not a single strain remained untyped for that particular reason. All the cultures listed in Table II as untypable (Group Z) strains were examined in agglutination tests with pure O and pure Vi immune sera and were found to contain the heat-labile BVi antigen. On the other hand, paratyphoid B cultures that show the accepted criteria of "roughness" (Arkwright, 1930) cannot be typed. According to the degree of antigenic degradation which they have suffered, such cultures may or may not be lysed by anti-O phages; they are, however, invariably resistant to the action of anti-Vi phages.

Table III shows in chronological order those outbreaks of paratyphoid B fever in the British Isles that have been typed by the Vi-phage method. Many of these outbreaks have been described in detail in published reports, and the various epidemiological aspects raised by the authors have been reviewed in an interesting study by Savage (1942). No published accounts are available of those outbreaks mentioned in Table III to which no reference is printed in the table. The information concerning these outbreaks has been supplied by the pathologists from whom the cultures were received and by the General Register Office. The figures specified in Table II, when read in conjunction with the data recorded in Table III, will convey an indication of the distribution of the various types of paratyphoid B bacilli throughout the country. Table III shows that all the large outbreaks that occurred during 1941 were due to Type 1 bacilli.

This first survey of necessity furnishes only fragmentary information, but it shows clearly the scope of applicability of the new typing method. Its value as an epidemiological weapon is beyond doubt. The extent to which it can be usefully applied to the control of paratyphoid B fever depends solely upon the degree of co-operation between clinician, field investigator, and laboratory worker.

Summary

Anti-Vi bacteriophages that act specifically on *Bact. paratyphosum* B are described. Anti-O bacteriophages, on the other hand, attack strains belonging to many diverse *Salmonella* species.

Anti-Vi phages of *Bact. paratyphosum* B can be adapted to develop a high degree of specificity for particular strains, whereas anti-O phages are incapable of such adaptation.

Four separate and distinct Vi-phage types and subtypes of *Bact. paratyphosum* B have been identified so far, and a method of typing strains of paratyphoid B bacilli has been developed similar to that which was first devised by Craigie and Yen for the typing of typhoid bacilli.

Of 714 strains isolated from patients or carriers in Great Britain only 50 (7%) could not be typed by means of the available four Vi-type phages. The larger outbreaks of the disease in 1941 were found to have been caused by Type 1 strains.

The significance of paratyphoid-B Vi-phage types is the same as that of typhoid Vi-phage types. The typing of paratyphoid B strains isolated from sporadic cases or outbreaks is a valuable epidemiological weapon and is certain to be widely applied in the future.

We should like to express our thanks to the pathologists of the Emergency Public Health Laboratory Service and of many other public health or clinical laboratories for their co-operation throughout this investigation; to Dr. J. R. Hutchinson, Dr. W. H. Bradley, and Colonel C. Maddock of the Ministry of Health for help in collecting epidemiological data; and to Dr. C. M. Wenyon for hospitality at the Wellcome Research Institution.

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A NOTE ON THE VALUE OF PHAGE TYPING IN THE INVESTIGATION OF AN OUTBREAK OF PARATYPHOID B FEVER

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Felix (1943) recently related his experiences of the typing of typhoid bacilli by means of Vi bacteriophage (Craigie and Yen, 1938), and in a companion article Bradley (1943) gave an account of the first application of this new knowledge to field investigations in this country, and proved, in peculiarly difficult circumstances, its value to epidemiologists. As a natural corollary Felix and Callow proceeded to apply a like laboratory technique to *Bact. paratyphosum* B—the preliminary results of which are reported on page 127 of this issue—and an opportunity recently occurred of ascertaining whether the harmony between the laboratory and field findings demonstrated in typhoid also held in paratyphoid B fever.

In Ipswich in late July and early August, 1941, there were twelve primary cases of paratyphoid B fever notified from twelve different addresses in the town. Ten of the patients had not eaten any food away from home for many weeks. By the courtesy of Dr. Hunter, the medical officer of health, and Dr. P. H. Martin of the Emergency Public Health Laboratory Service, cultures of the causal organism recovered from the stools of all the patients were submitted to Felix for phage typing. He found that ten of the patients were excreting *Bact. paratyphosum* B Type 2 and two of them Type 1. Colonel Maddock, a Medical Officer of the Ministry, made local inquiries and ascertained that, although no history of the consumption of one common article of food or drink from one source could be obtained, all the ten patients who had had no meals away from home had, at a material time, a common source of supply of "confectionery" from a shop in which an unattended case was found in the person of a daily domestic helper. There was no other common factor. This woman had continued at work for four weeks after she began to be ill, but ceased on Aug. 13, by which time she had infected her daughter, who lived with her. The helper's duties took her into the shop (she had no access to bulk supplies), and although they did not ordinarily include the handling of confectionery, there is ample evidence that she did this and also assisted in conveying unwrapped confectionery from the bakery on the premises into the shop. The bakery supplied confectionery in bulk to certain other shops, to which no cases were traceable, and all the ten patients implicated were those who were excreting *Bact. paratyphosum* B Type 2. Moreover, the same type was recovered from the stools of the two secondary cases. Of the two primary cases excreting Type 1 bacilli neither had had any dealings with the shop in question. One was staying in another part of Suffolk and the other at a town in the Midlands.

From the beginning of 1941 to the time of the investigation fifteen cases of paratyphoid B fever had been notified from twelve different parishes scattered throughout seven administrative districts in the county (i.e., outside Ipswich), and the conjectured dates of infection of seven of the primary cases fell within the period during which the source of infection was present in the Ipswich shop. Two of the seven were found to be excreting Type 2, the others Type 1. Both the former lived in parishes contiguous to Ipswich and were regular customers of the implicated shop.

All the primary Type 2 cases in Ipswich and the immediate neighbourhood, therefore, were associated with one particular shop in which an excreter of Type 2 was handling foodstuffs at a material time. There was thus complete harmony between the laboratory and the field findings.

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