THE HEALTH HAZARDS ASSOCIATED WITH THE CONSUMPTION OF SHELLFISH FROM POLLUTED WATERS

C. B. Kelly

Environmental Protection Agency
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That consumption of shellfish (oysters, clams, and mussels) harvested from polluted estuaries has been responsible for enteric diseases in man is a well established fact, documented many times over by epidemiological investigations and corroborated by microbiological and biological studies. To understand how these shellfish become vectors of enteric diseases, one must consider the following:

1. In collecting food, the shellfish take in and ingest bacteria, viruses and certain inorganic and organic compounds adverse to man's health.
2. Shellfish accumulate and concentrate bacteria and virus to levels in their bodies much higher than in the surrounding water. They also collect and assimilate metallic and organic compounds. The micro-organisms are seldom if ever found in the tissues of shellfish, but many inorganic and organic substances are stored in specific organs and tissues.
3. The entire animal, exclusive of the shell, is consumed by man. Thus, the food collecting organs and the gastro-intestinal system become part of the portions eaten by man.
4. The shellfish are often eaten raw, or only partially cooked.

The Feeding Mechanisms of the Oyster

An intricate coordinated ciliary action creates a current of water drawn in from the outside and drives the water through the gill slits. Here, food material, suspended or dissolved in the water, is removed, partly by mechanical action, but also by entrapment and adsorption on mucous that is generated by specialized cells in the gills. The mucous forms a "sheet" which, again by ciliary action, is transported over the gills to the labial palps, the mouth of the oyster. Through this combination of mechanical and physio-chemical mechanisms, the oysters can remove very small particles as small as bacteria and viruses, and by adsorption certain inorganic and organic compounds and substances. (1, 2, 3, 4).

Many external factors influence the rate at which oysters pump water through their gills. Probably the most fundamental of these factors is water temperature, (5, 6, 7) but pumping (the water transport process) and feeding (the food collecting process) are also effected by salinity (8), chemical agents, (9, 10) silt (11), and excessively high concentrations of plankton (11), to name a few.

Uptake of Bacteria by Shellfish

The uptake of bacteria by shellfish has been the subject of controlled *in vivo* studies, carried out primarily to gather knowledge on the influence of environmental factors such as temperature on the water/shellfish bacterial relationships, and to compare the rate of uptake of several species of shellfish.

In experiments conducted on Eastern Oysters, (Crassostrea virginica), Hard Clams, (Mercenaria mercenaria), and Soft Clams, (Mya arenaria) Kelly (12) reported species variation as well as the influence of temperature on the uptake of bacteria. Soft clams were highest in uptake, oysters next lower, and hard clams the lowest. Soft clams were least effected by temperature. Hard clams and oysters were relatively inactive at temperatures below 8°C. In studies in the Pacific Northwest, Kelly (13) showed a distinct species difference in uptake of bacteria by Pacific Oysters (Crassostrea gigas) and Olympia Oysters, (Ostrea lurida). Olympia oysters were consistently higher in bacterial content and the difference became greater in the warmer months. A definite seasonal pattern of changes in uptake by both species was evident. Kelly et al, (14) studied the accumulation of coliform organisms by Eastern Oysters native to the Gulf of Mexico coastal estuaries. These studies are particularly relevant to Pearl Harbor because of similarity in seasonal changes in water temperature in the species of oysters growing in the areas. In the Gulf Coast studies, the lowest uptake of bacteria occurred in August and September, when water temperatures were the highest. The highest rate of uptake occurred in the period October-December following a decline in water temperature.

Uptake of Virus by Shellfish

That virus are accumulated by oysters was demonstrated in a four-year study conducted by Metcalf and Stiles (15) in an almost completely enclosed estuary in New Hampshire that receives raw and treated domestic sewage. Viruses were isolated from 114 of 459 oyster samples and from 103 of 310 water samples. Eight identified and fourteen untypable strains of viruses were isolated from the oysters. Polio virus type I was most frequently found, but Polio virus types II and III were also found, and in addition, one strain each of Echovirus and Rheovirus, and 3 strains of Coxackievirus. A similar study was carried out in a moderately polluted area in Rhode Island by the EPA Northeastern Water Hygiene Laboratory. The isolations from clams and oysters included three poliovirus strains, three strains of echovirus and one of Coxackievirus.

