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Contributors

London School of Hygiene and Tropical Medicine

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Dr. Ballard's Report upon an Acute Specific Disease, characterised by a peculiar Diarrhoea, Epidemic among Persons who had partaken of Refreshments provided at a Sale on the Duke of Portland's Estate, at Welbeck, Notts.

GEORGE BUCHANAN,
Medical Department,
February 2, 1881.

ON Tuesday, June 15, 1880, and on the succeeding days up to Saturday 19th, there was an extensive sale of timber and machinery on the estate of the Duke of Portland, at Welbeck, Notts. Partly for business and partly to see a remarkable place, people from all parts of Nottinghamshire and from the neighbouring counties of Yorkshire, Lincolnshire, and Derbyshire, as well as from Bedfordshire, and probably even more distant localities, flocked to Welbeck. On Thursday 17th and Friday 18th it is estimated that from 1,500 to 2,000 people were present. The numbers were much smaller on the 15th and 16th. On these four days the sale was held in the timber yard adjoining the new stables and office buildings, but on Saturday the 19th at Norton brickyard, about two miles distant from them. On the 19th the attendance was comparatively small. For the accommodation of the visitors refreshments were provided on the spot, each day, by the proprietress of an hotel with a large trade at Mansfield, and many persons partook of them. Of those who thus partook, a large number residing over a very wide area, were subsequently taken ill, some slightly and some severely, and two of those attacked died from their illnesses. Some fragments of the food supplied at the sale were, moreover, taken away and distributed to five poor families (four in Mansfield and one in Worksop); members of these families (who had not been at the sale) were similarly attacked with illness, and two of these persons also died. Coroner's inquests were held in respect of two of the above deaths. I was instructed by the Board to attend one of these inquests, and generally to investigate the nature of the outbreak of illness and its cause. The inquiry was commenced on July 7, immediately on receipt of my instructions, and was continued up to July 30. The illnesses were generally attributed to the refreshments partaken of at the sale.

Refreshments provided.—These consisted of the following articles:—Cold boiled hams, cold baked or roasted beef, cold beefsteak pie, mustard and salt, bread and cheese, pickles and Chutnee sauce. The drinkables were bottled and draught beer, spirits, gingerbeer, lemonade, and water.

Source and preparation of refreshments.—The hams were what are known as "American hams," the mode of preparing which in this country is described in my first Report on Trade Nuisances (Supplement to Sixth Annual Report of the Local Government Board, p. 159). Seven hams altogether were sent to Welbeck. Six were purchased of a tradesman in Mansfield, and cooked in the hotel kitchen; but one was purchased ready cooked from a coffee tavern in Mansfield. As respects this seventh ham, I learn that it was cured and dried in America, and had been supplied to the coffee tavern by a different tradesman. The six purchased from the first-mentioned tradesman had been made on his premises* out of six legs of salted American pork, forming part of a consignment of five boxes (each containing about 5 cwt.) which he had received from a merchant in Hull about April 24. The six hams did not all come out of the same box of pork. When the order for six hams was given on June 11, only three could be supplied, which had been "washed" about 10 days previously; and then the tradesman opened a fresh

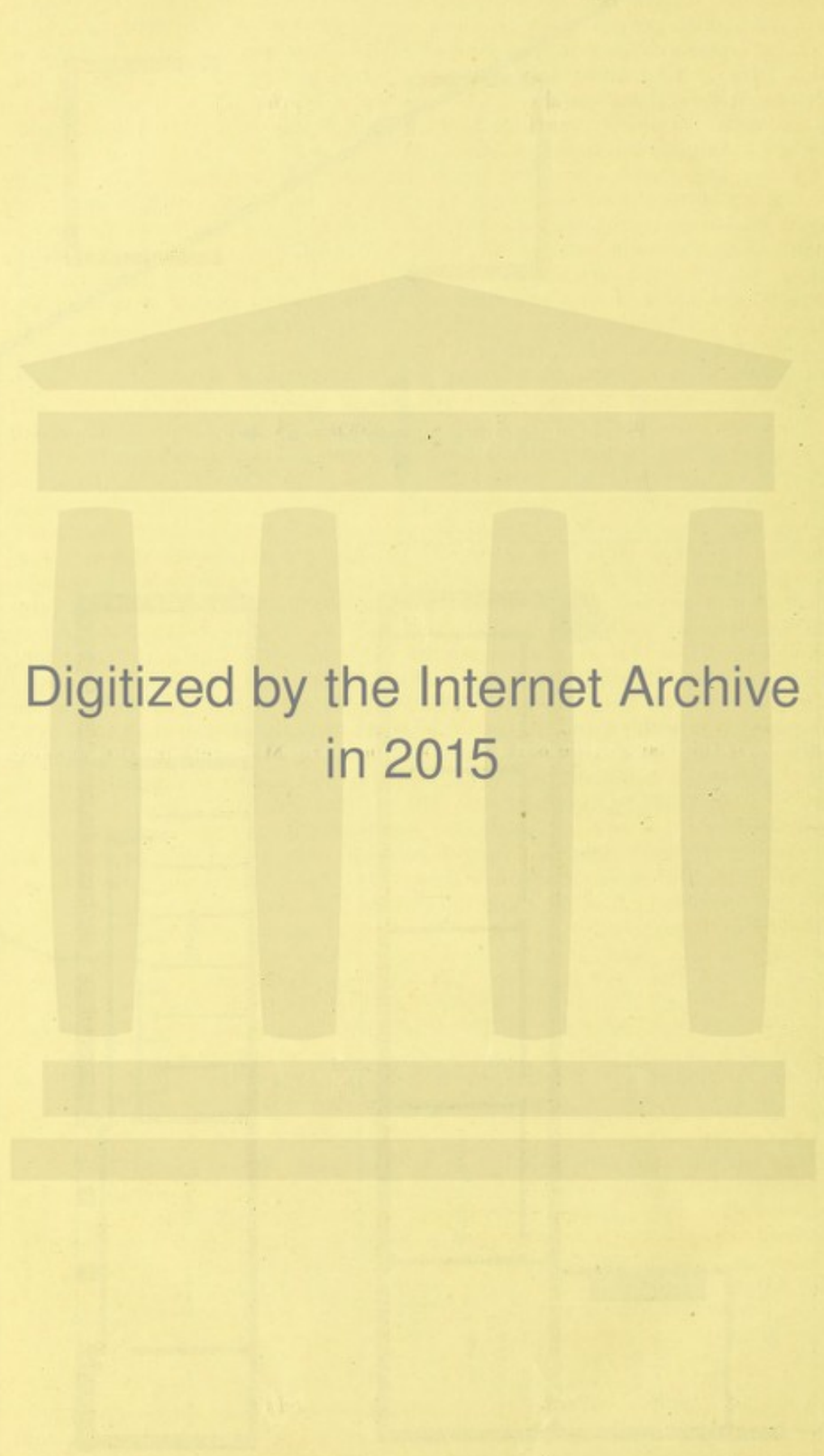
* The process, as conducted here, consisted in "washing" the pork in cold water to remove the excess of salt, and then hanging up in a chamber, where a good fire is kept, for the purpose of drying. The drying occupies generally about three days.

box and proceeded to wash more pork. He supplied three more hams of this washing on June 15. The three hams supplied on the 11th were boiled in tinned iron vessels by the cook in the hotel kitchen on Saturday 12th. Of the second three hams one was similarly boiled by the kitchenmaid on Wednesday 16th; the remaining two were boiled by the cook on the 17th.

