internal remedies for a fortnight only and "cured." No secondary manifestations were noticed.

2. The pains in the legs were markedly worse at night, and he also had occasionally slight nocturnal headache.

3. He married in 1881 at the age of 30. The following record gives the issue of his wife's pregnancies:

(a) Six months' child, stillborn, March, 1882.

(b) Seven months' child, stillborn; rash on trunk.

(c) Eight months' child; said to have been dead for 2 weeks before birth.

(d) Six months' child, stillborn.

(e) Female child, at full time, apparently healthy; is now 5 years old, and is in the Royal Infirmary with disease of the ulna and tibia.

(f) Miscarriage at two or three months.

(g) Male child, apparently healthy; died a fortnight after birth of "collapse of lungs."

(h) Miscarriage at 2nd month in 1893.

The condition of the patient, then, before treatment was as follows:—Paraplegia absolute (only slight movement of toes), anæsthesia complete, nearly up to umbilicus. Constant and severe pains in the legs and feet; absence of knee-jerks; paresis of the upper extremities; retention of urine; incontinence of feces; four large, deep bedsores over the sacral region, so that it would be difficult to find a more unpromising case for treatment.

He was put upon a water bed, the bladder and bowels were attended to, and the bedsores dressed with boracic powder. Daily inunction of 3j of mercurial ointment was commenced on January 9th, and for some time antipyrin (gr. xv) was given every evening on account of the pain in the legs.

A fortnight thereafter he could draw up his legs in bed, and every day further recovery was observed: the anæsthesia also was less marked, and gradually disappeared. By January 28th the retention of urine and incontinence of feces had passed away, and the antipyrin was stopped because the pains in the legs were gone.

The bedsores healed rapidly, and were quite cicatrised about the same time. On February 10th he was able to rise and walk a short distance in the ward, and after time massage was added to the other treatment. He could walk a longer distance every day, although his legs were tremulous at first. By February 28th the grasp of the hands was much stronger, the dynamometer registering 36 kilos in the right and 30 in the left hand, as compared with 10 kilos on admission. He left the infirmary on March 13th, and before leaving he was shown at a meeting of the Glasgow Pathological and Clinical Society. His recovery was perfect. He could walk as well as ever he did, and the knee-jerks even had returned.

Did time permit I might give you many other illustrations of the curious vagaries of syphilis, but I have said enough, I trust, to put you upon your guard, and to point the moral that in cases of a suspicious nature, it is well to give the patient the benefit of the doubt by inaugurating an energetic course of antisyphilitic treatment.

AN ADDRESS

ON THE SPREAD OF ENTERIC FEVER BY MEANS OF SEWAGE-CONTAMINATED SHELLFISH.¹

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SOME months ago an intelligent clergyman expressed surprise that with so many doctors there was any disease left. I made the obvious retort that it was even more surprising that with so many clergymen, sinners still abounded. The two cases are of course only comparable in so far as sin and disease are both caused by aberrations from the path of duty over which the individual or the community could exercise control. But the clergyman's remark is interesting, as illustrative of the lack of appreciation by even the educated laity of the difficulties connected with the prevention of disease. Even given a

known cause, how long before its practical removal is attempted, as witness the present almost complete lack of supervision in this country over the distribution and consumption of milk from tuberculous cows! But in too many instances our knowledge of the causation of disease is still most imperfect; and then our preventive measures must necessarily be empirical and uncertain.

Take such a disease as enteric fever. It is certain that this is caused by the inhalation, or probably oftener the swallowing, of a specific micro-organism. That this is most commonly conveyed by means of milk or water which has become specifically contaminated is well known. That the effluvia from defective drains sometimes cause it appears highly probable; though I doubt whether—having regard to the consideration that defective drains are extremely common and cases of enteric fever comparatively rare—it would be possible to satisfy the searcher after truth with a strongly logical mind that the relationship of cause and effect between bad drains and cases of enteric fever had been clearly established in any given cases.

When an outbreak of enteric fever comprising a considerable number of cases within a short time is being investigated, it is usually comparatively easy to discover the facts common to all. When, however, single cases are being investigated, the task is more difficult, and one has frequently to be contented with a lower degree of probability as to causation. I may perhaps be allowed to instance my own case.

On December 31st, 1895, I came home with headache and general *malaise*. Next morning I found that my temperature was over 102°, and I then passed through a well-marked attack of enteric fever followed by a relapse. How had this been acquired? I live in a house the sanitary condition of which is perfect to all tests. In the same house live three adults and two youths, who have remained perfectly well, notwithstanding the fact that I was nursed at my own home. In consequence of the information furnished by the Infectious Disease (Notification) Act, I am able to state that there were no other notified cases of enteric fever in connection with the milk supply to my household, and that there were no cases in the same neighbourhood, and therefore not the slightest reason to suppose that any accidental contamination of water mains had occurred.

The circumstances differentiating me from the rest of my household were as follows: On December 23rd and 24th, I was asked to see two patients at two different addresses, who were possibly suffering from enteric fever, but about whose cases the medical attendant had some doubt. Both of these patients, who were found to have enteric fever, were carefully examined by me, but there was not, so far as I remember, any faecal smearing of bed or body linen.

