

## AN OUTBREAK OF PARATYPHOID B FEVER

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(With 1 Figure in the Text)

### INTRODUCTION

IN the summer of 1940 an outbreak of paratyphoid fever occurred in Kettering and in the districts surrounding it. The total number of cases was 222. Most of them were mild, and the period of vague symptoms before a doctor was called in was in some as long as three weeks to a month. A few cases were more severe, and one or two at the beginning showed toxic symptoms which led to a diagnosis of meningitis. There was one death. The centre of the epidemic was in Kettering, but the surrounding districts were also affected. The population of this area in peace time is about 133,000: it has been somewhat increased by the influx of evacuees. The age and sex distributions are shown in Table 1.

Table 1. *Age and sex distributions of patients*

	0-5 years	5-10 years	10-15 years	15-20 years	20+ years	Total
% of cases						
Males	2.1	3.7	5.2	5.8	20.1	36.9
Females	3.7	5.2	7.4	8.9	37.9	63.1

The incidence was greater in women and children than in adult males. Fig. 1 shows in graphic form the number of notifications week by week. In a few instances the agglutination test of the patient's serum was the only examination made but in the majority *Bact. paratyphosum* B was isolated either from the blood, faeces or urine. The methods used in isolating the infecting organisms will be described in a separate paper. Many of the cases which were excreting small numbers of paratyphoid bacilli for only a short period were detected only by the use of selective 'enrichment' media, and the experience gained in the epidemic showed that a negative result based only on the use of a comparatively non-selective medium such as McConkey agar is of little value and may be dangerously misleading. Most of the specimens were examined at Leicester Emergency Public Health Laboratory, but a few, especially at the beginning, were sent to private laboratories.

### SUMMARY OF THE MAIN EVENTS

In 1927 an outbreak of paratyphoid fever occurred in the same area. There were four cases in the town and twenty-three in the surrounding districts. The vehicle of infection was considered to be cream buns made in a bakery in

the town. An employee in a shop belonging to the bakery firm was found to be excreting paratyphoid bacilli in the faeces on one occasion but, although it was felt that the root of the trouble was in the bakery, nothing was proved against any employee there.

In 1936 a second outbreak occurred in the district. This time there were nine cases in the town and twenty-six in the surrounding districts. The same bakery was suspected, although again no definite source of infection was found there.

On 9 June 1940 one of us examined at the request of their private medical attendant two patients, A and B, belonging to different households but both employed at the above-mentioned bakery. The diagnosis of enteric fever made by the private doctor was corroborated and the patients were removed to the

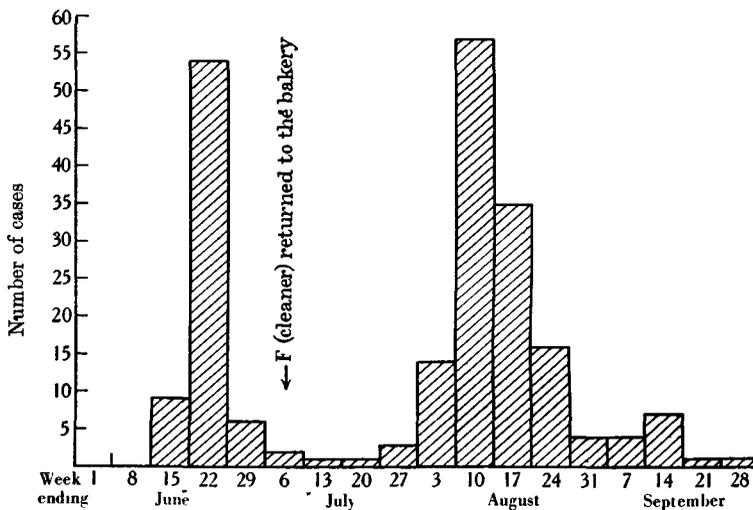


Fig. 1. Cases of paratyphoid notified week by week.