Liu (16), reports on observations on the physiology of the accumulation of viruses by shellfish, summarized as follows:

1. By far the greatest portion (95% +) of virus is found in the digestive system, the gills and the feces, but approximately 5% are found in the lymph.
2. The virus in the digestive system does not adhere to or penetrate any type of cells. These observations indicate that virus, for the most part experience a transient existence in the gastro-intestinal system of shellfish.

3. The mucous has a high absorbability for virus. When mucous was added to suspensions of virus in sea water, 80% of the virus attached to the mucous particles.

Quantitative estimations of the rate of virus accumulation by the Eastern Oyster were made by Mitchell et al (17). These studies, conducted in controlled flow-through experimental systems, feature concommitent observations on the accumulation of E. coli. The results show that rapid uptake of the virus occurred within one hour of exposure to the virus contaminated sea water. The rate of uptake decreased after about four hours and stabilized after 6 to 12 hours exposure. The viral content of the oyster meats reached 10-60 times that of the surrounding water. Accumulation of E. coli closely paralleled that of virus.

The finding of virus in shellfish in polluted estuaries, demonstration of the presence in feces, and in vivo experimentation which quantitated the rate and extent of accumulation of virus, as well as a behavior parallel to that of E. coli furnish scientific proof of the potential that shellfish can be indeed vectors of enteric viral diseases.

Uptake of Trace Metals by Shellfish

Shellfish can selectively concentrate metallic salts and organic materials to levels many hundred times that in the surrounding water. The mechanisms involved in the uptake of these inorganic and organic materials can include the following (18):

1. Particulate ingestion of suspended material from seawater.
2. Ingestion of food material such as plankton that have acquired these chemicals.
3. Uptake by exchange, for example, onto mucous sheets of the oyster.
4. The incorporation of metal ions into physiologically important systems.
5. Complexing of metals by coordinate linkages with appropriate organic molecules.

Polyvalent ions like Al^{+++}, Cu^{++}, Fe^{++}, Hg^{++} and Mn^{++} are easily caught and accumulated by the oyster, but not positive monovalent ions like Na^{+} and K^{+} which are present in greater quantities. (1) The capability of five species of bivalve mollusks to accumulate metals was determined by Pringle et al (19) in controlled studies in a simulated natural environment. The "enrichment factors" derived from these experiments are given in Table 1 and compared with values derived by other workers. These enrichment factors are referred to the seawater trace metal levels reported by Goldberg (20). A review of these data would prompt the following observations:

1. In a given species of mollusk, there is a wide range of enrichment factors among the several trace metals studies. For example, the factor for cadmium in oysters was found to be 226,000 and for manganese 2,900. The factors for other metals fall between these two values.
2. The enrichment factors for a given trace metal is often different in other species of mollusk. For example, the factors for copper in the oyster, the hard clam, the soft clam, and the surf clam were found to be 14,800, 900, 2,000, and 450, respectively. Pringle (19) states: "The apparent selectivity for trace metals among various species appears to depend to a considerable extent on the metals available in the environment, their chemical and physical properties, the kind and number of ligands available for chelation, transport and storage, and the stability of the complex formed."

Pringle (19) also reports on the results of a study to determine the levels of trace metals in shellfish in the natural environment. The average levels found in this study, which included approximately 100 stations along the Atlantic Coast from Maine through North Carolina are given in Table 2 .

The values shown in table 2 are average levels. There was a wide range of levels of several metals in samples collected from the different estuaries. Pringle attributes this to the environmental concentration of the particular metal, the temperature, the species concerned, and the physiological activity of the animal.

As was shown by the enrichment factors there is a differing selectivity of trace metals by the species studied. The affinity for zinc and copper is greatest in the oyster than in the other mollusks ; the soft clams accumulate more iron, to cite two examples.

As a result of the discovery of mercury in Lake St. Clair, authorities were prompted to investigate the possible occurrence of mercury in shellfish. The EPA Water Hygiene Laboratories at Narragansett, Rhode Island and at Dauphin Island, Alabama undertook surveys in several estuarines in collaboration with Federal and State agencies. In general, very low concentrations of mercury were found, well below the recommended tolerance limit of 0.5 parts per million. Values as high as 5.5 ppm were found in oysters harvested from an estuary in the State of Texas, the highest value having been found in oysters approximately 1,000 yards below a chlor-alkalie plant.