The beef sent from the hotel consisted of three rounds, and part of a fourth round, and three chines, all supplied by one butcher in Mansfield, who kills his own meat. They were, all but one chine, baked at a bakehouse in Mansfield; three rounds were baked on Saturday 12th; one chine was baked on Wednesday 16th, and partly cut at the hotel; one chine was roasted on Thursday 17th; and another chine baked on the Thursday, served hot at the market dinner at 2 o'clock and sent to Welbeck the same afternoon at 3 o'clock. Six beefsteak pies were made on Monday 14th, in the hotel kitchen. The bread, cheese, pickles, and condiments were such as were in habitual use in the hotel, the bread having been supplied by a Mansfield tradesmen. The drinkables were those in ordinary use in the hotel. Ample evidence, derived from considerations of distribution, soon disproved any causative relation of the water and other drinkables with the occurrences of disease. Articles of drink therefore will not be further mentioned in this report.

Storing and transmission of refreshments.—The food cooked at the hotel on the 12th was stored in the hotel pantry until the afternoon of Monday 14th, and then taken to Welbeck. The ham and one chine cooked on the 16th were similarly stored and sent to Welbeck on the 17th, the ham in the morning and the beef at 3 o'clock in the afternoon. The chine of beef cut at the market table at 2 o'clock on the 17th was sent, before it could be cold, together with the cooked coffee-tavern ham, to Welbeck at 3 o'clock, as provisions seemed likely to run short, and they had been telegraphed for; and another chine and part of a round cooked on the 17th, and stored for the night in the pantry, were sent to Welbeck on the Friday morning, 18th. Such provisions as were unconsumed on the Friday at Welbeck were kept there that night, and on Saturday morning were transmitted to Norton brickfield (where the sale was then going on), the remnants being returned in the evening to the hotel at Mansfield. The sanitary condition of the hotel pantry was not unexceptionable. It is a lofty room leading out of a scullery, ventilated at the roof and by some openings near the floor into the stable yard. Notwithstanding that a door leading from the scullery into the yard was open, there was, both in the scullery and in the pantry, a disagreeable smell when I visited the place on July 13th. Seeking for the cause of this smell, I found that a sink in the scullery had two openings with pipes leading from them, one into an untrapped drain communicating with the public sewer, and having in its course a receiver in which fat, &c. collects, and which was full; and the other into an underground swill tank, which was also full, and which is never, in fact, empty, its contents being only partially taken out for the feeding of pigs every day. Under a cupboard in the pantry I found a wooden vessel containing several pieces of partially cut ham, bacon and pork, but all mouldy and maggoty.

Refreshment room arrangements at Welbeck.—The plan attached to this Report is that of the place where the refreshments were dispensed at Welbeck. It was an apparently nearly new building, scrupulously clean and well kept and well paved in every part, forming one side of a quadrangle near the place of sale. Downstairs, on the ground level, the rooms used were those designated "engine-room" and "water-room." On the floor above, the parts used were those designated "waiter's-room," "dining-room," and "store-room." The "engine-room" and the "waiter's-room" communicate by means of a trap door (*a*), and a staircase was extemporised as a means of access for visitors from the former to the latter. The staircase represented as issuing from the dining-room was at the time shut off from it. The "stable," marked as communicating with the "engine-room" was not in use. During the day the three wide doors (*b*) of the engine-room were open for ready access of visitors, but they were closed at night. Within the engine-room, near the front part, was a long open drainage channel (*c*), merely covered with an open-work iron covering; it commenced by a trapped inlet in the "water-room," (which inlet was found, by the Medical Officer of Health when he examined



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it, to be foul and offensive), and terminated in a 3-inch pipe drain (*d*), which, on one side, communicated with the several stalls in the stable, and on the other side with a sewer (*e*) outside, at a man-hole (*f*) marked on the plan. There was no trap anywhere in this course. The sewer was the general sewer for this part of the estate, and it received sewage from water-closets of residences, from stables, cowsheds, &c., and was not provided with any means of ventilation. The only ventilation of the sewer was into the "engine-room" by the circuitous passage here indicated.

The refreshments were thus dispensed. In the day time, such as were not in actual use were stored on the floor of the "store-room," but, every evening, before the hotel servants left, they were taken down into the engine-room for the night, because it was regarded as the coolest room, and then the doors was closed and locked. In the "dining-room," 2*s.* luncheons were served, consisting of ham and beef, pie, and bread and cheese, with a glass of draught ale. In the "engine-room" the solid refreshments dispensed were sandwiches, made invariably of a mixture of ham and beef, with a due allowance of mustard, together with beer, spirits, &c. The food was cut in the "waiter's-room" by servants and attendants from Mansfield; the sandwiches were also prepared there and sent downstairs in piles to be dispensed. Some few of the visitors to the luncheon-room tell me they cut for themselves. The "water-room" was only used as a sitting-room for the manageress and for washing-up purposes. There was a tap there from which water was taken for drinking and other purposes. No suspicion attached to the water. The two attendants who opened the refreshment rooms in the mornings state that they never noticed a bad smell in the rooms on these or any other occasions. The food sent down to Welbeck on the Monday afternoon lasted up to Thursday. The beef and the coffee-tavern ham sent to Welbeck on the Thursday afternoon did not come into use until the Friday morning, when they were first cut. When a ham was begun to be cut it was gone on with until finished. The food cut at Norton brickfield on the Saturday was a chine and round of beef, a partially used ham, and a fresh ham. Of the last a large part was taken back to Mansfield in the evening, since it was subsequently in cut at the hotel, and a part (about half at the thick end) was given to me on July 13. It had been set aside and kept on account of the public excitement that was occasioned by the illnesses.

There were other unauthorised refreshment stalls about the premises, but I cannot learn that much or indeed anything else than liquors, sweets, &c. were sold at them; and certainly none of the persons taken ill appear to have patronised them.

1. *As to the Persons who partook of Refreshments at Welbeck and Norton, and were subsequently taken ill or are known to have escaped illness.*

Number of persons.—Of these I have a more or less complete record of the illnesses of 72, and I had given me assurances of similar illnesses having occurred in a considerable number of other persons who had attended and taken refreshments at the sale, so that it is certain that these 72 were by no means all that suffered. On the other hand, I myself inquired personally into 22 instances of individuals who had partaken of the same kind of refreshments as those who had suffered, and yet escaped illness altogether. Probably there were very many more escapes than these, since it was far more likely that I should hear of the sufferers than of those who did not suffer. In fact, in the course of my inquiry, I heard casually of several more of the latter class. We may take it, I think, that at least one-half, probably much more than one-half of those who partook of certain solid refreshments ate them without injury.

