the water in this case was probably not above 50° C. Such instances show how inefficiently the sterilization of the cans is carried out. The great irregularity of the results compared with those in which steam was used, show that the cleansing process is not constant in efficiency.

Two samples of souring milk taken from the bottom of the cans returned to the farmer during the summer gave 292,000,000 and 348,000,000 organisms per cc., and show to what a great extent badly cleaned cans may be a source of contamination. Four cans which had been " scalded " by the farmer and which were ready to receive the milk, were each washed out with 100 cc. of sterile water, and the number of organisms in 1 cc. of this water was, in one 48,000, in another 2,325,000, in a third 19,960,000, and in a fourth 605,000. Specimen 1, which shows the best results, was obtained from a can in a town cowshed where the cans were filled with actually boiling water, containing soda, and allowed to steep for half an hour. Specimens 2, 3 and 4 were from cans simply washed with so-called boiling water. The former is the best method to adopt when steam is not obtainable.

The following are the results of similar estimations made with the washings of cans which had been sterilized by steam at dairies, before being sent to the farmer :—

No. 1	..	24,000 per cc.
No. 2	..	12,900 ,,
No. 3	..	303 ,,
No. 4	..	140 ,,
No. 5	..	100 ,,

* The writer has not seen used in England any wooden barrels for carrying milk. These, however, are quite common in the West of Scotland. Such are much more difficult to clean than metal churns, and their use should not be encouraged.

These results show the great number of bacteria which are added to milk through improper cleaning, and show the superiority of steam over the other methods. Harrison has carried out a series of experiments showing the difference markedly. He rinsed out the cans with 100 cc. sterile water and then estimated the number of organisms per cc. of this water, as in the above estimations.

Series A. 10 samples were examined from cans improperly cleaned, and gave from 215,000 to 806,320 per cc.

Series B. 10 samples from cans cleaned by washing with tepid water and scalding, gave from 13,080 to 93,400 per cc.

Series C. 5 samples from cans cleaned by washing with tepid water and then steaming for 5 minutes gave from 355 to 1,792 per cc.

As will be seen later in dealing with the coliform organisms, dirty cans are a common source of contamination with these.

It is a common practice to wipe out cans after they have been scalded with a cloth which is kept lying about in a moist and often dirty condition. As in the cloth the organisms are growing with great rapidity during the intervals of use, any cleansing of the cans which has resulted from scalding is undone to a certain extent during the wiping out process. Another practice is to wash out the cans with cold water which is sometimes, in country farms, got from a suspicious source. In one sample received (No. 65), this water contamination was evidenced in the milk by the presence of B. fluorescens liquefaciens and B. violaceus.

In many cowsheds there is no proper place for keeping cans and pails. They may be kept in the scullery, in the wash-house, in a grain store, or in the cowshed itself, in all of which places they are exposed, from the time of cleaning in the morning till the afternoon milking, to the organisms of the air and to bacteria-laden dust. Still, in some there are excellent places or dairies built of glazed bricks, etc., for storing cans and pails. In one case the cans, it was found, were stored in a cowshed and two of the number were polluted with bird droppings and feathers. In another case, a milk cooler was contaminated by bird droppings through being kept in a grain store. On the farmer's attention being directed to this, he carefully removed the faecal matter from the cooler with his thumb, wiped his thumb on his trousers, and without further cleansing poured the milk over the same surface and then proceeded to milk without washing his hands. This is an extraordinary instance of carelessness and ignorance in a trade concerned with the supply of an important food stuff.

If cans and pails were kept mouth down after cleaning, much good would result, as in this way all falling bacteria would be prevented from entering them, and the water in which the organisms multiply would run off. This is especially important, as these vessels usually remain many hours before being used, and all this time are open to contamination by the organisms from the air and in some cases, possibly, by dust.

Another point that may be mentioned here is the treatment of the farmer's churns by the dairyman. The dairyman usually sends back the churns after he has emptied them without any treatment whatever. In the small quantity of milk usually left in the churns the bacteria multiply rapidly, especially in summer, and when the churns reach the farmer, they may contain an enormous number of bacteria as in the two instances mentioned above. Since they are undoubtedly a source of great contamination, it is essential that the dairyman should thoroughly cleanse the churns before returning them to the farmer, who should again clean them. The samples from the "steamed" cans mentioned above were got from vessels treated in this way by the dairyman before being sent back to the farmer.

(5) MILK COOLERS.—Especially if kept or used in dirty or dusty places, coolers may prove a source of contamination, and experiments were carried out to determine the extent to which they are responsible. The contamination takes place through the organisms of the air and dust falling on the milk during its passage over the cooler. It will be understood, of course, that the surface of milk exposed, being large, the maximum contamination from the air is permitted. The apparatus is usually cleaned after the morning or afternoon milking, and remains for many hours with its surface exposed to the air organisms which must to a great extent contaminate its surface, and later be washed into the milk.

The number of organisms falling on the surface will depend on the bacterial content of the air, and, as the air experiments already quoted show, the contamination will be greater in the cowshed than in the dairy. The cleaner the dairy and the greater the amount of moisture in the atmosphere, the smaller will be the number of organisms.

In the following experiments the mixed milk in each case was sampled before and after passing over the cooler, with the following results.

Experiment.	Condition of milk.	Agar 37° C. for 48 hrs.	Gelatine 20° C. for 96 hrs.	Relative numbers of	
				Liquefiers.	Non-Liquefiers.
A.	Not cooled	36,000	43,000	1	8.5
	Cooled ..	53,000	78,000	1	7
B.	Not cooled	12,000	14,600	0	12
	Cooled ..	31,000	129,000	1	5.6
C.	Not cooled ..	20,000	25,500	1	17
	Cooled ..	32,500	49,000	1	9
D.	Not cooled ..	37,750	76,000	?	?
	Cooled ..	77,000	162,000	?	?

The type of cooler in use and the conditions obtaining in each case were as follows :—

A. Cylindrical cooler kept in a clean dairy with the air moist.

B. Corrugated perpendicular cooler (Lawrence), kept between milkings in a very dirty and dusty grain store. When in use it hangs on the wall outside in a dusty yard, where, if the wind is blowing at all strongly, the dust from the main roadway 5 yards away is blown on to it.

C. Lawrence cooler hung outside the cowshed and directly over a courtyard gully, which was in a bad condition. Courtyard clean and pavement wet.

D. Lawrence cooler used in a dirty cowshed.

These experiments show conclusively that coolers may act as contaminators.

The increase in the number of bacteria, it will be noted, is least in the clean dairy and in the open air, experiments A and C, where the number of bacteria is almost doubled, and greatest in experiment B, where the cooler had been stored in a very dusty place and used in another dusty place, and in experiment D, where the cooler was stored and used in the cowshed.

Much of this contamination might be avoided if coolers were kept and used in a proper milk place or dairy, and all were made with covers as they sometimes are, or if not, were simply covered with sterile cloths (cheese-cloths) when not in use.

It will be noticed that the number of organisms growing at 20° C. is higher after cooling in all cases, and especially so in B, where the number growing at 20° C. is four times greater than the number at 37° C. The number of liquefiers is also increased in all cases. The explanation is that the bulk of the organisms were derived from the air, the organisms of which grow more readily at low temperatures, a great number of these being liquefiers.

It has been suggested that placing the churns in running cold water will cool the milk sufficiently and prevent this air contamination. This, however, it has been found, is a poor method of cooling. To get satisfactory results, owing to the bulk of the milk to be cooled, iced-water must be used, and the cans must remain in it for some time.

(6) MILKING MACHINES.—The results which might be expected to follow the use of milking machines are prevention of contamination from the udder, the air and the milker and the production of a milk containing few bacteria. Experiments performed during the course of this investigation, however, prove that milk so obtained contains a large number of bacteria. Two of the best modern milking machines were under observation, and on two occasions samples of the milk drawn by each machine were examined. The following results are the results obtained :—

		Agar 37° C.		Agar 20° C.
Machine A.—1	..	133,000 per cc.	..	172,500 per cc.
2	..	308,000 ,,	..	494,000 ,,
Machine B.—1	..	1,000,000 ,,	..	1,392,000 ,,
2	..	842,000 ,,	..	986,000 ,,

These results place the samples in the last column of the main table and amongst the worst specimens of milk. B 1 is worse than any other sample of milk examined, and B 2 is not much below the worst. The bacterial content of A 2 and B 2 are only exceeded by one sample.

These results show the machine to be a source of great contamination. The reasons for the pollution are mainly first, the difficulty in cleaning, and secondly, the sucking in of air and dust when the cups fall off. The difficulty in cleaning is due to the amount of tubing, especially rubber tubing, which in one machine reaches a length of several yards, and in the other of several feet. The machine is cleaned by running first strong soda water through all the tubing and apparatus, and then washing thoroughly with tepid water. Hot water, of course cannot be used, and certainly not steam, both being liable to destroy the rubber. The tepid water employed is incapable of killing the organisms in the tubes, and the apparatus stands from after the morning till the evening milking, during which time organisms in the water in the tubes are multiplying and are ready to contaminate the new milk passing through.

When the cups fall off the teats the bacteria-laden air is sucked into the tubes and contaminates the milk. There is no means of preventing the cups from falling on to the cowshed floor, as they sometimes do, and the suction being continuous, manurial dust, which is very rich in bacteria, is drawn into the apparatus.

The machines observed have been given the best chance possible, as the owners are expert farmers, and the cleaning is carried out in the dairy by experienced dairymaids. In both cases the cans were thoroughly cleaned, the cows groomed and the cowsheds excellent, so that the milking machine can alone be blamed for the very high bacterial content of the milk produced.

Such disappointing results might possibly be avoided if tubing could be used through which steam might be passed, and if the cups had check-valves to prevent the sucking in of air and dust at the moment the cups fall off the teats.

CONSIDERATION OF SOURCES OF CONTAMINATION.

It may be concluded from these experiments that the chief sources of contamination of milk at the cowshed are the cans and udders, the former acting chiefly in the warmer months, and the latter in the colder months when the cows live indoors. The effect of these two factors is seen best in the following striking practical example, which shows how efficient sterilization of the cans and the cleaning of the udders can influence the bacterial content of the milk from a whole cowshed.

At first, in the beginning of June, when the cows under observation were kept outside, the bacterial content of the milk was found to be 106,600 per cc. Then attention was called to the milk pails and cans, which were steamed and cleaned efficiently; the result was that at the end of June, the bacterial content was reduced to 61,000 per cc. Afterwards, attention was called to the udders of the cows which were dry rubbed, and to the hands of the milkers, with the result that the number was further reduced to 13,800 per cc. in the middle of July, and in November, when the cows were indoors, the number rose to 18,000. After washing the udders of the cows when still indoors, the bacterial content of the whole supply fell to 3,460 per cc. (C., Chart II.).

The milk having been produced with reasonable care and cleanliness by the ordinary cowmen, this count 3,460 per cc. may be taken as a standard for purposes of comparison with those of the milks examined. Comparing with it the best and worst in each column, in group A, the best, it will be noted is about a half greater, while the worst is about four times as great; in group B, the best is about $4\frac{3}{4}$ times and the worst about $13\frac{1}{2}$ times; in group C, the best is about $17\frac{1}{4}$ times and the worst is $28\frac{1}{4}$ times; and in group D, the best is about 31 times and the worst about 302 times as great.

Thus, in the whole 73 samples, 10.9 per cent. were increased from $\frac{1}{2}$ to 4 times the standard; 46.5 per cent. from $5\frac{1}{2}$ times to $13\frac{1}{2}$ times; 21.9 per cent. from $17\frac{1}{4}$ times to $28\frac{1}{4}$ times; and 20.5 per cent. from 31 to 302 times the standard. These figures and the foregoing experiments demonstrate how grossly the milk is contaminated at the cowshed, and justify the use of the terms good, fair, bad and very bad.

Leighton, from his experiments, concludes " that the number of bacteria per cubic centimetre in a given sample of milk forms an absolute indicator, by which the care and cleanliness to which the product has been subjected, from the time it is drawn to its delivery into the hands of the analyst, may be determined."

The writer's opinion based on these experiments coincides with that of Leighton, if the words " when it leaves the cowshed " are substituted for " from the time it is drawn to its delivery into the hands of the analyst." If all milk were kept in refrigerators from the time it leaves the cowshed, or if the milk was produced near to the place of sale, Leighton's dictum would hold absolutely, but where temperature and time are at work, the total bacterial content loses its value as an indicator, as a milk produced with care and cleanliness, but exposed to the influence of these factors will come to resemble, owing to multiplication of the organisms, one produced under the reverse conditions.

Russell states that the mixed milk of a herd that is kept with any reasonable degree of cleanliness, if examined immediately after it is milked, usually will not contain more than 5,000 to 20,000 germs per cc. Grotenfeld says that milk from cows well cared for and carefully milked will, as a rule, contain hardly more than 1,000 to 6,000. The experiments noted above show that milk containing less than 5,000 can, with the exercise of reasonable care and cleanliness, easily be obtained.

From these results the writer thinks it justifiable to propose for milk leaving the cowshed a standard of 50,000 bacteria per cc., which is a very fair one indeed. A bacterial count above this is the result of uncleanly methods of production. With such a standard, which allows of a pollution fourteen times what need occur with ordinary care, 42.4 per cent. of the samples taken at the cowshed might be condemned as grossly contaminated.

2. RAILWAY STATION.

Samples were taken from the milk cans at the railway stations, not immediately on arrival, but when received by the dairyman, and before he had interfered with them in any way. In this way it was hoped to estimate the maximum contamination occurring during railway transit, and while the milk was in the hands of the railway companies. The milk churn was always shaken before the sample was taken. In Tables II. in addition to the results of the bacterial estimations of these station samples, the temperature of the air and the temperature of the milk at the time of taking each sample, the temperature of the milk when it left the cowshed, and the percentage increase or decrease in the content of the milk since its departure from the cowshed will be found. A decrease is represented by a prefixed negative sign. Whether or not the milk was cooled at the cowshed is also indicated. The numbers of organisms per cc. range from 19,800 to 3,620,000; the average in the cold months being 131,500, and in the warm months, 309,500 per cc. These compare favourably with the numbers obtained by Hewlett and Barton, who examined the milk arriving at the various stations in London, and found the numbers to vary from 20,000 to 8,390,000.

In 5 out of 34 samples, there is found to be a decrease of from 2.4 to 60.5 per cent. The remaining 29 show an increase ranging from 1 to 525 per cent. The samples which show a decrease, numbers 14, 40, 42, 52 and 61, when taken, had temperatures from 17° to 7.5° C., and the times of transit varied from 2 to $13\frac{1}{4}$ hours. The three showing the greatest reduction in numbers, 60.5, 58.1, and 32.4 per cent. were on the way, 4, $13\frac{1}{4}$ and 13 hours respectively. The temperatures of these samples were 17° C., 9° C. and 7.5° C. The two showing least reduction, Nos. 14 and 40, had temperatures of 15° and 17°, and the duration of transit was 3 hours in the former and 2 hours in the latter. The milk from which samples 42 and 52 were taken left the cowshed at temperatures of 29° C. and 34° C., so that in transit, cooling took place, the temperatures of the air being 15° C. and 8° C. These show markedly, though unintentionally, the beneficial effects of cooling. In the samples numbered 12, 19, 44, 45, 48, 65 and 66, although the temperature of the milk in each case was under 17°, there is an increase varying from 4.1 per cent. to 558.4 per cent. Of these samples, two, 12 and 44, had each a temperature of 15° C., during a transit, the former of $1\frac{3}{4}$ hours, and the latter of $7\frac{1}{2}$ hours. The others had temperatures below 13° C. The remainder of the samples with a temperature over 20° C. show very irregular results when the action of time and temperature are considered.

Conn and Esten, who have carefully experimented with milk in relation to temperature, assert that usually no increase, but rather a reduction in the number of organisms takes place in milk for 6 hours after milking when kept at 20° C., and for 36 hours when kept at 13° C., while at 37° C. this period is very short, usually under 2 hours. If their conclusions are correct, then the percentages of increase in Nos. 12, 19, 45, 48, 54, 65 and 66 must be due to organisms entering during transit. Although thus stated in general terms, there are many variations in the results of the experiments by these observers. Also, though it is found that this period of inhibition becomes shorter as the temperature rises from 21° C. to 37° C., no accurate observations of its length have been made at temperatures between these two.

FIGURE 1.

Represents an Agar Plate which was held beneath the dirty udder for two minutes during milking, and showed 5,000 colonies after incubation at 20° C. for 96 hours. (Winter Experiment, cows inside). Each colony represents one organism originally falling on the plate.

FIGURE 2.

Agar Plate treated similarly, but udder had been dry brushed, showed 2,400 colonies. (Winter Experiment, cows inside).

FIGURE 3.

Agar Plate, treated similarly, but beneath dirty udder in summer when cows were out, showed 512 colonies. (Summer Experiment.)

FIGURE 4.

Agar Plate, treated in the same manner, but after udder had been washed, showed 260 colonies. (Winter Experiment, cows inside).

FIGURE 5.

Agar Plate which had been exposed to the air in the cowshed for two minutes, after incubation showed 150 colonies.

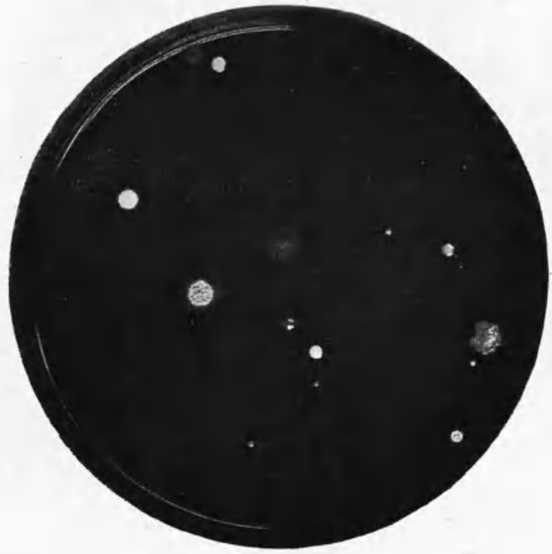


FIGURE 6.

Agar Plate exposed in a dairy or proper place for storing cans and milk at the cowshed for two minutes. 17 colonies.

FIGURE 7.

Agar Plate showing the number of colonies growing after inoculation with 1/20 cc. of milk from a dirty cow, 520 colonies. Milk contained 1,120 bacteria per cc.

FIGURE 8.

Agar Plate showing the number in 1/20 cc. of milk from a cow whose udder was washed, 19 colonies; 370 bacteria per cc.

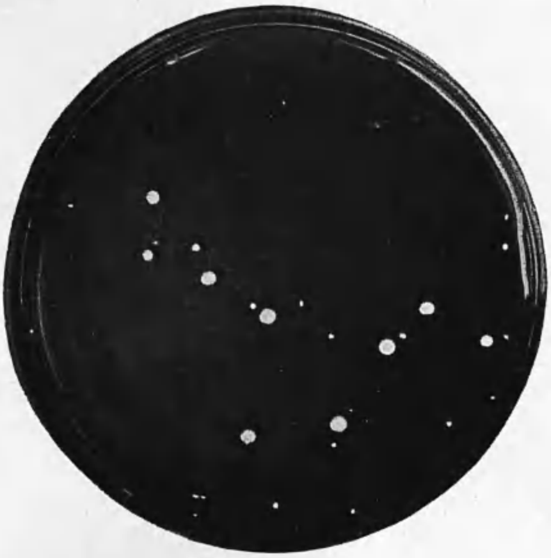


FIGURE 9.

Agar Plate showing the number of bacteria in 1/2,000 cc. of a sample of milk to which the term "fair" may be applied. 30 colonies, 50,000 bacteria per cc.

FIGURE 10.

Agar Plate showing the number in 1/2,000 cc. of a "very bad" milk. 126 colonies, 252,000 bacteria per cc.

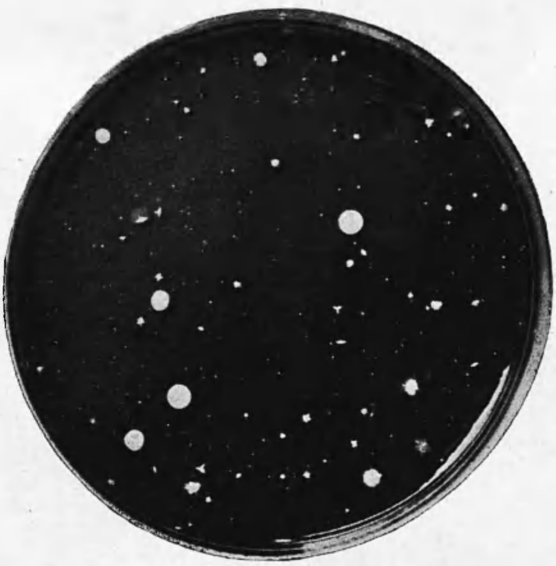


FIGURE 11.

Agar Plate showing the number in 1/2,000 cc. of milk drawn by a milking machine. 540 colonies, 986,000 bacteria per cc.

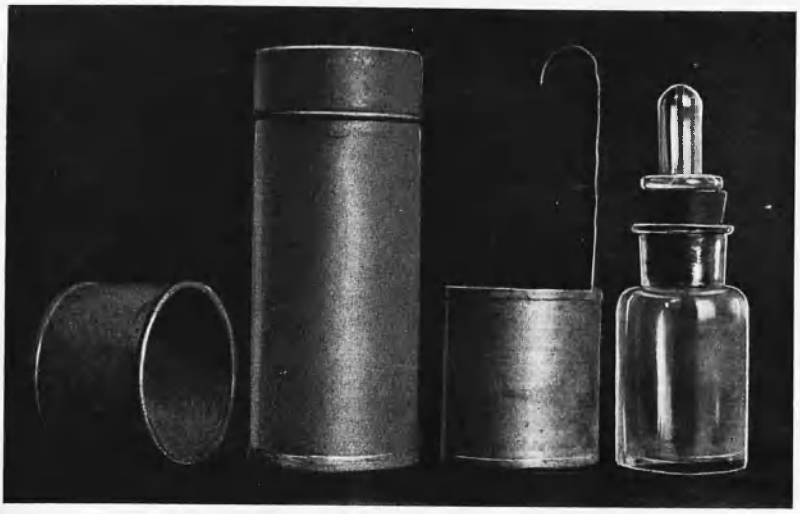


FIGURE 12.

Shows Delépine's sampling apparatus with author's bottle which has a rubber stopper with a glass centre piece.

FIGURE 13.

Shows the amount of desposit in the milk drawn from a dirty cow, .08 cc., or 80 volumes per milllon, and that from a clean (washed) cow, .0075 cc., or 7.5 volumes per million.

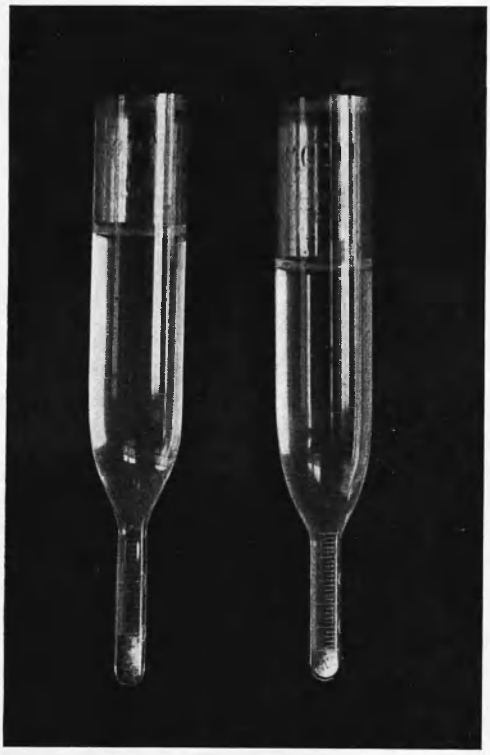


FIGURE 14.

Gives an example of the amount ot sediment in the milk at the cowshed and the amount in the same milk when retailed. A marked diminution is shown, .09 cc. or 90 volumes per million at the cowshed, and .05 cc. or 50 volumes when retailed. The amount here is very large in the cowshed milk.

FIGURE 15.

Shows the number of colonies growing on an Agar Plate which was exposed on the station platform, where milk is emptied out, for 5 minutes, 188 colonies.

FIGURE 16.

Shows the number growing on Agar Plate exposed in retailer's premises for 5 minutes, 14 colonies.

FIGURE 17.

Shows number after exposure for 5 minutes in a consumer's house, 55 colonies.

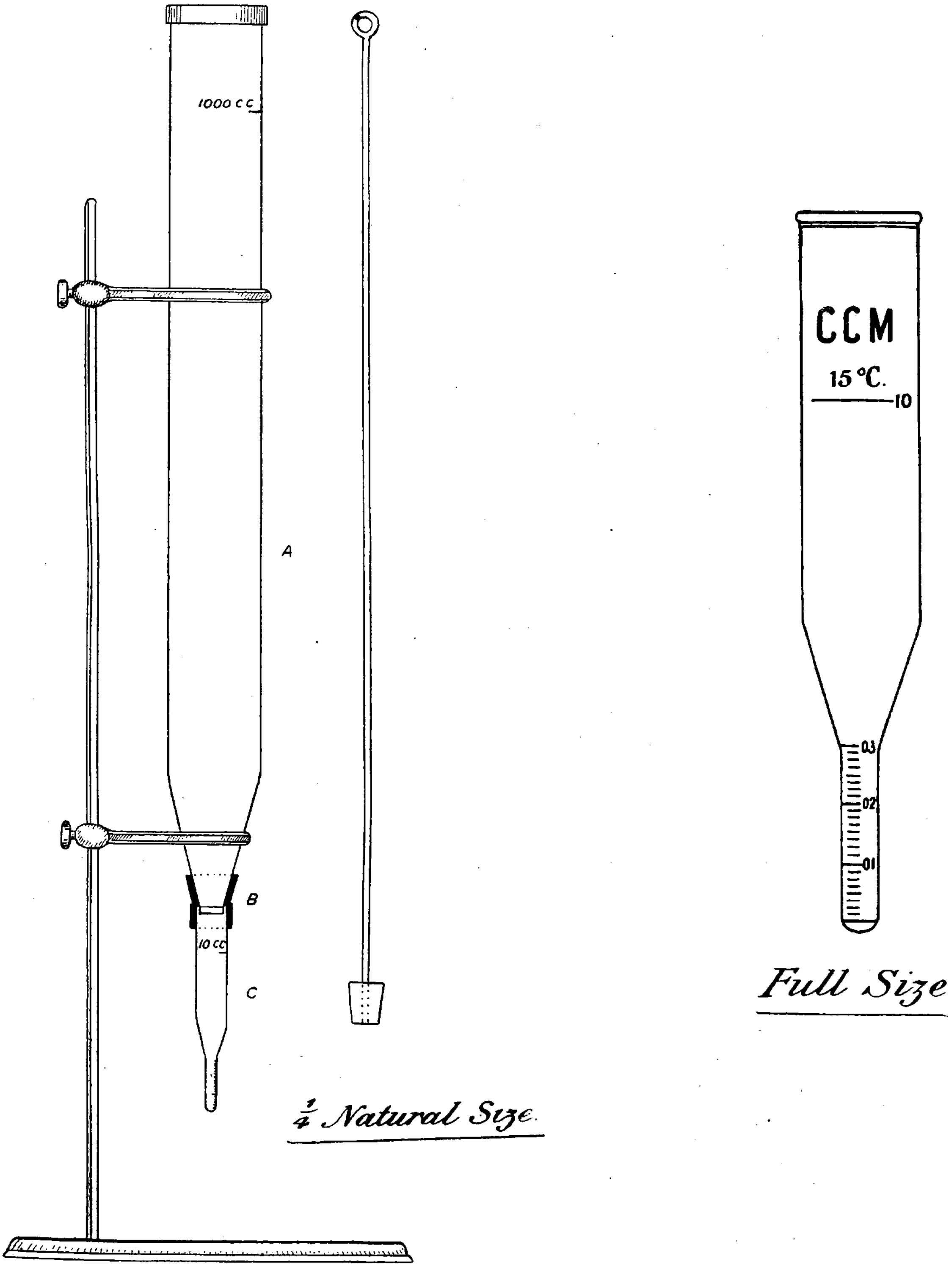


FIGURE 18.

APPARATUS FOR SEDIMENT ESTIMATION.

A = Glass Tube holding a litre of milk.

C = Tube for measuring sediment.

B = Rubber Tubing connecting A and C.

At the side is represented a brass rod, with rubber stopper attached, for plugging the lower end of tube A, when C is taken off.

There is also shown a full size sketch of the tube C which is graduated in 1/10 ths and 1/100 ths of a cc.

TABLE II.

Showing the bacterial content of the RAILWAY STATION Samples, &c.

No.	Bacteria per cc.	Per cent. Increase over Cowshed Sample.	Temperature when taken of Air	and Milk.	Temperature of Milk at Cowshed.	Distance travelled.	Hours in transit.	Cooling at Cowshed.
12	77,000	81.6	11°	15°	16°	15 miles	1¾ hours	yes
13	294,000	151.2	12°	25°	31°	10 ,,	2 ,,	,,
14	21,000	−9.8*	9°	15°	17°	21 ,,	3 ,,	no
15	56,950	51.8	18°	30°	34°	7 ,,	¾ ,,	,,
16	46,000	31.4	12°	26°	29°	17 miles	1 hour	no
17	84,160	208.2	14°	21°	28°	12 ,,	3 ,,	,,
18	28,800	5.6	11°	21°	21°	17 ,,	1¼ ,,	yes, churns put in water
19	29,900	68	8.5°	9.°	11°	8 ,,	1 ,,	yes
20	32,300	1.7	10°	23°	25°	8 miles	2½ hours	no
22	53,160	212.7	10°	24°	28°	12 ,,	2¾ ,,	,,
25	19,800	178.8	16°	26°	32°	15 ,,	2 ,,	,,
27	73,600	343.3	15.5°	24°	28°	16 ,,	2 ,,	,,
33	440,000	128.8	28°	26°	32°	34 miles	2¼ hours	yes
37	3,620,000	245.4	12°	22°	22°	10½ ,,	1½ ,,	,,
40	125,800	−2.4	12.5°	17°	17¼°	8½ ,,	2 ,,	,,
41	83,000	3.1	14.5°	30°	34°	20 ,,	1 ,,	no
42	130,300	−60.5	15°	17°	29°	30 miles	4 hours	yes, churns put in water
43	215,000	497.2	13.5°	28°	34°	7 ,,	2¼ ,,	no
44	537,000	558.4	17°	15°	21°	64 ,,	7½ ,,	yes
45	206,500	525.7	12°	12°	12.5°	100 ,,	13 ,,	,,
48	78,000	16.4	10°	12°	15°	47 miles	11¾ hours	yes
49	201,300	20.2	9.5°	29°	33°	9 ,,	1¾ ,,	no
52	57,500	−58.1	8°	9°	34°	28 ,,	13¼ ,,	,,
54	34,000	20.1	14°	13°	14°	38 ,,	15 ,,	yes
55	124,000	42.5	12.5°	22.5°	29°	4 miles	¾ hours	no
56	194,600	274.2	12°	20°	37°	10 ,,	1½ ,,	,,
57	33,500	67.5	13°	32°	30°	30 ,,	4 ,,	,,
61	106,000	−32.4	6°	7.5°	19°	38 ,,	13 ,,	yes
62	90,000	45.1	6°	21°	28°	22 miles	1¾ hours	no
65	202,000	4.1	7°	8°	8.5°	115 ,,	12¼ ,,	yes
66	129,000	106	5.5°	11°	25°	35 ,,	3 ,,	no
69	134,000	36.7	.5°	24°	31°	24 ,,	2¼ ,,	,,
70	242,000	108.6	10.5°	29°	34°	14 miles	1¾ hours	no
71	108,000	1	4.5°	24°	31°	12 ,,	1¾ ,,	,,
	232,600 per cc. average.							

* Minus signs show a decrease.

Freudenreich fails to confirm Conn and Esten's results, having found that the multiplication, at least in some samples, takes place much earlier. For example, one specimen of milk kept at 15° C., which was examined regularly during the 24 hours immediately following milking, gave the following results :—

Shortly after milking	..	9,000 per cc.
1 hour ,, ,,	..	31,750 ,,
2 hours ,, ,,	..	36,250 ,,
4 hours ,, ,,	..	40,000 ,,

In another instance the following were the figures :—

Drawn at 15.5°	.. ..	27,000 per cc.
4 hours ,,	.. ..	34,000 ,,
9 hours ,,	.. ..	100,000 ,,
24 hours ,,	.. ..	4,000,000 ,,

An example given by Conn shows a similar early multiplication :—

Milk drawn at 15° C.	..	153,000 per cc.
After 1 hour ,,	..	616,000 ,,
,, 2 hours ,,	..	539,000 ,,
,, 4 hours ,,	..	680,000 ,,
,, 7 hours ,,	..	1,020,000 ,,

Two examples may be given from Conn and Esten (Rock. Inst. Reprints, 1905) showing in the one an increase, and in the other a decrease after 6 hours incubation at 20° C.

Increase.		Decrease.	
2 hrs. at 20° C. ..	39,000 per cc.	0 hrs. at 20° C. ..	29,000 per cc.
6 ,, ,, ..	64,000 ,,	6 ,, ,, ..	21,000 ,,
12 ,, ,, ..	12,000,000 ,,	12 ,, ,, ..	920,000 ,,
18 ,, ,, ..	14,000,000 ,,	18 ,, ,, ..	2,100,000 ,,

The species and numbers of bacteria in milk being so variable, it is difficult to say definitely that in all samples of milk the organisms will be inhibited for a certain definite time. Some organisms grow more readily than others, and the delay in the increase in numbers may be due to the fact that some of the bacteria entering the milk find it at first an unsuitable medium and require time therefore to become acclimatized. Some, indeed, may die off at first, which would account for the reduction in numbers often observed after the milk has been kept a short time. This reduction is due to the so-called " bactericidal action " of the milk. If organisms, which have been growing in milk, are added by means of imperfectly cleaned cans, it is reasonable to suppose that they will begin to multiply more readily in the medium to which they are accustomed. The experiments of Coplans tend to prove this. He inoculated fresh milk with a culture of bacillus coli, which had been grown in fresh milk, and found that the period of inhibition, or what he calls latency, is less than that found when a culture of bacillus coli grown in broth is used. The samples of milk used by Conn and Esten were obtained from a dealer who kept his dairy in an exceptionally good condition, and the milk furnished was above the average. Here contamination by unclean cans would be prevented, organisms accustomed to milk being kept out, so that in most of their experiments the results are fairly constant so far as inhibition for a certain time is concerned. In reality, however, despite the number of examples examined, Conn and Esten made only one experiment, varying practically not at all, since supplied always from the same dairy. The samples taken in the present investigation were obtained from sources where contamination from the badly cleaned cans was almost a feature. Hence many organisms which, it is suggested, are milk bacteria, and capable of rapid growth, would be added.

The experiments of Freudenreich and of Conn quoted above show that the time of inhibition is not constant.

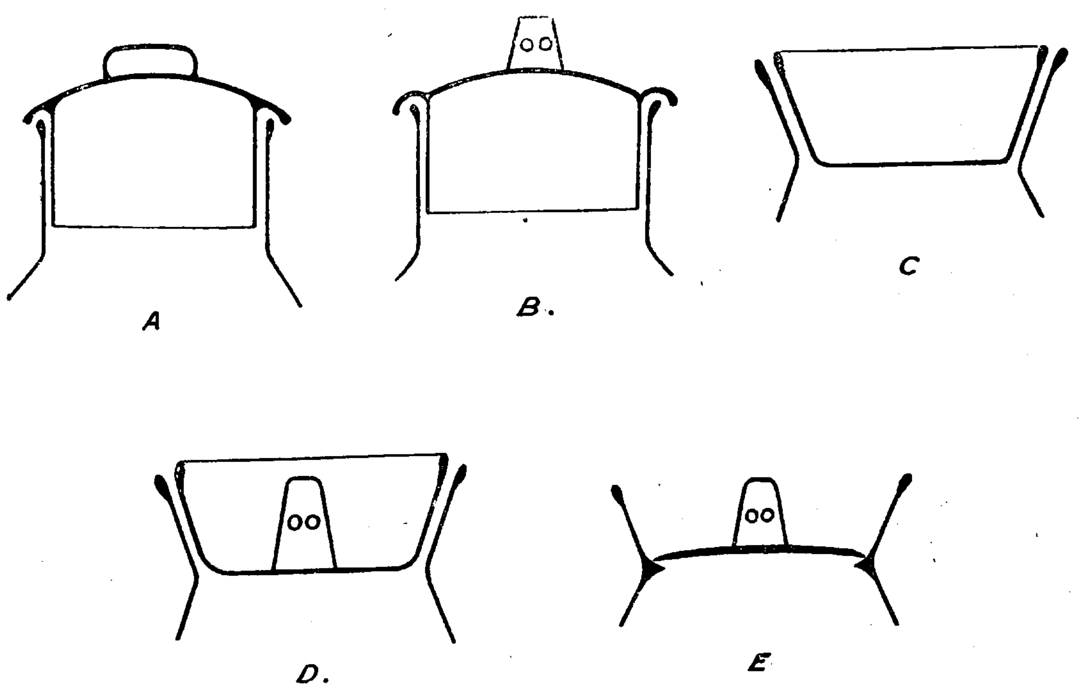
Owing to the absence of accurate knowledge regarding the bactericidal action (if any) of milk, its incidence and duration, it is difficult to say how much of the bacterial increase is due to multiplication of what may be called the original organisms, and how much to added ones.

Without great labour and the expenditure of a great amount of time, it was impossible to determine how much of the increase was due to extraneous organisms during the railway journey. No attempt was made to do so, and in considering the counts, no distinction is made, all organisms simply being enumerated. The subject of contamination during the railway journey will be discussed later when dealing with the total contamination when the milk reaches the consumer.

At this point, nevertheless, it is convenient to refer to the modes of contamination and the factors likely to influence the bacterial content of the milk during transit. These factors may be classified and considered in the following order:—

(1) The milk can or churn.
(2) Railway vans.
(3) Storage at railway stations.
(4) The mode of transference adopted by the dairyman.
(5) The temperature.
(6) The time of transit.

(1) THE MILK CAN OR CHURN.—Particular attention has been given during the investigation to the cans used and sketches have been made of as many as 45 railway milk churns. There seemed to be considerable variation, especially in the form of lid employed, of which there appeared to be five patterns in common use. Of the 45 sketched, 8 per cent. had lids which were rainproof and had no ventilating holes (fig. A) and 13.3 per cent. had rainproof lids with ventilating holes (B). In 6.6 per cent. the lid was funnel shaped and without ventilating holes (C), in 33.3 per cent. a funnel shaped lid with ventilating holes was used (D), while 37.7 per cent. had simple lids with or without ventilating holes (E). The lids lettered A and B in the figure are the best, being capable of preventing the contamination of the rim of the churn and the entrance of rain to which the cans are often exposed. The second type of lid has numerous holes in it, ostensibly for the ventilation of the milk-churn, but serving mainly for the entrance of contaminating materials. The objections to the various kinds are that rain has access round the edges, and that in the third and fourth types contamination of the rim of the churn by those handling it is possible. The latter is particularly objectionable since over this rim the milk is poured into the distribution cans.



The fourth type of lid is similar to the third except that it is provided with ventilating holes, but the fifth type is the most objectionable. The lid is simply a circular piece of metal which fits into and rests upon a projecting rim round the inside of the neck of the churn. The funnel shaped neck of the churn is quite unprotected. It is the part grasped by the men handling the cans, and also the surface over which the milk flows from the can into other receptacles. As the persons working with the churns rarely wash their hands, which are often very dirty, and usually spit upon their palms before touching the cans, the chances of the milk escaping uninjured are slight. Than this, a lid more calculated to allow contamination of the milk could not possibly be designed. Dust accumulates in the funnel shaped portion and either falls past the margin of the lid, which generally fits badly, or is washed off with the milk discharged from the cans. It is quite common for the milk to wash up over the rim lid during handling, and to take up the dust on the top in the process. During wet weather, any dust which escapes being washed in by the milk in this way is carried into the can by the rain.

Of all the lids, 46.6 per cent. had ventilating holes. The use of such lids may be due to the mistaken idea that the free circulation of air prevents souring of the milk. This idea has probably originated from the fact that when milk sours in a closed can the odour is more intense than in a ventilated one, owing to the concentration of the odorous gases. It is questionable if ventilation has any effect on the growth of the organisms, while the holes in the lid allow the entrance of dust and absorbable vapours.

Contamination may occur with any of the lids in consequence of the absence of fastenings, and the exposure of the milk to pilfering during transit. In no instance was a churn locked. Apparently milk producers are not aware of the fact that the railway companies do not object to the locking or sealing of milk churns.* It would be infinitely better if the tare weight of all churns was stamped on them by the makers and if the quantity of milk were ascertained by weight. This weighing would avoid the necessity for measuring out the milk in the station, the objections to which are referred to later.

On two occasions it was reported that there were used churns, one of type 2, and one of type 5, which were old, rusty, and dirty looking, and totally unfit to carry milk.

(2) RAILWAY VANS.—Refrigerator vans are not used at all in connection with the milk supply of the districts concerned in this investigation, nor, according to Lister, in any other part of the country.

