GASTRO-ENTERITIS ASSOCIATED WITH *PROTEUS VULGARIS*

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An outbreak of acute gastro-enteritis affecting at least eighteen individuals occurred in Avonmouth during the night of September 11, 1936. All the affected individuals had partaken of cockles sold by an itinerant vendor on the evening of that day, and only one person could be found who had eaten some of the cockles and who had not been ill. After an incubation period varying from three to six hours the illness commenced with headache, nausea, abdominal pain, vomiting, diarrhoea, and prostration. There was no pyrexia. With the exception of two cases the individuals affected were not seriously ill and had practically recovered within twenty-four or forty-eight hours. There were no deaths. The two patients who were seriously ill recovered in seven to ten days.

Considerable difficulty was experienced in tracing the vendor of the cockles, but largely owing to the indefatigable efforts of the chief sanitary inspector, aided by the police and interested patients, he was finally traced. The vendor was in the habit of receiving seven or eight bags of cockles a week from South Wales. On their arrival at his premises his routine procedure was to steep the cockles overnight in water in a pan to which salt had been added. This removed the larger portion of the sand present. The following morning the cockles were placed in a bucket with a perforated bottom and lowered into water boiling in an ordinary washing copper. This reduced the temperature of the water, but as soon as the water boiled again the bucket was removed, emptied, and refilled, and the process repeated. The heating loosened the cockles in their shells and allowed of their being riddled into either a small or large galvanized iron bath containing water and salt. The empty shells which remained in the sieve were discarded.

Close questioning elicited the fact that the vendor, his wife, and family were in the habit of performing their personal ablutions in the larger of these two baths when it was not actually being used for the preparation of the cockles. In the process it will be seen, therefore, that the cockles were washed in three lots of water and that the only heat to which they were subjected was when they were brought to the boil—a procedure occupying at most about two or three minutes. Further, when the bath used for the personal washing of the vendor and his family was employed to hold the cockles the latter were not subsequently subjected to heat or otherwise cleaned before being sold.

The premises in which the cockles were thus prepared consisted of a small cellar nearly completely underground, ill ventilated, and containing an accumulation of litter and rubbish. Both floor and ceiling were defective and the walls were dirty. The vendor, his wife, and family of six children all appeared healthy and had no symptoms relating to enteritis. He had carried out the business of selling cockles in different parts of Bristol and the surrounding villages for twelve years, and up till now had not been questioned. Inquiries among practitioners of districts other than Avonmouth where the vendor had sold cockles failed to disclose the occurrence of any cases of enteritis which could in any way be attributed to him.

Bacteriological Findings

Owing to the rapidity with which most of the patients recovered only two samples of stools in the liquid state were obtainable. Vomits were not secured. Throughout the investigation all the faeces examined failed to show the presence of organisms of the enteric, dysentery, or food-poisoning groups.

Case 1 (W. B.).—Faeces examined on September 14, by which time the patient had completely recovered, were hard and contained numerous atypical *B. coli*. *Proteus vulgaris* was not found.

Case 2 (C. W.).—The faeces on September 14 were still very diarrhoeic and contained *Proteus vulgaris* (motile spreading) and late-lactose-fermenting *B. coli*. A blood culture taken on September 18 was sterile. A serum test on September 18 in dilutions of 1 in 25, 1 in 50, 1 in 125, and 1 in 250 did not agglutinate the Standards Laboratory suspensions of *Bact. typhosum* H, *Bact. typhosum* O, *Bact. paratyphosum* A, *Bact. paratyphosum* B, *Bact. enteritidis* Gaertner, *Bact. aertrycke* (sp.), composite non-specific *Salmonella*, *Bact. newport* (sp.), *Bact. suipestifer* (para C) (sp.), and *Br. abortus*. The titres for various strains of *Proteus* are given in Table I.

TABLE I.—Serum of Case 2

Strain of <i>Proteus</i>	Dilution of Serum			
	25	50	125	250
(1) HXK (Nat. Coll.) ..	++	±	—	—
(2) OXK " " " ..	++	±	—	—
(3) HX2 " " " ..	++	+	—	—
(4) OX2 " " " ..	++	++	±	—
(5) OX19 " " " ..	++	+	±	—
(6) <i>Proteus mirabilis</i> (N.C.) ..	—	—	—	—
(7) OX19 (Standards) ..	++	+	—	—
(8) Case 2's strain " " ..	++	++	++	±
(9) Case 3's strain " " ..	++	++	++	±

++ = Complete agglutination.
+ = Incomplete agglutination.
± = Trace of agglutination.

The first six strains were obtained from the National Collection of Type Cultures and the seventh from the Standards Laboratory at Oxford. At 1 in 25 and higher dilutions the serum did not agglutinate the atypical *B. coli* from Case 1, and the late-lactose-fermenting *B. coli* from his own faeces. In a further examination of the faeces on September 23 *Proteus vulgaris* and late-lactose-fermenting *B. coli* were not found, but streptococci and *Bact. aerogenes* were present. The serum findings on September 25 were identical with those of the sample obtained on September 18, except that the titre for the patient's own strain of *Proteus vulgaris* had fallen slightly, so that complete agglutination was obtained at 1 in 50 and incomplete at 1 in 125. Almost identical results were secured with the strain of *Proteus* isolated from the bath (see below).

Case 3 (E. W., wife of Case 2).—Faeces examined on September 14 gave a growth of *Proteus vulgaris* (motile spreading). A suspension of the organism was agglutinated by the sera of both Cases 2 and 3 up to but not beyond a dilution of 1 in 25. When fed to mice it had no ill effects. Her serum on September 18 gave reactions similar to those of her husband's serum (see Table II). A blood culture made on September 18 was sterile. From the faeces (September 23) typical *B. coli* only were obtained. In a serum test on September 25 no alterations in the titres of the suspensions of *Proteus*

vulgaris were found and the serum still failed to agglutinate the Standards Laboratory suspensions of enteric and food-poisoning organisms.

