A SEVERE OUTBREAK OF FOOD INFECTION CAUSED BY A PARATYPHOID CARRIER[1].

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The outbreak of food infection which we are about to describe is of interest from more than one point of view. Not only was it possible to determine the organism which caused the outbreak and to trace its source to a paratyphoid carrier, but the bacteriological results yielded an important contribution to the difficult question of the *differentiation of Bacillus paratyphosus* B. and *B. enteritidis*, which for some years has been much discussed among bacteriologists[2].

The outbreak of the epidemic in question, of which full particulars are given in *The Journal of The Royal Institute of Public Health* for December 1910, occurred in the beginning of August 1910 in Wrexham and its neighbourhood. More than a hundred persons were affected, and five of the sufferers died. The symptoms were those of very severe meat poisoning, such as sickness, vomiting, much abdominal pain, diarrhoea, great weakness, etc.

It was easily found that all these persons had eaten pork pies originating from the same baker. The pies in question were all manufactured on the 5th of August, and sold on the 6th. The symptoms for the most part appeared about 12 hours after the pies were eaten.

As suspicion was fixed on the pies as the cause of the illness, the Medical Officer of Health of the district (Dr Llewelyn Williams) took

[1] Those of our experiments which are purely of bacteriological interest will be published elsewhere.

[2] One of us has made similar investigations on the pathogenicity of *Bacillus typhi murium* to man, which are confirmed by the results of this inquiry. *Vide* R. Trommsdorff (1906), *Archiv für Hygiene*, Vol. LV. p. 279.

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steps to obtain one of the suspected pies (Pie 1) for investigation, besides a portion of a pie (Pie 2) the remainder of which had caused the death of a person. These specimens were at once sent to the laboratories of The Royal Institute of Public Health.

It may be mentioned here that investigations in the Chemical Department of the Institute failed to detect any mineral or other poison in either specimen of pie, or in any of the ingredients subsequently received.

Both from Pies 1 and 2 emulsions were made. From these, direct cultures were taken, mice and rats fed, and mice, rats, and guinea-pigs injected. All of these animals died, with the exception of the rats. Their organs and blood throughout contained bacteria, which yielded colonies behaving in all respects like those in cultures obtained directly from the pies, growing blue on Drigalski, remaining colourless on Endo, and being easily recognisable as representatives of the hog-cholera group, by their motility, form, and cultural tests (no indole, gelatin not liquefied, gas and acid in glucose, no fermentation in milk and cane-sugar, fluorescence in neutral-red agar, formation of alkali in litmus whey), as well as by agglutination tests. The same bacillus could be cultivated from the blood and organs of mice and guinea-pigs which had been injected with the bacilli obtained from Pie 1, and from mice which had been fed with the same, and which had all died.

Further, from an elderly woman, who had been ill some 14 days and subsequently died, the heart, blood, organs, and faeces were submitted for examination. All the organs were found to be congested, and in the small intestine and caecum many superficial ulcers were present. The bacteriological investigation of the blood obtained from the heart yielded a pure culture of the same bacillus which had been found in Pies 1 and 2. Drigalski plates made from the various organs and faeces showed numerous blue colonies. On account of the wealth of material thus obtained the identity only of the colonies cultivated from the liver was exactly determined.

Further, the several specimens of blood from patients who had suffered were received for the agglutination test. The results of this test, which was carried out with different bacterial strains, can be seen in Table A. Four of the specimens (1—4) gave strong positive results, the fifth (No. 5) gave a strongly suspicious reaction.

The sera of persons who had eaten mutton pies from the same bakehouse, and who were said to have had abdominal pain, were regarded as a control.

TABLE A.