On December 23rd I examined a patient at the Borough Isolation Hospital, who had just been admitted for supposed enteric fever. He had acute peritonitis, which might or might not be due to perforation of the bowel in enteric fever. He died the same night, and next day I made a necropsy. There was general purulent peritonitis and a large number of typhoid ulcers, one of which had perforated. While removing the intestines from the abdominal cavity, they slipped back, and my face was splashed by the purulent and feculent contents of the peritoneum. Some of the material may have entered the nostrils or mouth, but I did not perceive this. I washed my face almost immediately afterwards. The first symptoms of enteric fever began eight days later. Had it been acquired at the necropsy or in visiting the enteric patients at their own homes? Few will hesitate in agreeing with me that the former was the cause, although a very rare one; but it is impossible to satisfy the objections which might be raised to this supposition by the critic. The matter must be left as it stands.

So, also, when we investigate small groups of cases of enteric fever occurring over a long period. Not only are we met with the difficulties necessarily associated with paucity of data, but we have also to choose between several possible origins of disease. Then comes the difficult determination of probability. Nothing is certain as to causation. It is all a question of probability, the degree of which varies infinitely between zero and infinity, between impossibility and certainty. The only certain point in the causation of disease

¹ Read at the Congress of the Sanitary Institute, Newcastle, Sept. 1896.

is that a cause exists; in actual life we can only indicate this cause in a given case, with a varying degree of probability. To use the definition of "cause" given by Jevons, by the cause of an event "we mean the circumstances which must have preceded it in order that the event should happen."

The essential cause of enteric fever is the specific bacillus of the disease. The secondary causes are the vehicles, be they water, milk, or shellfish or others, along with which this bacillus is mechanically ingested. This does not complete the definition of the cause of enteric fever. Something more is required. Of those drinking milk contaminated with enteric stools, on the average probably only 10 or 12 per cent. develop the disease. This might be explained on the supposition of accidental failure of the seed to take root. There are certain persons, however, in whom enteric fever, apart from accidental failure, will not develop, and we must therefore assume a share in the causation of enteric fever for certain favouring conditions of the system, resulting from inherited or acquired weakness.

The bearing of these preliminary remarks will be more evident when I have detailed the special circumstances that gave rise to the investigation the results of which I now give. Brighton has a well-earned reputation for freedom from preventable diseases, especially a disease like enteric fever, which is commonly associated with insanitary conditions. That an immense reduction has already been produced is evident from the following table. The same table shows the favourable position occupied by Brighton as compared with that of the metropolis.

Death-rate from "Fever" per 100,000 Inhabitants.

Year.	Brighton.	London.	Year	Brighton.	London.
1869	38.0	53.1	1883	24.6	27.3
1870	39.6	48.0	1884	14.5	25.4
1871	37.6	40.0	1885	16.2	17.0
1872	27.1	33.9	1886	11.5	17.2
1873	33.1	36.5	1887	11.6	16.2
1874	33.5	35.4	1888	13.2	17.8
1875	25.7	31.3	1889	15.8	14.0
1876	14.1	26.4	1890	11.3	15.5
1877	17.9	30.5	1891	11.2	14.2
1878	15.5	33.7	1892	6.9	10.7
1879	9.6	27.2	1893	12.7	16.6
1880	20.7	22.1	1894	9.0	14.9
1881	41.7	28.9	1895	11.7	
1882	24.9	27.6			

The table, however, while it indicates a very favourable state of matters when viewed from a comparative standpoint, shows that during the last ten years the rate of reduction in the fever death-rate has not been so rapid as previously. This is doubtless in part because there is less scope for improvement than in the past.

It suggests the view that the insanitary conditions to which enteric fever in the past was largely due have been in a large measure removed, while some cause apart from these must be invoked to account for a large share of the comparatively small amount of enteric fever still remaining.

My attention was first drawn, early in 1894, to the possibility of uncooked sewage-contaminated shellfish being a local cause of enteric fever by three cases, which I will now briefly narrate.

1. On March 4th, 1894, a fishmonger's errand boy, aged 13 years, began with enteric fever. There were in the same house five children under 10 years of age and three adults, who all, including the father and mother, remained well. About seventeen days before the onset of his illness the boy remembers that the foreman of the shop gave him three oysters. The drainage of this house was perfect. No other cases of enteric fever in connection with the same milk supply. No other members of this household took oysters.

2. On March 14th, 1894, a girl aged 13 years, began with enteric fever. She and her mother ate oysters frequently before the onset of illness. The mother had an attack of diarrhoea at time of onset of her child's fever, but did not keep to her bed. Drainage of this house was fairly good, and did not pass under the house. No other cases of enteric fever in connection with the same milk supply.

3. On March 17th, 1894, a man, aged 37, an invalid attendant, began with enteric fever. On February 28th he bought fifteen oysters from a barrow in the street. His wife declined to join in eating these. The man ate them all himself. The wife and one other adult living in the house have remained quite well. The drainage of this house was bad. The wife had lived in this house alone, her husband living at Havant until the day on which he had the oysters.

The first two of these cases are typical of a large number of others in which: (a) The only person eating the oysters was the only person acquiring enteric fever; or (b) other persons taking oysters had illness which stopped short of a

typical attack of enteric fever: while in both (a) and (b) no other ascribable cause of enteric fever was detected. The third case is typical of others (c) in which defective house drainage was found, in addition to the history of having eaten oysters within the period of incubation of enteric fever.

A fourth group of cases (d) may be made, in which only one person out of many eating oysters acquired enteric fever.

I propose to give illustrative cases belonging to each of these groups, as it appears to me that the strength of the evidence connecting shellfish with enteric fever can only be realised by a narration of such cases. Circumstantial facts which may from a mathematical standpoint be extremely weak, become strong when each link in the chain of evidence is visible.