The Uptake of Pesticides by Shellfish

Concern over the potential pollution of estuaries by pesticides and in turn shellfish, was spot-lighted by the massive fish kill in the Mississippi River in 1963. To assess this potential, studies were conducted in the estuaries in Louisiana that are influenced by discharges of the Mississippi River. (21) These studies were followed by studies of pesticides in hard clams in Raritan Bay, New York (22), in Galveston Bay, Texas following a mosquito control program (23), in selected stations on the South Atlantic Coast, and the Gulf of Mexico (24), and in Mobile Bay, Alabama (25).

In all of these studies the concentrations of chlorinated pesticides were found to be low, predominantly below the sensitivity of the analytical method, 0.01 parts per million. Measurable quantities of all but one (Aldrin) of the 12 pesticides were found in many of the samples. The highest values found were of DDT and isomers. Maximum values of 4.61, 2.17, 2.21, and 1.45 parts per million were found in oysters from four reefs in Mobile Bay. Even these highest values are well below the recommended tolerance limits set by the National Shellfish Sanitation Program (26).

Although these low concentrations of chlorinated pesticides are judged to be of little or no concern to human consumers of shellfish, they are significant to the well being of mollusks, crustaceae, and fish. Butler (27) reports that environmental pollution of as low as 10 parts per billion (p.p.b.) of some of these chemicals will prevent normal shell growth in mollusks.

He also states that oysters exposed to DDT for a week grew somewhat slower but otherwise not significantly damaged. If these oysters are fed to fish, more than half of the fish will die within 48 hours.

<u>Uptake of Marine Biotoxins by Shellfish</u>

It has been known for centuries that shellfish collect and store naturally occurring marine biotoxins that can be lethal to man. The most extensively studied of these toxins is the so-called saxitoxin, which is the cause of paralytic shellfish poisoning (28). This toxin is generated by dinoflagellates of the species Gonyaulax. It is found in the Northeastern United States and Eastern Canada estuaries, and on the Pacific Coast from California to Southern Alaska.

Oysters, clams, and mussels have been involved in toxicities to man, a topic which will be discussed in another part of this report.

The occurrence of the Gonyaulax toxin is characteristically associated with the colder waters of the North American and European continents and, therefore, not likely to occur in Pearl Harbor. It should also be noted that the occurrence of this toxin is not associated with domestic or industrial pollution. In fact, the first recorded incident on this continent was in the chronicles of Vancouver (29) who narrates an incident on landing in British Columbia in 1793.

Another biotoxin, this one generated by a dinoflagellate Gymnodimium breve has been associated with pollution or at least enrichment of sea water by phosphates (30). This organism periodically attains high population densities along the Florida West Coast, and the coasts of Texas and Mexico. Numerous mass fish mortalities have been associated with these "red tides". In 1962 the uptake of the toxin by oysters and clams was demonstrated by several illnesses among persons who had eaten these shellfish species harvested from Sarasota Bay, Florida (31).

Cummins et al (32) in a survey of the occurrence of the toxin in Gulf of Mexico estuaries detected the toxin in shellfish from the Florida west coast estuaries that often encounter red tides.

Two types of shellfish poison found in Japan are mentioned to illustrate possibilities of similar situations elsewhere. The first of these, venerupin poisoning, is named after the molluscan family Veneridae. Two species of these clams, the Japanese little neck clam Tapes semidecussata and the Japanese dosinia, Dosinia japonica are known to harbor the toxin. The Japanese oyster, Crassostrea gigas has also been involved (33).

The geographical scope of the toxic shellfish is limited to specific areas in the Kanagawa and Schizuoka Prefectures in Japan.

Venerupin is a lethal toxin. Mortality rates among persons that consumed tainted shellfish have been as high as 67 percent. Akiba (34) has associated the presence of a dinoflagellate, Prorocentrum sp. with the occurrence of toxic clams (34). The dinoflagellate was found in the digestive gland of the Japanese littleneck clam and extracts of the dinoflagellate produced toxic symptoms in mice similar to those produced by extracts of the clams.

The other example is a toxin found in the ovary of one of the family Veneridae of clams, the Japanese callista clam, Callista brevisiphonata. The clams are said to be toxic only during the spawning season. This toxicity differs from those mentioned above in the respect that there has been no association with dinoflagellates, and that it occurs only during the spawning season.