In only one instance during the present enquiry was milk carried in a van reserved for milk traffic only, and this only for part of the distance to be travelled. Here milk journeyed from Derbyshire to Hull, and by the special van as far as Doncaster only. This van and another running from Leeds to Sheffield once daily, are the only special vans used for carrying milk in the whole districts dealt with in this report. In all other cases, the ordinary luggage vans, which are usually badly ventilated and close in summer, were used for the milk transportation. The vans as a rule contained a miscellaneous collection of luggage, parcels, and dead meat. In one case a crate of live pigeons, in another a dog, and in another a quantity of fish accompanied the milk. In this last case the van was very dirty.

An Inspector reported in one instance that the van was full of people, some of whom were sitting on the lids of the cans, a practice which is common enough, but which might be a source of dangerous pollution, especially when so many defective lids are used. So many persons were in this van that the air, according to the Inspector, was foul. As is well known, luggage vans are usually not over clean, and are apt to be dusty. In dealing with luggage, also clouds of dust are apt to be raised, which settles upon the tops of the churns, to drop into the milk through defective lids or to be washed off by the contents of the cans on pouring out An Inspector reported that " a porter swept out a van, raising clouds of dust while the churns were in it, and the lids defective." The lids here were of the worst type, and badly fitted.

(3) STORAGE AT RAILWAY STATIONS.—As a rule, no special place is provided at railway stations for receiving or keeping churns. Usually they are simply placed on the platform exposed sometimes to the sun and always to dust. It is certain that milk is not treated by the railway servants as it ought to be as a food. Not the least care is taken in its handling, and churns are often stored in places where clouds of dust are raised by the traffic. At a certain station, there are to be seen regularly churns arranged round an iron urinal, exposed to the foul odours which may emanate from it.

Sometimes churns of milk arrive late in the evening and are kept overnight exposed on the station platform. This is a practice which should not be allowed. Either the dairyman ought to receive them or the railway authorities ought to store them in proper places where they are not exposed to contamination from dust, to the action of variations in temperature or to pilfering. Out of the 34 railway samples, three were taken from cans which had stood overnight in a station, in this way. These were all taken in the colder part of the year, so that the influence on them of temperature is not seen.

Owing to the uncertainty as to the extent of the contamination of the samples, it is impossible to say if any or all of the above three factors have been acting in any one case.

* In Leaflet (No. 110) issued by the Board of Agriculture and Fisheries, are given the results of enquiries regarding the locking or fastening of milk cans. In reply to an enquiry by the Board of Trade the Secretary of the Railway Companies' Association states : " The railway companies have considered the question, and I am requested to inform you with reference to the statement made in the letter from the Board of Agriculture, that senders have for a long time been allowed to send milk in sealed cans, the companies accept the declaration of the senders as to the quantity conveyed, no extra charge being made ; the only condition the companies require to be fulfilled is that the tare weight of the cans shall be stamped upon the outside of the can, so that in case of doubt the quantity of milk within the churn can be approximately ascertained by allowing $10\frac{1}{4}$ lbs. for each gallon of milk declared. It does not appear to the companies that there is any difficulty in the senders protecting themselves against alleged loss of milk in transit by sealing, padlocking, or otherwise fastening their cans."

Again he says : " The companies do not make any difference in the charges when sealed cans are used."

All farmers may procure this Leaflet free of charge from the Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W.

(4) MODE OF TRANSFERENCE BY DAIRYMAN.—In 14 out of 34 deliveries at railway stations, the churns were taken straight to the dairy and there transferred. Obviously this is the best method. In 16 the churns were emptied in bulk at or in the neighbourhood of the station in places which were often in a dirty and dusty condition. In four the milk was transferred by measuring. This last procedure, which could be avoided by weighing, is apt to result in much contamination. The dairyman usually measures out the milk by means of a quart or half-gallon measure into his own can from the farmer's, and in doing so has to insert his arm into the mouth of the milk vessel. As is usual with these dairymen, the sleeves are unprotected and often very dirty. While transferring the milk in bulk or by measure it is contaminated, more or less, with the bacteria in the air which are very abundant in this situation, and possibly also by dust. Plates were put down in the stations at places where the milk was transferred from the churns, and gave the following results during an exposure of five minutes, calculated as falling on the mouth of a 9 inch churn. Plates incubated at 20° C. for 96 hours.

A.	Station roadway where churns left	952
B.	Centre of station „ „	324
C.	Station roadway „ „	617
D.	Centre of platform „ „	233

These estimations show the number of organisms which may gain entrance when milk is being poured from one can into another at the station. The risk would be lessened by taking the milk for transference to the dairy where bacteria are fewer. These counts also show the number of organisms falling on the lids and remaining to be washed off by the milk when poured out. Much good would result and pollution be prevented if the railway companies provided special places with tiled walls, which could be easily kept clean and free from dust, for the storage of empty and full churns, and for use in connection with the milk traffic generally.

Sometimes the milk is sieved again on transference at the station. In this way a large surface is for a considerable time exposed to pollution, by bacteria from the air and dust. On one occasion a dairyman at a station was observed to strain the milk through muslin which he afterwards picked up and wrung out with his dirty hands into the main bulk of newly strained milk. This was not due to ignorance. The man was an unscrupulous individual. He looked round to see that no one was looking before he did it, and when he was watched on another occasion did not repeat the wringing. This is another example of the want of concern for the consumer. For a few drops of milk he was willing to contaminate the whole bulk of it.

All the experience gained in this investigation goes to show that by the use on railway churns of proper lids, which are dust and air proof; by the provision of clean vans for the carriage of milk only; and by the provision of proper storage places at the stations, contamination during transit could be prevented almost entirely.

The combined action of temperature and time can be more conveniently discussed under the section on the Dairy.

3. STREET.

Samples were taken from retailers' cans in the street. The procedure adopted was as follows:—At the railway stations the Inspectors saw the retailer get the churns from which the samples were previously taken, and asked him if the milk was mixed with any other, and also what part of the town he supplied. The Inspectors then left him, and later went to the district where the retailer supplied milk, and there obtained a sample as it was being retailed in the usual way.

In all the towns there is very much more milk supplied in the street than from dairies. The usual method of delivery is by a small hand can from which the milk is served by a dipper which usually hangs inside the can. The can is usually replenished from a much larger can, on a cart or trolley, from which the milk may be drawn from a tap, or from the top by dipping in a large measure. By this method the milk is usually delivered very rapidly, as the milk immediately after receipt is taken round by the dairyman, or retailer, and is then not exposed long to contamination or to the influence of temperature. In no case was bottled milk examined, this only being supplied by one or two large dairy companies.

The bacterial counts of the samples are given in Table III. with the temperature of the air and of the milk at the time of taking, the hours in transit from cowshed to the time of sampling, and the percentage increase or decrease. The number of organisms varies from 11,750 to 3,200,000 per cc., the average being 222,060 per cc. The percentage increase varies from 2.7 to 5,233, or $52\frac{1}{3}$ times the original amount. In three there is a decrease of –40.1, –18.4 and –5.8 per cent. In these cases the temperatures were 18.5°, 15° and 21°, and the times of transit $1\frac{1}{2}$, 4 and $2\frac{1}{2}$ hours respectively, showing the effect of low temperatures acting for a short time in inhibiting the growth and causing the death of some of the contained organisms.

A great irregularity in the station samples in regard to the relationship of temperature, time and percentage increase or decrease has been noted. The same remarks as regards the amount of increase due to the effect of temperature and to added organisms, apply here as in the case of the station samples.

To estimate the contamination of milk occurring during its delivery in the street is a very difficult matter. One could never, practically, imitate the progress of the milk during its retail with a can sealed to prevent further contamination, and so discover the increase occurring as a result of pollution. The subject of contamination in these samples will be discussed later.

The factors influencing the bacterial content of the milk during delivery in the street are :—

(1) The form of the small delivery can and large churn.
(2) The condition of the cans.
(3) The cleanliness of persons.
(4) Cooling.

(1) FORM OF THE HAND CAN AND CHURN.—The small hand can is usually of good construction with a hinged lid overlapping at the margin. The dipper used for measuring the milk is hung in the inside of the can with the handle protruding from the top. In this position, when not in use, it escapes contamination by dust and organisms. If care is taken not to unduly expose the milk to the air, and especially to blowing dust during distribution, it is difficult to see how much contamination can take place. Some small delivery cans are provided with taps from which the milk is run off into a measure. The measure here is usually hung on the outside, exposed to all contamination. Between the two forms there is little to choose, the one contaminating the milk by the open lid, and the other by the measure.

The large churn is usually kept in a cart or on a trolley, and from this the milk is transferred to the small delivery can, through a tap or by means of a large dipping measure introduced at the top, a practice which is objectionable unless the arm coverings are clean.

In two cases the cans and cart were reported as dirty. One only out of a great many examined on trolleys was found to be rusty and very dirty, and quite unfit for use as a milk vessel.

With regard to the lids, what has been said in dealing with railway churns applies equally here. All forms of lids are commonly seen. Here again we get contamination by dust, and if the lid is defective and of a bad form, rain is even more likely to gain entrance to the can which is usually exposed to the weather openly in the street.

(2) CONDITION OF THE CHURNS.—Contamination may take place from imperfectly cleaned cans, in the same way as at the cowshed. But the dairyman is more alive to the importance of cleanliness of milk vessels, and he finds it pays to see that they are thoroughly cleaned, as his milk keeps better. The farmer cannot appreciate the need for efficient sterilization in the same way as the dairyman, who suffers in his pocket through neglect. Still there is required greater uniformity of method and more general application of steam. To show the contamination occurring in the dairyman's churns and to provide a comparison with that in the churns of the farmer, some of the vessels were rinsed with 100 cc. of sterile water and the number of bacteria in 1 cc. of this estimated as in the former experiments. These samples were taken just before the milk was emptied into the cans, and without previous warning to the dairyman. As in the former case, the experiments were made during August and September. Three samples were taken at railway stations and one at a dairy. The following are the results obtained:—

	Agar 37° C. for 48 hrs.		Agar 20° C for 96 hrs.
I.	8,500	..	5,600 per cc.
II.	5,600	..	13,000 ,,
III.	93,500	..	123,600 ,,
IV.	40,300	..	50,300 ,,

The cans in all four cases, it was found, had been scalded with boiling water and soda.

The samples from the churns sterilized by steam, already quoted for comparison under Cowshed, were also from dairies.

A comparison of these results with those obtained previously bear out the contention that the cleaning of milk vessels is more efficiently carried out by the dairymen than by the farmers. The small cans and earthenware dairy bowls are usually also cleaned with boiling water and soda. These, because smaller in size, are more likely to be efficiently sterilized.

TABLE III.

Showing bacterial content of samples taken in the STREET.

No.	Bacteria per cc.	Per cent. Increase over Cowshed Sample.	Temperature when taken of Air	and Milk.	Temperature of Milk at Cowshed.	Hours in transit.	Cooling.
1	14,700	8.8	6°	14.5°	24.5°	2¼	no
2	13,416	-40.1	9°	18.5°	31°	1½	,,
3	15,000	165	12°	22.5°	26°	1½	,,
4	11,750	3.7	4.5°	22	23.5°	1½	,,
5	34,660	302	9.5°	14.5°	22° C.	¾	no
6	28,250 (Agar)	2.7	10°	27°	36° C.	1	,,
8	26,580	431	7°	23°	28° C.	1	,,
10	40,500	18.8	4.5°	14.5°	21° C.	2	,,
11	33,730	356	10°	23.5°	26° C.	1½	no
13	236,000	101.7	10°	20°	31° C.	3½	yes
14	19,000	-18.4	8°	15°	17° C.	4	,,
15	59,750	59.3	16°	22°	34° C.	2½	no
20	41,500	30.7	11°	23°	25°	3	no
21	35,000	29.6	9°	16°	21.5°	2	yes
22	21,000	23.5	10°	23°	28°	3½	no
23	27,000	4	14°	28°	30°	1¾	,,
24	81,500	73.4	15°	16°	16°	2¼	yes
25	110,000	1,450	16°	20°	32°	2½	no
26	136,000	540	15°	26°	34°	1¾	,,
27	257,000	1,450	15.5°	22°	28°	3¼	,,
28	59,000 (Agar)	121	9.5°	29°	32°	1¾	no
29	20,500 (Agar)	17	13°	29°	29°	¾	,,
30	3,200,000 (Agar)	5,233	14.5°	17°	34°	3¾	,,
31	244,500	1,900	15.5°	23°	34°	4½	,,
32	1,865,000	2,740	18°	28°	24°	1¾	no
33	660,000	243	18°	26°	32°	2¾	yes
34	103,000	11.4	12.5°	25°	28.5°	2¾	no
35	480,000	1,310	12°	19°	35°	3¼	,,
36	172,500 (Agar)	20.9	15°	13°	13°	2½	yes
37	1,421,000 (Agar)	236	13°	20°	22°	2¼	,,
38	159,000	63.9	14°	23°	30°	¾	yes, churns put in water
39	300,000	105.5	13°	24°	31°	1	no
42	424,000	28.5	13°	16°	29°	16¼	yes, churns put in water
43	uncountable	?	17°	24°	34°	4¼	yes
45	100,600	204	13°	13°	12.5°	18½	,,
46	49,000	65.5	12°	28°	31°	1½	no
48	134,000	100	9.5°	11°	15°	15¾	yes
49	344,000	74.3	11.5°	22°	33°	2¾	no
50	332,300	14.7	9°	20°	20°	½	yes, churns put in water
51	294,300	114	5°	21°	34°	3	no
59	328,000	100	6°	19°	35°	4½	no
62	101,000 (Agar)	62.9	6.5°	16°	28°	3¾	,,
63	26,500 (Agar)	8.1	13°	27°	30°	1	,,
64	63,000	48.9	5°	21.5°	27°	1	,,
68	62,600	-5.8	.5°	21°	32°	2½	no
71	175,000	63.5	5°	15.5°	31°	3¼	,,
72	42,000	82.6	0°	32°	33°	¼	,,
74	34,300	71.5	5.5°	19°	35°	2½	,,
	222,060 per cc. average.						

Although some of the dairymen have excellent places for sterilization and storage of cans, in other cases the provision is quite inadequate. In one instance, where a small quantity of milk is retailed from a small specially built and very clean dairy, there is no provision for sterilization except by means of water from the kitchen kettle. Owing to the small size of the vessels to be sterilized, this defect is less important than if large churns had to be sterilized. The only possible conclusion is that all retailers should have the means for proper sterilization and storage of cans and milk vessels.

(3) THE CLEANLINESS OF PERSONS.—It is refreshing to see at times a retailer with a white jacket, a shining milk churn and a spotless trolley. But such are much fewer than they ought to be. Out of 57 retailers observed, four were very clean, 35 clean, 3 fairly clean, five dirty, and one very dirty. One can readily imagine contamination taking place from the dirty clothes of a careless person retailing milk; but, what is still more important, those who are careless about themselves are likely to be careless about the milk which they handle.

(4) COOLING.—In no case was there any method adopted for cooling the milk in the churns during delivery in summer. A form of churn is now made in which a removable cylindrical chamber is fitted just inside the lid which can be filled with ice during the hot summer months. If such are not used, at least a white cover should be put over the churn to reflect the sun's rays impinging on it.

4. THE RETAILER'S PREMISES.

The samples taken at the retailer's premises were obtained by purchasing, some time after the milk had been exposed for sale. Retailer's premises include any places in which milk is retailed. The bacterial content of the samples, as indicated in Table IV., varied from 33,660 to 3,000,000 per cc., the average being 260,000 per cc. In three, 60, 61, and 65, a decrease in numbers as compared with the cowshed samples is shown. In these, the percentage reductions are 71, 29.5 and 30.9. The temperature in No. 60 was 18° C., and the transit time $2\frac{3}{4}$ hours. The temperatures in the remaining two were 8° and 7.5°, the times of transit being 17 and $13\frac{1}{4}$ hours respectively. These provide striking examples of the beneficial effect of cooling, a reduction occurring despite the fact that the milk was kept many hours. The increase in the other samples varies from 5.9 per cent. to 42,150 per cent., or $421\frac{1}{2}$ times. The relationship between temperature, time, and percentage increase is very irregular, but in some samples the effect of low and high temperatures and the influence of time are readily seen. For instance, sample 25, in transit for $19\frac{1}{2}$ hours at a temperature falling from 32° to 16° C., shows an enormous increase in the number of bacteria 7,100 to 3,000,000 per cc., $421\frac{1}{2}$ times the number found in the cowshed sample. Samples 52 and 54 show very small percentages of increase, 47.2 and 20 per cent., though taken $17\frac{1}{2}$ and 17 hours after the milk left the cowshed. The smallness of the increase is due to the low temperature of the milk, from 11° to 9° in the former, and from 14° to 13° in the latter.

In the retailer's premises the factors influencing the bacterial content of the milk are:—

(*a*) The cleanliness of milk vessels.
(*b*) The cleanliness of persons.
(*c*) The cleanliness of premises (ventilation and contents of place).
(*d*) Covering of the milk vessels.
(*e*) Cooling.

With regard to factors (*a*) and (*b*) it is unnecessary to add anything to what was said when considering the sterilization of milk vessels and the cleanliness of retailers' milk in connection with milk traffic in streets.

(*c*) CLEANLINESS OF PREMISES.—Milk is retailed in a variety of places from the excellent dairies reserved for that food only, to the dingy and dirty shop, or premises of a general dealer, who lives in the back kitchen connected with the shop. Out of 24 dairies from which samples were taken, 11 were places kept for the sale of milk and butter only; and in 13 the premises were used for other purposes in addition to milk selling, four being confectioners' shops, three dining or refreshment rooms, four grocers' or general dealers' stores, one a newspaper shop, and one the living room of a house.

In six of the 13, the shops were combined with dwelling-houses, with which they communicated directly. Thus only 45.8 per cent. were proper places for the sale of milk. The danger of the spread of infectious disease as a result of the communication between the milk store and a dwelling room, apart from any other objection, is sufficient to warrant the discontinuance of such an arrangement.

TABLE IV.

Showing bacterial content of the samples taken at RETAILER'S PREMISES.

No.	Bacteria per cc.	Per cent. Increase over Cowshed Samples.	Temperature when taken of Air	and Milk.	Temperature of Milk at Cowshed.	Hours in Transit.	Cooling.
7	116,000	36.2	8.5°	11.5°	23.5°	3	yes
9	33,660	52	9°	16.5°	17.5°	2¼	no
10	59,580	74.8	11.5°	16.5°	21°	3½	,,
12	81,000	91	16.5°	18°	16°	4¼	yes
16	50,600	44.5	17°	23.5°	29°	2	no
17	135,000	285	13°	20°	28°	4½	,,
18	52,500	92.6	12.5°	19.5°	21°	3	yes
25	3,000,000	42,150	17°	14°	32°	19¼	no
41	102,500	27.3	18°	16.5°	34°	1¾	no
44	771,000	888	15.5°	13.5°	21°	13½	yes
52	53,000	47.2	12.5°	9°	11°	17½	,,
53	92,500 (Agar)	180.3	17°	26°	32°	2¼	no
54	34,000 (Agar)	20	14°	13°	14°	17	yes
55	138,000	58.6	12.5°	13°	22.5°	3	no
56	303,500	483.6	8°	8°	20°	1¾	,,
60	110,000	−71	11°	18°	30°	2¾	,,
61	110,600 (Agar)	−29.5	19°	8°	19°	17	yes
65	134,000	−30.9	7°	7.5°	8.5°	13¼	,,
66	122,000	94.8	6°	9.5°	25°	3¼	no
67	43,000	5.9	17°	26°	31.5°	¾	,,
69	119,000	21.4	5°	16°	31°	4	no
70	241,000	107.7	11.5°	26.5°	34°	2¾	,,
73	43,300	116.5	10.5°	20°	31°	2¼	,,
75	293,000	714	12.5°	10.5°	33°	4	,,
	260,000 average per cc.						

General dealers' and grocers' stores at the best are apt to be dusty, and unfortunately the persons of this class selling milk in addition to other articles, are small shopkeepers in the poorer districts who keep neither themselves nor their shops clean. Of the 24 retailers' premises, eight were found to be very clean, 14 clean, one dirty and two very dirty. The means of ventilation in these premises were as follows :—Six were ventilated by a fan-light or air grate over the door, 11 were ventilated by the door only when open, and six by the door and window. When the shop communicates with a house, currents of air from the dwelling are apt to pass into the premises. In the case in which the milk was kept in the living room of a dwelling house, there was no ventilation whatever.

(*d*) COVERING OF MILK VESSELS.—When milk is allowed to stand uncovered in dairies, contamination will take place from the organisms of the air and dust. Pollution from this source is all the more important as the exigencies of the trade frequently require that the milk in these places shall stand exposed for a considerable time. The vessels used in dairies are usually small cans or earthenware bowls holding a few gallons. The cans usually have lids, but covers are not so often used for the bowls. Of the dairy samples, 11 were taken from receptacles which were covered, one being covered with cardboard, another with a wooden board and the others with metal covers. In 10 no covering whatever was used, and concerning the remaining three, no note was taken.

To show the contamination occurring from air organisms in uncovered vessels, plates were exposed in four dairies for half an hour, and gave the following results. Plates at 20° C. for 96 hours. Bacteria calculated as falling on a 12 inch can.

Dairy	A	..	909 bacteria.
,,	B	..	792 ,,
,,	C	..	990 ,,
,,	D	..	900 ,,

In Dairies A, B and D milk alone was kept, but in C, which shows the highest number, bread, butter, sweets, etc., were also sold.

To show the effect of the retailer's premises as a source of pollution, further experiments were carried out. A sample of milk was taken in a sterile bottle from a certain vessel in a dairy and kept for a variable number of hours on the counter in a wire cage, which was locked, near the milk from which it was obtained. During the time of exposure, the milk from which the sample had been taken was sold and dealt with by the retailer in the usual way, covered or uncovered. After some time, another sample was taken from the milk which was exposed for sale, and this with the control sample in the cage was put into an ice box at once and transmitted for examination. The control sample had thus been kept at the same temperature as the milk in the vessel, but *not exposed to contamination*, so that the added organisms could be estimated by comparing the results of the two samples. Eleven such experiments were carried out with the results shown in Table V. In four cases the receptacles were covered, and in three of these the number of bacteria in each sample was less than the control sample, while in the fourth there was a slight increase of 6.5 per cent. In one sample which was uncovered, there was a slight decrease, but it had only remained in the dairy for an hour and a half, which is a comparatively short exposure. The others all show an increase varying from 5 per cent. to 107.2 per cent. That a varying amount of contamination does take place in the dairy, and that it can be largely avoided by using covers for the milk vessels, is clear. The average increase in all is 22.7. This is the percentage increase due to contamination in the retailer's premises. Great stress, however, cannot be put on this average owing to the small number of experiments and to the great differences in the results in the various experiments. Nevertheless, it is useful for comparison.

In this connection it is to be borne in mind that flies may be a source of contamination, when the vessels are uncovered. These were not very numerous during the summer and autumn of 1907, as a matter of fact only in two dairies were they noted, and then only in small numbers.

(*e*) COOLING.—Only in one dairy was a refrigerator used, and in this the milk was stored during the summer. During the hot weather, in all the other dairies, no attempt was made to inhibit the action of the high temperature in encouraging the multiplication of the bacteria. The necessity for this is shown by samples 56 and 67. Two samples of each milk were taken, one was examined at once and the other was left in a sterile bottle in the dairy for a certain number of hours, to show the effect of the dairy temperature on the milk independent of contamination.

No. 56.	303,000 per cc. in the original sample.	.. after 16 hours at 18° C. ..	increased to 4,120,000 per cc.
No. 67.	43,000 per cc. in the original sample.	.. after 17½ hours at 5° C...	decreased to 41,000 per cc.

These results show markedly the effect of cooling.

Cooling to be of much value must be efficiently carried out. Two milks, 61 and 65, which were cooled at the cowshed to 19° and 8.5° C. respectively, and which were reduced later to 8° and 7.5° C. showed, when sampled 17 and 13½ hours after leaving the cowshed, a reduction in the number of organisms. Other marked examples of the effect of low temperature on the bacterial content are seen in Table VIII., in which are represented various samples which have been kept at different temperatures. The effect of the low temperature during the cold months, and of the high temperature in the warm months on all the milk in its transit from the cowshed to the consumer is shown on Chart III., page 40. In the following table of Freudenreich's the ratios of increase of bacteria in milk at different temperatures and at different times are well brought out.

The very small multiplication at 15° C. and the great increase at 35° C. are especially to be noted.

	0 hrs.	3 hrs.	6 hrs.	9 hrs.	24 hrs.
15° C.	1 ..	1 ..	2.5 ..	5 ..	163
25° C.	1 ..	2 ..	18.5 ..	107 ..	62,100
35° C.	1 ..	4 ..	1,290 ..	3,800 ..	5,370

Other observers, *e.g.*, Park, and Conn and Esten, have also shown the marked effect of temperature and time.

As already stated, after the milk has been drawn the bacteria present may undergo a reduction in numbers, due, it is supposed, to the so-called bactericidal action of the milk. Again, it has been pointed out that there is an interval after milking, during which there is little or no increase in number of bacteria. The length of this interval depends entirely upon the temperature to which the milk is exposed, being short when it is high, and long when it is low.

Obviously, therefore, by reducing the temperature of milk immediately after it leaves the cow, and by keeping it at a low temperature, the bacterial content can be kept down. The lower the temperature the greater will be the check on multiplication. Experiments performed by Conn and Esten show that when milk is kept at 20° C. the bacteria usually do not begin to multiply for 6 hours, but when kept at 13° C. not for 36 hours. After about 48 hours at this latter temperature the number of bacteria increases, but even after 50 hours the milk contains no more than the number found after 18 hours at 20° C.

It might be pointed out here that the higher the temperature the more readily do the glucose fermenting bacteria multiply. The members of this group readily cause souring and curdling of the milk, and on the whole are most undesirable organisms. Delépine has shown the influence of temperature and time in increasing the toxicity of milk when inoculated into animals, and the importance of the cooling of milk. On all grounds it is practically essential to cool the milk immediately after milking to below 13° C., and preferably to 10° C. To get this temperature in summer, ice is usually necessary for cooling the water which passes through the cooler. Park recommends that the temperature be lowered to 45° F. or 7.2° C.

After the cooled milk leaves the cowshed it may be exposed to a high temperature in summer, and if the time of transit be long, the cooling by the farmer may be slowly undone. For this reason the lower temperature recommended by Park is preferable.

Happily the most of the milk travels in the cool part of the day, and is not so liable to be affected by very high temperatures during transit.

Under the headings Retailer's Premises and Street, the necessity for cooling has already been pointed out. So important have they found cooling in America, that in 1904 the Boston Board of Health introduced a regulation requiring market milk to be kept below 50° F. or 10° C.

This temperature regulation becomes more useful when combined with a regulation regarding bacterial content. A temperature standard alone is no guarantee that a milk is good, since a milk swarming with bacteria may be as readily cooled as any other. The maximum content allowed in Boston is 500,000 per cc.

Much good would result if a temperature standard of 10° C. were adopted in this country.

CONSIDERATION OF BACTERIAL STANDARDS.

Taking the milk as supplied to the consumer in the street or at the retailer's premises, after it has been exposed to all influences which are likely to affect its bacterial content, we find that the number of organisms per cc. varies from 11,750 to 3,200,000. The average of those delivered in the street is 222,060, and of those retailed in dairies 260,000, showing not much difference between the two methods of delivery.

The following are the results from the milk supplies of other places :—

London	3,000,000–4,000,000	(Pakes)
,,	3,000,000–30,000,000	(Eyre)
,,	340,000–4,800,000	(Swithinbank & Newman)
New York	1,000,000–5,000,000	(Park)
Boston	30,000–4,220,000	(Sedgwick & Batchelder)
Middleton (Conn.)	11,000–85,500,000	(Loveland & Watson)
Maddison (Wis.)	15,000–2,000,000	(Russell)
Guelph	8,750–1,197,000	(Harrison)
Halle	6,000,000–30,000,000	(Renk)
Munich	200,000–6,000,000	(Cnopf)
Gressen	83,000–170,000,000	(Uhl)
Wurtzburg	220,000–23,000,000	(Clauss)

These figures, interesting as they are, are not comparable owing to the variable conditions under which the samples have been taken, and the different methods adopted in the bacteriological examinations.

Various bacterial standards have been proposed for milk. Park says that no milk over 50,000 or 100,000 bacteria per cc. should be sold, but proposed a standard at first of 1,000,000 per cc. Bitter set 50,000 bacteria per cc. as the standard of milk intended for human consumption. The Philadelphia Pediatric Society's Commission laid down as their requirements for certification not more than 10,000 per cc., which is a fair standard for certified milk. Lam proposed 1,000,000 per cc. as the limit. In Boston a maximum of 500,000 bacteria per cc. is enforced along with the temperature standard of 10° C. already mentioned. Slack has shown the beneficial effect on the milk supply of combining these two standards.

However greatly one might desire the fixing of such a low standard as Park's and Bitter's of 50,000 per cc., owing to the conditions prevalent, it would be quite impossible to impose it in this country at present. It would indeed be unfair to impose any bacterial standard at the retailer's premises, because of the conditions existent at the cowsheds and the mode of transport. In America, refrigerator vans are in general use, whereas none are used in this country. The bacterial content may be influenced by uncleanliness at the farm and by temperature in transit which are outside the control of the retailer.

Taking the standard of 500,000 enforced in Boston, we find that it would have been infringed by two, Nos. 37 and 44, or 5.8 per cent. of the station samples. This percentage would have been much greater had the summer been a hot one. Hewlett and Barton examined 26 samples of milk arriving at stations in London, and the results show that 11, or 42.3 per cent., were above the standard, and would have been condemned before they reached the retailer. If cowsheds were inspected and refrigerator vans used, then a standard might be imposed. To impose a standard of 50,000 per cc. or even less, at the cowshed, would entail no hardship whatever upon the farmer, everything there being under his control. The standard is indeed a very liberal one, and it is certain that its imposition would go far to ensure care at the cowshed, and to lessen contamination.

5. CONSUMER'S HOUSE.

The consumers' samples were taken after the milk had remained in the house some time, as far as possible when most of the milk was used, so as to allow the maximum contamination to take place before sampling. When milk was delivered in the morning, it was usually sampled in the afternoon, but when delivered in the evening, it was usually sampled next morning, after having remained overnight in the consumer's house.

The bacterial content of the samples taken at the homes of the consumers varied from 6,830 to 56,000,000 per cc. The average in the cold months was 641,900, and in the warm 8,237,000 per cc. The great increase over the content of the milk taken at the retailer's premises is seen in Chart III. The average for milk retailed in the cool months was 113,000, and that in the warm months 392,000 per cc.

To determine the actual contamination occurring in the consumer's house, the plan of taking control samples was followed. These were taken when the consumer obtained his supply of milk from the retailer, and were kept in sterile bottles locked in cages in the consumer's house until the samples of the milk purchased for consumption were taken. As the samples were kept at the same temperature and for the same length of time as the consumer's own milk, it was possible to estimate the contamination which had taken place.

To enable the control retailer's sample to be placed in the consumer's house with his supply of milk, and to get permission to take a sample of his milk later in the day, some information had to be given to the consumer. It may be argued that the consumer, having been warned of the sampling, may have taken special care of the milk, but he was always instructed to use the milk as usual. To note if this warning influenced the bacterial content by causing him to take additional care, "surprise" samples were taken at several houses, as well as other "warned" samples. These "surprise" samples were obtained by going to the home of someone who obtained milk from the same retailer about the same time, and without any warning whatever, asking for some of the milk which was obtained earlier in the day. Seven such "surprise" samples were taken at the same time as "warned" samples (Table VI.). The temperature and time during which they were kept were almost the same, and in only one instance was the bacterial content of the "surprise" sample greater than the "warned" sample. Thus it cannot be contended that the warning which was given to the consumer influenced much the contamination of the milk. It is to be noted that the samples were taken at all classes of houses from the small through house in slum districts to the self-contained house.

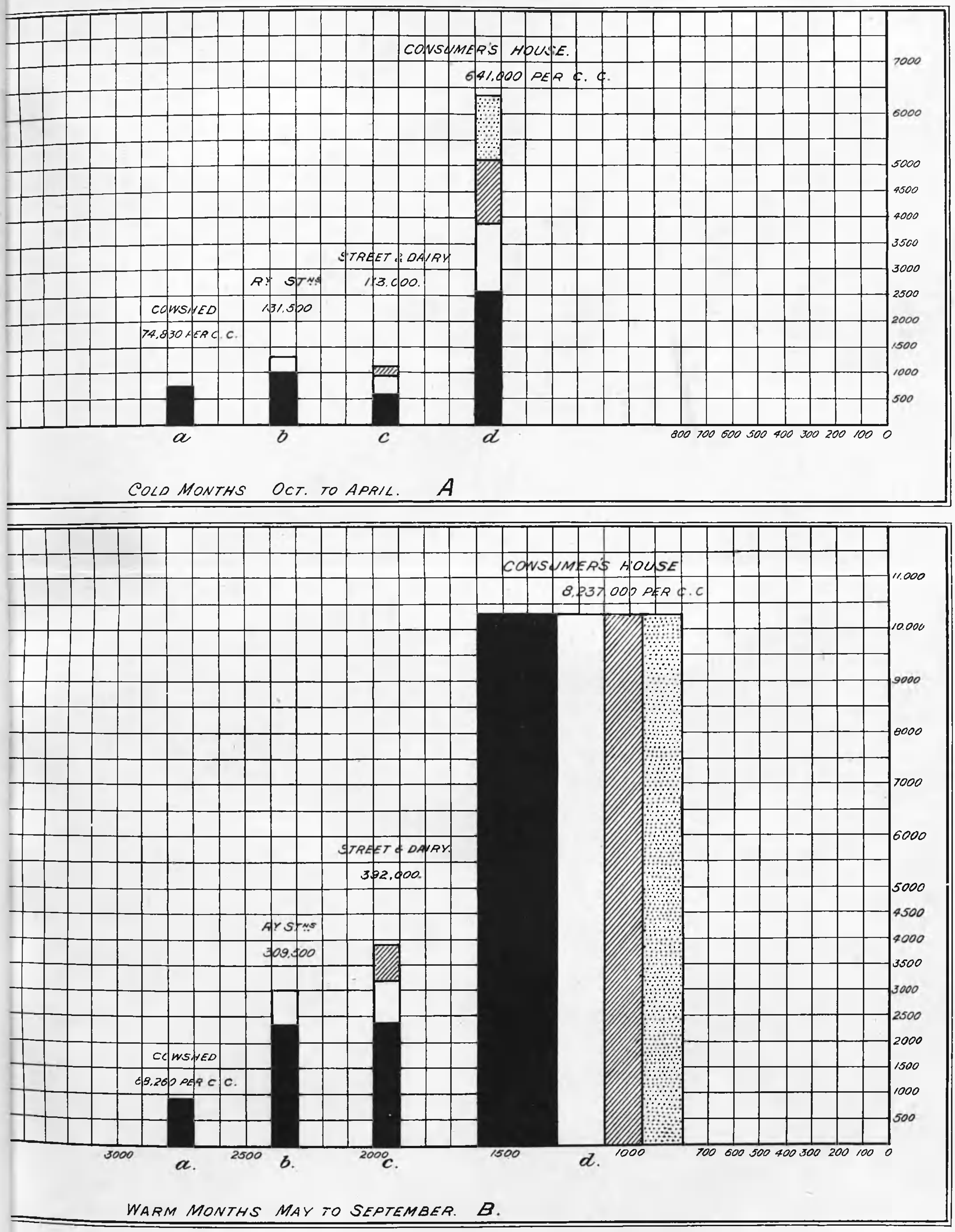


CHART III.

Showing the increase in the Average Bacterial Content as the Milk goes to the Railway Station, Retailer's Premises, and Consumer's House during the warm and the cold months of the year. The marked effect of the high temperature in Summer is seen in **B**, and the inhibitory effect of the low temperature in **A**. The amounts of contamination at the various stages are also represented in both **A** and **B**.

Black.	Contamination at Cowshed.
White.	Contamination in Railway transit, 21·1 per cent. of total content.
Crossed.	Contamination at Retailer's Premises, 18·5 per cent. of total content.
Dotted.	Contamination at Consumer's House, 19·0 per cent. of total content.

TABLE V.

Showing bacterial content of samples taken after the milk has remained in RETAILER'S PREMISES or DAIRIES, and that of the CONTROL SAMPLES.

No.	Dairy Control, in Shop same time as Dairy Milk. Bacteria per cc.	Dairy Milk after remained for Sale in Shop. Bacteria per cc.	Covered or not.	Temperature of Air	and Milk.	Hours in Shop.	Percentage Increase over Control.
55	130,000	170,000	no	15.5°	8°	5¼	30.7
56	4,120,000	4,340,000	no	8°	18°	16	5.3
60	178,000	133,000	no	11°	18°	1½	-25.2*
61	96,000 (Agar)	84,000 (Agar)	yes, nickelled cover	19°	8°	2¾	-12.5
65	175,000	168,000	yes	8°	7°	9	-4
66	147,000	109,000	yes	9°	9°	6¾	-25.8
67	41,000	51,000	no	5°	5°	17½	24.4
69	125,000	259,000	no	6°	5°	14½	107.2
70	1,220,000 (Agar)	2,360,000 (Agar)	no	12.5°	12°	7¼	93.4
73	36,600	64,000	no	10.5°	12°	2	76.5
75	291,000	310,000	covered with pasteboard	11°	7°	3	6.5
Total	6,559,600	8,048,000					
Average increase due to contamination ..		22.7%	Average time in premises ..				7.7 hours

* Minus sign shows a decrease.

TABLE VI.

Showing the difference in bacterial content of the "Surprise" and "Warned" Consumer's Samples.

Number of Sample.	"Surprise" Consumer's Sample Bacteria per cc.	Hours in house.	House dirty or clean.	Temperature of Milk in house.	"Warned" Consumer's Sample Bacteria per cc.	Hours in house.	House dirty or clean.	Temperature of Milk in house.
43	18,000,000	1¾	Clean	19.5°	14,200,000	1¾	Clean	20°
45	256,000	2½	Clean	12°	430,000	3½	Dirty	14°
46	233,000	6	Clean	19°	310,000	6½	Clean	17°
48	620,000	6½	Dirty	15°	650,000	6½	Not very clean	13°
49	4,880,000	14¾	Dirty	13.5°	7,760,000	14¾	Dirty	12°
50	2,880,000	5	Clean	15°	3,520,000	5¾	Very clean	14.5°
51	400,000	3	Clean	15.5°	440,000	1¼	Clean	15°

In consumer's houses 26 control retailer's samples were placed in the manner indicated. In 19 cases the samples from the consumer's own milk showed an increase over the controls, varying from 1.1 to 170.9 per cent., leaving out of consideration No. 74, which was a special sample in a dairy (Table VII.). In seven cases there was a decrease varying from 1.4 to 45.6. The average increase is 23.5 per cent., and this is due to contamination in the consumer's house. The remarks on the average increase per cent. being only of use for comparison, under RETAILER'S PREMISES, apply equally here, although the number of experiments in the consumer's house was greater.

TABLE VII.

Showing the bacterial content of the Consumer's Samples, with Control Samples.

Kept in the house.

Number of Sample.	Consumer's House Sample. Bacteria per cc.	Control Retailer's Sample. Bacteria per cc.	Temperature of Milk in House.	House Clean or Dirty.	Vessel Covered or Not.	Hours in Hours.	Per cent. Increase of Consumer's over Control Retailer's Sample.
33	56,000,000	35,840,000	20°	Clean	Open	15	56.2
34*	913,300	275,000	14°	,,	,,	7½	232*
35	1,980,000	3,560,000	15°	,,	,,	7	44.3
36	3,780,000 (Agar)	1,674,000 (Agar)	15¼°	,,	Covered	15¾	125.8
37	7,740,000 (Agar)	10,880,000 (Agar)	16°	Clean	Open	8¼	-28.8
38	27,840,000	27,520,000	21°	,,	,,	9¼	1.1
39	7,440,000	4,070,000	18.5°	,,	,,	8¾	82.8
40	10,240,000 (Agar)	No Control	15°	,,	,,	8¼	..
42	2,900,000	2,725,000	15°	Clean	Covered	4½	6.4
43	14,200,000	12,500,000	20°	,,	Open	1¾	13.6
44	7,435,000	6,155,000	18.5°	Dirty	Covered	3¼	20.7
45	430,000	245,000	14°	,,	Open	3½	75.5
46	310,000	250,000	17°	..	,,	6½	24
48	650,000	840,000	13°	Dirty	Covered	6½	-22.6
49	7,760,000	6,200,000	12°	,,	Open	14¾	25.1
50	3,520,000	2,700,000	14.5°	Clean	,,	5¾	30.3
51	440,000	455,000	15°	Clean	Open	1¼	-3.2
52	430,000	375,000	13°	,,	,,	5½	14.6
53	380,000	400,000	14.5°	Dirty	,,	2¾	-5
59	815,000 (Agar)	328,600 (Agar)	13°	Clean	,,	2¼	148.4
62	233,000	86,000 (Agar)	11°	Clean	Covered (paper)	11¾	170.9
63	68,000 (Agar)	125,000 (Agar)	11°	,,	Open	8½	-45.6
64	69,000	70,000	10°	,,	,,	8¼	-1.4
68	52,000	47,000	6°	,,	,,	7	10.6
71	389,000	322,000	8°	Clean	Open	13½	20.8
72	100,000	42,000	8.5°	,,	,,	14¾	138
74†	342,000	58,000	8.5°	,,	,, (swept)	14½	489.6†
Total	144,961,000	117,409,600					
Average increase due to contamination .. 23.5%				Average time in house		..	8 hours

* 34 was taken improperly and is not included in the calculation.