GROUP A.

4. A labourer, aged 37 years, began to be ill with enteric fever on August 3rd, 1894. Three weeks before this he bought 50 oysters and took them home, where they were eaten by himself and wife. Both had enteric fever. Drainage perfect. No cause for suspecting the milk.

5. Mrs. E., wife of a fishmonger, was confined of her first child on September 19th, 1894. On November 9th she failed with enteric fever, having taken oysters on 7 or 8 occasions about 3 weeks before this date. Drainage of house good. No other case of illness in house. No other cases in connection with same milk supply.

6. Alice W., aged 32, a cook, in the habit of frequently eating oysters. The oysters were ordered in the name of the mistress of the house, who subsequently had a bill for a large amount for oysters, etc. Sanitary condition of house perfect. Five other adults live in the same house. None had oysters. All remained well.

7. S., aged 27, a journeyman printer, died of enteric fever, which began August 4th, 1895. For a month before his illness had been working overtime, and frequently eating oysters from a barrow. The brother-in-law of this patient, who took oysters at the same time as the above patient, had attacks of diarrhoea and abdominal pain on several occasions during the two months preceding and accompanying S.'s attack. Sanitary condition of house good. Wife and lodger in the same house remained well.

8. P. C. B., aged 36 years, began with enteric fever on January 10th, 1896. On December 24th and 26th, he had given to him and ate oysters at two shops. Drainage of house good. One other adult in same house, who has remained well.

MUSSEL CASE.

9. P., aged 20, a drayman, began with enteric fever on February 3rd, 1895. Was in the habit of purchasing mussels twice a-week. These he ate raw. He died of enteric fever. Four other adults in the same house, no illness, good drains.

GROUP B.

10. Mr. G., aged 30, a commercial traveller. Onset of illness, August 27th, 1895. Very fond of oysters. On August 3rd he had eight oysters. Mr. C., who accompanied him, had an equal number, and had a violent attack of diarrhoea a week later. Drainage of house good. Four other adults and two children live in the same house, all well.

11. Mr. and Mrs. M. had oysters on September 5th, and within twenty-four hours both had pains, sickness, and diarrhoea. Mrs. M. subsequently remained well. Mr. M. began with enteric fever on September 13th, 1895. House drainage good. Four other persons in the house remained well.

12. Mr. C., a commercial traveller, had oysters with a boy named B., fourteen days before onset of enteric fever on September 22nd, 1895. B. had an attack of diarrhoea, but did not take to his bed. Drainage good. Two adults and three children in the house remained well.

GROUP C.

13. On April 13th, 1896, George M., aged 25 years, began with enteric fever. On April 3rd his sweetheart brought him four oysters. At the time he ate these he was recovering from influenza. The sanitary arrangements of this house were defective. Five other adults and one child living in this house remained well.

14. D. G., aged 33 years, began with enteric fever on January 26th, 1894. Since the previous Christmas he had frequently sore throats, while he took oysters frequently. The drainage of the house was very defective. The other occupants of the house (servants) were quite well. No milk infection.

MUSSEL CASES.

15. E. B., aged 33 years, a commercial traveller, began with enteric fever on April 11th, 1894. For six months he had frequently, including one occasion a fortnight before the onset of his illness, eaten raw mussels. The drainage of the house was defective. The seven other persons living in this house did not eat mussels. None of them had been ill.

16. Mrs. R., aged 40, a charwoman, began to be ill with enteric fever on September 6th, 1895, and her lodger, G. E., aged 20, on September 4th. Each ate six large mussels about three weeks previously. These were gathered by G. E. in the bed of a river below the point where the sewage of a town enters the river. No one else in the house ate mussels. The drainage was defective. No other cases of illness among the four other adults and one child in the house.

GROUP D.

17. A man, aged 18, carpenter, started with enteric fever on April 4th, 1896. Fourteen days earlier he and his father and three sisters bought and ate some raw mussels. The father had an attack of diarrhoea at the date of onset of his son's illness, the diarrhoea lasting for three days. The three sisters remained well. Drainage good.

18. On April 26th, D., aged 25 years, began with enteric fever. Since April 5th took oysters every evening up to the onset of his illness. Two other persons in the house ate a very few oysters from the same source when the patient could not eat his usual allowance and have remained

well. The above patient suffers from phthisis, and was ordered the oysters on that account.

19. Dr. —, aged 58 years, physician to a metropolitan hospital, arrived in the town on January 4th, 1896, from London. On the 5th he was present at a dinner party with about nine other persons. At this dinner he ate six oysters. He subsequently complained that one of the oysters had a disagreeable taste. He began to be ill on January 15th, with enteric fever. The sanitary condition of his own house in London and of the house in which he stayed in the town is perfect. Of the other members of the dinner party, all remained well except a gentleman, aged 63 years, who had what is described as "intestinal catarrh" a few weeks (apparently about a month) after the party.

It would be quite easy to multiply instances; but those already given will suffice to indicate the groups of cases in which there was the strongest reason to conclude that shellfish contaminated with sewage had caused enteric fever. Before giving the further evidence in confirmation of this view, I append the following statistical tables.

Cases of Enteric Fever notified since July 1st, 1893.

