Milk-scarlatina in London in 1885 : being a report on certain observed relations between scarlatina in various districts of London and milk supplied from a dairy farm at Hendon / George Buchanan.

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MILK-SCARLATINA:

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Milk-Scarlatina in London in 1885: being a Report on certain observed relations between Scarlatina in various Districts of London and Milk supplied from a Dairy Farm at Hendon.

George Buchanan,
Medical Department,
March 31st, 1886.

On December 18th, 1885, Mr. A. Wynter Blyth, Medical Officer of Health of St. Marylebone, personally reported to the Board a sudden and extensive outbreak of scarlatina that appeared to be associated with the distribution of milk from a particular retailer in South Marylebone. He described this retailer as obtaining his supplies from two farms, and the coincidence of the retail milk distribution with Marylebone scarlatina as being limited to that one portion of the milk supplies derived from a certain dairy farm at Hendon. Mr. Blyth further stated that he had visited this farm and had conferred with Dr. Cameron, the Hendon Medical Officer of Health, but that neither he nor Dr. Cameron had been able to discover, in the sanitary circumstances of the farm or in the health of those employed about the farm, any sort of clue to the means by which the milk had become infective. He had not heard of any veterinary examination of the cows.

Hereupon I received the Board's instructions to make inquiry into the whole case, and if occasion should arise, to investigate the conditions at the Hendon farm that might have a bearing on the question of production or dissemination of scarlatina by milk; and further, if any sort of malady among the cows should appear to require investigation, I was to obtain the co-operation of Dr. Klein in such pathological study as was needful.

Inquiry was commenced simultaneously in London districts and at Hendon. The experience of South Marylebone, as observed by Mr. Blyth, was compared with the corresponding facts for other London districts receiving supplies of milk from this Hendon farm. At the same time at Hendon search was made for cases of disease, not only of scarlatina, but of any disease resembling scarlatina; and not only among the families of those employed about the farm, but among their neighbours and in the district generally. The Hendon farmer was made acquainted with the general nature of the inquiry that was going on, and his help was invited in any investigation of his farm and his business that might afterwards become requisite.

In the course of a few days, by December 23rd, inquiries in the foregoing sense had been made. It had been learned that milk from this Hendon farm had been distributed by retail in St. John's Wood, in St. Pancras, in Hampstead, and at Hendon, as well as in South Marylebone; it had been distributed in these districts only; and from every one of these several districts—except from St. John's Wood—the same general story was forthcoming. Until the end of November or beginning of December 1885, the district had been for some months exceptionally free from scarlatina; about this date scarlatina had undergone sudden and notable increase in the district; and then and thenceforward a strikingly large proportion of the recorded cases had occurred among

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persons who proved, upon inquiry, to be customers of a milk retailer dealing in the particular Hendon milk.

At this early time of the inquiry, no special importance could be attached to the circumstance of scarlatina not having been noticed among the customers of the St. John's Wood business.

In each of the milk-districts (as I may call them) of South Marylebone, St. Pancras, and Hampstead, other milk besides milk from Hendon had been distributed by the retail dealer vending the particular Hendon milk; and as soon as special prevalence of scarlatina in those several milk-districts became apparent, it was of course seen that, instead of the Hendon milk, these other milks might be in question. This was possible though not probable. For these other milks had come from two different farms (from one to South Marylebone, from the other to Hampstead and St. Pancras), situated in widely separate counties, and distribution of scarlatina with milk not being an every-day occurrence, it was much less likely that absolutely distinct farms thus widely separated had at one and the same time been supplying to neighbouring districts in London milk having the same special concern with disease. It was much more likely, therefore, that the Hendon share of the milk, being common to the three businesses, had been the responsible agency.* And further, Mr. Blyth had ascertained in regard of the South Marylebone milk business that certain customers supplied with Hendon milk, *and Hendon milk alone*, had suffered scarlatina.

Then, as for antecedent disease among the Hendon population, of a nature to have had concern in the distribution of scarlatina with the Hendon farmer's milk it had, by December 23rd (thanks to Dr. Cameron's thorough knowledge of his district), come to be regarded as out of the question that any infection of the milk by such disease outside the farm could have taken place. It could be said that no scarlatina, nor any illness at all like scarlatina, had effected any of the persons employed about the farm, their families or neighbours at any such time or in any such way as to influence the farm or its produce. Such few cases of scarlatina as could be heard of at Hendon during 1885 had occurred at a distance from the farm and in families that had nothing whatever to do with the farm.

The foregoing experiences of different districts, and the considerations here presented as arising out of them, were held to constitute a notable presumption that the Hendon farm had been concerned with the scarlatina prevalences. It was a presumption that nowise amounted to proof, especially when it was seen to be an essential element of the problem that outside human agencies had to be set aside as not having been operative. Yet it was enough to give precedence to the Hendon farm as the place where search after conditions of milk infection might most profitably be made; and investigation of the circumstances of the Hendon farm was accordingly commenced without loss of time.†

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* As the inquiry advanced, and the exemption of the St. John's Wood consumers of Hendon milk was seen to be definite and beyond question, the fact appeared for the moment greatly to change the above probability. But on the other side there was the circumstance of a peculiarly intense incidence of scarlatina at Hendon among people who got no milk except from the Hendon farm. More about these occurrences will appear in the sequel.

† Though precedence was given to this investigation, it was not without much hesitation that the inspection of the dairy farm was begun. For ere now it has happened that official visits for purposes of knowledge have been confounded by the public with condemnation of the common sanitary doings of the farmer, with the result of unwarranted disaster to his business interests; and I had Dr. Cameron's assurance that in this case any such condemnation was very far from being deserved.

In passing to consider the possible relations between this farm and the outbreaks of scarlatina which had occurred in the milk districts of various retailers deriving parts of their supplies from the farm, I had the advantage of Dr. Cameron's assistance. This officer had had previous experience of disease associated with the consumption of a particular milk, and as my inquiry at Hendon proceeded he proved himself a very able coadjutor. In what follows respecting the Hendon dairy farm I may claim that my methods and conclusions had throughout his consent and confirmation. On Milk-Scarlatina in London.

The dairy farmer, though willing to afford and though indeed desirous of affording us every assistance, was utterly incredulous of the presumptive evidence tending to connect disease with the milk supplied from his farm, and till a late period of the inquiry he remained so. His cowmen were perfectly incredulous also. And truly, having regard to the facts that we first elicited, as to freedom from illness of those at the farm and as to the peculiar care given to the sanitary affairs of the farm and its dairy, the farmer's incredulity could not but be regarded as justifiable. He had certainly done his best to avoid known conditions of danger, and had not suspected that any such condition, known or unknown, had been present on his farm. The farm was found to have had especial pains taken to render it, as the phrase is, sanitarily perfect. At the instance of one of the London retailers with whom the farmer had dealings,* the place had for several years been the subject of special supervision by the medical officer of health of the district, my coadjutor in this inquiry, Dr. Cameron. He had seen that the West Middlesex Company's water was laid on to the farmhouse, to the dairy, and each of the several cowsheds; he had seen specially to the wholesomeness, as regards drainage, cleanliness, ventilation, and the like, of the house, the farmyard, the cowsheds, and the dairy; securing for the last all needful appliances for effectual cleansing of dairy utensils by hot water or steam; and, month by month, he had inspected the farm premises with reference to these and similar details, for the express purpose of safeguarding the milk against contamination of any detectable kind. Further, under the same arrangement, Dr. Cameron had specially attended to the health conditions of those employed about the farm and their children, with a view to early detection of any malady among them that might by chance injuriously affect the milk with which they had to do. He had even undertaken to observe and to report to the London retailer, by whom his services were retained, on any occurrences of infectious illness in the neighbourhood of the farm, even though it did not directly affect the families of people employed there. The farmer too who had consented to the exercise of this supervision over his doings, had attended to every suggestion made to him, and had taken every precaution to secure his farm and his milk against any known sanitary fault or misadventure. He had a separate shed for any sick animal, and a separate shed for the observation of newly arrived animals.

Thus, with Dr. Cameron's aid, the point was speedily reached at which it could provisionally be affirmed of the Hendon farm milk that, if indeed it had caused scarlatina among its consumers, it had not

* This retailer owned the St. Pancras and Hampstead businesses, and will be mentioned in this Report as Mr. Y. He has for some years shown the same solicitude in respect of the other farms from which his milk is brought to London. In other ways, too, he has habitually been on the alert to secure his customers from any risk of milk-infection, and to place his business above suspicion. His attitude towards sanitary matters in their wider aspect has been much in advance of his fellows; and thus the abundant aid he has furnished to the present inquiry has been correspondingly of the greatest value.

acquired the ability to do so in any commonly accepted way, such as through unwholesome conditions of water or drainage, or through careless handling of milk or milk utensils by persons carrying scarlatina infection. Nor, during the long subsequent acquaintance with the farm gained in the course of this inquiry, did any reason appear for modifying this conclusion.

It was not long, therefore, before we found ourselves confronted with the alternative, which thenceforth constituted itself into the hypothesis which we had to examine, that the cows themselves must have had something or other to do with any scarlatina which had been distributed along with their milk.

Our reliance for the discovery of such a something, and for an understanding of its nature, lay in ascertaining in detail every parallel between the doings at the dairy farm and the observed scarlatina.

From the point of view now reached, every peculiarity of scarlatina incidence on the various districts supplied with milk from the Hendon farm acquired a new importance. Exemptions, specialities in point of time, and of extent of prevalence, now claimed to be considered under the aspect of possible relation with the operations of the farm. The history of the observed scarlatina, thus investigated with all attainable exactness, is given in summary in the table subjoined. Leaving to the health officers of the several districts to narrate, in the health interests of their districts, the local characters of the outbreaks, I here show for each retailer of the Hendon milk the locality of his operations, the amount of this and of other milk distributed by him, and the dates of notable incidence of scarlatina on the consumers of milk delivered from his shop, together with such facts as are to be had about the relative amounts of scarlatina in the customers of the several businesses. I designate the retailers by letters rather than by their names.

Retailers of Hendon Milk.	Milk-District situated at	Total Amount, in Barn Gallons, of Milk distributed Daily.		Date of Notable Incidence of Scarlatina on Customers of Retail Business.	Degree of Incidence at one and another Period.
		Hendon Milk.	Other Milk.		
Mr. X -	South Marylebone.	63	10	End of November and early December to date of inquiry.	Customers suffered heavily and in increasing numbers up to date of inquiry.
Mr. Y (1*)	Hampstead -	18	25	End of November or early December, and Mid-December.	Customers did not suffer nearly so heavily as Mr. X's customers. They were attacked in two groups, one a small group, limited in time at the beginning, the other a large group, from the middle of December to the date of inquiry.
Mr. Y (2*)	St. Pancras -	6 or 7	45	Early December and Mid-December.	Comparatively few customers suffered. Attacks, however, grouped in time much as in Y (1) business.
Mr. Z -	St. John's Wood.	20	4	—	No scarlatina among customers up to date of inquiry.
Mr. P -	Hendon -	1 or 2	—	Early December -	Number of families consuming the milk day by day not a dozen. Two of them suffered; the earliest invaded being attacked near end of first week of December.

* Mr. Y. had two retail milk establishments, Y (1) in Hampstead, and Y (2) in St. Pancras Hendon milk was delivered to him at his Hampstead place of business, and there only; from hence some of it was transferred by his own men to his St. Pancras establishment.

Of the special phenomena that were learned about the scarlatina outbreaks, and that are shown in summary on this table, those which established the most important claim to recognition by the inquirer into the farm operations, were seen to be as follow :—

(*a.*) In those four districts (the milk districts of a former paragraph) wherein scarlatina had shown an extravagant incidence upon the milkman's customers (probably, as we have seen, upon the consumers of the Hendon milk), the disease had begun its peculiar incidence *at one and the same time*, namely, *about the end of November or beginning of December*.

(*b.*) In one of those districts (that of Mr. X) scarlatina continued *day by day, and with increasing force up to the date of the inquiry*, to attack the customers of the retail business.

(*c.*) In two other of those districts (those of Mr. Y's two businesses) scarlatina behaved in a different fashion. In each district, after attacking in some number *for a few days at the end of November and beginning of December* the customers of the business, the disease showed *no fresh attacks for about ten days* (the period of intermission was short, but was quite clearly and sharply defined), and then *about the middle of December attacked them again in larger number, and continued to do so up to the date of inquiry*.

(*d.*) In the fifth district (that of Mr. Z's business) *no scarlatina whatever*, either at the end of November or subsequently, *down to the time that the investigation was proceeding*, had been learned of by the best inquiry that could be made in the parish.

In the study of the farm operations, which was now set on foot for the detection of conditions parallel to these special phenomena, the most striking phenomenon—one which, indeed, demanded explanation if any relation of the Hendon milk to the disease were to be upheld—was this definite exemption of the St. John's Wood people who had dealings with Mr. Z. It was, indeed, a remarkable fact. Mr. Z got five-sixths of his milk from the Hendon farm, and distributed an ample quantity of it among numerous customers. Yet there was a total absence of scarlatina from among these customers.

Examination of the circumstances of the cows at the Hendon farm was now directed to ascertain whether *any new condition pertaining to the cows* had arisen in the farm or had been contributed to the farm business at such time and in such way as to be coincident with the ability of the milk to produce scarlatina in its consumers, first, at the end of November in four milk districts, afterwards, throughout December, in Mr. X's milk district, and after an intermission in December, in Mr. Y's two milk districts; while the condition in question was absent from the cows that furnished milk for Mr. Z's business.

The process of inquiry was tedious, involving investigation of a variety of circumstances, such as food of cows, calving of cows, health of cows, arrival and departure of cows, and so forth; and, up to a certain point, it proved barren of result. For a long time nothing could be heard of that was new or changed. During many weeks, or even months, before the scarlatina outbreaks among milk consumers, no change had been made in the food of the Hendon cows; much of this food had been the produce of the farm; the source of other kinds of food had remained unaltered, the quality of the food had not (the farmer averred) changed or deteriorated. So too, as regarded calving of cows, and health of cows. The business did not include the rearing of calves; it was a

milk business, pure and simple, the cows being "stall-fed" all the year round, and, as matter of fact, no cow had calved at the farm since September. As to health of cows, it was confidently affirmed that, for months past, not one of them had suffered any illness; indeed, with the exception of everyday trivial ailments, the cows had been, it was stated, particularly free from all maladies to which stall-fed cows are admittedly more liable than other cows.

