employed at the waterworks were tested for the Widal reaction to detect unrecognised cases of enteric fever, and were kept under close medical observation.

To sum up, the safety of a water supply depends upon:—

1. The purity of the source, and its freedom from possible pollution. In this respect, rivers fail notoriously.

2. The control of the source by constant inspection, and the imposition of stringent regulation.

Here again in practice this is most difficult indeed, almost impossible in the case of rivers.

3. The provision of sufficient sedimentation accommodation. In many rivers this most vital essential is ignored.

4. Efficient filter beds, and the bacteriological control of such.

These are liable to become defective, and in the absence of sedimentation beds are not a sufficient protection.

5. Sufficient storage accommodation for pure water. This is often absent, and even when provided generally inadequate.

6. The previous epidemiological history of the supply.

There can be no question, I think, that on the whole, river supplies are generally precarious, and may become dangerous—it has been asserted that no river is long enough to purify itself, and yet there is no doubt that most rivers undergo some amount of purification in their course.

On the other hand, there is the experience of large towns like London, which have been for many years drinking water derived from sources notoriously polluted without incurring the onset of any large epidemic.

On the whole, it is advisable where rivers supply towns, to err on the side of safety, and to insist upon the provision of efficient filtration bacteriologically controlled, and sufficient sedimentation beds and pure water reservoir accommodation; anything short of this is a risk not to be contemplated with equanimity, and sooner or later to court possible disaster. In compiling this paper, free use has been made of the writings of Drs. Houston, Gordon, Thresh, Savage, Horrocks, Prescott, and Gage.

YORKSHIRE MILK.*

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MUCH good work is being done, especially in America, in studying the changes which occur in commercial milk, and a vast amount of information on the subject is available to any diligent collector. It is a good sign of the time, however, when local authorities themselves undertake an investigation in the interests of the public health. Such an investigation has been carried on for a twelve-month in Yorkshire, and the results have been issued in a report extending to 113 foolscap pages of letterpress and tables. The first five pages consist of the report of the joint committee of Yorkshire authorities, and contain the conclusions to which they have come; while the remaining pages, forming the bulk of the publication, consist of the report to the joint committee of the expert bacteriologist whom they commissioned to conduct the investigation on the lines they laid down.

I.

How the Inquiry originated.—Some two years ago, Dr. Mitchell Wilson, the able and experienced medical officer of health to the East Riding County Council, directed the attention of his authority, whose district lies chiefly in a quite agricultural neighbourhood, to the importance of looking into the whole subject of milk production from a sanitary point of view. Later he addressed a memorandum to the county and county borough medical officers of Yorkshire. The East Riding Council, impressed with the importance of the subject, conferred with the Council of the West Riding, whose district embraces not only a considerable area of a largely agricultural character, but also a large urban population, in the villages and smaller towns, where the woollen industry flourishes. It was then suggested that the large county boroughs, to whom so great a portion of the farmer's milk is sold, might with advantage be asked to join in any inquiry, and a circular was sent to the councils of all the county authorities in

* Report on an Investigation as to the Contamination of Milk, carried out on behalf of the Councils of the County Boroughs of Bradford, Hull, Leeds, Rotherham and Sheffield, and the Administrative Counties of the East and West Ridings of Yorkshire. Copies of this Report (Price 2s. 6d.) may be obtained from the Clerk of the Council, County Hall, Beverley.

Yorkshire asking them to send delegates to a conference on the subject. This conference, which was held in Leeds, on the 23rd of July, 1906, was attended by representatives of most of the county authorities in Yorkshire and their medical officers of health, and the conference recommended that a joint investigation should be conducted, with the aid of an expert, to ascertain if any contamination of milk occurred, and, if so, at what stages of its journey from the cow to the consumer, and what was the extent and nature of the contamination. This recommendation, with certain resolutions as to the general conduct of the proposed inquiry, was transmitted by the clerk of the East Riding County Council to the several authorities represented, and the councils of the East and West Ridings, and those of the cities, or county boroughs, of Bradford, Hull, Leeds, Rotherham and Sheffield, agreed to join in the investigation, and to share the estimated expense of £500, according to their rateable value. When these authorities had appointed their representatives (one from each authority, along with the medical officer of the authority), they, along with the chairman of the Joint Farm Committee of the Ridings, the Professor of Agriculture, and the Lecturer on Agricultural Chemistry at the Leeds University, met, agreed on certain lines of action, and proceeded to advertise in the agricultural and medical journals for an expert bacteriologist willing to undertake the investigation. Several very promising candidates offered themselves, and the joint committee unanimously decided to offer the appointment to Mr. Thomas Orr, of Hamilton, who had, in the laboratory of Dr. Buchanan, bacteriologist to the Glasgow City Council, already studied the bacteriology of milk. The committee, in their own unanimous report, speak very highly of, and the printed report submitted to them, which they have given in full, speaks even more highly to, the excellence of Dr. Orr's work.

