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Non-specific illness associated with the consumption of molluscan shellfish: a report of current investigations in England

by

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Records of illness associated with the consumption of molluscan shellfish extend back to the early 1800s (see Halstead 1965) and the majority of cases can be placed under one or more of the following headings: (i) gastro-intestinal or choleratic shellfish poisoning, (ii) erythematous poisoning (allergy), and (iii) paralytic shellfish poisoning. However, despite improved laboratory and bioassay techniques, many cases of illness cannot be assigned to any recognized agent. This paper reviews typical incidents of non-specific illness occurring in the United Kingdom and assesses the possible causes and solutions.

Since the introduction of shellfish purification methods utilizing ultra-violet light (Wood 1961) no cases of typhoid following the consumption of raw molluscs have been reported in the United Kingdom. Oysters produced from the ultra-violet-type plants, and mussels from Dodgson-type chlorinated systems reach a high sanitary standard (Wood 1963) and are rendered free of known pathogens, particularly those of faecal origin. In spite of the high standards achieved, however, a number of cases of gastro-enteritis have occurred following the consumption of oysters treated in approved installations.

A major incident of this type, associated with oysters from a new fishery in south-west England, occurred in October 1966. Following the severe winter of 1962-63 oysters were in short supply and efforts were made to re-open this particular fishery which had been closed in 1937 under the Public Health (Shellfish) Regulations of 1934. This closure, imposed by the local authority, followed a case of paratyphoid associated with the consumption of cockles. In 1966 a plant using ultra-violet light was constructed and its operation supervised by the local authority; six licences were issued for the taking of oysters. Bacteriological tests of water and oysters before and after treatment demonstrated that initially

grossly polluted shellfish were free of E. coli after treatment and satisfied the normal bacteriological standards. Two weeks after the fishery opened, approximately 30 cases of gastro-enteritis occurred in the district following consumption of treated oysters. A number of factors became evident at that time, the exact significance of which is not clearly understood. Most of the persons who became ill lived in an area which at that time was affected by an epidemic of gastric illness characterized by vomiting and diarrhoea. However, several cases occurred some miles away in a town affected by the epidemic to a lesser degree, where all those who consumed oysters were ill. At the focus of the oyster and gastro-enteritis outbreaks a few people who ate the oysters were unaffected; these were largely fishermen accustomed to eating local shellfish. The picture was further complicated because, of the 5 450 oysters which were sold at the time, only the 400 sold locally were implicated in the outbreak. The remaining 5 050 were sent to other markets and no similar incidents were reported.

The dominant symptoms of the illness were malaise, vomiting and diarrhoea, with secondary symptoms in some cases of muscular and stomach pains persisting for up to 5 days. Diarrhoea and vomiting were particularly evident in those cases where six or more oysters were eaten, and one individual who ate two dozen oysters was seriously ill for 48 hours and unwell for 5 days afterwards. The incubation period varied considerably - from 24 to more than 72 hours - but was generally 36 hours, and illness persisted for 12-24 hours. Some people recovered rapidly and others experienced mild discomfort for days afterwards. An outbreak with similar features is reported by Gunn and Rowlands (1969). A feature of these and other incidents was that severity and persistence of illness showed no correlation with numbers of oysters consumed. A case is known of one illness where a single oyster was chewed but not ingested. The delayed onset of symptoms and the absence of a dose/response correlation suggests an infective process rather than an intoxication, where severity would be expected to increase with dose. Cooked oysters from this and other sources have failed to produce any response.

Since the 1966 incident many lines of investigation have been pursued and have included examination of similar incidents elsewhere. A review of this work will be made to summarize the investigations and the conclusions drawn on the cause of non-specific gastric illness.

Pesticides Examination of shellfish for the presence of pesticides, particularly the chlorinated hydrocarbons, revealed very low concentrations of these substances, and although little is known of the long-term effect of these compounds they were not present in quantities sufficient to produce relatively acute effects.

Sewage pollution Although all the shellfish implicated in cases of gastro-enteritis were found to be of high sanitary quality by the absence of E. coli and of pathogens such as Salmonellae and Shigellae, there is a marked tendency for shellfish causing illness to originate from water subjected to sewage pollution. From examination of sewage discharges in the affected area of the south-west outbreak, only two Salmonellae (S. senftenberg and S. bredeney) were detected in 47 samples examined. No viruses or pathogens such as Salmonella were identified in oysters taken directly from the areas receiving these discharges.

Heavy metals Levels of zinc, copper and lead in shellfish associated with illness show considerable variation. Oysters from the source of the 1966 outbreak contained zinc (range 900-1 050 ppm on a wet weight basis), copper (104-209 ppm), and lead (1-1.5 ppm), and these concentrations are within the ranges found in over 200 samples of market shellfish taken from other acceptable areas. In order to assess the significance of the heavy metal concentrations, macerated shellfish were fed to cats, but although there was some diarrhoea and vomiting, the results were too variable to be of great significance. This may reflect the sensitivity of cats to oyster tissue, seawater salts or heavy metals, but carefully controlled experiments of this type may prove a useful technique for future work.