Year.	Number of Cases subsequently found not to be Enteric Fever.	No. of Cases of Enteric Fever the infection of which was imported from other districts.	No. of cases apparently originating in the town, in which—				
			(a) It was stated that no oysters or other shellfish had been eaten.	(b) It was doubtful as to whether shellfish had been eaten.	(c) Origin was directly ascribable to oysters.	(d) Origin was directly ascribable to other shellfish.	Total Cases of Local Origin.
1893 (From Midsummer)	1	16	19	6	6*	...	31
1894	15	15†	33	1	16	5*	55
1895	12	19	37	...	7‡	12§	56
1896 (Up to Aug. 4th)	8	7†	26	3	7*	3*	39
	36	57	115	10	36	20	181

* No secondary cases.

† Two cases ascribable to oysters. In a large proportion of cases no history could be obtained.

‡ Including one secondary case.

§ Including four secondary cases due to personal infection.

|| Including two doubtful cases.

Thus the total number of cases originating in the towns during 1893-4-5-6 was 181.

Of these the percentage (a) in which a negative history as regards shellfish was obtained was ... 63.5

(b) In which the history was doubtful was ... 5.5

(c) In which the origin was ascribable to oysters ... 19.9

(d) In which the origin was ascribable to other shellfish... 11.1

100.0

Milk Supply.—The following statement as to milk supply deals with the cases of enteric fever having a local origin during 1894-5-6.

In 1894 there were 21 cases ascribable to shellfish. These had 14 distinct milk supplies. Two cases were supplied with condensed milk. One milkman supplied two patients in different streets. In 3 cases the milk supply was unknown.

The 33 cases ascribed to other causes than shellfish had 15 milk supplies where this could be ascertained. In 11 cases the supply was unknown. One milkman supplied 3 cases, and 2 milkmen supplied 2 cases each.

In 1895 there were 14 primary cases ascribable to shellfish, having 5 known milk supplies, 2 from condensed milk, and 5 unknown. Two milkmen supplied 2 cases each.

The 37 remaining cases had 14 known milk supplies. In 9 cases the milk supply was unknown. There was one milk supply for 5 cases (these occurred in a public institution, and were caused by personal infection), one milk supply for 5 cases also due to personal infection, and one supply for 3 other cases. Three milkmen supplied 2 cases each.

In 1896 the 10 cases ascribable to shellfish had eight sources of milk supply and two from condensed milk.

The 26 remaining cases had twenty-one sources of milk supply. There were 3 cases in connection with one milk supply.

It should be stated that in every instance the ultimate source of the milk supply was ascertained. The facts, it need hardly be said, do not lend themselves to the supposition

that milk infection was operating in either of the two groups of cases; but much less so in the cases ascribable to shellfish than in those ascribable to other causes. The source of milk supply was not always ascertainable: but so far as known the facts for 1894-5-6 are as follows:

Forty-five cases ascribable to shellfish had thirty-three known separate milk supplies.

Ninety-three cases not ascribable to shellfish had 47 known separate milk supplies.

Streets affected.—The following are the data as to streets in which cases of enteric fever occurred in 1894-5-6.

1894. Shellfish cases—21 cases in 19 streets. In two instances in different streets 2 cases occurred in one house.

Non-shellfish cases—33 cases in 24 streets. Three cases in one house in two different streets, and 3 other cases in single houses in one of those streets. No drain common to more than one house, in these or any of the subsequent cases.

1895. Shellfish cases—14 streets involved in 14 primary cases; 4 secondary cases, from personal infection in one house, and 1 secondary case in another house.

Non-shellfish cases—27 streets involved in 37 cases, 4 cases in one house in E. street, 3 cases in one house and 1 case each in two houses in C. street, 2 cases in one house in P. street, ditto in S. street, and 5 cases in one public institution.

1896. Shellfish cases—10 streets involved in 10 cases.

Non-shellfish cases—22 streets involved in 26 cases, 2 cases in one house in two streets, 2 cases in two houses in one street.

Thus in the shellfish cases in 1894-5-6, 45 cases occurred in 43 streets; while in the cases ascribable to other causes, 96 cases occurred in 73 streets.

It is evident therefore that there was no common cause at work in any special neighbourhood, such as infection through sewers or water mains. It may be added that the streets in question were scattered throughout the whole town, not being specially clustered in any one district.

The 115 cases in which a negative history as regards shellfish was obtained require further attention. The 96 of these cases occurring in 1894-95-96 may be arranged as follows:

	1894.	1895.	1896.*	Totals.
A. There was a history of personal infection from some preceding case ...	7	14	3	24
B. There were defective house drains, but no history of other cases ...	12	10	12	34
C. No evidence as to source of the disease could be ascertained, though inquiries were made...	14	13	11	38
	33	37	26	96

* To August 4th.

The cases under heading (A) require little further comment. They illustrate the too little recognised dangers of nursing enteric fever by amateurs, or in houses where the best arrangements are impracticable.

The cases under heading (B) comprise houses in which along with cases of enteric fever defective drains were found. It may be stated that there were usually drains passing under houses, and the test employed was the hydraulic test, which reveals defects often not discovered by volatile agents. All new drains in the town are thus tested, and during the three years, 1893-95, 1,739 old drains which had been found defective were relaid and made absolutely water-tight.

In the cases under the heading (C) there was a negative history as to shellfish, there was no history of possible infection from previous cases, and no defects of house sanitation could be detected. It would thus appear that in 38 local cases out of 150—that is, in 25.3 per cent. of the total local cases—no source of the disease could be detected. It must, however, be remembered that in urban conditions of life it is much more difficult than in rural conditions of life to trace the antecedents of each patient during the three weeks preceding his attack. Sometimes the patient himself could not be questioned, and we had to trust to the recollection of the wife or some other relative who was not completely cognisant of the doings of the patient at the time when the infection was received. I cannot, therefore, think that there is much weight in the argument that some unknown cause or causes

which operated in the 38 cases may have been at work in the 56 cases which have been ascribed by me to sewage-contaminated shellfish. The slight importance which might attach to such an argument disappears when we weigh the facts in connection with each individual case, and the proof to be given later of gross contamination by sewage of other shellfish from the same source as those ostensibly causing the cases of enteric fever.