Sex and age of sufferers.—Of the 72 (mentioned above) who suffered, 65 were males and only 7 females; of the 22 who escaped, 19 were males and only 3 females. The women who went to Welbeck went for pleasure (usually in parties of several together), and it appeared that in many instances they took their own refreshments with them from their homes. The solid refreshments sold at Welbeck were mostly eaten by the men. I have no record

of any children having partaken at Welbeck of refreshments provided there, so that all the above sufferers and non-sufferers were adults. Mostly they were people in the prime of life; but actual age did not appear to have had any influence on the occurrence of illness or on its severity where it did occur.

Refreshments partaken of.—All the 72 persons whose cases I inquired into had partaken either of the 2s. luncheon or of the sandwiches at the refreshment bar. 42 of them had eaten luncheons, and 30 had eaten sandwiches, mostly only one sandwich. Of those 22 (whose cases I investigated) who had not suffered after the refreshments, 11 had eaten luncheon and 11 sandwiches only. From these facts, especially taken in conjunction with another, namely, that, on the whole, the number of persons who merely took a sandwich at the bar was far larger than the number who took lunch upstairs, one inference may be drawn, viz., that a larger (probably a much larger) proportion of those who ate largely of the provisions suffered subsequently than of those who ate sparingly.

2. *As to persons who were not present at Welbeck or Norton, but who partook of Food brought from the Refreshment Rooms.*

Mrs. S. S., residing in a cottage in a narrow street in Mansfield, having been engaged by the manageress of the refreshment rooms to carve the provisions at Welbeck on the Tuesday, Wednesday, Thursday, and Friday, took home with her each day the trimmings of the sandwiches—the meat only, none of the bread—and not only gave some to her own children at home, but to two other poor families, neighbours of hers, one of whom gave some to a fourth family. Members of all these families who ate the food suffered from illness in the same way as those persons who were taken ill after eating at Welbeck. (a.) Of the S. family, three children and one woman who ate of these bits were taken ill. (b.) Of the L. family, Mrs. L. and a grown up son ate of the bits, were taken ill and died in a few days; a lodger who ate of them was also taken ill, and a poor man who came into the house and “merely ate a shred of ham given him by Mrs. L. from her fingers,” was also taken ill. (c.) Of the W. family, consisting of Mr. and Mrs. W., and five children, the two adults, and two of the children partook of some of the bits and were taken ill; those children who did not eat any not having suffered at all. (d.) Of the R. family, four adults who ate of the bits were taken ill, while one adult and three children who did not eat of them did not suffer. The bits consisted both of ham and beef; they had not been separated, but were brought home by Mrs. S. all mixed together in a dish each day. Altogether 16 persons, adults and children, who ate of these bits suffered from the characteristic illness, none having suffered who did not eat of them; and two of the 16 died. The two who died were extremely poor and chronically half starved. On one of them, Mrs. L., an inquest was held, and Dr. Godfrey, the medical attendant, gave it as his opinion, after having made a post-mortem examination of the body, that the death had resulted from choleraic diarrhœa, but that a state of semi-starvation had contributed to the fatal issue.

On the last day of the sale at Norton brickyard (viz. on Saturday), an engine-driver, who worked there, brought home to his family in the evening some of the sandwiches which were left over. Three adults, viz., he and his wife, and his wife's brother, ate them on Sunday evening. He and his wife were taken ill in the same way as others, but the wife's brother, so far as I can gather, was not taken ill.

On Wednesday the 16th, in the evening, there were brought back to the hotel at Mansfield some bottoms of rounds of beef and some ham bones with (it is said) a little meat on them. What little ham was left on the ham bones the cook says was eaten by the hotel servants, and the beef (enough for three or four persons) was hashed by her for the servants' dinner on the Thursday. The bones were put into the stock-pot for soup making. On Thursday evening some ham bones, with nothing on them, were brought home and put in the stock-pot. On Saturday the ham and beef in cut at Norton for sandwich making and unconsumed, were brought home to the hotel in the evening. The beef was eaten by the hotel servants (of whom altogether there were 13). The ham was sufficiently uncut to go into the commercial room where some of it was eaten;

and on Monday, 21st, the proprietress of the hotel says that the Deputy Coroner ate his lunch off it. So far as I have been able to ascertain by inquiry, none of the persons who (not having partaken of food at Welbeck) ate of these returned provisions suffered at all in consequence. Part of the ham returned on the Saturday was given to me for experiment.

3. *Characteristics of the subsequent Illnesses.*

I propose to speak of the attacks under the name "Diarrhœal Illness," because diarrhœa was the most constant of all the symptoms observed, and the other symptoms were in some respects so peculiar that I am indisposed to give to the disease any name otherwise generally recognised. As might have been anticipated from our experience of diseases in general, there were varieties in severity among the cases investigated, and symptoms strongly marked in some were slightly marked or altogether wanting in others. Perhaps I shall do the best service by first giving a general sketch of the course of the illness, subsequently illustrating it by a description of a few well marked cases.

A period of incubation preceded the illness. In 51 cases where this could be accurately determined, it was 12 hours or less in 5 cases; between 12 and 36 hours in 34 cases; between 36 and 48 hours in 8 cases; and later than this, only in 4 cases. In many cases the first definite symptoms occurred suddenly, and evidently unexpectedly, but in some cases there were observed during the incubation more or less feeling of languor and ill health, loss of appetite, nausea or fugitive griping pains in the belly. In about a third of the cases the first definite symptom was a sense of chilliness usually with rigors or trembling, in one case accompanied by dyspnœa; in a few cases it was giddiness with faintness, sometimes accompanied by a cold sweat and tottering; in others the first symptom was headache or pain somewhere in the trunk of the body, *e.g.*, in the chest, back, between the shoulders or in the abdomen, to which part the pain, wherever it might have commenced, subsequently extended. In one case the first symptom noticed was a difficulty in swallowing. In two cases it was intense thirst. But, however the attack may have commenced, it was usually not long before pain in the abdomen, diarrhœa and vomiting came on, diarrhœa being of more certain occurrence than vomiting. The pain in several cases commenced in the chest or between the shoulders and extended first to the upper and then to the lower part of the abdomen. It was usually very severe indeed, quickly producing prostration or faintness with cold sweats. It was variously described as "crampy," "burning," "tearing," &c. The diarrhœal discharges were in some cases quite unrestrainable, and (where a description of them could be obtained) were said to have been exceedingly offensive, and usually of a dark colour. Muscular weakness was an early and very remarkable symptom in nearly all cases, and in many it was so great that the patient could only stand by holding on to something. Headache, sometimes severe, was a common and early symptom; and in most cases there was thirst, often intense and most distressing. The tongue, when observed, was described usually as thickly coated with a brown velvety fur, but red at the tip and edges. In the early stage, the skin was often cold to the touch, but afterwards some fever set in, the temperature rising in some cases to 101°, 103°, and 104°. In a few severe cases where the skin was actually cold, the patient complained of heat, insisted on throwing off the bed clothes, and was very restless. The pulse in the height of the illness became quick, counting in some cases 100 to 128. The above were the symptoms most frequently noted. Other symptoms occurred, however, some in a few cases, and some in only solitary cases. These I now proceed to enumerate. Excessive sweating, cramps in the legs or in both legs and arms, convulsive flexion of the hands or fingers, muscular twitchings of the face, shoulders or hands, aching pain in the shoulders, joints, or extremities, a sense of stiffness of the joints, prickling or tingling or numbness of the hands lasting far into convalescence in some cases, a sense of general compression of the skin, drowsiness, hallucinations, imperfection of vision, and intolerance of light. In three cases, (one, that of a medical man) there was observed yellowness of the skin, either general or confined to the face and eyes. In one case, at a late stage of the illness, there was some pulmonary congestion, and an attack of what was regarded as gout. In the fatal cases death was preceded by collapse like

that of cholera, coldness of the surface, pinched features and blueness of the fingers and toes, and around the sunken eyes. The debility of convalescence was in nearly all cases protracted to several weeks.