Plankton Following the 1966 incident, water from the area where the oysters were taken was monitored for the presence of potentially toxic dinoflagellates. In July 1967 Gonyaulax tamarensis were found at a concentration of 1.2×10^6 cells/litre and in August Prorocentrum micans reached 5×10^5 cells/litre. Extracts of oysters and mussels from these waters prepared with acid (McFarren 1959), ether (McFarren et al. 1965), and ethanol (Akiba and Hattori 1949) were injected intraperitoneally into mice without ill effect; mice fed on shellfish were similarly unaffected. It was concluded therefore that, although both Gonyaulax and Prorocentrum were very numerous and had been implicated in cases of paralytic poisoning elsewhere (McCollum et al. 1968, Pinto and Silva 1956), these particular strains were non-toxic. It is significant that during the

September-March oyster season, when non-specific illness appears, dinoflagellates and other related phytoplanktonic organisms are either absent from coastal waters or present in very low numbers. An interesting incident reported by Korringa and Roskam (1961) showed a possible link between gastro-enteritis associated with the consumption of mussels and the presence of three dinoflagellates, tentatively identified as Prorocentrum micans, P. scutellum and Dinophysis acuminata; these or similar organisms may be the cause of non-specific as opposed to paralytic illness on other occasions.

Bacteriology In all or most of the reported cases of non-specific illness the major research effort has been into the bacteriology of the shellfish, in an attempt to isolate some known pathogen. Laboratories of the Public Health Laboratory Service at Truro and Colindale (London), in cooperation with this laboratory, have carried out exhaustive investigations to determine possible bacteriological causes. Tests for Escherichia coli, Salmonellae, Shigellae, Clostridium welchii, faecal streptococci (especially S. faecalis), Staphylococci and a known cause of gastro-enteritis, Vibrio parahaemolyticus have been negative or failed to reveal significant numbers of any of these organisms. Plate counts on a variety of non-selective media at 20, 30 and 37°C showed the bacterial content to range from 10^3/g to a maximum of 10^7/g, but comparable figures have been obtained from samples of market shellfish not associated with illness. Similar observations have been made with shellfish stored in purification tanks or in air at 5 and 15°C. Air storage at 15°C allows a considerable increase in non-specific bacteria (Wood 1964) but potentially pathogenic organisms have not been detected. Barrow and Miller (1969) looked in detail at the performance of two ultra-violet purification plants, one of which was known to have been associated with outbreaks of gastro-enteritis. They showed that the presence of low-temperature haemolytic Vibrios (probably V. anguillarum or V. alginolyticus) in purified oysters was generally restricted to oysters from the suspect plant. Since the organisms were destroyed by ultra-violet irradiation it was suggested that the increase of organisms in the water might be a result of multiplication exceeding the rate of destruction. Subsequent surveys by this laboratory demonstrated similar organisms in 26 of 28 samples of unpurified shellfish and 17 of 26 samples of purified oysters from other sources. The significance of this organism is therefore not easy to establish, but it may be of value however in acting as an 'indicator' of the ability of oysters to remove

psychrophilic bacteria during purification. From all these tests the conclusion is reached that if these incidents of illness are caused by a bacterial agent it is not a recognized pathogen. However, little is known about the significance of large numbers of non-specific bacteria, particularly the Vibrios, of marine origin and this is a field which should receive further attention.

Purification methods Although all ultra-violet purification plants conform to certain specifications (Wood 1961), the type of construction and standard of operation varies from plant to plant. To assess the significance of these differences, laboratory and field experiments have been undertaken to determine the changes taking place in the total bacterial content of oysters when operating conditions are varied. These tests, undertaken by my colleague Miss Sheila Halls, have included changes in the intensity of exposure to ultra-violet light, the density of shellfish, and the build-up of organic matter following continuous use of the plants. Some interesting results have been obtained but the significance of the variables is difficult to interpret. What becomes increasingly evident is that the relationship between the method of treatment and the bacterial content of oysters is far from predictable. It seems that oysters have a commensal bacterial flora which cannot be removed by purification; this flora is variable both in numbers and types of bacteria and in terms of season and geographic origin of the shellfish. Superimposed on this background flora are the adventitious marine, estuarine and terrestrial (including sewage) bacteria which are ingested from the environment. Work in this laboratory has indicated a highly significant correlation ($P < 0.001$) between water temperature and total bacterial counts of oysters from a lightly polluted area of the River Crouch. It seems probable that at low water temperatures most of these bacteria are of the commensal type. The absence of any cases of illness associated with oysters consumed one or two days later than those producing symptoms suggests that the causative agent is changed or disappears during the period of storage out of water.

Future work Although illnesses associated with the consumption of raw oysters are sporadic, the failure of approved purification installations to eliminate the problem is considered adequate reason for work in this field to be continued. At the Fisheries Laboratory, Burnham-on-Crouch, in the coming months, special attention will be paid to controlled human feeding tests using oysters from the source of the 1966 incident.

Attempts will be made to assess whether symptoms follow the ingestion of raw and cooked shellfish or bacteria-free filtrates. The use of ligated rabbit gut (De and Chatterje 1953) for determining whether or not bacteria recovered from oysters are capable of producing enteritis will also be considered.

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