Specimens of serum taken 18. VIII. 10	Specimens of serum from sick persons who had eaten pork pies					Specimens of serum from persons who had eaten mutton pies		
Serum No. :—	1	2	3	4	5	6	7	8
Register No. :—	328	329	331	332	330	369	371	373
(1) Culture No. 1 (direct culture from Pie 1)	—	—	—	—	—	—	—	—
(2) Culture No. 5 (culture from heart blood of guinea-pig injected with direct culture from Pie 1 (culture No. 1))	2500	1280	160	320	80	—	—	—
(3) Culture No. 11 (from heart blood of guinea-pig injected with direct culture from Pie 2)	—	1280	160	320	80	—	—	—
(4) Culture No. 17 (from heart blood of fatal human case)	—	—	—	—	—	—	—	—
(5) *B. paratyphosus* B.[1] ...	320	1280	160	320	80	—	—	—
(6) *B. enteritidis*[1]	40	160	160	320	80	—	—	—
(7) *B. paratyphosus* A.[1] ...	40	40	40	160	40	—	—	—

A more detailed discussion of these results will follow.

We further received specimens of blood from three relatives of the person who died, and whose blood and organs had been sent for examination. These persons had assisted in the nursing of the deceased woman and, not having eaten any of the pies, were attacked with symptoms exactly similar to those of the woman they had nursed. Further, the son of the deceased woman died after some 14 days' illness, the death certificate giving gastro-enteritis as the cause. It was not possible for us to obtain in this latter case any postmortem material or excrement.

The results of the agglutination tests in the three attendants are given in Table B.

TABLE B.

Specimens of blood taken 13. IX. 10	Specimens of serum of persons who had nursed a fatal case, and had been attacked with a similar illness		
Serum No. :—	1	2	3
Register No. :—	393	394	395
(1) Culture No. 1 (direct from Pie 1) ...	60	240	60 + 120 ±
(2) Culture No. 5 (from heart blood of guinea-pig injected with direct culture from Pie 1 (culture No. 1))	60	240	120 + 240 ±
(3) Culture No. 17 (from heart blood of fatal human case)	60	60	120 + 240 ±
(4) *B. paratyphosus* B.[1]	60	120	120 + 240 ±

Two of the sera gave a strongly positive result.

[1] We are indebted for these strains to the courtesy of Dr Prausnitz of the Metropolitan Asylums Board.

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From this it is clear that the organisms found in the two specimens of suspected pork pies, and which were identical with that obtained from the heart blood and liver of the deceased person, were members of the hog-cholera group.

Further, the specific agglutinations for these bacteria, as well as for typical representatives of the hog-cholera group, were detected in the blood of five persons who had partaken of the pies, and who suffered in consequence, as well as in two other persons who had not eaten any of the pies but who had been engaged in nursing a fatal case consequent upon such consumption.

It is therefore established that the organisms isolated from the pork pies were the cause of the outbreak.

It is interesting to note the evidence afforded of contact infection by the illnesses affecting the three attendants on the deceased person, and the strong probability of the fatal case of the son being likewise attributable to the same cause.

No cases of illness of a typhoid character have, so far as is known, occurred since August in Wrexham or its vicinity.

The important question now arises, How did these bacilli reach the pies? There are, naturally, many possibilities. The first was to suspect the meat, and attribute the origin of the infection to a septicaemic animal. Samples of the meat used were not obtainable, but the investigations of the Medical Officer of Health strongly tended to exclude this hypothesis. The meat came from a butcher who had killed 15 pigs at the same time, pieces of meat from all being mixed and put through a mincing machine together. The product was delivered to different customers, and among them to this particular baker who had issued the infected pies. No symptoms of illness were caused by pies manufactured by any of the other customers of the butcher. It would be remarkable—if there had been a septicaemic animal—that all the infected meat should have been sent to the one baker. But of course such a possibility would not have been disregarded had it not been that another source of infection was detected.

Other ingredients used in the manufacture of the pies were lard, gelatin, and flour. We received samples of each, and these were tested culturally and by animal experiments (4 mice were fed with each specimen, and 4 guinea-pigs and 4 mice were injected with each). The lard was found to be sterile. In the flour the *Bacillus coli communis* could be detected. In the gelatin a bacillus pathogenic and toxic to mice and rabbits was detected; this however is of purely

bacteriological interest. (The bacillus liquefied gelatin and behaved otherwise culturally as a *B. paratyphosus* B.)