The mildest cases were characterised usually by little remarkable beyond the following symptoms, viz., abdominal pains, vomiting, diarrhoea, thirst, headache, and muscular weakness, any one or two of which might be absent.

Post mortem examinations were made in three out of the four fatal cases, but the offensiveness in two of these instances was said to be so overpowering that they were hurried over in such a manner as to have afforded but little of the instruction which might have been derived from them. The following is all I could ascertain about these cases.

Case 1.—W. W., aged 64, a mason, residing at Worksop, partook of sandwiches downstairs at the refreshment room at Welbeck between one and two o'clock both on Wednesday 16th, and Friday 18th. He had been complaining of pains in his chest and side for some weeks previously, but was quite well enough to attend to his business. On the Friday night, when in bed, he complained of feeling cold, and requested his wife to lie close to him for warmth. On the Saturday morning he ate but little breakfast and said he ached all over. In the course of that day he was seen by Dr. O'Connor, of Worksop. He was then suffering from vomiting and diarrhoea, with severe pains in the belly, and cramp in the belly and legs. The stench of the stools was terrible; his wife said that she could not stop in the room with him, but sat on the stairs, and the stench pervaded the whole house. His evacuations, which he could not restrain, were of a brown colour. When Dr. O'Connor saw him there was an abundant dry brown velvety fur on the tongue; the pulse was 128; the temperature was not taken. On Monday 21st, a condition of collapse commenced, the features were altered, eyes sunken, extremities cold, and fingers and toes blue. Dr. Bartolomé, of Sheffield, saw him in consultation on Wednesday 23. Then his skin was cold and clammy, he looked shrivelled and blue, and his countenance was pinched. He died on Friday 25th. Post mortem examination, at which Dr. Lloyd, of Worksop, and Dr. Housley, of Retford, assisted, was made 26 hours after death. The body was rigid, with livid staining posteriorly. Membranes of brain adherent to cranium; brain congested. Lungs soft in parts from congestion or pneumonia of the dying; parts would float in water; heart healthy; blood not abnormally fluid; intestines claret-coloured externally, but neither the stomach nor the intestines were opened; they were tied and sent with their contents to Mr. Allen, public analyst at Sheffield. Liver healthy; the capsules of kidneys stripped off readily, much blood flowed from them when they were cut, but otherwise they appeared healthy. In addition to the stomach and intestines, the kidneys and a portion of the liver were sent to Mr. Allen. He examined them and their contents for mineral poisons without result. He also looked microscopically for trichina in the walls of the stomach and bowels but found none; portions of the intercostal and pectoralis muscles and of the diaphragm were also examined for trichina, without result, by Drs. Pritchard and White, of Retford.

The next case is very imperfect.

Case 2.—Mrs. L., aged 62, a poor woman, took charge of Mrs. S. S.'s children at Mansfield, while their mother was engaged assisting at the Welbeck refreshment rooms. On Wednesday 16th, about noon, she partook of some of the fragments of meat which Mrs. S. S. had brought home. She was taken ill at Mrs. S. S.'s house on Friday afternoon; she felt very faint, and diarrhoea came on with vomiting and pains in the abdomen. When Dr. Godfrey, of Mansfield, saw her on Saturday, these symptoms were continuing, and she was also suffering from extreme thirst. She was much emaciated as if she were half-starved; he regarded the case as one of choleraic diarrhoea. She fell into a state of collapse and *died* in the afternoon of the 22nd. Dr. Godfrey made a post mortem examination of the body on the 23rd. It was extremely emaciated, and presented no evidence of decomposition. There was no abnormal fluidity of the blood. There were old standing adhesions of the pleura on the left side and congestion of the left lung. The mucous membrane of the stomach and intestines was highly congested, which Dr. Godfrey regarded as the result of some violent irritation; he says he did not observe that they were abnormally softened. Otherwise, he says, the organs were healthy.

Case 3.—Mr. S., a publican at Barlborough, aged 37, drove a party of visitors to the sale and back in the evening on Thursday, 17th. He was there all day, and in the course of the day ate four sandwiches in the refreshment room, and drank so much liquor that he was "fresh" when he returned home. He then went into the yard and vomited, and the same evening diarrhœa commenced. His wife says that it was not customary for him to vomit when he got tipsy. About 10 a.m. the next day he complained of burning pain at the lower part of the abdomen. The vomiting and purging continued, and he became cold, and the skin clammy to the touch, but at the same time he complained of heat and insisted on lying outside the bed. He said he was "all on fire." There were no sweats. He was very restless, and would get up and walk about the room. As his illness went on, he had cramps in the legs, and his eyes became sunken and the skin round them blue. His mind was clear to the last. The evacuations were at first offensive. At first, it is said, they looked like water with bits of white matter floating in it; afterwards, when they ran from him in bed, they were of a dark green colour. He was very thirsty, and drank copiously of water. There was no suppression of urine. He died at midnight on Friday, the 25th. Dr. Wills, the medical officer of health of the district, made a post mortem examination 60 hours after death. The body was in a state of commencing putrefaction, and consequently he says he did as little as possible. He merely opened the stomach, and in several places the intestines also. He found the mucous membrane of the stomach of a bright arterial red colour in patches, but says that the mucous membrane of the intestines was rather anæmic in appearance, and the intestine contained a little bile. He took portions of the stomach and intestines away, and examined them microscopically for trichina, and chemically for arsenic, antimony, and copper, but with a negative result in each instance.

The two following examples will illustrate the nature of the illness in severe non-fatal cases:—

Case 4.—Mr. W., aged 38, a master joiner, residing at New Basford, near Nottingham, and naturally a strong healthy man, went to the sale on Thursday, June 17, only, and at about 1 p.m. lunched at the refreshment rooms. He ate ham and beef, bread and cheese, and drank only water, being a total abstainer. He noticed that the fat of the ham was of a greenish-yellow colour, but says it did not taste badly. The lean of the ham tasted very salt. The beef was well cooked. At supper time in the evening he experienced a difficulty in swallowing the milk he had for supper. He says it seemed to choke him. He "thought it was his own stupidity," so he persisted in trying, but had to give it up at last and went to bed. He awoke in the morning with shivering and muscular twitchings of his hands and between the shoulder blades. He says he felt "as if his shoulder blades were loose and were jerked backwards." His wife thought he had caught a severe cold. However, he had his breakfast, and directly afterwards began to feel a griping at the lower part of belly. He passed a loose stool, and then took some diarrhœa mixture. The muscular twitchings went off after breakfast. The diarrhœa now increased, but without tenesmus, and an evacuation appeared to relieve his pains. The motions were at first very offensive, but he does not know what they were like in appearance. He felt quite prostrated, and says he had no power in his arms. He ate hardly a mouthful at dinner time. In the afternoon he was seized with vomiting, and about 3 p.m. with faintness, but does not think he became quite unconscious, since he recollected ammonia having been held to his nose. His hands and feet were now cold. After the faintness he became very drowsy, and his mind began to wander; he fancied he saw his daughter (who was not there) at his bedside with a monstrous head. His sleep at night was broken and his feet were cold. As the diarrhœa and vomiting went on, he found he could not bear the light, but he had not much headache. He suffered intensely from thirst. He had no medical attendance until the evening of Tuesday, 22nd, when he was first seen by Dr. Brooks, of Nottingham. At that time his prostration was very great, and the vomiting and diarrhœa had been incessant. The stools now were noticed to be green, separate from the water in the pan, and without remarkable offensive odour. The hands and feet were cold and numbed, and there were pains, but not fixed pains, in the joints, chiefly the knees and shoulders.