† 74 was a special sample taken in a shop, also not included.

The bacterial content at the consumer's house is influenced by several factors :—

(*a*) The cleanliness of milk receptacles.
(*b*) The place where stored.
(*c*) Covering.
(*d*) Flies.
(*e*) The temperature of storage place.

(*a*) THE CLEANLINESS OF RECEPTACLES.—The receptacles used at the home of the consumer are more likely to be clean, owing to their small size and the small quantity of boiling water required to sterilize them. In only one instance, No. 48, was the consumer's receptacle found to be dirty and carelessly washed before being used.

Householders know by experience, better even than the dairyman, that to keep milk from souring it is necessary to thoroughly scald the milk vessels.

The bacterial content of three receptacles which were about to be filled with milk was determined. They were washed out with 100 cc. sterile water and 1 cc. of this was used for the determination. The plates were incubated at 20° C. for 96 hours, and resulted as follows :—

A. 8 per cc. ; B. 5 per cc. ; C. 50 per cc.

These results show that not much contamination takes place from the receptacles of the consumer.

(*b*) THE PLACE WHERE STORED.—Out of 75 samples, 37 were stored in pantries, 25 in cellars, 10 in kitchens, and 3 in shops. Although the effect of storage in these situations cannot be pointed out in the samples taken, one can see that contamination will take place more readily in a kitchen where the dust is more easily and frequently disturbed owing to the greater traffic. In 22 out of 75 cases, there was no ventilation whatever in the places in which the milk was stored.

To show that organisms may contaminate the milk in the keeping-place in the consumer's house, culture plates were exposed each for half an hour close to where the milk was kept. These plates, after exposure, were incubated at 20° C. for 96 hours, and gave the following results. Area of the plates about 12 square inches.

I. Pantry (very dirty and dusty)	133
II. Pantry (very clean)	43
III. Kitchen (dirty)	800
IV. Pantry (clean)	104

Chiefly for the reason already stated, the contamination is greatest in the kitchen or living room, and least in a clean pantry.

The cleanliness of the house did not apparently affect the bacterial content of the samples much. In 12 out of 75, the houses were dirty. In 5 of these the contamination was found by control samples. In 2 of these five cases a decrease, one of 5 per cent., and the other of 22.6 per cent. was noted, the latter being from a covered milk. In the remaining 3, there was an increase of 25.1, 20.7 and 75.5 respectively.

(*c*) COVERING.—As to the covering of the milk great carelessness exists. The milk vessel is often kept in the kitchen, and no protection whatever from the dust is provided, even when the floor is swept and clouds of dust raised. In only eight cases were the milk vessels in the consumer's house covered. The contamination in five of these was controlled by means of duplicate samples in closed bottles placed in the consumer's house. The results were very irregular ; four showing an increase over the duplicates—170.9, 125.8, 20.7 and 5.4 per cent. respectively—and one a decrease of 22.6 per cent. The samples obtained from uncovered vessels show increases from 1.1 to 170.9 per cent., and decreases from 3.2 to 45.6. These irregular results may be due to other factors not noted, but it is reasonable to suppose, as in the case of the dairy vessels, that covering will prevent contamination from the organisms of the air, dust and flies. Sample 74 is a marked example of pollution by dust. The milk in this instance was kept in an open bowl overnight in a shop, and the sample was taken after the floor was swept in the morning. The increase is as much as 489.6 per cent. This is not a consumer's sample, but a shop sample kept under unusual circumstances, and only put in this table for convenience of discussion.

(*d*) FLIES.—Flies were much more commonly found in consumers' houses than in dairies. In 4 houses they were numerous, in 10 few, and in the remainder they were absent. Flies undoubtedly may be a source, perhaps not of great, but of dangerous pollution. R. M. Buchanan has shown experimentally that flies can carry a large number of pathogenic organisms on their legs. These may be a source of pollution of the milk at the cowshed and at the retailer's premises, but especially at the home of the consumer, where they are usually more numerous. One can readily see how epidemic diarrhœa, if, as seems likely, it is due to a specific organism, could be transmitted from infective material to milk in this way at all the points of transit.

(e) THE TEMPERATURE OF STORAGE PLACE.—The bacterial content of the consumers' samples depends greatly on the temperature at which the milk has been kept. Table VIII. shows the great increase which takes place when milk is kept at a favourable temperature. In this table is shown the bacterial content of the milk sold to the consumer as well as that of the same milk kept sealed in a sterile bottle for a time at the temperature of the consumer's home. These examples, along with others already given, show the importance of keeping the milk cool in the home of the consumer as in other situations. Of the necessity for this most house-wives are fully aware.

CONSIDERATION OF TOTAL CONTAMINATION.

TOTAL AMOUNT OF CONTAMINATION.—It has already been stated that the average increase of organisms due to contamination at the dairy was 22.7 per cent., and at the consumer's house 23.5 per cent. The milk was exposed for from 1½ to 17½ hours in the former and from 1½ hours to 15¾ hours in the latter. The average time of exposure was, in the dairy 7.7, and in the consumer's house 8 hours. It must be noted that the time was very long in some cases. If the bacteria in the milk are increased by 22.7 per cent. at the dairy and by 23.5 per cent. at the consumer's house, it means that the dairyman is responsible for 22.7 of 122.7 organisms, or 18.5 per cent., and the consumer 23.5 of 123.5, or 19 per cent., or both together 37.5 per cent. of the total organisms in the milk consumed. The remainder, or 62.5, must have been added at the farm, during the railway transit, and by the retailer's cans. It is difficult to say how much contamination takes place during delivery in the street. Probably owing to the rapid delivery and the covered cans, it is much less than that occurring at the dairy. It may be noted in this connection that milks retailed in the street, averaging 222,060 per cc. contained at the farm an average of 86,680 per cc., while those retailed in dairies, averaging 260,000, contained at the farm 75,380 per cc. Apparently the increase and therefore contamination is less in the street than at the dairy.

Although it is evident organisms can be added during the railway transit, it is questionable if the number is, comparatively speaking, great. Contamination owing to defective lids will take place, but it will be very small compared with that occurring in the dairy or consumer's house, where the whole surface of the milk is exposed to dust and air organisms. The dairyman's cans are also a source of contamination before the milk reaches the dairy, though, as has already been shown, the amount from these vessels is very much less than from those of the farmer.

The estimation of the amount of pollution of the milk at the farm, apart from that occurring during railway transit and before the dairy is reached, is exceedingly difficult. This difficulty is due, as already stated, to the influence of temperature. That temperature has a great influence on the bacterial count is seen in Table VIII., in which is given the bacterial count of the milk obtained from the retailer, and the count of the same milk after it has been kept in a sterile bottle for some time, in the dairy or in the consumer's house, at a certain temperature. In this connection, specimen No. 33 is most interesting, the organisms having increased from 660,000 to 35,840,000 per cc.

An attempt was made to estimate the total contamination of the milk occurring in transit from the cowshed fo the consumer's house by means of Control Samples. The control sample was taken at the cowshed at the same time as that obtained for ordinary examination purposes. Instead of being sent to the laboratory, however, the control was retained in a hand-bag at the temperature of the air until the consumer's house was reached, where it was left, to be kept at the same temperature as the consumer's milk, until a sample of the latter was taken. It was thus maintained, protected from contamination, till the consumer had made his purchase, at the temperature of the air, which was higher or lower than the temperature of the milk exposed in the churn. The control samples Nos. 1 to 31, were not put into the home of the consumer with his supply of milk, but were kept at the temperature of the air, which was very variable, either much higher or much lower than that in the consumer's house. Owing to this difference in temperature, the results of the control cowshed, and the consumer's samples are not comparable. Thus they are valueless for estimating the amount of contamination. The controls (32 to 75) were put into the consumer's house in the manner already mentioned. The results here are more trustworthy owing to the control cowshed and the consumer's samples having been kept for a much longer time at the same temperature.

In table IX. the bacterial content of the consumer's samples, 32 to 75, is shown side by side with those of the cowshed controls. The temperature of the milk when the consumer got his milk from the retailer, the temperature of the milk kept in the consumer's house and the maximum temperature of the atmosphere on the day each set of samples was taken are also included in the table. When the control cowshed sample is poured into the small sample bottle it is suddenly cooled owing to its small bulk, and quickly reaches the temperature of the air. The temperature of the air was usually lower than that of the bulk of the milk in the churn. This control sample when put into the house with the consumer's milk will from that time be kept under temperature conditions exactly similar to the latter.

TABLE VIII.

Showing bacterial content of the Street or Dairy Milk, and that of the same milk kept in the house or dairy in a sealed sterile bottle for a certain time at the temperature of the place.

No.	Street or Retailer's Premises. Iced at once. Bacteria per cc.	Street, or Retailer's Premises (control), after kept. Bacteria per cc.	Temperature of House or Dairy.	Number of Hours in House or Dairy.
33	660,000	35,840,000	20°	15
34	103,000	275,000	14°	7½
35	480,000	3,560,000	15°	7
36	172,500	1,674,000	15¼°	15¾
37	1,421,000	10,880,000	16°	8¼
38	159,000	27,520,000	21°	9¼
39	300,000	4,070,000	18.5°	8¾
41	102,500 R.	300,000	15.5°	13
42	424,000	2,725,000	15°	4½
44	771,000 R.	6,155,000	18.5°	3¼
45	100,600	245,000	14°	3½
46	49,000	250,000	17°	6½
48	134,000	840,000	13°	6½
49	344,000	6,200,000	12°	14¾
50	332,300	2,700,000	14.5°	5¾
51	294,300	455,000	15°	1¼
52	53,000 R.	375,000	13°	5½
53	92,500 R.	400,000	14.5°	2¾
55	138,000 R.	130,000	14°	5¾
56	303,500 R.	4,120,000	13°	16
59	328,000	328,600	13°	2¼
60	110,000 R.	178,000	14°	4
61	110,600	96,000	10.5°	2½
62	101,000	86,000	11°	11¾
63	26,500	125,000	11°	8½
64	63,000	70,000	10°	8¼
65	134,000 R.	175,000	10°	8¾
66	122,000 R.	147,000	13.5°	6½
67	43,000	41,000	5°	17½
68	62,600	47,000	6°	7
69	119,000 R.	125,000	8°	14¼
70	241,000	1,220,000	13.5°	17
71	175,000	322,000	8°	13½
72	42,000	42,000	8.5°	14¾
73	43,300 R.	36,600	12°	1¾
74	34,300	58,000	8.5°	14½
75	293,000 R.	291,000	10°	3

R = Those kept in retailers' premises or dairies (the others being kept in houses).

If we separate from Nos. 32 to 75, the sets in which the temperature of the milk sold to the consumer is higher than the maximum temperature of the air on that day, that being the highest temperature at which the control sample could have been kept, we shall be able to use them in calculating the contamination occuring during transit. In these, obviously, the control is kept at a lower temperature than the milk in the churn until it reaches the consumer's house, when the temperature becomes the same for both. If the control sample were at a higher temperature than the milk in the churn, the bacteria would multiply more rapidly, and the results would be useless for comparison and detecting the increase due to contamination. In three, namely, Nos. 36, 43 and 48, the control sample may have been at a higher temperature than the retailer's milk and, as already mentioned, Sample 74 was a special one and cannot be discussed in this connection.

Omitting Nos. 36, 43, 48 and 74, it is found that the percentage increase in bacterial content in the consumer's sample over the control varies from -74 per cent. to 882 per cent. the former showing a great reduction in numbers, and the latter an increase of eight times the original amount. The average increase, which is due to contamination in transit, is 142.1 per cent. In other words, 142.1 of 242.1 organisms, or 58.6 per cent., of the total organisms in the milk used by the consumer, are due to contamination in transit. This percentage, the control sample always being lower in temperature than the milk in delivery, must be regarded as high. It has already been shown that the percentage of organisms present due to contamination at the dairy and consumer's house is in all. 37.5. Subtracting this 37.5 from the total contamination 58.6, 21.1 per cent. is found to be the amount due to pollution during railway transport. In other words, of every 100 bacteria swallowed by the person consuming the milk, 41.4 are the result of growth of those organisms already present before the milk left the cowshed, while the remainder 58.6 are due to the pollution in transit. The statement given below shows the derivation of the 58.6 of transit pollution.

Total organisms in consumer's milk as used		100
Total organisms due to dairy pollution	18.5	
Total organisms due to consumer's house pollution	19.0	
Total organisms due to railway transit	21.1	
		58.6
Total organisms in consumer's milk propagated from those in the milk at the time of leaving the farm		41.4

Here the amount of pollution at the dairy has been estimated but, as has already been remarked, the amount in the street, though it could not be accurately stated, would probably be less. Again, this percentage, 58.6, which is the total contamination in transit, is much higher than it ought to be owing to the temperature of the control sample always being lower than that of the milk in the churn. Hence the calculation is in favour of the farmer.

These figures, however, must not be taken as absolute. The averages have been obtained from a small number of observations, especially in Table V. Again, in obtaining the averages figures very wide apart have been necessarily added. Nevertheless, these numbers are useful for purposes of comparison, and must only be used for this purpose, and not to express the amount of contamination exactly.

If 3,460 per cc., the bacterial content of the milk produced with reasonable care and cleanliness, be taken to represent the amount due to unavoidable contamination at the farm, and we compare it with 80,860 per cc., the average percentage of this latter amount added to the milk by the farmer owing to want of care and cleanliness is found to be no less than 95.7 per cent. In other words, 95.7 per cent. of the average bacterial content of milk leaving the farm is preventable in ordinary practice. Hence 95.7 per cent. of this 41.4 per cent., or 39.6 per cent., is the amount of bacterial contamination which the farmer contributes to the milk consumed, and which he could easily prevent. From this one must conclude that the greatest amount of preventable contamination is added at the farm, and that during railway transit, at the retailer's premises, and at the consumer's house smaller amounts are added which are in each instance about half that contributed at the cowshed.

Table X. gives the bacterial content of the cowshed, railway stations, retailers' and consumers' samples arranged in series, to show the increase in the number of organisms from the time the milk leaves the cowshed. In some the increase is very great, while in others it is small, and in some even a reduction occurs. In five samples, namely, Nos. 57, 60, 61, 64, 65, 67 and 68 (Table XI), the number of organisms in the milk at the consumer's house is little more and in three, Nos. 60, 65, and 68, it is less than the number at the cowshed, despite the fact that many hours elapsed before the consumer's sample was taken. These results are due to the low temperature at which the milk was kept. These samples were taken in mid-winter, and show markedly, owing to the growth of the bacteria being in abeyance as a result of the low temperature, that the total contamination in some cases is small during transit compared with that at the cowshed. They also show that the amount of contamination in transit calculated above is somewhat overstated, and that at the farm understated. The highest increase per cent. is 63.1, whereas the average of all the samples, estimated by means of the controls is 142.1.

These findings are not surprising when the numerous sources of contamination existent at the cowshed are contrasted with those at the various stages of transit from the farm to the consumer.

TABLE IX.

Consumer's Samples and Cowshed Controls compared.

No.	Consumer's House. Bacteria per cc.	Control Cowshed Bacteria per cc.	Temperature when Retailer's Sample obtained of Air	and Milk.	Maximum Daily Temperature of the Air.	Temperature of Milk in House.	Hours kept in House.	Per cent. Increase over Cowshed Control.
32	2,320,000	1,850,000	18°	28°	25°	12°	9	25.4
33	56,000,000	9,600,000	18°	26°	22.5°	20°	15	483
34	913,300	420,000	12.5°	25°	17°	14°	7½	117
35	1,980,000	180,000	12°	19°	17.5°	15°	7	10
36	3,780,000 (Agar)	1,420,000 (Agar)	15°	13°	19.5°	15¼°	15¾	166
37	7,740,000 (Agar)	3,866,000 (Agar)	13°	20°	15.5°	16°	8¼	100
38	27,840,000	12,800,000	14°	23°	18.5°	21°	9¼	117.5
39	7,440,000	1,600,000	13°	24°	21.5°	18.5°	8¾	365
40	10,240,000 (Agar)	9,280,000 (Agar)	12.5°	17¼°	17°	15°	8¼	10.3
41	1,150,000	1,186,000	18°	16.5°	16.5°	15.5°	13	–3
42	2,900,000	2,630,000	13°	16°	16.5°	15°	4½	10.2
43	14,200,000	11,660,000	17°	24°	17.5°	20°	1¾	21.7
44	7,435,000	6,755,000	15.5°	13.5°	18.5°	18.5°	3¼	10.6
45	430,000	375,000	13°	13°	13°	14°	3½	14.6
46	310,000	135,000	12°	28°	19°	17°	6½	129.6
47	Contaminated							
48	650,000	1,450,000	9.5°	11°	13.5°	13°	6½	–55
49	7,760,000	2,440,000	11.5°	22°	13.5°	12°	14¾	218
50	3,520,000	2,600,000	9°	20°	12.5°	14.5°	5¾	35.4
51	440,000	190,000	5°	21°	4.5°	15°	1¼	131.5
52	430,000	245,000	12.5°	9°	8.5°	13°	5½	75.5
53	380,000	75,000	17°	26°	10.5°	14.5°	2¾	406.6
54	192,000 (Agar)	No Control.	14°	13°	9°	13°	6	..
55	170,000	96,500	12.5°	13°	10°	14°	5¾	76.1
56	4,476,000	2,985,000	8°	20° (cowshed)	10°	13°	16	49.9
57	29,000	27,000	4°	30° (cowshed)	6°	8°	Taken on arrival.	7.4
58	Contaminated							
59	815,000 (Agar)	144,000 (Agar)	6°	19°	3°	13°	2¼	466
60	181,000	380,000	11°	18°	6°	14°	4	–52.3
61	192,500 (Agar)	74,000 (Agar)	6°	8°	6°	10.5°	2½	161
62	233,000 (Agar)	58,500 (Agar)	6.5°	16°	6.5°	11°	11¾	298.2
63	68,000 (Agar)	37,500 (Agar)	13°	27°	9.5°	11°	8½	81.3
64	69,000	56,600	5°	21.5°	8.5°	10°	8¼	23.2
65	164,000	631,000	7°	7.5°	7.5°	10°	8¾	–74
66	100,000	44,600	6°	9.5°	4°	13.5°	6½	124.2
67	50,000	52,500	17°	26°	1.5°	5°	17½	–4
68	52,000	47,000	.5°	21°	2°	6°	7	10.6
69	218,000	114,000	5°	16°	1.5°	8°	14¼	91.2
70	2,711,000 (Agar)	276,000 (Agar)	11.5°	26.5°	11.5°	13.5°	7	882
71	389,000	170,000	5°	15.5°	2.5°	8°	13½	128.8
72	100,000	26,000	0°	32°	4°	8.5°	14¾	284.6
73	67,600	26,000	10.5°	20°	4.5°	12°	1¾	160
74	342,000	24,300	5.5°	19°	5.5°	8.5°	14½	1,307
75	(Floor swept.) 317,000	327,000	12.5°	10.5°	6.5°	10°	3	–3
Total	149,630,400	61,800,200*						

Average increase due to contamination in transit .. 142.1%

*Excluding 36, 43, 48 and 74. For reasons see text.

TABLE X.

Showing the bacterial content of the Cowshed, Railway Station, Retailer's and Consumer's Samples of each set.

No.	Cowshed.	Railway Station	Retailer's Premises.	Consumer's House.
1	13,500	—	14,700	21,375
2	22,416	—	13,416	31,166
3	5,660	—	15,000	6,830
4	11,330	—	11,750	14,500
5	8,610	—	34,660	13,110
6	27,500	—	28,250	52,500
7	85,130	—	116,000	139,160
8	5,000	—	26,580	31,410
9	21,500	—	33,660	68,830
10	34,080	—	40,500	62,500
11	7,360	—	33,730	176,500
12	42,400	77,000	81,000	181,600
13	117,100	294,000	236,000	655,500
14	23,300	21,000	19,000	67,300
15	37,500	56,950	59,750	828,000
16	35,000	46,000	50,600	1,545,000
17	27,300	84,160	135,000	3,110,000
18	27,250	28,800	52,500	757,000
19	17,800	29,900	—	50,000
20	31,750	32,300	41,500	1,065,000
21	27,000	—	35,000	820,000
22	17,000	53,160	21,000	849,000
23	26,000	—	27,000	397,500
24	47,000	—	81,500	147,500
25	7,100	19,800	110,000	10,000,000
26	21,250	—	136,000	763,000
27	16,600	73,600	257,000	1,052,500
28	26,660	—	59,000	411,600
29	17,500	—	20,500	268,600
30	60,000	—	3,200,000	3,840,000
31	12,800	—	244,500	1,180,000
32	65,600	—	1,865,000	2,320,000
33	192,250	440,000	660,000	56,000,000
34	92,400	—	103,000	913,300
35	34,000	—	480,000	1,980,000
36	142,600	—	172,500	3,780,000

TABLE X.—*continued.*

No.	Cowshed.	Railway Station.	Retailer's Premises.	Consumer's House.
37	1,048,000	3,620,000	1,421,000	7,740,000
38	97,000	—	159,000	27,840,000
39	146,000	—	300,000	7,440,000
40	129,000	125,800	—	10,240,000
41	80,500	83,000	102,500	1,150,000
42	330,000	130,300	424,000	2,900,000
43	36,000	215,000	Uncountable	14,200,000
44	78,000	537,000	771,000	7,435,000
45	33,000	206,500	100,600	430,000
46	29,600	—	49,000	310,000
47	—	—	—	—
48	67,000	78,000	134,000	650,000
49	197,300	201,300	344,000	7,760,000
50	286,600	—	332,300	3,520,000
51	137,500	—	294,300	440,000
52	36,000	57,500	53,000	430,000
53	63,500	—	92,800	380,000
54	28,300	34,000	34,000	192,000
55	87,000	124,000	138,000	170,000
56	52,000	194,600	303,000	4,476,000
57	20,000	33,500	—	29,000
58	—	—	—	—
59	164,000	—	328,000	815,000
60	380,000	—	—	181,000
61	157,000	106,000	110,600	192,500
62	62,000	90,000	101,000	233,000
63	24,500	—	26,500	68,000
64	42,300	—	63,000	69,000
65	194,000	202,000	134,000	164,000
66	62,600	129,000	120,600	100,000
67	40,600	—	43,000	50,000
68	66,500	—	62,600	52,000
69	98,000	134,000	119,000	218,000
70	116,000	242,000	259,000	2,711,000
71	107,000	108,000	175,000	389,000
72	23,000	—	42,000	100,000
73	20,000	—	43,000	67,600
74	20,000	—	34,300	342,000
75	36,000	—	293,00	317,000

TABLE XI.

Showing in some Consumers' Samples little increase over the Cowshed ones.

No.	Cowshed Bacteria per cc.	Consumer's House, Bacteria per cc.	Temperature at			Maximum Daily Temperature.	Time of Transit from Cowshed.	Increase per cent.
			Cowshed.	Retailer's Premises.	Consumer's House.			
57	20,000	29,000	30°	—	8°	6°	17¾	45
60	380,000	181,000	30°	18°	14°	6°	4¼	-52.4
61	157,000	192,500	19°	8°	14°	6°	19¾	22.2
64	42,300	69,000	27°	21.5°	10°	8.5°	10	63.1
65	194,000	164,000	8.5°	7.5°	10°	7.5°	22½	-15.4
67	40,600	50,000	31.5°	26°	5°	1.5°	19½	23.1
68	66,500	52,000	32°	21°	7.5°	2°	9½	-21.8

SECTION II.

The estimation of the sediment in milk taken at the cowshed and at the point where it is supplied to the consumer, to ascertain if any increase occurs in the amount in transit.

SEDIMENT IN MILK.—The terms " filth" and " dirt" have been applied to what is and will be called " sediment" in milk. It consists of the material which falls to the bottom of the milk vessel after standing for some time. The term sediment can be applied to all deposits, whereas filth and dirt cannot, as in the case where a white deposit of siliceous particles was found in the milk. This came from the material used to polish the inside of a can which had not been washed out properly afterwards. There is also a slight deposit in milk taken directly from the teat of the cow, which cannot be classified as filth or dirt, consisting as it does of cells and cellular debris from the udder and ducts.

The sediment is composed of various elements, for example, vegetable particles from manure, granular dust particles, leucocytes, and cellular debris, hairs, particles of straw, yeasts and bacteria.

The origin is chiefly the material adherent to the udder of the cow, and especially the manure which is shaken off into the milk during the process of milking.

According to Backhaus, about one-half of fresh manure dissolves in milk, and this does not appear as sediment. But it has already been noted that it is not fresh manure which gains entrance to the milk, but the dry material which is almost free from water, and which adheres to the hair of the animal.

As the amount of sediment is directly connected with the method of straining, it will be convenient to make some reference to this subject here.

MILK FILTERING OR STRAINING.—This is a process which becomes necessary as a result of want of cleanliness. Experiments showing the effects of cleanliness and of washing the udders on the sediment present in the milk have been mentioned. The sediment from milk of clean cows was from six to ten times less than that from the milk from dirty cows. It is much more important to prevent the contamination from manure than to remove it after it has been washed in the milk and has grossly contaminated it. The mistaken idea, that if the manure is removed from the milk all that is required has been done, has already been remarked on. The object should be to prevent its entry.

However, so long as the cows are ungroomed and the udders are left unclean, it will be necessary to use strainers. These are necessary not only from an aesthetic point of view, but also to prevent some of the bacterial contamination which occurs from dirt or manure, which usually is hard and takes some time to soften and do its full amount of pollution by its contained organisms. The longer it is permitted to remain in the milk the greater will be the quantity dissolved and the greater the contamination. It must be remembered, however, that even after the manure is on the strainer it is being washed and softened by the milk constantly poured upon it, and that its contained germs still continue to reach the fluid already strained.

Various filters or strainers are used, from the old coarse gauze, alone or with muslin, to the most recent sterile cotton-wool filter.

To show the greater efficiency of the cotton-wool filter over the ordinary gauze and muslin strainer, the milk from a cowshed, containing 20 cows, which were kept in a dirty condition, was on two separate days divided into two, the one half being passed through a patent cotton-wool filter, and the other through muslin over a wire gauze strainer. The sediment in the two was estimated with results as follows :—

1st Estimation—

Cotton wool filter ..	7.5	pts. per million.
Gauze and muslin..	40	,, ,,

2nd Estimation—

Cotton wool filter ..	7.5	pts. per million.
Gauze and muslin..	45	,, ,,

These show the cotton-wool filter to be about six times more efficient than the gauze and muslin. The time taken to strain is longer, but if the milk from each cow is put in as it is obtained, no time need be lost.

Estimation of Sediment.—Various methods have been used to determine the quantity of sediment; one method is to filter through filter paper, afterwards washing, drying, and weighing the deposit. The drawback here is the amount of manipulation and weighing, and the inability to examine the sediment microscopically.

Barwise and White have put forward a method by which the sediment in a litre is arrested on a layer of fine gauze (Mull muslin) on which it is stated the number of particles can be counted. There is here a want of exactness in the estimation.

Foulerton centrifuges 150 cc. of milk and counts the number of particles thrown down. The objections here are that the amount of milk is too small to give a fair result and that an accurate estimation of particles is impossible.

The method adopted in this investigation was a modification of that used by Houston. The apparatus employed is that shown in figure 18. It consists of a glass cylinder holding rather more than a litre, tapering to fit inside a 10 cc. centrifuge tube, to which it is connected by means of a piece of rubber tubing. The centrifuge tube is tapered at its lower end and is graduated in 1/10ths and 1/100ths of a cc. The graduated part holds up to .3 cc. In making an estimation of the sediment, 1 cc. of formalin is first added to the milk to prevent souring, and the growth of the organisms, and the mixture is then shaken up, and poured into the cylinder up to the 1,000 cc. mark. A glass cover is placed over the cylinder and the whole allowed to stand for 12 hours—usually overnight. At the end of 12 hours, a brass rod fitted with a rubber stopper at the lower end is passed through the milk, and fitting into the outlet of the cylinder prevents escape of the fluid when the centrifuge tube is detached. This tube is centrifuged at a speed of 1,500 to 2,000 revolutions per minute for 3–5 minutes, and the milk poured off. Sodium carbonate solution (1 per cent.) is then added up to the 10 cc. mark, and the centrifugalizing repeated. The deposit is then read off. If the top of the deposit is not level, it may be stirred up a little by a wire and again centrifuged.

The "primary" readings before centrifugalization were not taken owing to the readings being untrustworthy on account of the great variations in bulk. Particles of straw or vegetable matter may lie across the tube and holding up the smaller and lighter particles, lead to a higher "primary" reading. When centrifuged, the deposit is forced to the bottom of the tube, and the bulk remains little changed, even though the speed or the time of centrifugalization is increased. For the collection of the samples, bottles holding slightly over a litre of milk, and provided with rubber stoppers were used.

By using a litre of milk, a fairer sample is obtained than when a smaller quantity is used for deposit estimations. Such an amount also gives sufficient deposit to be measured accurately as volumes per million. The deposit can afterwards be examined for leucocytes and streptococci. The method is easily applied and the actual estimation does not take up much time.

The samples of milk were taken at the cowshed and at the retailer's premises or in the street, where it was supplied to the consumer, to ascertain if there was any increase during transit. The results are arranged in Table XII. Before the samples were taken, the milk was thoroughly mixed.

Sixty-one cowshed samples were taken for the sediment estimation with corresponding samples at the point where the milk was supplied to the consumer. On considering the results of the milk taken at the cowshed, it is found that the average amount of sediment of milk from dirty cows is 52.5 volumes per million, the lowest being 20 volumes, and the highest 120 volumes, and the average of milk from clean cows 31.7 parts, the lowest being 7.5, and the highest 80 volumes per million.

TABLE XII.

Showing the Sediment content of the Cowshed and the Retailer's Samples, with the results of Microscopic Examination, etc.

Serial Number.	Cowshed Sample. Volumes per Million.	Retailer's Samples. Volumes per Million.	Cowshed Clean or Dirty.	Method of Straining at Cowshed.	Streptococci.	Leucocytes. Cowshed	Leucocytes. Retailer's	Cellular Debris.	Granular Debris.	Town or Country Milk.
13	120	40	Very dirty cows, &c. ..	Gauze sieve	Not examined	Not examined		Not examined ..	Not examined	Country
14	25	15	Very clean	Two sieves and flannellette	,,	,,		,, ..	,,	,,
15	15	10	Clean	Sieve and muslin ..	,,	,,		,, ..	,,	,,
16	60	25	Teats clean	Sieve and muslin; sieved second time at dairy	,,	,,		,, ..	,,	,,
17	30	10	Clean	"Ulax" filter	Not examined	Not examined		Not examined ..	Not examined	Country
18	20	20	Clean	Ordinary filter, with patent cotton material called "Strainen"	,,	,,		,, ..	,,	,,
19	7.5	7.5	In open air	"Ulax"	,,	,,		,, ..	,,	,,
20	50	25	Teats dirty	Gauze sieve..	,,	12	7	Much	Little; small hairs present	,,
21	45	35	Udders dirty. N.B.—Wet milker	Gauze sieve	—	.5	.5	Little; hairs present in both samples	Little; hairs present	Country
22	60	35	Clean	Gauze sieve	—	3	1.6	Much	Much	,,
23	115	80	Teats clean	Through double thickness of cotton	Many	100	30 Almost pure pus	Much; some hairs ..	Much	,,
24	50	25	Teats dirty	Linen rag over can	Not examined	Not examined		Not examined ..	Not examined	Town
25	20	20	Teats dirty	Gauze sieve; sieved second time at dairy	Not examined	Not examined		Not examined ..	Not examined	Country
26	25	10	Clean; 9 clean, 2 dirty, 1 passable	Muslin over cans	,,	,,		,, ..	,,	Town
27	15	25	Clean teats and udders; cows in field day and night	Brass sieve and four thicknesses of fine muslin	—	.5	.5	Very little	Very little ..	Country
28	55	15	Teats clean	Wire sieve	—	7	2.5	Some	Some	,,
29	35	35	Very clean	Brass sieve and muslin ..	—	2	1.5	Little	Little	Town
30	60	40	Teats clean	Brass sieve	A few chains ..	8	3	Some	Some	,,
31	35	15	Teats clean	Brass sieve	—	5	1.5	Little	Little	Country
32	40	40	All clean	Gauze strainer	Few	22	31.1	Much	Some	Town

TABLE XII.—*continued.*

Serial Number.	Cowshed Sample. Volumes per Million.	Retailer's Samples. Volumes per Million.	Cowshed Clean or Dirty.	Method of Straining at Cowshed.	Streptococci.	Leucocytes. Cowshed	Leucocytes. Retailer's	Cellular Debris.	Granular Debris.	Town or Country Milk
34	35	30	Very clean	Gauze sieve	Few	8	9	Little ; hairs present in both	Little	Town
35	25	20	Clean	Gauze and muslin	—	5.4	3.3	Little	,, ..	,,
36	30	10	Very clean	" Ulax "	Occasional ..	4.3	2.6	Little ; fibres of cotton present in both	,, ...	,,
37	30	30	Clean teats	Gauze sieve ; sieved second time at dairy	—	1	1	Little	,, ...	Country
38	30	30	Clean ; cows out	Gauze sieve two thicknesses of linen	—	1	.5	Little	Little	Country
39	25	20	Teats washed	Gauze and four fold muslin	—	3.1	4	,, ...	,, ...	,,
40	20	15	Clean	" Ulax "	—	6.5	6.4	Very little ; a few cotton hairs in both	Very little ..	,,
41	50	15	Clean	Gauze sieve	Few	4	2	Little	Little	,,
42	20	10	Teats clean	Gauze sieve	Few	3	2	Very little	Very little ..	Country
43	50	55	Teats washed	Gauze sieve	Many	2.4	2.3	Much	Much	,,
44	30	30	Teats clean	Gauze sieve	,, ...	30	28	Little	Little	,,
45	15	5	Very clean indeed	Gauze sieve	—	6.6	8	Very little ; small fibres of cotton	Very little ..	,,
46	20	25	Clean	Gauze and linen rag over it	Few	4	10	Little	Little	Town
47	50	50	Teats clean	Gauze sieve	—	.5 Only occasional leucocyte	.5	Much	Much	Country
48	50	50	Teats dirty ; cows out ..	Gauze sieve	—	.5	.5	Some	Some	,,
49	20	40	Teats dirty	Metal sieve and linen rag ..	—	nil Occasional	nil	Very little ; two long hairs in cowshed	Very little ..	,,
50	15	15	Clean	Brass sieve	—	1	2	Some ; few hairs in both	Some	Country
51	50	25	Teats dirty	Brass sieve	Few	9	3.5	Much	Much	Town
52	20	5	Clean	Through three wire sieves ..	—	12	8	,, ...	Little	Country
53	35	15	Teats fairly clean	Brass sieve	Few	22	8	Little	,, ...	

TABLE XII.—*continued.*

Serial Number.	Cowshed Sample. Volumes per Million.	Retailer's Samples. Volumes per Million.	Cowshed Clean or Dirty.	Method of Straining at Cowshed.	Streptococci.	Leucocytes. Cowshed	Leucocytes. Retailer's	Cellular Debris.	Granular Debris	Town or Country Milk.
54	50	20	Teats clean	Brass sieve and muslin ..	—	6	4	Much ; some hairs in both	Much	Country
55	20	35	Clean	Brass sieve	Few	4.5	12.5	Much	Little	Town
56	25	15	Clean	Brass sieve	—	2.1	1.5	Little ; hairs in both	Little	Country
57	80	20	Teats clean	Brass sieve	Very few ..	6.3	1.7	Much	,, ...	,,
59	20	7.5	Very clean	Sieved twice, then through muslin	—	7.2	4.2	Much	Little	Country
60	25	30	Teats fairly clean	" Ulax " form of filter ..	—	3.3	4.4	Little	,, ...	Town
61	25	10	Teats dirty	Sieved and then muslin ..	—	16.1	3.5	Some	,, ...	Country
62	50	35	All very dirty ; teats very dirty	Sieved once	—	5	3	Much	Much	,,
63	40	20	Very clean	Strainer and three fold muslin	—	21	5.5	Much	Much	Town
64	10	5	Very clean udders rubbed with clean cloth	Through four fold " Wainswood " linen strainer	—	15	10	Some	Some	,,
65	30	25	Fairly clean	Two strainers of fine perforated linen	—	9	7	,, ...	,, ...	Country
66	25	20	Teats rubbed with dry cloth	Four fold muslin	—	8.5	6	,, ...	,, ...	,,
67	7.5	15	Fairly clean	" Ulax "	Very few ..	4.1	2.6	Very little	Very little ..	Town
68	40	30	Teats clean	Sieve and linen cloth ..	—	7.5	6.5	Some	Some	,,
69	35	25	Fairly clean ; teats clean ..	Sieve and linen under sieve	—	11.1	7	,, ...	,, ...	Country
70	90	50	Udders dirty	Sieve and linen rag beneath	Not examined	Not examined		Not examined ..	Not examined	,,
71	60	40	Udders dirty	Metal sieve and then linen rag	—	6	2.5	Little	Much	Country
72	45	20	Clean	Fine canvas	—	6	3.5	Some	,, ...	Town
73	10	20	Clean	Wire sieve and muslin ..	—	18	20	Much	Little	Country
74	40	20	Clean	Wire sieve	—	17	9	,, ...	Much	,,
75	25	15	Clean	Wire sieve and muslin ..	Few	12	6	Little	Little	Town

A sterile cotton-wool filter after the form of the " Ulax " was used in six cowsheds, patent " Wainswood " linen in one, and flannelette in one. The average volumes per million in the milk from these was 19.4, the individual amounts varying from 7.5 to 30 volumes per million. In all the other cowsheds a simple gauze strainer or gauze with a covering of muslin was used, the amounts varying from 15 to 120 volumes per million, with an average of 40.4.

It will be seen from these results that the amount of sediment in the milk at the cowshed varies with the cleanliness of the cows and the method of filtering.

On comparing the samples taken at the cowshed with those taken from the retailer, it is found that the latter show a decrease in the sediment, varying from 14.2 to 75 per cent. in 42 out of 61, or 68.8 per cent. of the samples, while in 11 samples, or 18 per cent., the sediment is the same in both. Adding these two together, we get 86.8 per cent., in which the farmer was wholly responsible for the sediment in the milk sold by the retailer. In 8 samples, or 13.1 per cent., there is an increase of from 10 to 66.6 per cent.

In 6 of the 8 samples in which there is an increase, the leucocytes were found to be more numerous in the sediment of those obtained from the retailers than in those obtained at the cowsheds. Leucocytes come from the udder of the cow and cannot gain entrance during transit, so that the increase in the deposit in these cases where the leucocytes also are increased cannot be wholly due to added material in transit. It may be due to imperfect shaking, or to the taking of the milk at the bottom of the receptacle.

The decrease in the deposit in the retailers' samples may have been due to the sedimentation of the milk during transit, and to the deposit remaining at the bottom of the churn when the milk was poured from the farmer's into the retailer's can. The decrease was not due to straining by the dairyman, as in only three cases was this done, Nos. 16, 25 and 37, in the first of which there was a decrease in the retailer's sample, while in the other two the deposits in both the cowshed and the retailer's samples were the same.

The following table shows the percentage of cowshed and of retailer's samples having different amounts of sediment. The greatest proportion of retailer's samples it will be noted fall into the first column, and none are found in columns 5 and 6.

	Vols. per million 0-20.	Vols. per million 20-40.	Vols. per million 40-60.	Vols. per million 60-80.	Vols. per million 80-100.	Vols. per million 100-120.	Vols. per million 120-140.
Cowshed Samples ..	27.8%	39.4%	26.2%	1.6%	1.6%	3.2%	..
Retailers' Samples ..	52.4%	39.3%	6.5%	1.6%	..	..	..

From these results one must conclude that the sediment gains entrance at the cowshed, and little, if any, in transit.

Houston has proposed a standard of 50 parts per million, but the writer, after considering the results of the various experiments, is inclined to suggest a lower one. Forty volumes per million or even 30 would be a very generous standard indeed. When the cotton-wool filter was used in the experiments, the sediment, even when the udders of the cows were very dirty, did not exceed 10 volumes, and where it had been used at the cowsheds by the farmers, the deposit did not exceed 30 volumes per million.

If this standard of 40 parts per million were adopted, 5 samples, or 8.2 per cent., of the retailer's samples would be condemned, while 20 samples or 32.8 per cent. of those taken at the cowshed, would fail to pass the test. The fact that so many as 41 out of 61, or 67.2 per cent of the cowshed samples gave 40 parts or less per million, shows that such a standard is easily possible.

It is worth noting at this point that 4 out of 18, or 22.2 per cent. of the town milks, and 16 out of 43, or 37.2 per cent. of the country milks, gave over 40 volumes of sediment per million.