The lines of the Inquiry.—Having settled on the bacteriologist, the committee conferred with him upon the lines of inquiry already generally agreed upon. From the first their intention was to carry out the original suggestion of Dr. Mitchell Wilson, of following a particular consignment of milk from the cow to the consumer, measuring the amount of its bacterial content at every stage on the way. From the first also it was evident to those of the committee conversant with the

bacteriology of milk that such a series of examinations might lead to absolutely valueless results, unless some system of testing control samples could be devised. For instance, a sample of milk secured at the cowshed from the churn in which it would travel to one of the larger towns, placed in ice, and, sent to the laboratory for examination, might be found to contain say "a" bacteria per cubic centimetre. At the householder's doorstep in the town, a second sample of the same consignment might be obtained, put into ice, and also sent to the laboratory, and found to contain "b" bacteria per c.c. It would obviously be unfair to say that the increase of bacteria, due to faulty handling of the milk after it left the farm, was represented by either $b-a$ or b/a . Obviously some control of the experiment would be necessary. The most obvious suggestion to meet this difficulty was to take a second sample at the farm and convey it to the point of delivery to the consumer, subject to the same conditions of time and temperature as the milk in the farmer's and retailer's cans. To illustrate by an example. The first country milk examined by Dr. Orr (No. 7 in his cowshed list), contained in each c.c. 85,130 organisms, capable of growing on gelatine at ordinary room temperatures. A sample of the same consignment of milk was obtained at the retailer's premises three hours later (9.45 a.m.), and gave rise under the same circumstance, to 116,000 colonies, an apparent increase of colony-producing bacteria of 36 per cent. (pp. 37 & 100). But a second sample of milk had been placed at the farm in a second sterilised bottle, and instead of being sent in ice to the laboratory direct, was carried in the pocket of the inspector to the town, until the retailer's milk was sampled three hours later at his own premises. Curiously enough the bacterial content of this sealed milk, not iced till the time of procuring the retailer's sample, was 117,160 per cubic centimetre, instead of 116,000. The bacteria in the retailer's sample had increased just over 36 per cent., those in the sealed sample carried in the inspector's pocket had increased nearly 2 per cent. more. The actual 2 per cent. of further increase is perhaps a negligible quantity. What is clear is that the increase of 36 per cent. in the milk in the retailer's possession could not logically be ascribed to fresh pollution on the way, when the control showed an equal (in reality a slightly increased) multiplication of bacteria. In this instance, which is selected simply

because it is first on the list, the milk had been passed over a cooler at the farm, but this had only reduced the temperature of the milk to 23.5° C. (= 74.3° F.), though the temperature of the air at the time of sampling was 4° C. (= 39° F.). Even this amount of cooling might do something to inhibit the growth of bacteria already in the milk of the churn. But in the case of the retailer, the cool place in which the milk had been placed (8.5° C. = 47.3° F.) had probably reduced the temperature of the milk still further, for when the retailer's sample was collected, its temperature was recorded as 11.5° C. (= 52.7° F.) or 12° C. (= 51.6° F.), lower than when it left the farm (p.100). The cooler keeping-place of the retailer probably accounts fully for the 2 per cent. less increase in his than in the control sample. This example, however, illustrates the difficulties of what at first sight looked a very simple investigation. To some extent these were anticipated, and control samples provided for at most of the sampling stages. The difficulty of dealing, however, with such a multitude of samples as would be necessary to control all observation and observe every consignment at every step made it necessary to limit the number of samples collected. Dr. Orr, as a bacteriologist, seems to have enlarged the scope of the inquiry, and to have undertaken to some extent a classification of the bacterial flora found at various stages. Obviously this research greatly increased the value of the inquiry, for it introduced the consideration of whether any organisms different in kind from those received at the cowshed entered the milk on its way.