He passed urine naturally. After the 22nd he continued much in the same way for three or four days, and then began to improve, and after a fortnight was able to get up in the afternoon. He says that, when he began to get about, he felt when he walked as if the upper part of his trunk "would swing round," and that he was uncertain of his foot-hold; but this might have been nothing but the result of his extreme debility. He lost during his illness 12 lbs. of weight. Dr. Seaton,* of Nottingham, saw him on July 14, and he was then very weak and unable to exert himself. At that time the cuticle was peeling off in patches from the last phalanges of his fingers and thumbs.

Case 5.—Mr. W., age 61, a wheelwright, residing at Ranby, was at the Welbeck sale on one day only, namely, Thursday, 17th. At about 1 o'clock he ate two sandwiches at the refreshment room, and drank a small bottle of beer. He says that all the next day, Friday 18th, he "felt something very wrong" in his inside, he had, nipping pains in his belly, and "felt queer all over." But he ate some beef for dinner in the middle of the day and had his tea as usual. He felt very drowsy all day. He went to bed feeling very ill. In the night he woke up shivering, and then became hot with violent pains in the head. On the Saturday he had some pains in his belly, and had to keep in bed, where he was now seen by Dr. White, of Retford. His pulse was then 120, and his temperature 104°. The tongue was covered with a brownish fur, but was morbidly red at the tip and edges. On Sunday 20th, diarrhoea commenced, and it did not cease altogether for a fortnight. He began to vomit on 21st. There was intense thirst during the whole of the first week of the illness. After a few days of medical treatment, feeling a little better, he went downstairs and then there was a return of the drowsiness, and severe pains, with redness and swelling, occurred in the metatarso-phalangeal joints of both great toes, with œdema of the feet and tenderness of the calves of the legs. This was about the 9th or 10th day of his illness. The right foot was worse than the left. While he was thus suffering, namely, about July 2, he was seized with severe pain under the right shoulder blade with some dyspnoea, but it is said without cough. Dr. White found, on examination, dulness with moist rhonchi at the base of both lungs, posteriorly, but he could hear no friction. He regarded the pain as diaphragmatic. About the same time he had severe crampy pains in the calves of both legs, and subsequently there was pain over the situation of the right kidney, which Dr. White thought might be muscular. When I saw him on July 11, he was still in bed and very weak, and there were still some redness and swelling remaining in the balls of both great toes.

Information was sought as to the possibility of the characteristic diarrhoea being communicable to other people after the manner of enteric or other fever. Two instances alone suggested this possibility, and neither of them seems entitled to much weight. The one instance was of a man and his wife coming to visit Mrs. L. (*Case 2*) during her illness. The man was attacked a day or two after with smart purging, seemingly of the same sort as Mrs. L., and his wife had a slight attack of diarrhoea later on. But as the house was one to which pieces of food from Welbeck had been taken, the chance of the man and wife having themselves eaten of it could not be absolutely set aside, and it would not be safe to ascribe their attacks to infection from Mrs. L. The other case was that of Mr. W's. wife (*Case 1*, and note her experiences). She had not been at the sale, yet she and her baby both suffered from diarrhoea during her husband's illness. But I cannot say that this diarrhoea, occurring at the end of June, in people exposed to fœtid bowel evacuations, had anything in it to indicate an infective property in the Welbeck disease.

4. Cause of the Illness.

Keeping in view the series of cases at Mansfield, where persons of different families who had not been at Welbeck were nevertheless ill after eating what was brought from thence, no hypothesis as to the cause which does not refer it to the meat dispensed there or to the mustard

* I am indebted to Dr. Seaton for the particulars of this, and of eight other cases, which he kindly undertook to visit in the neighbourhood of Nottingham, and to report to me upon; as well as for valuable suggestions and assistance in the course of the inquiry. Throughout the inquiry I also had the valuable assistance of Dr. Wills, the Medical Officer of Health of the district.

laid upon it within the sandwiches can be entertained. The mustard was Colman's mustard, part of a keg of mustard in habitual use at the hotel, and, therefore, free from suspicion. Obviously it was either the ham or the beef or both which had done the mischief. I have mentioned previously that the sandwiches provided were invariably made with a mixture of ham and beef. As a rule also, those who had luncheon upstairs partook both of ham and beef; both were cut for them and put upon the plate together. But in the course of the enquiry, while general testimony confirmed this statement, I found four individuals, who having a dislike for ham, ate nothing but beef at luncheon. Of these, three escaped illness. Of the fourth person, who suffered a characteristic illness, something more has to be said. He was a man who had no definite employment, but who was engaged by the hotel proprietress to assist in waiting at the rooms. It is quite possible that this man's account of himself was not altogether to be trusted. I saw him at a time after the first inquest, when popular opinion was running specially against the ham, while the man's employers were confidently asserting its wholesomeness. His memory may be supposed to have become less accurate while this contention was going on round him.

The general report of those who partook of the beef at luncheon upstairs was that it was good, and on the whole well cooked. The ham, however, whether eaten at luncheon or in the sandwiches, was a good deal complained of. Both its appearance and flavour were complained of. Some said that it was not sufficiently cooked (a common fault with hams cooked for sale), some that the fat had a yellowish or greenish tint, others that it was too salt, others that it "tasted queer," and others that it had no flavour of ham at all, all which may have been true for persons partaking of different parts of different hams; but many found no fault at all. Some persons found the sandwiches so distasteful that after eating a mouthful they threw the rest away. No one, however, stated that the ham was tainted. All this, however, favoured the popular opinion against the ham, and I shall have to show presently that there was probably something in the ham calculated to render it unwholesome. I only met with one person, and he was one of the hotel servants, who told me that he had daily eaten nothing but ham at the rooms, and he said he had not been ill.

Some of the medical men who attended the sick professionally suspected that the hams were trichinised, and that they might have been treating cases of trichina disease. But, although I felt bound to respect this suspicion, I did not at any time seriously entertain it myself. I felt, however, that in the present state of our acquaintance with that disease it would have been unwise altogether to ignore its possibility in this instance. I, myself, thought it more probable that the meat, exposed to the influence of sewer air night after night in the lower refreshment-room, had, perhaps, undergone some chemical change short of actual putridity which had rendered it unwholesome. On the whole, I felt very much in the dark, and with a view to obtaining some light upon the subject, and to test, so far as was practicable, the correctness of the above notion, I set on foot the experiments and observations which I am now about to detail. The result has been not only the refutation of both the above notions; but to detect in the ham the presence of a morbid element, which, so far as I know, is now for the first time demonstrated.

