WEDNESDAY—NOVEMBER 18, 1964

Chairman — CAPTAIN GEORGE FERGUSSON, *Minister of Agriculture and Fisheries, Bridgetown, Barbados, W. I.*

The Botulism Problem in Seafoods

HAROLD B. ALLEN
U. S. Bureau of Commercial Fisheries
Washington, D. C.

Abstract

1963 will long be known in the fishing industry as the year of the botulism disaster. Four outbreaks of botulism poisoning in the United States were attributed to fishery products. Twenty-three people were affected and nine died in these outbreaks. Both canned tuna and smoked fish were involved. All of these poisonings were caused by a single type of botulinus organism, type E.

A botulinus type E is usually associated with marine products. It has been found in most parts of the world in latitudes north of the 40th parallel. One southern isolation of the type E botulinus organism was reported in Galveston Bay. Other types, such as A, B, and D, are found in southern soils. Therefore, producers of foods in all parts of the world, both north and south, must remain alert to the dangers of botulism.

The botulinus organism is resistant to heating, drying, and disinfectants, especially in its seed-like spore stage. It grows best at room temperature in tight containers which exclude oxygen. The toxin produced in foods by the growing microbe can be destroyed by cooking. The best means to prevent botulism in seafoods is through good plant sanitation, and proper packaging, refrigeration, and handling of the product.

DURING THE PAST TWO YEARS, we have heard much about botulism. We have heard about outbreaks from tuna fish and outbreaks from smoked fish. The fishing industry is greatly concerned and has asked a number of questions, such as:

1. Why are we now hearing about botulism in seafoods? Fishing is one of our oldest industries. Has not botulism been found before?
2. Just what is botulism?
3. Do I have a botulism problem in the products produced in my plant? In other words, is it a problem with shrimp, oysters, crab, or red snapper?
4. What can I do if I have this problem? Must I wait helplessly for botulism to strike and then possibly lose my business?

I will attempt to answer these questions.

Why are we just now hearing about botulism in seafoods?

In 1963, botulism became strongly associated with seafoods. This was due to bad luck and to processing changes taking place in the smoked-fish industry.

The 1963 outbreaks may be attributed partly to bad luck because this was the case in the incident involving canned tuna. As you may recall, the tuna was packed in a plant in California, and defects occurred in the sealing process. After the cans had been retorted, the bacteria containing botulism gained entry into some of them. Later, while the cans were in the warehouses and on their way to the consumer, the bacteria grew and produced its deadly toxin. Three cases of botulism resulted in Michigan. Two of the people stricken eventually died. All canned tuna from that particular plant was called back and destroyed, and the plant was temporarily closed. The same event could have happened with almost any canned food, as is evidenced by the fact that a case of botulism occurred shortly thereafter in Canada from commercially canned liver paste.

A serious problem has now developed in the smoked-fish industry. During recent years, basic processing changes have occurred. Many of you will remember that before we had mechanical refrigerators in our homes and before refrigeration was commonly used in the food industry, smoked fish was generally a very dry and salty product. Later, as smokers and grocers found that they could extend the storage life of lightly smoked fish by shipping them on ice or holding them in refrigerated cabinets, the need to smoke the product until it was very dry and salty to prevent spoilage seemed to disappear, and the consumer developed a taste for a milder smoked flavor. Nowadays, much of our smoked fish is lightly cooked and is smoked only to impart desirable flavor and color. With this process, the product still contains enough moisture to allow any botulinus bacteria present to grow. The product may, nevertheless, have been heated enough to kill many of the spoilage bacteria. Any botulinus organisms present are free to grow without competition from the bacteria that cause spoilage. When suitable conditions occur, the botulinus organism may therefore produce its toxin, but there may be no accompanying off odors and flavors to warn the consumer.

Unfortunately, many of the people who still remember the hard-smoked and heavily salted fishery products do not realize that these changes have taken place; or, more importantly, they may not realize the significance of the changes in terms of the public health hazard involved. They treat smoked fish much as they formerly did—that is, they may place it on a shelf at room temperature and expect it to last for weeks. This can be a fatal mistake, as has been shown by some of our recent experiences.

In 1963, this mistake unfortunately was repeated and four major outbreaks of botulism were attributed to fishery products. In these outbreaks, 23 people were affected, and 9 died. This contrasts with the experience in 1962 during which time one non-fatal case of botulism was attributed to fishery products.