For the rest, the general directions of the committee, subject to any slight variations which might prove to be necessary as the inquiry went on, were—

To examine bacteriologically samples of milk from the same consignment at various stages of its journey, and, so far as possible, control samples, protected from outside contamination, but exposed to the same vicissitudes of temperature as those to which the milk in bulk was subjected.

To collect the samples at the farm and other places without warning, and to note at the time of collection the temperature of the air in the place of sampling, as well as of the milk from which the sample was taken. To note also the conditions obtaining

at the farm, the retail shop, the consumer's house; as to cleanliness, purity and temperature of the atmosphere. This included a general description of the cattle, as to housing and cleanliness, and of the condition of the farm otherwise. It was suggested that, in regard to country farms, the sampling should be done if possible by a town and country inspector acting in concert.

The work of bacterium counting, etc., to be done at the laboratory attached to the experimental farm at Garforth, where the Professor of Agriculture of the Leeds University promised active assistance.

It will be seen later that the conducting of the research work by Dr. Orr at the farm enabled him to make an experimental investigation as to the comparative bacterial content of milk from cows in various stages of cleanliness, which have a very considerable value.

The conditions of sampling, as afterwards modified, and the means taken to secure freedom from contamination in collecting, as well as the technique of culturing, will be found in Dr. Orr's portion of the report at pp. 8, 9 and 10.

II.

The findings of the Joint Committee.—While the report of their expert will be read with interest by all who have studied, or are studying, the important subject of milk contamination, the pronouncements on the part of a committee representing agricultural and urban authorities, trained agriculturalists and medical officers of health, will be regarded with a certain amount of confidence as the finding of a mixed body of business men and agricultural and sanitary experts. This confidence will be increased when it is known that the committee's report is signed by all its members without reservation.

Doubtless some points in their report would have received greater emphasis had the committee been a purely rural or a purely urban one—a purely sanitary or a purely agricultural commission. Perhaps, on account of its very moderation, the report is entitled to all the greater respect. The committee in arriving at their conclusions, naturally felt themselves limited to a consideration of the facts disclosed by the investigation itself,

and refrained from pronouncing, even on strong outside evidence, on questions on which their own inquiry has thrown no special light. These limitations, justified as they are by the conditions of their appointment, render it impossible to regard their findings as a full and complete solution of the whole subject of milk contamination. Limited to a single year, and that about the wettest and coolest on record, and limited, therefore, in some respects to a very small number of examinations, their inquiry stops short, naturally, at any appraisalment of the exact amount of filth added to the milk uniformly at any particular stage of its journey. They do, however, unanimously find "that serious contamination does take place, and, to a great extent, of a preventable character"; and that, "in general, the greatest amount of contamination occurs at the cowshed." This last fact they attribute (a) to the dirty condition of the cows' udders, and (b) to the imperfect cleansing of the milk cans. They point out that contamination from the latter cause is greatest in summer.

They, referring to chapter and verse in the expert's report, state that this contamination at the cowshed can be almost entirely prevented by (a) washing of the udder and flanks of the cow and the hands of the milker; (b) sterilization of all vessels used; (c) rejection of the fore-milk; (d) avoidance of dust-raising work during milking; and (e) immediate removal of milk from the cowshed as soon as collected from the cow. They find that these precautions have an even greater importance in preventing contamination of the milk than even the purity of the atmosphere within and the cleanliness of the cowshed itself, important as these matters are from other points of view.

They lay stress upon the influence of temperature on the multiplication of bacteria introduced at the cowshed, and point out that such multiplication "is mainly a question of the temperature at which the milk is kept, and the time that elapses before consumption. The lower the temperature, and the shorter the interval of time the less do the bacteria multiply." They add that "the valuable effects of cooling cannot be fully attained unless the cooler itself during storage and use is effectively protected from contamination."

The committee then point out that, with the precautions they recommend in regard to sealed cans and coolness, no further contamination need occur in transit. They deprecate

the common practice of pouring milk from the farmers' to the retailers' cans in the dust-laden atmosphere of the railway station.

Additional contamination they say "arises from—

"(a) Exposure to dust—for example, in retail shop, during street delivery, or in the consumer's house;

"(b) Imperfectly cleansed milk receptacles, such as retailers' cans or consumers' vessels."

