part of the tanks, the contents of which cannot be withdrawn beneath a level of four feet six inches from the bottom. Here the organic matter of the sewage will, we anticipate, be fluidified through the agency of the putrefactive bacteria.

After a due period of rest (and putrefactive fermentation) the supernatant disintegrated sewage will be drawn off—skimmed off gently—by “floating arms,” without the contents of the lower portion of the tank being disturbed. This supernatant liquid will be discharged, through an “aerating channel,” into one or other of the cultivation beds. These consist to a depth of two feet nine inches of coke breeze, which affords a very large surface or breeding ground for the nitrifying bacteria, with three inches of gravel on the top. In these beds the principal part of the purification process will be carried on. The routine will be arranged so that the disintegrated sewage will remain here, exposed to the action of the nitrifying micro-organisms, for a period of sixteen hours, when the purified sewage will be drawn off, and the filters allowed to rest or aerate for eight hours.

Very little sludge results in connection with this process, but full provision has been made for dealing with it. Perforated iron pipes have been laid along the bottom of the closed tanks, leading to a couple of sludge wells, one on either side. Once in six months, perhaps, the valves will be opened for a short time, when the pressure of the liquid above will force the thicker sludge, at the bottom of the tanks, through the pipes into the sludge wells, from which it will be raised by chain-pumps.

Such is the process as it is likely to be carried out. But it has been recognised that the biological method of sewage purification is, after all, still in a probationary stage. This is, I believe, the first occasion on which it has been resorted to in Scotland. A further safeguard has consequently been placed in reserve. Should the biological process not prove the success which is anticipated, it can be supplemented, or even replaced, by a precipitation process. Over the pipe conveying the sewage to the tanks has been erected a precipitating house. In this have been placed, ready for use, a couple of “lime mixers.” In these, by a simple contrivance, slaked lime will be mixed with water. A certain quantity of the lime will be taken up and dissolved in the water, forming “lime water.” It is found that lime water is a more efficient precipitant than a stronger mixture of lime and water. The lime water can be added to the sewage in any proportion desired, and very effective precipitation obtained. The addition of the lime water would not in any way interfere with the activity of the bacteria. It is confidently anticipated, however, that the biological process will prove a success, and that no process of

chemical precipitation will ever have to be resorted to. Of course, should it be found desirable, the second mixer can be used for a precipitant other than lime.—*A.R.*, 1897.

MEMORANDUM AS TO THE CONNECTION BETWEEN THE CONSUMPTION OF SHELL-FISH CONTAMINATED BY SEWAGE AND INFECTIOUS DISEASE.

BY

ARTHUR NEWSHOLME, M.D., Medical Officer of Health of Brighton. Examiner in State Medicine to the University of London.

THE causes of enteric fever have probably have been more thoroughly investigated than those of any other single disease. It is generally recognised that the contagium of this disease is derived from the excreta of patients suffering from it, either by direct infection in connection with the nursing of patients or by indirect infection in a more remote manner. The chief indirect means by which infection may be received are as follows:—

1.—Emanations from defective drainage arrangements or from a subsoil which is chronically contaminated by the typhoid organism, this organism being able to live and multiply in a sewage-contaminated subsoil.

2.—Contamination of water or milk by dejecta derived from enteric fever patients.

3.—Contamination of shell-fish or other foods by dejecta derived from enteric fever patients.

It has been a source of disappointment to the authorities of many great towns that the provision of unpolluted drinking water, and the construction of main sewerage works and of water-tight house drains, which free the subsoil from contamination, have not been followed by so great a reduction in the mortality from enteric fever as might have been expected.

The Brighton Sanitary Authority have shared in this disappointment. They have entirely eliminated cases of enteric fever caused by contaminated water; they have had in recent years no cases traceable to contaminated milk; the majority of the house drains in the town are completely water-tight, and the subsoil is thus kept free from the contamination which favours the continued vitality of the typhoid organism within it. Notwithstanding these facts, they find that though the amount of enteric fever is low in Brighton they still suffer from more of this disease than they had reasonable grounds to expect, having regard to their large expenditure on the sanitary improvement of the town.

A considerable proportion of the cases are imported, but when these are eliminated they find that a large share (at the least 30 per cent.) of the cases originating in the municipal borough of Brighton are caused by conditions other than those mentioned under the first two headings above.