Shellfish Borne Bacterial Enteric Diseases

Knowledge that shellfish can be vectors of bacterial enteric diseases dates back for centuries. Fisher (36) developed a partial list of more than 100 shellfish borne outbreaks of typhoid fever or gastroenteritis that occurred from 1815 to 1936. More recently, Tufts (37) has supplemented this list by recording shellfish borne outbreaks of typhoid fever, salmonellosis, and gastro-enteritis during the period 1940 to 1968. These records were derived from CDC Mortality and Morbidity reports and summaries. This list includes 24 outbreaks of enteric disease scattered throughout the United States. Shellfish associated typhoid fever occurred as recently as 1968. Chassagne (38) reported that in France in 1960, there were 2,263 declared cases of typhoid and paratyphoid fever. Epidemiological reports received from 490 of these revealed that shellfish was responsible for 83 cases. An outbreak of gastro-enteritis involving more than 100 cases occurred in Tokyo, Japan in 1966, (39) attributed to the consumption of oysters harvested from areas of questionable quality and/or contaminated in processing.

An isolated case of enteric disease should not be considered lightly. The classic series of events described by Old and Gill (40) shows the potential for mass spreading (85 cases) of typhoid fever. The person, an oyster fisherman contracted typhoid fever eight years previous to the reported shellfish borne outbreak. He became a carrier as a result of this illness. It is hypothesized that he contaminated his daily catch of oysters while they were in wet storage in an area that was exposed to overboard discharges from the boat on which he stayed overnight. He "peddled" these oysters the hamlets in Louisiana where the illnesses occurred.

Hepatitis and Shellfish

The association of shellfish with outbreaks of infectious hepatitis is quite recent. Roos (41) in 1956 identified oysters as the vector of hepatitis in Sweden. He attributes 119 cases to the consumption of oysters supplied by fish dealers in one community. The incident is reminiscent of the outbreak of typhoid fever in 1924 and 1925 (42). In both incidents the oysters had been subjected to wet storage in confined basins that received discharges of human excreta. Kjellander (43) reports that some 529 shellfish-associated cases of hepatitis occurred in Sweden in 1956.

The first recorded outbreak of hepatitis in the U.S. from the consumption of raw oysters (44) attributes the contamination of the shellfish to the discharge of raw domestic sewage from a community sewerage system and from a commercial shipyard. During the first three months of January 1961, (while these discharges were occurring), 84 cases of oyster related hepatitis occurred in Pascagoula, Mississippi, and Mobile and Troy, Alabama, where the incriminated oysters had been sold to seafood markets and one restaurant. The oysters were harvested from heavily contaminated waters in Pascagoula Bay, tributary to the river in which the discharges occurred.

The consumption of raw clams from polluted waters was the cause of infectious hepatitis in Greenwich, Connecticut in late 1960 and early 1961 (45). The source of pollution is attributed to be the partially treated sewage treatment plant effluent serving a population of 9,700. This discharge could reach the clam beds in less than two hours. Excessively high coliform and fecal coliform densities were found throughout the receiving estuary.

Other incidents of shellfish-associated hepatitis are given in Table 3. The outbreaks in New Jersey (primarily Raritan Bay) and Northeastern States, Southern New Jersey, and Connecticut are the findings obtained in epidemiologic surveillance activities by the National Communicable Disease Center and/or state or local health agencies. In most of the cases reported, shellfish were incriminated if the patient declared that he had eaten shellfish within the expected incubation period prior to the onset of illness.

Diseases Due to Fish and Shellfish Contamination by Chemical Pollutants

Probably the most investigated incidents of disease due to the consumption of metal contaminated fish and shellfish are the two outbreaks of mercury poisoning in Japan. The earlier of these occurred in the Minamata Bay area, in Kumomoto Prefecture (46). The source of the mercury was a vinyl chloride and an acetaldehyde plant that discharged mercury contaminated waste water into Minamata Bay and the Minamata River. During the period 1950 to 1960, the waste was discharged without treatment. A treatment plant was installed in 1960 but it allowed some organic mercury to be discharged. Improvement in the treatment process in 1966 resulted in an abrupt decrease of the mercury content of fish in the discharge area. Minamata Bay is not suitable for commercial fishing but had been used as a source of seafood for many families inhabiting the small villages (total population 10,000) on the shores of the Bay.

During the period 1953 to 1960, 111 cases of mercury poisoning due to the consumption of fish or shellfish were reported. The death rate was 36.9%, but most of the survivors have suffered permanent and severe disability. That methyl mercury was the causative agent was confirmed by finding methyl mercury compounds in the waste, in fish and shellfish, and in the victims of the disease.