It may be asked whether the amount of sediment has any relation to the number of bacteria present. If the sediment results of the cowshed samples are considered, it is found that those having 50 volumes and over per million numbered 9 or 26.4 per cent., of the samples in Group B., 3 or 25 per cent. of those in Group C., and 4 or 25 per cent. of those in D. In Group A., the sediment of only two was estimated, and no percentage can be calculated. It must be concluded from these percentages that there is no relationship between the amount of sediment and the number of bacteria present. This is only to be expected since the dirt is taken out by straining only after it has contaminated the milk by the organisms in it.

The imposing of such a sediment standard would, in all probability, cause greater care to be taken in the treatment of the milk, both by the farmer and by the dairyman.

Physical Characters of the Sediment.—The deposit was usually dark brown in colour, sometimes grey, and often contained hairs or pieces of straw. Sometimes a whitish translucent layer was found on the top, but this was always excluded from the estimation.

Microscopic Examination.—For microscopic observation, slides were made in the following way :—The solution of sodium carbonate was poured off and distilled water was added up to the .2 cc. mark. Then with a thick platinum wire the deposit was mixed and run into the thick part of the tube when a loopful of this watery sediment was spread over a marked part of a slide, ⅜ of an inch square. The film was dried, fixed in equal parts of ether and alcohol, and stained with methylene blue. This is simply a rough and ready method of obtaining a fixed amount of deposit on the slide for comparative purposes.

The examination revealed a variable amount of vegetable cells and granular material as well as leucocytes and sometimes hairs. Bacteria were always present, and sometimes yeast cells. Certain elements were often seen which appeared like the walls of collapsed cells. They were stained faintly with methylene blue, had no granular structure and no nucleus. Their size varied from two to six times the breadth of a leucocyte. Their shape was at times oval, but usually irregular, with rounded and smooth margins. On the surface were lines which crossed irregularly from one corner to another.

The whitish translucent layer already mentioned was found to be composed of these bodies and these were present in varying amounts, in nearly all samples examined. Examinations of manure for them proved negative. The milk of several cows was separately examined, and in one case these structures were abundantly present, but in the others scanty. The cow from which this milk was obtained possessed what was called a "fleshy" udder. Apparently they have their origin in the interior of the udder. Search has been made for references to these bodies, but without success. Their significance is therefore questionable.

Definite chains of streptococci were seen in 17 deposits. These were usually few in number, but in three cases they were numerous.

Other films were prepared and stained by the Ziehl-Neelsen method for tubercle bacillus, but the results were negative in all cases. It must be remarked, however, that failure to find the tubercle bacillus in this way is no evidence of its absence, while at the same time, other acid-fast bacilli staining in the same way may be present.

Leucocytes.—The leucocytes were counted as so many per field when viewed with a ⅙ inch objective and a No. 4 eye piece. Twelve fields were counted and the average taken. This method is a simple and rapid one for comparing the number of leucocytes in the various deposits. It must be noted, however, that the sediment was primarily obtained for estimation of amount and not for the estimation of leucocytes. Nevertheless, it was thought desirable to compare the numbers of leucocytes in different samples.

The term "pus" has often been applied to these cells, but such a use of the term is unfortunate as it is impossible to tell the difference between a pus-cell and a leucocyte. Savage remarks "That milk should not contain pus cells few will deny, but what constitutes pus in milk ? All milk contains leucocytes. When does a leucocyte become a pus cell, and what distinguishes one from the other ?" and again he says, "I cannot differentiate between a leucocyte and a pus cell, and I am not prepared at this stage to lay down an arbitrary standard as to what number of leucocytes per c.mm. is to be designated pus in milk."

It was only in 1897 that Stokes and Wegefarth first drew attention to a method of estimating the number of what they called pus cells in milk. Eastes, Bergey, Stewart and Slack successively investigated the subject, and published similar film methods of estimation. In 1905 the Doane-Buckley method for the estimation of the number of leucocytes by the Thoma-Zeiss hamacytometer was put forward by Doane as possessing greater scientific accuracy than the others. Savage, quite independently of Doane's work, published about the same time, a method practically similar.

Various standards have been proposed as to the number of leucocytes, estimated by these methods, which may constitute pus. These standards, however, have been arbitarily fixed from apparently insufficient data, and Russell and Hoffmann have shown that the subject requires further elucidation before any standard can be adopted. These observers found that the leucocyte content of normal milk from apparently normal animals is often so high that the milk would be classed as coming from diseased animals when judged by the standards which have already been proposed.

The great variability in the number of leucocytes in different samples of milk is shown in the results in the table. The leucocytes in the milk taken at the cowshed varied from 5 to 100 per field. The sediment in this last case was large in amount, 115 parts per million, and was composed practically of leucocytes so that this could undoubtedly be called pus. Further the milk from which it was obtained came from a cowshed in which a cow was suffering from acute tuberculosis, the udder possibly being involved. Streptococci were numerous in this sediment. The next highest number of leucocytes per field was 30, but here doubt exists as to whether the term pus can be applied, although many streptococci were again present. Below this there are all gradations from 22 to .5 per field. Apparently there is little relationship between leucocyte count and the presence of streptococci. In some sediments with a low count there were streptococci, while in some with a high count streptococci were absent. The significance of streptococci in the milk deposit is also doubtful, and requires further elucidation. The leucocyte counts in retailers' samples were usually less than the cowshed, although in some cases it was greater. Great stress, however, must not be put on this difference owing to the inaccuracy of the method of enumeration adopted.

SECTION III.

The estimation of the number of bacilli enteritidis sporogenes (Klein) at each stage of transit to discover if these organisms are added at any point.

The bacillus enteritidis sporogenes was believed by Klein to be the cause of epidemic diarrhœa, but Hewlett, Balfour Stewart and Glynn are of opinion that it has little causal connection with the disease. The first two observers have shown that it occurs widely distributed in nature, and is especially common in dust. They have also found it frequently present in milk.

Being a strict anaerobe, it does not grow under ordinary conditions, and unlike most other organisms, does not multiply in the milk at high temperatures. If a certain number of these organisms gain entrance at the farm, therefore, they will not be in greater numbers at the retailer's premises, or at the consumer's house, unless some have been added in transit.

TECHNIQUE.—Certain quantities of all the samples of milk examined were tested for bacillus enteritidis sporogenes. In the first series (Nos. 1 to 46) the amounts used were 10 cc., 1 cc., and 1/10 cc. In the second (Nos. 48 to 75) the quantities were increased to 20 cc., 10 cc., and 1 cc. The smaller amounts, 1 cc. and 1/10 cc., were each added to 10 cc., of sterile litmus milk and the larger amounts, 20 cc. and 10 cc., were put into empty sterile tubes. These were then heated at 80° C. for 15 minutes, put into Buchner's tubes with pyrogallate of potash, and incubated for 48 hours. The tubes showing the characteristic "enteritidis" change were counted as positive. No animal inoculations were made to confirm them. The results are arranged in Table XIII.

In the first series 17 out of 40, or 42.5 per cent. cowshed samples showed the presence of bacillus enteritidis sporogenes in 10 cc., while it was absent in all samples in 1 cc. and 1/10 cc. In 25 consumers' samples the organism was found in the same quantity as in the cowshed samples of the same set. In the consumers' samples, Nos. 5, 21, 22, 24, 27 and 40, it was absent from 10 cc., while present in the cowshed samples in a like amount. The bacillus was present in 10 cc. in six consumers' samples, Nos. 6, 7, 25, 30, 32 and 35, but absent in 10 cc. in the cowshed, railway station and retailers' samples of the same sets. It will be noted that in no case was evidence of the presence of the bacillus obtained in quantities ~~over~~ 10 cc. For under
this reason in the second series of examinations the amounts examined were increased the least used being 1 cc. In two station samples, Nos. 12 and 46, a positive result was obtained, the other samples in the same set being negative. Had this result been due to contamination at the railway station, the organisms would have been present also in the dairy and the consumer's house samples. Its absence from these shows that its presence in the former is due to accident in culturing. In two cases, 33 and 44, the organism is present in 10 cc. in the street and consumers' samples but absent at the cowshed, which must be taken as evidence of contamination possibly with dust in the street.

TABLE XIII.

Showing the quantity of milk of the various samples in each set in which Bacillus enteritidis sporogenes was present.

SERIES I.

Serial No.	Cowshed Sample.			Control Cowshed Sample.			Railway Station Sample.			Retailer's Sample.			Control Retailer's Sample.			Consumer's Sample.		
	10 cc.	1 cc.	1/10	10 cc.	1 cc.	1/10	10 cc.	1 cc.	1/10	10 cc.	1 cc.	1/10	10 cc.	1 cc.	1/10	10 cc.	1 cc.	1/10
7	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-	-
8	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-	-
9	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-	-
10	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-	-
11	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-	-
12	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
13	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-
14	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	.	.	.	+	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	.	.	.	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	.	.	.	+	-	-
19	-	-	-	-	-	-	-	-	-	.	.	.	.	.	.	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	.	.	.	-	-	-
21	+	-	-	-	-	-	.	.	.	+	-	-	.	.	.	-	-	-
22	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
23	+	-	-	+	-	-	.	.	.	+	-	-	.	.	.	+	-	-
24	+	-	-	+	-	-	.	.	.	+	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	.	.	.	+	-	-
26	-	-	-	-	-	-	.	.	.	-	-	-	-	-	-	-	-	-
27	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	-	-	-
28	-	.	-	-	-	-	.	.	.	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	.	.	.	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	.	.	.	-	-	-	-	-	-	+	-	-
31	+	-	-	-	-	-	.	.	.	-	-	-	+	-	-	+	-	-
32	-	-	-	-	-	-	-	-	-	.	.	.	.	.	.	+	-	-
33	-	-	-	.	-	-	-	-	-	+	-	-	-	-	-	+	-	-
34	+	-	-	+	-	-	+	-	-	.	.	.	+	-	-	+	-	-
35	-	-	-	-	-	-	-	-	-	.	.	.	-	-	-	+	-	-
36	-	-	-	-	-	-	-	-	-	.	.	.	-	-	-	-	-	-
37	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-
38	-	-	-	+	-	-	-	-	-	.	.	.	+	-	-	+	-	-
39	-	-	-	-	-	-	-	-	-	.	.	.	-	-	-	-	-	-
40	+	-	-	-	-	-	.	.	.	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	.	.	.	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-
44	-	-	-	-	-	-	.	.	.	+	-	-	-	-	-	+	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	42.5%	-	-															

SERIES II.

Serial No.	Cowshed Sample.			Control Cowshed Sample.			Railway Station Station.			Retailer's Sample.			Control Retailer's Sample.			Consumer's Sample.		
	20 cc.	10 cc.	1 cc.	20 cc.	10 cc.	1 cc.	20 cc.	10 cc.	1 cc.	20 cc.	10 cc.	1 cc.	20 cc.	10 cc.	1 cc.	20 cc.	10 cc.	1 cc.
48	+	+	–	+	–	–	+	–	–	–	+	–	+	+	–	–	–	–
49	+	+	–	+	+	+	+	+	–	+	+	–	+	+	–	+	+	–
50	+	+	–	+	–	–	–	–	–	–	+	–	+	–	–	+	+	–
51	+	+	–	–	+	–	.	.	.	–	–	–	+	–	–	+	+	–
52	+	–	–	+	+	–	+	–	–	+	–	–	–	–	–	–	–	–
53	+	–	–	+	+	–	.	.	.	–	–	–	+	–	–	+	–	–
54	+	–	–	+	+	–	+	–	–	+	–	–	.	.	.	+	–	–
55	+	+	–	+	+	–	+	+	–	+	+	–	+	+	–	–	–	–
56	+	+	–	+	–	–	+	–	–	+	+	–	+	–	–	–	–	–
57	+	–	–	+	–	–	+	–	–	.	.	.	.	.	.	–	–	–
59	+	+	–	+	–	–	.	.	.	+	–	–	+	–	–	+	+	.
60	+	+	–	+	+	–	.	.	.	+	+	–	+	+	–	+	+	–
61	+	–	–	+	–	–	+	+	.	+	+	–	–	–	–	+	+	–
62	+	+	–	+	–	–	+	–	–	+	+	–	–	–	–	+	–	–
63	+	–	–	+	–	–	.	–	–	+	–	–	–	–	–	–	–	–
64	–	+	–	+	–	–	.	.	.	+	–	–	–	–	–	–	–	–
65	+	+	–	+	–	–	+	+	.	+	+	–	+	+	–	+	+	–
66	+	–	–	–	–	–	+	–	–	+	–	–	–	–	–	–	–	–
67	+	+	–	+	+	+	.	–	–	+	+	–	+	+	–	+	+	–
68	–	–	–	–	–	–	.	.	.	–	–	–	–	–	–	–	–	–
69	+	–	–	+	–	–	+	.	.	+	–	–	–	–	–	–	–	–
70	+	–	–	+	+	–	–	–	–	+	+	–	–	–	–	+	–	–
71	–	–	–	+	–	–	–	–	–	+	–	–	–	+	–	+	+	–
72	+	–	–	+	+	–	.	.	.	+	–	–	+	–	–	+	–	–
73	–	–	–	–	–	–	.	.	.	+	–	–	+	–	–	+	–	–
74	+	+	–	+	+	–	.	.	.	–	–	–	–	–	–	+	–	–
75	+	–	–	+	–	–	.	.	.	+	–	–	–	–	–	–	–	–
	85.3%	48.1%	–															

The conclusion arrived at from the whole experiment is, that contamination by bacillus enteritidis sporogenes took place in six sets of this series, 16, 17, 25, 30, 32 and 35, or 15 per cent., at the consumer's house, and in two, 33 and 44, or 5 per cent., in the street. In five, 21, 22, 24, 27 and 40, there was no contamination during transit, but in the others it is doubtful. This doubt is due to the dilutions employed 10 cc. and 1 cc., which are so wide apart as to be unsatisfactory for detecting small additions.

The second series is more useful owing to the dilutions used. Of 27 cowshed samples, 23, or 85.3 per cent., were positive in 20 cc.; 12, or 44.4 per cent., were positive in 10 cc. and 20 cc.; 10, or 37 per cent., were positive in 20 cc., and negative in 10 cc.; 2, or 7.4 per cent., were positive in 1 cc.; and 3, or 11.1 per cent., were negative in 20 cc.

In 18 sets the cowshed samples contained the organism in amounts from which it was absent in the consumers' samples. In two the organism was present in smaller amounts in the consumers' samples than in those from the cowshed, in one it was present in the dairy sample only, while in six it was the same in the cowshed and consumers' samples.

This means that in at least 66.6 per cent., contamination by these organisms in transit did not occur, in 11.1 per cent. contamination did take place, while in 22.2 per cent. there is doubt. The farmer, therefore, in a large proportion of the samples, is solely responsible for the presence of this organism in the milk at the consumer's house. On comparing the results of these examinations for enteritidis sporogenes with the total bacterial counts at the cowshed, little relationship is found. This want of relationship is seen in the following table, which compares the percentage of samples in each group in the Cowshed Table, having bacillus enteritidis sporogenes present in 10 cc., with the percentage showing its absence in 10 cc. of milk.

TABLE.

Percentage of samples in each main group positive and negative as regards bacillus enteritidis sporogenes in 10 cc. of milk.

Group.	Positive per cent.	Negative per cent.
A.	75	25
B.	40.5	59.5
C.	40	60
D.	56.25	43.75

Had there been any relationship between the total bacterial content and the presence or absence of bacillus enteritidis sporogenes, group A. should have come out very much better, and groups C. and D. very much worse.

The significance of Klein's bacillus is questionable. It is present in 10 cc. in 75 per cent. of the milk samples in Group A., which otherwise are good milks, containing very few bacteria, while absent in the same amount in others containing a larger number of bacteria. Its presence may be due to dust pollution, either in the place where the cans are stored or in the cowshed.

Houston found the organisms in 1/10 cc. in 5 per cent. of the samples taken at the railway stations and retailers' premises, and in 1 cc. in 32.5 per cent. In 10 per cent. of the samples of milk taken from separate cows it was found in 1 cc. also. The writer examined the milk of ten separate cows whose udders had been washed and whose milk was collected in sterile pails, the quantity examined in each case was 50 cc., and the result in each was negative.

Houston has proposed as a standard that milk should not contain bacillus enteritidis sporogenes in 1 cc. This standard appears a very fair one and is only infringed by two samples, Nos. 49 and 67, and then only in the control cowshed samples, and not in the remaining samples of the sets. Possibly the presence of the organism in these is entirely accidental, an occurrence which is liable to take place in estimating organisms by this method of dilution.

SECTION IV.

The estimation of the number of glucose-fermenting bacteria and streptococci at each stage to determine the increase due to contamination during transit.

1. GLUCOSE-FERMENTING BACTERIA.—Under this head are grouped all the organisms producing acid and gas in glucose taurocholate broth (MacConkey's medium). The gas-forming bacteria of some observers and the colon or coliform bacteria of others are included under this head. Bacillus coli communis, a lactose fermenter, has always been considered the index of pollution by sewage or excrement. Many bacteria have been described which are closely related to this organism, and these often have been spoken of as "atypical bacilli coli."

The excellent work done by MacConkey in regard to these organisms has enabled identification of the so-called atypical forms to be carried out in a more rational way by employing media containing carbohydrates, and has shown how numerous are the bacteria possessing the characteristics of this group to which the term colon or coliform has been applied.

It is probable that all these glucose fermenters, including as they do, the lactose and non-lactose fermenters, are of faecal origin and are as sure an indication of faecal contamination, human or animal, as bacillus coli communis.

CULTURE METHODS.—The medium used was the bile-salt or sodium taurocholate peptone solution of MacConkey poured into Durham's tubes. To these tubes were added quantities from 1 cc. to 1/1,000,000 cc. of each sample of milk. They were then incubated at 37° C. for at least 48 hours, and those showing the presence of gas after that time were plated out to confirm the presence of glucose-fermenting organisms, and for the purpose of identification by methods considered below.

The bile-salt broth, it has been found, is much more likely to give positive results than plain glucose broth with the same amount of milk. The bile-salt appears to stimulate the growth of the glucose-fermenters while preventing the growth of other organisms which might have an inhibitory effect on them. It must be remarked, however, that non-lactose fermenters were sometimes obtained alone in the lowest dilutions. In 13 out of 389 samples, or 3.3 per cent. examined, positive results were obtained in Durham's tubes, but on sub-culturing, no glucose fermenters were found. In 10 only, or 2.5 per cent., were non-lactose fermenters found alone. This shows that taurocholate broth is a valuable medium for demonstrating the presence of the lactose and non-lactose fermenters, but not of bacillus coli alone. In all cases where a positive result is marked in the tables, organisms belonging to the group of lactose or non-lactose fermenters have been isolated on sub-culturing.

The control samples were also examined to find if any contamination by these organisms took place in transit, but the results are of little value on account of the method employed. Where the quantities used for inoculation purposes are 1 cc., 1/10 cc., 1/100 cc., 1/1,000 cc., etc., only a rough idea of the number present can be obtained. For instance, supposing a milk gives a positive result in 1 cc., but not in 1/10, there may be from one to nine organisms present, or if a positive result is given in 1/100 and not in 1/1,000, there may be from 101 to 999 organisms, and it may happen that by chance a positive result may be obtained in 1/1,000 cc. where there are less than 999 organisms present. Thus, small additions cannot be detected, and the control samples are of little or no value for showing contamination by these organisms during transit.

Although inaccurate, it is the only method generally applicable to a large number of samples, and the results give a general idea of the numbers, within certain limits, of the glucose fermenting bacteria present.

The results are given in Table XIV., where is indicated the highest dilution of each sample in which these organisms were present.

In the following table are represented the percentages of the cowshed, retailers' and consumers' samples, giving positive results in the various dilutions, as well as those negative in 1 cc.

	Cowshed Samples. Per cent.	Retailers' Samples. Per cent.	Consumers' Samples. Per cent.
1 cc. negative	23.2	10.7	2.9
1 cc. positive	42	20	15.9
1/10 cc. "	15.9	33.8	15.9
1/100 cc. "	5.8	13.8	15.9
1/1,000 cc. "	10.1	12.3	18.8
1/10,000 cc. "	2.9	7.7	18.8
1/100,000 cc. "	—	1.5	11.6
1/1,000,000 cc. "	—	—	—

TABLE XIV.

Showing the highest dilution of each Sample in which glucose fermenting bacteria were found.

No.	Cowshed.	Cowshed Control.	Railway Station.	Street.	Retailer's Premises.	Retailer's Control.	Consumer's House.
5	1 cc.	—	..	1 cc.	..	1/100	1 cc.
6	—	—	..	1 cc.	..	1/10	1/100
7	—	—	..	..	—	—	—
8	—	—	..	..	..	—	—
9	1 cc.	1 cc.	..	..	1/10	1/10	1/10
10	1 cc.	1 cc.	..	1 cc.	1/10	1/10	1/10
11	1/10	1/10	..	1/10	..	1/100	1/1,000
12	1 cc.	1/100	1/10	..	1/10	1/100	1/100
13	1/10	1/10	1 cc.	1/1,000	..	1/10,000	1/10,000
14	—	1 cc.	1 cc.	1/10	..	1 cc.	1/10
15	1 cc.	1/10	1 cc.	1/10	..	1/1,000	1/100
16	—	1 cc.	—	..	1/10	1/10,000	1/10,000
17	—	—	1 cc.	..	1/10	1/1,000	1/10,000
18	—	1 cc.	—	..	—	1/10	1/100
19	1/1,000	1/1,000	1/1,000	..	..	..	1/1,000
20	1/10	1/100	1/10	1/10	..	1/10,000	1/10,000
21	1 cc.	1/10	..	1/10	..	1/1,000	1/1,000
22	1/10	1/100	1/100	1/10,000	..	1/100,000	1/10,000
23	1/1,000	1/1,000	..	1/10	..	..	1/100,000
24	1/1,000	1/10,000	..	1/1,000	..	1/100,000	1/1,000
25	—	1/100	—	1/10	1/100	..	1/1,000
26	1 cc.	1 cc.	..	1/10	..	1/100	1/10
27	1/10	1/10,000	1 cc.	1/10	..	1/1,000	1/100,000
28	—	1/10	..	—	..	1/100	1/1,000
29	1 cc.	1/10	..	1/10	..	1/100	1/100,000
32	1 cc.	1/10	..	1/10,000	..	1/10,000	1/1,000
31	1 cc.	—	..	1/10	..	1/10	1/100
32	1 cc.	1/100	..	1/1,000	..	..	1/1,000
33	1/10	1/100	1/1,000	1/100	..	1/10,000	1/100,000
34	1 cc.	1/10	..	1/10	..	1/10	1/10
35	1 cc.	1/10	..	1/10	..	1/100	1/1,000
36	1/100	1/100,000	..	1/1,000	..	1/100,000	1/100,000
37	1/10,000	1/10,000	1/10,000	1/100,000	..	1/10,000	1/10,000
38	1/1,000	1/100,000	..	1/100	..	1/10,000	1/10,000
39	—	1/10	..	—	..	1/10	1/100
40	1/1,000	1/100,000	1/10,000	..	..	—	1/100,000

TABLE XIV.—*continued.*

No.	Cowshed.	Cowshed Control.	Railway Station.	Street.	Retailer's Premises.	Retailer's Control.	Consumer's House.
41	—	1/1,000	—	..	—	1/10	1 cc.
42	1/10	1/10	1/10	1/100	..	1/1,000	1/1,000
43	1/10	1/1,000	1/100	1/1,000	..	1/10,000	1/1,000
44	1/10	1/1,000	1/100	..	1/10,000	1/100	1/10,000
45	—	1 cc.	1/1,000	1/100	..	1/1,000	1/100
46	—	—	..	—	..	1 cc.	1 cc.
47	..	..	..	..	..	..	..
48	1/1,000	1/100,000	1/1,000	1/10,000	..	1/100,000	1/100,000
49	1/100	1/1,000	1/100	1/10	..	1/1,000	1/1,000
50	1/1,000	1/10,000	..	1/1,000	..	1/10,000	1/10,000
51	1 cc.	1 cc.	..	1 cc.	..	1 cc.	1/100
52	1/10	1/10	1/10	..	1/10	1/100	1/10
53	1 cc.	1 cc.	..	..	1/10	1 cc.	1 cc.
54	1 cc.	1 cc.	1 cc.	..	1 cc.	1 cc.	1 cc.
55	1 cc.	1/10	1/10	..	1 cc.	1/10 cc.	1 cc.
56	1 cc.	1 cc.	1/10	..	1/100 cc.	1/10,000	1/100,000
57	—	1 cc.	1 cc.	..	..	..	1 cc.
58	..	..	..	..	..	..	..
59	1 cc.	1/10	..	1 cc.	1/10	1 cc.	1 cc.
60	1/10,000	1/100,000	..	..	..	1/100	1/100
61	1 cc.	1 cc.	1/100	..	1/1,000	1/1,000	1/10,000
62	1 cc.	1 cc.	1 cc.	1 cc.	..	1 cc.	1/10
63	1 cc.	1/10	..	1 cc.	..	1/100	1/10
64	—	1 cc.	..	1 cc.	..	1 cc.	1 cc.
65	1/100	1/100	1/100	..	1/100	1/10	1/100
66	1 cc.	1 cc.	1 cc.	..	1/100	—	1 cc.
67	1/10	1/10	..	..	1 cc.	1 cc.	1/10
68	1 cc.	1 cc.	..	1 cc.	..	1/10	1/10
69	1/100	1/100	1/100	..	1/1,000	1/100	1/10,000
70	1 cc.	1/100	1 cc.	..	1 cc.	1/1,000	1/10,000
71	1 cc.	1/10	1 cc.	1 cc.	..	1/10	1/10,000
72	1 cc.	1 cc.	..	1 cc.	..	1 cc.	1/10
73	—	—	..	..	1/100	1/10	1/100
74	1 cc.	—	..	1/10	..	—	1 cc.
75	1 cc.	1 cc.	..	..	1/10,000	1/1,000	1/1,000

A smaller percentage of retailers' than of cowshed samples are found negative in 1 cc., and a still smaller pecrentage of consumers' samples. The percentages positive of retailers' samples and consumers' samples in the higher dilutions are much greater than those of the cowshed samples. There is, apparently, a gradual increase in the number of glucose fermenting bacteria as the milk goes from the farmer to the retailer and to the consumer, but it cannot be said how much this increase is due to the influence of temperature stimulating the growth of those already present, and how much to contamination. Conn has shown that these organisms, which he classes under the B. lactis aerogenes group, multiply much more rapidly at the higher temperatures (above 20° C.) than the other bacteria which do not ferment glucose. These organisms, therefore, will be in greater proportion in milk in the warm than in the cool months of the year. Hence there is the much greater necessity for cooling to prevent the glucose fermenting organisms increasing with the rise in temperature in the summer.

There is also a relationship between high bacterial content and a large number of the glucose fermenting organisms. For instance, taking the cowshed samples which are negative in 1 cc., it is found that in Table I. they form 40 per cent. of group A., 82.3 per cent. of B., 13.3 per cent. of C., and 6.25 per cent. of D. The two samples which give a positive result in 1/10,000, the highest dilution, are both in group D.

Source of Glucose-Fermenting Bacteria.—Harrison examined the milk from 25 cows for glucose-fermenters, called by him gas-producing organisms. The udders were brushed and wiped with a damp cloth, the first milk was rejected and the samples taken in sterile test tubes. From the milk of two of these cows, gas-producing bacteria were isolated. The milk of these two cows was tested a week later with similar results. He notes also in this connection that Moore and Ward also isolated gas-producing bacteria from the udders of certain cows, but it is evidently an exceptional state of affairs.

MacConkey examined six samples of milk drawn into sterile test-tubes from a single cow, two being taken at the beginning, two in the middle, and two at the end of the milking. Three samples drawn in the same way from another cow were examined; one was taken at the beginning, the second in the middle, and the third at the end of milking. Another sample consisting of portions of the whole milk of a single cow drawn straight from the udder into a sterile test-tube was also examined. In all these samples glucose-fermenting organisms were absent.

During the present investigation similar experiments were carried out. The cows had their udders washed and the milk was drawn with great care into sterile flasks in the manner already mentioned in connection with the examination of the foremilk, etc. Samples of the fore-milk, of the mid-milk, and of the strippings from the right fore-quarter of the udder of eight different cows as well as of the fore-milk from all the other quarters of the same cows, were examined. Of each sample, 10 cc. were inoculated into double strength glucose taurocholate broth and incubated for 48 hours at 37° C. Further 50 cc. of each were incubated at 37° C. for 12-16 hours, and then sub-cultured into glucose taurocholate broth, which was again incubated for 48 hours. That is 60 cc. of each sample were examined for this group of organisms. In all 48 samples a negative result was obtained. These results correspond with those of MacConkey.

Taurocholate-agar plates were held underneath the udders of six cows, which were not groomed or washed, during milking, and from all six plates glucose-fermenting bacteria were isolated.

Manure was examined for gas formers, both old material sticking to the cows and fresh. The manure, weighed in a sterile flask, was mixed with 100 cc. sterile water, and the lowest amount of this fluid giving a positive result is shown in the following table :—

		Quantity.	Highest Dilution.	Result.
I.	(Fresh) ..	2.152 grams shaken up in 100 cc. sterile water ..	1 cc. ..	Positive
II.	(Fresh) ..	.59 ,, ,, ..	1/100 cc. ..	,,
III.	(Old) ..	1.115 ,, ,, ..	1/100 cc. ..	,,
IV.	(Old) ..	2 ,, ,, ..	1/1,000 cc. ..	,,
V.	(Fresh) ..	2.37 ,, ,, ..	1 cc. ..	,,
VI.	(Old) ..	1.79 ,, ,, ..	1/100 cc. ..	,,
VII.	(Fresh) ..	1.875 ,, ,, ..	1/100 cc. ..	,,
VIII.	(Old) ..	1.560 ,, ,, ..	1/1,000 cc. ..	,,

It is seen that old manure contains a greater number of glucose-fermenting organisms than fresh.

Some milk churns at farms, after being cleaned and prepared to receive the milk, were examined for members of this group of bacteria. The cans were washed out with 100 cc. sterile water and from this dilutions were made and inoculated into glucose-broth. The following are the highest dilutions which gave positive results :—

1.	Highest dilution positive ..	1/1,000 cc.	of washings.
2.	,, ,, ..	1/10,000 cc.	,,
3.	,, ,, ..	1/1,000,000 cc.	,,
4.	,, ,, ..	1/100,000 cc.	,,

The dust found on the window ledges in the cowshed was examined on four occasions for these organisms with negative results. The moist material on the floor of the cowshed, however, gave positive results in the two samples examined.

On twelve occasions open sterile plates also were placed in the cowshed for ten minutes each. These were washed out with sterile broth and inoculated into taurocholate broth tubes, but gave negative results. Harrison also found that these organisms were absent from the cowshed air.

These experiments show that the glucose fermenting bacteria gain entrance from the dirt on the udder, from manure and from the milk vessels, but not from the air or dust. They further show that a greater number of them can be introduced by means of the fluid left in improperly cleaned cans than by the usual amount of manure getting into the milk during milking. Two estimations of the quantity of manure getting into quantities of 12 and 14 gallons of milk during milking gave 2 and 1.4 grams respectively.

Probably these organisms found in the cans originally come from manure, and are thereafter propagated in the milk kept at a temperature favourable for growth. The fresh milk is being constantly infected by the bacteria left in the dirty cans.

To determine the effect of washing the udders and of sterilizing the cans, on the presence of the glucose-fermenters in milk, the following experiments were undertaken. The udders were washed, the cans sterilized by steam as before, and the cows were milked by men with clean hands. Eight cows were treated in this way, and the milk of each cow was found to be negative in 50 cc. The whole milk of a herd of 10 cows, whose udders had been washed, was examined, but no gas formers were present in 10 cc. Two samples of milk from dirty cows were next examined, and these both gave positive results in 10 cc., but negative in 1 cc.

The following is an example showing that milk cans may be the source of the greatest number of glucose-fermenting organisms. In a sample of the whole milk of a cowshed, where the cows were ungroomed and very dirty, taken early in the year, there was found to be glucose fermenters in 1/10 cc. When greater attention later was paid to the sterilization of the cans by steaming thoroughly, the cows remaining still ungroomed, these organisms were absent in 1 cc., but present in 10 cc., while still later, when the udders were washed as well, they were absent in 10 cc.

These results show that it is easily possible with care to obtain milk showing an absence of glucose-fermenters in 1 cc. To obtain this result it is most essential to have the cans or milk vessels thoroughly cleaned, and scalded by either steam or boiling water.

Milk produced with care and cleanliness should, therefore, show no glucose fermenters in 1 cc. Of the cowshed samples taken during the investigation, 16, or 23.2 per cent., gave a negative result in 1 cc., and 29, or 42 per cent., a positive result in 1 cc. The conclusion one draws from these results is that no milk containing glucose-fermenting organisms in 1 cc. at the cowshed should be allowed to be sold, but at first a standard might be imposed forbidding the sale of milk showing at the farm these organisms in 1/10 cc. With such a standard, 34.8 per cent. of the milks examined at the cowshed would have been condemned.

Five samples of dry station dust were examined for glucose fermenters, but the results were negative. H. Chick (1901) examined samples of dry road dust and found bacillus coli, typical and atypical, as a rule absent. In the wet samples examined, bacillus coli was usually found. Drying apparently, therefore, kills these organisms. Dry dust blown on to the churns at the railway station or in transit therefore, cannot be a source of these organisms, although Houston (see later) is of a contrary opinion.

Dairymen's cans after being cleaned and made ready to receive milk, were also examined for members of this group of organisms, in the same month as the farmers' cans. They were washed out with 100 cc. distilled water, and of this different quantities (1 cc. to 1/1,000,000) were used for inoculating glucose taurocholate broth tubes. The following table shows the highest dilution of each giving a positive result.

I.	..	1 cc.	..	negative.
II.	..	1 cc.	..	negative.
III.	..	1/10,000 cc.	..	positive.
IV.	..	1/1,000 cc.	..	positive.
V.	..	1 cc.	..	negative.
VI.	..	1 cc.	..	negative.

These results show that the retailers' cans or churns are not a source of so great contamination as the farmers'.

Four samples of dust taken in dairies and four in dirty houses were examined, but all gave negative results.

Sterile plates were also exposed to the air and dust in four places in which milk was retailed, and in four consumers' houses for an hour. These were washed out with 2 cc. sterile broth and glucose broth tubes inoculated with 1 cc. The results were negative in all cases.

Four receptacles used by the consumer were washed with 100 cc. sterile water, which was examined, but no glucose-fermenting organisms were present in 10 cc. of the liquid.

Flies, as already mentioned, may be a source of glucose-fermenters at the cowshed, dairy or consumer's house, but especially at the latter, where they are most numerous. Their legs may become contaminated by animal or human faeces, the latter where privy middens exist, and by that means the milk may become infected even by pathogenic organisms, for example, those of typhoid fever, or possibly of epidemic diarrhœa. Flies, however, cannot be a source of any very great contamination by glucose-fermenting organisms.

Considering all the sources of the glucose-fermenting bacteria, one must conclude that by far the greatest number gain entrance at the cowshed.

The objections to the adoption of a standard of total organisms in milk sold by retailers prevail also in the case of the glucose-fermenting bacteria.

2. STREPTOCOCCI.—Streptococci were searched for in the milk samples in the following manner.

The medium used was glucose broth, made according to MacConkey's formula, but omitting the sodium taurocholate, which inhibits the growth of streptococci. The medium was contained in Durham's tubes, which were inoculated with quantities of milk from 1 cc. to 1/1,000,000 cc. The tubes, after inoculation, were incubated for 48 hours at 37° C. Those showing an acid reaction were further examined. Two films made from the fluid in each, were stained with methylene blue and examined microscopically for streptococcal chains. Only films showing definite chains of streptococci were counted positive. The remarks as to the control samples being of no value under "Glucose fermenting bacteria" also apply here.

SOURCE OF STREPTOCOCCI.—The milk from the right fore-quarter of the following cows, taken with the greatest precautions into a sterile flask, was examined for these organisms. Glucose broth was used as above.

		Fore-milk.			Mid-milk.			Stripping.	
		10 cc.	1 cc.		10 cc.	1 cc.		10 cc.	1 cc.
Cow A.	..	–	–	..	–	–	..	–	–
,, B.	..	–	–	..	–	–	..	–	–
,, C.	..	+	–	..	+	–	..	–	–
,, D.	..	–	–	..	–	–	..	–	–
,, E.	..	+	–	..	+	–	..	+	–
,, F.	..	+	–	..	+	–	..	+	–
,, G.	..	+	–	..	+	–	..	–	–
,, H.	..	+	–	..	–	–	..	–	–
,, K.	..	+	–	..	+	–	..	+	–

Next the fore-milk from the other quarters, lettered *b*, *c* and *d*, of the same cows was examined in the same way.

	b. 10 cc.	*b.* 1 cc.	*c.* 10 cc.	*c.* 1 cc.	*d.* 10 cc.	*d.* 1 cc.
Cow A.	+	–	–	–	–	–
,, B.	–	–	–	–	–	–
,, E.	+	+	–	–	–	–
,, F.	+	–	+	–	+	+
,, G.	+	–	–	–	–	–
,, H.	–	–	–	–	–	–
,, K.	–	–	–	–	–	–

The highest dilutions of each sample showing the presence of streptococci are noted in Table XV. Streptococci were present in all samples, and the percentages of cowshed, retailers' and consumers' samples giving positive results in the various dilutions are shown in the table.

		Cowshed Samples.	Retailers' Samples.	Consumers' Samples.
1 cc.	Negative ..	—	—	—
1 cc.	Positive ..	—	—	—
1/10 cc.	,,	17.4	9.2	2.9
1/100 cc.	,,	34.7	26.1	24.6
1/1,000 cc.	,,	31.8	36.9	23.2
1/10,000 cc.	,,	14.5	24.6	23.2
1/100,000 cc.	,,	1.4	3.0	26.
1/1,000/000 cc.	,,	—	—	—

The percentages showing a positive result in the highest dilutions increase from left to right in the table, being greatest in the consumers' samples column, as in the case of the glucose-fermenting bacteria.

Comparing the table showing the percentages of glucose-fermenters with this table of the streptococci, it is found that the percentages of the former in the highest dilutions are much greater than of the latter. Streptococci are thus more abundantly present in the milk than the glucose-fermenting bacteria.

It is apparent from these results that milk free from streptococci is not got directly from the teat. These organisms are sometimes present in one or more quarters, but not always in all four, and are often absent altogether from all the quarters of some cows. Savage has also found streptococci often present in milk taken directly from the teat, even in amounts as small as 1/10 cc. Houston, Conn and others also have found streptococci in milk taken direct from the udder.

Streptococci are found in manure in large numbers. In the following table the highest dilutions, in which streptococci are found, are compared with those containing the glucose fermenters. The manure was treated in the same way as when examining for glucose fermenters by mixing with 100 cc. sterile water and making the dilutions from this solution.

			Streptococci.	Glucose Fermenters.
I.	Fresh	2.15 grams	1/10 cc.	1 cc.
II.	Fresh	.59 ,,	1/10 cc.	1/100 cc.
III.	Old	1.115 ,,	1/100,000 cc.	1/100 cc.
IV.	Old	2 ,,	1/100,000 cc.	1/1,000 cc.
V.	Fresh	2.37 ,,	1/10 cc.	1 cc.
VI.	Old	1.79 ,,	1/100,000 cc.	1/100 cc.
VII.	Fresh	1.875 ,,	1/10 cc.	1/100 cc.
VIII.	Old	1.560 ,,	1/10,000 cc.	1/1,000 cc.

The table shows the remarkable difference between the number of streptococci in fresh manure and that in old. It demonstrates also that the glucose fermenters in the old material are much less numerous than the streptococci, while there is not much difference between the two in fresh manure. In two samples of fresh manure, the streptococci are present in 1/10 and the glucose-fermenters in 1 cc., while in other two, the streptococci are present in 1/10 cc., and the glucose-fermenters in 1/100 cc. Obviously, therefore, old manure is a great source of streptococci, as of other contaminating organisms.

Another source is the improperly cleaned cans of the farmer as well as those of the retailer, where the souring milk which contains large numbers of streptococci is imperfectly washed out and the organisms are not killed by sterilization.

TABLE XV.

Showing the highest dilution of each Sample in which Streptococci were found.