5. *Experiments instituted and their Results.*

I obtained from the hotel at Mansfield the residue of the ham brought back on the 19th, and mentioned (p. 4) as having been subsequently partaken of by visitors at the hotel. It was about half the ham (or rather less) at the thick end. I divided this into two equal portions, one portion I kept as it was; the other portion I suspended for 20 hours in the partially open man-hole of the Welbeck sewer (marked (f) on the plan). Side by side with this, but not in contact with it, I similarly suspended half a cold roasted shoulder of mutton, perfectly fresh and good. I obtained from the tradesman who supplied the ham to the hotel (and whose willing aid in the inquiry I have much pleasure in acknowledging) half of an uncooked ham made out of the before-mentioned consignment of American pork. I forwarded these,

carefully packed so as to prevent contact, to Dr. Klein for microscopical examination and experiment. I caused to be sent to him also a portion of one of the kidneys of W. W. (*Case 1*), which had been hardened in spirit by Mr. Allen, the Sheffield Analyst. Other bits of tissue, intestines, stomach, &c., from the same body, and from that of Mr. S. (*Case 3*), were also forwarded; but they were useless on account of the decomposition they had undergone before they were put into the spirit. The observations and experiments made with these substances by Dr. Klein are fully recorded in the Appendix (A) to this Report. It will be sufficient for me here to summarise their results.

1st. The absence of trichinæ in the ham was established.

2nd. The presence, in all three portions of ham—the raw ham and the cooked ham, both that which had been and that which had not been exposed to sewer air—of a species of *bacillus*, with sporules of the same, was demonstrated. The bacillus threads and sporules were in connection with the muscular fibre and in the intermuscular tissue.

3rd. Bacillus material from the raw ham and from that portion of the cooked ham which had not been exposed to the sewer air, was successfully cultivated in the incubator. Cultivation was not attempted with the ham and the mutton that had been exposed to sewer air.

4th. Experiments upon animals, dogs, cats, mice, rats, rabbits, and guinea-pigs, by feeding or inoculation, or by both methods, were made both with material from the hams and with the cultivated material, with the following general results, viz. :—

- a. The experiments made with the portion of ham that had been exposed to the sewer air, and with the mutton similarly exposed, produced only negative results.
- b. The experiments made with the raw ham and with the portion of cooked ham not so exposed, produced in all but a few instances positive and remarkable results, viz., disease in the animals experimented on.
- c. The experiments made with the raw ham were more uniformly successful than those made with the cooked ham.
- d. The experiments made with cultivated material gave in all cases positive results.
- e. The morbid condition produced in the animals, and found on post mortem examination, was most uniformly pneumonia (in one instance with pleuritis) or pulmonary hyperæmia. In some, hæmorrhage into the pulmonary tissue was observed. In some, there was hæmorrhage into the tissue of the liver, or the organ was found enlarged. In some the spleen was found enlarged or congested. In three instances peritonitis, slight or severe, was found. Two dogs fed and inoculated with the cooked ham, and killed on the 8th day (one having suffered from colic on the first day of feeding), exhibited after death evidence of severe desquamative hyperæmia or inflammation of the stomach and intestines, the contents of which contained bacilli and a few pus-corpules. Bacilli were found in the blood of two white mice which died ~~four~~ ^{24/} hours after having been fed and inoculated with material from the raw ham; but no bacilli was discoverable in the blood of two other mice inoculated with this blood, although, when they were killed on the 2nd and 3rd days respectively, they both were found to have severe pneumonia with enlarged liver and large congested spleen. Nor were bacilli found in the blood of four other animals in which they were sought for after death.

5th. In the kidney of W. W. there were discovered evidences of parenchymatous inflammation, and the afferent arterioles and capillaries of the Malpighian corpuscles were found plugged with emboli formed of masses of bacilli.

In these observations and experiments, we have a clue to the solution of the difficulty, which the ordinary methods of inquiry failed to furnish. In two hams taken indiscriminately out of the same consignment there was found a *living parasitic thing*, capable of spreading by its growth and reproduction through the material in which it was found, and *capable of pro-*

ducing disease in animals into whose system it was introduced; capable also of growth and reproduction within the system of these animals. Taking into consideration the fact that a number of persons who ate of ham of the same consignment suffered from disease induced by such eating, and the further fact that in the kidney of one of them large numbers of bacilli (similar to those found in the hams experimented with) were found, it appears reasonable to infer that some of the hams of that consignment were similarly affected with the parasite, and that *either the parasite itself, or some virus essentially associated with it, was the active agent in the production of the diseased condition* observed in the human subjects of the epidemic, and in the animals which were experimented on by Dr. Klein.

There are two difficulties in the way of accepting this explanation. There is, first, the fact that many persons who had partaken of other hams of the same consignment, in some instances day after day, altogether escaped disorder; and, secondly, the fact that part of the same ham which in Dr. Klein's hands produced disease in dogs and rabbits, had apparently been eaten with impunity in the hotel. The first of these difficulties does not seem to deserve much weight. It is not likely that every ham consumed at the sale was affected in the same way and to the same degree, that cooking had operated alike upon all portions of the hams, and that all who ate of the hams were alike susceptible to the injurious influence. So some of the consumers might be expected to escape. The second difficulty is perhaps more serious; but, if allowance be made for the unequal operation of heat upon the thicker and thinner portions of a ham; for the thinner portion being that eaten at the hotel, while Dr. Klein experimented with the thicker and presumably less cooked portion; and for the fact that Dr. Klein got even from this portion less uniform results than he got from a raw ham; there would not seem to be any great difficulty in understanding how people at the hotel may with impunity have eaten portions of a ham which really did contain material capable of producing disease. The escape of these people then does not count for much against the conclusion indicated by Dr. Klein's affirmative results.

It remains for me, in concluding this report, to comment on some few matters noted during the inquiry, and in the subsequent experiments.

There was a notable difference between the several days of the sale in respect of the amount of disease resulting from the food consumed on one and on another day. This difference is shown in the following table, which has reference only to the 72 persons who became ill after partaking of sandwiches or luncheon at Welbeck or Norton. The numbers in column 1 are certain, since these represent cases where the consumption of such food was on one day only. The numbers in column 2 are less certain, being of those who partook of these foods on more than one day. In accordance with the observation that the illness generally began not later than a day or so after the operation of the cause, I have in this column 2 referred such cases to the last day (not being the day of attack) of their eating the sandwiches or luncheon. Column 3 is the sum of these, and shows with much probability the relative numbers of persons who suffered from the food distributed on the several days of the sale.

NUMBER of CASES referable to food partaken of on the several days mentioned.