The cases under heading (B) are more open to difficulty. Here were 34 cases of enteric fever, in which the only ascertainable circumstance bearing on the cases was the presence of defective house sanitation. There is no town which has done more than that in which I live to perfect its system of house sanitation, and each year the proportion of houses which will bear the most rigid tests of modern sanitation is largely increased. It is very doubtful whether many of the cases of enteric fever in which defective house drainage was found were really caused by this. Assuming, however, that they were caused by drain effluvia, we have further to consider the fact that in 21, not including 5 secondary cases due to infection, of the shellfish cases occurring in the three years, 1894-6, there were also defective house drains, while in 24 of the shellfish cases during the same years the house drains were perfect. In the shellfish cases associated with defective drains may not the latter have been the cause of the enteric fever? In answering such a question, we must have regard to considerations of probability. There is no such thing as certainty in actual life. The only problems capable of actual proof or demonstration are mathematical. It is our duty and practice in daily life to decide in each given case according to the balance of probability. We cannot state this better than in the words of Bishop Butler in his *Analogy*.²

"In questions of difficulty, or such as are thought so, where more satisfactory evidence cannot be had or is not seen, if the result of examination be that there appears on the whole any, the lowest presumption on one side and none on the other, or a greater presumption on one side, though in the lowest degree greater, this determines the question even in matters of speculation; and in matters of practice will lay us under an absolute and formal obligation in point of prudence and of interest, to act upon that presumption or low probability, though it be so low as to leave the mind in very great doubt which is the truth."

Applying this valuable and authoritative rule to our present case, there can be no doubt that enteric fever is much more likely to be caused by the eating of sewage-contaminated shellfish than by the inhalation of drain effluvia. Nearly every large outbreak of enteric fever in recent years has been traced to the swallowing of specifically contaminated water or milk. As investigation has become more exact, the number of outbreaks attributed to the inhalation of effluvia has steadily diminished, and it is generally admitted that enteric fever is much more commonly caused by the ingestion than by the inhalation of the specific infection. The case may be put thus:—Given evidence that the shellfish ingested by the about-to-be patients are contaminated by sewage (*vide postea*), and given that the ingestion of sewage-contaminated food is much more likely to cause enteric fever than the inhalation of sewage-contaminated air, we are bound, in view of the balance of probability, to conclude that when these two possible causes are present, it is the shellfish which are the active causes of enteric fever in these particular cases. Such a conclusion is consonant with reason and common sense, even where there is but a "presumption or low probability," but I venture to say that in this instance we have to deal with a high degree of probability, which leaves very little ground for dispute.

One further point remains to be considered, in reference to the group of cases in which one person only out of several persons eating shellfish developed enteric fever. This simply indicates what might, on *a priori* considerations, have been anticipated.

Not everyone receiving a specific infection develops the specific disease. There must be a suitable soil as well as seed.

There is no reason to suppose that every oyster in a given purchase is specifically contaminated with the typhoid

bacillus. As a matter of probability one would not expect this. The circumstances are totally different from epidemics of enteric fever originating from contaminated milk or water. Here it is reasonable to expect that the virus might be uniformly diffused throughout the fluid. And yet in such epidemics only a certain proportion of the persons drinking the infected material develop the disease.

In the famous Marylebone outbreak of enteric fever in 1873, of 760 families supplied from the infecting dairy, 15 per cent. were invaded by the disease.

We should expect on *a priori* grounds that the percentage of persons attacked (stated in terms of the total number of persons partaking of the food in question) would be very much smaller in a shellfish outbreak than in an outbreak caused by infected liquids. The exact number of persons suffering from eating the oysters it is impossible to ascertain. Many slighter cases of actual illness escape detection.

Local Conditions affecting the Shellfish.—We have now given the direct evidence connecting the cases previously tabulated with the consumption of oysters or other shellfish. Nearly all these oysters and mussels (there were 36 cases ascribed to oysters and 20 to mussels) were directly traced to one particular source. At this place the condition of things was such that the oysters laid down between high and low water mark were exposed to contamination with sea water containing a large amount of suspended sewage twice a day; and the mud remaining behind in contact with the oysters showed evidence of the presence in it of sewage.

The sewers discharging near these oysters contained the sewage of several thousand persons.

The mussels indicated in the preceding cases grew in a river bed below the point of discharge of the sewerage of several thousand persons.

Bacterioscopically the water derived from close to the oysters was certified by Dr. Klein, F.R.S., to show "distinct evidence of being polluted with sewage to a considerable degree."

Connection of Cases with Cases probably contaminating the Shellfish.—Only one further link in the chain of evidence is required to connect the oysters and mussels with the cases of enteric fever in the town. Were there cases of enteric fever, the excreta from which drained into the river from which the oysters and mussels were derived, rendering it possible for them to cause any of the cases of enteric fever ascribed to shellfish? The cases notified in a portion of this drainage area under the Infectious Disease (Notification) Act have been most kindly placed at my disposal. From another portion I can obtain no information, and the following tabular statement is to this extent incomplete. It is further incomplete, owing to imperfect notification. Thus, in 1895, there were two deaths from enteric fever and only five cases were notified, which gives a fatality of 40 per cent; while in 1894 there were three deaths out of five cases notified, giving a fatality of 60 per cent. In view of these figures it is fairly certain that a large share of the cases of enteric fever in these villages remained unnotified, though they none the less polluted the water in which the oysters were bathed twice a day.