But upon passing to consider in detail the comings and goings of cows to and from the farm, some important information was forthcoming, and the inquiry began to assume a more hopeful aspect. The business of the farm being an affair of milk production only, had required a high average yield from the cows kept there; so that cows, as they "dried off," had been in practice replaced by fresh and "newly-calved" cows purchased as occasion required from the country. And it turned out that on the 15th November, three newly-calved cows, purchased from Derbyshire, had been received into the business.* Before November 15th, no new cows had been received since the middle of October; and after November 15th, none had been received until December 4th, when four additional cows had been purchased from Oxfordshire.

In the addition to the dairy farm on November 15th of three newly-calved cows, there appeared a circumstance eminently worth further exploration. For (*a*), it was seen that the arrival from Derbyshire of those newly-calved cows (November 15th) did in fact shortly precede the first occurrences of scarlatina in the four milk districts, namely, at the end of November or beginning of December; so that the cause of scarlatina (whatever it was) was actually manifested in these four districts just after† the time when the milk of those cows came to be included in the produce of the farm. Accordingly, the next questions that arose were, had there been anything (*b*) in the distribution of the milk of those particular cows, or (*c*), in the subsequent relation of those cows with the new-comers of December 4th, or of either set with other cows in the herd, parallel to the observed specialities of scarlatina incidence upon the four infected milk districts? Going on to seek answer to these questions in the facts of the dairy farmer's procedures, some further very interesting and suggestive correspondences were presently obtained.

As regards the concern which the several retail milk businesses had with the milk of newly-imported cows, it has to be premised that such cows were not at once added to the stock in the general cowsheds of the farm. In accordance with a custom instituted for the purpose of guarding against the introduction of foot-and-mouth disease, the new-comers were at first placed in what is known as "the quarantine shed," a little removed from the farmyard. New cows are here kept until their freedom from that disease is regarded as assured, usually for a week or ten days. As matter of custom, their milk is not used in the business immediately after calving, but after a while and before the cow is removed from the quarantine shed, it is judged permissible to use the "quarantine milk." At the expiration of this quarantine period newly imported cows are taken from their special shed and distributed according to the requirements of the general business in the three several sheds of the farm along with the other cows already there.

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* The dealer who was believed to have purchased these cows in Derby market, and who sold them to the Hendon farmer, resolutely refused all information whatever.

† It was necessarily "after"; for with scarlatina as with other infectious diseases, there is an interval between the date of reception of the infection and the first manifestation of the disease. In scarlatina this interval is known to be less than a week.

The particular batches of animals received on November 15th and December 4th were dealt with on this plan. The precise period of quarantine in the case of each batch had not been recorded, but it was believed by those about the farm that the 15th November cows had stayed in the quarantine shed longer than usual; the 4th December cows for not more than a week.

At the date—the third or fourth week of November—at which the milk of the farm, if it had any infective ability, must have acquired that ability, the cows at the farm numbered 90 or 100, distributed in the several cowsheds as follows:—in the "large shed," 40 or 50; in the "middle shed," 30; in the "small shed," 20. At this date, the 15th November cows were still in the quarantine shed. A few days later, somewhere about the end of the month, the 15th November cows were transferred into the general cowsheds, and very shortly afterwards their places in the quarantine shed were taken by the cows received from Oxfordshire on December 4th. These in turn were transferred to the general cowsheds about December 11th.

At the date in question, the distribution among the London retail dealers (I defer for a time further mention of Hendon consumers) of the milk of the cows in the several sheds was effected with much uniformity, each morning and evening, as follows:—

From the "large shed," Mr. X and Mr. X only, was supplied. The milk of the shed did not indeed suffice for his whole requirements, and the balance was made up by a varying quantity of milk from the "middle shed."

From the "middle shed," Mr. X and Mr. Y received their supplies, and not any other dealer. Mr. Y received all the milk from this shed, except what was required for Mr. X, and in so far as this quantity was insufficient for Mr. Y's requirements, the supply to him was made up from the "small shed." As before said, all milk of the farm received by Mr. Y for his two businesses was delivered to him at one place, namely, at Hampstead.

From the "small shed," Mr. Y and Mr. Z received their supplies, and not any other dealer. Mr. Z received all the milk from this shed, except what was required for Mr. Y, and Mr. Z received milk from no other shed.

From the "quarantine shed" milk was being distributed at the date in question: on some days it went to make up Mr. X's supply, on other days to make up that of Mr. Y, frequently perhaps to both of them on the same day. But rarely, if ever, had it been added to churns destined for Mr. Z, for in the routine of the farm his churns were seldom brought out of the small shed before the quarantine milk had been disposed of.

Now as we have seen, the chief facts as to time-incidence of scarlatina on the four milk-districts of South Marylebone (X), Hampstead and St. Pancras (Y (1) and Y (2)), and St. John's Wood (Z), were as follow:—

Mr. X's customers began to suffer at the end of November and continued to suffer in increasing number up to the date of inquiry.

Mr. Y's customers, in the districts of both his businesses, suffered slightly at the end of November and beginning of December. Then for a while they ceased to be attacked; but about the middle of December they were again attacked in greater numbers and more persistently than before.

Mr. Z's customers had not suffered at all, so far as could be heard of, up to the period that the inquiry had reached.

It will be evident to the reader that, in our search for new conditions within the farm corresponding to the appearance of the milk outbreaks

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in London, we had now succeeded in finding one such condition, namely, the distribution of the particular milk furnished by the newcoming 15th November cows. Scarlatina among Mr. X's customers appears soon after the milk of the 15th November cows in the quarantine shed comes to be added to the milk delivered to Mr. X. Scarlatina among Mr. Y's customers appears in Y's two milk districts soon after the milk of these same cows comes to be added to the milk delivered to Mr. Y. Scarlatina among Mr. Z's customers is absent; no milk from these cows is added to the milk delivered to Mr. Z. But this was not all.

Having in view the other specialities observed in the local behaviour of scarlatina in the several milk districts, it came to be seen at this stage that if the above concurrence was in truth indicative of cause and effect, we must be able to set down *a priori* certain other parallel events which, if they had occurred, would greatly strengthen the inference. This was accordingly done, and when certain probable events had been formulated, inquiry was made as to their actual occurrence.

Taking as a postulate that the likeliest method by which a result producible by the milk of particular cows would become varied or modified, was by variation or modification of the relations of the cows themselves within the business of the farm, the following three propositions were set out as matters of probability:—

(*a.*) In the last days of November or the earliest days of December, a change had probably been made in the manner of distributing the milk produced by the 15th November cows, and most likely this change had consisted in the transference of those cows themselves, or some of them, into the "large shed" and delivery of their milk thenceforward along with the milk of the other cows in that shed.

(*b.*) About the second week of December, some of the 15th November cows, or some of the 4th December cows (which up to December 11th had occupied the quarantine shed), or some other cows that had been during early December in close relation with the 15th November cows, were probably transferred to the "middle shed," and their milk delivered from thence.

(*c.*) It was not probable that at any time up to the end of the second week in December, any of the 15th November cows, nor any of the 4th December cows, nor any cow that had been in close relation with such cows, had been transferred to the "small shed."

These probabilities were formulated in view of the special time-distribution of scarlatina in Mr. X's district, and in Mr. Y's two districts, and in view of the continuous exemption of Mr. Z's district. They were not announced in any way to the farmer or his men; and in the search after facts, care was taken to avoid putting leading questions to the people who had been engaged about the cows. Once or twice indeed a statement was made by way of interrogation—to receive the assent of a cowman, who could not divine whence our information had come. In the outcome, it was found that, as matter of fact:—

(*a.*) The three 15th November cows had been, towards the end of November, transferred to the "large shed." Here they all still remained at the date of inquiry, and their milk had been delivered from hence.

(*b.*) The four 4th December cows had been transferred about 11th of December, two of them into the "large shed," the other two of them into the "middle shed"; and in these sheds they were found at the date of inquiry, their milk going into the general supply of the respective sheds.

(*c.*) At no time up to the date of inquiry had any of the 15th November cows nor any of the 4th December cows, nor any other cows been transferred to the "small shed."

In short, what had been seen to be a succession of probabilities if the scarlatina in London districts were indeed the outcome of the milk distributed from the Hendon farm, was now established as a succession of facts.

We had thus reached the point of excluding external scarlatina, of associating the importation of particular cows into the Hendon farm with presence of scarlatina in London districts, and of connecting by a series of parallel events the milk furnished by those cows, and related cows, with the peculiarities of scarlatina prevalence among consumers of the Hendon farmer's milk. Under these circumstances, it was not judged necessary to go beyond the Hendon farm and to inquire at the two other farms that also sent milk into the London districts of South Marylebone, Hampstead, and St. Pancras, in search of the cause of scarlatina in those districts. Henceforward, until anything to the contrary should appear, an influence, competent to produce scarlatina among the consumers of the milk, was held to have operated from those cows which were received into the Hendon farm on November 15th, and the further concern of the inquiry was with the nature of such influence.

Adhering to the design of the inquiry to proceed altogether upon the circumstantial evidence obtainable within the actual epidemic before making any comparison with former experiences, investigation of the probable nature of the influence by which the Hendon milk had operated to produce scarlatina in its consumers was now begun. After much thought about alternatives it was found necessary to accept, provisionally, the belief that the influence in question, having belonged in the first instance to the 15th November cows, had belonged *to the constitution* of the cows :—was in fact some species of cow disease. And the acquisition of this influence by other cows had become so very probable, that a corresponding probability arose that any such disease in the cow had been in fact an infective disease communicable from cow to cow. The considerations of circumstance that forced these beliefs on acceptance were cogent, no alternative to them was discernible, and we could not see that feeding well and milking abundantly were reasons against the hypothesis of such disease.

Seeking for any exact circumstantial evidence that might possibly exist, indicative of a particular cow or cows having been at fault, the only morsel of such evidence that tendered itself was a specially promising one, but it proved disappointing. A friend of the farmer who had by favour been supplied with the "milk of a single cow," had had his family very heavily stricken by scarlatina at Hendon about the end of the first week in December. A specially fine cow had been designated for his service; but it presently appeared that the milk of that same cow, being regarded as peculiarly rich in quality, had also been taken for the children of people employed about the farm, and among these children there had been no scarlatina whatever. Thus the expectation of identifying that cow as a disease-producer was at an end, and another sort of interest in her arose. The cow was at the beginning of December living with other cows in the large shed away from the 15th November cows in the quarantine shed. It was not for some days later that the facts about this theoretical "one cow" supply were learned: the practice had certainly been less inflexible than the intention; and it was found to have been perfectly possible, to say the least, that

on some occasion in early December (when the farm bailiff's back was turned) the supposed "one cow" supply had indeed been dipped out of a common churn in the large shed, in such a way that those who drank it would be in precisely the same relations to the milk service of the farm as the consumers of the Hendon milk who were living in South Marylebone.

During the further study of the doings at the farm, some days of Christmas intervened, and immediately on the resumption of inquiry it was found that a most instructive but pitiful experiment had been going on at Hendon. In this Christmastide, medical men practising in the district had been called to case after case of scarlatina occurring in separate houses and obtaining the proportions of a little epidemic. The houses were at Child's Hill and elsewhere near the farm, and were occupied by people of the labouring class and the poor. The first case had dated from December 20th. Upon inquiry as to the milk supply of these families it was ascertained that they, one and all, had shortly before their invasion been exceptionally furnished with milk from the Hendon farm under circumstances as follows:—On December 15th the whole of Mr. X's milk, 63 barn gallons, mainly derived from cows in the large shed, had been returned on the farmer's hands with an intimation by the Marylebone Health Officer that he believed the milk, or some of it, to have been causing scarlatina in his district. Hereupon the farmer, though discrediting the allegation, determined not to seek for a new market for that section of his milk. The returned milk went to the pigs. For the rest, those of his customers, he said, who still desired his milk could if they chose continue to take it and be served as before, but he gave orders that the section of his produce which he regarded as being under suspicion, namely, all the milk of the large shed, should, with the exception of some to be used for pig-feeding, be thrown into a pit freshly dug in one of his fields. His instructions, however, were not completely carried out by his cowmen. It became known in the neighbourhood that milk from the farm was being thrown away, and at once a number of poor neighbours put in an appearance and begged for it. To most of them it was refused, to all those who applied to the farm bailiff; but by special grace of certain cowmen some of these neighbours received gratuitously on December 16th and subsequent days, a portion of the produce of the large shed that would otherwise, as they and the cowmen believed, have been wasted. It was among these people that scarlatina appeared about a week afterwards. It invaded some half dozen families, forming an unknown (but certainly a large) proportion of the families to whom the milk had been given, and it attacked no family to whom it was not supplied.—Conversely, upon subsequent inquiry in South Marylebone, it was found that in the period about Christmas when these Hendon families were falling ill of scarlatina new cases ceased, almost suddenly, to appear among the families supplied by the South Marylebone milk seller, and afterwards there were no fresh attacks except what were referable to spread from previous sufferers.

The experiment was complete and confirmed the inferences which had before been drawn from the distribution of scarlatina in metropolitan districts. No more of the inculpated milk was sent to London throughout the whole period of the inquiry, and of course none of it was given to neighbours after the relations of it to scarlatina at Child's Hill had been seen.

There is little more to tell of the relations that were found to exist between the Hendon cows and human scarlatina, but that little is of interest.

In the last days of December after the foregoing circumstantial evidence had been, in essentials, worked out, the 15th November cows were still in the large shed: the two 4th December cows which had been put into the large shed on December 11th were still there; and the other two 4th December cows which on 11th December were placed in the middle shed, had been taken therefrom and put into the large shed, because circumstances had by this time thrown suspicion on their milk.

At this time, examination of the cows was made with a view to the detection of any, even the slightest, disease among the cows; and it was found that several in the large shed were suffering from vesicles and ulcers on the teats and udders, and that the cow most severely affected was one of those received into the farm on December 4th.

Dr. Klein, whose assistance was now invited, visited the farm with Dr. Cameron and myself on December 31st and following days, and we found that these sores on teats and udders were very general among the cows of the large shed, in the several cows being of different degrees of intensity and recency. The 15th November cows were not suffering, but on close examination of their teats and udders scars were found on two of them of a kind that satisfied us of their having shortly before suffered from the malady. Of the four 4th December cows two were suffering from the disease, one (transferred from the middle shed) had it badly, other cows in the shed had it in a more recent form. In the middle shed there were several recent cases and in the small shed two early cases of it were at this date detected.

An outside observer knowing something of cows had perceived just before Christmas certain cows in the large shed, particularly on the left-hand side of it, to be suffering from "bad quarters." He did not attach any importance to the fact, except for the unusual quantity of the ailment. The cows on the left-hand side of this shed, however, at that date included the cows imported to the farm on 15th November, and two also of those imported on 4th December.