Food eaten on the subjoined day appears to have caused illness	1. To persons who ate of it on that day only, numbering	2. To persons who ate of it on that and on previous days, numbering	3. To total number of persons.
Tuesday, June 15 - -	4	—	4
Wednesday, „ 16 - -	8	5	13
Thursday, „ 17 - -	31	4	35
Friday, „ 18 - -	9	5	14
Saturday, „ 19 - -	1	5	6

The number of persons attending the sale on the Tuesday and Wednesday were much the same, but it would appear that thrice the number of cases of infection referable to the Tuesday are referable to the Wednesday. Thursday and Friday were the days on which the refreshment rooms were most thronged. I cannot discover that there was much difference in this respect between the two days; yet it would appear that three times as many people were infected on the Thursday as on the Friday, and it is quite possible that some of the 10 cases referred with less certainty to the Friday and Saturday (on which last but few persons attended the sale) were really infected on the Thursday. Now, the only hams in cut up to the Thursday night were those which were cooked at the hotel on Saturday 12th. Before the dispensing of food at Welbeck on the Tuesday, two and a half days had elapsed since the cooking of them; on the Wednesday, three and a half days, and on the Thursday, four and a half days. During these intervals opportunity had been afforded for the extension afresh through the ham of any virus that might have been left undestroyed by the process of cooking. But on the Friday, this first batch of hams having been used up, the coffee-tavern ham, belonging to a different category of hams, about which I know nothing, came into use; and on that and the succeeding days hams which had been more recently cooked. Probably the comparatively small number of persons infected on Friday and Saturday was partly due to the hams that were then in cut having been more recently cooked, so that opportunity had not arisen for the re-extension of living bacillus from the underdone portions into the well cooked portions. Later on, however, such opportunity may be believed to have arisen; and now we may see a fresh reason for the success of Dr. Klein's experiments with a ham that three weeks before had been eaten at the hotel with impunity.

A word as to the effect of sewer air upon the meat exposed to its influence. The bacillus remained in it, but the power of the meat to produce specific injury to animals was no longer manifested. Dr. Klein suggests, and the hypothesis is in harmony with the view that assigns to the bacilli an essential share in the production of the disease, that the progress of common decomposition may have destroyed the specifically harmful quality of the meat, without altering the microscopic characters of the bacilli. These questions of re-infection and of ultimate destruction of infection during one and another stage of decomposition are of the greatest interest in zymotic pathology.

November 11, 1880.

EDWARD BALLARD.

APPENDIX.

A.

Dr. Klein's report on microscopic examination and experiments made by him in connexion with Dr. Ballard's Welbeck enquiry.

A.—Received from Dr. Ballard on July 15, 1880 :—

- I. Portion of cooked ham.
- II. Another portion of the same ham that had been exposed to sewer air.
- III. Half a cooked shoulder of mutton that had been exposed to sewer air.

B.—Received from Dr. Ballard on July 31, 1880 :—

- IV. Portion of raw ham of the same consignment as ham I. [American pork dried in England.]

HAM I.

MICROSCOPIC EXAMINATION.

The greater part of this ham was full of maggots and putrid, but other portions that were tolerably well preserved, when examined under the microscope, contained in connexion with the surface of the muscular fibres and in the intermuscular fibrous tissue certain organisms absent in ordinary putrefaction. These organisms were numerous bright sporules and bacillus filaments, the former isolated, or more often in groups, the latter of various lengths from a short bacillus rod to eight and ten times its length, either with or without the sporules in their interior. Compare figure I. The sporules and the bacillus threads, there can be no doubt from the examination of the preparations, were generally connected with one another, just as is the case with any other kind of bacillus, *e.g.*, bacillus of hay, bacillus of anthrax, bacillus of fat-acid fermentation, bacillus of putrefaction, of septicæmia, &c. &c.

EXPERIMENTS.

The following experiments were made with this ham :—

Experiment 1.—Two dogs that had been kept for the last three months under very regular diet and had enjoyed perfect health, were fed with bits of this material on the morning of July 16. In the evening of the same day one of the dogs had severe colics, the animal, lying on its stomach, groaned a great deal and refused food. July 17, the animal seemed all right again; the other dog showed no symptoms of disturbance.

Experiment 2.—Both dogs were again fed with the same material on July 19, but without producing any symptoms in either animal.

Experiment 3.—These two dogs were inoculated into the skin of the thigh with the same material on July 16, an infinitesimal particle of the material being used. 24 hours afterwards the points of inoculation were swollen and red. In one animal it developed after three days into a hard nodule of about the size of a pea, the inguinal glands of the same side being at the same time slightly swollen.

Both these dogs were killed on July 23, and the following appearances presented themselves at the post mortem. In both animals the stomach and intestines were distended by, and filled with, a transparent yellowish tenacious fluid, which under the microscope exhibited numerous flakes of epithelial cells detached from the mucous membrane, thick bacilli isolated and in groups, few pus-corpuscles.

The mucous membrane of the stomach and intestines showed slight hyperæmia. The epithelium of the surface had become much loosened, so that on the slightest shaking of the membrane the epithelium became detached in large flakes.

One of the dogs had a cyst in the right kidney of about the size of a pea.

Experiment 4.—A healthy cat was fed on July 16 with the above material (Ham I.) No result. On post mortem examination (July 23) nothing abnormal was found.

Experiment 5.—Two mice were fed and inoculated July 16. No result, July 23.

Experiment 6.—One rabbit was fed and inoculated on July 16. It did not exhibit any symptoms of illness during life. On July 23 it was killed; both lungs showed numerous hæmorrhages in the shape of red spots of a minute size.

CULTIVATION.

Material (Ham I.) had been cultivated in the incubator, a minute particle being suspended in a drop of perfectly fresh white of egg placed in a cultivation glass cell, such as I used on former occasions. (See Reports of the Medical Officer of the Local Government Board for 1877, Supplement, p. 210.)

Experiment 7.—After two days' cultivation, a minute quantity of the fluid of the glass-cell specimen was used for inoculating subcutaneously four white rats. The next day the animals were quiet and did not feed well. When left undisturbed they became stupid and sleepy. Two of them were killed after two days, the other two after four days. On making the post mortem the following was found;—The two animals that were killed after four days had a slightly enlarged spleen, the other two showed no alteration of this organ. In all four animals the lungs exhibited a few hæmorrhages, the upper lobes being slightly hyperæmic. Neither in the blood nor in the spleen could any bacilli be detected.

HAM II.

MICROSCOPIC EXAMINATION.

A part of it, full of maggots and putrid. Portions that were not in this bad state when examined under the microscope contained the same kind of sporules and bacillus filaments on the surface of the muscle fibres, and in the intermuscular fibrous tissue as were found in Ham I. (See figure 1.) Besides these organisms, there were found numerous bacteria and torulæ.

EXPERIMENTS.

The following experiments were made with this material:—

Experiment 8.—Two dogs, one cat, four mice, and two rabbits, were fed and inoculated, but none of these animals showed any symptoms, and the post mortem revealed no abnormal condition.

The difference between Hams I. and II. is striking enough, and it is perhaps not unnecessary to draw attention to the fact that in Ham II. signs of putrefaction (*vide* bacteria and other organisms) had everywhere set in, while in Ham I. in some parts such was not the case; and it is quite possible that the virus which in the above animals experimented upon with Ham I. produced an effect, may have been altogether destroyed by putrefaction in Ham II., although it may have been in it originally.

MUTTON III.

MICROSCOPIC EXAMINATION.