They then proceed, after directing attention to certain experiments detailed in Dr. Orr's report, to urge "that a very great improvement in the cleanliness of our milk supply might be effected if the attention and co-operation of the various persons concerned were secured in the following points." These it may be as well to quote in full. They are—

(a) *On the part of the Milk Producer.*—The absolute necessity of cleaning the udder and flanks of the cow, and of washing and sterilizing the receptacles in which milk is placed.

The desirability of rejecting the "fore-milk," and of removing the milk when drawn, as rapidly as possible, to a dust-free atmosphere.

The great improvement in keeping properties which may be effected by cooling the milk to 50° F. as soon as possible by means of a clean cooler, suitably protected from dust and other contamination.

The provision of cans with lids of such a type as to render contamination from without impossible. The cans in which milk is forwarded should be locked or sealed.

(b) *On the part of the Railway Company.*—The urgent necessity for rapid transit, especially during warm weather.

The provision of special vans, kept scrupulously clean and reserved for the milk traffic.

The necessity of maintaining the milk at a temperature not exceeding 50° F. during the time it remains in their charge.

The provision of a special shed in which milk should be placed immediately on its arrival at the station. This shed should be kept clean and cool, and used only for milk traffic.

(c) *On the part of the Retailer.*—The undesirability of transferring the milk from the farmer's can, as is usual at present, in the station precincts.

The prime importance of scrupulous cleanliness in all details of the handling of milk.

The desirability of thoroughly cleansing the farmer's cans before returning them. This implies the necessity, after washing out with clean cold water, of maintaining the can, etc., for some time at steam heat, in order to ensure thorough cleansing and sterilization, or, failing a supply of steam, of a thorough scalding with an abundance of boiling water.

The necessity of complete protection of all milk from dust prior to sale.

The importance of keeping the milk at a temperature not above 50° F.

(d) *On the part of the Consumer.*—The necessity for scrupulous cleansing and scalding with boiling water of vessels in which milk is placed. The further necessity of protecting the milk from dust during storage, of keeping it as cool as possible, and certainly at a temperature not exceeding 50° F.

Having dealt with these points thus in detail, the committee make an observation of such practical importance that, coming as it does from impartial investigators, it may be quoted in full:—

As a result of their investigation, the committee are of opinion that a much cleaner and more wholesome supply of milk can be obtained without a costly outlay in premises or special apparatus. It is, however, abundantly clear that, in dealing with an article that is so easily contaminated as milk, details which are very commonly regarded as trifling are really of the greatest importance, and it is evident that painstaking care at every point, with scrupulous cleanliness in person and habit, are absolutely essential. This involves intelligent supervision on the part of those owning or managing cowsheds, better arrangements on the part of the railway companies, and the exercise of care on the part of retailers and consumers.

The committee hope that, when it is realised how important a foodstuff milk is, and how liable it is to contamination, the common sense of all concerned in its handling may be relied upon to ensure their co-operation in the directions indicated.

To help in the attainment of this object the committee consider that a popular leaflet, based on the results of this investigation, would considerably help in the education of public opinion on the matter.

III.

The Report of the Expert.—Dr. Orr may be congratulated upon the opportunity afforded him for beginning so interesting an investigation. It has evidently been a labour of love. The mere requirements of his committee might have been satisfied with about half the work that his enthusiasm has led him to undertake. Yet none of the extra work he has brought to the task is valueless, though much of it must be regarded as preparatory to a longer inquiry.

Town and Country Milk.—The milks examined, except where experiments were undertaken at the farm, were all milks produced in or brought for sale into the five large county boroughs. He estimates roughly that some 58,000 gallons of milk are consumed in these towns daily, and that less than 24,000 of this is produced in the towns themselves. The

remaining 34,000 comes in, nine-seventeenths of it by road and eight-seventeenths by rail, the average distance travelled being about a dozen miles. Most of this milk was produced in Yorkshire, though about 8000 gallons came from Derbyshire (p. 7). Seventy-five sets of samples were collected, but in two cases some contamination occurred, and their bacteriological characteristics are not considered. In the remaining seventy-three, two or more samples were in every case taken at the cowshed, and one or more at other stages; not always the same stages in different milks. The samples obtained at these later stages were all collected in the towns named. The samples at the cowshed were taken in town or country, according to the situation of the shipen.