We were unable to suspect any one of the raw ingredients from which the pie had been made, but even if an organism belonging to the hog-cholera group had been found, no conclusion could have been drawn as we know, from the work of Uhlenhuth and his collaborators, that such bacteria are occasionally ubiquitous.

Another source of the infection of the pies was therefore sought, and this in the direction that during or after their preparation the most probable infection was by someone in the bakehouse. Specimens of the blood of all persons engaged in the bakehouse were therefore obtained, with the view of determining their agglutination results (Table C).

TABLE C.

Specimens of blood taken 27. VIII. 10	Specimens of serum of the persons engaged in the bakehouse				
Serum No. :—	1	2	3	4	5
Register No. :—	337	338	339	345	351
(1) Culture No. 1 (direct from Pie 1)	—	—	20	120	—
(2) Culture No. 5 (from heart blood of guinea-pig injected with culture No. 1)	—	160	20	—	—
(3) Culture No. 17 (from heart blood of fatal human case)	—	80	20	—	—
(4) *B. paratyphosus* B. "Prausnitz" ...	—	160	20	—	60

All gave negative reactions except in two cases, the serum of a boy (No. 2, 338) and of the head cook (No. 4, 345).

These two persons were consequently suspected of being possible carriers, and of having caused the infection. It was desirable, therefore, that their faeces and urine should be examined. This was first done in the case of the boy who had recently commenced work at the bakery, but with negative results after repeated examinations. The boy had, however, eaten the pies in question, and the agglutination results can be attributed to the bacilli obtained from the pie thus eaten growing in the boy's organs, etc.

The examination of the excreta of the head cook gave abundant evidence of the presence of bacilli, which proved to belong to the hog-cholera group, and which were apparently identical with those in the pies and in the heart blood of the fatal human case. *Thus the blood of the head cook—who was said not to have eaten any of the pies, and who had not been ill in the least degree—gave a strong positive reaction, and eight weeks after the epidemic she was found to be excreting members of the*

hog-cholera group in her faeces. She might, therefore, be considered as a chronic bacillus carrier, and the direct cause of the infection.

The head cook had apparently never passed through any typhoid-like illness, nor had she so far as is known ever caused a like outbreak before. As she left the bakery at once, it was not possible to obtain a second specimen of her stools. From the urine of this woman (who had long suffered from cystitis) we likewise obtained a large number of apparently typhoid-like bacteria in pure culture.

We also obtained these same organisms from the specimen of Pie 1. It seems probable that the woman had transmitted her entire specific flora to the pies, although she was supposed personally to have had nothing to do with their making. How this transmission actually occurred it is of course impossible to say.

With regard to matters concerning the exact nature of the bacteria, which bore a causal relation to the cause of the outbreak, we propose to deal with them in more detail after further experimental work, but it must here be remembered that the hog-cholera group contains organisms apart from those which are essentially pathogenic to animals (*B. typhi murium*, *B. suipestifer*, *B. psittacosis*, etc.), the *B. paratyphosus* B., *B. enteritidis* Gaertner, and others.

Without doubt the Group *Enteritidis* can be differentiated, by the agglutination test, from the Group *Paratyphosus* B., *B. suipestifer*, *B. psittacosis*, *B. typhi murium*, etc. But this is not possible in all cases, or at least not without difficulty, as the agglutination test is somewhat uncertain for the exact differentiation of bacteria of these two groups, this being a difficulty which cannot easily be overcome. It is stated by many that the diagnosis between the *Enteritidis* and the *Paratyphosus* B. can easily be made, by means of trustworthy sera for the respective organisms, but this is not our experience. We were not in a position to make a diagnosis although we obtained an enteritidis-serum from the Lister Institute, London, through the kindness of Dr Ledingham, and another enteritidis-serum and a paratyphosus B.-serum from the Institute of Infectious Diseases, Berlin, through the kindness of Professor Lentz.