Infectious Diseases Hospital. Bacteriological and serological examinations at once confirmed the suspicion that both patients were suffering from paratyphoid B fever. It was then found that a third patient, C, who was also employed at the bakery and who had during the previous few days been suspected of suffering from cerebrospinal meningitis was actually a case of paratyphoid fever. Thereafter in the next few days fresh notifications of paratyphoid fever rose sharply and it was evident that an outbreak of some size was developing (see Fig. 1). The histories of many of the cases pointed clearly to the bakery as the source of infection, and in addition two more cases, both of the ambulant type, were discovered among the bakery staff. By the end of June the number of new cases occurring each week had dropped considerably, and the epidemic appeared to be over. During July a few fresh cases occurred and it was then discovered that F, a cleaner in the bakery, who had been away ill during the first part of the epidemic and had returned to work

on 3 July, had been suffering from paratyphoid fever. It was feared that another outbreak would occur, and this did in fact happen. The number of notifications rose abruptly in the last week of July and at the beginning of August. Four more cases, three of them ambulant and one with clinical symptoms, were discovered among the staff of the bakery, which was closed from 1 to 24 August. The number of cases in the second outbreak was more than double the number in the earlier part, but by the end of August the number of fresh notifications rapidly fell, the bakery was reopened on 24 August, and no fresh cases which could be directly attributed to it developed.

#### EVIDENCE AGAINST THE BAKERY

The previous history of the bakery and the fact that the first three patients were employed there made it appear from the very start that an outbreak of paratyphoid fever connected with the bakery had begun. The following administrative measures were therefore taken within a few days of receiving the first notifications: (a) the medical practitioners in the town, the County Medical Officer, the Regional Medical Officer of the Ministry of Health and the Director General, Army Medical Service, were informed of the situation; (b) as a precautionary measure a notice that all milk and water intended for drinking or cooking should be boiled was inserted in the local newspaper; (c) at a meeting of the doctors in the town all information then available regarding the probable source of the outbreak and the nature of the cases was given and laboratory facilities and hospital accommodation were discussed; (d) a conference of the County Medical Officer and the Medical Officers of Health of the surrounding districts was held.

The suspicions already focused on the bakery were strengthened in the next few days by a study of the histories of new cases which rapidly increased in number. Many patients gave a history of having eaten confectionery from the bakery, while a few patients had bread only from the bakery and a few others had consumed meat pies which were made at another establishment and delivered by the vans of the bakery firm. Several cases gave additional evidence implicating the bakery:

(a) Q had been in a sanatorium since March and apart from articles brought to her by her husband on Wednesdays she had the same diet as the other patients: she developed paratyphoid fever on 10 June. Her husband had taken cream cakes from the bakery to her on 15, 22 and 29 May. No other cases of paratyphoid fever occurred in the sanatorium.

(b) R, aged 7, was given a cake from the bakery on either 25 May or 1 June; she ate only one mouthful. On 11 June she showed the first symptoms of paratyphoid fever.

(c) B, one of the three employees of the bakery who were the first cases, took a selection of cakes from the bakery on 1 June to his sister-in-law. She developed paratyphoid fever: the date of her first symptoms was 7 June; she

did not eat any articles from the bakery except the cakes brought to her by B on 1 June.

(d) S obtained cakes from the bakery on 4, 5 and 6 June. Some of these were eaten in her house, some were given to T, a neighbour. Both S and T developed paratyphoid fever. S first had symptoms on 13 June, and T on 25 June.

(e) A patient from Leicester visited Kettering on one day only, 27 May, when she ate cakes from the bakery; she developed paratyphoid fever on 14 June.

Investigations of conditions in the bakery were started immediately; these included examination of the general working arrangements, the state of cleanliness of the premises, employees and processes, the work of each man and his period of service, laboratory examination of his blood, faeces and urine, and bacteriological examinations of samples of each ingredient used in the bakery and of the water supply. These last can be briefly dismissed: the ingredients (including milk and cream from the dairy which supplied the bakery) were examined with negative results and the water supply was found to be satisfactory. Careful inquiry into the running of the bakery during the month immediately preceding the epidemic revealed no change either in personnel or in distribution of the work which could account for the time and manner of its onset, with the possible exception of M who will be referred to later. Investigation of the premises yielded no clue as to the exact path by which infection was spread either amongst the employees of the bakery or amongst the general population of the area supplied by it. A detailed account of the lay-out of the bakery and of the arrangement of the work is for that reason omitted. It must, however, be mentioned that the distribution of cases *inside* the bakery suggested that the risk of infection was not confined to one department and that the source of infection was either some fixed point to which all the employees would go at one time or another, or alternatively some infective person or material liable to move from one point to another in the bakery.