The following are the dates of notification of cases of enteric fever in the districts draining into the river near the oyster and mussel beds:—

1893.—March 26th; May 10th, 27th; August 4th, 14th; September 13th; October 14th; November 7th.

1894.—June 16th; July 31st; August 27th; September 6th; October 25th.

1895.—January 27th; March 8th; October 1st, 6th; November 21st.

1896.—February 17th; March 15th.

The cases of enteric fever attributable to oysters and mussels from the same source were notified as follows:—

1893.—August 10th; September 3rd, 25th; October 4th, 26th; November 21st; December 27th.

1894.—February 1st; March 6th, 15th, 20th, 26th, 28th; April 3rd, 3rd, 18th; July 14th; August 14th, 28th; October 19th; November 19th, 26th; December 2nd, 8th.

1895.—February 15th; August 26th; September 3rd, 8th, 15th, 18th, 25th, October 6th; November 19th, 26th; December 3rd, 6th.

1896.—January 2nd, 2nd, 18th, 20th; April 15th, 23rd; May 4th.

Notwithstanding these defects, the tabular statement appended appears to me most suggestive. The longest apparent interval between a case of enteric fever notified in the villages abutting on the river bank on which the oyster ponds are placed and corresponding cases attributed to the eating of oysters derived from these ponds is between three and four

² Vol. I, p. 3, Clarendon Press Edition.

months. In actual fact, it is reasonable to believe that it was much less than this.

This raises the question as to how long the typhoid bacillus will survive under the conditions here described.

Experiments on Viability of Typhoid Bacilli in Oysters.

A.—Professor Robert Boyce, M.B., Professor of Pathology, and Professor W. A. Herdman, D.Sc., F.R.S., Professor of Zoology in University College, Liverpool, described at the Ipswich meeting (1895) of the British Association experiments made by them.

They summarise their experiments bearing on the present question as follows:

The toleration of sewage, etc.—It was found that oysters could, up to a certain point, render clear sewage-contaminated water, and that they could live for a prolonged period in water rendered opaque by the addition of faecal matter; and that the faecal matter obtained from cases of typhoid was more inimical than that obtained from healthy subjects.

The infection of the oyster by the micro-organisms.—The results of the bacteriological examination of the water of the pallial cavity of the oyster, and of the contents of the rectum, showed that in the cases of those laid down in the open water of the bay the colonies present were especially small in number, whilst in those laid down in proximity to the drain pipe the number was enormous (for example, 17,000 as against ten in the former case). It was found that more organisms were present in the pallial cavity than in the rectum. In the case of the oysters grown in water infected with the bacillus typhosus, it was found that there was no apparent increase of the organisms, but that they could be identified in cultures taken from the water of the pallial cavity and rectum fourteen days after infection.

"It is found that the typhoid bacillus will not flourish in clean salt water, and our experiments seem to show, so far, that it decreases in numbers in its passage along the alimentary canal of the oyster."

B.—Dr. Charles J. Foote, of the Yale Medical School, U.S.A., found that the typhoid bacilli were alive forty-eight hours after being placed in the interior of the shell of a living oyster, and the same after inoculation into the oyster. Experiment was not continued beyond this time.

Experiments on Viability of Typhoid Bacilli in Sea Water.—Experiments of Giaksa show that the typhoid bacilli can maintain their vitality in sea water, sterilised or not, for many days.³

Experiments of Freytag show that the typhoid bacillus will live six months in a concentrated solution of salt.

Foster has also shown that the typhoid bacillus will resist the action of a saturated solution of salt for weeks, and even for months.⁴

Viability of Typhoid Bacilli in Fresh Water.—Cassedeat, examining the drinking water of Marseilles (a very hotbed of waterborne typhoid fever), could not find the characteristic bacilli in 1 out of 250 cultivations made of 70 specimens of water, though he found closely resembling bacilli.

The reason was not, as pointed out by Cassedeat, because the typhoid bacillus will not live in water, as in distilled water to which a cultivation of typhoid bacilli was purposely added he could distinguish their presence at the end of forty-four days, and when they were added to distilled water along with half a dozen other forms, they were still living and active at the end of seventeen days.⁵

Klein⁶ found in some experiments that "by adding in the first instance large numbers of typhoid bacilli—always, be it noted, along with a trace of nutritive material—to samples of London water, sterilised by filtration before inoculation, living bacilli were recoverable therefrom in two out of the three samples even after the lapse of eight weeks."

*Experiments on Viability of Typhoid Bacilli in Sewage.*⁷—

³ BRITISH MEDICAL JOURNAL, February 16th, 1895, p. 392.

⁴ Dr. C. J. Foote: Report of Connecticut State Board of Health (Report for 1894, p. 265).

⁵ *Annales de l'Institut Pasteur*, October 25th, 1890.

⁶ Twenty-fourth Annual Report of the Local Government Board, Supplement of the Medical Officer, page 417.

⁷ These experiments, while perfectly trustworthy on the minimum side, almost certainly do not indicate the maximum duration of life of the typhoid bacillus in the soil, as it is impossible to say that the negative results obtained at the end of a given time prove the actual absence of living typhoid bacilli.