There was a similar outbreak of organic mercury poisoning in Niigata, Japan (47), resulting from discharges of an acetaldehyde plant. During the period June 1964 to July 1965, 26 cases of methyl mercury poisoning, with 5 deaths have been documented.

The symptomology of Minamata Disease, the environmental and physiological pathways and other details are beyond the scope of this report. However, it must be noted that inorganic mercury can be converted to the highly toxic methyl form as a result of biological action in sediments on river and lake bottoms. This biological process is said to be responsible for the return of a highly toxic agent to the aquatic biota that otherwise might be stable deposits of mercury in sediments.

The Minamata Disease incidents are examples of acute effects resulting from relatively short time exposures to a highly toxic material. Such episodes are relatively easy to detect, and if found in time, remedial and preventive measures can be undertaken. The more subtle health effects on man are those resulting from long-term exposure to low environmental levels of a toxic material or combinations of such toxicants. There is some knowledge, although not adequate, of the maximum total body burden of many toxicants from all sources that should not result in these long-term adverse effects and these are referred to in the development of safe tolerance limits in water, foods, and other media consumed by man or to which he may be exposed. Tolerance limits for metals, pesticides and radionuclides in shellfish (48) (49) have been proposed, based on the above mentioned and other criteria for their establishment.

In the application of these limits to shellfish in an individual environment, it should not be concluded that if one finds levels of one or more of these agents in excess of the tolerance, the shellfish are acutely dangerous to eat. Rather, the conclusion must be drawn that consumption of these shellfish will place an unexpected and perhaps even unknown stress on the body burden. The seriousness of this will vary with the toxicant and the nature of its physiological effect on man. The reason for eliminating discharges of such toxic agents into shellfish areas becomes obvious.

Marine Biotoxins in Shellfish

It was mentioned earlier in this report that the occurrence of paralytic shellfish poison is not associated with domestic or industrial pollution, and, therefore, is of only passing interest. Halstead (50) lists more than 957 cases, with more than 222 deaths, worldwide, from 1689 to 1962.

The toxin generated by the dinoflagellate Gymnodinium breve has been associated with pollution or at least enrichment of the marine area by phosphate (30). This organism has been associated with massive fish kills that occur periodically on the coast of the Gulf of Mexico. Definite association of human illness due to the consumption of shellfish contaminated with the toxin was demonstrated in December 1962 (31). Several persons became ill after eating oysters, Crassostrea virginica, and clams, Mercenaria campechiensis harvested from Sarasota Bay, Florida while a red tide outbreak was occurring. The symptoms in man were not similar to those produced by the paralytic shellfish poison. They were similar in many respects to those produced by the ciguatera fish poison found in certain fishes of the Pacific and the Carribean.

Another observation made by Cummins (51) is relevant to the recreational use of marine areas. Irritation of the upper respiratory tract was experienced by field staff during the course of surveys and sampling tours. The symptoms were spasmodic coughing, sneezing, and respiratory distress. On some occasions, irritation of the eye was experienced.

The cause of these irritations was the inhalation of toxic products in the red tide blooms that had become aerosolized by rough surf action resulting from brisk winds. These observations were similar to those of other workers in red tide areas (52). It is probably the cause of a similar series of incidents on the coast of New Jersey in 1968.

Discussion

There is no doubt that consumption of shellfish taken from polluted waters is extremely hazardous. History has shown that diseases have occurred and, therefore, it is predictable that outbreaks will continue to occur. The frequency of occurrence is a function of not only the presence and quantities of domestic and industrial waste discharges, but also the occurrence and prevelance of specific bacterial or viral disease and non-symptomatic carriers of such diseases among the contributing population and the presence and quantities of toxic agents in the domestic and industrial waste discharges.

There are many unknowns in the picture. For example, at the time of the Minamata incident it was known that organic mercury compounds were toxic, but the extreme toxicity of methyl mercury was not known, nor was the fact the bacterial action in bottom sediments can convert inorganic mercury to methyl mercury. There is still not a clear understanding of the long-range chronic effects of many metallic ions or organic compounds. The causative agent(s) of infectious hepatitis have not been identified, and cultural methods for these agent(s) have not been developed.

It should also be recognized that so long as shellfish are present in polluted estuaries, they will be enticing to sports fishermen and unscrupulous commercial fishermen. Resulting diseases will be inevitable. Patrol of polluted areas may have resulted in reducing the extent of bootlegging, but as history will demonstrate it has not eliminated the occurrence of disease. The most logical approach is the removal of shellfish from polluted areas. Obviously, it would be desirable to make productive use of these resources and there are methods available that to some extent and with certain contaminants these methods will result in the decontamination or detoxification of the mollusks.