The results of investigating the personnel of the bakery must, however, be described in some detail, since it was these investigations that showed a large proportion of the employees to be actually infective at one time or another. The staff at the beginning of the outbreak consisted of twenty-six men, of whom seven had been employed both in the 1927 and in the 1936 outbreaks. On the supposition that there might be a chronic carrier in the bakery, it was natural to expect that a true chronic carrier would be found among these seven men. On the other hand it was possible that the hypothetical carrier might not now be excreting paratyphoid B bacilli, but might have infected another member or other members of the staff who in their turn would have been the direct cause of the epidemic and therefore at this date (14 June) might still be a source of danger to the public. It was decided therefore that short of closing the whole bakery, a step for which there would be no legal

powers, an immediate attempt should be made to find a carrier among the staff. Accordingly faeces, urine and blood samples were taken from all of them on that date except for one or two samples which were examined in the next day or two. Faeces and urine samples were all negative, but the serum from eight persons showed some significant agglutination reactions (see Table 2). It was decided to concentrate attention at first on these eight by repeated examination of faeces, urine and blood, but not to forget the seven men who

Table 2. *Results of agglutination tests on samples of blood from certain members of the staff of the bakery*

Date	Names	Typhoid O	Typhoid H	Paratyphoid B O.	Paratyphoid B.H.	Salmonella
14. vi. 40	D	...	..	...	1/100	...
18. vi. 40	D	...	1/25	—	1/250	..
20. vi. 40	D	.	—	1/25	1/500	...
15. vii. 40	D	—	—	—	1/1000	1/50
14. vi. 40	E	...	—	1/25	—	...
20. vi. 40	E	.	1/125	1/125	1/250	...
1. vii. 40	E	1/50	1/50	1/50	1/250	..
15. vii. 40	E	1/50	1/25	1/50	1/125	1/50
14. vi. 40	K	...	—	—	1/125	...
20. vi. 40	K	...	—	—	1/125	...
1. vii. 40	K	—	—	—	1/50	...
19. viii. 40	K	—	—	—	—	—
14. vi. 40	L	..	—	—	1/125	...
20. vi. 40	L	.	—	—	1/250	.
1. vii. 40	L	—	—	—	1/125	..
19. viii. 40	L	—	—	—	—	—
14. vi. 40	*M	..	1/250	1/25	1/125	...
20. vi. 40	M	..	1/250	1/25	1/125	...
1. vii. 40	M	—	1/250	1/25	1/50	...
12. vii. 40	M	—	1/250	1/25	1/125	...
19. viii. 40	M	—	1/250	—	1/250	1/50
14. vi. 40	*N	.	1/125	—	1/50	..
20. vi. 40	N	—	1/125	—	1/50	...
1. vii. 40	N	—	1/125	—	1/50	...
19. viii. 40	N	—	1/50	—	1/50	1/25
14. vi. 40	O	.	—	1/25	—	...
20. vi. 40	O	..	—	1/25	1/125	...
1. vii. 40	O	—	—	—	1/25	..
19. viii. 40	O	—	—	—	—	—
14. vi. 40	*P	...	1/50	—	1/50	..
20. vi. 40	P	...	1/50	—	1/50	..
1. vii. 40	P	—	1/50	—	1/50	.
19. viii. 40	P	—	1/50	—	1/50	—

\* Inoculated.

had been in the bakery in all three epidemics, and amongst whom it was reasonable to look with especial care for a chronic carrier. Of these seven men, one (A) was a clinical case already in hospital, three came into the group of eight whose serum showed some positive findings, while the remaining three showed no agglutinins in their serum. Of the eight whose serum did show agglutinins in significant titre, three, M, N and P, had been inoculated in the past, some years previously. Subsequent samples of serum from these eight men on 20 June were interesting. To take the uninoculated men first:

D. This man was at first suspected as a possible source of infection because many of the cases outside the town occurred in an area to which he delivered confectionery. Suspicion was increased when repeated examinations of his serum showed a rising 'H' titre to *Bact. paratyphosum* B, reaching 1/500 on 20 June (see Table 2). His faeces were examined twice during this period with negative results, but on 22 June and twice subsequently *Bact. paratyphosum* B was isolated. It was soon realized, however, that he was unlikely to be the source of the outbreak, because he would not account for the cases in the town or for cases which occurred in the delivery areas of the two other roundsmen (T and U) whom there was no reason to suspect, and the laboratory evidence makes it unlikely that he was actually infective during the period when the original focus which started the outbreak was active. It is therefore doubtful whether he was responsible even for the cases which occurred in his own delivery area. However, since he never admitted to having had any symptoms of illness at all, he must be regarded as an ambulant case who might have given rise to many fresh cases if he had continued at work. It is certain that he would never have been detected without repeated laboratory investigations.

E. This man, who also had no symptoms, showed such an abrupt rise in his serum titres between 14 and 20 June (see Table 2) that he was suspected of being an ambulant case, following the same reasoning which was justified in the case of D. The suspicion against him was felt to be strong enough to demand that he should not be allowed to return to work, and he too was found to be excreting *Bact. paratyphosum* B a few days later. It was, however, clear from the rising and varying agglutinin titres of E's serum that he could not be regarded as a chronic carrier any more than D, and it was felt that the problem was still unsolved.

Of the other members of this group of eight, K, L and O showed fluctuations in their B.H. titres (see Table 2) and it is quite possible that one or even all of them were transient carriers, but repeated examinations of their faeces were negative.

There remain M, N and P. These three had all been inoculated with T.A.B. vaccine some years previously. N and P, who showed steady serum titres on three occasions and from whom repeated samples of faeces were negative, did not come under serious suspicion. M on the other hand was for some time strongly suspected as a chronic carrier. He was one of the seven men who had been working in the bakery through all three epidemics and he was the only member of the staff who had at various times, particularly when work was exceptionally heavy as it had been during the weeks preceding the outbreak, worked at all points in the bakery from the cake-making room to the delivery vans. The cases which developed inside the bakery were not confined to any one part of it, and as men from different parts of the bakery would normally have little contact with each other, it was felt that the most likely explanation of these cases was to be found in the existence of a carrier who might frequent

different parts of the bakery, and M was the only man who answered this description. Laboratory investigations appeared at first to strengthen the suspicion against him. Repeated examination of his serum by Dr Felix showed a persistent though low-titre Vi antibody for paratyphoid B (dilution 1 in 5). The interpretation of this was rendered more difficult by the isolation, on one occasion only, of *Bact. senftenberg* from his faeces. Whether this could have any bearing on his persistent Vi antibody is open to argument. Repeated examinations of his faeces and urine were made over a period of three months and he was admitted to hospital for one night to make quite sure that the specimens which had been obtained had not been tampered with in any way: it was unfortunately impossible to obtain a sample of his duodenal juice. In the end no evidence of a decisive nature could be produced against M. Since all the examinations of faeces and urine failed to reveal *Bact. paratyphosum* B there is no real justification for regarding him as a carrier.

The position in the last week of June then was that the bakery had been proved beyond all reasonable doubt to be the source of the outbreak, that eight members of the staff whose serum gave suspicious reactions had been investigated with special care, and that *Bact. paratyphosum* B had been isolated from the faeces of two of these in the absence of any symptoms. It was decided that the serum of the six remaining members should be investigated yet again, and that faeces and urine from all the members of the staff should be investigated once a week. No further cases were discovered in the bakery during this period. The rate of appearance of fresh cases outside the bakery rapidly decreased, and by the beginning of July it appeared that apart from possible secondary cases the outbreak had been brought under control. In the meantime attention was paid to certain defects in the washing and sanitary arrangements of the bakery which remained open during this period.

At the end of July, however, a small number of fresh cases were detected, and investigation revealed that one member of the bakery staff (F) had been ill from 13 June until 3 July. On 13 June a sample of faeces had been examined and found negative. The man, who was employed as a cleaner and was mentally subnormal, had been diagnosed by his doctor as suffering from heat stroke and was allowed to return to work on 3 July. As soon as his illness and his return were discovered by the Medical Officer of Health, blood, faeces and urine were sent to the laboratory for examination. His serum showed a B.H. titre of 1/5000 and it was obvious that his illness had in fact been paratyphoid fever. Faeces and urine examined at the same time as the serum and on four subsequent occasions gave negative results, but unfortunately there is no information about his faeces and urine during the crucial period between his return to work on 3 July and the discovery of his high B.H. titre on 26 July. It was feared that an outbreak would occur again, and this did in fact happen. The number of notifications showed a steep rise in the first week of August and between 1 and 10 August seventy-one new cases were diagnosed. The second outbreak was similar to the first: there was the same evidence of products of

the bakery having been consumed by a high proportion of the patients, and there were also fresh cases among the staff, three without symptoms and one a definite clinical case.