What is botulism?

Many of you have asked, "Just what it botulism?" In reply, we can say that botulism is a type of food poisoning caused by a species of bacteria. The scientific name of this species is *Clostridium botulinum*. The name "botulism" originally came from the word botulus, which means sausage. It was so named by Ermengem in 1896 as the result of German cases of botulism in which sausage was involved. Botulism outbreaks in various parts of the world have been attributed to many different products, including preserved meat paste, home-canned vegetables, fish eggs, sausage, and salted hams. If these foods become a source of botulism, all of them are found to have something in common—they have been partially preserved by heating, smoking, or use of

chemicals, and they contain the botulinus bacteria. There are involved here, however, several types of the botulinus organisms, as we shall discuss next.

Th botulinus bacteria is a common soil organism occurring in many parts of the world. It may be found on the raw vegetables we eat, such as carrots and potatoes. When it is consumed without its having had a chance to grow, it causes no difficulty. The problem begins only when the bacteria is allowed to grow and produce its deadly toxin before the food is eaten.

There are six types of botulinus organisms. These are called A, B, C, D, E, and F. Four of these—Types A, B, E, and F—affect human beings. Type C primarily causes poisoning in ducks and other birds as well as in mink. Type D is limited to cattle, horses, and sheep that eat forage containing the toxin. Type E is unique in that is usually associated with products from fish, including both marine and fresh-water species. These six types of botulinus organisms are usually distinguished by their immunologically distinct toxins. We find, for example, that an animal may be immune to Type E and not immune to Types A or B. By the same token, if a person is ill with botulism poisoning and is treated with the antitoxin from a type of toxin different from the one that has stricken him, he will receive no benefit from the antitoxin injection. For that reason, antitoxins used by the medical profession should be a mixture of Types A, B, E, and F.

If the botulinus organism gains entry into a food, it must have several special conditions in order to grow and produce toxins.

1. It must have a favorable temperature. The botulinus organism apparently does not grow below 38F. Rather, it grows well at room temperature.
2. It does not grow if the environment is too acid for it. We therefore do not find it growing in acid foods such as canned tomatoes, but we do find it growing in nonacid foods such as beans, peas, or fish.
3. It grows best without oxygen. We term this type of growth anaerobic. Such anaerobic conditions may be found below the surface of a fish or perhaps in a fishery product packed in an air-tight container.
4. It requires time to grow and produce its deadly toxin. At temperatures of about 40F, it may require as many as 30 days before significant amounts of toxin are produced. At 85F, deadly quantities of toxin can be produced within only a few days.

Since it grows somewhat more slowly than the normal spoilage bacteria, the fish or other food will usually spoil, so that before the botulinus toxin is produced, people will not eat the food because of off odors and flavors. Keep in mind, however, that the toxin may nevertheless be present in certain types of foods in which this warning odor and flavor has not been produced.

I am sure you now realize that conditions favorable for the growth of the botulinus organism exist with many of the foods we eat today. One of the fortunate things about the botulinus toxin, however, is that it can be destroyed by cooking. Heating the coldest part of the product at 180F for 30 minutes or boiling for 10 minutes will render the toxin harmless. This fact may have saved the lives of some of us.

Unfortunately, the botulinus organism has a unique ability to develop a spore (seed-like) within its cell body. This spore is more resistant to disinfectants, heat, and drying than are non-sporeforming bacteria. If bacteria are present in fish partially preserved through heating or smoking, the spores of the botulinus organism may survive while other bacteria may be destroyed.

The spores then germinate and grow slowly and produce their toxin without competition from the spoilage bacteria normally present. Only very small quantities of this toxin need be produced for the food to become poisonous. It has been estimated that only about 20 grams of pure toxin—less than an ounce—equally distributed to all the people on the earth would be fatal to all.

Do I have a botulism problem in my plant?

Knowledge of the highly poisonous nature of botulinus toxin leads us to ask, "Is there a botulism problem in my plant; that is, is there a problem with the fishery products from the Gulf area?" Unfortunately, the answer to this question could be "yes." A potential problem of botulism poisoning does exist in the Gulf as it does in every part of the world. With regard to fishery products in the Gulf area, the problem may be less severe than it is in more northern areas.