Messrs. Lawes and Andrewes, in their report to the London County Council, showed that typhoid bacilli inoculated into sterilised sewage died within a few days when the sewage was maintained at 37° C. At 20° C., the ordinary temperature of the air, the duration of their life was longer, but probably not over a fortnight.

It is necessary to note that:

(a) These were laboratory experiments, not made under natural conditions.

(b) Only small quantities of the sewage were tested, and the negative results are therefore not conclusive.

(c) Further, it has been shown above that the typhoid bacilli will live for months in sea water; and that they will live in oysters inoculated with them at least fourteen days. (Boyce and Herdman.)

Later experiments made by Klein on similar lines⁸ showed that colonies of typhoid bacilli remained in sterile sewage at the end of three weeks from the time of its artificial inoculation. Furthermore, in sterile sewage to which nitrates had been added the typhoid bacilli continued to exist in enormous numbers at the end of eight weeks.

Duration of Viability of Typhoid Bacilli in Soil.—This has an important bearing on the infection of the oysters to which the preceding cases are ascribed, as these were derived from ponds in close propinquity to enormous mud banks, largely composed of sewage sludge.

Stephenson and Murphy's *Hygiene*, vol. ii, p. 320, states: "It is now generally admitted that the enteric fever organism is capable of thriving in the soil. It is a common experience in rural districts, and apart from sewerage systems, to observe the disease hang about a particular locality. Once introduced into a village, it will often recur regularly as the autumn comes round, invading households deriving their water supply from different wells, households not possessing community of insanitary conditions of a sort to explain the fever. This seems consistent with a specific organism capable of abiding in the soil, multiplying therein at its proper season, and so contaminating the soil over considerable areas."

Dr. Sims Woodhead mentions that typhoid bacilli in faeces kept in a sterilised tube remained alive at the end of 15 days.⁹

MM. Grancher and Deschamps came to the conclusion, as the result of their researches, that the typhoid bacillus "retains its life in the midst of all the organisms soil contains 5½ months after it has been sown."¹⁰

Karlinski found that the typhoid bacillus lives in earth three months; that when buried with typhoid excreta its duration of life was shorter than when buried with blood; and that it lived longer in the deeper than in the more superficial layers.

Dr. Dempster (1894) found that in sterilised soils the typhoid bacillus retained its vitality as follows:

1. Dry soils, evaporation not prevented, white crystal sand up to ninth day; yellow sand up to eighteenth day; garden earth up to fourteenth day.

2. Moist soils, evaporation not prevented, in white sand bacilli alive on twenty-third day; in yellow sand and garden earth forty-second day.

SUMMARY OF EVIDENCE.

The evidence associating as cause and effect the eating of shellfish with the cases of enteric fever may be thus summarised:

A. There were four groups of cases of enteric fever ascribable to shellfish.

1. The only person eating shellfish was the only person acquiring enteric fever.

2. Other persons eating shellfish at the same time had minor ailments.

3. Defective house drains were found in the houses in which the eating of shellfish was followed by enteric fever.

4. Not all the persons eating shellfish developed enteric fever.

In the first group, the proof is as positive as it is possible

⁸ Twenty-fourth Supplement of the Medical Officer to the Local Government Board, p. 407.

⁹ *Bacteria and their Products*, p. 198.

¹⁰ *Archiv de Med. Experim. et d'Anatom. Path.*, No. 1, January 7, 1869, quoted in *Public Health*, p. 57, vol. iii.

to have it in such an inquiry; and the general statement that there is danger in eating shellfish from certain sources, and that the public have a right to be protected from this danger may be based on these cases.

The evidence derived from the second group of cases strongly confirms this conclusion.

In the third group we have to balance probabilities. Knowing that enteric fever is much more generally traced to contaminated food than to the inhalation of drain or sewer effluvia, and assuming that the shellfish in question (*vide postea*) were contaminated by sewage, the weight of probability, which as practical men we are bound to accept, is greatly on the side of the view that these cases were caused by eating the sewage-contaminated shellfish, and not by inhaling drain effluvia.

In the fourth group, we note that

(a) A special soil as well as a special seed is required to produce enteric fever.

(b) It is not reasonable to assume that every shellfish from a sewage-contaminated source contains the typhoid bacillus.

(c) Even when an outbreak of enteric fever is caused by contaminated milk or water, only a small percentage of the persons drinking these are attacked.

B.—1. The ponds from which the oysters were derived and the bed of the river from which the mussels were derived, to which the preceding cases are ascribed, were subject to gross contamination by sewage.

2. The water and mud from the oyster pond gave bacterioscopic evidence of sewage contamination.

3. There were cases of enteric fever in the districts draining into the above river, in close contiguity of time to the cases which I have ascribed to oysters and mussels from this source.

ADDENDUM.

The following point as to age and sex distribution of the cases ascribed to shellfish as compared with that of other cases, although I do not wish to press it, appears to have some significance.

In the Three Years, 1894-5-6.

	Males.	Females.
(a) Cases in which there was a negative history as to shellfish	44	53
(b) Cases imported into the town	21	20
(c) Cases attributed to shellfish	30	21

Thus among the case attributed to shellfish, 58.8 per cent. of the cases were among males, while in imported cases (in which the question of shellfish could not be worked out) the proportion of males and females was nearly equal; and among patients in which there was a negative history as to shellfish, only 44.9 per cent. of the cases were among males. It is notorious that oyster eating is much more largely a male than a female indulgence.