Since two of these men were employed in the cream department and one on delivery work, it was feared that any one of them might give rise to yet a third wave of cases. This did not occur, and it is possible that owing to weekly examinations of faeces and urine from each employee these four cases were detected and eliminated from the bakery almost as soon as they began to excrete paratyphoid organisms.

At the end of July when it was realized that a fresh outbreak associated with the bakery was occurring, the owner, following advice given to him, decided to close the bakery. Accordingly on 1 August the bakery was closed for 24 days, and none of the agents supplied from it received any goods from that source during the same period. After a sharp rise in the number of notifications during the early half of August the numbers of new cases fell fairly rapidly and by the end of the month only odd cases were occurring each week. The bakery was reopened on 26 August, but before the reopening the following measures were taken:

(1) A letter containing suggestions regarding the maintenance of a high standard of cleanliness and advising improvements of the premises was sent to the owner. Points mentioned were avoidance of the use of another man's drinking vessel, immersion of the hands in disinfectant before pulling the chain of the water closet, immersion in disinfectant of the handle and chain of the water closet at least once daily, wiping of door handles with disinfectant at least once daily, provision of a plentiful supply of towels in the lavatory, provision of a sink and a washbasin in the cream, cake-making and bread departments, provision of a washbasin in the packing department as near as possible to the packing table with a notice stating that each packer must wash his hands immediately before packing, boiling of all knives, spreaders, cream bags, etc., after making each batch of cakes, and provision of a steam sterilizing cabinet of sufficient size to take the large utensils such as the cream bowl and the whisk.

(2) Samples of blood were taken from all members of the staff who were going to be employed at the bakery when it reopened. None of these samples showed anything suspicious.

It was explained to the owner that, though negative results had been obtained with five or more samples of faeces and urine from all the bakery employees who had suffered from paratyphoid fever, no absolute guarantee could be given that they would not excrete paratyphoid bacilli in the future. The owner decided not to re-employ any of these men, and to continue to employ M (one of the inoculated men) only on work which did not involve the handling of food. The rightness of the first decision may be doubtful, but it is clear that the whole question of the re-employment of such persons in food establishments requires careful consideration.

## SUMMARY OF EVIDENCE AGAINST THE BAKERY

There is little doubt that the bakery was the source of infection:

(1) Including temporary as well as permanent employees, excreta from thirty-two men working in this bakery were examined repeatedly over a period of two months. Ten of these were found to be either clinical or ambulant cases of paratyphoid: from nine of them paratyphoid bacilli were isolated at one time or another during this period, while the tenth (F) was undoubtedly a clinical case, though unfortunately the diagnosis rested only on serological evidence. Only five of these men showed clinical symptoms; the remaining five were found to be infected as the result of routine examination of all members of the bakery staff. Five of the ten were discovered during the first wave of the epidemic in the second and third weeks of June: the other five were detected in the last week of July and the first week of August, at the beginning of the second wave of the epidemic (see Table 3). It is interesting to note that of the latter group of five men two were extra employees taken on to replace men already missing—a fact which points strongly to the existence of a fresh or at least a recurrent focus of infection inside the bakery at the beginning of July.

(2) The histories of many patients of which some examples have already been given indicated infection by means of foodstuffs from the bakery. Of the town cases 49 % gave a history of eating cream confectionery from that source, 64 % stated that they had consumed either cream confectionery or cakes, and 70 % admitted having had either cream confectionery, cakes or bread. For the cases outside the town regarding which particulars were received the corresponding figures were 55, 67 and 69 %. Combining the two sets of figures gives 52 % having consumed cream confectionery, 66 % cream confectionery or cakes, and 70 % cream confectionery, cakes or bread. It is true that about one-third of the cases gave no such history, but a considerable proportion of negative histories was only to be expected, and the individual histories of some of the patients cited above are striking enough to leave little doubt that the main focus of infection was in the bakery.