Examined under the microscope the material contained signs of ordinary putrefaction, *e.g.* micrococci and bacteria.

EXPERIMENTS.

Experiment 9.—Feeding and inoculation experiments on dogs, cats, rabbits, and mice produced no effect whatever.

HAM IV.

MICROSCOPIC EXAMINATION.

The microscopic examination revealed in connection with the surface of the muscular fibres, and in the intermuscular connective tissue the same kind of sporules and bacillus (rods and filaments) as were found in connection with the hams I. and II.

EXPERIMENTS.

The following experiments were made with this material:—

Experiment 10.—One dog was fed on August 1. It remained apparently well until August 13, being lively and feeding well. It was killed on August 13, when its lungs were found affected with severe pneumonia, one lung more so than the other. In this and all other cases to be referred to in the following observations, the pneumonia was in the stage generally described as the stage of red hepatisation, all the air-vesicles being distended by and filled with blood and fibrin, and the bronchial walls infiltrated with pus-cells. The bronchial cavity containing muco-sanguineous matter, with a few leucocytes. The several lobes and lobules were not uniformly affected. In the dog the liver contained several hæmorrhages in the form of red streaks, patches, and spots.

Experiment 11.—Two cats were fed on August 1, with the same material. They remained apparently healthy until August 13, when they were killed. The lungs of both animals showed pneumonia, as in the dog. The liver showed the hæmorrhages only in one cat, and in the same animal the spleen was found distinctly enlarged.

Experiment 12.—Two rabbits were fed and subcutaneously inoculated with the material on August 1. They were killed on August 13. Both lungs of both animals were affected with pneumonia. No other organ diseased.

Experiment 13.—Two guinea pigs were fed and inoculated on August 1. They were killed on August 13. Pneumonia was found in both lungs of both animals of the same

character as in the previous animals. One of them had in addition hæmorrhages in the liver and an enlarged spleen.

Experiment 14.—Two guinea pigs were fed and inoculated on August 5. They were killed on August 13, and exhibited the same pneumonia as the previous animals.

Experiment 15.—Three white mice were fed and inoculated on August 5. One of these mice remained perfectly well. Two of them died spontaneously on August 6, *i.e.*, after 24 hours. In both animals both lungs showed very severe pneumonia; the liver was much congested, and the spleen normal. In the blood were numerous minute bacilli.

Experiment 16.—With this blood inoculated, on August 6, two white mice. They did not feed well on August 8 and 9, and were killed on August 10. In both animals both lungs showed very severe pneumonia; the spleen was much congested and large, the liver pale and somewhat enlarged. Neither the blood nor the spleen contained any bacilli.

Experiment 17.—Two white mice were inoculated on August 7. They were killed on August 13. One animal had very severe peritonitis; a large quantity of tenacious purulent exudation in the peritoneal cavity; pleuritis; and pneumonia in the apex of both lungs. The spleen of this animal was much enlarged. The second mouse had severe pneumonia of both sides, the spleen slightly enlarged; slight peritonitis.

Experiment 18.—Two guinea pigs were inoculated on August 7. They were killed on August 13. In both animals there was bilateral pneumonia; the spleen was not enlarged, the liver slightly enlarged.

CULTIVATION.

After 24 hours cultivation, in the incubator, of material of this ham IV, in the same manner as above-mentioned, fluid was obtained which was injected subcutaneously into—

Experiment 19.—Two white mice, on August 6. [It is necessary to mention here that in the microscopic slides that had been kept for 24 hours in the incubator, the growth of the sporules, and in connection with them of the bacillus filaments and bacillus rods, similar to those found in the ham IV., described and figured previously in Fig. I, was very distinct and abundant.] The two mice were killed on August 10. One of them showed severe pneumonia of both sides, the spleen was much enlarged, the liver pale and enlarged. In the other mouse there were two or three hæmorrhagic patches in each lung; the spleen was not enlarged.

Experiment 20.—Two guinea pigs were inoculated with the same cultivation on August 6. They were not feeding well on August 10, 11, and 12, and were killed on August 13. Both animals had severe pneumonia, very extensive on both sides; the bronchial glands were much enlarged. Peritonitis. The liver was slightly enlarged and showed on its surface a few white specks.

I received also a bottle containing viscera, hardened in spirit, of the man W. W. (*Case 1*), sent by Mr. Allen. Only part of the kidney was fit for microscopic examination. This organ exhibited severe parenchymatous inflammation, casts being present in most of the urinary tubules of the pyramids. The most interesting appearance, however, was shown by the afferent arterioles and capillaries of the Malpighian corpuscles of the cortex, they being distended and plugged by emboli of beautiful bacilli. See Figures 2 and 3.

E. KLEIN.

B.

EXTRACT from the Meteorological Register kept at Mansfield, by
Mr. WM. TYRER, F.M.S.

Date.	Barometer.		Readings of Hygrometer.				Thermometer, 9 p.m.	
	Morning.	Evening.	Morning.		Evening.		Max.	(Min.)
	In.	In.	Dry bulb.	Wet bulb.	Dry bulb.	Wet bulb.		
Saturday, June 12	30·027	29·978	47·6°	47·0°	53·4°	49·7°	67·0°	40·0°
Sunday, „ 13	29·985	30·023	62·8°	57·4°	58·7°	56·2°	71·6°	44·9°
Monday, „ 14	30·072	30·170	60·4°	57·6°	53·7°	52·4°	62·6°	51·7°
Tuesday, „ 15	30·129	30·072	50·3°	51·3°	50·8°	50·6°	56·9°	49·9°
Wednesday „ 16	30·050	30·201	53·7°	53·7°	54·7°	54·2°	55·8°	50·1°
Thursday, „ 17	30·227	30·251	55·2°	55·1°	55·9°	55·2°	69·8°	52·3°
Friday, „ 18	—	29·941	62·6°	58·6°	54·3°	53·7°	69·2°	46·5°
Saturday, „ 19	29·770	29·687	50·5°	50·5°	57·9°	57·6°	68·0°	47·5°

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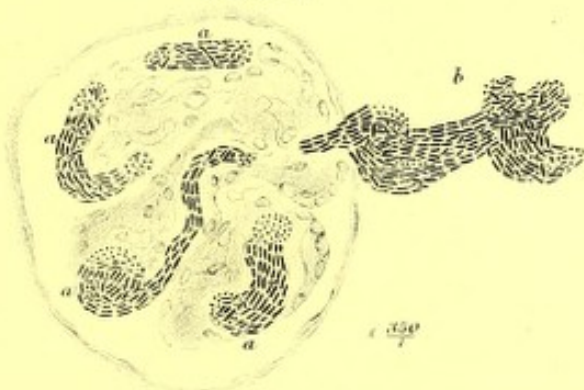
[12762.—200.—2/81.]

Figure 1.



Isolated muscle-fibre of horn 1, with sporules & bacilli on its surface.

Figure 2.



A Malpighian corpuscle of the kidney.
 a. Some of the capillaries of the glomerulus filled with & distended by bacilli.
 b. The afferent vessel plugged by bacilli.
 The bacilli are viewed endwise and sideways.
 They are much more numerous in the vessels than is shown in the drawing.

Figure 3.



Part of an arterial vessel plugged by bacilli.