Our belief in the existence on this farm of a constitutional disease among the cows competent to produce scarlatina among human consumers of the cows' milk was now becoming unreserved. The identity of the disease and its more obvious characters and its communicability appeared to have been demonstrated. Also, in the phenomena of the disease itself, Dr. Klein found reason for regarding it as more than a local complaint affecting the skin of the teats and udders. He regarded it as a general or constitutional disease; one that might, probably enough, be communicable from cow to cow.

Dr. Klein took with him for experimental purposes samples of milk, contents of vesicles and discharges from ulcers of affected cows; and afterwards two of such cows were purchased and conveyed to Dr. Klein at the Brown institution for further observation and for pathological investigation there. He will report on the clinical features and on the pathology of the disease.

No deference to Dr. Klein's belief, any more than the now admitted concurrences of human disease with milk consumption, weighed in any degree with the people employed about the farm to induce them to credit the notion that the health of the cows had been in question. Had not the cows eaten well and given full yield of milk, they asked, and how then could they be ill? If they had any ailment, it must be, and it was, of no consequence, and it could not have been connected with disease in man.

So they reasoned, and it was doubtless this disbelief that occasioned a little less reticence among the cowmen. But one day a certain cowman who had undertaken to point out for Dr. Klein the most recent case he could find of sore teats, mentioned to us his having first seen such early

beginning of the complaint in the case of one cow, that he very well knew, and on being requested to point out that cow he led his questioner to the large shed and showed him one of the Derbyshire cows that had come to the farm on November 15th.—It was now admitted on all hands that this cow had been the first to suffer from the malady and that she suffered very badly; that not long afterwards, other cows in the large shed and a 4th December cow in the middle shed were also found affected; and that latterly the disease was known to have spread abroad in the large shed and in the middle shed and now to be invading the small shed. To the last however the cowmen were all sure that the disease was of no possible importance whatever and could not have affected the quality of the cows' milk.

Our discovery of this extended prevalence of the cow disease, now, on January 1st, in all the sheds of the farm, was a very disquieting circumstance, for the middle and small sheds were still furnishing milk to London consumers. We felt it necessary to advise the farm bailiff (in the temporary absence of the farmer through illhealth) at once to seek out every cow that now was or that might become affected with sore teats or udder, or any other sort of ailment; to isolate every such cow, and to keep all her milk out of the business; and to prevent cowmen employed in the tending or milking of sound cows from having anything whatever to do with the cows thus set apart. These precautions were taken after January 1st, and we had good reason to think, only just in time to prevent a disastrous repetition of the events of December. For, in gathering up the later facts concerning the various local epidemics of scarlatina in their relation to the Hendon milk service, the following facts appeared:—

(*a.*) In South Marylebone, as has been told, the new outbreaks had ceased shortly after the delivery of milk to Mr. X had ceased; and at Hendon, up to the end of December, no fresh outbreaks had occurred after those above recorded as following on the use of milk refused by Mr. X.

(*b.*) In Hampstead and St. Pancras milk districts, where Mr. Y continued to supply milk from the Hendon farm, a diminution if not a temporary cessation of fresh outbreaks had taken place about Christmas, but in the first days of January they were again becoming somewhat numerous. The reduction and the recrudescence had corresponded well with the removal of the two December 4th cows from the middle to the larger shed; and with the appearance, shortly after, of new cases of the cow-disease among the animals of the middle shed.

(*c.*) Just about the same time, in the early days of January, milk from the small shed, which had previously been without share in scarlatina production appeared, almost suddenly, to be implicated. The daughter of one of the cowmen who was employed in this shed, and who by permission took home milk from the small shed, but from no other, was attacked by scarlatina the day after her arrival in London on a visit; and, almost simultaneously with the fresh attacks among Mr. Y's customers, the customers of Mr. Z, in St. John's Wood milk district, began to suffer from scarlatina. These events corresponded to a nicety with the appearance for the first time of the cow disease among the animals of the smaller shed.

Thus the precautionary measures enjoined on the farm bailiff were not in time to prevent the beginnings of another manifestation of scarlatina in London, and their value in preventing subsequent outbreaks could not be estimated. For, on these fresh appearances of illness among their

customers, Messrs. Y and Z at once discontinued all supplies from the Hendon farm. The whole milk of the farm was now thrown on the farmer's hands, and was given to the pigs or buried.—While this report is in preparation, I have made inquiry of Messrs. Y and Z as to any further scarlatina, peculiar to their customers, and I find that none has occurred in the milk districts of Hampstead, of St. Pancras, or of St. John's Wood since the beginning of January.

I think it just, in concluding my account of these scarlatina epidemics and their cause, to repeat what I have before said of the Hendon farm and its proprietor. The farmer had taken every care he knew how to take, for the health-state of his farm premises, of his men, and of his cows; he gave all information and assistance in his power during the course of my inquiry; and he obeyed the suggestions that were made to him during the inquiry, although he did not always see the reason for them, and although they interfered to a dismal degree with his immediate trade interests.

W. H. POWER.

MILK-SCARLATINA:

REPORTS TO THE LOCAL GOVERNMENT BOARD.

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LOCAL GOVERNMENT BOARD.

PAPERS

with

AN INTRODUCTORY REPORT BY THE MEDICAL OFFICER OF THE BOARD:—April 1886.

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REPORT.

TO THE RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

SIR,

OUTBREAKS of disease related to local milk-supplies have for many years been the subject of study by local sanitary inquirers; and in almost every year since the constitution of your Board, your Medical Department has been called on to investigate such occurrences. Sometimes the disease has been enteric fever, sometimes scarlatina, sometimes diphtheria; and within the experience of the Board there have been fifteen instances where one or other of these diseases has been shown upon sufficient evidence to have been distributed with the milk-service of the families invaded. In the case of the scarlatina outbreaks it was inevitable that infection of the milk by human agency should present itself as the readiest explanation of the facts; but as successive epidemics have occurred and have been found capable of more exact study, distrust of this explanation has arisen, and the means by which the milk receives its infective properties has come to be regarded as unknown—as possibly being related to the milk as a secretion of the cow.

A scarlatina epidemic in St. Giles and St. Pancras in 1882 was the subject of investigation by Mr. Power for the Board; and the disease was here distributed with a milk-service derived from a Surrey farm. In this case two facts could be affirmed: the one that a cow recently come into milk at this farm had been suffering from some ailment, seemingly from the time of her parturition, of which loss of hair in patches was the most conspicuous manifestation; the other that there existed no discoverable means by which the milk, which had coincided with scarlatina in its distribution, could have received infective quality from the human subject. The circumstances of the milk-service did not, indeed, in this case permit of a relation being established between ailment of any particular cow and the disease spread from the farm. But the facts were so far suggestive that, at the instance of the Board, some experimental observations were made by Dr. Klein as to the concern of animals with human scarlatina; and it was found that a definite disease was producible in the cow by means of scarlatina-infection, producible most readily when the cow was in milk.

The experiments were not at the time carried farther than the production of this disease, and the recognition of certain of its characters; among these the most interesting was its quality of communicability from one animal to another by inoculation.

The investigations with which the present papers are concerned were directed by the Board, last December, in view of information furnished by Mr. Wynter Blyth, the Medical Officer of Health of Marylebone. This officer had observed a sudden outbreak of scarlatina in his district to be associated with the distribution of milk by a particular retail dealer, and that this dealer obtained the greater portion of his supply from a farm at Hendon. Mr. Blyth had found reason for believing that the disease had prevailed exclusively among customers furnished with milk from that source.

Mr. Power, to whom the Board entrusted the duty of making more extended inquiry into the facts concerning milk-supplies from this Hendon farm, presently learned that a similar prevalence of scarlatina had occurred about the same time in other parishes of the metropolis that were furnished with milk from the same farm; and that in those parishes, as in Marylebone, the prevalence of the disease had been very much restricted to consumers of this milk.

I refer to Mr. Power's report for the steps by which he first established a presumption that the Hendon milk had been the vehicle of scarlatina to its London consumers; by which he afterwards excluded pre-existent human disease at and about the Hendon farm, and excluded also anything of the kind commonly known as "sanitary" conditions there, as having had concern with the infectivity of the milk; and by which he came successively to regard certain sections of the milk-supplies within the farm, and eventually certain cows, as having to do with the observed results. The whole of Mr. Power's report on these matters will have to be studied before the exactness of his observations and the validity of his inferences can be duly apprehended. In the end he has demonstrated, beyond reasonable doubt, the dependence of the milk-scarlatina of December on a diseased condition of the milch cows at the farm; a condition first introduced there in the previous month by some animals newly arrived from Derbyshire; and he finds strong circumstantial evidence for believing that the later phenomena of this dependence were brought about through the extension of the diseased condition of one set of animals to another set, after the fashion of an infection. Mr. Power leaves to others to give a full description of the phenomena of disease observed in the cow. Its manifestations, he tells us, were not particularly conspicuous, and one of the more prominent, namely, sores on the udders and teats, was very possibly common to it and to other less important states observed in milch cows.

The second report of the present series is by Dr. Klein, whose services were invited by the Board, as soon as circumstantial evi-

dence had established a relation between scarlatina and the consumption of Hendon milk. Dr. Klein records his early investigations into the intimate nature of the ailment present among the cows. In its own province Dr. Klein's report is as important and as interesting as Mr. Power's, and its more immediate significance lies in the complete harmony between the conclusions obtained from Mr. Power's etiological researches and the inferences as to communicability and other characters of the Hendon cow-disease that follow from pathological inquiry. By the inoculation into calves, either directly of the discharges from cow-ulcers, or indirectly of sub-cultures of those discharges artificially prepared, Dr. Klein has succeeded in producing, now local, now general, disease in the calf; disease having unmistakable affinities, under some conditions with the Hendon cow-disease, under other conditions with scarlatina in the human subject:—on the one hand, ulcers on the skin of the calf anatomically identical with the ulcers on the teats of milch cows: on the other hand, general disease in the calf, at first of inconspicuous nature, but passing on to serious changes in the internal organs, more particularly in the kidneys of the calf; the more characteristic of these changes being anatomically identical with those resulting in the human subject from the operation of the scarlatina poison.

It is intended that Dr. Klein's report on this subject, as it will appear in the Supplement to the fifteenth volume of the Board's Reports, shall be illustrated by some drawings of the microscopical appearances which he describes. And it is also proposed that during the forthcoming year a portion of the grant annually made by Parliament for the scientific purposes of the Board shall be allotted to further study of the relations that exist between human scarlatina and diseases of animals. But as it has already been judged desirable to publish Mr. Power's report convicting the animals of a milk farm of participation in the distribution of scarlatina to consumers of their milk, so on receipt of Dr. Klein's paper, your Board has thought proper that the two shall without delay be published together. They will properly form a starting point for fresh observation and experiment, not only by your Medical Department, but by all who have the opportunity of investigating the new and promising fields of research that are opened by the recent experiences of Hendon.

I am enabled, by the favour of the Epidemiological Society, to reproduce here, as a third paper, an account of the phenomena of the Hendon cow disease, recently presented to that Society by Dr. Cameron, the Medical Officer of Health for the district and the medical adviser of the Hendon farmer. His account consists partly of observations actually made by himself among the cows of the farm, and he brings these down to a later date than the completion of Mr. Power's etiological inquiries. But further, with the aid of people familiar with cows and who thought they recognized in the disease at the farm one stage of a disease which they were able to describe as a whole, Dr. Cameron

has drawn up what he and his informants together would regard as a connected clinical history of the disease. I have thought that, provisionally, his paper will have practical value to the milk-farmer.

I have the honour to be,
Sir,
Your obedient servant,

GEORGE BUCHANAN.

April 1886.

PAPERS.

No. I.

MILK-SCARLATINA in LONDON in 1885: being a REPORT by Mr. W. H. POWER on certain observed relations between SCARLATINA in various DISTRICTS of LONDON and MILK supplied from a DAIRY FARM at HENDON.

No. 1.

On Milk-Scarlatina in London; by Mr. W. H. Power.

ON December 18th, 1885, Mr. A. Wynter Blyth, Medical Officer of Health of St. Marylebone, personally reported to the Board a sudden and extensive outbreak of scarlatina* that appeared to be associated with the distribution of milk from a particular retailer in South Marylebone. He described this retailer as obtaining his supplies from two farms, and the coincidence of the retail milk distribution with Marylebone scarlatina as being limited to that one portion of the milk supplies derived from a certain dairy farm at Hendon. Mr. Blyth further stated that he had visited this farm and had conferred with Dr. Cameron, the Hendon Medical Officer of Health, but that neither he nor Dr. Cameron had been able to discover, in the sanitary circumstances of the farm or in the health of those employed about the farm, any sort of clue to the means by which the milk had become infective. He had not heard of any veterinary examination of the cows.

Statement to Board.

Hereupon I received the Board's instructions to make inquiry into the whole case, and if occasion should arise, to investigate the conditions at the Hendon farm that might have a bearing on the question of production or dissemination of scarlatina by milk; and further, if any sort of malady among the cows should appear to require investigation, I was to obtain the co-operation of Dr. Klein in such pathological study as was needful.

Inquiry was commenced simultaneously in London districts and at Hendon. The experience of South Marylebone, as observed by Mr. Blyth, was compared with the corresponding facts for other London districts receiving supplies of milk from this Hendon farm. At the same time at Hendon search was made for cases of disease, not only of scarlatina, but of any disease resembling scarlatina; and not only among the families of those employed about the farm, but among their neighbours and in the district generally. The Hendon farmer was made acquainted with the general nature of the inquiry that was going on, and his help was invited in any investigation of his farm and his business that might afterwards become requisite.

Personal inquiry.

In the course of a few days, by December 23rd, inquiries in the foregoing sense had been made. It had been learned that milk from this Hendon farm had been distributed by retail in St. John's Wood, in St. Pancras, in Hampstead, and at Hendon, as well as in South Marylebone; it had been distributed in these districts only; and from every one of these several districts—except from St. John's Wood—the same general story was forthcoming. Until the end of November or beginning of December 1885, the district had been for some months exceptionally free from scarlatina; about this date scarlatina had undergone sudden and notable increase in the district; and then and thenceforward

Scariatina found in certain milk businesses;

* The diagnosis of "scarlatina," in the cases with which this Report will be concerned, was made without hesitation by every practitioner who had charge of the cases, alike in the metropolis and at Hendon.

a strikingly large proportion of the recorded cases had occurred among persons who proved, upon inquiry, to be customers of a milk retailer dealing in the particular Hendon milk.