One of the reasons for this statement is the reported domestic distribution of botulinus Type E organism, the type that is usually associated with fishery products. The botulinus Type E organism, with one exception, has been isolated only north of the 40th parallel. The single exception south of the 40th parallel occurred as a result of finding the Type E organism in samples taken in Galveston Bay. At the present time, the Bureau of Commercial Fisheries, several other agencies, and a number of universities are beginning to search for botulinus Type E organism in other southern areas. Many people expect it will be found because, until now, the organism has been sought mainly in those northern locations where outbreaks have occurred.

Another reason the problem of botulism in the Gulf area is less acute than it might be in other parts of the world is that fishery products of the Gulf are usually sold fresh or frozen, rather than smoked or semipreserved, and are properly cooked prior to being consumed. Although botulinus bacteria may be found on shrimp, crab, and oysters, these bacteria will not grow and produce toxin if the fishery products are kept under proper refrigeration. The products about which we must be alert in the South are pasteurized crabmeat and smoked mullet and mackerel. These products often are cooked and then sealed in containers that do not allow access to air. In the cooking process, many of the "normal" spoilage bacteria have been destroyed. So we must be vigilant; we must produce and handle fishery products from southern waters in a manner that will prevent the growth of these dangerous bacteria.

What can I do to prevent botulism in my plant?

With this thought in mind, we may ask, "What can I do to prevent botulism arising from products produced in my plant?" The answer is fourfold.

1. We must follow good plant-sanitation practices. Botulinus organisms have been found in the intestinal tract and on the surface areas of fish. It does not normally occur deep within the muscle. Careful cleaning and plant-sanitation practices must be observed in order to prevent the muscle of the fish from becoming contaminated with intestinal contents during the preparation stages of product processing. It is especially important to maintain good plant clean up practices so botulinus organisms will not accumulate on equipment, in flumes, or on cutting knives.

2. We may retard the growth of the botulinus organisms through proper packaging. Air-tight packaging of semipreserved fishery products provides an ideal environment for the growth of the botulinus bacteria. Therefore, airtight

plastic bags or hermetically sealed tin cans should not be used on semipreserved fishery products.

3. We can control botulism by maintaining the temperature of the product below 38F during all periods of storage and distribution, including the consumer stage of handling and storage. The lowest temperature at which the botulinus Type E organism has been known to produce toxin is 38F.

4. We can sometimes use chemicals to control the growth of botulinus bacteria in fishery products. Chemicals, of course, are applicable only to certain types of speciality and preserved products. Salt concentrations in the neighborhood of 8 to 10% inhibit the growth of the botulinus bacteria. Significant quantities of acids in a product also prevent the growth of this organism.

We must remember that everyone in the fish-processing industry, in the Gulf area as well as in the other parts of the United States and the world, must be aware of the dangers of botulism. We must be familiar with the growth characteristics of the botulinus organism producing the deadly toxin. A single outbreak of botulism attributable to fishery products can result in tragic deaths, destroy the public's faith in the products involved, and damage the entire fishing industry for many years.

Notes on the Ecology of DONAX DENTICULATUS (Linne)

B. WADE
University of the West Indies
Kingston, Jamaica

Abstract

Donax denticulatus (Linne) is a burrowing clam found in the intertidal zone of sandy beaches in Jamaica. It lives only in the saturated region of the wash zone, and migrates synchronously with the tides to maintain this zonation. Its distribution is influenced by the size and sorting of the beach sands, the organic content of the sands, and the degree of exposure of the beach to direct wave action. Enormous populations sometimes develop and different populations show wide variations in densities and maximum sizes of individuals. Chance settling of the planktonic larvae and high mortality in the first four months of life determine the density of populations. Maximum sizes of individuals depend on their growth rates, determined by the availability of food as suspended particulate organic matter. The most thriving populations occur near the mouths of rivers.

INTRODUCTION

Donax denticulatus (Linné) is a common bivalve found in the intertidal zone of sandy beaches in Jamaica. It is particularly interesting because of its special adaptations for living on wave swept beaches and also because of the enormous populations which frequently develop. Hitherto, there has been no comprehensive investigation of the biology of any one species of *Donax*. This present study is therefore aimed at discovering as much as possible about the ecology of *D. denticulatus*, and elucidating those features of its morphology responsible for its great success on the beach.