Of the seventy-three sets of cowshed samples bacteriologically examined, twenty-four came from town, forty-nine from country cowsheds. These numbers do not quite correspond to the proportions of town and country milks consumed in these boroughs—33 per cent. of the examinations were of town-produced milk, but the consumption of such milk was about 40 per cent. As the object was rather to find out where and to what extent contamination occurred, the committee seem to have wished for a larger number of samples of the longer-distance milks.

The cowshed milk was, in every case (except where used as a control) packed in ice when taken. Dr. Orr made a series of examinations of freshly-gathered milk, and of the same milk after it had been kept for various periods in ice and found that the variations between the fresh and the ice-preserved milks were not greater than might occur from experimental errors (p. 9).

He divided the cowshed milks into four classes, according to their bacterial content. Class A consisted of eight out of the seventy-three cowshed milks examined, and in which the bacterial colonies per cub. cent. at room temperature did not exceed 15,000. In this class, with the lowest bacterial content, six of the eight were town and two were country milks. But, as a percentage, 25 per cent. (six out of twenty-four) of the town milks came into this less-polluted class. Of the country milk, two out of forty-nine, or just over 4 per cent., came into class A. The actual numbers are, of course, too small for one to attach importance to the percentages.

Dr. Orr's Class B contained thirty-four

milks, twelve from town, twenty-two from country milk farms. In all these the bacterial content per cubic centimetre was more than 15,000 and less than 50,000. Twelve of the twenty-four town milks came into this class, or 50 per cent. Twenty-two of the forty-nine country milks came into Class B, or nearly 45 per cent.

Of all the milk taken in ice directly from the dairy of origin to the laboratory, therefore, 75 per cent. of those from town sheds and 49 per cent. of those from the country, were found to produce less than 50,000 colonies on gelatine at room temperature. "In three of the twenty-two country and one of the twelve town milks in Class B, the gelatine culture was spoiled and the figures are taken from the agar culture at blood heat. The agar count is usually less."

Clean and Dirty Milk.—Dr. Orr suggests that 50,000 bacteria per c.c. might, in the meantime, be looked upon as a sort of dividing line between moderately clean and very dirty milks. He made an endeavour, however, to estimate the contamination of milk, also according to the amount of sediment it contained. For this purpose he procured somewhat larger quantities of milk, allowed it to settle, and then centrifugalised the sediment by an arrangement he describes, and which was a modification of Houston's. He regards forty parts of washed sediment per million parts of milk as a convenient dividing line. Forty-three country milks examined direct from the cowshed had an average just under forty-one. Eighteen town milks similarly examined gave an average of twenty-eight. An interesting point about this part of the investigation is that the milk taken in these sixty-one consignments at the point of delivery contained much less sediment than that from the farmers' own cans at the starting point. A certain amount of the dirt taken in at the farm had probably settled in the farmers' cans, and not been transferred to those of the retailer.

Nature of the Sediment.—A good deal of information about this sediment will be found in the expert's report.

At page 50, he describes it as consisting of "vegetable particles from manure, granular dust particles, leucocytes and cellular debris, hairs, particles of straw, yeasts and bacteria. "The origin," he adds, "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."

As he regards the amount of sediment as "directly connected with the method of straining," he enters fully into the subject of the various modes of filtering and their relative efficiency. Table XII contains an account of the sixty-one milks already mentioned, and gives the amount as volumes per million, first of the cowshed milk, then of that of the same milk as retailed. The fourth column gives the inspector's report as to the cleanliness of the cows, the fifth the method of straining. The two following columns deal with the presence of streptococci where looked for, and the proportion of leucocytes in the farmer's and the retailer's sample. The three following columns deal with the cellular and granular debris and the source of the milk—town or country.