At this early time of the inquiry, no special importance could be attached to the circumstance of scarlatina not having been noticed among the customers of the St. John's Wood business.

probably in consumers of Hendon milk

In each of the milk-districts (as I may call them) of South Marylebone, St. Pancras, and Hampstead, other milk besides milk from Hendon had been distributed by the retail dealer vending the particular Hendon milk; and as soon as special prevalence of scarlatina in those several milk-districts became apparent, it was of course seen that, instead of the Hendon milk, these other milks might be in question. This was possible though not probable. For these other milks had come from two different farms (from one to South Marylebone, from the other to Hampstead and St. Pancras), situated in widely separate counties, and distribution of scarlatina with milk not being an every-day occurrence, it was much less likely that absolutely distinct farms thus widely separated had at one and the same time been supplying to neighbouring districts in London milk having the same special concern with disease. It was much more likely, therefore, that the Hendon share of the milk, being common to the three businesses, had been the responsible agency.* And further, Mr. Blyth had ascertained in regard of the South Marylebone milk business that certain customers supplied with Hendon milk, *and Hendon milk alone*, had suffered scarlatina.

from a particular farm.

Then, as for antecedent disease among the Hendon population, of a nature to have had concern in the distribution of scarlatina with the Hendon farmer's milk it had, by December 23rd (thanks to Dr. Cameron's thorough knowledge of his district), come to be regarded as out of the question that any infection of the milk by such disease outside the farm could have taken place. It could be said that no scarlatina, nor any illness at all like scarlatina, had affected any of the persons employed about the farm, their families or neighbours, at any such time or in any such way as to influence the farm or its produce. Such few cases of scarlatina as could be heard of at Hendon during 1885 had occurred at a distance from the farm and in families that had nothing whatever to do with the farm.

The foregoing experiences of different districts, and the considerations here presented as arising out of them, were held to constitute a notable presumption that the Hendon farm had been concerned with the scarlatina prevalences. It was a presumption that nowise amounted to proof, especially when it was seen to be an essential element of the problem that outside human agencies had to be set aside as not having been operative. Yet it was enough to give precedence to the Hendon farm as the place where search after conditions of milk infection might most profitably be made; and investigation of the circumstances of the Hendon farm was accordingly commenced without loss of time.†

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* As the inquiry advanced, and the exemption of the St. John's Wood consumers of Hendon milk was seen to be definite and beyond question, the fact appeared for the moment greatly to change the above probability. But on the other side there was the circumstance of a peculiarly intense incidence of scarlatina at Hendon among people who got no milk except from the Hendon farm. More about these occurrences will appear in the sequel.

† Though precedence was given to this investigation, it was not without much hesitation that the inspection of the dairy farm was begun. For ere now it has happened that official visits for purposes of knowledge have been confounded by the public with condemnation of the common sanitary doings of the farmer, with the result of unwarranted disaster to his business interests; and I had Dr. Cameron's assurance that in this case any such condemnation was very far from being deserved.

In passing to consider the possible relations between this farm and the outbreaks of scarlatina which had occurred in the milk districts of various retailers deriving parts of their supplies from the farm, I had the advantage of Dr. Cameron's assistance. This officer had had previous experience of disease associated with the consumption of a particular milk, and as my inquiry at Hendon proceeded he proved himself a very able coadjutor. In what follows respecting the Hendon dairy farm I may claim that my methods and conclusions had throughout his consent and confirmation.

Conditions observed at Hendon.

The dairy farmer, though willing to afford and though indeed desirous of affording us every assistance, was utterly incredulous of the presumptive evidence tending to connect disease with the milk supplied from his farm, and till a late period of the inquiry he remained so. His cowmen were perfectly incredulous also. And truly, having regard to the facts that we first elicited, as to freedom from illness of those at the farm and as to the peculiar care given to the sanitary affairs of the farm and its dairy, the farmer's incredulity could not but be regarded as justifiable. He had certainly done his best to avoid known conditions of danger, and had not suspected that any such condition, known or unknown, had been present on his farm. The farm was found to have had especial pains taken to render it, as the phrase is, sanitarily perfect. At the instance of one of the London retailers with whom the farmer had dealings,* the place had for several years been the subject of special supervision by the medical officer of health of the district, my coadjutor in this inquiry, Dr. Cameron. He had seen that the West Middlesex Company's water was laid on to the farmhouse, to the dairy, and each of the several cowsheds; he had seen specially to the wholesomeness, as regards drainage, cleanliness, ventilation, and the like, of the house, the farmyard, the cowsheds, and the dairy; securing for the last all needful appliances for effectual cleansing of dairy utensils by hot water or steam; and, month by month, he had inspected the farm premises with reference to these and similar details, for the express purpose of safeguarding the milk against contamination of any detectable kind. Further, under the same arrangement, Dr. Cameron had specially attended to the health conditions of those employed about the farm and their children, with a view to early detection of any malady among them that might by chance injuriously affect the milk with which they had to do. He had even undertaken to observe and to report to the London retailer, by whom his services were retained, on any occurrences of infectious illness in the neighbourhood of the farm, even though it did not directly affect the families of people employed there. The farmer too who had consented to the exercise of this supervision over his doings, had attended to every suggestion made to him, and had taken every precaution to secure his farm and his milk against any known sanitary fault or misadventure. He had a separate shed for any sick animal, and a separate shed for the observation of newly arrived animals.

Sanitary state of farm.

Thus, with Dr. Cameron's aid, the point was speedily reached at which it could provisionally be affirmed of the Hendon farm milk that, if indeed it had caused scarlatina among its consumers, it had not acquired the ability to do so in any commonly accepted way, such as

Provisional hypothesis of cow disease.

* This retailer owned the St. Pancras and Hampstead businesses, and will be mentioned in this Report as Mr. Y. He has for some years shown the same solicitude in respect of the other farms from which his milk is brought to London. In other ways, too, he has habitually been on the alert to secure his customers from any risk of milk-infection, and to place his business above suspicion. His attitude towards sanitary matters in their wider aspect has been much in advance of his fellows; and thus the abundant aid he has furnished to the present inquiry has been correspondingly of the greatest value.

through unwholesome conditions of water or drainage, or through careless handling of milk or milk utensils by persons carrying scarlatina infection. Nor, during the long subsequent acquaintance with the farm gained in the course of this inquiry, did any reason appear for modifying this conclusion.

It was not long, therefore, before we found ourselves confronted with the alternative, which thenceforth constituted itself into the hypothesis which we had to examine, that the cows themselves must have had something or other to do with any scarlatina which had been distributed along with their milk.

Our reliance for the discovery of such a something, and for an understanding of its nature, lay in ascertaining in detail every parallel between the doings at the dairy farm and the observed scarlatina.

Relations of scarlatina cases to farm operations.

From the point of view now reached, every peculiarity of scarlatina incidence on the various districts supplied with milk from the Hendon farm acquired a new importance. Exemptions, specialities in point of time, and of extent of prevalence, now claimed to be considered under the aspect of possible relation with the operations of the farm. The history of the observed scarlatina, thus investigated with all attainable exactness, is given in summary in the table subjoined. Leaving to the health officers of the several districts to narrate, in the health interests of their districts, the local characters of the outbreaks, I here show for each retailer of the Hendon milk the locality of his operations, the amount of this and of other milk distributed by him, and the dates of notable incidence of scarlatina on the consumers of milk delivered from his shop, together with such facts as are to be had about the relative amounts of scarlatina in the customers of the several businesses. I designate the retailers by letters rather than by their names.

Retailers of Hendon Milk.	Milk-District situated at	Total Amount, in Barn Gallons, of Milk distributed Daily.		Date of Notable Incidence of Scarlatina on Customers of Retail Business.	Degree of Incidence at one and another Period.
		Hendon Milk.	Other Milk.		
Mr. X -	South Marylebone.	63	10	End of November and early December to date of inquiry.	Customers suffered heavily and in increasing numbers up to date of inquiry.
Mr. Y (1*)	Hampstead -	18	25	End of November or early December, and Mid-December.	Customers did not suffer nearly so heavily as Mr. X's customers. They were attacked in two groups, one a small group, limited in time at the beginning, the other a large group, from the middle of December to the date of inquiry.
Mr. Y (2*)	St. Pancras -	6 or 7	45	Early December and Mid-December.	Comparatively few customers suffered. Attacks, however, grouped in time much as in Y (1) business.
Mr. Z -	St. John's Wood.	20	4	—	No scarlatina among customers up to date of inquiry.†
Mr. P -	Hendon -	1 or 2	—	Early December -	Number of families consuming the milk day by day not a dozen. Two of them suffered; the earliest invaded being attacked near end of first week of December.

* Mr. Y. had two retail milk establishments, Y (1) in Hampstead, and Y (2) in St. Pancras. Hendon milk was delivered to him at his Hampstead place of business, and there only; from hence some of it was transferred by his own men to his St. Pancras establishment.

† But see page 12, para. (*c*.)

Specialities of London scarlatina.

Of the special phenomena that were learned about the scarlatina outbreaks, and that are shown in summary on this table, those which established the most important claim to recognition by the inquirer into the farm operations, were seen to be as follow :—

(*a.*) In those four districts (the milk districts of a former paragraph) wherein scarlatina had shown an extravagant incidence upon the milkman's customers (probably, as we have seen, upon the consumers of the Hendon milk), the disease had begun its peculiar incidence *at one and the same time*, namely, *about the end of November or beginning of December*.

(*b.*) In one of those districts (that of Mr. X) scarlatina continued *day by day, and with increasing force up to the date of the inquiry*, to attack the customers of the retail business.

(*c.*) In two other of those districts (those of Mr. Y's two businesses) scarlatina behaved in a different fashion. In each district, after attacking in some number *for a few days at the end of November and beginning of December* the customers of the business, the disease showed *no fresh attacks for about ten days* (the period of intermission was short, but was quite clearly and sharply defined), and then *about the middle of December attacked them again in larger number, and continued to do so up to the date of inquiry*.

(*d.*) In the fifth district (that of Mr. Z's business) *no scarlatina whatever*, either at the end of November or subsequently, *down to the time that the investigation was proceeding*, had been learned of by the best inquiry that could be made in the parish.

In the study of the farm operations, which was now set on foot for the detection of conditions parallel to these special phenomena, the most striking phenomenon—one which, indeed, demanded explanation if any relation of the Hendon milk to the disease were to be upheld—was this definite exemption of the St. John's Wood people who had dealings with Mr. Z. It was, indeed, a remarkable fact. Mr. Z got five-sixths of his milk from the Hendon farm, and distributed an ample quantity of it among numerous customers. Yet there was a total absence of scarlatina from among these customers.

Their connexion with new conditions at farm.

Examination of the circumstances of the cows at the Hendon farm was now directed to ascertain whether *any new condition pertaining to the cows* had arisen in the farm or had been contributed to the farm business at such time and in such way as to be coincident with the ability of the milk to produce scarlatina in its consumers, first, at the end of November in four milk districts, afterwards, throughout December, in Mr. X's milk district, and after an intermission in December, in Mr. Y's two milk districts; while the condition in question was absent from the cows that furnished milk for Mr. Z's business.

The process of inquiry was tedious, involving investigation of a variety of circumstances, such as food of cows, calving of cows, health of cows, arrival and departure of cows, and so forth; and, up to a certain point, it proved barren of result. For a long time nothing could be heard of that was new or changed. During many weeks, or even months, before the scarlatina outbreaks among milk consumers, no change had been made in the food of the Hendon cows; much of this food had been the produce of the farm; the source of other kinds of food had remained unaltered, the quality of the food had not (the farmer averred) changed or deteriorated. So too, as regarded calving of cows, and health of cows. The business did not include the rearing of calves; it was a milk business, pure and simple, the cows being "stall-fed" all the year

round, and, as matter of fact, no cow had calved at the farm since September. As to health of cows, it was confidently affirmed that, for months past, not one of them had suffered any illness; indeed, with the exception of everyday trivial ailments, the cows had been, it was stated, particularly free from all maladies to which stall-fed cows are admittedly more liable than other cows.

among newly arrived cows.

But upon passing to consider in detail the comings and goings of cows to and from the farm, some important information was forthcoming, and the inquiry began to assume a more hopeful aspect. The business of the farm being an affair of milk production only, had required a high average yield from the cows kept there; so that cows, as they "dried off," had been in practice replaced by fresh and "newly-calved" cows purchased as occasion required from the country. And it turned out that on the 15th November, three newly-calved cows, purchased from Derbyshire, had been received into the business.* Before November 15th, no new cows had been received since the middle of October; and after November 15th, none had been received until December 4th, when four additional cows had been purchased from Oxfordshire.

In the addition to the dairy farm on November 15th of three newly-calved cows, there appeared a circumstance eminently worth further exploration. For (*a*), it was seen that the arrival from Derbyshire of those newly-calved cows (November 15th) did in fact shortly precede the first occurrences of scarlatina in the four milk districts, namely, at the end of November or beginning of December; so that the cause of scarlatina (whatever it was) was actually manifested in these four districts just after† the time when the milk of those cows came to be included in the produce of the farm. Accordingly, the next questions that arose were, had there been anything (*b*) in the distribution of the milk of those particular cows, or (*c*), in the subsequent relation of those cows with the new-comers of December 4th, or of either set with other cows in the herd, parallel to the observed specialities of scarlatina incidence upon the four infected milk districts? Going on to seek answer to these questions in the facts of the dairy farmer's procedures, some further very interesting and suggestive correspondences were presently obtained.

As regards the concern which the several retail milk businesses had with the milk of newly-imported cows, it has to be premised that such cows were not at once added to the stock in the general cowsheds of the farm. In accordance with a custom instituted for the purpose of guarding against the introduction of foot-and-mouth disease, the new-comers were at first placed in what is known as "the quarantine shed," a little removed from the farmyard. New cows are here kept until their freedom from that disease is regarded as assured, usually for a week or ten days. As matter of custom, their milk is not used in the business immediately after calving, but after a while and before the cow is removed from the quarantine shed, it is judged permissible to use the "quarantine milk." At the expiration of this quarantine period newly imported cows are taken from their special shed and distributed according to the requirements of the general business in the three several sheds of the farm along with the other cows already there.

The particular batches of animals received on November 15th and December 4th were dealt with on this plan. The precise period of

* The dealer who was believed to have purchased these cows in Derby market, and who sold them to the Hendon farmer, resolutely refused all information whatever.

† It was necessarily "after"; for with scarlatina as with other infectious diseases, there is an interval between the date of reception of the infection and the first manifestation of the disease. In scarlatina this interval is known to be less than a week.

quarantine in the case of each batch had not been recorded, but it was believed by those about the farm that the 15th November cows had stayed in the quarantine shed longer than usual; the 4th December cows for not more than a week.