In the three years 1894-5-6:

	Aged Under 20.	Aged 20 to 30.	Aged 30 & over.
(a) Cases in which there was a negative history as to shellfish	44	16	36
(b) Cases imported into the town	17	10	14
(c) Cases attributed to shellfish	18	15	18

Thus among the cases attributed to shellfish, 61.1 per cent. of the cases were of adults over 20, while in imported cases 58.5 per cent. were of adults over 20; and in cases in which there was a negative history as to shellfish, 54.2 per cent. of the cases were of adults over 20.

The list of occupations is also very suggestive. It can scarcely be a coincidence that occupations like the following should preponderate among the shellfish cases:

Insurance agent	Wife of fishmonger
Betting agent	City man
Manager of theatre	Merchant
Publican	Wife of caterer
Waggonette driver	Medical practitioner
Police constable	Restaurant keeper
Commercial traveller	Errand boy at fishmonger's shop.

Five of the patients were convalescents from some other ailment, for whom oysters had been ordered.

I have now completed my task. It may be interesting to add that the Corporation of Brighton, anxious to ensure their visitors and residents from imported as they have done from indigenous sources of disease, attempted during last session

of Parliament to obtain the local powers embodied in the following clause of their Local Improvement Bill.

In case the medical officer of health is in possession of evidence that any person in the borough is suffering from infectious disease attributable to the consumption of shellfish supplied within the borough, from any pond, river, or other place, situate within or without the borough, in which shellfish are commonly kept, bred or cultivated, and in which pond, river, or place such shellfish have been (or are liable to be) exposed to contamination by sewage, or that the consumption of shellfish from such pond, river, or place is likely to cause infectious disease to any person residing in the borough, such medical officer shall, if authorised in that behalf by an order of a justice having jurisdiction in the locality in which such pond, river, or place is situate, have power to inspect such pond, river, or place, and all shellfish, matters and things therein, and if on such inspection the medical officer of health is of opinion that the infectious disease is or is likely to be caused by the consumption of shellfish supplied from such pond, river, or place, he shall report thereon to the Corporation or to the Sanitary Committee of the Council, and the Corporation or the Sanitary Committee, as the case may be, may thereupon give notice to the person by whom such shellfish is so kept, bred, or cultivated, to appear before them within such time, not being less than twenty-four hours, as shall be specified in the notice, to show cause why an order should not be made prohibiting the supply within the borough of any shellfish from such pond, river, or place until such order has been withdrawn by the Corporation or the Sanitary Committee as the case may be; and if in the opinion of the Corporation or the Sanitary Committee, as the case may be, such person fails to show such cause, then the Corporation or such Committee, as the case may be, may make such order as aforesaid, and the Corporation or such Committee, as the case may be, shall forthwith give notice of the fact to the sanitary authority and County Council (if any) of the district or county in which such pond, river, or place is situate, and also to the Local Government Board. An order made by the Corporation or such Committee as aforesaid in pursuance of this section shall be forthwith withdrawn on the Corporation or such Committee, as the case may be, or the medical officer of health being satisfied that the cause of the infection has been removed. Any person refusing to permit the medical officer of health, on the production of such order as aforesaid, to inspect any such pond, river, or place, or after any such order prohibiting the supply of shellfish as aforesaid has been given supplying within the borough any shellfish from such pond, river, or place, in contravention of such order, or selling it for consumption in the borough, shall be liable to a penalty not exceeding £5, and to a daily penalty not exceeding 40s. Provided always that proceedings in respect of such offence shall be taken before the justices of the peace having jurisdiction in the locality where the said pond, river, or place is situate. Provided that no person on whom an order prohibiting the supply of such shellfish has been made by the Corporation or such Committee as aforesaid shall be liable to an action for breach of contract if the breach be due to such order. Every person who shall wilfully obstruct such medical officer or other officer of the Corporation assisting him in the exercise of the powers of this section shall be liable for such offence to a penalty not exceeding £5.

It was drafted so as to give similar powers to those conferred on local authorities adopting the Act by the Infectious Disease Prevention Act, relating to milk; and the mode of procedure is the same in both cases. The Corporation through their counsel intimated to the Parliamentary Committee their willingness to accept any power of appeal to the Court of Quarter Sessions or to the Local Government Board which might be suggested.

The clause was disallowed. It was opposed by neighbouring local authorities, because it introduced the "vicious principle" of inspection by a medical officer of health outside his own district; and by the Local Government Board, on the ground, I believe, that any powers to be given relative to shellfish should be general and not local, and that they were at that time engaged through one of their medical inspectors on an investigation of the whole subject. The plan of the Local Government Board is one contrary both to precedent and to the public interests. The majority of the important health clauses of the Public Health Amendment and the Infectious Disease Prevention Acts were embodied in Local Acts obtained by various Corporations throughout the country for years before they were crystallised into the above-named Adoptive Acts. It is not creditable to the Local Government Board that it should lag behind local authorities in their attempts to secure more efficient means to prevent the spread of disease, and still less so that the Board should obstruct these local authorities in their attempts.

The opposition of neighbouring local authorities raises a point which has already been settled in principle in favour of the clauses promoted by the Brighton Corporation in the powers relating to milk above referred to. If it is undesirable that any medical officer of health should be disallowed to trace the disease arising within his district to its probable source without his district, there is certainly need in this, as in many other matters, for the immediate co-operation of inspectors of the Local Government Board to prevent the continued existence of sources of disease which the local health officials are not allowed to investigate.