Bacillus enteritidis, Klein.—Section III of Dr. Orr's report sets out some of the work done in estimating the comparative numbers of these bacteria present in the same milks examined at different stages. The importance of this part of the investigation lies in the circumstance that, as an anaërobe, the bacillus does not multiply in warm milk, so that any increase in the numbers found at different stages would seem to predicate an addition from without after the milk left the cowshed. The method of ascertaining the comparative numbers present was less exact than the method of counting bacteria by the colonies produced on nutrient jelly. The method followed resembled in some of its details that usually employed in estimating roughly the numbers of colon bacilli. The samples were taken in certain known amounts, and the presence or absence of the organism tested in these different quantities. In a first series of estimates—consignments 7 to 46—the milk was used in quantities of 10 c.c., 1 c.c., and one-tenth of a cubic centimetre each, the smaller quantities being diluted by the addition of 10 c.c. of sterile litmus milk, the larger simply put into sterile tubes. They were heated for a quarter of an hour at 80° C. (= 176° F.), put into Buchner's tubes with pyrogallate of potassium, and incubated for forty-eight hours. The tubes which gave the enteritidis change were counted as positive. Inoculations were not made. Out of the forty cowshed samples, seventeen (42.5 per cent.) gave the characteristic change in the quantities where 10 c.c. of the milk was used, but not

where the quantity employed was smaller. In twenty-five samples from milk kept in the house of the consumer, the presence or absence of this bacillus was recognised in each in the same quantity as in the corresponding cowshed sample. In six consumers' samples the organism was recognised in the 10 c.c. tubes, although not recognised in the tubes of the same quantity in the cowshed milk.

In another six samples similarly compared, the reverse was the case. The cowshed milk, in quantities of 10 c.c., had given the special reaction, but the consumers' samples of the same milk failed to do so.

As in no case had the presence of the bacillus been proved in quantities less than 10 c.c., it was resolved to deal with the remaining samples in larger quantities. Accordingly, in the second series of twenty-seven samples—Nos. 48 to 75, excluding 58—the quantities used were 20 c.c., 10 c.c., and 1 c.c. The cowshed milk gave positive results in twenty-three (or 85 per cent.) of the 20 c.c. quantities, and in the 10 c.c. quantities the positive result was secured in thirteen (or 48 per cent.). In none, where only 1 c.c. was used, was the positive result recognisable. In one out of the three milks where 20 c.c. gave no evidence in the cowshed sample, such evidence was obtainable in the same quantity in the consumers' sample. On the other hand, in eight consumer's samples, where the result had been positive in 20 c.c. of milk from the cowshed, the evidence was negative in that from the consumer's house. On the whole, the inquiry indicates that the presence of this bacterium was most frequently due to contamination at the farm, though in about 11 per cent. its presence would seem to point to after contamination. The significance of this bacillus is considered, and it is not perhaps necessary to remind the reader not to confuse this bacillus with Gärtner's *B. E. sporogenes*.

It should perhaps be added that, in Table XIII, Dr. Orr has set out the result in each series of his tests for this bacillus, not only in the cowshed sample, but in the control sample from the cowshed, and (where they were obtained) in the railway station sample, the retailer's sample, and the retailer's control sample, as well as in the sample kept at the consumer's house. A study of this table is interesting, revealing points where a general examination such as is given from a comparison only of the consumer's and cowshed

samples might mislead. For instance, in No. 74, the last milk but one examined in this way, the cowshed sample gave a positive result both in 20 c.c. and in 10 c.c. The control cowshed sample, which presumably had suffered from temperature as much and for as long a time as the consumer's sample, also showed the presence of the bacillus in the 20 c.c. and 10 c.c. specimens. The consumer's sample only reacted in the 20 c.c. specimen, while the action of the test gave no result in any of the quantities submitted to it from the retailer's milk or the retailer's control. In No. 73, both cowshed and cowshed control gave negative results, but the retailer's sample, the retailer's control, and the consumer's sample, all gave positive results in the larger quantity. In No. 72, all the samples examined—cowshed, cowshed control, retailer's, retailer's control and consumer's—gave a positive result in 20 c.c., but, rather curiously, the cowshed control, and only the cowshed control, gave a positive result in 10 c.c. Anomalies of this kind are noticeable in several other cases, and, as already said, warrant a careful study of the table itself. Dr. Orr found no definite relationship between the presence of this bacillus and a large general bacterial content.

Glucose ferments.—In section IV. Dr. Orr deals with the organisms in each batch of specimens producing acid and gas in McConkey broth. The quantities of milk added to the broth varied from 1 c.c. to the millionth part of a cubic centimetre. The inoculated tubes were incubated at 37° C. for at least forty-eight hours, those showing the presence of gas after that time were plated out for purposes of further identification. The general result was to show that coliforms were found in higher and higher dilutions as the milk travelled. Dr. Orr, however, regarded the method as too rough to show how much of the increase was due to simple multiplication, and how much, if any, to additions on the way. Table XIV sets out the smallest quantity in which this coliform reaction was manifested in the cowshed sample and the cowshed control, in the railway station sample, the street sample, the sample taken on the retailer's own premises, and the control sample so taken and in the sample taken after being kept at the customers' house. This table also will repay study, but it is impossible even to refer to all the interesting problems opened out by this research. Fortunately Dr. Orr has put most of his findings into figures.