No.	Cowshed.	Cowshed Control.	Railway Station.	Street.	Retailer's Premises.	Retailer's Control.	Consumer's House.
5	1/10	1/10	..	1/10	..	1/100	1/10
6	1/10	1/10	..	1/100	..	1/100	1/100
7	1/100	1/10	..	..	1/100	1/100	1/100
8	1/10	1/10	..	1/10	..	1/10	1/100
9	1/10	1/100	..	..	1/100	1/100	1/100
10	1/100	1/100	..	1/100	1/100	1/100	1/100
11	1/100	1/100	..	1/100	..	1/100	1/1,000
12	1/100	1/1,000	1/100	..	1/100	1/100	1/100
13	1/100	1/100	1/1,000	1/1,000	..	1/10,000	1/10,000
14	1/100	1/100	1/100	1/100	..	1/100	1/1,000
15	1/100	1/100	1/10	1/10	..	1/1,000	1/100
16	1/10	1/100	1/10	..	1/1,000	1/10,000	1/10,000
17	1/10	1/10	1/100	..	1/1,000	1/1,000	1/1,000
18	1/1,000	1/10,000	1/1,000	..	1/1,000	1/10,000	1/10,000
19	1/1,000	1/1,000	1/1,000	..	..	..	1/1,000
20	1/10	1/10	1/100	1/100	..	1/10	1/10
21	1/100	1/1,000	..	1/1,000	..	1/1,000	1/1,000
22	1/1,000	1/1,000	1/100	1/100	..	1/1,000	1/10,000
23	1/10	1/100	..	1/100	..	..	1/10,000
24	1/1,000	1/1,000	..	1/1,000	..	1/1,000	1/100
25	1/10	1/1,000	1/10	1/10	1/1,000	..	1/10,000
26	1/100	1/100,000	..	1/1,000	..	1/10,000	1/100,000
27	1/10	1/10,000	1/100	1/1,000	..	1/1,000	1/100
28	1/10,000	1/1,000	..	1/1,000	..	1/10,000	1/100
29	1/100	1/1,000	..	1/100	..	1/100	1/10,000
30	1/100	1/100,000	..	1/10,000	..	1/100,000	1/100,000
31	1/1,000	1/100	..	1/10,000	..	1/100,000	1/10,000
32	1/1,000	1/100	..	1/1,000	..	..	1/1,000
33	1/1,000	1/100,000	..	1/10,000	..	1/100,000	1/100,000
34	1/1,000	1/1,000	..	1/1,000	..	1/1,000	1/10,000
35	1/10,000	1/10,000	..	1/10,000	..	1/100,000	1/10,000
36	1/10,000	1/10,000	..	1/1,000	..	1/10,000	1/1,000
37	1/10,000	1/100,000	1/10,000	1/100,000	..	1/100,000	1/100,000
38	1/1,000	1/10,000	..	1/1,000	..	1/10,000	1/100,000
39	1/1,000	1/10,000	..	1/10,000	..	1/100,000	1/100,000
40	1/10,000	1/100,000	1/10,000	..	..	1/10,000	1/100,000

TABLE XV.—*continued.*

No.	Cowshed.	Cowshed Control.	Railway Station.	Street.	Retailer's Premises.	Retailer's Control.	Consumer's House.
41	1/100,000	1/100,000	1/100,000	..	1/10,000	1/10,000	1/100,000
42	1/10,000	1/1,000	1/1,000	1/10,000	..	1/10,000	1/100,000
43	1/1,000	1/1,000	1/1,000	1/10,000	..	1/100,000	1/100,000
44	1/10,000	1/100,000	1/10,000	..	1/10,000	1/100,000	1/100,000
45	1/100	1/100	1/1,000	1/1,000	..	1/10	1/1,000
46	1/1,000	1/10,000	..	1/10	..	1/10,000	1/10,000
47	..	..	..	..	..	..	..
48	1/1,000	1/1,000	1/1,000	1/1,000	..	1/1,000	1/10,000
49	1/100	1/100,000	1/1,000	1/10,000	..	1/100,000	1/100,000
50	1/10,000	1/100,000	..	1/10,000	..	1/100,000	1/100,000
51	1/10,000	1/1,000	..	1/100,000	..	1/10,000	1/100,000
52	1/1,000	1/1,000	1/10,000	..	1/1,000	1/1,000	1/10,000
53	1/1,000	1/10,000	..	..	1/10,000	1/10,000	1/100,000
54	1/100	1/100	1/100	.	1/100	..	1/100
55	1/10,000	1/10,000	1/10,000	..	1/1,000	1/1,000	1/1,000
56	1/100	1/1,000	1/1,000	..	1/1,000	1/10,000	1/100,000
57	1/100	1/10,000	1/1,000	..	..	..	1/1,000
58	..	..	..	..	..	..	..
59	1/100	1/10,000	..	1/1,000	1/100	1/1,000	1/100
60	1/100	1/10,000	..	..	..	1/1,000	1/100
61	1/1,000	1/1,000	1/10,000	..	1/1,000	1/100	1/100
62	1/100	1/100	1/100	1/10,000	..	1/1,000	1/1,000
63	1/100	1/100	..	1/10	..	1/100	1/1,000
64	1/100	1/10,000	..	1/1,000	..	1/1,000	1/1,000
65	1/1,000	1/10,000	1/10,000	..	1/10,000	1/10,000	1/10,000
66	1/100	1/100	1/1,000	..	1/10,000	1/1,000	1/1,000
67	1/1,000	1/1,000	..	..	1/100	1/100	1/100
68	1/1,000	1/1,000	..	1/10,000	..	1/10,000	1/1,000
69	1/100	1/10,000	1/10,000	..	1/100	1/1,000	1/10,000
70	1/100	1/100	1/100	..	1/100	1/1,000	1/10,000
71	1/1,000	1/10,000	1/1,000	1/1,000	..	1/10,000	1/100,000
72	1/1,000	1/100	..	1/100	..	1/100	1/1,000
73	1/10	1/10	..	..	1/10	1/10	1/100
74	1/1,000	1/1,000	..	1/1,000	..	1/10,000	1/100,000
75	1/10	1/100	..	..	1/100	1/100	1/100

The washings of the farmers' cans which were examined for glucose-fermenters were also examined for streptococci with the following results. The cans, it will be remembered, were washed out with 100 cc. sterile water, and the dilutions made from this.

		Highest dilution positive.
I.	..	1/100 cc.
II.	..	1/1,000 cc.
III.	..	1/100,000 cc.
IV.	..	1/10,000 cc.

Dairymen's cans, treated in the same way, gave :—

		Highest dilution positive.
I.	..	1 cc. negative.
II.	..	1 cc. negative.
III.	..	1/1,000 cc. positive.
IV.	..	1/1,000 cc. positive.
V.	..	1 cc. negative.
VI.	..	1 cc. negative.

Four samples of dust from the cowshed were examined, and all contained streptococci. No streptococci were found in four samples of station dust. Four sterile plates were exposed in retailers' premises and four in consumers' houses for an hour each. These were washed out with sterile broth, which was inoculated into glucose broth, but all gave negative results.

These experiments show that the greatest sources of streptococci are the improperly cleaned cans of the farmer, manure, and later, the improperly cleaned cans of the dairyman. The farmer here also is responsible for the admission of the greatest number of these organisms to the milk.

The differentiation of streptococci is still very unsatisfactory. Gordon has introduced a series of tests for identification purposes, but further extended observations are necessary to secure a firm basis for classification. It would be necessary in the present instance, before drawing conclusions as to the origin of these organisms in milk, to differentiate fully all streptococci occurring in milk as it leaves the udder and those in bovine faeces.

Houston isolated from milk 172 streptococci and determined their reactions in the various media suggested by Gordon. He compared the results obtained with those of streptococci of faeces, human and bovine, but it cannot be said that the results were of much value in determining the origin of the streptococci in the milk. More observations and more complete differentiation are necessary.

It is questionable whether a standard for streptococci would be of value owing to their presence in the milk directly drawn from the cow, and owing to the difficulty in differentiation.

The glucose-fermenting organisms, on the other hand, both because they are not found in milk drawn directly from the teat and because they can be readily differentiated, are an excellent index of contamination outside the udder, *e.g.*, from manure and dirty cans. Moreover, the number of the glucose-fermenters in old manure and in souring milk is not much smaller than the streptococci, and their presence or absence in 1 cc. of milk forms a sufficiently sensitive test of pollution by means of these.

SECTION V.

The identification of the various species of glucose-fermenting bacteria to determine if any new species are added at various points of transit of the milk.

This method of detecting added organisms has proved unsatisfactory for three reasons. In the first place, organisms found in the sample taken at the cowshed may not be found in the retailer's or the consumer's sample, owing to some organisms growing more rapidly and becoming more numerous than those which were originally the more abundant. Again, an organism may be present in the cowshed sample and only become apparent in the milk taken at the retailer's premises or consumer's house after it has multiplied, owing to exposure to a temperature favourable for growth. Lastly, on incubation in taurocholate broth, one organism may increase very rapidly and another only very slowly, so that, on sub-culturing, the former only appears on the sub-culture plate. Nevertheless, it seems probable that the differentiation of the non-lactose and lactose fermenting bacteria in milk will be of value as showing the number of species of organisms found in milk taken at the cowshed.

Unfortunately, the methods of differentiation are very varied. If a more uniform method were established, more valuable data might be accumulated regarding the distribution of all these organisms.

In the present investigation, the methods of MacConkey, in which the carbohydrate-splitting properties of these organisms are taken advantage of, have been followed.

It has been suggested that the action of these bacteria on the different carbohydrates varies, and that the reactions therefore, are of little value for differentiation purposes. MacConkey has shown that B. coli communis and B. cloacae can be kept for months under unfavourable conditions without losing their fermentative power, and it has been observed frequently, that, though an organism after being kept for some time does not act so vigorously, on sub-culturing several times the usual fermentative power returns. Many cultures of different organisms isolated during the present investigation have been kept growing on agar for from a few months to over a year without any of them losing their fermentative powers.

TABLE XVI.

Giving the Biological attributes of all the Glucose-fermenting Bacteria isolated.

No.	Name.	Glucose.	Lactose.	Saccharose.	Dulcite.	Adonite.	Gelatine stab.	Agar slope.	Indol 5 day growth.	Voges and Proskauer.	Motility.
1	-	+	+	-	-	-	White streak	Opaque white	+ −	-	-
2	B. acidi lactici (Hüppe)	+	+	-	-	+	,,	,,	+ −	-	-
3	B. Grünthal ..	+	+	-	-	-	,,	,,	+ −	-	+
4	B. coli communis (Escherich)	+	+	-	+	-	,,	,,	+ −	-	+
5	-	+	+	-	+	-	White streak	Opaque white	+ −	-	-
6	B. coscoroba ..	+	+	+	-	-	,,	,,	+ −	-	-
7	B. cloacae ..	+	+	+	-	-	Slow liquefaction	,,	-	+	+
8	B. lactis aerogenes	+	+	+	-	+	White streak	,,	+ −	+	-
9	B. neapolitanus	+	+	+	+	-	White Streak	Opaque white	+ −	-	-
10	-	+	+	+	+	-	,,	,,	+ −	-	+
11	B. oxytocus perniciosus	+	+	+	+	+	,,	,,	+ −	+	-
12	B. pneumoniae (Fried.)	+	+	+	+	+	,,	,,	+ −	-	-
13	-	+	+	+	-	-	White streak	Opaque white	-	+	+
20	-	+	+	-	+	+	,,	,,	+	-	+
21	-	+	+	+	-	-	Slow liquefaction	Yellow growth	-	+	+
22	-	+	+	+	+	-	,,	,,	-	-	+
23	-	+	+	+	-	+	White streak	Opaque white	+	+	+
24	-	+	+	-	-	+	,,	,,	+	-	+
14	B. proteus ..	+	-	+	-	+	Liquefaction.	,,	-	+	+
15	,,	+	-	+	-	-	,,	,,	-	+	+
16	B. proteus ..	+	-	+	-	-	White streak	..	-	+	+
17	-	+	-	-	+	-	,,	Opaque white	-	-	+
18	-	+	-	-	-	-*	,,	,,	-	-	+
19	-	+	- A(4days)	+	-	+	,,	,,	+	+	+
25	-	+	-	+	+	-	White streak	Opaque white	-	+	+
26	-	+	-	+	+	-	Yellow streak	Yellow growth.	-	+	+

* Ferments Mannite.
+ = Acid and Gas Production.
A = Acid Production.

Klotz instances one organism which did not at first ferment lactose and saccharose, but which was found later by growing in these media to acquire the power of fermenting them. One cannot, however, draw general conclusions from experiments with a single organism.

Twort sub-cultured repeatedly organisms of the typhoid-coli group in sugars which they did not ferment, and he affirms that they acquired the power of fermenting them. He states that " the fermentation reactions are characterized by acid reactions, but are rarely accompanied by the production of *gas*."

The production of *gas*, however, is the prominent feature in fermentation by the members of the colon group, stress being placed on the production of gas, not only on acidity. If Twort's assertions were correct, then one would expect to find, frequently, organisms, in the stage of transition, which produce acid and gas in some sugars, and acid only in others. Although during the present investigation many organisms belonging to this group have been examined, such instances of an organism producing acid in some sugars and acid and gas in others have been conspicuous by their absence. The writer, after considering the unsatisfactory nature of these experiments and his own results, is inclined to suggest the more general use of the tests recommended by MacConkey for the differentiation of the glucose-fermenting bacteria. The tests employed were :—

1. Morphology.
2. Motility.
3. Staining by Gram's method.
4. Liquefaction of Gelatine.
5. Fermentation of Glucose.
6. ,, lactose.
7. ,, Saccharose.
8. ,, dulcite.
9. ,, adonite.
10. Voges and Proskäuer reaction.
11. Indole.

Houston's " flaginac " classification of the glucose-fermenting organisms called by him B. coli (or coli-like microbes) does not go far towards the identification of them.

The indole reaction is untrustworthy, as seen in Table XVIII., where organisms giving otherwise similar reactions may differ in the production of indole.

The milk test apparently is not of much value in differentiation. The first 200 lactose fermenters were tested in milk, but in all acid and clot were formed in three days, and in the case of the others the test was discarded.

TECHNIQUE.—The taurocholate broth tubes inoculated from each milk sample showing acid and gas after 48 hours, were further used for sub-culturing. The highest dilution and the 1 cc. tubes giving positive results, were each sub-cultured in the following way. A loopful of the fluid was mixed with sterile plain broth, and a loopful of this was spread on a taurocholate agar plate by means of a sterile glass rod bent at right angles, and incubated for 48 hours at 37° C. The taurocholate agar used was the modification of MacConkey's, suggested by Grünbaum and Hume. It contains crystal violet in addition to the lactose, bile-salt and neutral red employed by MacConkey. The medium used in these experiments, however, was not neutralized as recommended by Grünbaum and Hume. The writer has found this medium with crystal violet better than that with neutral red alone, as it shows up more clearly the different lactose fermenters in different shades of colour. The various colonies showing different shades of colour were then sub-cultured on agar slopes for 24 hours. After 24 hours' growth, the various media recommended were inoculated from this tube.

Gelatine tubes were kept from three to four weeks for liquefaction.

The organisms isolated in the sets of samples from 1 to 54, were tested for indole by means of sodium nitrite and hydrochloric acid, but in those from 55 to 75, Marshall's para-amidobenzaldehyde test was used. This is a much better test than the old one. A bright cherry red colour is given in the presence of indole, and one advantage of the test is that no doubtful reactions are given, the result either being definitely positive or negative. All organisms were tested by staining by Gram's method, but all were decolourised. The cultures in plain broth were examined for motility after 12-24 hours' growth, but not after 24 hours.

In Table XVI. are represented the different organisms isolated, with their reactions. Table XVII. shows the organisms represented by the numbers 1, 2, 3, etc., in Table XVI., found in the various milk samples. The cowshed control and the cowshed are considered one sample, as also are the retailer's and retailer's control. The controls are the same samples of milk as the non-controls, but have been influenced by temperature and time.

In Table XVIII., the number of the different glucose fermenters found in the samples at the various stages of transit are stated as well as the number of each species, giving the indole and the Voges and Proskauer reactions. In Table XVI., numbers 1 to 13, and 20 to 24, are lactose fermenters, while 14 to 19, and 25 and 26 are non-lactose fermenters.

In all, 850 glucose-fermenting organisms have been isolated from milk. B. lactis aerogenes, No. 8, is seen to be by far the most common organism. It is remarkable that the bacillus acidi lactici of Hüppe, No. 2, has been found once only. MacConkey found that Hüppe's organism fermented adonite. There is an organism, No. 1, very commonly present which, except that it does not ferment adonite, gives reactions very similar. Number 24 is an organism which gives the reactions of Hüppe's acidi lactici, but is motile. B. Grünthal, No. 3, is very common. B. coli communis (Escherich), No. 4, is fairly common. Number 5 is an organism giving the reactions of B. coli, except that it is non-motile. B. coscoroba, No. 6; B. cloacae, No. 7; B. neapolitanus, No. 9; and B. oxytocus perniciosus, No. 11, are often found. Number 10, an organism fairly frequently found giving the reactions of B. neapolitanus, is motile. Another organism frequently occurring is No. 13, which gives reactions similar to B. cloacae, but does not liquefy gelatine. Its appearance on taurocholate agar is also distinct, being flat and rather dry, whereas B. cloacae gives a mucoid moist growth. Numbers 21 and 22 are organisms giving a yellow growth in gelatine after a week's growth. The reactions of No. 23 with the exception of motility, are the same as B. lactis aerogenes.

Of the non-lactose fermenters, No. 17 was found eight times and exhibits the characteristic reactions of the paratyphoid group. A fair number of organisms belonging to the proteus group, Nos. 14, 15 and 16 have been isolated. It will be noted that the bacillus which Morgan isolated from many cases of epidemic diarrhœa, has not been found, though No. 18 possesses similar characteristics, except that it ferments mannite and does not produce indole.

B. lactis aerogenes was found by MacConkey twice while B. coli, B. neapolitanus, B. cloacae and B. oxytocus perniciosus were found, 12, 15, 10 and 16 times respectively. The samples of milk examined, however, were few. MacConkey states that B. oxytocus perniciosus, B. neapolitanus and B. coli communis occur in greatest number in fresh milk, while B. cloacae and B. lactis aerogenes appear at a later stage. This assertion is not borne out by the results of the present investigation of the freshest milk, namely, in cowshed samples in which B. lactis aerogenes and B. cloacae are as abundant proportionally, as in the consumers' samples. MacConkey, however, based his conclusions on a restricted number of samples. In fresh milk, theoretically, one would expect to discover the organisms which are found on the exterior of the udder and in manure.

The organisms isolated from manure and from plates held underneath the udder during milking, are chiefly No. 1, B. coli communis, No. 5, B. coscoroba, and B. neapolitanus. (See Table XVII). B. lactis aerogenes, and B. cloacae were not found in manure, but on the udder plates the former was found on three occasions and the latter once, while B. oxytocus perniciosus was not found at all. The results show that there must be some important source of these organisms other than manure. This source is undoubtedly the imperfectly cleaned cans. B. cloacae and B. lactis aerogenes have been found by MacConkey to multiply more rapidly than B. acidi lactici and bacillus coli when incubated in broth, and the same it would appear is the case in milk.

Apparently, a few organisms of the lactis aerogenes, cloacae and oxytocus perniciosus species, get into the milk from manure and from the udder, and multiply much more rapidly than the others during the journey to the retailer. When the cans are improperly cleaned, often after the cans have "soured," these organisms will be in great numbers in the fluid left in the cans ready to infect the freshly drawn milk. The results in Table XVIII., showing the preponderance in number of B. lact. aerogenes, further indicate that the cans are the greatest source of B lactis aerogenes and of the glucose fermenting organisms generally.

Houston compared the number of B. coli, a term used by him synonymously with glucose-fermenting bacteria, found in milk, fermenting cane sugar or saccharose, with that of B. coli in human faeces, sewage and cow dung, and found the number in the former greater. From this, he concluded "that the results seem to indicate that a proportion of the B. coli met with in milk may not be derived from fresh excrement, but from some other source of contamination, *e.g.*, dust. An alternative explanation would be that in milk the "cane-sugar fermenting B. coli" multiply more rapidly than the "non-cane-sugar fermenting B. coli," and so the normal ratio of the one to the other becomes altered. But I do not think this can be the explanation, because B. coli 1 to 21, were isolated from the milk of 20 separate cows freshly milked, the milk being iced, carried to the laboratory, and examined immediately on arrival. Yet here also the cane-sugar fermenting B. coli were numerous. Out of 21 specimens, nine gave a completely positive result, two a slight positive result, and ten a negative result."

TABLE XVII.

Showing the Glucose-fermenting bacteria, represented by the numbers in Table XVI., isolated in all the samples, in manure, &c.

Serial Number.	Cowshed sample.	Cowshed control sample.	Railway Station sample.	Retailer's sample.	Retailer's control sample.	Consumer's sample.
5	—	16	—	7 b	9 a, 9 a	9 a, 9 a
6	—	—	7 a b (sl)	15	—	—
7	—	—	—	—	—	—
8	—	—	—	—	—	—
9	—	—	—	—	4 ab, 14	—
10	—	7 a b, 14 a b	—	7 a (sl), b	1 a, 14 a b	1 a
11	6 a	7 b a (sl), 1 a, 9 a	—	14	9 a, 8 a ? b ?	6 a, 14, 7 b, 1 a, 8 ab
12	1 a	6 a, 6 a, 1 a	6 a, 14	9 a	—	6 a, 14
13	9 a ?, 9 a	9 a, 9 a	8 a b	6 a	8 a	8 a b, 6 a, 15 a
14	9 a, 9 a, 9 a	9 a	9 a	9 a, 9 a	9 a b	9 a
15	10 a	9 a, 6 a	13 a b	8 a b, 6 a	6, 8 a ?	8 a b
16	—	8 b	—	6 a ? 8 a b	6 a ? 11 a b, 8 a ? b, 6 a	8 b, 8 a b
17	—	—	6 a	9 a, 9 a	9	12, 8 b, 8 b
18	—	6 a ?	—	—	8 b, 9	8 b, 13 b, 8 a
19	6 a	13, 18, 18, 6	10, 3	—	—	13, 13 a ? 13
20	8 a b, 18, 1, 18	1 a, 8 b, 8 a ?	1, 1, 5, 15	12 a, 12 a, 1	9, 9	8 a b, 1 a, 1
21	—	9 a, 9 a, 15 a, 16 a b	—	1 a ? 1 a	1 a, 1 a	1 a, 1 a
22	6 a	6 a ?	3 a, 3	3 a	1	8 b, 6 a
23	8 a b, 1 a	—	—	20	—	8 a b, 8 a b
24	6 a (sl), 9 a ? 8, 6 a	6 a ? 5 a, 5 a, 8	—	6, 4 a, 21 b	5 a, 6 a, 8	8 b, 8
25	—	13 b	—	11 a b, 1, 21 b 1, 3 a, 3, 3	—	11 a b, 3, 8 b, 6
26	—	6 b (sl)	—	6 b, 8 b (sl), 8 b (sl)	8 b (sl), 8 b (sl)	8 a, 8 b
27	10, 4 a, 4 a, 4 a	10, 1, 10 a, 10	1, 4 a	1 a, 4 a, 10 a	10 a, 1, 5, 10 a	1 a, 4 a, 5 a, 10, 10, 5 a
28	—	11 b, 11 b	—	7 b, 11 b, 11 b	—	8, 11, 7 b
29	9, 1	3, 11, 3, 11	—	3, 9 a, 3, 9 a	3, 10 a, 12, 3, 10 a	3, 9 a, 10, 10
30	6	8, 8	—	8, 7 b, 15	8, 7 b, 1	7 b, 8
31	8, 18	—	—	9 a, 8 b	11 a b, 9 a, 6, 8 a ?	9 b, 9 a
32	22, 10, 18	4, 8 b, 8 b	—	11 b, 11 a b, 4, 18	—	8 b, 9
33	3 a, 8	3 a, 15, 8 b	9 a, 9 a	4, 15, 4	8 a, 9, 8 b	3 a, 9 a, 9 a, 18, 18
34	12 a, 10 a	3, 5, 3	—	9 a (sl), 1 a, 19	1 a, 8 a, 9 a, 1 a	5 a, 17 a, 17
35	18	4 a, 1 a	—	9 a, 7 b, 7 b	8 a, 8 b, 4 a, 4	4 a, 4, 18 a, 8, 4
36	8 b, 8 b, 8 b	8 a (sl), b, 8 a (sl) b, 8 b, 8 a (sl) b (sl)	—	8 a (sl) b, 8 b, 8 b	8 a (sl) b, 8 b, 18 a, 8 b (sl), 8 b	8 a (sl) b, 8 b, 8 b, 17 a
37	8 a, 8 b, 3, 3	8 a (sl) b, 8 a (sl) b, 14 a (sl) b, 17 a, 4 a	3, 8 b (sl), 8 b	9 a, 13, 8 a, 14 a b, 3	4 a, 4	4, 6 a, 14 a b, 8 a b
38	7 a b, 4 a, 15 b, 8 b	8, 15 b, 15 b, 15 b	—	7 a (sl) b, 1 a, 15 b, 4	7 b, 4, 4, 8 a, 6, 4	7 b, 10 a, 15 b, 12 a, 15 a (sl) b
39	—	8 a (sl) b. 8 b, 18 a (sl), 8 a (sl), 8 a (sl), 8 a (sl) b (sl)	—	—	8 a (sl) b, 8 a (sl) b	3, 8 a
40	4 a, 11 a b, 11 a b	11 a b, 11 a b	11 a b, 11 a b, 4 a	—	—	11 a b, 11 a b, 4 a
41	—	11 a b, 8 b, 1 a	—	11 a b, 1 a ? 7 b, 7 b	—	8 a (sl) b, 8 a (sl) b, 1 a (sl)
42	11 a b, 5 a, 8 a	11 a b, 6, 10 a, 13	11 a b, 1 a, 13	5 a, 13, 11 a b	8 a, 1 a, 8 a	5, 10 a
43	8 a b, 5 a, 4 a, 4 a, 8	11 a b, 8 a b, 24 a, 15 b, 8 a b, 8 a b, 17 b	—	—	—	23 a b, 4 a, 11 a b 5 a, 24, 15 b, 8 a b, 8 a b
44	4, 4 a, 8 a	4 a, 4 a, 11 a (sl) b, 11 a (sl), b, 4	4, 8	11 b, 11 a b, 15 b, 11 a b	11 a b, 8, 8 a, 4 a,	11 a b, 10 a, 4, 8 b
45	—	8 a b	11 a b, 1 a, 3, 3, 18 a (sl)	5 a, 1 a, 3 a, 8 a, b, 11 a b	11 a b, 15 a (sl) b, 10 a, 13 b, 11 a b	8 a, 3 a, 3 a 11 a b, 11 a b, 15 a (sl) b 11 a b, 11 ab
46	—	11 a b	—	11 a b, 15 b	—	4 a 11 a b
47	—	—	—	—	—	—
48	5, 6 a, 8 a (sl) b, 8 ab	8 a b, 5 a, 5 a (sl), 9, 8 a b, 8 a b	5 a, 8 a b	8 a b, 5 a, 5 a, 7 b	8 a (sl) b, 9 a, 1 a, 8 a b	8 a, 5 a, 8 a (sl) b 5 a, 8 a b, 8 a b, 8 ab

TABLE XVII.—*continued.*

Serial Number.	Cowshed sample.	Cowshed control sample.	Railway Station sample.	Retailer's sample.	Retailer's control sample.	Consumer's sample.
49	7 *a b*, 7 *a*? *b*, 7 *b* ..	9 *a*, 19 *a* (*sl*) *b*, 8 *a* (*sl*) *b*	8 *a b*, 19 *b*, 19 *b*, 8 *a* (*sl*) *b*	19 *a*? *b*, 19 *a*? *b*, 8 *a b*	8 *a b*, 3 *a*, 19 *b*, 11 *ab* 3 *a b* ?	19 *a b*, 3 *a*, 19 *b*, 19 *b* 19 *a* (*sl*) *b*, 1 *a*, 3 ..
50	16 *a* (*sl*) 11 *a b*, 9 *a*, 5 *a* (*sl*), 5 *a*	8 *a b*, 10 *a*, 9 *a*, 8 *ab*, 5 *a*	—	13, 6 *a*, 6 *a* (*sl*) ..	4 *a*, 13 *a*, 5 *a* ..	11 *a b*, 4 *a*, 5 *a* (*sl*).. 24 *a*, 8 *a* (*sl*) *b*, 8 *a b*
51	1 *a*, 6 *a*	11 *a b*, 11 *a b* ..	—	11 *a b*, 1 *a* ..	11 *a b*	11 *a b* .. 6, 10, 1 *a* ..
52	11 *a b*, 4 *a*, 11 *a b*	11 *a b*, 11 *a b* ..	11 *a b*, 11 *a b* ..	11 *a b*, 4	11 *a b*, 11 *a b* ..	11 *a b*, 11 *a b*
53	9 *a*	—	—	—	—	—
54	6 *b*	—	—	—	—	20 *a* .. 9 *a*, 9 *a*, 9 *a*, 13 *b*(*sl*)
55	4 *a*, 11 *a b* ..	—	3 *a*	4 *a*, 16 *b* .. .. 25 ..	11 *a b*	4 *a*, 11 *a b* 8 *b*, (*sl*) ..
56	1, 9 *a*	6	1, 1	6 *a*, 8 *a*, 8 *a* .. .. 1, 1, 1, 1 ..	8 *a b*, 1, 9 *a*, 1 *a b*?	6 *b*, 1, 1 ..
57	—	—	1 *a*, 18, 11 *a b* ..	—	—	18
58	—	—	—	—	—	—
59	8 *b*, 19 *b*	8	—	8	8 *b*, 19 *b*	8, 19 *b*
60	3 *a*, 8 *a*, 8 *b*, 8 *b* ..	3 *a*, 8 *a*, 8 *b* ..	—	3, 3, 26, 5 .. .. 3, 3 *b*? 3 ..	10 *a*, 3, 8 *b* ..	10, 10 *a*, 8
61	8 *a*, 9 *a*	10 *a*	8 *a b*, 3, 1 ..	8 *a b*, 1 *b* (*sl*), 18, 8 *b*? .. 8 *a b*, 3 ..	8 *b*, 3, 1	4 *a*, 9 *a*, 10 *a*, 3
62	6 *a b*, (*sl*)	6	13 *b*, 18	19 *b*	6, 18	9 *a*, 1 *a*, 18
63	17, 13 *b*	8 *b*, 4, 16 *b* ..	—	3, 16 *b*	1, 16 *b*, 4, 17 *b*, 8 ..	8, 13, 16 *b*, 3, 3, 17 *a*
64	—	8	—	7 *b*	9 *a*	4, 7 *b*
65	10 *b*, 7 *a*, 13 *b*, 13 *b*	9 *a*, 9 *a*, 16 *b*, 9 *a*, 9 *a*, 1	10 *a*	10 *b*, 25 *b*, 10 .. 10 *a*, 13 *a* ..	7 *b*, 9 *a*, 9 *a* ..	7 *b*, 16 *b*, 9 *a*, 13, 16 *b*
66	—	—	—	47 *a* .. .. 16 *b* ..	—	9 *a*
67	3 *a*, 10 *a*, 4 *a*, 1 *a*, 3	8 *a b*, 16 *b*, 13 *a*, 10 *a*	—	24 *a*, 4 *a* .. .. 10 *a*, 2 ..	10 *a*	8 *a b*, 10 *a*, 1 *a*, 10 *a*
68	9 *b* (*sl*)	—	—	9 *a*	9 *a*, 9 *b*	—
69	7 *b*, 9 *b*	7, 7 *b*, 7 *b*, 7 *b* ..	3, 7 *b*, 7 *b* ..	7 *b*, 7 *b* .. .. 7 *b*, 13 *a* ..	7 *b*, 3 *b*, 8, 7 *b* ..	8, 3, 8, 13
70	10 *a*	6 *a*, 5, 10 ..	—	10 *a*	10 *a*, 10 *a*	5 *b*
71	9 *a*, 16 *b*	10 *a*, 3 *b*, 3 *b* ..	9 *a*, 3 *b*	3 *b*	10 *a*, 3 *b*	26 *b*, 3 *b*, 19 *b*, 3 *b*
72	8 *b*, 25 *b*	5 *a*, 1 *a*	—	8 *b*	12	1 *a*, 1 *a*
73	—	—	—	7 *b*, 8 *a b* .. .. 7 *b*, 8 *a b* ..	7 *b*, 8 *a b*	7 *b*, 8 *a b*
74	5 *a*	—	—	20 *a*, 5 *a*	—	9 *a*
75	10 *a*, 13 *b*, 18 ..	10 *a*, 13 *b* ..	—	10 *b*, 6 *b*, 6 *b*, 6, 18, 1 10 *a*, 13 *b*, 18 ..	1, 10, 10, 13 *b*, 18	10 *a*, 10 *a*, 13 *b*, 18, 18, 13 *b*

MANURE:

(1) 6 *a*, 17 *a*, 17 *a* (*sl*), 6 *a*, 4 *a*, 1 *a*, 6 *a*, 17 *a*, 6 *a*
(2) 6 *a*, 4 *a*
(5) 10 *a*
(7) 5 *a*, 5 *a*
(9) 6 *a*, 25 *a*, 5 *a*, 5 *a*
(11) 5 *a*, 5 *a*, 5 *a*, 17

(2) 9 *a*
(4) 10 *a*, 9 *a*, 4 *a*, 1 *a*
(6) 21 *b*, 9 *a*, 25 *a*, 9 *a*
(8) 5 *a*, 1 *a*
(10) 9 *a*, 25 *a*, 9 *a*, 25 *a*, 6, 5 *a*, 5

MOIST MANURIAL DUST FROM COWSHED FLOOR:

(1) 6 *a*, 6 *a*, 9 *a*

PLATES HELD UNDER UDDER DURING MILKING:

(1) 4 *a*, 4 *a*, 8 *b*
(3) 8 *a* (*sl*) *b*
(5) 7 *b*, 6, 1

((2 4 *a*, 8 *b*
(4) 6 *a*
(6) 6 *a*, 5, 22 *b*

a = Indole reaction.
b = Voges and Proskauer reaction.
Sl = Slight Reaction.
? = Doubtful reaction.

TABLE XVIII.

Showing the number of Organisms belonging to each group of the glucose-fermenting bacteria isolated, with the number giving the indole and the Voges and Proskauer reactions.

No. of Organism in Table XVI.	Cowshed Samples. No. of Organisms.	Cowshed Samples. No. giving Indole.	Cowshed Samples. No. giving V. and P. Reaction.	Railway Station Samples. No. of Organisms.	Railway Station Samples. No. giving Indole.	Railway Station Samples. No. giving V. and P.	Retailer's Samples. No. of Organisms.	Retailer's Samples. No. giving Indole.	Retailer's Samples. No. giving V. and P.	Comsumer's Samples. No. of Organisms.	Comsumer's Samples. No. giving Indole.	Comsumer's Samples. No. giving V. and P.	Total Organisms found in Milk Samples. No. of Organisms.	Total Organisms found in Milk Samples. No. giving Indole.	Total Organisms found in Milk Samples. No. giving V. and P.	Manure and from Udder Plates. No. of Organisms.	Manure and from Udder Plates. No. giving Indole.	Manure and from Udder Plates. No. giving V. and P.
1	16	10	—	9	3	—	32	16	2	16	14	—	73	43	2	4	3	—
2	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—
3	14	5	2	10	2	1	25	5	5	14	4	2	63	16	10	—	—	—
4	19	15	—	3	2	—	21	9	1	14	9	—	57	35	1	6	6	—
5	14	11	—	2	1	—	8	7	—	9	7	1	33	26	1	11	9	—
6	22	14	3	2	2	—	18	9	3	8	5	1	50	30	7	12	10	—
7	12	5	11	3	1	3	23	2	23	7	—	7	45	8	44	1	—	1
8	62	32	42	8	5	7	59	34	39	48	26	34	177	97	122	3	1	3
9	27	24	2	4	4	—	30	24	2	17	15	1	78	67	5	7	6	—
10	18	12	1	2	1	—	20	14	2	14	9	—	54	36	3	2	2	—
11	23	19	21	7	7	7	24	21	24	16	15	16	70	62	68	—	—	—
12	1	1	—	—	—	—	4	2	—	2	1	—	7	4	—	—	—	—
13	9	1	6	3	1	2	9	3	3	11	1	4	32	6	15	—	—	—
14	2	2	2	1	—	—	4	2	2	3	1	1	10	5	5	—	—	—
15	7	1	5	1	—	—	8	1	5	5	1	5	21	3	15	—	—	—
16	7	2	5	—	—	—	4	—	4	3	—	3	14	2	12	—	—	—
17	3	—	1	—	—	—	1	—	1	4	3	—	8	3	2	4	3	—
18	8	1	—	3	1	—	7	1	—	7	1	—	25	4	—	—	—	—
19	2	1	2	2	—	2	6	2	5	6	2	6	16	5	15	—	—	—
20	—	—	—	—	—	—	2	1	—	1	1	—	3	2	—	—	—	—
21	—	—	—	—	—	—	2	—	2	—	—	—	2	—	2	1	—	1
22	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	1
23	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1	—	—	—
24	1	1	—	—	—	—	1	1	—	2	1	—	4	3	—	—	—	—
25	1	—	1	—	—	—	2	—	1	—	—	—	3	—	2	4	4	—
26	—	—	—	—	—	—	1	—	—	1	—	1	2	—	1	—	—	—
Total glucose-fermenting bacteria isolated													850			56		

It has already been pointed out that these organisms were not found in dust. With the explanation of the " cane-sugar fermenting B. coli " multiplying more rapidly, the writer agrees, but he cannot agree with him in regard to the disproving of this explanation by means of the results of the milk from the 20 separate cows. Here, apparently, contamination from the milk pail has not been eliminated. No mention is made of efficient sterilization. The milk vessels, as already mentioned, are the great source of the glucose-fermenters and of lactis aerogenes, and other saccharose fermenters.

Again, the comparison of the percentage of certain groups of organisms found in milk with those in faeces, human and animal, is likely to lead to erroneous conclusions in regard to their source, owing to the more rapid multiplication of certain organisms noted by MacConkey. If in Table XVII. the organisms found in the milk at the consumers' house are compared with those in the milk at the retailers' premises or cowshed, it will be noted that often bacteria present in the cowshed or retailers' sample are not found in the consumer's sample, and even in the cowshed control sample, showing that some may be overwhelmed in numbers by others during transit. These same remarks may be applied also to the comparison of streptococci of milk with those of another source.

The results of the examination of cow dung, both by MacConkey and the writer show, contrary to Houston's results, the greater preponderance of organisms fermenting saccharose.

Hence the writer cannot in the least agree with Houston in his final conclusion, namely, " These comparative results suggest that a proportion of the numerous B. coli found in milk are not derived directly from fresh excrement, but from some other source of contamination, *e.g.*, dust."

Voges and Proskauer Reaction.—This test has been tried and recommended by MacConkey for the differentiation of B. lactis aerogenes, B. cloacae and oxytocus perniciosus from the other lactose fermenters. Harris found that other organisms of the colon group gave the reaction and stated that it was of no value. The writer applied the test to all glucose-fermenting organisms, and the results are found in Table XVIII. The reaction has been given by many other organisms than the B. lactis aerogenes, B. cloacae and B. oxytocus perniciosus, more especially by those of the proteus group, Nos. 14, 15 and 16. It is not given constantly by all bacilli of these groups, although it is apparently a very constant and an excellent confirmatory test for B. cloacae and B. oxytocus perniciosus. It is not apparently so good a test for B. lactis aerogenes as stated by MacConkey.

There is only one conclusion that one can come to in regard to these glucose-fermenting organisms, namely, that their chief primary source is the manure at the cowshed, and that they are further propagated in the milk. It will be readily understood from the above remarks that it is a very difficult problem to ascertain whether certain organisms belonging to this group have been added during transit. However, the greatest sources of them have been noted and the remedies already suggested.

CONCLUSIONS.

Although during the course of the Report reference has been made to the conclusions to be drawn from the results obtained, it seems advisable to bring them together at this point and to classify the sources of contamination before making any recommendations.

The chief conclusion to which we are forced is that the greatest amount of contamination of the milk supply takes place at the farm. This is based on the results of the experiments, which showed that—

(*a*) Of the total organisms in the milk used by the consumer, the greatest number are contributed by the farmer. During railway transit, at the retailer's premises, and in the consumer's house smaller amounts are added, the amount in each instance being apparently about the same.

(*b*) Of the glucose fermenting or intestinal organisms and the streptococci, by far the greatest number are added at the farm. The retailer adds a certain number, the consumer none.

(*c*) The sediment or " dirt " gains entrance to the milk chiefly at the cowshed. In 86.8 per cent. of the samples examined, there was no increase in the sediment when sold by the retailer, but a decrease in 68.8 per cent.

(*d*) The farmer was responsible for the bacilli entertidis sporogenes (Klein) in the milk consumed in 66.6 per cent. of the samples. In 11.1 per cent. of the samples these bacilli were added by the retailer or the consumer, while in 22.2 the source was doubtful.

CHIEF SOURCES OF CONTAMINATION.

A. At the Cowshed.

Improperly cleaned milk vessels and the dirty udders of the cows are the source of by far the greatest amount of contamination by organisms and especially by glucose-fermenters and streptococci. The dirty milk vessels contribute much more than the dirty udders in summer, but in winter the opposite is the case.

Milkers with dirty hands and dirty clothes and especially wet milkers contribute their share of pollution.

The air and dust in the cowshed add to the contamination, and coolers, as often used, contribute a certain amount.

B.—At the Railway Station.

Contamination while the cans are in the hands of the railway authorities occurs mainly as a result of placing them in dusty vans, storing them in improper or dusty parts of the station, and of improper or rough handling, causing the milk to splash over the lid.

The railway porters, and others, who sit upon the churns are responsible for a certain amount of contamination also. The risk is increased in all cases when the cans are provided with lids which are badly fitting or of faulty construction.

C.—On the Retailer's Premises or Street.

Badly cleaned cans are a source of contamination here also, although not so great as at the cowshed, owing to the retailer paying greater attention to the cleaning process.