Specialities of distribution of their milk

At the date—the third or fourth week of November—at which the milk of the farm, if it had any infective ability, must have acquired that ability, the cows at the farm numbered 90 or 100, distributed in the several cowsheds as follows:—in the "large shed," 40 or 50; in the "middle shed," 30; in the "small shed," 20. At this date, the 15th November cows were still in the quarantine shed. A few days later, somewhere about the end of the month, the 15th November cows were transferred into the general cowsheds, and very shortly afterwards their places in the quarantine shed were taken by the cows received from Oxfordshire on December 4th. These in turn were transferred to the general cowsheds about December 11th.

At the date in question, the distribution among the London retail dealers (I defer for a time further mention of Hendon consumers) of the milk of the cows in the several sheds was effected with much uniformity, each morning and evening, as follows:—

From the "large shed," Mr. X and Mr. X only, was supplied. The milk of the shed did not indeed suffice for his whole requirements, and the balance was made up by a varying quantity of milk from the "middle shed."

From the "middle shed," Mr. X and Mr. Y received their supplies, and not any other dealer. Mr. Y received all the milk from this shed, except what was required for Mr. X, and in so far as this quantity was insufficient for Mr. Y's requirements, the supply to him was made up from the "small shed." As before said, all milk of the farm received by Mr. Y for his two businesses was delivered to him at one place, namely, at Hampstead.

From the "small shed," Mr. Y and Mr. Z received their supplies, and not any other dealer. Mr. Z received all the milk from this shed, except what was required for Mr. Y, and Mr. Z received milk from no other shed.

From the "quarantine shed," milk was being distributed at the date in question: on some days it went to make up Mr. X's supply, on other days to make up that of Mr. Y, frequently perhaps to both of them on the same day. But rarely, if ever, had it been added to churns destined for Mr. Z, for in the routine of the farm his churns were seldom brought out of the small shed before the quarantine milk had been disposed of.

parallel to distribution of scarlatina

Now as we have seen, the chief facts as to time-incidence of scarlatina on the four milk-districts of South Marylebone (X), Hampstead and St. Pancras (Y (1) and Y (2)), and St. John's Wood (Z), were as follow:—

Mr. X's customers began to suffer at the end of November and continued to suffer in increasing number up to the date of inquiry.

Mr. Y's customers, in the districts of both his businesses, suffered slightly at the end of November and beginning of December. Then for a while they ceased to be attacked; but about the middle of December they were again attacked in greater numbers and more persistently than before.

Mr. Z's customers had not suffered at all, so far as could be heard of, up to the period that the inquiry had reached.

It will be evident to the reader that, in our search for new conditions within the farm corresponding to the appearance of the milk outbreaks in London, we had now succeeded in finding one such condition, namely, the distribution of the particular milk furnished by the newcoming 15th

November cows. Scarlatina among Mr. X's customers appears soon after the milk of the 15th November cows in the quarantine shed comes to be added to the milk delivered to Mr. X. Scarlatina among Mr. Y's customers appears in Y's two milk districts soon after the milk of these same cows comes to be added to the milk delivered to Mr. Y. Scarlatina among Mr. Z's customers is absent; no milk from these cows is added to the milk delivered to Mr. Z. But this was not all.

Peculiarities of time-distribution of scarlatina

Having in view the other specialities observed in the local behaviour of scarlatina in the several milk districts, it came to be seen at this stage that if the above concurrence was in truth indicative of cause and effect, we must be able to set down *a priori* certain other parallel events which, if they had occurred, would greatly strengthen the inference. This was accordingly done, and when certain probable events had been formulated, inquiry was made as to their actual occurrence.

Taking as a postulate that the likeliest method by which a result producible by the milk of particular cows would become varied or modified, was by variation or modification of the relations of the cows themselves within the business of the farm, the following three propositions were set out as matters of probability:—

(*a.*) In the last days of November or the earliest days of December, a change had probably been made in the manner of distributing the milk produced by the 15th November cows, and most likely this change had consisted in the transference of those cows themselves, or some of them, into the "large shed" and delivery of their milk thenceforward along with the milk of the other cows in that shed.

(*b.*) About the second week of December, some of the 15th November cows, or some of the 4th December cows (which up to December 11th had occupied the quarantine shed), or some other cows that had been during early December in close relation with the 15th November cows, were probably transferred to the "middle shed," and their milk delivered from thence.

(*c.*) It was not probable that at any time up to the end of the second week in December, any of the 15th November cows, nor any of the 4th December cows, nor any cow that had been in close relation with such cows, had been transferred to the "small shed."

parallel to peculiarities of time-distribution of milk.

These probabilities were formulated in view of the special time-distribution of scarlatina in Mr. X's district, and in Mr. Y's two districts, and in view of the continuous exemption of Mr. Z's district. They were not announced in any way to the farmer or his men; and in the search after facts, care was taken to avoid putting leading questions to the people who had been engaged about the cows. Once or twice indeed a statement was made by way of interrogation—to receive the assent of a cowman, who could not divine whence our information had come. In the outcome, it was found that, as matter of fact:—

(*a.*) The three 15th November cows had been, towards the end of November, transferred to the "large shed." Here they all still remained at the date of inquiry, and their milk had been delivered from hence.

(*b.*) The four 4th December cows had been transferred about 11th of December, two of them into the "large shed," the other two of them into the "middle shed"; and in these sheds they were found at the date of inquiry, their milk going into the general supply of the respective sheds.

(*c.*) At no time up to the date of inquiry had any of the 15th November cows nor any of the 4th December cows, nor any other cows been transferred to the "small shed."

In short, what had been seen to be a succession of probabilities if the scarlatina in London districts were indeed the outcome of the milk distributed from the Hendon farm, was now established as a succession of facts.

We had thus reached the point of excluding external scarlatina, of associating the importation of particular cows into the Hendon farm with presence of scarlatina in London districts, and of connecting by a series of parallel events the milk furnished by those cows and by related cows, with the peculiarities of scarlatina prevalence among consumers of the Hendon farmer's milk. Under these circumstances, it was not judged necessary to go beyond the Hendon farm and to inquire at the two other farms that also sent milk into the London districts of South Marylebone, Hampstead, and St. Pancras, in search of the cause of scarlatina in those districts. Henceforward, until anything to the contrary should appear, an influence, competent to produce scarlatina among the consumers of the milk, was held to have operated from those cows which were received into the Hendon farm on November 15th, and the further concern of the inquiry was with the nature of such influence.

Relation of scarlatina to certain cows established.

Adhering to the design of the inquiry to proceed altogether upon the circumstantial evidence obtainable within the actual epidemic before making any comparison with former experiences, investigation of the probable nature of the influence by which the Hendon milk had operated to produce scarlatina in its consumers was now begun. After much thought about alternatives it was found necessary to accept, provisionally, the belief that the influence in question, having belonged in the first instance to the 15th November cows, had belonged *to the constitution* of the cows :—was in fact some species of cow disease. And the acquisition of this influence by other cows had become so very probable, that a corresponding probability arose that any such disease in the cow had been in fact an infective disease communicable from cow to cow. The considerations of circumstance that forced these beliefs on acceptance were cogent, no alternative to them was discernible, and we could not see that feeding well and milking abundantly were reasons against the hypothesis of such disease.

Nature of morbific quality in cows.

Seeking for any exact circumstantial evidence that might possibly exist, indicative of a particular cow or cows having been at fault, the only morsel of such evidence that tendered itself was a specially promising one, but it proved disappointing. A friend of the farmer who had by favour been supplied with the "milk of a single cow," had had his family very heavily stricken by scarlatina at Hendon about the end of the first week in December. A specially fine cow had been designated for his service; but it presently appeared that the milk of that same cow, being regarded as peculiarly rich in quality, had also been taken for the children of people employed about the farm, and among these children there had been no scarlatina whatever. Thus the expectation of identifying that cow as a disease-producer was at an end, and another sort of interest in her arose. The cow was at the beginning of December living with other cows in the large shed away from the 15th November cows in the quarantine shed. It was not for some days later that the facts about this theoretical "one cow" supply were learned: the practice had certainly been less inflexible than the intention; and it was found to have been perfectly possible, to say the least, that on some occasion in early December (when the farm bailiff's back was turned) the supposed "one cow" supply had indeed been dipped out of a common churn in the large shed, in such a way that those who drank it would be in precisely the same relations to the milk service of the

farm as the consumers of the Hendon milk who were living in South Marylebone.

Notable experiment at Hendon during inquiry.

During the further study of the doings at the farm, some days of Christmas intervened, and immediately on the resumption of inquiry it was found that a most instructive but pitiful experiment had been going on at Hendon. In this Christmastide, medical men practising in the district had been called to case after case of scarlatina occurring in separate houses and obtaining the proportions of a little epidemic. The houses were at Child's Hill and elsewhere near the farm, and were occupied by people of the labouring class and the poor. The first case had dated from December 20th. Upon inquiry as to the milk supply of these families it was ascertained that they, one and all, had shortly before their invasion been exceptionally furnished with milk from the Hendon farm under circumstances as follows:—On December 15th the whole of Mr. X's milk, 63 barn gallons, mainly derived from cows in the large shed, had been returned on the farmer's hands with an intimation by the Marylebone Health Officer that he believed the milk, or some of it, to have been causing scarlatina in his district. Hereupon the farmer, though discrediting the allegation, determined not to seek for a new market for that section of his milk. The returned milk went to the pigs. For the rest, those of his customers, he said, who still desired his milk could if they chose continue to take it and be served as before, but he gave orders that the section of his produce which he regarded as being under suspicion, namely, all the milk of the large shed, should, with the exception of some to be used for pig-feeding, be thrown into a pit freshly dug in one of his fields. His instructions, however, were not completely carried out by his cowmen. It became known in the neighbourhood that milk from the farm was being thrown away, and at once a number of poor neighbours put in an appearance and begged for it. To most of them it was refused, to all those who applied to the farm bailiff; but by special grace of certain cowmen some of these neighbours received gratuitously on December 16th and subsequent days, a portion of the produce of the large shed that would otherwise, as they and the cowmen believed, have been wasted. It was among these people that scarlatina appeared about a week afterwards. It invaded some half dozen families, forming an unknown (but certainly a large) proportion of the families to whom the milk had been given, and it attacked no family to whom it was not supplied.—Conversely, upon subsequent inquiry in South Marylebone, it was found that in the period about Christmas when these Hendon families were falling ill of scarlatina new cases ceased, almost suddenly, to appear among the families supplied by the South Marylebone milk seller, and afterwards there were no fresh attacks except what were referable to spread from previous sufferers.

The experiment was complete and confirmed the inferences which had before been drawn from the distribution of scarlatina in metropolitan districts. No more of the inculpated milk was sent to London throughout the whole period of the inquiry, and of course none of it was given to neighbours after the relations of it to scarlatina at Child's Hill had been seen.

There is little more to tell of the relations that were found to exist between the Hendon cows and human scarlatina, but that little is of interest.

Observations on cow ailments

In the last days of December after the foregoing circumstantial evidence had been, in essentials, worked out, the 15th November cows were still in the large shed: the two 4th December cows which had been put into the large shed on December 11th were still there; and the other two 4th December cows which on 11th December were placed in the middle shed, had been taken therefrom and put into the large shed,

because circumstances had by this time thrown suspicion on their milk.

At this time, examination of the cows was made with a view to the detection of any, even the slightest, disease among the cows; and it was found that several in the large shed were suffering from vesicles and ulcers on the teats and udders, and that the cow most severely affected was one of those received into the farm on December 4th.

Dr. Klein, whose assistance was now invited, visited the farm with Dr. Cameron and myself on December 31st and following days, and we found that these sores on teats and udders were very general among the cows of the large shed, in the several cows being of different degrees of intensity and recency. The 15th November cows were not suffering, but on close examination of their teats and udders scars were found on two of them of a kind that satisfied us of their having shortly before suffered from the malady. Of the four 4th December cows two were suffering from the disease, one (transferred from the middle shed) had it badly, other cows in the shed had it in a more recent form. In the middle shed there were several recent cases and in the small shed two early cases of it were at this date detected.

An outside observer knowing something of cows had perceived just before Christmas certain cows in the large shed, particularly on the left-hand side of it, to be suffering from "bad quarters." He did not attach any importance to the fact, except for the unusual quantity of the ailment. The cows on the left-hand side of this shed, however, at that date included the cows imported to the farm on 15th November, and two also of those imported on 4th December.

Our belief in the existence on this farm of a constitutional disease among the cows competent to produce scarlatina among human consumers of the cows' milk was now becoming unreserved. The identity of the disease and its more obvious characters and its communicability appeared to have been demonstrated. Also, in the phenomena of the disease itself, Dr. Klein found reason for regarding it as more than a local complaint affecting the skin of the teats and udders. He regarded it as a general or constitutional disease; one that might, probably enough, be communicable from cow to cow.

Dr. Klein took with him for experimental purposes samples of milk, contents of vesicles and discharges from ulcers of two affected cows (I. and II.); and afterwards two of such cows (III. and IV.) were purchased and conveyed to Dr. Klein at the Brown institution for further observation and for pathological investigation there. He will report on the clinical features* and on the pathology of the disease.

No deference to Dr. Klein's belief, any more than the now admitted concurrences of human disease with milk consumption, weighed in any degree with the people employed about the farm to induce them to credit the notion that the health of the cows had been in question. Had not the cows eaten well and given full yield of milk, they asked, and how then could they be ill? If they had any ailment, it must be, and it was, of no consequence, and it could not have been connected with disease in man.

So they reasoned, and it was doubtless this disbelief that occasioned a little reticence among the cowmen. But one day a certain cowman who had undertaken to point out for Dr. Klein the most recent case he could find of sore teats, mentioned his having first seen such early beginning of the complaint in the case of one cow, that he very well knew, and on being requested to point out that cow he led his questioner to the large shed and showed him one of the Derbyshire cows that had come to the farm on November 15th.—It was now admitted on all hands that this cow had been the first to suffer from the malady and that she suffered very badly; that not long afterwards, other cows in the large shed and a 4th December cow in the middle shed were also found

and demonstration of cow first attacked.

* The clinical characters of the disease are the special subject of Dr. Cameron's paper, No. III. —G. B.

affected; and that latterly the disease was known to have spread abroad in the large shed and in the middle shed and now to be invading the small shed. To the last however the cowmen were all sure that the disease was of no possible importance whatever and could not have affected the quality of the cows' milk.

Episode.