In this connection, however, one must refer to the search for gas formers in fresh and dry cowshed manure, and in the washings from milk churns already prepared *more bucolico* for the reception of fresh milk. This last test is so important that at the risk of being wearisome it must be referred to. Four milk churns, which were ready to receive the new milk, were washed out, each with 100 c.c. of sterile water, and dilutions of this fluid inoculated into glucose broth. In No. 1, the dilution of 1 in 1,000 gave the reaction; in No. 2, of 1 in 10,000; in No. 4 of 1 in a million; and in No. 5, of 1 in 100,000. Such a result must give us pause. The report is, however, full of wayside experiments of this sort, showing with what enthusiasm the bacteriologist set about his work.

Streptococci.—The milk of nine cows, drawn direct from the udder into sterile flasks, was examined for streptococci. Quantities of 10 c.c. and 1 c.c. of the fore, the middle, and the last-drawn milk, were examined for these chains. The 1 c.c. in no case gave a definite result, but in quantities of 10 c.c. positive results were given in six of the nine cows in the foremilk, in five of the nine in the mid-milk, and in three of the nine in the strippings. The milk, in each case, had been drawn from the right fore-quarter of the animal. In seven of the nine cows the same experiment was made with the milk from the other three teats. Teat *B* gave a positive result in four of the seven cows with 10 c.c., and in one of them also with 1 c.c. Teat *C* gave only one positive result in the 10 c.c. quantity, while teat *D*, in one case, also gave the positive result, but with both the ten and the single cubic centimetre.

The highest dilutions showing presence of streptococci are given on p. 67, and show an increase of the organism as the milk travelled. As in the coliforms, the method is too rough to show what amount of fresh contamination occurred at such stage; the results, are, however, set out in detail in Table XV, which, like its predecessor, gives the dilution responsive in the sample from the cowshed and its control, the station, the street, the shop and its control, and the household keeping cellar. Various side issues are discovered and results of experiments, such as with "clean" milk cans given. The dairyman's "clean" cans seem to have been somewhat freer from streptococci than those of the farmer. It may be mentioned here in passing that the farmer's

cans, when washed by the milk vendor, were generally freer from bacterial life than when washed by himself.

Distinctions between Bacteria found.—A valuable table (XVI) gives the special organisms identified, and the results, as + or −, of the growth of the glucose ferments on glucose, lactose, saccharose, ducite and adonite, as well as the appearances in a gelatine stab, on an agar slope, the development of indol, the response to the Voges and Proskauer reaction, and the presence or absence of motility. Table XVII gives for each of the bacilli so isolated a statement in which milks and at what stages it was found, and which of the reactions named were present in each case. The same information as to manure, dry and moist, and as to the plates exposed under cows during milking, is added to this table; while in Table XVIII we are presented with the numbers of certain of these plated-out organisms found in samples at different stages. The work represented by these three tables deserves more notice than can be given it at the end of a somewhat lengthy review.

Suggestions and Conclusion.—It is interesting to compare the conclusions of the report with the pronouncement of the joint committee, and note which of the former have been regarded as not yet proven. The final tables show nearly every analysis made, and give a faint idea of the work involved in the inquiry.

The important question as it seems to us is, "Who is to continue this inquiry?" Valuable as has been the work done at the instance of these Yorkshire authorities, it almost seems as if they had stopped just as the inquiry was getting most valuable. What modification of the results would have taken place had the summer of 1907 been a hot and dry, instead of a cool and wet, one? What modification of Dr. Orr's interesting estimate of the proportionate guilt of causing contamination (which the committee have not adopted in full) would have occurred if the method of obtaining a control of the milk in the keeping cellar had been adopted earlier, and especially if it had been extended over a considerable period of warm weather?

These are interesting questions one would like to see answered. "Who will bell the cat?" Nothing has been said about the pictures. One generally looks at them first. We hope the farmers who get held of this brochure will do so and feel a holy awe.