Pollution will take place in retailers' premises owing to the milk receptacles being uncovered, especially where the keeping-place is dusty, or the clothes of the retailer dirty. Organisms may be added by carelessness in handling, *e.g.*, by the use of a dipper which has been kept on a dusty counter.

D.—At the Consumer's House.

Pollution takes place here as a result of keeping the milk in a dusty place and leaving it uncovered. Only a small amount of contamination occurs from the receptacles of the consumer.

Flies are a source of contamination at all stages of transit, but especially at the consumer's house, where they are usually more abundant.

SUGGESTIONS.

These may be summarized shortly, as most have already been discussed at length in the foregoing pages. The points which seem to the writer to call for attention if a clean supply is to be obtained, are :—

I.—At the Cowshed.

1. The proper ventilation, lighting and cleanliness of all cowsheds.
2. The grooming of all milch-cows and the washing of their udders.
3. The cleanliness of the milker, the washing of the hands and the use of overalls.
4. The provision of proper places for storing cans and the means of securing a plentiful supply of boiling water or of steam for scalding them.
5. The keeping of milk pails and milk in the cowshed as short a time as possible.
6. The rejection of the foremilk.
7. The discontinuance of wet-milking.
8. The cooling of milk directly after drawn by passing over a clean cooler kept in a proper place. The cooling of all milk to 10° C. or 50° F.
9. The provision at all cowsheds of a proper and clean place or dairy where cans can be kept and cooling carried out.
10. The use of an efficient strainer, the filtering medium being of cotton-wool, linen, flannel or other close material.
11. The imposition of the following standards :—
    (*a*) A bacterial standard of 50,000 organisms per cc.
    (*b*) Milk not to contain glucose-fermenting bacteria in 1/10 cc.
    (*c*) A sediment standard (at first) of 40 volumes per million.
12. The provision of tight fitting lids, which overlap the neck, on all cans or churns.
13. The sealing or locking of all cans for transit.
14. The systematic inspection of all cowsheds and cows.
15. The education of the farmers in the proper methods of producing a clean milk.

II.—At the Railway Station.

16. The provision of properly ventilated and clean vans reserved for milk traffic only, and the use of refrigerator vans for milk travelling long distances in summer.

17. The provision at stations of proper, cool and clean places for keeping full and empty milk churns awaiting delivery.

18. The prohibition of sitting on cans or interfering with them so as to expose them to contamination.

19. The disallowance of pouring or measuring out of milk in the station or street, and the requiring of its being taken to the dairy for that purpose.

III.—At the Dairy or Street.

20. The sale of milk only in clean and well ventilated places where milk or milk and dairy produce only are sold.

21. The provision of means of storage and of cleaning and scalding the milk vessels.

22. The discontinuance of sweeping of floors and the substitution of washing.

23. The keeping of milk in proper covered receptacles.

24. The cleanliness of milk retailers.

25. The imposition of :—

(a) A temperature standard of 10° C.

(b) A sediment standard of 40 volumes per million.

26. The cleansing and scalding of the farmer's cans by the dairyman before returning them.

27. The systematic inspection of all dairies.

28. The education of the retailers in the proper methods of handling milk.

IV.—At the Consumer's House.

29. The use of clean vessels and the protection of the milk from flies and dust by a covering.

30. The keeping of milk in cool well-ventilated places.

31. The education of the general public in the methods of keeping milk free from contamination, and of preventing rapid growth of the organisms in it.

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APPENDIX I.

TABLES giving full particulars of all the samples taken with their bacteriological results.

COWSHED.

Serial Number.	Date.	Source.	When taken.	Temperature of Air	and Milk.	Cooling.	Cleanliness of Cowshed.	Stall.	Udder and teats.	Hands and clothes.
1	18th March	Leeds ..	6.45 a.m.	3° C.	24.5° C.	None ..	Clean ..	Clean ..	Clean ..	Clean
2	21st March	Leeds ..	6.45 a.m.	7° C.	31° C.	None ..	Walls splashed	Clean ..	Clean ..	Clean
3	25th March	Leeds ..	7.15 a.m.	6° C.	26° C.	None ..	Clean ..	Clean ..	Clean ..	Clean
4	28th March	Leeds ..	7 a.m.	4° C.	23.5°	None ..	Clean ..	Clean ..	Clean ..	Clean
5	3rd April	Leeds ..	6.30 a.m.	10° C.	22° C.	None ..	Clean ..	Clean ..	Clean ..	Dirty hands
6	4th April	Leeds ..	4 p.m.	11° C.	36° C.	None ..	Dirty ..	Dirty ..	Clean ..	Dirty hands
7	9th April	West Riding	6.45 a.m.	4° C.	23.5 °	Cooler ..	Very dirty	Dirty ..	Clean ..	Fairly clean
8	11th April	Leeds ..	6.45 a.m.	6° C.	28° C.	None ..	Clean ..	Clean ..	Clean ..	Clean
9	16th April	West Riding	7.15 a.m.	4° C.	17.5°	None ..	Dirty ..	Dirty ..	Dirty ..	—
10	18th April	West Riding	7 a.m.	3.5° C.	21° C.	None ..	Dirty ..	Fairly clean	Clean ..	Clean
11	22nd April	Leeds ..	7.15 a.m.	9.5° C.	26° C.	None ..	Clean ..	Clean ..	Very clean ..	Clean
12	25th April	West Riding	7 a.m.	8° C.	16° C.	Cooler ..	Fairly clean	Clean ..	Clean ..	Clean
13	29th April	Sheffield, Derbyshire	6.45 a.m.	6° C.	31° C.	None ..	Very dirty	Very dirty	Very dirty ..	Very dirty
14	2nd May	Derbyshire	4.30 p.m.	11.5°	17° C.	Cooler ..	Very clean	Very clean	Very clean ..	Very clean
15	6th May	West Riding	5.15 p.m.	19°	34° C.	None ..	Clean ..	Clean ..	Clean ..	Clean
16	9th May	S. Derbyshire	5.15 p.m.	15° C.	29° C.	None ..	Dirty ..	Dirty ..	Clean ..	Clean
17	14th May	Hull, East Riding	6.15 a.m.	11°	28°	None ..	Clean ..	Clean ..	Clean ..	Hands clean, clothes dirty
18	16th May	East Riding	7.45 a.m.	9°	21°	Stood in tanks of water	Clean ..	Clean ..	Clean ..	Hands clean, clothes dirty
19	22nd May	East Riding	7.15 a.m.	8°	11° C.	Cooler ..	Temporary shed	No stalls ..	Clean ..	Clean
20	27th May	East Riding	6.30 a.m.	11°	25°	None ..	Fairly clean	Dirty ..	Clean ..	Dirty
21	30th May	East Riding	11.15 a.m.	10°	21.5°	Cooler ..	Dirty ..	Dirty ..	Dirty udders	Very dirty hands, wet milker
22	4th June	East Riding	6.15 a.m.	7°	28°	None ..	Clean ..	Fairly clean	Clean, but greasy ; grease teats	Clean, but greasy
23	6th June	East Riding	3.30 p.m.	13.5°	30°	None ..	Dirty ..	Dirty ..	Clean ..	Clean hands, washed; For wet milkers, dipping hands in milk
24	12th June	Bradford ..	8.45 a.m.	11.5°	16°	Cooler ..	Clean ..	Dirty ..	Dirty ..	Very dirty hands and clothes
25	17th June	West Riding	3.30 p.m.	16°	32°	None ..	Very dirty	Dirty ..	Dirty ..	Dirty
26	20th June	Bradford ..	7.30 a.m.	14°	34°	None ..	Clean ..	Clean ..	Fairly clean ..	Dirty
27	27th June	West Riding	7.15 a.m.	12½°	28°	None ..	Very dirty	Very dirty	Clean ..	Clothes dirty and hands dirty
28	2nd July	Rotherham, West Riding	7.45 a.m.	7.5°	32°	None ..	Very clean	Very clean	Clean ..	Clean

* The Numerals 1, 2, 3, 4, 5, 6 and 7, represent 1cc., 1/10, 1/100, 1/1,000, 1/10,000, 1/100,000 and 1/1,000,000 cc. respectively.
+ = Present. — = Absent. Agar incubated for 48 hours. Gelatine for 72 hours.
† B. E. S. = Bacillus enteritidis sporogenes.

Cans.	Ventilation and Lighting.	Bacteria per cc. Agar 37° C.	Bacteria per cc. Gelatine 20° C.	Glucose-fermenting bacteria.							Streptococci.							B.E.S.			Serial Number.
				1	2	3	4	5	6	7*	1	2	3	4	5	6	7	20 cc.	10 cc.	1 cc.	
Clean, scalded	Good	13,250	13,500																		1
Clean, scalded	Bad	17,666	22,416	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Clean, scalded	Good	5,580	5,660	–	–	–	–	–	–	–	+	–	–	–	–	–	–	.	.	.	3
Clean, scalded	Good ..	9,660	11,330	–	–	–	–	–	–	–	+	–	–	–	–	–	–	.	.	.	4
Scalding water	Good	6,660	8,610	+	–	–	–	–	–	–	+	+	–	–	–	–	–	.	.	.	5
Clean, scalded	Very bad ..	27,250	27,500	–	–	–	–	–	–	–	+	+	–	–	–	–	–	.	.	.	6
Clean, scalded	Bad	44,080	85,130	–	–	–	–	–	–	–	+	+	+	–	–	–	–	.	+	.	7
Clean, hot water	Good	2,500	5,000	–	–	–	–	–	–	–	+	+	–	–	–	–	–	.	+	–	8
Clean, scalded	Fairly good ..	18,330	21,500	+	–	–	–	–	–	–	+	+	–	–	–	–	–	.	+	–	9
Clean, scalded	Good, manure pit 6 yds. from shed door	31,125	34,080	+	–	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	10
Clean, scalded	Badly lit and ventilated, blocked by buildings	6,930	7,360	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	11
Clean, scalded	Good	40,000	42,400	+	–	–	–	–	–	–	+	+	+	–	–	–	–	.	–	–	12
Scalded	Bad, 350 c. ft. ..	80,730	117,100	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	13
Scalded	Good, 450-500 c. ft.	16,300	23,300	–	–	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	14
Scalded	Good, 600-700 c. ft.	25,460	37,500	+	–	–	–	–	–	–	+	+	+	–	–	–	–	.	–	–	15
Scalded	None, loft over shed, light when door opens, no ventilation, 297 c. ft.	30,600	35,000	–	–	–	–	–	–	–	+	+	–	–	–	–	–	.	–	–	16
Scalded with steam	Good, manure heap 6 ft. from cowshed	20,250	27,300	–	–	–	–	–	–	–	+	+	–	–	–	–	–	.	–	–	17
Scalded with steam	Good	11,500	27,250	–	–	–	–	–	–	–	+	+	+	+	–	–	–	.	–	–	18
Scalded by steam	Good, open shed	10,000	17,800	+	+	+	+	–	–	–	+	+	+	+	–	–	–	.	–	–	19
Scalded	By open door and open joints of roof only	10,000	31,750	+	+	–	–	–	–	–	+	+	–	–	–	–	–	.	–	–	20
Scalded, steam	None, except by open door and roof joints, cubic space insufficient	Spoiled	27,000	+	–	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	21
Scalded with steam	None, in one shed no light or ventilation, cubic space insufficient	4,000	17'000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	.	+	–	22
Scalded in steam	Insufficient ventilation and cubic space	4,000	26,000	+	+	+	+	–	–	–	+	+	–	–	–	–	–	.	+	–	23
Scalded	Good, fair light and ventilation, air space insufficient	25,100	47,000	+	+	+	+	–	–	–	+	+	+	+	–	–	–	.	+	–	24
Scalded with boiling water	Light and ventilation not sufficient	4,000	7,100	–	–	–	–	–	–	–	+	+	–	–	–	–	–	.	–	–	25
Washed with boiling water	Good light and ventilation sufficient	8,600	21,250	+	–	–	–	–	–	–	+	+	+	–	–	–	–	.	–	–	26
Washed with boiling water	Good, no light except when door opens, air space good	15,170	16,600	+	+	–	–	–	–	–	+	+	–	–	–	–	–	.	+	–	27
Very clean, scalded	Good, air and light sufficient, 614 c. ft.	26,600	Spoiled	–	–	–	–	–	–	–	+	+	+	+	+	–	–	.	–	–	28

COWSHED.—*continued.*

Serial Number.	Date.	Source.	When taken.	Temperature of Air	and Milk.	Cooling.	Cleanliness of Cowshed.	Stall.	Udder and teats.	Hands and clothes.
29	4th July	Rotherham	6.30 p.m.	13	29°	None ..	Very clean	Very clean	Very clean ..	Very clean ..
30	9th July	West Riding	7 a.m.	11°	34°	None ..	Dirty ..	Dirty ..	Clean ..	Clean ..
31	11th July	West Riding	7 a.m.	9.5°	34°	None ..	Clean ..	Dirty ..	Clean ..	Clean ..
32	16th July	Leeds, West Riding	6.30 a.m.	15°	24°	None ..	Clean ..	Clean ..	Clean ..	Fairly clean ..
33	17th July	West Riding	3.15 p.m.	18°	32°	Cooler ..	Clean ..	Clean ..	Clean ..	Clean ..
34	23rd July	Leeds ..	6.15 a.m.	11°	28.5°	None ..	Very clean	Very clean	Very clean ..	Clean ..
35	25th July	Leeds ..	6.30 a.m.	11.5°	35°	None ..	Clean ..	Clean ..	Clean ..	Clean ..
36	29th July	Leeds ..	3 p.m.	14°	13° C.	Cooler ..	Very clean	Very clean	Clean ..	Clean ..
37	1st Aug.	Hull, East Riding	7.30 a.m.	10°	22°	Cooler ..	Dirty ..	Dirty ..	Clean ; cows out	Clean ..
38	6th Aug.	East Riding	6.45 a.m.	14°	30°	Stood in cold water	Fairly clean	Fairly clean	Fairly clean ..	Fairly clean ..
39	12th Aug.	East Riding	7.15 a.m.	12½°	31°	None ..	Walls clean, floor dirty	Dirty ..	Clean, teats washed	Clean, hands washed
40	15th Aug.	East Riding	6.30 a.m.	12.5°	17.25°	Cooler ..	Temporary shed	No stalls ..	Clean ..	Clean ; wet milker
41	20th Aug.	Sheffield, Derbyshire	5.15 p.m.	15°	34°	None ..	Fairly clean	Fairly clean	Clean ..	Clean hands, clothes dirty
42	22nd Aug.	Sheffield, Derbyshire	5.15 p.m.	14°	29°	Churn put into cold water	Very dirty	Very dirty	Fairly clean ..	Fairly clean ..
43	27th Aug.	West Riding	6.45 a.m.	8°	34°	None ..	Very dirty	Very dirty	Clean, teats well washed	Clean
44	29th Aug.	West Riding	7.30 p.m.	19.5°	21°	Cooler ..	Dirty ..	Dirty ..	Fairly clean	Fairly clean
45	3rd Sept.	North Riding	5.30 p.m.	11.5°	12.5°	Cooler ..	Clean ..	Clean ..	Clean ..	Clean ..
46	11th Sept.	Bradford ..	8 a.m.	9°	31°	None ..	Fairly clean	Fairly clean	Fairly clean ..	Clean ..
47	16th Sept.	West Riding	6 p.m.	13°	15°	Cooler ..	Walls dirty	Fairly clean	Dirty ..	Fairly clean ..
48	14th Oct.	Bradford, Lancashire	7 p.m.	11°	15°	Cooler ..	Fairly clean	Fairly clean	Dirty ..	Hands dirty, got wet in milking ; very dirty
49	17th Oct.	West Riding	4 p.m.	11°	33°	None ..	Clean ..	Dirty ..	Dirty ..	Hands clean, later dirty and wet with milking
50	22nd Oct.	Rotherham, West Riding	9.45 a.m.	10.5°	20° C.	Cans in water trough	Clean ..	Clean ..	Clean ..	Clean ..
51	24th Oct.	Rotherham	4.15 p.m.	8.25°	34°	None ..	Rather dirty	Rather dirty	Rather dirty ..	Clean ..
52	28th Oct.	Derbyshire	5.30 p.m.	7.5°	11°	Cooler ..	Clean ..	Clean ..	Clean ..	Clean ..

Cans.	Ventilation and Lighting.	Bacteria per cc. Agar 37° C.	Bacteria per cc. Gelatine 20° C.	Glucose-fermenting bacteria. 1	2	3	4	5	6	7	Streptococci. 1	2	3	4	5	6	7	B.E.S. 20 cc.	10 cc.	1 cc.	Serial Number.
Scalded	Good, air space and light sufficient	17,500	Spoiled	+	–	–	–	–	–	–	+	+	+	–	–	–	–	.	–	–	29
Scalded	Good, air space and light sufficient	39,000	60,000	+	–	–	–	–	–	–	+	+	+	–	–	–	–	.	–	–	30
Scalded	Good, 480 c. ft. Sufficient light and ventilation	9,860	12,800	+	–	–	–	–	–	–	+	+	+	+	–	–	–	.	+	–	31
Hot water	Good, 500 c. ft. Light deficient	29,100	65,600	+	–	–	–	–	–	–	+	+	+	+	–	–	–	.	–	–	32
Clean, boiling water	Good, light and ventilation good	120,500	192,250	+	+	–	–	–	–	–	+	+	+	+	–	–	–	.	–	–	33
Scalding and polishing	Good light and ventilation good	40,000	92,400	+	–	–	–	–	–	–	+	+	+	+	–	–	–	.	+	–	34
Scalding and polishing	Good light and ventilation	25,000	34,000	+	–	–	–	–	–	–	+	+	+	+	+	–	–	.	–	–	35
Scalded	Good	142,600	Spoiled	+	+	+	–	–	–	–	+	+	+	+	+	–	–	.	–	–	36
Scalded	Bad, insufficient ventilation, no light except by ventilators, 654 c, ft.	423,000	1,043,000	+	+	+	+	+	–	–	+	+	+	+	+	–	–	.	+	–	37
Soap and soda and hot water	Bad light and ventilation	38,160	97,000	+	+	+	+	–	–	–	+	+	+	+	–	–	–	.	–	–	38
Hot water and soda	Good, 348 c. ft., no light except by ventilators	93,000	146,000	–	–	–	–	–	–	–	+	+	+	+	–	–	–	.	–	–	39
Scalded	Good	129,500	Spoiled	+	+	+	+	–	–	–	+	+	+	+	+	–	–	.	+	–	40
Soap and water scalded	By open door only, 285 c. ft. per cow	58,000	80,500	–	–	–	–	–	–	–	+	+	+	+	+	+	–	.	–	–	41
Soap and water and scalded	None, no light or ventilation except by open door	196,600	330,000	+	+	–	–	–	–	–	+	+	+	+	+	–	–	.	–	–	42
Soap and water and scalded	No light except by doorway, grate for ventilation, 250 c. ft. per cow	30,500	36,000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	.	+	–	43
Soda, hot water and soap	Fairly good, 200 c. ft. per cow	22,500	78,000	+	+	–	–	–	–	–	+	+	+	+	+	–	–	–	–	–	44
Scalded	Very well lit and ventilated	13,000	33,000	–	–	–	–	–	–	–	+	+	+	–	–	–	–	.	–	–	45
Clean, washed boiling water	Ventilation through roof crevices, cracks and broken window, poorly lit and ventilated	23,300	29,600	–	–	–	–	–	–	–	+	+	+	+	–	–	–	.	–	–	46
Clean, boiling water	Good, 440 c. ft.	Contaminated																			47
Clean, scalded	Insufficient air space and light	Spoiled	67,000	+	+	+	+	–	–	–	+	+	+	+	–	–	–	+	+	–	48
Clean, boiling water	Bad light and ventilation	Spoiled	197,300	+	+	–	–	–	–	–	+	+	+	–	–	–	–	+	+	–	49
Very clean, scalded	538 c. ft., not sufficient light and ventilation	181,300	289,600	+	+	+	+	–	–	–	+	+	+	+	+	–	–	+	+	–	50
Clean, scalded	Good, 964 c. ft., good light and ventilation	57,300	137,500	+	–	–	–	–	–	–	+	+	+	+	+	–	–	+	–	–	51
Very clean	Good, 850 c. ft., sufficient light and ventilation	24,000	36,000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	+	–	–	52

COWSHED.—*continued.*

Serial Number.	Date.	Source.	When taken.	Temperature of Air	Temperature of Milk	Cooling.	Cleanliness of Cowshed.	Cleanliness of Stall.	Cleanliness of Udder and teats.	Cleanliness of Hands and clothes.
53	31st Oct.	West Riding	6.30 a.m.	8.5°	32°	None ..	Dirty ..	Dirty ..	Fairly clean	Clean ..
54	7th Nov.	Leeds, West Riding	5.15 p.m.	8°	14°	Cooler	Fairly clean	Dirty ..	Clean, out at grass	Clean ..
55	12th Nov.	Leeds ..	6.45 a.m.	11° C.	29° C.	None ..	Clean ..	Clean ..	Clean ..	Clean ..
56	13th Nov.	West Riding	3.30 p.m.	8°	37°	None ..	Clean ..	Clean ..	Clean ..	Clean ..
57	18th Nov.	West Riding	3.45 p.m.	4°	30°	None ..	Dirty ..	Rather dirty	Clean ..	Dirty ..
58	20th Nov.	Leeds ..	3.15 p.m.	8.5°	20°	None ..	Clean ..	Clean ..	Clean ..	Fairly clean ..
59	25th Nov.	Sheffield Town	6.45 a.m.	5°	35°	None ..	Very clean	Very clean	Very clean ..	Very clean ..
60	29th Nov.	Town ..	8.15 a.m.	7°	30°	None ..	Dirty ..	Dirty ..	Fairly clean ..	Dirty ..
61	3rd Dec.	Derbyshire	5.30 p.m.	5°	19°	Cooler ..	Very dirty	Dirty ..	Dirty ..	Clothes dirty, clean hands
62	5th Dec	Derbyshire	4.45 p.m.	5°	28°	None ..	Filthy, dirty	Very dirty	Very dirty ..	Very dirty ..
63	9th Dec.	Hull ..	7.30 a.m.	10°	30°	None ..	Very clean	Very clean	Very clean, udders rubbed with dry cloth	Hands washed very clean
64	11th Dec.	Hull ..	7.15 a.m.	6°	27°	None ..	Very clean	Very clean	Very clean, udders rubbed with dry cloth	Clean hands, washed
65	16th Dec.	Derbyshire	5.30 p.m.	7°	8.5°	Cooler ..	Very clean	Fairly clean	Dirty ..	Hands washed clean
66	1st Jan.	East Riding	7 a.m.	4°	25°	None ..	Moderate ..	Moderate ..	Dirty, rubbed with dry cloth	Clean ..
67	2nd Jan.	Leeds ..	4.30 p.m.	1°	31.5°	None ..	Fairly clean	Fairly clean	Dirty ..	Fairly clean ..
68	9th Jan.	Bradford ..	7.15 a.m.	4°	32°	None ..	Dirty	Clean ..	Dirty ..	Clean ..
69	13th Jan.	West Riding	3.30 p.m.	1.5°	31°	None ..	Rather dirty	Fairly clean	Dirty ..	Hands washed fairly clean
70	16th Jan.	West Riding	6.15 a.m.	9.5°	34°	None ..	Very dirty	Dirty ..	Dirty ..	Rather dirty ..
71	20th Jan.	West Riding	3.15 p.m.	5°	31°	None ..	Dirty ..	Dirty ..	Dirty ..	Clothes dirty
72	23rd Jan.	Rotherham	6.30 p.m.	0°	33°	—	Clean ..	Clean ..	Clean ..	Clean ..
73	28th Jan.	Rotherham	8.15 a.m.	4°	31°	—	Dirty walls	Clean ..	Clean ..	Clean ..
74	30th Jan.	West Riding	4.15 p.m.	2°	35°	None ..	Clean ..	Clean ..	Clean ..	Clean ..
75	4th Feb.	Rotherham	6.30 a.m.	2°	33°	None ..	Clean ..	Clean ..	Clean ..	Clean ..

Cans.	Ventilation and Lighting.	Bacteria per cc. Agar 37° C.	Bacteria per cc. Gelatine 20° C.	Glucose-fermenting bacteria.							Streptococci.							B.E.S.			Serial Number.
				1	2	3	4	5	6	7	1	2	3	4	5	6	7	20 cc.	10 cc.	1 cc.	
Clean, cold water and scalded	Poorly lit and ventilated, 460 c. ft.	33,000	63,500	+	–	–	–	–	–	–	+	+	+	+	–	–	–	+	–	–	53
Clean, scalded	No light or ventilation, 7 ft. high	28,300	Spoiled	+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	–	–	54
Brushed and scalded	Well lit and ventilated	82,600	87,000	+	–	–	–	–	–	–	+	+	+	+	+	–	–	+	+	–	55
Clean, washed in hot water	Bad, deficient light and ventilation	32,500	52,000	+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	+	–	56
Clean, by scalding	Good light and ventilation	14,600	20,000	–	–	–	–	–	–	–	+	+	+	–	–	–	–	+	–	–	57
Clean, by scalding	Bad, deficient light and ventilation	—	—																		58
Scalded	Good, well lit and ventilated, 800 c. ft.	157,600	164,000	+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	+	–	59
Hot water, soap and scalded	Good, well lit and ventilated	162,000	380,000	+	+	+	+	+	–	–	+	+	+	–	–	–	–	+	+	–	60
Soap and water, scalded	Well ventilated, badly lit, 500 c. ft.	157,000	Spoiled	+	–	–	–	–	–	–	+	+	+	+	–	–	–	+	–	–	61
Soda and hot water	None whatever, 200 c. ft.	62,000	Spoiled Agar 20°C	+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	+	–	62
Scrubbed and scalded	Good, sufficient light and ventilation, 800 c. ft.	24,500	Spoiled	+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	–	–	63
Scalded	Good, well lit and ventilated, 800 c. ft.	39,300	42,300	–	–	–	–	–	–	–	+	+	+	–	–	–	–	–	+	–	64
Scrubbed and scalded	Good ventilation but no windows	82,000	194,000	+	+	+	–	–	–	–	+	+	+	+	–	–	–	+	+	–	65
Scalded with steam	Sufficient cubic space, no ventilation, little light	48,600	62,600	+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	–	–	66
Scalded	Bad, deficient light and ventilation	39,300	40,600	+	+	–	–	–	–	–	+	+	+	+	–	–	–	+	+	–	67
Clean, washed and scalded	Poor, insufficient light and ventilation	60,600	66,500	+	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	68
Clean, scalded	500 c. ft., fairly well let and ventilated	128,000	98,000	+	+	+	–	–	–	–	+	+	+	–	–	–	–	+	–	–	69
Clean, scalded	500 c. ft., badly lit and ventilated	30,300	116,000	+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	–	–	70
Clean, scalded	Bad, air and ventilaton deficient	75,000	107,000	+	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	71
Clean, scalded	Good light and ventilation, 860 c. ft.	8,600	23,000	+	–	–	–	–	–	–	+	+	+	+	–	–	–	+	+	–	72
Clean, scalded	Good light and ventilation, 1,716 c. ft.	36,600	20,000	–	–	–	–	–	–	–	+	+	–	–	–	–	–	–	–	–	73
Clean, scalded	Good light and ventilation, 540 c. ft.	11,600	20,000	+	–	–	–	–	–	–	+	+	+	+	–	–	–	+	+	–	74
Clean, scalded	Good, 622 c. ft.	24,300	36,000	+	–	–	–	–	–	–	+	+	–	–	–	–	–	+	–	–	75

COWSHED

Serial Number.	Time taken.	Time iced.	Time carried until iced.	Organisms per cc. Agar 37° C.	Organisms per cc. Gelatine 20° C.
1	6.45 a.m.	9.30 a.m.	2¾ hours	21,250	22,500
2	6.45 a.m.	9.45 a.m.	3 hours	12,750	12,875
3	7.15 a.m.	9 a.m.	1¾ hours	6,080	6,500
4	7 a.m.	9.15 a.m.	2¼ hours	11,830	15,330
5	6.30 a.m.	8.45 a.m.	2¼ hours	8,610	10,650
6	4 p.m.	9.30 a.m.	17½ hours	41,660	—
7	6.45 a.m. 6.45 a.m.	5 0 p.m. 9.45 a.m.	10¼ hours 3 hours	49,580 33,300	106,660 71,830
8	6.45 a.m.	4.15 p.m.	9½ hours	11,500	22,000
9	7.15 a.m.	5 p.m.	9¾ hours	20,300	24,240
10	7 a.m.	6 p.m.	11 hours	41,250	52,000
11	8.15 a.m.	6 p.m.	9¾ hours	11,750	12,830
12	7 a.m.	6.15 p.m.	11¼ hours	67,160	74,330
13	6.45 a.m.	2.30 p.m.	7¾ hours	84,500	120,300
14	4.30 p.m.	8 a.m.	15½ hours	34,000	34,300
15	5.15 p.m.	7.15 a.m.	14 hours	105,000	231,000
16	5.15 p.m.	7.15 a.m.	14 hours	165,000	270,000
17	6.15 a.m.	5.15 p.m.	11 hours	55,000	88,000
18	7.45 a.m.	5.15 p.m.	9½ hours	8,600	50,500
19	7.15 a.m.	5 p.m.	9¾ hours	9,830	37,600
20	6.30 a.m.	5 p.m.	10½ hours	82,000	55,300
21	11.15 a.m.	5.45 p.m.	6½ hours	Spoiled	83,600
22	6.15 a.m.	6 p.m.	11¾ hours	22,500	Spoiled
23	3.30 p.m.	8.45 a.m.	17¼ hours	35,000	188,000
24	8.45 a.m.	5.15 p.m.	8½ hours	278,000	475,000
25	3.30 p.m.	10.30 a.m.	19 hours	127,000	798,000
26	7.30 a.m.	5.15 p.m.	9¾ hours	92,600	93,000
27	7.15 a.m.	5 p.m.	9¾ hours	77,500	115,300
28	7.45 a.m.	4.15 p.m.	8½ hours	55,500	Spoiled
29	6.30 p.m.	8.30 a.m.	14 hours	36,000	Spoiled
30	7 a.m.	3.45 a.m.	8¾ hours	66,000	128,000
31	7 a.m.	2.30 p.m.	7½ hours	19,000	53,000
32	6.30 a.m.	5.15 p.m.	10¾ hours	1,010,000	1,850,000
33	3.15 p.m.	9.15 a.m.	18 hours	840,000	9,600,000
34	6.15 a.m.	4.30 p.m.	10¼ hours	Spoiled	420,000
35	6.30 a.m.	4.45 p.m.	10¼ hours	1,930,000	1,800,000
36	3 p.m.	9.30 a.m.	18½ hours	1,420,000	Spoiled

CONTROL.

Glucose-Fermenting Bacteria.							Streptococci.							B. E. S.			Serial Number.
1	2	3	4	5	6	7	1	2	3	4	5	6	7	20 cc.	10 cc.	1 cc.	
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	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
+	+	-	-	-	-	-	+	+	+	+	-	-	-	.	-	-	29
+	+	-	-	-	-	-	+	+	+	+	+	+	-	.	-	-	30
-	-	-	-	-	-	-	+	+	+	-	-	-	-	.	-	-	31
+	+	+	-	-	-	-	+	+	+	-	-	-	-	.	-	-	32
+	+	+	-	-	-	-	+	+	+	+	+	+	-	-	-	-	33
+	+	-	-	-	-	-	+	+	+	+	-	-	-	-	+	-	34
+	+	-	-	-	-	-	+	+	+	+	+	-	-	-	-	-	35
+	+	+	+	+	+	-	+	+	+	+	+	-	-	-	-	-	36

COWSHED

Serial Number.	Time taken.	Time iced.	Time carried until iced.	Organisms per cc. Agar 37° C.	Organisms per cc. Gelatine 20° C.
37	7.30 a.m.	6 p.m.	10½ hours	3,866,000	Spoiled
38	6.45 a.m.	5.15 p.m.	10½ hours	6,480,000	12,800,000
39	7.15 a.m.	5.15 p.m.	10 hours	2,405,000	1,600,000
40	6.30 a.m.	5 p.m.	10½ hours	9,280,000	Spoiled
41	5.15 p.m.	7.30 a.m.	14¼ hours	870,000	1,186,000
42	5.15 p.m.	1.30 p.m.	8¼ hours	930,000	2,630,000
43	6.45 a.m.	1 p.m.	6¼ hours	4,000,000	11,660,000
44	7.30 p.m.	12.15 p.m.	16¾ hours	1,300,000	6,755,000
45	5.30 p.m.	1 p.m.	19½ hours	40,000	375,000
46	8 a.m.	4 p.m.	8 hours	115,000	135,000
47	6 p.m.	4 p.m.	22 hours		Contaminated
48	7 p.m.	5.15 p.m.	22¼ hours	Spoiled	1,450,000
49	4 p.m.	9.45 a.m.	17¾ hours	Spoiled	2,440,000
50	9.45 a.m.	4 p.m.	6½ hours	1,420,000	2,600,000
51	4.15 p.m.	8.30 p.m.	4¼ hours	50,000	190,000
52	5.30 p.m.	3.45 p.m.	22¼ hours	55,000	245,000
53	6.30 a.m.	11.30 a.m.	5 hours	45,000	75,000
54	5.15 p.m.	10.30 a.m. Retailer's premises	17¼ hours	70,000	Spoiled
55	6.45 a.m.	9.45 a.m. Retailer's premises	3 hours	95,600	96,500
56	3.30 p.m.	9.30 a.m.	18 hours	983,000	2,985,000
57	3.45 p.m.	9.30 a.m.	19¾ hours	13,500	27,000
58	3.15 p.m.	9.30 a.m.	17¼ hours	—	—
59	6.45 a.m.	1.30 p.m.	6¾ hours	144,000	Spoiled
60	8.15 a.m.	12.30 p.m.	4½ hours	190,000	380,000
61	5.30 p.m.	1.15 p.m.	19¾ hours	74,000	Spoiled
62	4.45 p.m.	8 a.m.	15¼ hours	58,500	Spoiled (Agar 20° C.)
63	7.30 a.m.	5.15 p.m.	9¾ hours	37,500	Spoiled
64	7.15 a.m.	5.15 p.m.	10 hours	57,000	56,600
65	5.30 p.m.	4 p.m.	22½ hours	290,000	631,000
66	7 a.m.	5.15 p.m.	10¼ hours	41,000	44,600
67	4.30 p.m.	11 a.m.	18½ hours	42,000	52,500
68	7.15 a.m.	4.45 p.m.	9½ hours	45,000	47,000
69	3.30 p.m.	10 a.m.	18½ hours	62,000	114,000
70	6.15 a.m.	4.30 p.m.	9¾ hours	276,000	586,000
71	3.15 p.m.	8.45 a.m.	17½ hours	122,500	170,000
72	6.30 p.m.	9.30 a.m.	15 hours	9,600	26,000
73	8.15 a.m.	12.30 p.m.	4¼ hours	35,000	26,000
74	4.15 p.m.	9.30 a.m.	17¼ hours	16,500	24,300
75	6.30 a.m.	1.30 p.m.	7 hours	131,000	327,000

CONTROL.—*continued.*

Glucose-fermenting Bacteria.							Steptococci.							B.E.S.			Serial Number.
1	2	3	4	5	6	7	1	2	3	4	5	6	7	20 cc.	10 cc.	1 cc.	
+	+	+	+	+	-	-	+	+	+	+	+	+	-	-	+	-	37
+	+	+	+	+	+	-	+	+	+	+	+	-	-	-	+	-	38
+	+	-	-	-	-	-	+	+	+	+	+	-	-	-	-	-	39
+	+	+	+	+	+	-	+	+	+	+	+	+	-	-	-	-	40
+	+	+	+	-	-	-	+	+	+	+	+	+	-	-	-	-	41
+	+	-	-	-	-	-	+	+	+	+	-	-	-	-	-	-	42
+	+	+	+	-	-	-	+	+	+	+	-	-	-	-	+	-	43
+	+	+	+	-	-	-	+	+	+	+	+	+	-	-	-	-	44
+	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	45
-	-	-	-	-	-	-	+	+	+	+	+	-	-	-	-	-	46
																	47
+	+	+	+	+	+	-	+	+	+	+	-	.	-	+	-	-	48
+	+	+	+	-	-	-	+	+	+	+	+	+	-	+	+	+	49
+	+	+	+	+	-	-	+	+	+	+	+	+	-	+	-	-	50
+	-	-	-	-	-	-	+	+	+	+	-	-	-	-	+	-	51
+	+	-	-	-	-	-	+	+	+	+	-	-	-	+	+	-	52
+	-	-	-	-	-	-	+	+	+	+	+	-	-	+	+	-	53
+	-	-	-	-	-	-	+	+	+	-	-	-	-	+	+	-	54
+	+	-	-	-	-	-	+	+	+	+	+	-	-	+	+	-	55
+	-	-	-	-	-	-	+	+	+	+	-	-	-	+	-	-	56
+	-	-	-	-	-	-	+	+	+	+	+	-	-	+	-	-	57
																	58
+	+	-	-	-	-	-	+	+	+	+	+	-	-	+	+	-	59
+	+	+	+	+	+	-	+	+	+	+	+	-	-	+	+	-	60
+	-	-	-	-	-	-	+	+	+	+	-	-	-	+	-	-	61
+	-	-	-	-	-	-	+	+	+	-	-	-	-	+	-	-	62
+	+	-	-	-	-	-	+	+	+	-	-	-	-	+	-	-	63
+	-	-	-	-	-	-	+	+	+	+	+	-	-	+	-	-	64
+	+	+	-	-	-	-	+	+	+	+	+	-	-	+	+	-	65
+	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	66
+	+	-	-	-	-	-	+	+	+	+	-	-	-	+	+	-	67
+	-	-	-	-	-	-	+	+	+	+	-	-	-	-	-	-	68
+	+	+	-	-	-	-	+	+	+	+	+	-	-	+	-	-	69
+	+	+	-	-	-	-	+	+	+	-	-	-	-	+	+	-	70
+	+	-	-	-	-	-	+	+	+	+	+	-	-	+	-	-	71
+	-	-	-	-	-	-	+	+	+	-	-	-	-	+	+	-	72
-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	73
-	-	-	-	-	-	-	+	+	+	+	-	-	-	+	+	-	74
+	-	-	-	-	-	-	+	+	+	-	-	-	-	+	-	-	75

RAILWAY

Serial Number.	Distance travelled.	Cleanliness of van, etc.	When taken.	Time from cowshed.	Temperature of Air	and Milk.	How transferred.
1	—	—	—	—	—		—
2	—	—	—	—	—		—
3	—	—	—	—	—		—
4	—	—	—	—	—		—
5	—	—	—	—	—		—
6	—	—	—	—	—		—
7	—	—	—	—	—		—
8	—	—	—	—	—		—
9	—	—	—	—	—		—
10	—	—	—	—	—		—
11	—	—	—	—	—		—
12	15 miles	Clean, cans and passengers' luggage	8.15 a.m.	1¼ hours	11° C.	15° C.	Pouring in, in bulk, station platform
13	10 miles	Clean, meat in van	8.45 a.m.	2 hours	12°	25°	Sieved in bulk into retailer's vessel; transferred in station; dirty
14	21 miles ..	Very clean; mail bags and boxes	7.30 p.m.	3 hours	9°	15°	By pouring in and sieved
15	7 miles ..	Clean; parcels in van	6 p.m.	¾ hour	18°	30°	Poured into retailer's can at station
16	17 miles ..	Clean; milk cans and parcels	6.15 p.m.	1 hour	12°	26°	Poured in bulk ..
17	12 miles ..	Clean; passengers' luggage	9.15 a.m.	3 hours	14°	21°	Taken to dairy ..
18	17 miles ..	Churn, passengers' parcels, live dog	9 a.m.	1¼ hour	11°	21°	Measured out with measure
19	8 miles ..	Dirty; dirty sawdust, mail bags and churns	8.15 a.m.	1 hour	8.5°	9°	Direct to dairy ..
20	8 miles ..	Some dirty sawdust, luggage	9 a.m.	2½ hours	10°	23°	Taken to dairy ..
21	—	—	—	—	—		—
22	12 miles ..	Dusty; eggs, &c., crate of live pigeons and luggage	9 a.m.	2¾ hours	10°	24°	Taken to dairy ..
23	—	—	—	—	—		—
24	—	—	—	—	—		—
25	15 miles ..	Fairly clean; strong smell of fish; only milk vessels	5.30 p.m.	2 hours	16°	26°	Emptied in bulk in very dirty station
26	—	—	—	—	—		—
27	16½ miles	Fairly clean; travelling bag	9.15 a.m.	2 hours	15.5°	24°	Measured out ..
28	—	—	—	—	—		—
29	—	—	—	—	—		—
30	—	—	—	—	—		—
31	—	—	—	—	—		—
32	—	—	—	—	—		—
33	34 miles ..	Clean; full of milk cans	5.30 p.m.	2¼ hours	18°	26°	In bulk .. ..
34	—	—	—	—	—		—
35	—	—	—	—	—		—
36	—	—	—	—	—		—

STATION.