Our discovery of this extended prevalence of the cow disease, now, on January 1st, in all the sheds of the farm, was a very disquieting circumstance, for the middle and small sheds were still furnishing milk to London consumers. We felt it necessary to advise the farm bailiff (in the temporary absence of the farmer through illhealth) at once to seek out every cow that now was or that might become affected with sore teats or udder, or any other sort of ailment; to isolate every such cow, and to keep all her milk out of the business; and to prevent cowmen employed in the tending or milking of sound cows from having anything whatever to do with the cows thus set apart. These precautions were taken after January 1st, and we had good reason to think, only just in time to prevent disaster from a repetition of the events of December. For, in gathering up the later facts concerning the various local epidemics of scarlatina in their relation to the Hendon milk service, the following facts appeared:—

(*a.*) In South Marylebone, as has been told, the new outbreaks had ceased shortly after the delivery of milk to Mr. X had ceased; and at Hendon, up to the end of December, no fresh outbreaks had occurred after those above recorded as following on the use of milk refused by Mr. X.

(*b.*) In Hampstead and St. Pancras milk districts, where Mr. Y continued to supply milk from the Hendon farm, a diminution if not a temporary cessation of fresh outbreaks had taken place about Christmas, but in the first days of January they were again becoming somewhat numerous. The reduction and the recrudescence had corresponded well with the removal of the two December 4th cows from the middle to the larger shed; and with the appearance, shortly after, of new cases of the cow-disease among the animals of the middle shed.

(*c.*) Just about the same time, in the early days of January, milk from the small shed, which had previously been without share in scarlatina production appeared, almost suddenly, to be implicated. The daughter of one of the cowmen who was employed in this shed, and who by permission took home milk from the small shed, but from no other, was attacked by scarlatina the day after her arrival in London on a visit; and, almost simultaneously with the fresh attacks among Mr. Y's customers, the customers of Mr. Z, in St. John's Wood milk district, began to suffer from scarlatina. These events corresponded to a nicety with the appearance for the first time of the cow disease among the animals of the smaller shed.

Thus the precautionary measures enjoined on the farm bailiff were not in time to prevent the beginnings of another manifestation of scarlatina in London. Their value in preventing further and more extended outbreaks in the several localities could not be estimated. For, on these fresh appearances of illness among their customers, Messrs. Y and Z at once discontinued all supplies from the Hendon farm. The whole milk of the farm was now thrown on the farmer's hands, and was given to the pigs or buried.—While this report is in preparation, I have made inquiry of Messrs. Y and Z as to any further scarlatina, peculiar to their customers, and I find that none has occurred in the milk districts of Hampstead, of St. Pancras, or of St. John's Wood since the beginning of January.

No. II.

No. 2.

On Milk-Scarlatina; by Dr. Klein.

REPORT on a DISEASE of Cows prevailing at a FARM from which SCARLATINA had been distributed along with the MILK of COWS; by DR. KLEIN, F.R.S.

IN a recent report to the Board, "On certain observed relations "between scarlatina in various districts of London and Milk supplied "from a Dairy Farm at Hendon," Mr. Power has related the circumstances under which I became associated in inquiry at the farm in question; and, while briefly indicating certain provisional inferences of my own as to the nature of the malady discovered among the cows there, Mr. Power goes on to promise an account by me of the special features and pathology of the disease. This I now proceed to give.

Disease observed at Hendon Farm.

Its clinical characters:

The cows (I. and II.) which were the first subjects of my investigations had on the teats and udder several flat, irregular ulcers, varying in diameter from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch; some ulcers were more or less circular, others extended in a longitudinal direction on the teat. The ulcers were covered with a brownish or reddish-brown scab, which when scraped away left exposed a granulating slightly indurated base. The margin of such ulcer was not raised, nor was there any perceptible redness of the skin around. But where I afterwards got the opportunity of watching the earlier stages (especially in animal IV.), it was noticed that a small vesicle made its appearance on a greatly swollen and red teat, in the course of a couple of days assuming the character of the above ulcers. In another cow an ulcer, about $\frac{1}{2}$-inch in diameter, was becoming covered in its central part with a scab, while at its margin vesiculation was still distinctly visible.

local

As a rule, *i.e.*, in most animals, the disease affected the teats, but in some there was also on the lower part of the udder here and there an ulcer. In such animals patches denuded of hair were noticed on various parts of the skin, the tail and back particularly. In these patches the epidermis was scaly, and the cutis more or less thickened. The animals looked thin, but not strikingly so, except in one or two cases of animals that had only a few weeks ago been admitted to the place, and which therefore had calved comparatively recently (see Mr. Power's report). As regards the feeding capacity of affected animals, their milking power, and their body temperature, nothing abnormal could be detected.

and constitutional.

Two animals (to be referred to as cow III. and cow IV.) became the special subjects of study after they had been removed from the farm to the stables of the Brown Institution.

The temperatures (Centigrade degrees) of cow III. were as follows:—

	Morning Temp.	Evening Temp.
January 4	38·8°	38·7°
„ 5	38·9	38·9
„ 6	38·8	38·3
„ 7	38·9	—
„ 8	39	39
„ 9	38·8	38·7

The temperature afterwards remained as above without alteration.

The temperatures of cow IV. were:—

January 6	38·4	38·3
„ 7	38·7	—
„ 8	38·4	38·8
„ 9	38·6	38·5

In animal III. the ulcers were present, and on January 4 were at their full development and covered with crusts. They gradually died away, and subsequently healed up by January 10, leaving, however, a whitish indistinct flat scar.

When this animal was received there were noticed on its coat several patches where the hair was gone, and the epidermis was rough and scaly.

Animal IV. when received showed several scabs in the skin of the back; it had also muco-sanguineous discharge from the vagina (the animal was in the third month of pregnancy), and redness and excoriation of the mucous membrane of the vagina. One teat, which was much swollen and inflamed, presented in several places brownish crusts. These when taken off left an infiltrated firm sore, from which, when squeezed, a thickish lymph oozed out. Similar crusts were found on other teats and on the udder. The greatest development of the sores in this cow was on January 7. On January 9 the sores were decreasing; the animal was then killed.

Post-mortem characters.

On opening the chest it was found that both lungs exhibited in the upper posterior lobes numerous petechiæ under the pulmonary pleura; the peripheral lobules of these parts being much congested. There were numerous adhesions by recent soft lymph between the lower lobes of the lung and the costal pleura, particularly laterally. In the liver there were several reddish streaks and patches, reaching from the surface of the organ to a depth of about $\frac{1}{4}$ of an inch. In these patches the liver tissue was much softened. The spleen and kidneys, with exception of slight congestion, appeared normal. In the placenta there were numerous petechiæ.

Cow III. was killed on March 12. For some days previously the animal had been getting very thin, notwithstanding its ravenous and excessive eating. On post-mortem examination the following appearances were found:—

In the lungs there were numerous lobules, especially in the peripheral parts, which showed great congestion; there were in addition pleural adhesions; the cortex of the kidney was congested, but its medulla was pale.

Direct inoculation into calves.

Experiments were now made with the matter of the ulcers, with a view of ascertaining whether or not the disease was transmissible to other animals.

On January 7, when the ulcers of cow IV. had reached their maximum development, I took scrapings from some of the ulcers on the udder and teats, having first removed the crust, and inoculated in several places the skin of groin and inside of ear of two calves (1 and 2.) For inoculation a superficial small incision (not longer than about $\frac{1}{4}$-inch) was made, passing in an oblique direction through the superficial part of the corium, and into this pouch a particle of the scraping was rubbed.

On January 9, with scraping of ulcers of the cow before she was killed, I inoculated two calves (3, 4), introducing the matter as before into the corium of the groin and of the inside of ear.

Calves 1 and 2 showed during the first three days after insertion of the matter no change at the seat of inoculation.

Four days after inoculation:—There was in calf 1 one place in the groin which promised to become an ulcer. Calf 2 showed on the ear one promising place, the other places of inoculation having nearly healed.—At the same distance of time after inoculation calf 3 showed two promising places on the ear, and calf 4 showed two promising places in both groin and ear. Calf 3 also showed a kind of vesiculation at the margin of the spot inoculated and commencing formation of a crust in

the centre. What I call promising places of inoculation were spots that had become swollen and tender, the other and not promising places were spots that seemed healing or were already healed and dry.

On the sixth day:—Calf 1 showed four successful places in the groin; the places had become swollen and enlarged with imperfect vesiculation at the margin and formation of crust in the centre.—Calf 3 had four successful places on the ear; and calf 4 had the same number in the groin.

On the seventh day:—In calf 1 all places except one in the groin had nearly disappeared. This place was now a distinct ulcer covered with a crust, on removing which a granulating infiltrated base was exposed. In calf 2 all places of inoculation were decreasing, covered with small scabs, easily detached.—In calf 3 the sores on the ear had enlarged to about ½-inch in breadth, each of them covered in their whole extent by a brownish crust. In calf 4 all except one place on ear were healing.

On the eleventh day:—Calf 1 had still one ulcer in groin not yet healing. Calf 2 had one ulcer on ear not quite healed up.—Calf 3 had four big ulcers still progressing; crusts thick, and corium much indurated. Calf 4 had one ulcer on ear much diminished in size.

By the eighteenth day:—The ulcerations in calf 3 (one ulcer had been cut out for microscopic examination) had all healed up and become converted into flat scars. In the other animals the healing was completed at an earlier date.

Simultaneously with the above experiments several inoculations with materials of the ulcer of cow No. IV. had been made into the skin of the groin of ten guinea-pigs and of three dogs. In the guinea-pigs no result was obtained; but in one of the dogs one place of inoculation appeared swollen and inflamed on the third day. On the fifth day this place was an oblong ulcer of about ¼-inch in diameter; the margin was red and swollen, but the centre was without crust (the animal had been frequently seen to lick it). On the seventh day the ulcer was much smaller, and it had nearly healed up by the tenth day.

Summary of results.

From these experiments there can be no doubt whatever that by inoculating a particle of matter from the sores of an affected cow a positive result has been obtained in all four calves. In calf 3 this result was best and most striking. After an incubation of about three days the places of inoculation became swollen, tender, and spreading; on the fifth to the sixth day the change was distinct, the successful places having become sores; in the marginal part showing vesiculation, and in the centre formation of crusts. The sore enlarged during the next few days, and on removing the crust a raw surface was exposed, the corium itself being found infiltrated. According to the intensity of the process the retrogressive change sets in later or sooner; in slight cases the healing begins about the ninth or tenth day, in severe cases (calf 3) not before the end of the second week.

Having thus demonstrated this disease of the cow to be directly communicable from animal to animal, I set to work to study its minute anatomy.

Minute anatomy of the disease: of skin ulcers,

The microscopic examination of fine sections through the ulcer of the cow shows the following conditions:

The corium throughout the whole extent of the ulcer is infiltrated with round cells. This infiltration, though densest in the central portions of the ulcer, is sufficiently pronounced even in the peripheral parts, but it gradually fades away on passing from the ulcer to the normal skin. The infiltration in the deeper parts of the corium is limited to the vascular branches, but in the superficial parts is more diffuse, the

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papillæ becoming at the same time thicker. This thickening of the papillæ fades off towards the periphery of the ulcer.—The most noteworthy changes are, however, present in the epithelium. In the peripheral portions of the diseased part there are present in the superficial layers of the stratum Malpighii close to the stratum lucidum, as also in the stratum lucidum itself, numerous cavities of different sizes. These cavities lie closely side by side; the most superficial ones are either covered by the stratum lucidum or extend between the layers of this stratum. The former cavities descend into the depth of the epithelium; at the very margin of the diseased part they are smallest, and they do not in depth comprise more than the superficial third of the stratum Malpighii. They enlarge in depth gradually as we pass from the periphery of the ulcer towards its centre; at its very centre they involve the whole thickness of the stratum Malpighii. At the same time it is to be noticed that, at the marginal parts, the cavities, although closely placed side by side, are well separated from one another by thicker or thinner trabeculæ composed of epithelium; while at or near the centre of the ulcer these trabeculæ get destroyed, and the cavities become confluent, and the covering layers of the cuticle having here also given way, their contents extend on to the free surface of the ulcer. These contents, which go to form what has been above mentioned as the crust, spread thus gradually over the surface, not only of the centre, where the stratum lucidum has become lost, but also over the rest of the ulcer. In the marginal positions, *i.e.*, where the superficial layers of the cuticle are still present as cover of the above cavities, this layer (*i.e.*, the stratum lucidum) separates the contents of the cavities from the crust. The contents of these cavities consist (*a*) of an albuminous fluid looking, in hardened sections, uniformly granular or containing also fibrinous threads; (*b*) of a few red blood corpuscles; and (*c*) chiefly of round cells or pus cells, the nuclei of which, near to and on the surface, gradually break up into amorphous granular matter.

In the central parts of the ulcer the whole exudation undergoes degeneration into débris, and not only in its superficial, but also in its deeper portions. While some cavities contain very few cells and are filled chiefly with albuminous fluid (granular or fibrinous), others are almost entirely filled with pus cells closely packed together. In the papillæ near the cavities the blood vessels are engorged and there is also escape of red blood discs.

On a careful examination it is evident that the origin of these cavities is in enlargement of and exudation into the tissue of the papillæ, but only of those portions nearest to the stratum lucidum, and from hence arises formation of cavities in the cuticle. The whole anatomical details of the distribution and arrangement of these cavities recall vividly the conditions observed in the vesicles of cow pock and of sheep pock, and on comparing under a low power of the microscope a section through a sheep pock with a section through the ulcer of the cow now under consideration, the similarity is very striking indeed.

There are, however, anatomical differences between the two diseases. The infiltration of the corium is slighter in the cow ulcer than in the sheep pock, and in the cow ulcer the cavities form in a more superficial stratum of the epidermis.

There is in the disease we are now considering a good deal of infiltration of the epithelium by round cells derived from the cavities, not only into the stratum Malpighii, but also, and particularly in the marginal parts, into the cuticle; the round cells burrowing in great

numbers between the scales of this stratum, and ultimately reaching the free surface to join those of the crust.

Fine sections made through the ulcer artificially induced by inoculation in the ear of calf 3, proved its complete identity in anatomical respects with the ulcer in the cow. The infiltration of the superficial corium; the formation of cavities, filled with exudation cells and fluid, in the superficial layers of the epithelium, particularly between the layers of the cuticle; the final destruction in the centre of the ulcer of the covering cuticle; and the extension of the exudation over the free surface to form here the crust, are the same in both instances.

Microscopic examination of the internal organs of cow IV. revealed facts as follow:—

in internal organs.

In the lung.—Sections made through the portions above mentioned as containing much congested lobules, show not only great congestion of the blood vessels, large and small, but a large amount of hæmorrhage; blood in substance being present in the air vesicles and infundibula, in the lymph spaces of the interlobular septa, and in the tissue and lymphatics of the pleura. In the latter membrane numerous diplococci are to be met with. Here and there the same diplococci occur in the alveolar wall and in the tissue of the interlobular septa.