It is well known by every medical officer of

health that in a considerable proportion of cases of enteric fever the source of infection remains undetected, after elimination of water or milk or defective sanitary arrangements as possible causes of infection. This remark applies particularly to the sporadic cases which, in towns under an efficient sanitary régime, form the majority of the total cases. Such cases constitute the main difficulty in completely eradicating enteric fever. It is through contamination of water or milk on a large scale from such sporadic cases that our great epidemics of enteric fever arise.

It is furthermore now becoming more generally recognised that enteric fever is much more frequently acquired from ingesta (food and drink) than by inhalation of the poison. But the cases in which difficulty in tracking the source of infection occurs being isolated items, without any connecting link with others in the same neighbourhood, it is easily understood why there has been considerable diffidence in arriving at the conclusion that such cases are caused by specifically contaminated shell-fish. This cause of enteric fever has now, however, become generally recognised.

It was recognised early in 1894 by the Medical Officer of Health of Brighton, and as will be seen by the summary of local action hereinafter given, the subject has almost constantly been before the Brighton Sanitary Authority since that time. The representations made by that Authority were one of reasons leading to the appointment of a Medical Inspector of the Local Government Board to make a detailed inquiry into "Oyster Culture in Relation to Disease;" and Dr. Bulstrode's report, issued in October, 1896, amply confirms the isolated observations previously made. Enteric fever is not the only disease which has been traced to specifically contaminated shell-fish, for, as Sir R. Thorne Thorne remarks, "In the report 'on Cholera in England in 1893,' which I had the honour of submitting to the Board in December, 1894, I expressed my conviction that the distribution of shell-fish from Cleethorpes and Grimsby as a centre, had been concerned in the diffusion of scattered cases of cholera over a somewhat wide area of England." Medical officers of health in various parts of England have also reported on cases of enteric fever traceable to the consumption of sewage-contaminated shell-fish. As long ago as 1880, Sir Charles Cameron shewed the "possible relation of typhoid fever to the consumption of specifically polluted oysters" in Dublin.

The contribution of Sir William Broadbent, F.R.S., to the "British Medical Journal" (1895, vol. 1., p. 61), of Sir Peter Eade to the same Journal (1895, vol. 1., p. 121), and numerous similar contributions show that, as attention is being increasingly drawn to this cause of enteric fever, it is becoming recognised as a not infrequent cause of sporadic cases of this disease.

The following letter from Sir William Broad-

bent, Physician to the Prince of Wales, is an important contribution on the subject:—

[COPY.]

"84, Brook Street,
"Grosvenor Square,
"London, W.,
"January 21st, 1898.

"DEAR DR. NEWSHOLME,—I have read with much interest and entire approval the petition to the Local Government Board on the regulation of the supply of oysters and other shell-fish for food purposes. Some years ago I published a series of cases demonstrating the causation of typhoid fever by oysters, and every year since I have seen cases in which typhoid fever has been distinctly traced to oysters; at times the form of fever has been very deadly. The investigations made by Dr. Bulstrode and others have not only furnished scientific confirmation of the clinical conclusions, but have shown that the source of contaminated oysters, etc., can be identified, and that a remedy can be applied. It seems to me, therefore, an imperative duty that some such measures as those indicated in the petition should be adopted, and I certainly support the petition. I am not sure that I can attend with the deputation, but if you will give me notice of the time and place I will make an effort to be present.

"Yours very truly,
(Signed) "W. H. BROADBENT."

Medical attention has of late been specially directed to the question of the relation between the consumption of shell-fish contaminated by sewage and infectious disease.

The report of the Medical Officer of the Local Government Board on this subject, and the valuable evidence collected by Dr. Bulstrode and contained in the appendix to that report, have drawn public attention to the very serious danger to public health which arises from the condition of certain of the oyster ponds and receptacles used for the storage of oysters in preparation for the market. The facts recorded in these reports as to the cases of the oyster ponds at Southend, Cleethorpes, Medina River, Penryn River, Brightlingsea Creek, Southwick, and Colne River, and in the cases of certain storage pits and other receptacles at Southend Pier, Blackwater River, Wivenhoe, Grimsby Fish Dock, Poole, Warsash, Bosham and Emsworth, shew in all these instances the oyster ponds or receptacles are subject to sewage contamination of the grossest and most dangerous description.