(3) The general distribution of the cases outside the town coincided with the areas in which the products of the bakery were sold.

(4) Two previous epidemics of paratyphoid B fever had occurred in the town and surrounding districts in 1927 and 1936. On both occasions there was similar evidence pointing to the bakery as the source of infection. In 1927 a woman who worked in a shop associated with the bakery was found at one examination to be excreting *Bact. paratyphosum* B, but it was never proved whether or not she was a chronic carrier. In any case she had nothing to do with the 1936 epidemic for which no explanation was ever found.

Such then is the evidence against the bakery: it must be admitted, however, that the exact point in the bakery at which the infection originated is a matter for conjecture. The second wave of the epidemic can without much

Table 3. Clinical and 'ambulant' cases of paratyphoid B infection in staff of bakery

Name date	Laboratory investigations			Symptoms	is
	Blood	Faeces	Urine		
Clin. 10	10. vi. 40 B.H. 250	All negative	13. vi. 40 positive, negative many times	4. vi. 40	
Clin. 10	10. vi. 40 B.H. 5000	14. vi. 40 positive, negative many times	14. viii. 40 positive, negative many times	1. vi. 40	
Clin. 11	11. vi. 40 B.H. 250	14. vi. 40 positive, negative many times	All negative	31. v. 40	
Amb 23	14. vi. 40 B.H. 100 18. vi. 40 B.H. 250 20. vi. 40 B.H. 500	22. vi. 40 positive and twice subsequently; negative twice before and many times after	All negative	No sympt	
Amb 28	14. vi. 40 B.H. — 20. vi. 40 B.H. 250	23. vi. 40 positive, negative twice before and many times subsequently	All negative	No sympt	
Clin. 27	26. vii. 40 B.H. 5000	13. vi. 40 negative; 26. vii. 40 negative and twice subsequently	All negative	Off work 13 diagnosed	o 3 July, it stroke
Clin. 30	30. vii. 40 Blood culture positive. Serum: B.H. 25, B.O. 500	29. vii. 40 positive and untal 9. ix. 40, then negative five times; negative twice before (14. vi and 22. vii)	29. vii. 40 negative	Played cric Felt ill, le 40	. vii. 40. x 29. vii.
Amb. 1. v	3. viii. 40 B.H. 25, B.O. 100	31. vii. 40 positive, negative five times subsequently	31. vii. 40 negative	No sympto	
Amb. 1 v	10 viii. 40 B.H. 50, B.O. —	3. viii. 40 positive, 14. viii. 40 positive, 2. ix. 40 positive, negative five times subsequently	Negative	No sympto	
Amb. 7. v	9. viii. 40 B.H. 125	5. viii. 40 positive, negative on four occasions before; negative five times after 8. ix 40	All negative	No sympto	

† These two were extra employees taken on to replace those absent through illness, etc.

doubt be attributed to F, the bakery cleaner of low mental capacity whose illness, diagnosed as heat stroke, was really paratyphoid fever; it is very probable that his faeces or urine contained paratyphoid bacilli during some part of the period from 3 to 26 July when he was at work in the bakery after his illness and that by this means the products of the bakery became infected. The cause of the first outbreak was not discovered.

#### LESSONS OF THE EPIDEMIC

Some of the points mentioned in the introduction may now be more fully elaborated. The outbreak was instructive in several ways:

(1) It showed the value of early and repeated examinations of blood and excreta not only from clinical cases but also from possible contacts, especially when these are employed in food establishments. The helpful co-operation of the medical practitioners in the neighbourhood who quickly informed the health authorities of suspicious cases in their practices contributed to the prompt diagnosis of many cases early in their clinical course. The prompt removal of these cases to hospital, before they had time to spread infection, may account for the small number of secondary cases: out of 222 cases there were only five which could be definitely described as secondary. On the other hand many of the cases were mild and had atypical or very slight symptoms, and this may account for the comparatively low proportion of positive blood cultures obtained: the records show only twenty out of a total number of 125 samples in which blood cultures were attempted. It was inevitable that in spite of the utmost vigilance a number of cases should be missed until the second or third week of their clinical course. It was just in these cases that the value of repeated laboratory examinations was shown. There is no doubt that many would have been missed completely if either the serum or the excreta or both had not been examined repeatedly. This was particularly well shown among the employees of the bakery staff. A single examination of their excreta and blood would have given little or no useful information: the two earliest of the ambulant cases D and E discovered in the bakery were suspended from work only because of suspicious changes in their serum agglutinins, and paratyphoid bacilli were not found in their faeces until the third examination, and were then found to be present only over a period of about two weeks. It should be again emphasized that enrichment methods were employed as a routine in the examination of the excreta.