Bacteria per cc. Agar 37° C.	Bacteria per cc. Gel. 20° C.	Glucose-fermenting bacteria.							Streptococci.							B.E.S.			Serial Number.
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	20 cc.	10 cc.	1 cc.	
—	—																		1
—	—																		2
—	—																		3
—	—																		4
—	—																		5
—	—																		6
—	—																		7
—	—																		8
—	—																		9
—	—																		10
—	—																		11
68,000	77,000	+	+	-	-	-	-	-	+	+	+	-	-	-	-	.	+	-	12
215,300	294,000	+	-	-	-	-	-	-	+	+	+	+	-	-	-	.	+	-	13
17,500	21,000	+	-	-	-	-	-	-	+	+	+	-	-	-	-	.	.	-	14
47,400	56,950	+	-	-	-	-	-	-	+	+	-	-	-	-	-	.	-	-	15
24,000	46,000	-	-	-	-	-	-	-	+	+	-	-	-	-	-	.	-	-	16
29,500	84,160	+	-	-	-	-	-	-	+	+	+	-	-	-	-	.	-	-	17
15,160	28,800	-	-	-	-	-	-	-	+	+	+	+	-	-	-	.	-	-	18
11,500	29,900	+	+	+	+	-	-	-	+	+	+	+	-	-	-	.	-	-	19
18,800	32,300	+	+	-	-	-	-	-	+	+	+	-	-	-	-	.	-	-	20
—	—																		21
4,000	53,160	+	+	+	-	-	-	-	+	+	+	-	-	-	-	.	+	-	22
—	—																		23
—	—																		24
7,160	19,800	-	-	-	-	-	-	-	+	+	-	-	-	-	-	.	-	-	25
—	—																		26
21,160	73,600	+	-	-	-	-	-	-	+	+	+	-	-	-	-	.	+	-	27
—	—																		28
—	—																		29
—	—																		30
—	—																		31
—	—																		32
Spoiled	440,000	+	+	+	+	-	-	-	+	+	+	+	+	-	-	-	+	-	33
—	—																		34
—	—																		35
—	—																		36

Serial Number.	Distance travelled.	Cleanliness of van, etc.	When taken.	Time from cowshed.	Temperature of Air	and Milk.	How transferred.
37	10½ miles	Very dusty ; parcels, &c.	9 a.m.	1½ hours	2°	22°	In farmer's own churn direct ; porter swept out van while cans in it, raising clouds of dust
38	—	—	—	—		—	—
39	—	—	—	—		—	—
40	8½ miles ..	Milk cans clean ; luggage	8.30 a.m.	2 hours	12.5°	17°	In farmer's can intact
41	20 miles ..	Van clean ; dirty bicycles, other parcels	6.15 p.m.	1 hour	14.5°	30°	Direct to dairy by retailer
42	30 miles	Van clean ; full of people ; air foul	9.15 p.m.	4 hours	15°	17°	Left all night in station ; passengers sitting on churns
43	7 miles ..	By cart	9 a.m.	2¼ hours	13.5°	28°	Not transferred ..
44	64 miles ..	Very clean ; only milk churns	3 a.m.	7½ hours	17°	15°	In farmer's can to dairy
45	100 miles ..	Very dirty ; fish, &c.	6.30 a.m.	13 hours	12°	12°	Poured in bulk into retailer's can at station ; stood all night in van at station
46	—	—	—	—		—	—
47	38 miles ..	Fairly clean ..	7.15 a.m.	13¼ hours	12.5°	14°	Emptied into large can in bulk
48	47 miles ..	Fairly clean ; passengers' luggage	6.45 a.m.	11¾ hours	10°	12°	In bulk .. ..
49	9 miles ..	Van fairly clean ..	5.45 p.m.	1¾ hours	9.5°	29°	In bulk on station platform ; station dirty
50	—	—	—	—		—	—
51	—	—	—	—		—	—
52	28 miles ..	Fairly clean ; other milk cans	6.45 a.m.	13¼ hours	8°	9°	Measured out overnight in station
53	—	—	—	—		—	—
54	38 miles ..	Clean ; milk cans and luggage	8.15 a.m.	15 hours	14°	13°	Poured in bulk in station ; overnight in station
55	4 miles ..	Clean cart	7.30 a.m.	¾ hour	12.5°	22.5°	In bulk .. ..
56	10 miles ..	Clean; milk churns only	5 p.m.	1½ hours	12°	20°	In bulk .. ..
57	30 miles ..	Clean ; milk churns	7.45 p.m.	4 hours	13°	32°	In bulk .. ..
58	—	—	—	—		—	—
59	—	—	—	—		—	—
60	—	—	—	—		—	—
61	38 miles ..	Very clean ; other milk churns, parcels, &c.	6.30 a.m.	13 hours	6°	7.5°	From station to dairy ; overnight in station
62	22 miles ..	Clean ; other milk churns, parcels, &c.	6.30 p.m.	1¾ hours	6°	21°	Poured out in station
63	—	—	—	—		—	—
64	—	—	—	—		—	—
65	115 miles	Clean ; used for milk only	6.15 a.m.	12¾ hours	7°	8°	In same can direct to dairy
66	35 miles ..	Fairly clean ; parcels, &c.	10 a.m.	3 hours	5.5°	11°	In farmer's can direct to dairy
67	—	—	—	—		—	—
68	—	—	—	—		—	—
69	24 miles ..	Clean ; no other contents	5.45 p.m.	2¼ hours	.5°	24°	In bulk ; strained again through linen
70	14 miles ..	Fairly clean ; milk cans only	8 a.m.	1¾ hours	10.5°	29°	Straight to dairy ..
71	12 miles ..	Fairly clean ; parcels, &c.	5 p.m.	1¾ hours	4.5°	24°	Same can taken round the streets

STATION.—*continued.*

Bacteria per cc. Agar 37° C.	Bacteria per cc. Gel. 20° C.	Glucose-fermenting bacteria.							Streptococci.							B.E.S.			Serial Number.
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	20 cc.	10 cc.	1 cc.	
1,152,000	3,620,000	+	+	+	+	+	−	−	+	+	+	+	+	−	−	−	+	−	37
—	—																		38
—	—																		39
125,800	Spoiled	+	+	+	+	+	−	−	+	+	+	+	+	−	−	−	−	−	40
55,300	83,000	−	−	−	−	−	−	−	+	+	+	+	+	+	−	−	−	−	41
31,000	130,300	+	+	−	−	−	−	−	+	+	+	+	−	−	−	−	−	−	42
150,600	215,000	+	+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	−	43
130,600	537,000	+	+	+	−	−	−	−	+	+	+	+	+	−	−	−	+	−	44
64,000	206,500	+	+	+	+	−	−	−	+	+	+	+	−	−	−	−	−	−	45
—	—																		46
Con	taminated																		47
Spoiled	78,000	+	+	+	+	−	−	−	+	+	+	+	−	−	−	+	−	−	48
Spoiled	201,300	+	+	+	−	−	−	−	+	+	+	+	−	−	−	+	+	−	49
—	—																		50
—	—																		51
Spoiled	57,500	+	+	−	−	−	−	−	+	+	+	+	+	−	−	+	−	−	52
—	—																		53
34,000	Spoiled	+	−	−	−	−	−	−	+	+	+	−	−	−	−	+	−		54
119,000	124,000	+	+	−	−	−	−	−	+	+	+	+	+	−	−	+	+	−	55
50,000	194,600	+	+	−	−	−	−	−	+	+	+	+	−	−	−	+	−	−	56
Spoiled	33,500	+	−	−	−	−	−	−	+	+	+	+	−	−	−	+	−	−	57
—	—																		58
—	—																		59
—	—																		60
106,000	Spoiled	+	+	+	−	−	−	−	+	+	+	+	+	−	−	+	+	−	61
90,000	Spoiled (Agar 20°C)	+	−	−	−	−	−	−	+	+	+	−	−	−	−	+	−	−	62
—	—																		63
—	—																		64
117,000	202,000	+	+	+	−	−	−	−	+	+	+	+	+	−	−	+	+	−	65
118,000	129,000	+	−	−	−	−	−	−	+	+	+	+	−	−	−	+	−	−	66
—	—																		67
—	—																		68
103,000	134,000	+	+	+	−	−	−	−	+	+	+	+	+	−	−	+	−	−	69
67,000	242,000	+	−	−	−	−	−	−	+	+	+	−	−	−	−	−	−	−	70
95,000	108,000	+	−	−	−	−	−	−	+	+	+	+	−	−	−	−	−	−	71

STREET.

Serial Number.	When taken.	Time from cowshed.	Distance from farm, etc.	Temperature of Air and Milk.	Dusty or rainy.	Cleanliness of Cart.	Cleanliness of Can.	Cleanliness of Retailer.
1	9 a.m.	2¼ hours	—	6° C. 14.5° C.	Dry, clean	Clean	Clean	Clean
2	8.15 a.m.	1½ hours	—	9° C. 18.5°	Dry	Clean	Clean	Clean
3	8.45 a.m.	1½ hours	—	12° C. 22.5°	Clean	Clean	Clean	Clean
4	8.35 a.m.	1½ hours	—	4.5° C. 22°	No dust	Clean	Clean	Clean
5	7.15 a.m.	¾ hour	—	9.5° C. 14.5°	Dry	Clean	Clean	Clean
6	5 p.m.	1 hour	5 miles	10° C. 27°	Street dirty	Clean	Clean	Clean
7	—	—	—	—	—	—	—	—
8	7.45 a.m.	1 hour	—	7° C. 23° C.	Wet	Clean	Clean	Clean
9	—	—	—	—	—	—	—	—
10	9 a.m.	2 hours	—	4.5° C. 14.5°	Rather dusty	Clean	Clean	Clean
11	8.45 a.m.	1½ hours	¼ mile from farm	10° C. 23.5°	Clean	Clean	Clean	Clean
12	—	—	—	—	—	—	—	—
13	10.15 a.m.	3½ hours	13 miles from premises	10° C. 20° C.	No dust	Fair	Clean	Fair
14	8.30 p.m.	4 hours	22 miles from farm	8° C. 15° C.	No dust	Very clean	Very clean	Very clean
15	7.45 p.m.	2½ hours	9 miles from farm	16° 22°	Dusty	Fairly clean	Fairly clean	Clothing dirty hands clean
16	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—
20	9.30 a.m.	3 hours	8½ miles	11° 23°	Clean	Clean	Rusty and dirty	Dirty
21	1.15 p.m.	2 hours	8 miles	9° 16°	Raining	Hand can	Very clean	Clean
22	9.45 p.m.	3½ hours	13½ miles	10° 23°	Dusty	Hand can	Clean	Clean
23	5.15 p.m.	1¾ hours	8 miles	14° 28°	Damp	Dirty	Clean	Clean
24	11 a.m.	2¼ hours	1½ miles	15° 16°	Rain	Dirty	Clean	Clean
25	6 p.m.	2½ hours	15½ miles	16° 20°	Clean, no dust	Clean	Clean	Clean
26	9.15 a.m.	1¾ hours	1 mile	15° 26°	Raining	Clean	Clean	Clean
27	10.30 a.m.	3¼ hours	17 miles	15.5° 22°	Clean and dry	—	Clean	Fairly clean
28	9.30 a.m.	1¾ hours	2½ miles	9.5° 29°	No dust	Very clean	Very clean	Very clean
29	7.15 p.m.	¾ hour	¾ mile	13° 29°	After rain	Clean	Clean	Clean
30	10.45 a.m.	3¾ hours	3 miles	14.5° 17°	No dust	Very clean	Very clean	Very clean
31	11.30 a.m.	4½ hours	6½ miles	15.5° 23°	No dust	Clean	Clean	Clean
32	8.15 a.m.	1¾ hours	5 miles	18° 28°	None	Clean	Clean	Clean
33	6 p.m.	2¾ hours	34½ miles	18° 26°	None	Clean	Clean	Clean
34	9 a.m.	2¾ hours	2 miles	12.5° 25°	None	Clean	Clean	Clean
35	9.45 a.m.	3¼ hours	3 miles	12° 19°	Raining	Clean	Clean	Clean
36	5.30 p.m.	2½ hours	½ mile	15° 13°	No dust	Clean	Clean	Clean
37	9.45 a.m.	2¼ hours	11¼ miles	13° 20°	Dusty	—	Clean	Clean
38	7.30 a.m.	¾ hour	2½ miles	14° 23°	Dusty	Dirty	Clean	Clean
39	8.15 a.m.	1 hour	3 miles	13° 24°	Raining	Clean	Clean	Clean
40	—	—	—	—	—	—	—	—

Method of delivery, dipper, etc.	Bacteria per cc. Agar 37° C.	Bacteria per cc. Gelatine 20° C.	Glucose-fermenting bacteria. 1	2	3	4	5	6	7	Streptococci. 1	2	3	4	5	6	7	B.E.S. 20 cc.	10 cc.	1 cc.	Serial Number
Dipper	14,250	14,750	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Dipper	13,583	13,416	.	.	.	.	.	.	.	+	+	–	–	–	–	–	.	.	.	2
Dipper	13,410	15,000	–	–	–	–	–	–	–	+	–	–	–	–	–	–	.	.	.	3
Dipper	11,660	11,750	–	–	–	–	–	–	–	+	–	–	–	–	–	–	.	.	.	4
Dipper	31,160	34,660	+	–	–	–	–	–	–	+	+	–	–	–	–	–	.	.	.	5
—	28,250	—	+	–	–	–	–	–	–	+	+	+	–	–	–	–	.	.	.	6
—	—	—																		7
Dipper	19,410	26,580	–	–	–	–	–	–	–	+	+	–	–	–	–	–	.	+	–	8
—	—	—																		9
Dipper	39,500	40,500	+	–	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	10
Dipper	31,250	33,730	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	11
—	—	—																		
Small can and dipper	144,000	236,000	+	+	+	+	–	–	–	+	+	+	+	–	–	–	.	+	–	13
Can and dipper	18,160	19,000	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	–	–	14
Small can and dipper	50,600	59,750	+	+	–	–	–	–	–	+	+	–	–	–	–	–	.	–	–	15
—	—	—																		16
—	—	—																		17
—	—	—																		18
—	—	—																		19
Dipper	9,800	41,500	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	–	–	20
Dipper	30,000	35,000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	.	+	–	21
Dipper	7,000	21,000	+	+	+	+	+	–	–	+	+	+	–	–	–	–	.	–	-	22
Dipper	4,500	27,000	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	+	-	23
Dipper	48,000	81,500	+	+	+	+	–	–	–	+	+	+	+	–	–	–	.	+	–	24
Dipper	36,300	110,000	+	+	–	–	–	–	–	+	+	–	–	–	–	–	.	–	–	25
Dipper	82,000	136,000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	.	–	–	26
Dipper	46,100	257,000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	.	+	–	27
Pouring in ..	59,000	Spoiled	–	–	–	–	–	–	–	+	+	+	+	–	–	–	.	–	–	28
By can dipper	20,500	Spoiled	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	–	–	29
By dipper ..	3,200,000	Spoiled	+	+	+	+	+	–	–	+	+	+	+	+	–	–	.	–	–	30
Brass tap ..	145,800	244,500	+	+	–	–	–	–	–	+	+	+	+	+	–	–	.	–	–	31
Dipper	890,000	1,865,000	+	+	+	+	–	–	–	+	+	+	+	–	–	–	.	–	–	32
Dipper	150,600	660,000	+	+	+	–	–	–	–	+	+	+	+	+	–	–	–	–	–	33
Dipper	50,500	103,000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	–	+	–	34
Dipper	198,300	480,000	+	+	–	–	–	–	–	+	+	+	+	+	–	–	–	–	–	35
Dipper	172,500	Spoiled	+	+	+	+	–	–	–	+	+	+	+	–	–	–	–	–	–	36
Dipper	1,421,000	Spoiled	+	+	+	+	+	+	–	+	+	+	+	+	+	–	–	+	–	37
Dipper	47,830	159,000	+	+	+	–	–	–	–	+	+	+	+	–	–	–	–	–	–	38
Dipper	184,300	300,000	–	–	–	–	–	–	–	+	+	+	+	+	–	–	–	–	–	39
—	—	—																		40

STREET.—*continued.*

Serial Number.	When taken.	Time from cowshed.	Distance from farm, etc.	Temperature of Air and Milk.	Dusty or rainy.	Cleanliness of Cart.	Cleanliness of Can.	Cleanliness of Retailer.
41	—	—	—	—	—	—	—	—
42	9.30 a.m.	16¼ hours	30 miles ..	13° 16°	No dust ..	Dirty ..	Dirty ..	Very dirty ..
43	11 a.m.	4¼ hours	8 miles	17° 24°	No dust ..	Clean ..	Clean ..	Clean ..
44	—	—	—	—	—	—	—	—
45	10 a.m.	18½ hours	113 miles ..	13° 13°	No dust ..	Clean ..	Clean ..	Fairly clean
46	9.30 a.m.	1½ hours	¾ mile	12° 28°	No dust ..	Clean ..	Clean ..	Clean ..
47	8.45 a.m.	14¾ hours	38¼ miles ..	13½° 14°	Clean ..	Clean ..	Clean ..	Clean ..
48	10.45 a.m.	15¾ hours	47¾ miles ..	9½° 11°	No dust ..	Carried by trolley	Fairly clean..	Fairly clean
49	6.45 p.m.	2¾ hours	10 miles ..	11.5° 22°	Wet from rain	No cart ..	Fairly clean	Fairly clean ..
50	10.15 a.m.	½ hour	2½ miles ..	9° C. 20° C.	No dust ..	Clean ..	Clean ..	Clean ..
51	7.15 p.m.	3 hours	1½ miles ..	5° 21°	No dust ..	Very clean ..	Very clean ..	Very clean ..
52	—	—	—	—	—	—	—	—
53	—	—	—	—	—	—	—	—
54	—	—	—	—	—	—	—	—
55	—	—	—	—	—	—	—	—
56	—	—	—	—	—	—	—	—
57	—	—	—	—	—	—	—	—
58	5 p.m.	1¾ hours	5 miles	8° 20°	Raining heavily	Clean ..	Clean ..	Clean ..
59	11.15 a.m.	4½ hours	4 miles	6° 19°	None ..	Clean ..	Clean ..	Clean ..
60	—	—	—	—	—	—	—	—
61	—	—	—	—	—	—	—	—
62	8 p.m.	3¼ hours	23 miles ..	6.5° 16°	No rain or dust	Fairly clean	Fairly clean	Clean ..
63	8.30 a.m.	1 hour	—	13° 27°	Dry, no dust	Clean ..	Clean ..	Clean ..
64	8.15 a.m.	1 hour	1 mile	5° 21.5°	Street wet	Clean ..	Clean ..	Clean ..
65	—	—	—	—	—	—	—	—
66	—	—	—	—	—	—	—	—
67	—	—	—	—	—	—	—	—
68	9.45 a.m.	2½ hours	1 mile	.5° 21°	Ground frozen	Clean ..	Clean ..	Clean ..
69	—	—	—	—	—	—	—	—
70	—	—	—	—	—	—	—	—
71	7 p.m.	3¾ hours	—	5° 15.5°	Dry and clean	Clean ..	Clean ..	Clean ..
72	6.45 p.m.	¼ hour	¼ mile	0° 32°	Frosty ..	—	Very clean ..	Very clean ..
73	—	—	—	—	—	—	—	—
74	6.45 p.m.	2½ hours	5 miles	5.5° 19°	No dust ..	Clean ..	Very clean ..	Clean ..
75	—	—	—	—	—	—	—	—

Method of delivery, dipper, etc.	Bacteria per cc. Agar 37° C.	Bacteria per cc. Gelatine 20° C.	Glucose-fermenting bacteria.							Streptococci.							B.E.S.			Serial Number.
			1	2	3	4	5	6	7	1	2	3	4	5	6	7	20 cc.	10 cc.	1 cc.	
—	—	—																		41
Dipper	115,000	424,000	+	+	+	–	–	–	–	+	+	+	+	+	–	–	–	–	–	42
Dipper	Uncount-able	Uncount-able	+	+	+	+	–	–	–	+	+	+	+	+	–	–	–	+	–	43
—	—	—																		44
Dipper	43,000	100,600	+	+	+	–	–	–	–	+	+	+	+	–	–	–	–	–	–	45
Dipper ..	25,500	49,000	–	–	–	–	–	–	–	+	+	–	–	–	–	–	–	+	–	46
Dipper	Con	taminated																		47
Dipper	Spoiled	134,000	+	+	+	+	+	–	–	+	+	+	+	–	–	–	–	+	–	48
Dipper	Spoiled	344,000	+	+	–	–	–	–	–	+	+	+	+	+	–	–	+	+	–	49
In bulk to Institution	176,300	332,300	+	+	+	+	–	–	–	+	+	+	+	+	–	–	–	+	–	50
Pint measure ..	117,600	294,300	+	–	–	–	–	–	–	+	+	+	+	+	+	–	–	–	–	51
—	—	—																		52
—	—	—																		53
—	—	—																		54
—	—	—																		55
—	—	—																		56
—	—	—																		57
Dipper	—	—																		58
Dipper	261,300	328,000	+	–	–	–	–	–	–	+	+	+	+	–	–	–	+	–	–	59
—	—	—																		60
—	—	—																		61
Ordinary measure not dipper	101,000	Spoiled	+	–	–	–	–	–	–	+	+	+	+	+	–	–	+	+	–	62
Dipper	26,500	Agar 20°C. Spoiled	+	–	–	–	–	–	–	+	+	–	–	–	–	–	+	–	–	63
Dipper	42,500	63,000	+	–	–	–	–	–	–	+	+	+	+	–	–	–	+	–	–	64
—	—	—																		65
—	—	—																		66
—	—	—																		67
Dipper	68,000	62,600	+	–	–	–	–	–	–	+	+	+	+	+	–	–	–	–	–	68
—	—	—																		69
—	—	—																		70
Dipper	135,000	175,000	+	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	71
Dipper	15,000	42,000	+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	–	–	72
—	—	—																		73
By pint measure	34,000	34,300	+	+	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	74
—	—	—																		75

RETAILER'S

Serial Number.	When taken.	How far from farm.	Temperature of Air and Milk.	Ventilation.	Flies.	Receptacle covered or not.	Other contents of place.	Cleanliness of place.
1	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—
7	9.45 a.m.	—	8.5° C. 11.5°C.	Sliding door	—	None	Only milk	Clean
8	—	—	—	—	—	—	—	—
9	9.30 a.m.	18 miles	9° C. 16.5° C	Open door	—	In churn	Cans of milk	Clean
10	10.30 a.m.	8 miles	11.5° C. 16.5°	By shop door and window	—	Lids on cans on counter	Confectionery	Very clean
11	—	—	—	—	—	—	—	—
12	11.15 a.m.	—	16.5° C. 18° C.	By window	—	Tin can and dipper	—	Clean and persons clean
13	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—
16	7.15 p.m.	—	17° 23.5°	Good, by window over doorway and air-grate	None	Open	Butter, pastry, &c.	Clean
17	10.45 a.m.	12 miles	13° 20°	—	None	Can open	—	Clean
18	10.45 a.m.	17 miles	12.5° 19.5°	Good ventilation between kitchen and shop door	None	Open	Eggs, butter, and confectionery	Very clean
19	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—
25	10.45 a.m.	—	17° 14°	None	Few	Cupboard	General dealer in slum district	Very dirty and dusty
26	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—
32	—	—	—	—	—	—	—	—
33	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—
35	—	—	—	—	—	—	—	—
36	—	—	—	—	—	—	—	—
37	—	—	—	—	—	—	—	—
38	—	—	—	—	—	—	—	—
39	—	—	—	—	—	—	—	—
40	—	—	—	—	—	—	—	—
41	7 p.m.	—	18° 16.5°	Over door only	Few	Bowl covered by cardboard box lid	Butter, potatoes, cabbages, &c.	Fairly clean
42	—	—	—	—	—	—	—	—
43	—	—	—	—	—	—	—	—
44	9 a.m.	64 miles	15.5° 13.5°	No proper ventilation, door left open	Fair number	Basin covered with a board	Mineral waters, &c.	Very dirty

PREMISES.

Kind of receptacle and dipper.	Bacteria per cc. Agar 37° c. 48 hrs.	Bacteria per cc. Gel. 20° c. 72 hrs.	Glucose fermenting bacteria.							Streptococci.							B.E.S.			Serial No.
			1	2	3	4	5	6	7	1	2	3	4	6	6	7	20 c.c.	10 c.c.	1 c.c.	
—	—	—																		1
—	—	—																		2
—	—	—																		3
—	—	—																		4
—	—	—																		5
—	—	—																		6
Churn	88,830	116,000	–	–	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	7
—	—	—																		8
Dipper	23,300	33,660	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	9
Tin can and dipper	51,500	59,580	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	10
—	—	—																		11
Cans and bowls	79,000	81,000	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	–	–	12
—	—	—																		13
—	—	—																		14
—	—	—																		15
Basin dipper ..	42,000	50,600	+	+	–	–	–	–	–	+	+	+	+	–	–	–	.	–	–	16
Dipper	48,000	135,000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	.	–	–	17
Dipper, white bowls for milk	21,000	52,500	–	–	–	–	–	–	–	+	+	+	+	–	–	–	.	–	–	18
—	—	—																		19
—	—	—																		20
—	—	—																		21
—	—	—																		22
—	—	—																		23
—	—	—																		24
Dipper, stone-ware jar	152,500	3,000,000	+	+	+	–	–	–	–	+	+	+	+	–	–	–	.	+	–	25
—	—	—																		26
—	—	—																		27
—	—	—																		28
—	—	—																		29
—	—	—																		30
—	—	—																		31
—	—	—																		32
—	—	—																		33
—	—	—																		34
—	—	—																		35
—	—	—																		36
—	—	—																		37
—	—	—																		38
—	—	—																		39
—	—	—																		40
Dipper	74,300	102,500	–	–	–	–	–	–	–	+	+	+	+	+	–	–	–	–	–	41
—	—	—																		42
—	—	—																		43
Dipper	115,300	771,000	+	+	+	+	+	–	–	+	+	+	+	+	–	–	–	–	–	44

Serial Number.	When taken.	How far from farm.	Temperature of Air and	Milk.	Ventilation.	Flies.	Receptacle covered or not.	Other contents of place.	Cleanliness of place.
45	—	—	—		—	—	—	—	—
46	—	—	—		—	—	—	—	—
47	3.30 p.m.	—	20°	18°	Small window ..	Moderate number	Open bowl ..	Meat, vegetables, ham	Fairly clean
48	—	—	—		—	—	—	—	—
49	—	—	—		—	—	—	—	—
50	—	—	—		—	—	—	—	—
51	—	—	—		—	—	—	—	—
52	11 a.m.	28 miles ..	12.5°	9°	Window and 2 doors	None ..	In covered cans	None	Very clean ..
53	8.45 a.m.	—	17°	26°	Window, door, and fireplace	—	Covered cans	Ordinary living room	Clean ..
54	10.15 a.m.	38 miles	14°	13°	Good	—	Covered ..	Very clean ; none	Very clean ..
55	9.45 a.m.	—	12.5°	13° C.	Window used for ventilation	None ..	Open bowls and can	Nothing but milk	Clean ..
	3 p.m.	—	15.5°	8° C.	Windows and air grate	None ..	Open bowls ..	Milk bowl ..	Clean ..
56	5.15 p.m.	—	8°	?	Door	None ..	Open bowl ..	Refreshments ..	Clean ..
	9.15 a.m.	—	8°	?	Door	None ..	Open bowl ..	Refreshments ..	Clean ..
57	—	—	—		—	—	—	—	—
58	—	—	—		—	—	—	—	—
59	11 a.m.	—	11°	18°	Fanlight over door	None ..	Open bowls ..	Newspaper shop	Dirty ..
	12.30 p.m.	—			Fanlight oper door	None ..	Open bowls ..	Newspaper shop	Dirty
60	—	—	—		—	—	—	—	—
61	10.30 a.m.	38 miles ..	19°	8°	Ventilation over door and electric fan	None ..	Tight-fitting cover, metal nickelled	Pastry, butter	Very clean ..
	1.15 p.m.	—	19°	8°	—	None	Tight-fitting cover, metal nickelled	Pastry, butter	Very clean
62	—	—	—		—	—	—	—	—
63	—	—	—		—	—	—	—	—
64	—	—	—		—	—	—	—	—
65	6.45 a.m.	115 miles	7°	7.5°	Fanlight and top of window	None ..	In can, loose cover	None	Very clean ..
	3.45 p.m.	115 miles	8°	7°	Fanlight and top of window	None ..	In can, loose cover	None	Very clean ..
66	10.15 a.m.	35 miles	6°	9.5°	From door ..	None ..	None, bowl ..	None	Very clean ..
	5 p.m.	35 miles	9°	9°	From door ..	None ..	None, bowl ..	None	Clean ..
67	5.15 p.m.	—	17°	26°	None	None ..	In covered cans	Sink in room ..	Very clean ..
	10.45 a.m.	—	5°	5°	None	None ..	Uncovered jug	No food stuffs	Clean ..
68	—	—	—		—	—	—	—	—
69	7.30 p.m.	24 miles	5°	16°	Open shop door	None ..	Open bowl ..	Grocer's shop, bacon, &c.	Fairly clean
	10 a.m.	24 miles	6°	5°	Open shop door	None ..	Open bowl ..	Grocer's shop, bacon, &c.	Fairly clean
70	9 a.m.	14 miles	11½°	26½°	Door and fan-light on door	None ..	Open bowl	Butter, eggs, bread	Clean ..
	4.15 p.m.	14 miles	12½°	12°	Door and fan-light on door	None ..	Open bowl ..	Butter, eggs, bread	Clean ..
71	—	—	—		—	—	—	—	—
72	—	—	—		—	—	—	—	—
73	10.30 a.m.	—	10.5°	20°	Door	None ..	Open basin ..	Butter	Fairly clean
	12.30 p.m.	—	10.5°	12°	Door	None ..	Open	Butter	Clean ..
74	—	—	—		—	—	—	—	—
75	10.30 a.m.	—	12.5°	10.5°	Door	None ..	Tin bowl, paste board over milk	Butter, &c. ..	Fairly clean
	1.30 p.m.	—	11°	7°	Door	None ..	Tin bowl, paste board over milk	Butter, &c. ..	Fairly clean

PREMISES.—*continued.*

Kind of receptacle and dipper.	Bacteria per cc. Agar 37° c. 48 hrs.	Bacteria per cc. Gel. 20° c. 72 hrs.	Glucose fermenting bacteria.							Streptococci.							B.E.S.			Serial No.
			1	2	3	4	5	6	7	1	2	3	4	6	6	7	20 c.c.	10 c.c.	1 c.c.	
																				45
—	—	—																		46
—	—	—																		47
Enamelled ladle	Contaminated																			48
—	—	—																		49
—	—	—																		50
—	—	—																		51
—	—	—																		
Half-pint dipper	29,000	53,000	+	+	-	-	-	-	-	+	+	+	+	-	-	-	+	-	-	52
Pint measure ..	92,500	Spoiled	+	+	-	-	-	-	-	+	+	+	+	+	-	-	-	-	-	53
Dipper	34,000	Spoiled	+	-	-	-	-	-	-	+	+	+	-	-	-	-	+	-	-	54
Tin measure ..	123,000	138,000	+	-	-	-	-	-	-	+	+	+	+	-	-	-	+	-	-	55
Tin measure ..	56,600	170,000	+	-	-	-	-	-	-	+	+	+	+	+	-	-	+	+	-	
Tin measure ..	101,000	303,500	+	+	+	-	-	-	-	+	+	+	+	-	-	-	+	-	-	56
Tin measure ..	905,000	4,340,000	+	+	+	+	+	-	-	+	+	+	+	+	-	-	+	+	-	
																				57
—	—	—																		58
—	—	—																		
Dipper	176,000	110,000	+	+	-	-	-	-	-	+	+	+	-	-	-	-	+	+	-	59
Dipper	123,000	133,000	+	+	-	-	-	-	-	+	+	+	-	-	-	-	+	+	-	
																				60
..	—	—																		
Bowl and dipper	110,600	Spoiled	+	+	+	+	-	-	-	+	+	+	+	-	-	-	-	-	-	61
Bowl and dipper	84,000	Spoiled	+	+	+	+	-	-	-	+	+	+	-	-	-	-	+	+	-	
																				62
—	—	—																		63
—	—	—																		64
—	—	—																		
Dipper in can with lid to cover	62,500	134,000	+	+	+	-	-	-	-	+	+	+	+	+	-	-	+	+	-	65
Dipper in can with lid to cover	90,000	168,000	+	+	+	-	-	-	-	+	+	+	+	+	-	-	+	+	-	
Dipper	Spoiled	122,000	+	+	+	-	-	-	-	+	+	+	+	+	-	-	+	-	-	66
Dipper	66,600	109,000	+	-	-	-	-	-	-	+	+	+	+	-	-	-	-	-	-	
Block tin measure	38,000	43,000	+	-	-	-	-	-	-	+	+	+	-	-	-	-	-	+	-	67
—	38,000	51,000	+	-	-	-	-	-	-	+	+	+	-	-	-	-	+	+	-	
—	—	—																		68
Metal dipper ..	71,000	119,000	+	+	+	+	-	-	-	+	+	+	-	-	-	-	+	-	-	69
Metal Dipper ..	97,600	259,000	+	+	+	+	-	-	-	+	+	+	+	-	-	-	+	-	-	
Metal Dipper ..	82,000	241,000	+	-	-	-	-	-	-	+	+	+	-	-	-	-	-	+	-	70
Metal dipper ..	2,360,000	Spoiled	+	+	+	+	+	-	-	+	+	+	+	+	+	-	+	-	-	
—	—	—																		71
—	—	—																		72
Dippers ..	42,000	43,300	+	+	+	-	-	-	-	+	+	-	-	-	-	-	-	-	-	73
Dipper	59,300	64,000	+	+	+	+	-	--	-	+	+	-	-	-	-	-	+	-	-	
—	—	—																		74
Dippers ..	141,000	293,000	+	+	+	+	+	-	-	+	+	+	-	-	-	-	-	-	-	75
Dippers ..	163,000	310,000	+	+	+	+	-	-	-	+	+	+	-	-	-	-	+	-	-	

CONTROL STREET OR

Serial Number.	When taken.	When iced	How long carried.	Street or Dairy.	Organisms per cc. Agar 37° C.	Organisms per cc. Gel. 20° C.
1	9 a.m.	9.30 a.m.	30 mins.	Street	17,500	16,125
2	8.15 a.m.	9.45 a.m.	1½ hours	Street	26,716	21,300
3	8.45 a.m.	9 a.m.	15 mins.	Street	35,900	41,900
4	8.30 a.m.	9.15 a.m.	¾ hour	Street	14,510	15,580
5	7.15 a.m.	8.45 a.m.	1½ hours	Street	44,700	Spoiled
6	5 p.m.	5.30 p.m.	½ hour	Street	46,000	48,000
7	9.45 a.m.	5 p.m.	7¼ hours	Street	36,250	117 160
8	7.45 a.m.	4.15 p.m.	8½ hours	Street	29,580	52,750
9	9.30 a.m.	5 p.m.	7½ hours	Street	34,000	69 250
10	9 a.m.	6 p.m.	9 hours	Street	69,000	76,300
11	8.45 a.m.	6 p.m.	9¼ hours	Street	34,500	49,000
12	11.15 a.m.	6.15 p.m.	7 hours	Dairy	172,000	185,300
13	10.15 a.m.	2.30 p.m.	4¼ hours	Street	302,500	380,600
14	8.30 p.m.	8 a.m.	11½ hours	Street	18,600	28,300
15	7.45 p.m.	7.15 a.m.	11½ hours	Street	253,300	1,136,000
16	7.15 p.m.	7.15 a.m.	12 hours	Dairy	380,300	566,000
17	10.45 a.m.	5.15 p.m.	6½ hours	Dairy	133,500	394,500
18	10.45 a.m.	5.15 p.m.	6½ hours	Dairy	138,500	271,300
19						
20	9.30 a.m.	5 p.m.	7½ hours	Street	157,000	367,000
21	1.15 p.m.	5.45 p.m.	4½ hours	Street	Spoiled	500,000
22	9.45 a.m.	6 p.m.	7¾ hours	Street	640,600	Spoiled
23						
24	11 a.m.	5.15 p.m.	8½ hours	Street	703,000	848,000
25						
26	9.15 a.m.	5.15 p.m.	8 hours	Street	1,476,000	1,130,000
27	10.30 a.m.	5 p.m.	6½ hours	Street	694,500	611,000
28	9.30 a.m.	4.15 p.m.	6¾ hours	Street	230.000	Spoiled
29	7.15 p.m.	8.30 a.m.	13¼ hours	Street	33,000	Spoiled
30	10.45 a.m.	3.45 p.m.	5 hours	Street	18,000,000	Spoiled
31	11.30 a.m.	2.30 p.m.	3 hours	Street	1,820,000	3,520,000
32						
33	6 p.m.	9.15 a.m.	15¼ hours	Street	2,666,000	35,840,000
34	9 a.m.	4.30 p.m.	7½ hours	Street	68,300	275,000
35	9.45 a.m.	4.45 p.m.	7 hours	Street	1,626,000	3,560,000
36	5.30 p.m.	9.30 a.m.	16 hours	Street	1,674,000	Spoiled
37	9.45 a.m.	6 p.m.	8¼ hours	Street	10,880,000	32,000,000
38	7.30 a.m.	5.15 p.m.	9¾ hours	Street	6,040,000	27,520,000
39	8.15 a.m.	5.15 p.m.	9 hours	Street	3,860,000	4,070,000
40	7 p.m.	9.45 p.m.	2¾ hours	Street	225,000	300,000

RETAILER'S PREMISES.