The case with respect to sewage-contaminated oyster beds and storage ponds is summarised by Dr. Bulstrode in these words:—

"It must have been apparent from these descriptions and maps that at certain places along our coasts no care whatever has been exercised in

the selection of localities for layings serving as fattening beds and for storage ponds, in order to ensure that oysters in these places should be reasonably free from risk of sewage pollution; and also it will be clear that considerations of accessibility and convenience have, in many instances, at least, determined the selection of storage ponds, fattening beds and layings. A general view of the conditions will have served to demonstrate that many of the larger and more important companies possess 'layings,' fattening beds and storage ponds in the main free from the risks of dangerous sewage pollution; and that, moreover, where security in this sense does not obtain, it may—in not a few instances, at least—be easily brought about by the simple expedient of altering the position of the fattening beds or storage pits. But, on the other hand, it will have been obvious to the reader that there are cases where the risk of sewage pollution to oysters is so great and so undeniable, that nothing short of complete diversion of the sewers or drains, or withdrawal of existing fattening beds or ponds from use, can be regarded as satisfactory in the public interest. It would indeed appear that, in several places along our coasts, the conditions are at least equally bad, if not worse, than those which are reported to have brought about the very remarkable outbreak of enteric fever at Wesleyan College, Connecticut, U.S.A."

The circumstances attending the trade in oysters and other shell-fish in Brighton are such as to render the accurate tracing of the connection between the consumption of specifically contaminated shell-fish and attacks of enteric fever easier than those usually existing in great towns.

The following is the chain of evidence which has enabled the Medical Officer of Health to establish the connection between cases of enteric fever and the consumption of oysters and other shell-fish:—

a.—Most of the oysters and mussels consumed

in Brighton are derived from a particular source, concerning which it is only necessary to quote Dr. Bulstrode's remark (Report p. 73). "Sufficient has come to light for the purpose of demonstrating that the Southwick oyster ponds are in a most improper and unsafe position."

b.—Enteric fever is endemic in the population whose drains and cesspools discharge near the oyster ponds and mussel beds in question.

c.—Sewage-derived organisms were found in the mud of the oyster ponds, and in the interior of oysters obtained from them by Dr. Klein, F.R.S., and by Professor Boyce, of University College, Liverpool.

d.—In a large proportion of the cases the one person taking oysters or mussels from the above source within three weeks preceding the date of onset of illness is the one person subsequently taken ill with enteric fever.

e.—When other persons in the same house had eaten shell-fish they had diarrhoea or other evidence of illness, although this did not develop into typical enteric fever.

The following tabular statement shows that 30·7 per cent. of the total cases of enteric fever originating in Brighton during 1897, were definitely traceable to the eating of sewage-contaminated oysters or mussels, as compared with 31·8 per cent. in 1896, with 33·9 per cent. in 1895, and with 38·2 per cent. in 1894.

The spread of enteric fever by means of sewage-contaminated shell-fish has been a cause of anxiety to the Brighton Sanitary Authority since March 29th, 1894, when the Sanitary Committee had before them the particulars of eight cases of enteric fever which had occurred during the preceding quarter, and which were attributable to the consumption of oysters derived from oyster layings grossly contaminated by sewage. These particular beds will be described as X in the present memorandum. (For particulars as to these beds see Dr. Bulstrode's Report, p. 73.)

YEAR.	Total cases of local origin.	No. of cases in which it was stated that oysters or other shell-fish had not been eaten.	No. of cases in which it was doubtful whether shell-fish had been eaten.	No. of cases in which origin was directly traceable to oysters.	No. of cases in which origin was directly traceable to other shell-fish.	Total of foregoing cases traceable to oysters and other shell-fish.	Percentage of last-mentioned cases to total local typhoid cases.
1893 (from Midsummer)	31	19	6	6*	—	6	—
1894	55	33	1	16	5	21	38·2
1895	56	37	—	7†	12	19	33·9
1896	94	61	2	22‡	8	30	31·8
1897	88	47	11	11	16	27	30·7

* No secondary cases.

† Including one secondary case.

‡ Including two secondary cases.

Average percentage of cases of local origin in the four years, 1894-97, traceable to shell-fish = 33·1 per cent.