An extract from our experimental tables (Table D) may serve as an example.

The enteritidis-serum from the Lister Institute was absolutely unable to differentiate between the strains of the *B. paratyphosus* B. and *B. enteritidis* which we had in hand, although these strains proved later to be what they were represented.

Very much the same result was given by the enteritidis- and paratyphosus B.-sera from the Institute of Infectious Diseases, Berlin, so that we could arrive at no definite conclusion as to the identity of the bacilli in the pies from agglutination with these sera, although the general result of the experimental evidence was in favour of the *B. paratyphosus* B.

TABLE D.

Strains	Enteritidis-sera London	Enteritidis-sera Berlin	Paratyphosus B.-sera Berlin, Prof. Lentz
(1) Enteritidis. "Pr., Metropolitan Asylums Board"	1280	6400	5000
(2) Enteritidis. "Uhlenhuth, Kais. Gesundheitsamt, Berlin"	320	1600	100
(3) Paratyphosus B. "Pr., Metropolitan Asylums Board"...	1280	3200	5000
(4) Paratyphosus B. "Rennes, Pasteur's Institute, Paris"	3200	800	5000
(5) Culture No. 1 as above	320	3200	5000
(6) Culture No. 9 *a* (direct from Pie 2) ...	160	3200	5000
(7) Culture No. 17 as above	80	1600	5000
(8) Culture No. 21 (from liver of fatal human case)	320	3200	5000
(9) Culture No. 4 (from heart blood of a guinea-pig injected with an emulsion of Pie 1) ...	640	1600	1600
(10) Culture No. 12 *b* (from heart blood of a guinea-pig injected with an emulsion of Pie 2)	640	1600	1250

We were, however, at last (beside the agglutination toxicity tests, etc.) enabled to make an absolutely certain diagnosis by the use of sera prepared by us with strains obtained from cases during the outbreak, as well as through the enteritidis- and paratyphosus B.-sera obtained from Professor Uhlenhuth (Kaiserlichens Gesundheitsamt, Berlin). The following Table serves to show this:—

TABLE E.

Strains	Prof. Uhlenhuth's sera Enteritidis	Prof. Uhlenhuth's sera Paratyphosus B.	Sera prepared by us with strains No. 1	Sera prepared by us with strains No. 17
Culture No. 1	125	8000	6400	3200
,, No. 9 *a*	125	8000	3200	6400
,, No. 17	125	8000	1600	12800
,, No. 21	125	8000	3200	6400
Paratyphosus B. "Pr., Metr. Asylums Board"	125	8000	3200	6400
Paratyphosus B. "Rennes, Pasteur's Institute, Paris" ...	125	8000	3200	6400
Enteritidis. "Pr., Metr. Asylums Board"	4000	500	—	—
Enteritidis. "Uhlenhuth, Kais. Gesundheitsamt, Berlin" ...	4000	250	—	100

The results of these experiments are absolutely clear: the organisms which caused the outbreak were *B. paratyphosus* B. The diagnostic difficulties which occurred in this case were due to the difference which exists in respect of agglutination binding and agglutination formation, *i.e.* the specific binding groups failed with the majority of our strains.

We should like in conclusion to draw attention to the practical importance of this investigation, which shows the bearing of the question of *Bacillus paratyphosus* B. carriers in their relationship to the preparation and sale of food. For milk this importance is already recognized, but for other foods the transmission of this bacillus through carriers is, as far as we are aware, not yet described. This case, therefore, is of great interest.

It is clear from a practical standpoint that persons who have passed through a paratyphoid illness should not be occupied in the food trade, unless repeated bacteriological examinations of their excreta have afforded negative results. Such preventive measures would not exclude, however, healthy bacillus carriers from causing outbreaks similar to the one here described.