Sections through *the liver* show a great deal of change. Under the capsule, as well as in the substance of the liver, there occur, in connection with the interlobular branches of the portal vein, larger and smaller foci of inflammation, consisting in the presence of numerous round cells. Some of these foci are several millimetres in diameter, others are very small. From the interlobular tissue the inflammation extends into the lobules between the liver cells. The liver cells of these lobules involved in the inflammatory process are swollen up, and many of them are undergoing disintegration. In some of these foci, particularly those situated in the vicinity of the capsule, the round cells are so much crowded that given foci look almost like miliary abcesses. The blood vessels are much distended and filled with blood.

Numerous diplococci and short coccus-chains occur in the parts surrounding the inflammatory foci. These are particularly numerous near the capsule in the vicinity of inflamed parts.

Sections through the *kidney* showed well-marked glomerulo-nephritis; infiltration of the sheath of the cortical arterioles with numerous round cells; the epithelium of the convoluted tubules swollen, opaque, and in many places disintegrating.

The lungs and kidney of cow III. showed on microscopic examination the same appearances as in cow IV.; in addition there was a good deal of round-cell-infiltration in the wall of the infundibula and bronchi in the lung, and around the cortical arterioles in the kidney. In the bloodclots filling the alveoli and small bronchi of the lung there were present larger and smaller clumps of micrococci.

Search was now made for micro-organisms inhabiting the tissues of the ulcer of the cow, with a view of ascertaining what were present, and afterwards whether any single kind of those found had the power, when dissociated from the diseased tissues and inoculated into healthy animals, of transferring the disease.

Micro-organisms discovered in the ulcer.

Removing the crust, scraping off the most superficial layer, then squeezing the ulcer so as to collect a droplet of lymph, I spread it in thin films on cover-glasses, and dried, stained, and mounted the several specimens in the usual manner. Such a specimen, examined under the microscope, revealed a number of red blood discs, mixed up with large numbers of pus cells, each of which contained two, three, or four small

nuclei and remnants of epithelial cells. Amongst the pus cells numerous dumb-bells of micrococci (or diplococci), and a few short chains of the same, were met with. In size, these micro-organisms do not differ from those described in connection with foot-and-mouth disease. In many sections—stained in fuchsin, or in methyl blue, or in gentian violet—through the diseased tissue of the cow, as well as that of calf 3, there were found the same diplococci and chains in the contents of the superficial cavities, as well as in the depth of the epithelium. In the latter stratum they were met with abundantly throughout the whole extent of the marginal portion of the ulcer, but not beyond it. In the superficial parts, namely, in the contents of the cavities in the stratum lucidum, the same chains were to be found, provided the pus cells were not too closely packed. They were very numerous in the tissue of the crust, and also in the superficial central portions of the ulcer that had undergone degenerate change. There occurred also in the crust and in the necrotic parts of the ulcer numerous clumps or zooglea of micrococci; but these micrococci are not to be confounded with the chains of streptococci to be presently described, nor yet with those streptococci which are found occurring singly.

have special characters when grown in nutritive media.

From the deeper parts of an ulcer of cow IV. material was obtained with which tubes containing either solid nutritive gelatine, or Agar-Agar mixture, were inoculated. After some days, and in both media, a micrococcus appeared, the growth of which was extremely characteristic. These are its characters, in the nutritive gelatine: after 3—6 days incubation at 20° C., the growth made its appearance at the point or line of inoculation, in the form of small points or granules, whitish in colour and tolerably closely placed. During the next few days their number and size increased. At the end of a fortnight the line of inoculation was visible as a streak of whitish granules or droplets, some large others small, more or less closely placed. On the surface of the gelatine the growth, like a film of granules, spreads slowly in breadth, but even after months remains small. When inoculated into the depth of the gelatine, the channel of inoculation becomes visible as a whitish streak, made up of smaller and larger droplets. The gelatine is not liquefied by the growth. The same characters are assumed by the growth in Agar-Agar mixture, and in solid serum. The general aspect of the growth in gelatine, in Agar-Agar, and in serum, is very similar to that presented by the *streptococcus* of foot-and-mouth disease (see my report of this year upon that malady*), but with this difference, namely, that in gelatine tubes the streptococcus of foot-and-mouth disease is a little faster in its growth, and its component granules are a little more distant. Nevertheless, I have tubes of both kinds of organisms in gelatine and in Agar-Agar—tubes which cannot be from their general appearances easily distinguished. In faintly alkaline broth, or in broth and peptone, the micrococcus of the cow ulcers grows readily, and in the same manner as that of foot-and-mouth disease. But there is one test by which the two kinds of organism can be very readily distinguished: the streptococcus of foot-and-mouth disease, when grown in milk, does not affect the fluid character of the milk, whereas milk inoculated with the organism obtained from the cow's ulcer will, if kept for two days in the incubator at 35° C., have been turned completely solid. This difference is a very striking difference, and a few days' growth in milk suffices for distinguishing without fail between the two.

Streptococcus.

Speciality of growth in milk

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* To appear in the Supplement to the Fifteenth volume of the Board's Reports.—G. B.

The microscopic examination of a culture in broth peptone, in gelatine, or in Agar-Agar mixture shows that the growth consists of spherical micrococci, arranged as diplococci, and as shorter and longer straight, wavy, or curved chains—streptococcus,—these latter sometimes of great length. As regards the shape of the micrococci, the mode of their division, the branchings of the chains, the presence here and there in the chain of a large element amongst the smaller ones, the organisms of the ulcers hardly differ from the description which I am preparing of the streptococcus of foot-and-mouth disease. The elements of a coccus-chain of the foot-and-mouth micro-organism are, however, smaller than those of the disease under consideration.

The streptococcus chains of a growth in broth are short during the first few days; but later on, when the growth settles down more into the deeper parts of the broth, the chains become of great length. So also in Agar-Agar tubes of one to two or more weeks' incubation.

appears absent from udder-milk.

A curious fact, to which importance must provisionally attach, is this: In a cow having several of the ulcers on the teats, the fingers of the milker pressing over the ulcers would constantly rub off from the latter particles of matter, and the fingers and the teat being kept moist, this matter would easily mix with the milk as it passes from the teat. To learn whether the milk *while in the udder* contained the streptococci, the following experiment was made: A teat free of any ulcer was milked so as to obtain a few ounces of milk, and from this milk a large number of gelatine and Agar-Agar tubes were inoculated; a second teat of the same cow, affected by an extensive ulcer, was milked to the same extent, and from the milk thus obtained a large number of other gelatine and Agar-Agar tubes were inoculated. In the first series no single tube showed the growth of the above-described streptococcus, whereas in the second series one gelatine tube and one Agar-Agar tube were found to develop the typical growth of the streptococcus.

We cannot draw any certain inference from this one observation, but evidently the experiment deserves repetition.

Effects of inoculating its sub-cultures.

With a cultivation (a third sub-culture) in Agar-Agar mixture of this streptococcus, I, on February 1, inoculated subcutaneously in the groin two calves (5 and 6). On February 27 calf 6 was found dead. The subcutaneous tissue at and for some distance around the seat of inoculation showed much effusion, and the inguinal glands were swollen and red. There was peritonitis, with sanguineous exudation, congestion, and hæmorrhagic spots in omentum and in the serous coat of the stomach. The spleen appeared small and its capsule thickened. The liver was greatly congested. Kidneys were large and much congested. The ileum was much congested in its mucous membrane, and the epithelium detached in flakes. The mesenteric glands belonging to the ileum were greatly enlarged and hyperæmic. Both lungs were congested, the superficial lobules showed so much congestion that they looked almost solid, and were of a deep red colour. A few petechiæ under the pleura. Bronchial glands enlarged and congested. There was pericarditis, and the heart was distended by and filled with coagulated blood. The organs of the throat were found much congested. The hairy parts of the skin were not examined.

Calf 5 showed on March 7, around the nostrils and lips of the mouth, and on hard palate and gums, numerous irregularly outlined patches not raised above the level of the skin. These patches had a discoloured, brownish, very slightly raised margin, and a paler centre; they were round or irregular, some as small as $\frac{1}{8}$ of an inch, others four to six times larger. The animal was killed on March 8. On

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post-mortem examination the following appearances were noted: Congestion of some of the peripheral lobules in both lungs; the pleura pulmonalis slightly opaque, numerous soft lymph adhesions between it and the costal pleura; in the spleen several hæmorrhagic patches under the capsule in the shape of bullæ filled with semi-congealed blood; spleen pulp softened and very congested; kidney congested; organs of the throat congested.

to produce a specific disease,

There can then be no doubt that a definite disease has been produced in both animals, of which the affection of the lungs is a conspicuous feature, and coincides with, though more pronounced than, the lung disease noticed in cow IV.

In calf 5 there was, in addition, the disease of the skin and in the mouth, which, as the microscopic examination proved, is in a certain degree similar to the disease in cow IV. and calf 3. More in detail, this is what is found as regards the skin: The tissue of the papillæ and of the superficial corium is infiltrated with round cells, and the blood

having characters in skin and elsewhere:

vessels of the papillæ are distended and filled with blood. In their peripheral portions, their most superficial parts, the papillæ are very much distended by extravasated blood and round cells;—in fact the first rudiments of cavities are forming in them. The same condition, but more pronounced, obtains in the cuticle, where between its layers there are present small cavities filled with blood and round cells or only fluid and a few round cells. There is, in addition to this, a general infiltration with round cells of the layers of the cuticle. The brownish reddish colour of the marginal parts is due to this condition. In the central part the cuticle is loosened by the formation of such cavities containing fluid and a few round cells; by this its layers were separated and ultimately detached. In the cavities of the cuticle occur very fine diplococci and chains. So also in the infiltrated and enlarged papillæ, and in the deeper layers of the epithelium in the whole extent of the diseased skin, diplococci and short chains are present.

In neither of these cases of subcutaneous inoculation was there found any rent or breakage of the stratum Malpighii, *i.e.*, no real ulcer. The anatomical features here described in many respects resemble the lesion of the skin in human scarlatina (see my report for 1876). I did not, unfortunately, look at other (the hairy) parts of the skin to see whether there were any such patches in this calf. (Some observations on the kidney of calf 5 are noted in the sequel.)

Examination of the organs of calf 6:

(*a.*) *The lung.*—Congestion of all blood vessels, large and small. Transudation of fluid and hæmorrhage into the alveolar cavities of part of some lobules of the lung while the rest of the alveolar cavities are collapsed, the capillaries around them very much congested; infiltration with leucocytes of the interlobular septa, extending also into the inter-alveolar septa. In some of the lobules next to the pleura the engorgement of the capillaries is extremely great, blood *en masse* filling the alveoli to the extent of producing a state of red hepatisation. The pleura itself is thickened by exudation of fluid and leucocytes. The bronchi do not show any distinct alteration. Numerous diplococci and a few chains are met with in the pleura and in the congested parts of the lobules, in the alveolar wall, and in those alveolar cavities which contain exudation and blood. The bronchial glands show great changes: the capsule and septa being much thickened by exudation and leucocytes; the lymph-vessels everywhere filled with round cells; the tissue of the follicles and medulla much swollen.

(*b.*) *The liver* shows extreme congestion of all vessels in all parts, inter- and intralobular. The liver cells are opaque, granular, and atrophic.

(*c.*) *The ileum.*—The epithelium of the surface detached and gone; the epithelium of the Lieberkühn follicles loosened, and in most places detached; the mucosa shows great congestion and infiltration; in the superficial layers the villi show hæmorrhage, the tissue being filled with blood corpuscles, fibrin, and leucocytes; and in many spots the superficial layers of the mucosa are necrotic.

The Peyer's glands are much swollen and inflamed; the central portion of their follicles are breaking down.

Micrococci and bacilli pervade everywhere the tissue of the mucosa. The mesenteric glands in relation with the ileum have their capsules, septa, follicles, and medullary cylinders much congested and inflamed.

in kidney.

(*d.*) *The kidney.*—The changes in this organ are highly interesting, since they completely coincide with those in acute scarlatinal nephritis in man: great congestion of the cortex, leading in some parts to hæmorrhage into the parenchyma; glomerulo-nephritis with exudation of albuminous fluid and blood into the cavities of the Malpighian corpuscles; granular or opaque swelling of the epithelium of the uriniferous (convoluted) tubules, with degeneration into granular débris of many of the epithelial cells; miliary foci of aggregations of round cells around small blood vessels; congestion of the medulla.

[The kidney of calf 5 was also examined microscopically, and the changes were exactly the same as those found in the kidney of calf 6, viz., congestion of the glomeruli, glomerulo-nephritis, transudation of albuminous fluid and red blood corpuscles into the cavity of Bowman's capsule; opaque swelling of the epithelium of the convoluted tubules, granular disintegration of the epithelium in many places; infiltration with round cells around some arterioles of the cortex; and congestion of the medulla.]

(*e.*) *The heart's blood* was examined for organisms, and in it, by the staining with Weigert's gentian violet, a few diplococci and a few chains could be distinctly detected.

Cultivations were made with this blood in tubes containing Agar-Agar mixture, and a growth of the streptococcus was obtained in all respects identical with the streptococcus that had been employed for inoculation of this animal.

Relation of disease with streptococci.

In view of the whole of this evidence, I consider it conclusively established that this streptococcus is identical with the virus of the cow disease.

Its strong resemblances to human scarlatina.

We have, then, inoculated subcutaneously with sub-cultures of the streptococcus these two animals, calves 5 and 6, with the result of producing a general disease, which in many respects bears a close resemblance to human scarlatina. The minute anatomical characters of the eruption on the skin around the nostrils and mouth in calf 5 is of much significance in this connection, as also is the disease in the liver in both animals, and above all, the disease in the kidney. This latter organ corresponds so closely with a kidney of an acute case of human scarlatina, that sections made of the one and compared with those of the other, of which I preserved a large collection from my former investigation into the anatomy of human scarlatina (see Medical Officer's Report for 1876), show no difference whatever.*

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* Referring to the commencement made in 1882 of investigation of the results producible in the cow by inoculation with the material of human scarlatina, see p. 67 of report of that year, I would propose that this study be extended without loss of time.

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The outcome of the investigation thus far, and it is of importance until further differentiated observations shall have been made, may be stated thus:—By inoculating the virus directly taken from the local disease (the ulcer on the teats) of the cow into the corium of the calf the same local disease is produced, namely, a change in the skin, which commences as a congestion of the papillæ and corium, and an exudation of fluid and leucocytes. This leads in the superficial parts of the epidermis to the formation of cavities, which, enlarging and extending and opening on to the surface and extending into the depth, ultimately lead to the formation of an ulcer. But the virus, in the form of an artificial cultivation of the streptococcus derived from the above ulcer of the cow, when inoculated into the subcutaneous tissue, that is, when introduced almost directly into the vascular system (for all matter injected subcutaneously is easily absorbed by the lymphatics and carried into the blood system) sets up a general disease resembling to a considerable degree in its anatomical features human scarlatina.