(2) It showed the value of day-to-day contact between the public health authority and the laboratory. The laboratory was not treated as a mere factory for the turning out of positive or negative reports, but the bacteriologist had the opportunity to view the epidemic as a whole, to appreciate the significance of the various administrative measures taken, and in many cases to send requests for further specimens which would certainly not have been asked for without this knowledge and would probably not have been sent if a fee had been charged for each specimen.

(3) It showed the part that may be played in the spread of an epidemic by ambulant cases or temporary carriers who have been infectious either at the onset of the outbreak or during its course. It is not widely enough realized that many of these may be free from symptoms, and even after repeated questioning can give no history of even the mildest sort of illness. The high percentage incidence of cases, especially of the ambulant type, in the bakery staff naturally aroused anxiety as to the numbers of undetected ambulant cases among the contacts of the cases outside the bakery. Samples of faeces and urine from many households were examined and four were found to be positive, but these investigations could not be made in the same thorough way as the examinations of the bakery staff, and it is very likely that a number of ambulant cases remained undetected. The danger was obvious if any of these should happen to be an employee in a food establishment. Accordingly an arrangement was made with all the bakeries and dairies in the town, and so far as was practicable in the adjacent areas, that the Public Health Department should be notified of their intention to employ any new staff and should be informed at once if any member of their staff became ill. A number of such employees were in fact temporarily suspended from work for various reasons pending full examinations of their blood, faeces and urine, while the necessity for the first precaution was shown by the case of D who it will be remembered was one of the ambulant cases mentioned above. This man was found on 13 July to be working on a bread delivery van of a different bakery in spite of strict instructions not to undertake any work connected with the handling of food. He was known to be excreting paratyphoid bacilli five days previously. He discontinued his new employment two hours after starting it.

In conclusion it seems probable that the prompt removal from work of all members of the bakery staff who showed suspicious serum reactions, together with the regular examination of faeces and urine from all members of the staff and strict control of other food establishments in the town, may have prevented the first wave of the outbreak from developing into something much larger than it did. The failure to detect F, the cleaner whose return to work was followed by a fresh wave of cases, was due to an unfortunate chain of events; but it is worth remembering that any of the other members of the bakery staff who were found to be excreting paratyphoid bacilli might, if not promptly isolated, very well have been responsible for fresh waves of cases by infecting articles of food in the bakery even during a space of only a few hours. The investigation shows how essential it is that when an outbreak of enteric occurs every possible step should be taken at once to guard against the danger of food being handled by ambulant cases who, since many of them are quite symptomless, can be detected only by the strictest bacteriological control.

## SUMMARY

An outbreak of paratyphoid fever involving 222 cases showed several features of interest:

(1) A particular bakery was identified beyond all reasonable doubt as the source of infection.

(2) In spite of this, all attempts to find a true chronic carrier in the bakery or elsewhere failed.

(3) The outbreak showed the danger to the public caused, not only by acute and convalescent cases and by possible chronic carriers, but by the less obvious and for that reason all the more sinister 'ambulant' cases or temporary carriers, many of whom may never be recognized. This was particularly true among the bakery staff of whom as many as one-third were found at one time or another to be actually infective.

(4) The value of early and repeated laboratory investigation of blood and excreta was clearly shown.

(5) The bacteriological and serological examinations were carried out by a laboratory to which payment is made by a block grant and not on a fee-per-specimen basis. Because the decision as to the number and extent of the laboratory investigations undertaken was not influenced by considerations of cost, the fullest collaboration was possible between the public health authorities and the laboratory.

To all those in public health departments and in the laboratory who contributed towards the investigation of the epidemic we would express our gratitude.

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