Glucose-fermenting Bacteria.							Steptococci.							B.E.S.			Serial Number.
1	2	3	4	5	6	7	1	2	3	4	5	6	7	20 cc.	10 cc.	1 cc.	
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	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
+	+	+	–	–	–	–	+	+	+	–	–	–	–	.	–	–	29
+	+	+	+	+	–	–	+	+	+	+	+	+	–	.	–	–	30
+	+	–	–	–	–	–	+	+	+	+	+	+	–	.	–	–	31
																	32
+	+	+	+	+	–	–	+	+	+	+	+	+	–	–	–	–	33
+	+	–	–	–	–	–	+	+	+	+	–	–	–	–	+	–	34
+	+	+	–	–	–	–	+	+	+	+	+	+	–	–	–	–	35
+	+	+	+	+	+	–	+	+	+	+	+	–	–	–	–	–	36
+	+	+	+	+	–	–	+	+	+	+	+	+	–	–	+	–	37
+	+	+	+	+	–	–	+	+	+	+	+	–	–	–	+	–	38
+	+	–	–	–	–	–	+	+	+	+	+	+	–	–	–	–	39
–	–	–	–	–	–	–	+	+	+	+	+	–	–	–	–	–	40

CONTROL STREET OR

Serial Number.	When taken.	When iced.	How long carried.	Street or Dairy.	Organisms per cc. Agar 37° C.	Organisms per cc. Gel. 20° C.
41	9.30 p.m.	9.30 p.m.	2½ hours	Dairy	170,000	433,000
42	9.30 a.m.	1.30 p.m.	4 hours	Street	1,250,000	2,725,000
43	11 a.m.	1 p.m.	2 hours	Street	9,450,000	12,500,000
44	9 a.m.	12.15 p.m.	3¼ hours	Dairy	610,000	6,155,000
45	10 a.m.	11.30 a.m.	1½ hours	Street	115,000	245,000
46	9.30 a.m.	4.15 pm.	6¾ hours	Street	160,000	250,000
47	8.45 a.m.	4 p.m.	7¼ hours	Street		Contaminated
48	10.45 a.m.	5.15 p.m.	6½ hours	Street	Spoiled	840,000
49	6.45 p.m.	9.45 a.m.	15 hours	Street	Spoiled	6,200,000
50	10.15 a.m.	4 p.m.	4¾ hours	Street	1,436,000	2,700,000
51	7.15 p.m.	8.30 p.m.	1¼ hours	Street	106,000	455,000
52	11 a.m.	3.45 p.m.	4¾ hours	Dairy	90,000	375,000
53	8.45 a.m.	11.30 a.m.	2¾ hours	Dairy	146,000	400,000
54						
55	9.45 p.m.	3 p.m.	5¼ hours	Dairy	56·600	130,000
56	5.15 p.m.	9.15 a.m.	16 hours	Dairy	810,000	4,120,000
57						
58	5 p.m.	9.30 a.m.	17¼ hours	Street		
59	11.15 a.m.	1.30 p.m.	2¼ hours	Street	328,600	Spoiled
60	11 a.m.	12.30 p.m.	1½ hours	Dairy	209,600	178,000
61	10.30 a.m.	1.15 p.m.	2¾ hours	Dairy	96,000	Spoiled
62	8 p.m.	8 a.m.	12 hours	Street	86,000	Spoiled
63	8.30 a.m.	5.15 p.m.	8¾ hours	Street	125,000	Agar 20° C. 192,500
64	8.15 a.m.	5.15 p.m.	9 hours	Street	40,300	70,000
65	6.45 a.m.	3.45 p.m.	9 hours	Dairy	81,000	175·000
66	10.15 a.m.	5.15 p.m.	7 hours	Dairy	77,000	147,000
67	5.15 p.m.	11 a.m.	17¾ hours	Dairy	38,600	41,000
68	9.45 a.m.	4.45 p.m.	7 hours	Street	56,000	47,000
69	7.30 p.m.	10 a.m.	14½ hours	Dairy	83,000	125,000
70	9 a.m.	4.30 p.m.	7½ hours	Dairy	1,220,000	1,668,000
71	7 p.m.	8.45 a.m.	13¾ hours	Street	176,000	322,000
72	6.45 p.m.	9.30 a.m.	14¾ hours	Street	13,000	42,000
73	10.30 a.m.	12.30 p.m.	2 hours	Dairy	52,600	36,600
74	6.45 p.m.	9.30 a.m.	14¾ hours	Street	39,000	58,000
75	10.30 a.m.	1.30 p.m.	3 hours	Dairy	170,000	291,000

RETAILER'S PREMISES.—*continued.*

Glucose-Fermenting Bacteria.							Streptococci.							B. E. S.			Serial Number.
1	2	3	4	5	6	7	1	2	3	4	5	6	7	20 cc.	10 cc.	1 cc.	
+	+	–	–	–	–	–	+	+	+	+	+	–	–	–	–	–	41
+	+	+	+	–	–	–	+	+	+	+	+	–	–	–	–	–	42
+	+	+	+	+	–	–	+	+	+	+	+	+	–	–	+	–	43
+	+	+	–	–	–	–	+	+	+	+	+	+	–	–	–	–	44
+	+	+	+	–	–	–	+	+	–	–	–	–	–	–	–	–	45
+	–	–	–	–	–	–	+	+	+	+	+	–	–	–	–	–	46
																	47
+	+	+	+	+	+	–	+	+	+	+	–	–	–	+	+	–	48
+	+	+	+	–	–	–	+	+	+	+	+	+	–	+	+	–	49
+	+	+	+	+	–	–	+	+	+	+	+	+	–	+	–	–	50
+	–	–	–	–	–	–	+	+	+	+	+	–	–	+	–	–	51
+	+	+	–	–	–	–	+	+	+	+	–	–	–	–	–	–	52
+	–	–	–	–	–	–	+	+	+	+	+	–	–	+	–	–	53
																	54
+	+	–	–	–	–	–	+	+	+	+	–	–	–	+	+	–	55
+	+	+	+	+	–	–	+	+	+	+	+	–	–	+	–	–	56
																	57
																	58
+	–	–	–	–	–	–	+	+	+	+	–	–	–	+	–	–	59
+	+	+	–	–	–	–	+	+	+	+	–	–	–	+	+	–	60
+	+	+	+	–	–	–	+	+	+	–	–	–	–	–	–	–	61
+	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	62
+	+	+	–	–	–	–	+	+	+	–	–	–	–	–	–	–	63
+	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	64
+	+	–	–	–	–	–	+	+	+	+	+	–	–	+	+	–	65
–	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	66
+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	+	–	67
+	+	–	–	–	–	–	+	+	+	+	+	–	–	–	–	–	68
+	+	+	–	–	–	–	+	+	+	+	–	–	–	–	–	–	69
+	+	+	+	–	–	–	–	+	+	+	+	–	–	–	–	–	70
+	+	–	–	–	–	–	+	+	+	+	+	–	–	–	+	–	71
+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	–	–	72
+	+	–	–	–	–	–	+	+	–	–	–	–	–	+	–	–	73
–	–	–	–	–	–	–	+	+	+	+	+	–	–	–	–	–	74
+	+	+	+	–	–	–	+	+	+	–	–	–	–	–	–	–	75

CONSUMER'S

Serial Number.	Time delivered.	Time of Sampling.	How long from Cowshed.	How long in House.	Temperature of Air and Milk.	Where Stored.	Receptacle covered or not.	Ventilation.	Flies.
1	9 a.m.	9.30 a.m.	2¾ hours	½ hour	10° C. 15° C.	Pantry	Open	Good	—
2	7.45 a.m.	9.45 a.m.	3 hours	2 hours	17° C. 18.5°	Kitchen	—	Good	None
3	8.45 a.m.	9 a.m.	1¾ hours	¼ hour	16.5° C. 19.5°	Front passage	—	Good	None
4	7.45 a.m.	9.15 a.m.	2¼ hours	1½ hours	4° C. 16° C.	Dairy	Open	Good	None
5	7.15 a.m.	8.45 a.m.	2¼ hours	1½ hours	16° C. 16.5°	Pantry	Open	Good	None
6	5 p.m.	9.30 a.m.	17½ hours	16½ hours	13° C. 11.5°	Cellar	Open	Good	None
7	11 a.m.	5 p.m.	10¼ hours	6 hours	17° C. 14° C.	Pantry	Open	Good	None
8	7.45 a.m.	4.15 p.m.	9½ hours	8½ hours	6° C. 12° C.	Pantry	Open	Good	None
9	9.45 a.m.	5 p.m.	9¾ hours	7¼ hours	9.5° C. 14.5°	Pantry	Open	Good	None
10	9 a.m.	6 p.m.	11 hours	9 hours	12° C. 14° C.	Pantry	Open basin	Good	None
11	8.15 a.m.	6 p.m.	10¾ hours	9¾ hours	12.5° C. 15°	Scullery	—	Good	None
12	11.15 a.m.	6.15 p.m.	11¼ hours	7 hours	15° C. 16.5°	Pantry	—	Good	None
13	10.15 a.m.	2.30 p.m.	7¾ hours	4¼ hours	18° 17.5°	Cellar, meat kept	Jug open	None	None
	10.15 a.m.	3 p.m.	8¼ hours	4¾ hours	11.5° 12°	Cupboard	Basin, covered	Good	None
14	8.15 p.m.	8 a.m.	15½ hours	11¾ hours	15° 10°	Kitchen	Covered basin	Good	None
15	8.30 p.m.	7.15 a.m.	14 hours	10¾ hours	15° 11°	Cellar	—	Fair	None
16	7 p.m.	7.15 a.m.	14 hours	12½ hours	18° 13°	Cellar	Open	None	None
17	10.45 a.m.	5.15 p.m.	11 hours	6½ hours	15.5° 15.5°	Pantry	Open	Good, door and window	None
18	11.15 a.m.	5.15 p.m.	9½ hours	6 hours	15° 15°	Cupboard in ketchen	Open	None, except by joints of door	None
19	8.45 a.m.	5 p.m.	9¾ hours	8¼ hours	12° 10.5°	Larder	Open bowl	Good, moveable window	None
20	9.45 a.m.	5 p.m.	10½ hours	7¼ hours	17° 15.25°	Pantry	Open basin	Good	Small number
21	1.30 p.m.	5.45 p.m.	6½ hours	4¼ hours	13.5° 13.5°	In coffee room	Open	Good	None
22	10 a.m.	6 p.m.	11½ hours	8 hours	12° 12°	In room	Open	None	None
23	5.45 p.m.	8.45 a.m.	17¼ hours	15 hours	12° 12.75°	Front sitting room	Open	Good	None
24	10.45 a.m.	5.15 p.m.	8½ hours	6½ hours	13° 13°	Cellar	Open	Moderate	None
25	6.15 p.m.	10.30 a.m.	19 hours	16¼ hours	20° 15°	Cellar	Open basin	None	None
26	9.15 a.m.	5.15 p.m.	9¾ hours	8 hours	19° 14°	Cellar	Open	Good	None
27	10.45 a.m.	5 p.m.	9¾ hours	6¼ hours	16.5° 17.5°	Cellar	Open	Cellar grate	None
28	9.30 a.m.	4.15 p.m.	8½ hours	6¾ hours	15.5° 15.5°	Pantry	Open	Good	None
29	7.30 p.m.	8.30 a.m.	14 hours	13 hours	13° 12°	Cellar	Covered	None except cellar grate	None
30	11 a.m.	3.45 p.m.	8¾ hours	4¾ hours	14° 13.5°	In shop	Open	Good	None
31	11.30 a.m.	2.30 p.m.	7½ hours	3 hours	17° 16.5°	Pantry	Open	Bad	None
32	8.15 a.m.	5.15 p.m.	10¾ hours	9 hours	12° 12°	Pantry	Open	Good	None
33	6.15 p.m.	9.15 a.m.	18 hours	15 hours	18° 20°	Living room, on sideboard	Basin, open	Good	None
34	9 a.m.	4.30 p.m.	10¼ hours	7½ hours	13.25° 14°	Cellar	Open jug	Good	None
35	9.45 a.m.	4.45 p.m.	10¼ hours	7 hours	14° 15°	Cellar, meat, butter, &c.	Open basin	Good	None
36	5.45 p.m.	9.30 a.m.	18½ hours	15¾ hours	15° 15.25°	Pantry	Covered basin	Good	None
37	9.45 a.m.	6 p.m.	10½ hours	8¼ hours	16° 16°	Pantry	Open basin	Good	None
38	8 a.m.	5.15 p.m.	10½ hours	9¼ hours	22.5° 21°	Pantry	Open basin	Bad	None
39	8.30 a.m.	5.15 p.m.	10 hours	8¾ hours	21° 18.5°	Pantry	Open basin	Good	Many flies
40	8.45 a.m.	5 p.m.	10½ hours	8¼ hours	21° 15°	Pantry	Open bowl	Good	None

HOUSE.

Clean or Dirty.	Type of House: Large or Small.	Bacteria per cc. Agar. 37° C.	Bacteria per cc. Gel. 20° C.	Glucose Fermenting Bacteria.							Streptococci.							B. E. S.			Serial Number.
				1	2	3	4	5	6	7	1	2	3	4	5	6	7	20 cc.	10 cc.	1 cc.	
Clean	£20 house and shop	23,000	21,375	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Clean	8s. per week	37,500	36,166	–	–	–	–	–	–	–	+	+	–	–	–	–	–	.	–	–	2
Clean	Well built	6,160	6,830	–	–	–	–	–	–	–	+	+	–	–	–	–	–	.	–	–	3
Clean	£19	12,160	14,500	–	–	–	–	–	–	–	+	–	–	–	–	–	–	.	–	–	4
Clean	£18 house	11,210	13,110	+	–	–	–	–	–	–	+	+	–	–	–	–	–	.	–	–	5
Clean	7s. per week	52,500	Spoiled	+	+	+	–	–	–	–	+	+	+	–	–	–	–	.	–	–	6
Clean	Cramped rooms	106,000	139,160	–	–	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	7
Clean	£40	25,250	31,410	–	–	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	8
Clean	—	19,000	68,830	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	9
Very clean	5s. 6d. weekly, slum	54,500	62,500	+	+	–	–	–	–	–	+	+	+	–	–	–	–	.	+	–	10
Clean	7s. weekly, slum	113,000	176,500	+	+	+	+	–	–	–	+	+	+	+	–	–	–	.	+	–	11
Clean	5s. 6d.	171,600	181,600	+	+	+	–	–	–	–	+	+	+	–	–	–	–	.	–	–	12
Clean	5s. 6d. weekly	476,000	655,500	+	+	+	+	+	–	–	+	+	+	+	+	–	–	.	+	–	13
Very dirty	6s. weekly	317,600	415,000	+	+	+	+	–	–	–	+	+	+	+	–	–	–	.	+	–	
Clean	£150 public house	110,000	67,300	+	+	–	–	–	–	–	+	+	+	+	–	–	–	.	+	–	14
Clean	7s. 6d. per week	354,300	828,000	+	+	+	–	–	–	–	+	+	+	–	–	–	–	.	–	–	15
Clean	7s. 6d. weekly	1,545,000	Spoiled	+	+	+	+	+	–	..	+	+	+	+	+	–	–	.	+	–	16
Clean	4s. 3d. per week, privy 3 ft. from pantry	697,500	3,110,000	+	+	+	+	+	–	–	+	+	+	+	–	–	–	.	–	–	17
Very clean	Self-contained house and butcher's shop	357,000	757,000	+	+	+	–	–	–	–	+	+	+	+	+	–	–	.	+	–	18
Very clean	Infirmary	9,830	50,000	+	+	+	+	–	–	–	+	+	+	+	–	–	–	.	–	–	19
Very clean	Self-contained house on first floor	382,000	1,065,000	+	+	+	+	+	–	–	+	+	–	–	–	–	–	.	–	–	20
Fairly clean	Self-contained refreshment place in slum district	112,000	820,000	+	+	+	+	–	–	–	+	+	+	+	–	–	–	.	–	–	21
Clean	Dining rooms	849,000	Spoiled	+	+	+	+	+	–	–	+	+	+	+	+	–	–	.	–	–	22
Clean	Self-contained house and shop	192,000	397,500	+	+	+	+	+	+	–	+	+	+	+	+	–	–	.	+	–	23
Very clean	7s. 9d. per week	94,600	147,500	+	+	+	+	–	–	–	+	+	+	–	–	–	–	.	–	–	24
—	4s. 6d. per week, back-to-back	733,000	10,000,000	+	+	+	+	–	–	–	+	+	+	+	+	–	–	.	+	.	25
Clean	4s. 6d. per week	156,000	763,000	+	+	–	–	–	–	–	+	+	+	+	+	+	–	.	–	–	26
Fairly clean	5s. per week, back-to-back	935,000	1,052,500	+	+	+	+	+	+	–	+	+	+	–	–	–	–	.	–	–	27
Very clean	Workhouse	411,600	Spoiled	+	+	+	+	–	–	–	+	+	+	–	–	–	–	.	–	–	28
Very dirty	4s. 3d. per week	268,600	Spoiled	+	+	+	+	+	+	–	+	+	+	+	+	–	–	.	–	–	29
Very clean	3 rooms and shop	3,840,000	4,370,000	+	+	+	+	–	–	–	+	+	+	+	+	+	–	.	+	–	30
Dirty	3s. 4d. per week	1,140,600	1,180,000	+	+	+	–	–	–	–	+	+	+	+	+	–	–	.	+	–	31
Clean	8s. per week	1,366,000	2,320,000	+	+	+	+	–	–	–	+	+	+	+	–	–	–	.	+	–	32
Clean	9s. per week	4,240,000	56,000,000	+	+	+	+	+	+	–	+	+	+	+	+	+	–	–	+	–	33
Clean	6s. per week, back-to-back	1,000,000	913,000	+	+	–	–	–	–	–	+	+	+	+	+	–	–	–	+	–	34
Clean	Detached, about £40; Ladies' School	1,530,000	1,980,000	+	+	+	+	–	–	–	+	+	+	+	+	–	–	–	+	–	35
Clean	£15 yearly and rates	3,780,000	Spoiled	+	+	+	+	+	+	–	+	+	+	+	–	–	–	–	–	–	36
Clean	18s. 6d. per month	7,740,000	32,960,000	+	+	+	+	+	+	–	–	+	+	+	+	+	–	–	+	–	37
Clean	Small shop, self-contained house	6,240,000	27,840,000	+	+	+	+	+	–	–	+	+	+	+	+	+	–	–	+	–	38
Clean	5 rooms, 5s. 1d. per week	4,433,000	7,440,000	+	+	+	–	–	–	–	+	+	+	+	+	+	–	–	–	–	39
Very clean	Infirmary, Hull	10,240,000	Spoiled	+	+	+	+	+	+	–	+	+	+	+	+	+	–	–	–	–	40

Serial Number.	Time delivered.	Time of Sampling.	How long from Cowshed.	How long in House.	Temperature of Air	and Milk.	Where Stored.	Receptacle covered or not.	Ventilation.	Flies.
41	6.30 p.m.	7.30 a.m.	14¼ hours	13 hours	19.5°	15.5°	Cellar	Open basin	Fairly good ..	None ..
42	9 a.m.	1.30 p.m.	20¼ hours	4½ hours	14.5°	15°	Cellar	Covered basin	Good	None ..
43	11.15 a.m.	1 p.m.	6¼ hours	1¾ hours	22°	20°	Cellar	Open ..	Not visible ..	A few ..
*	11.30 a.m.	1.15 p.m.	6½ hours	1¾ hours	21.5°	19.5°	Cellar	Open jug	None	A few ..
44	9 a.m.	12.15 p.m.	16¾ hours	3¼ hours	20.5°	18.5°	Sideboard in kitchen	Covered jug	None	Good number
*45	9 a.m.	11.30 a.m.	18 hours	2½ hours	15.5°	12°	Cellar	Open ..	None	Numerous
	9.30 a.m.	1 p.m.	19½ hours	3½ hours	17.5°	14° C.	Cellar	Open jug	None	Numerous
46	9.45 a.m.	4.15 p.m.	8½ hours	6½ hours	18°	17°	Cellar	Open-jug ..	By window and door	Few ..
*	10 a.m.	4 p.m.	8 hours	6 hours	19°	19°	In living room on table	Open jug ..	Door and windows	Few ..
47	9.45 a.m.	4 p.m.	22 hours	6¼ hours	17°	16½°	Cellar	Open jug ..	Open door in passage	Not many
48	10.45 a.m.	5.15 p.m.	22¼ hours	6½ hours	11½°	13°	Cellar	Basin covered	None except door	Few ..
*	10.30 a.m.	5 p.m.	22 hours	6½ hours	12°	15°	In cupboard near fireplace (open)	Basin very dirty and washed out carelessly before used	None	Few ..
49	7 p.m.	9.45 a.m.	17¾ hours	14¾ hours	14½°	12°	Cellar	Open jug ..	None	Not many
*	7 p.m.	9.45 a.m.	17¾ hours	14¾ hours	12°	13½°	Living room ..	Open basin	—	Very few
50	10.15 a.m.	4 p.m.	6¼ hours	5¾ hours	15.5°	14.5°	Pantry	Open basin	Good	None ..
*	12.30 p.m.	5.30 p.m.	7¾ hours	5 hours	15°	15°	Cellar	Open basin	None	None ..
*51	5.30 p.m.	8.30 p.m.	4¼ hours	3 hours	15.5°	15.5°	Cupboard ..	Open basin	None	None ..
	7.30 p.m.	8.45 p.m.	4½ hours	1¼ hours	11°	15°	Cellar	Open jug	None	None ..
52	10.15 a.m.	3.45 p.m.	22¼ hours	5½ hours	13°	13°	Cellar	Open jug ..	None	One found in milk
53	9 a.m.	11.30 a.m.	5 hours	2 hours	14.5°	14.5°	Cellar	Open jug ..	None	None ..
54	8.45 a.m.	2.45 p.m.	19½ hours	6 hours	14°	13°	In passage ..	Covered can	Good	None ..
55	9.15 a.m.	3 p.m.	8¼ hours	5¾ hours	15°	14°	Cellar pantry, meat, eggs	Open basin	Door and window	None ..
56	5.30 p.m.	9.30 a.m.	18 hours	16 hours	15°	13°	Living room, bread, &c.	Open bowl	Door and window	None ..
57	—	9.30 a.m.	17¾ hours	—	10°	8°	Special dairy ..	In bowl ..	Windows ..	None ..
58	5 p.m.	9.30 a.m.	17¼ hours	16½ hours	10°	10°	Scullery	Open bowl	Window and door	None ..
59	11.15 a.m.	1.30 p.m.	6¾ hours	2¼ hours	13°	13°	Cellar	Open basin	Good	None ..
60	8.30 a.m.	12.30 p.m.	4¼ hours	4 hours	14°	14°	—	Open basin	Good	None ..
61	10.45 a.m.	1.15 p.m.	19¾ hours	2½ hours	14°	10.5°	Cellar, eatables	Open jug ..	Bad	None ..
62	8.15 p.m.	8 a.m.	15¼ hours	11¾ hours	10°	11°	Room near house, food, &c.	Jug covered with paper	Good	None
63	8.45 a.m.	5.15 p.m.	9¾ hours	8½ hours	11°	11°	Pantry, food, &c.	Open basin	By door ..	None ..
64	9 a.m.	5.15 p.m.	10 hours	8¼ hours	10.5°	10°	Scullery	Open basin	Between scullery and kitchen door	None ..
65	7.15 a.m.	4 p.m.	22½ hours	8¾ hours	10°	10°	Scullery, uncooked potatoes	Open pie dish	Good	None ..
66	10.45 a.m.	5.15 p.m.	10¼ hours	6½ hours	13°	13.5°	Pantry, food, &c.	Open jug ..	None except through door	None ..
67	5.30 p.m.	11 a.m.	19½ hours	17½ hours	5°	5°	Scullery	Open basin	None	None ..
68	9.45 a.m.	4.45 p.m.	9½ hours	7 hours	7½°	6°	Scullery	Open basin	Window made to open	None ..
69	7.45 p.m.	10 a.m.	18½ hours	14¼ hours	9°	8°	Cellar	Open jug ..	None	None ..
70	9.30 a.m.	4.30 p.m.	10¼ hours	7 hours	13°	13½°	Cellar	Open jug ..	The door opens into living room	None
71	7.15 p.m.	8.45 a.m.	17½ hours	13½ hours	9½°	8°	Cellar head ..	Open jug ..	Small windows	None ..
72	6.45 p.m.	9.30 a.m.	15 hours	14¾ hours	8.5°	8.5°	Pantry	Open ..	Good	None ..
73	10.45 a.m.	12.30 p.m.	4¼ hours	1¾ hours	11.5°	12°	Cellar	Open basin	Door	None ..
74	7 p.m.	9.30 a.m.	17¼ hours	14½ hours	9.5°	8.5°	In furniture shop	Open basin	Open to street, floor swept	None ..
75	10.30 a.m.	1.30 p.m.	7 hours	3 hours	10°	10°	Cellar	Open jug ..	—	None ..

* Surprise.

HOUSE.—*continued.*

Clean or Dirty.	Type of House: Large or Small.	Bacteria per cc. Agar. 37° C.	Bacteria per cc. Gel. 20° C.	Glucose Fermenting Bacteria.							Streptococci.							B. E. S.			Serial Numb.
				1	2	3	4	5	6	7	1	2	3	4	5	6	7	20 cc.	10 cc.	1 cc.	
Dirty ..	£50 per annum, shop and house	550,000	1,150,000	+	–	–	–	–	–	–	+	+	+	+	+	+	–	–	–	–	41
Clean ..	5s. 6d. per week	1,280,000	2,900,000	+	+	+	+	–	–	–	+	+	+	+	+	+	–	–	–	–	42
—	7s.	10,800,000	14,200,000	+	+	+	+	–	–	–	+	+	+	+	+	+	–	–	+	–	43
Clean ..	7s. 6d. per week	12,500,000	18,000,000	+	+	+	+	+	–	–	+	+	+	+	+	+	–	–	+	–	*
Dirty, filthy	2s. per week, small house, very dirty locality	776,000	7,435,000	+	+	+	+	+	–	–	+	+	+	+	+	+	–	–	+	–	44
Clean ..	7s. per week ..	Spoiled	256,000	+	+	+	–	–	–	–	+	+	+	–	–	–	–	–	–	–	*45
Dirty ..	3s. per week ..	113,000	430,000	+	+	+	–	–	–	–	+	+	+	+	–	–	–	–	–	–	
Fairly clean	Through house, 6s. 6s. per week	275,000	310,000	+	–	–	–	–	–	–	+	+	+	+	+	–	–	–	–	–	46
Clean ..	Cottage, 5s. 2d. per week	290,000	233,000	+	–	–	–	–	–	–	+	+	+	+	+	+	–	–	–	–	*
Clean ..	£20 annually ..	Contaminated																			
Not very clean	Cottage ..	Spoiled	650,000	+	+	+	+	+	+	–	+	+	+	+	+	–	–	–	–	–	48
Dirty ..	Cottage ..	Spoiled	620,000	+	+	+	+	+	+	–	+	+	+	+	–	–	–	–	–	–	*
Dirty ..	Through house, 5s. 6d. per week	Spoiled	7,760,000	+	+	+	+	–	–	–	+	+	+	+	+	+	–	+	+	–	49
Dirty ..	Back-to-back, 4s. 6d. per week	Spoiled	4,480,000	+	+	+	+	+	–	–	+	+	+	+	+	–	–	+	–	–	*
Very clean	Public Institution, hospital	2,363,000	3,520,000	+	+	+	+	+	–	–	+	+	+	+	+	+	–	+	+	–	50
Clean ..	Small boarding house	1,390,000	2,880,000	+	+	+	+	+	–	–	+	+	+	+	+	+	–	+	+	–	*
Clean ..	Club-house ..	136,600	400,000	+	–	–	–	–	–	–	+	+	+	+	+	+	–	+	+	–	*51
Clean	Villa	290,000	440,000	+	+	+	–	–	–	–	+	+	+	+	+	–	–	+	+	–	
Clean ..	4-roomed house	85,000	430,000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	52
Rather dirty	4-roomed house	145,000	380,000	+	–	–	–	–	–	–	+	+	+	+	+	+	–	+	–	–	53
Very clean	Restaurant ..	192,000	Spoiled	+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	–	–	54
Clean ..	10s. per week ..	58,000	170,000	+	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	55
Clean ..	8s. per week ..	1,426,000	4,476,000	+	+	+	+	+	+	–	+	+	+	+	+	+	–	–	–	–	56
Clean ..	Workhouse ..	Spoiled	29,000	+	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	57
Clean ..	Back-to-back, 6s. per week	—	—																		58
Clean ..	6s. per week ..	815,000	1,520,000	+	–	–	–	–	–	–	+	+	+	–	–	–	–	+	+	–	59
Clean ..	10s. per week ..	88,000	181,000	+	+	+	–	–	–	–	+	+	+	–	–	–	–	+	+	–	60
Clean ..	7s. per week ..	192,500	Spoiled	+	+	+	+	+	–	–	+	+	+	–	–	–	–	+	+	–	61
Clean ..	8s. 6d. per week	233,000	Spoiled Agar 20° C.	+	+	–	–	–	–	–	+	+	+	+	–	–	–	+	–	–	62
Very clean	£14 10s. per annum, 5 rooms	68,000	185,000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	63
Fairly clean	£10 10s. per annum, self-contained	52,000	69,000	+	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	64
Dirty ..	£16 4s. per year, 5 rooms	95,000	164,000	+	+	+	–	–	–	–	+	+	+	+	+	–	–	+	+	–	65
Clean ..	16s. 6d. per month, 4 rooms	78,000	100,000	+	–	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	66
Clean ..	5s. 6d., back-to-back	43,000	50,000	+	+	–	–	–	–	–	+	+	+	–	–	–	–	+	+	–	67
Clean ..	4s. 6d. weekly back-to-back	53,600	52,000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–	68
Dirty ..	3s. weekly, back-to-back, slums	114,000	218,000	+	+	+	+	+	–	–	+	+	+	+	+	–	–	–	–	–	69
Dirty ..	4s. 10d. per week, back-to-back	2,711,000	Spoiled	+	+	+	+	+	–	–	+	+	+	+	+	–	–	+	–	–	70
Fairly clean	4s. 3d. per week, back-to-back	300,000	389,000	+	+	+	+	+	–	–	+	+	+	+	+	+	–	+	–	–	71
Clean ..	Semi-detached villa	30,000	100,000	+	+	–	–	–	–	–	+	+	+	+	–	–	–	+	–	–	72
Clean ..	Through, 4 rooms	63,000	67,600	+	+	+	–	–	–	–	+	+	+	–	–	–	–	–	–	–	73
Clean ..	House and shop	244,000	342,000	+	–	–	–	–	–	–	+	+	+	+	+	+	–	+	–	–	74
Clean ..	4 rooms ..	176,000	317,000	+	+	+	+	–	–	–	+	+	+	–	–	–	–	–	–	–	75

APPENDIX II.

Showing copies of Investigation Sheets.

PRIVATE AND CONFIDENTIAL.

MILK INVESTIGATION.

Identifying Number or Label ....

SAMPLE TAKEN AT COWSHED.

NOTE.—The sample should be taken from mixed milk, and *after* any cooling process ; in other words, it should be taken from the milk as it is to be sent off for delivery.

1. Place where sample is taken (give Name and Address)..........
2. Date.......... 3. Time (*a*) of Milking—from....to.... (*b*) of taking Sample........
4. Mention train (if any) by which the milk is to travel..........
5. Temperature (*a*) of outside air..........(*b*) of place where cows are milked.......... (Taken if possible before milking begins.)

   (*c*) of the milk at the time of taking sample..........
6. Size of milk can from which the milk is taken..........
7. Number of cows whose milk is contained in the can..........
8. Amount and kind of any straining or filtering to which the milk has been subjected..........
9. Extent of any cooling process ....
10. Condition as to cleanliness of :—

    (*a*) The Cowshed .... (*d*) The Milker's hands and clothes..........

    (*b*) The Stall .... (*e*) Milk vessels (state method of cleaning, if possible)

    (*c*) The Cows (especially the teats) ....
11. The situation of the Cowshed with reference to any permanent or temporary manure pit (giving distances) ....
12. The material of which the cowshed is built, and its condition as regards light, ventilation, and air space ....
13. Any general observations..........

Signed..........

NOTE.—Where more than one person has been engaged in the work of taking a sample, the report form must be signed by *each* such person.

PRIVATE AND CONFIDENTIAL.

MILK INVESTIGATION.

Identifying Number or Label ....

SAMPLE TAKEN AT RAILWAY STATION.

1. Name of Station..........
2. (*a*) Station from which milk has travelled.......... (*b*) Distance in miles..........
3. Condition as regards cleanliness of the Railway Van in which the milk has been carried, and a note as to any other contents of the Van..........
4. (*a*) Date of taking Sample.......... (*b*) Time..........
5. Temperature (*a*) of the Station (outside air).......... (*b*) of the milk at the time of taking Sample
6. Any marks or numbers on the can ....
7. Describe construction of can and whether it has any ventilating holes and any false lid..........
8. Whether the can was locked or otherwise fastened..........
9. The method adopted in transferring the milk from the Farmer's can to the Retailer's can, *i.e.*, whether in bulk or measured out..........
10. Cleanliness (*a*) of the Farmer's can.......... (*b*) the place where the transference takes place..........
11. Any general observations with special reference to possibilities of contamination ....

Signed..........

NOTE.—Where more than one person has been engaged in the work of taking a sample, the report form must be signed by *each* such person.

PRIVATE AND CONFIDENTIAL.

MILK INVESTIGATION.

Identifying Number or Label ....

SAMPLE TAKEN WHEN MILK IS DELIVERED IN THE STREET.

1. Place where sample is taken and from whom ....
2. Date .... 3. Time of taking sample ....
4. Distance from place of delivery by wholesale dealer, *e.g.*, Railway Station, Farmer's or Retailer's premises (stating which) ....
5. Temperature (*a*) of the air at the time of taking sample .... (*b*) of the milk ....
6. Conditions as to dust, rain, &c. ....
7. Cleanliness (*a*) of Cart .... (*b*) of Cans .... (*c*) of clothing and hands of retailer....
8. Method of delivery of milk to customer, *i.e.*, whether by bottle, private can or retailer's small can, and whether from a large can with dipper or from a vessel with tap and measure ....
9. Any general observations ....

Signed ....

NOTE.—Where more than one person has been engaged in the work of taking a sample, the report form must be signed by *each* such person.

PRIVATE AND CONFIDENTIAL.

MILK INVESTIGATION.

Identifying Number or Label ....

SAMPLE TAKEN IN RETAILER'S PREMISES.

1. Place where sample is taken (give Name and Address) ....
2. Date .... 3. Time of taking sample ....
4. Temperature (*a*) of the room in which milk is stored ....
   (*b*) of the milk at time of taking sample ....
5. Aspect of the place or room where milk is stored ....
6. Means of ventilation ....
7. Mention absence or presence of an unusual number of flies ....
8. Whether any arrangements for keeping milk free from dust, flies, &c., such as gauze or other covering, or glass cases ....
9. Any means of keeping the milk cool ....
10. Other contents of the room in which the milk is stored ....
11. Cleanliness (*a*) of the premises .... (*b*) of the persons serving in the premises (especially sleeves of coats or dresses) ....
12. Nature of receptacle for milk storage ....
13. Nature of dipper used for measuring out the milk ....
14. Any general observations ....

Signed ....

NOTE.—Where more than one person has been engaged in the work of taking a sample, the report form must be signed by *each* such person.

PRIVATE AND CONFIDENTIAL.

MILK INVESTIGATION.

Identifying Number or Label ....

SAMPLE TAKEN IN CONSUMER'S HOUSE.

1. House where sample is taken and Name of Occupier ....
2. Date .... 3. Time (*a*) of delivery of milk and by whom ....
   (*b*) of taking sample ....
4. Temperature (*a*) of the room where milk is stored ....
   (*b*) of the milk at time of taking sample ....
5. Situation in which the milk has been kept in the house, kind of receptacle and how covered, mentioning any other articles of food or drink in close proximity ....
6. Cleanliness and means of ventilation of the place where the milk is stored ....
7. Mention absence or presence of an unusual number of flies ....
8. Any sanitary conditions likely to affect the milk, such as defective sink or drain, nearness of any closet, ashpit, ashbox, &c., to the house, wall or windows ....
9. Occupation of the Tenant ....
10. Rental and type of the house ....
11. Any general observations ....

Signed ....

NOTE.—Where more than one person has been engaged in the work of taking a sample, the report form must be signed by *each* such person.

I

Taken just after meal. Erect position
Shows all food in stomach, air in cardiac end.
Traces of previous bismuth meal in large intestine

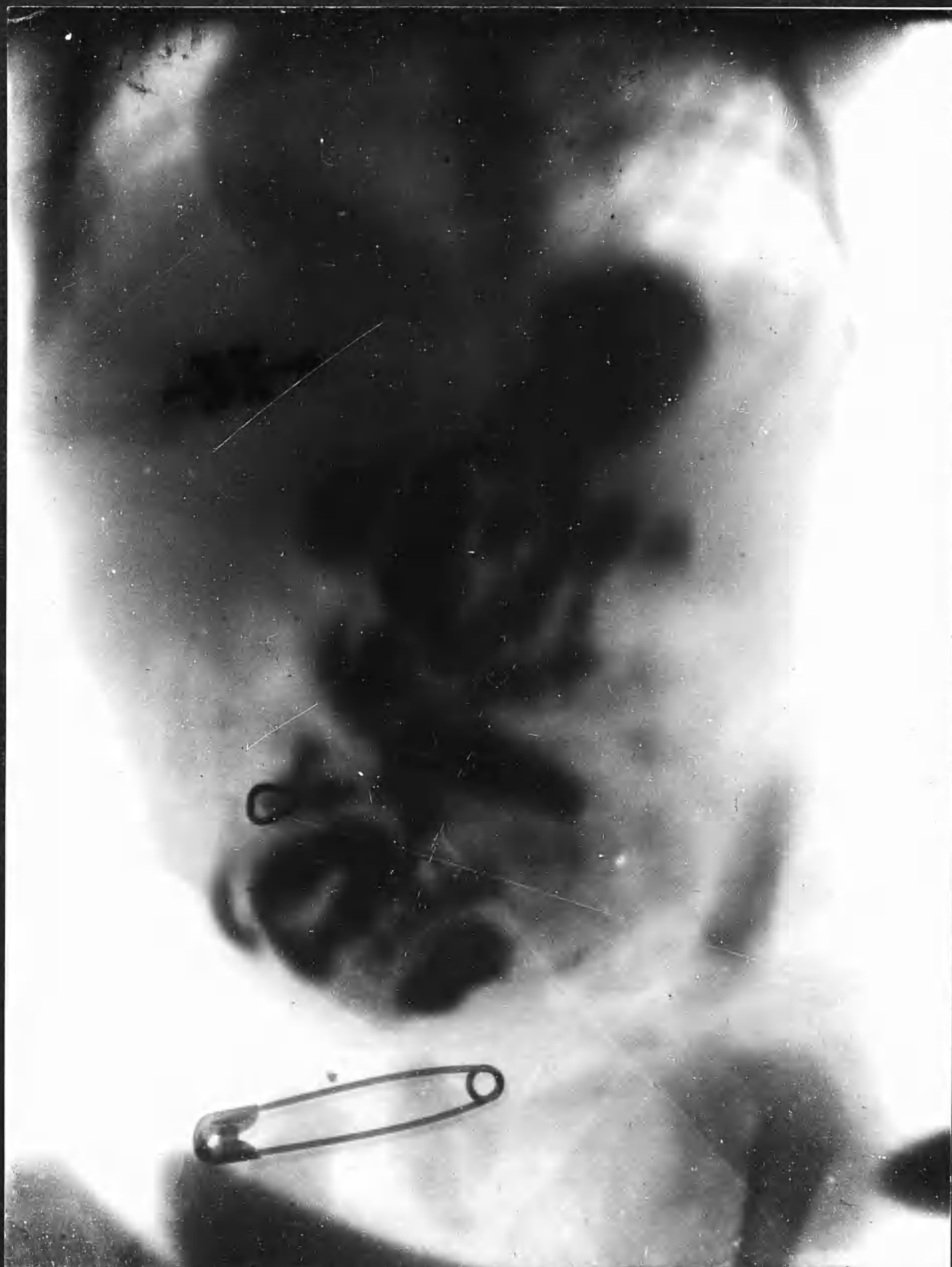
II

Taken 30 minutes after a meal, in the erect position
Shows air in stomach, Food in stomach and bowel
Colon distended with gas, traces of bismuth from previous meal

III

Taken 1 hour after a meal. Recumbent position
Shows stomach well distended with food, which is
also seen in the bowel, especially towards the pelvis
caecum and ascending colon distended with gas.

IV

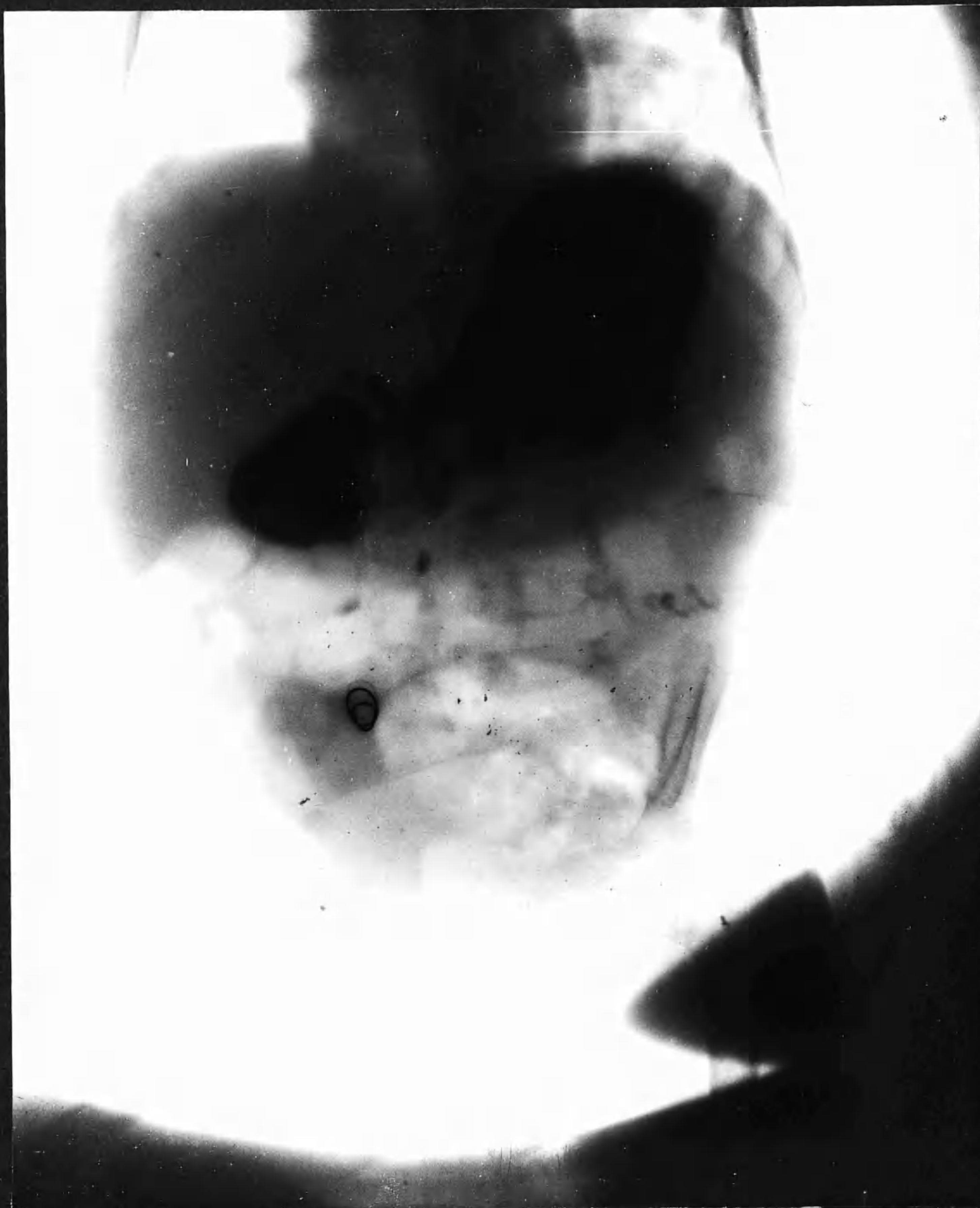


Taken 1 hour and 5 minutes after original meal and immediately after small quantity of bismuth. Recumbent. Shows bismuth slightly distending stomach and previous meal all in small intestine

V

Taken immediately after meal. Recumbent.
Shows all food still in stomach and distinct outline
of whole colon distended with gas. The liver shadow
seems larger than usual

VI



Taken 45 minutes after meal Recumbent.
Shows stomach well distended with food, and small quantity in duodenum

VII

Taken 75 minutes after meal. Recumbent
More than half food still in stomach. Rest seen
indistinctly in intestine.