Furthermore, as respects the concern that cow's milk may have in the communication of disease—the consideration which led to the present investigations—we have some facts which appear to me to afford very suggestive indications for further pathological study. As I have pointed out on a previous page, it would seem that the milk pure does not contain the organism, but (whether or not this observation be confirmed) the milk during the act of milking is pretty sure to become contaminated by the fingers of the milker bringing down into the milk particles from the ulceration on the teat. The organism contained in these particles would find in the milk a good medium in which to multiply. Such milk would then practically correspond to an artificial culture of the streptococcus, such as we have found capable of setting up a general disease, when inoculated subcutaneously into calves. It is true we have as yet no experience of the inoculation of a known milk sub-culture into the human subject, but in the case of calves, we have learnt that the general disease resulting from inoculation of an Agar-Agar sub-culture had characters closely allied to, if not identical with, human scarlatina. Then, feeding of animals with the cultures has not yet been tried, so that at present we are without information as to the characters of any disease that may be produced in calves by that means; whether or not calves fed with milk sub-culture of our streptococci exhibit the same pathological states as we have found to be produced by inoculation of calves with an artificial culture,—states that bear so marked a resemblance to those of scarlatina in the human subject. In order completely to understand these and other relations, more experiments are required, and these I hope soon to have an opportunity of making.

Until I am in a position to state at greater length the peculiarities of the infective phenomena of the disease under consideration, I refrain from further comment on its various interesting and promising aspects.

No. III.

No. 3.

Dr. Cameron's Observations.

EXTRACT from a PAPER to the EPIDEMIOLOGICAL SOCIETY (Session 1885–6), entitled OBSERVATIONS on a certain MALADY occurring among COWS at a TIME when the MILK produced by them disseminated SCARLET FEVER; by JAMES CAMERON, M.D., Medical Officer of Health of Hendon.

Cow disease at Hendon.

I WISH to lay before you a short description of a cow disease which has been the subject of investigation by Mr. Power, Dr. Klein, and myself during a recent inquiry into an outbreak of scarlet fever which occurred in the districts of St. Marylebone, St. John's Wood, Hampstead, and Hendon, amongst consumers of milk derived from a dairy farm situated within my sanitary district.

* * * * * *

Description.

In entering upon a description of this cow-disease, it is necessary to note that what I have to say has not all of it been the result of personal observation. Especially is this the case as regards some of the earlier symptoms, which, of necessity, have been learnt from other persons. The account of these, therefore, though I have taken great pains to sift the statements made to me in this connexion, and, indeed believe them to be fairly accurate, must be held liable to future correction or modification. But the account I give of the course of the disease after the appearance of the eruption on the teats and udder is my own, and is, I think, less subject to qualification in the above sense.

From my own observation, together with what I can learn respecting it, the disease would appear to be capable of general description as follows :

General.

A specific contagious and infectious disease, occurring usually in the first instance amongst newly-calved cows, and capable of being communicated to healthy cows by direct inoculation of the teats with virus conveyed by the hands of the cowman after milking a diseased cow, and perhaps by discharges from the mouth, nose, and eyes of infected cows coming in contact with the manger at which other cows may feed. It has been communicated to man* by inoculation with virus from the vesicles on the teats and udder, and seemingly, it is communicable, *though perhaps in another form*, through the medium of the milk. In the cow it is characterised by general constitutional disturbance ; a short initiatory fever; a dry, hacking cough ; sometimes quickened breathing; sore-throat in severe cases ; discharges from the nostrils and eyes ; an eruption on the skin around the eyes ; an eruption on the hind quarters; vesicles on the teats and udder ; alteration in the quality of the milk-secretion, and well-marked visceral lesions. The actual disease may continue in the animal for from four to six weeks, and it would seem that in some cases subsequent ill-health may last for from two to three months, or even longer, causing great emaciation and debility. It is difficult to speak of the fatality of the disease, but it would appear that sometimes,

* A trustworthy informant received the virus of this disease into a recent scratch upon his forefinger while milking a diseased cow. He suffered from general weakness, malaise, and loss of appetite. About four or five days after inoculation a vesicle or small blister appeared on the finger. This became broken and several others formed on the back of the hand. The whole hand and the fingers became swollen and inflamed, the inflammation extending in broad lines as far as the elbow. The general disturbance lasted a fortnight.

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though rarely, cows have died in its course, perhaps from affections of the internal organs.

Besides attacking by preference newly-calved cows, the disease is especially prone to attack cows that have been in low condition of health before calving, and cows which have slipped their calves. In cows where, after calving, there may have been retained portions of membrane or placenta, and where the cleansing has been imperfect, with an offensive lochial discharge, it is apt to appear within the first fortnight after the calving.

Dealt with in greater detail, the phenomena* of the disease appear to be as follow :

Febrile.

Fever.—At the commencement of the illness the cow is somewhat feverish, the nose is brown and dry, the coat is rough and staring. This fever may last, in severe cases, from seven to eight days ; in slighter cases, from three or four days to a week.

Skin and mucous membranes.

Two or three days after the commencement of the fever, the skin around the eyes, in cases of severe attack of the malady, becomes puffy and swollen, and in another two or three days, *i.e.*, about the fourth to sixth day of the fever, a minute red rash, about the size of pin-heads, and slightly raised above the level of the skin, appears upon the skin around the eyeballs. The cuticle on this part usually peels off about three or four weeks after the rash appears, leaving the skin hereabouts devoid of hair.

Discharge from the Eyes and Nose.—About the time that the rash appears on the skin surrounding the eyes, a yellow mattery discharge comes from under the eyelids, and collects in the inner corner of the eye. This discharge is, in particular cases, sometimes so severe that it is necessary to cleanse it away with a sponge. In severe cases, too, the discharge may continue for some time, and is believed to be contagious. A nasal discharge of a similar nature is apt to appear about the same time, and is believed, also, to be contagious.

Cough.—A dry, husky, hacking, irritative cough, with bronchial rales and quickened breathing, frequently comes on with the initiatory fever. The cough may last, more or less, as long as the cow is ill, and the quickened breathing may continue for a fortnight, or longer in some cases.

Sore-throat.—Sore-throat is stated to occur in severe cases, especially in newly-calved cows, attended with puffiness and swelling under the jaw. It comes on with the irritative cough, and is, in some cases, so bad that the cow has to be fed with gruel. In slighter cases the sore-throat has not been particularly noticed, and may or may not have been present.

Bowels and Urine.—In very acute cases the bowels are inclined to be loose. The urine is sometimes scanty and high-coloured, and the cow loath to pass it.

Teats and udder.

Teats and Udder.—From five to seven days, more or less, after the commencement of the illness, one or more teats become enlarged, swollen to nearly double the natural size, and slightly œdematous.

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* *Mem.*: Many of the above constitutional phenomena, particularly any rise of temperature indicative of fever, were absent from the cases observed among Hendon cows by Mr. Power and Dr. Klein. In these parts of his description, Dr. Cameron is probably relying on the statements of others as to what they have observed in cases which they consider to be of the same nature as the Hendon cases.—G. B.

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On fingering the teat there is no feeling of induration or hardness. Vesicles or bullæ next appear upon the swollen teats, and upon the udder between or near the teats. In number they range from two to four on a teat, varying in size from a pea to a horsebean, and containing at first a clear fluid. The first vesicle frequently appears between the two fore-teats, close to the abdominal vein, and is usually as large as a good-sized horse-bean. This vesicle is not preceded by a hardened papule as in cow-pox, but is in the first instance a vesicle or bulla.* These vesicles usually become rubbed and broken in milking, leaving raw sores, sometimes red, in other cases pale in colour, with raised, ulcerated-looking edges. Sometimes a few smaller accessory vesicles are formed around the margin of these ulcerated sores. The lymph from these vesicles in this stage can seemingly be conveyed by the hands of the cowman to healthy cows, and so propagate the disease by direct inoculation of their teats. Shortly after the vesicle has been broken, a brown scab forms upon the sore. These scabs may remain attached for five or six weeks, or may fall off in ten days or a fortnight, a smaller one forming afterwards. A thin, watery fluid exudes from under the scab, and the sore ultimately heals under it.

I examined the teats of several cows five or six weeks after they were attacked. The scabs then varied in size from a shilling to a florin; they were about one-eighth of an inch thick in the centre, thinning off towards the edges. On picking off some of these, the recently-healed skin was of a pearly-blue colour, with a slight tendency to bleed when the scab was forcibly detached; but there was no depression or pitting of the skin. After the vesicle had become broken and the scab formed, the swelling of the teat gradually subsided.

Distinction from other conditions.

Difference between Cow-pox, Chapped Teats, and these Vesicles.—As, in the course of our inquiry, it was strongly asserted by several people who examined the cows, that they were suffering from cow-pox, it is worth noting some of the differences between cow-pox and this disease. Both appear on the cow's teats and on the udder, at or near the bases of the teats, but in *cow-pox* a hardened *pimple* first appears, and this pimple becomes a vesicle, which, if it remains unbroken by the hands of the cowman, develops into a globular or oval acuminated *pustule*. A central depression forms in the vesicle, with raised, pearly-looking edges, with hardening round the margin, and with a distinct areola. —In the *cow-disease now in question*, there is no hard pimple preceding the vesicle and there is no subsequent formation of pustule; there is no central depression of the vesicle, no marginal induration, no areola, and when the scabs fall off there is no pitting of the skin.—It deserves mention that some persons who examined the cows affirmed that the sores on the teats were of the nature of *chaps*, caused by exposure to cold winds when the teats were moist. This was an altogether unsatisfactory explanation, because, although some of the animals stood opposite the doors (which were usually shut), many others affected with the same disease were not so exposed; and, moreover, the chapped teats, resulting from exposure to cold winds, commonly bleed in milking. These sores do not bleed in milking, unless when very roughly used.

Phases of eruption.

Skin Eruption.—I have already mentioned that one of the early symptons of the disease is puffing of the skin around the eyeballs, with a minute red eruption or rash upon it about the size of pin-heads. This was insisted on in an account given me by a competent and

* But see Dr. Klein's account of the anatomy of the eruption; particularly in the case of animal IV.—G. B.

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seemingly very accurate observer. But besides this rash an eruption appears upon the top of the hind-quarter, on one or both sides, extending, in some cases, down the outside of the leg as far as the hock, in others to the fetlock joint. I am inclined to think that the first stage of this eruption appears about the same time as the first appearance of the vesicles upon the teats; but, on account of the difficulty of seeing it upon a cow's skin, it is impossible to say so with absolute certainty. It was most difficult to find amongst the cow's hair any eruptive spots in the first stage, but on careful searching one was found upon the skin of a cow which we supposed to be in that stage. The spot was circular, about the size of a split pea, red, not raised above the level of the skin, but with a slightly thickened base. About 14 days after the commencement of the illness, this eruption on the hind-quarters has arrived at its scabbing stage, and the severity of the eruption has appeared to correspond, to some extent, with the severity of the attack, and the number of vesicles upon the teats and udder. In cows whose teats and udder showed numerous vesicles, the eruptive spots were plentiful and close together; in cases where the vesicles were few in number, and the animal evidently suffering from a slight attack of the disease, the eruption was not so well marked, but showed more in isolated spots, ranging in size from a split pea to a shilling. This eruption was confined entirely to the rump and outside of the hind quarter, there being none under the tail, on the back, or behind the ears. The skin eruption in its later stages consisted of patches of eczematous-looking crusts. When a crust was picked off, the hair came off with it, exposing a raw, moist sore, the crusts and the sores looking exactly like eczematous scabs and sores. In some cases, where the scab had been forcibly detached when newly formed, the sore looked bloody. In more advanced cases, the scab, when picked off, showed the skin healed under it, but devoid of hair. There was no pitting of the skin.

The milk of affected cows.

The Milk.—In a specific disease affecting the constitution of the cow shortly after calving, it might be expected that the milk, being an animal secretion, would be in some way affected by the disease. Specific virus circulating in the cow's blood is obviously likely to contaminate the milk produced by her, and through this medium to convey the disease to human beings. Early in the disease the milk of cows suffering in this way, if set aside for some hours, as matter of fact is apt to become ropy, or, as I have heard it described, "ropy," "slimy," or "as thick as a pudding." This condition of the milk may occur, it is said, even before the vesicles appear upon the teats and udder, or the eruption on the hind-quarters. It shows itself in milk that may have been set aside for from six to twelve hours for the cream to rise, and it ought to be looked for in all suspicious cases of cow illness. In some cases, when the cow is being milked, the first few "draughts" of the teat may bring thick or knotty milk, but afterwards there is nothing abnormal to be seen in it. In many cases there is nothing particular discernible about the milk as it comes from the cow; it flows freely, and looks exactly like ordinary milk. As the milk from this dairy farm was sent direct from the farm to the milk shop, and immediately distributed to the customers, this peculiarity would not have had time to show itself; and, further, as the cream is now usually removed by "separators," this milk would not, in all probability, have been set aside for the cream to rise. In cases where, at a dairy farm, only one or two cows are suffering from a mild attack of the disease, this ropiness might not show itself if the milk was mixed with a quantity of milk from

healthy cows, although this mixed milk might very well be capable of injuriously affecting those who consumed it.*

I believe that this ropiness of milk appears in several cow diseases. Its precise nature, and the causes which give rise to it, require careful investigation. It was particularly noticed, and described to me by several persons, as having been observed by them about three years ago, in milk supplied from another dairy farm in this district a few days before a severe outbreak of diphtheria among consumers of the milk. This ropiness of the implicated milk was the subject of much discussion at the time, and was attributed by the farmer to feeding the cows on too much clover hay. He admitted the fact of the ropiness of the milk, and took, he said, milk from each individual cow, to see, if possible, which animal gave ropy milk, but he did not set the milk aside to stand awhile, and so failed to detect the culprit. Unfortunately, in this instance, several of the cows were removed and killed before there was a chance of examining them, and so an opportunity of gaining, perhaps, important information was lost. This outbreak was the subject of special inquiry and report by Mr. Power. [*See* Medical Officer's Report to the Local Government Board for 1883, p. 42.]

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[Dr. Cameron concludes his paper to the Epidemiological Society by suggesting to farmers and cowkeepers certain precautions which they may advantageously take, while the current knowledge of the subject remains as it is.]

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* Observe in this connexion, the results obtained by Dr. Klein of inoculating milk from which teat-discharges are excluded.—G. B.

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