Relaying of shellfish from polluted to clean waters has been practiced for centuries. This procedure exploits the well known ability of mollusks, by way of their feeding mechanisms and other physiological processes to attain equilibrium with the new aquatic environment. Equilibrium is attained fairly rapidly in the case of bacteria and viruses, but, in the case of metallic ions and toxins, it proceeds slowly, requiring many months with some agents.

Relaying involves some risks. These include mortality of shellfish and the continued possibility of poaching. Little can be done about the former, except to conduct the activity at periods of optimal activity of the shellfish and to avoid as much as possible the opportunity for the ravages of predators. Poaching can be minimized by proper selection of the clean water area, tight patrolling of the area, and control of harvesting, planting and re-harvesting.

Controlled purification, (Depuration) utilizes the same biological principles, but differs from relaying in that the process is carried out in tanks on shore, using purified water, or in cribs or floats located in areas of extremely high sanitary quality. The high cost of facilities construction, handling of the shellfish and power costs for pumping place severe limitations on the period of time of exposure of a given lot of shellfish to this process.

It would be economically feasible to provide for preferably two and not more than three days holding. Therefore, the depuration process would be applicable only to removal of bacteria or viruses. It has also been demonstrated that there is an upper limit of levels of bacteria and viruses beyond which the depuration process is unreliable. This limit has not yet been clearly defined but it is quite definite with the present state of knowledge, the depuration process would not be reliable with oysters showing the coliform densities that currently prevail in Pearl Harbor.

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TABLE 1. - TRACE METAL ENRICHMENT FACTORS FOR SHELLFISH

COMPARED WITH THAT OF THE MARINE ENVIRONMENT

Element (1)	Oyster (2)	Quahaug (3)	Soft Shell Clam (4)	Surf Clam (5)	Mussel (6)	Whelk (7)
Cadmium	318,000a 266,000	750	800	-	100,000a 800(2)	6,300
Chromium	60,000a 31,600	23,400	10,400	-	-	-
Copper	13,700a 14,800	900	2,000	450	3,000a 1,150	3,800
Iron	68,200a 6,700	3,000	41,000	18,400	196,000a 2,900	-
Manganese	4,000a 2,900	2,900	3,350	1,100	13,500a 1,500	2,100
Nickel	4,000a 3,250(1)	4,500	4,250	-	-	-
Lead	4,000a 4,100	5,800	3,400	-	-	-
Zinc	110,300a 148,000	2,100	1,700	1,525	9,100a 2,200	8,200

a Values from work of Brooks and Rumsby (5).

TABLE 2. - AVERAGE TRACE METAL LEVELS IN SHELLFISH TAKEN FROM ATLANTIC COAST WATERS, IN PARTS PER MILLION OF WET WEIGHT

Element	Eastern Oyster	Soft Shell Clam	Northern Quahaug
Zinc	1428	17	20.6
Copper	91.50	5.80	2.6
Manganese	4.30	6.70	5.8
Iron	67.00	405	30
Lead	0.47	0.70	0.52
Cobalt	0.10	0.10	0.20
Nickel	0.19	0.27	0.24
Chromium	0.40	0.52	0.31
Cadmium	3.10	0.27	0.19

TABLE 3 — Outbreaks of Infectious Hepatitis Associated with Ingestion of Shellfish

Location of Outbreak	Year	Month with Peak Number of Cases	Vehicle	Number of Cases Known	Period of Outbreak
1. Sweden	1955	December	European Oyster	529	40 Days
2. Mississippi and Alabama	1961	January	Eastern Oysters	84	57 Days
3. North Carolina	1964	March	Eastern Oysters (and Clams)	3	9 Days
4. New Jersey N.E. States	1961	February	Hard Clams	493	5-6 mos.
5. Fairfield County, Connecticut	1961	March	Hard Clams (some were cooked)	50	15 weeks
6. Southern New Jersey and Greater Philadelphia Area	1964	January	Hard Clams	252	5-6 mos.
7. Connecticut	1964	January	Hard Clams	123	5-6 mos.
8. Canada	1965	?	Pacific Oysters	3	?
9. East Brunswick, New Jersey	1966	October	Hard Clams (some were cooked)	4	1 month
Total	1955-66	--------	Oysters, Clams	1,541	