On April 19th, 1894, the Sanitary Committee had before them particulars of further cases of enteric fever arising from the same cause. At the same time samples of mud from the market ponds in question were submitted to bacteriological examination by Dr. Boyce, now Professor of Pathology, University College, Liverpool, who stated that the results pointed "unmistakably to the presence in the immediate vicinity of the oyster beds of sewage matter contaminated with human excreta."

On April 20th, 1894, the Medical Officer of Health interviewed Mr. Power, the Assistant Medical Officer of the Local Government Board (in the absence of Dr. Thorne), and urged the importance of the Local Government Board bringing pressure to bear upon the responsible local authorities to execute an efficient combined system of main sewerage. Such a scheme is still in the future, though an Inspector of the Local Government Board has (December, 1897) held an inquiry into a proposed combined scheme affecting two out of four of the local authorities responsible for the pollution of the oyster and mussel layings at X.

The Brighton Sanitary Authority, during 1894, wrote to the Port Sanitary Authority of Shoreham, and as the result of their letter the owners of the market ponds at X were served with a notice from the Port Sanitary Authority requiring them to close the oyster ponds. On August 18th, 1894, the Medical Officer of Health reported that these ponds were again in use, and reported three additional cases of enteric fever traceable to oysters derived from them.

On October 11th, 1894, the Medical Officer of Health found that the two small sewers adjoining the market ponds had been lengthened, so as to discharge 50 and 78 feet, respectively, from the nearest ponds.

On December 7th, 1894, a Deputation from the Brighton Town Council, consisting of the Mayor (Mr. Alderman Botting, J.P.), the Chairman of the Sanitary Committee (the late Councillor Loader), Sir Joseph Ewart, J.P., Councillor McClean, Town Clerk, and the Medical Officer of Health, waited upon the Parliamentary Secretary of the Local Government Board (Sir Walter Foster), who was accompanied by Sir Hugh Owen and Dr. Thorne Thorne. At this interview Sir W. Foster stated that "he regarded the site where the oyster ponds were now placed as an open sewer, and absolutely unfit for its present use." He added that "there was no doubt that the question was one of general importance, and that some general regulations for the control of the trade in shell-fish were necessary."

The Medical Officer of Health of Brighton continued to report, during the next two years, cases of enteric fever caused by sewage-contaminated shell-fish as they arose. In his annual reports he

made the statement that 38·2 per cent. (1894), 33·9 per cent. (1895), 31·8 per cent. (1896), and 30·7 per cent. (1897), of the total cases of enteric fever originating in Brighton were caused by sewage-contaminated shell-fish. The Brighton Sanitary Authority, being impressed with the importance of obtaining powers to enable them to cope with a cause of disease which was responsible for one-third of their total indigenous enteric fever, attempted, in the Session of 1896, to obtain Parliamentary Powers authorising them to prohibit the sale, within the Borough, of shell-fish known or suspected to be the cause of infectious disease, similar to those which the Local Government Board are now asked in the memorial to confer upon local authorities generally. This clause was, however, rejected by the Police and Sanitary Committee of the House of Commons, largely it is believed, because of the statement of the Local Government Board that their investigation on the subject was not complete, and because of the statement of the Board of Trade that powers of the nature asked for, if granted, should be general and not local.

The present law does not enable local authorities to prevent the sale, within their district, of shell-fish from a source known to be grossly contaminated with sewage; and although cases of enteric fever may have been previously traced to the consumption of shell-fish from the same source, the powers with respect to the seizure of unwholesome food (Public Health Act, 1875, Sec. 116) do not meet this case. It is impossible to say in a particular instance, without a bacteriological examination requiring from seven to ten days, whether a given lot of oysters exposed for sale contain typhoid bacilli. The recent failure to find typhoid bacilli in the Maidstone water, at a time when it was spreading enteric fever, shows that negative results cannot be trusted. The machinery of Section 116 of the Public Health Act is quite inoperative when applied to the requirements of this case.—A. R., 1897.

THE VACCINATION ACT, 1898.

CHAPTER 49.

An Act to amend the Law with respect to Vaccination.

[12th August, 1898.]

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal and Commons, in this present Parliament assembled, and by the authority of the same as follows :

1. *Vaccination within six months after birth* ; 30 and 31 *Vict. c. 84.*—(1.) The period within which the parent or other person having the custody of a child shall cause the child to be vaccinated shall be six months from the birth of the child, instead