Unfortunately samples of cockles were not obtainable for examination, either at the houses of the affected patients or on the premises of the vendor. All the vessels used by the vendor in the preparation of the cockles were therefore rinsed with sterile saline, and the resulting rinsings, as well as a sack in which the cockles had been delivered, were examined, without success, for organisms of the food-poisoning, enteric, and dysentery groups. *Proteus vulgaris* (motile spreading) was found in considerable numbers in the bath which had been used for the ablutions of the vendor and his family before and after the final rinsings of the cockles. The organism was

TABLE II.—Serum of Case 3

Strain of <i>Proteus</i>	Dilution of Serum			
	25	50	125	250
(1) HXK (Nat. Coll.) ..	++	++	+	—
(2) OXK " ..	++	++	++	—
(3) HX2 " ..	++	±	±	—
(4) OX2 " ..	++	++	±	—
(5) OX19 " ..	++	++	++	±
(6) <i>Proteus mirabilis</i> (N.C.) ..	±	±	—	—
(7) OX19 (Standards) ..	++	++	±	—
(8) Case 2's strain ..	++	++	++	—
(9) Case 3's strain ..	++	++	++	—

++ = Complete agglutination.
+ = Incomplete agglutination.
± = Trace of agglutination.

not found in the washings from any of the other vessels or in the sack. The strain of *Proteus* was agglutinated by the sera from Cases 2 and 3 (see above).

"All three strains of *Proteus* isolated—that is, from the faeces of the second and third cases and from the bath—liquefied gelatin, produced indole, and gave identical sugar reactions. Thus all failed to ferment lactose, dulcitol, and mannitol, and all produced acid and gas in glucose, saccharose, maltose, and salicin."

Samples of faeces, blood for blood culture, and sera for agglutination were obtained from both the vendor and his wife on September 22. Neither of the faeces yielded *Proteus vulgaris* or other pathogenic organisms, although that of the woman contained some late-lactose-fermenting *B. coli*. The blood cultures were both sterile and the sera in dilutions of 1 in 25 and higher both failed to agglutinate any of the suspensions of *Proteus vulgaris* or any of the Standards Laboratory's suspensions of enteric or food-poisoning organisms.

Discussion

Previous outbreaks of food poisoning for which *Proteus vulgaris* has been held responsible have been recorded by Glücksmann (1899), Silberschmidt (1899), Pfuhl (1900), Demnitz (1926), and Wilson (1929). Usually, however, the evidence has not been convincing, and it is to be noted that the majority of these were reported prior to the obtaining of the more exact knowledge held to-day of the Salmonella group. In the case recorded by Demnitz, however, the agglutination of the *Proteus* suspension by the patient's serum at a dilution of 1 in 400 considerably strengthened the evidence for attributing the patient's diarrhoea to that organism.

In the investigation of epidemics of acute gastro-enteritis not due to the ingestion of food in itself inherently poisonous or contaminated with a chemical poison, considerable caution must be exercised in attri-

buting responsibility for the outbreak to any organism other than staphylococci or members of the Salmonella group. This is especially true when a *Proteus* is suspected; for, as Savage (1929) has written, "The evidence that organisms like *B. coli*, *B. proteus*, or Morgan's bacillus can cause food-poisoning is slender, and although many outbreaks have been attributed to them critical investigation does not substantiate the association." Bengtson (1919) held a similar view. It is on account of the rarity of cases of food poisoning justifiably regarded as due to *Proteus vulgaris* as well as on account of the hygienic lessons to be learned that this outbreak is here recorded.

It is suggested that the evidence given is sufficient to incriminate *Proteus vulgaris* as the cause of the outbreak. Admittedly the organism may be present, though never in large numbers, in the stools of normal individuals and enteric patients (see Wilson, 1929), and the secretion of inflamed surfaces such as enteric and dysenteric ulcers appears to offer a suitable pabulum for its development. It is conceivable, therefore, that the *Proteus* found was an invader secondary to another organism, but the interval for such a sequence of events seems to be unduly short. Further, the serological reactions of Cases 2 and 3 suggest an aetiological significance not only on account of the titre (125 in each case), but also on account of the fall in titre in the second patient from 125 to 50 in one week.

According to a pamphlet issued in June, 1936, by the Standards Laboratory the limit of normal agglutination for the strains of *Proteus* OX19, OXK, and OX2 is 1 in 50 (Weil-Felix reaction). The titres of the second patient's serum for these suspensions were just within the limits, but the serum of Case 3 had definitely higher titres for the strains of *Proteus* OXK and OX19 derived from the National Collection of Type Cultures. Twelve sera submitted to the laboratory for the Wassermann test gave titres less than 1 in 25 for all the suspensions used.

The original source of the *Proteus* is a matter for speculation. There is no evidence to make one suspect that the cockles were contaminated on arrival at the vendor's premises. Cockles, though often contaminated by sewage (Leighton, 1927), are able to grow well on clean, sandy areas. The outbreak was confined entirely to those who had partaken on the one evening only. The evidence suggests a contamination of the particular batch of cockles sold on September 11—some time during or subsequent to their preparation. The use of the final receptacle for personal ablution and the general uncleanness of the premises favour this possibility. Further, the fact that at least one individual who had partaken of the cockles had not suffered therefrom suggests that the contamination of the batch was not of even distribution, and so probably arose at a late stage of the preparation.

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