

# XXXI.—CASES OF POISONING CAUSED BY SPOILED CODFISH, AND THE UNNECESSARY PROHIBITION OF THE SALE OF RED- DENED CODFISH.\*

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By a circular dated December 31, 1885, the minister of commerce instructed the prefects to prohibit the sale of red codfish throughout the entire French territory. The prohibitory orders of the prefects, issued in accordance with this circular, threatened venders of reddened codfish with articles 423, 471, and 477 of the penal code, and the law of March 27, 1851, relative to the suppression of frauds in the sale of goods, *i. e.*, they may be punished by imprisonment, fines, seizure of their goods, and the publication of the judgment by means of placards; moreover, dealers are made responsible for any cases of sickness which may be caused by the use of red cod. This prohibitory measure, which was taken in consequence of several cases of poisoning caused by spoiled codfish, has raised energetic protests in all the ports where fishing fleets are fitted out, and especially in Bordeaux, which is the most important center of the codfish trade.

At the urgent request of interested parties, indorsed by the deputies and senators from the sea-board departments, the new minister of commerce, Mr. Lockroy, has withdrawn the circular of his predecessor, until fuller information on the subject could be obtained; but this withdrawal is only temporary and not final, as some papers have erroneously stated.

We have therefore deemed it useful to make an exhaustive study of this whole question, and to submit the results to the Bordeaux Society of Medicine and Surgery and to the central Council of Public Hygiene of the Gironde.

Our work is divided into five parts:

(1) In the first we give a brief historic review of all the cases of poisoning caused by spoiled codfish, which, as far as our knowledge goes, have been noticed in the annuals of science. We give at the same time a sketch of the symptoms which have been found to accompany these cases of poisoning.

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\*"*Des accidents toxiques occasionnés par la morue avariée, et de l'interdiction de la mise en vente des morues rouges.*" From the *Journal de Médecine de Bordeaux*, vol. xv, 1886, p. 425. Translated from the French by HERMAN JACOBSON.

(2) In the second we endeavor to ascertain the physical characters of the codfish which have produced these cases of poisoning, with the aid of all the information contained in the reports of the physicians who have treated these cases.

(3) In the third we give the results of recent investigations relative to the nature of the red color of the codfish; and we show that not only is the red in the codfish not poisonous, but that it is not even the determining cause of the putrid change of the codfish. We endeavor, moreover, to ascertain under what special conditions this abnormal color develops, and we show the means by which it may be caused to disappear, or by which its development may be prevented.

(4) In the fourth we show that all the cases of poisoning which have been observed must be attributed solely to the eating of spoiled codfish, whose flesh had already become more or less putrid. We also give the results of investigations relative to the specific poisonous matter contained in spoiled codfish. We compare the phenomena produced by eating spoiled codfish with those produced by other spoiled articles of animal food, and show the difference between these phenomena.

(5) In the fifth we enter into some technical details regarding the cod fisheries, and regarding the curing and preserving of cod; we show the important place which this fish holds among the articles of human food; and we point out the evil effect which the ministerial circular of December 31, 1885, is liable to produce on national and local commerce, without yielding any benefit for hygiene and the health of the people.

#### I.—REVIEW OF CASES OF POISONING, IN CHRONOLOGICAL ORDER.

(1) *Case on a gun-boat in 1866, reported by Dr. Maréchal, chief physician of the navy.*

“In 1866 there suddenly appeared on the 5th of June, in the port of Toulon, a sickness which fortunately was not very serious, but which, when night set in, had attacked about one hundred and thirty men belonging to the navy. All awoke with violent colic, followed soon by liquid, copious, and frequent operations, sometimes by vomiting, and more or less pronounced headache; nearly all the patients had a cold skin, and occasionally they were slightly feverish. In nearly all cases a very marked prostration was noticed, accompanied by profuse perspiration, and an evident tendency to a syncopal condition.

“I at once began to search for the cause of these phenomena. The kitchen utensils were in perfect condition, but the crew had on that day had codfish for their meals. I had the codfish brought to me, and tasted it raw, after I had already eaten it cooked at the same meal as the crew and without producing in me the slightest inconvenience.

“The appearance of the phenomena was as follows: After a period varying between half an hour and one hundred and fifteen hours, and averaging from five to fifteen hours, the symptoms began to appear.

The first were digestive troubles, consisting at first in a feeling of dryness in the mouth and throat, which most of the patients considered as an excessive thirst, while some considered it as the sharp after-taste of their dinner, which they hoped to overcome by drinking copiously. But soon, no matter whether they drank anything or not, they had a feeling of heaviness in the stomach, and a disagreeable bloated feeling, which very soon, however, turned to a severe stomach-ache. In the evening more than half the men were on their feet again, and on the following day most of them did not feel any traces of this slight indisposition."

(2) *Case reported by Dr. Hermann, of St. Petersburg, in 1878.*

In 1878, 108 persons at St. Petersburg were poisoned by eating the salt and dried cod called "stock-fisch," which forms a common article of food in Russia. Dr. Hermann treated four of the worst cases. One of them, forty-four years of age, died after twenty-four hours; and the autopsy showed a hemorrhagic injection of the ileum and the larger intestines. The symptoms in all cases were faintness, stupor, violent colic, diarrhea, vomiting, cramps in the lower extremities; pulse weak, a little quicker than usual; stomach elastic, no sensation of pain when pressed.

In most cases convalescence was reached on the third day; in one case the diarrhea lasted longer than two days. The codfish which had produced these cases had a bad taste and odor; and a sample examined under the microscope showed that the muscular tissue had become granulous and brittle; while the streaks of the muscular fiber were no longer apparent. The codfish had a deep yellow color.

(3) *Case in a regiment of the Foreign Legion, at Sidi-Bel-Abbès, in 1878.*

Dr. Schaumont has published in the *Recueil de mémoires de Chirurgie et de Pharmacie militaires* (vol. for 1878, p. 504), a report on a case of poisoning of the same kind, showing extremely grave symptoms.

The case occurred in the night of April 19, 1878, in a company of the Foreign Legion stationed at Sidi-Bel-Abbès, province of Oran, Algiers. At 9 p. m. the physician was informed that 20 men had been taken with violent colic, diarrhea, and vomiting. At 11 p. m. the number of patients had increased to 64, and the condition of those who had been taken first became more and more serious. An hour later the number of patients had reached 80. In all, 122 men were sick, 17 of whom had to be sent to the hospital.

"All complained at first of vertigo, headache, and nausea; the face became livid; then followed cramps in the stomach, and vomiting of food matter, and finally frequent and violent attacks of diarrhea. At last the lower extremities began to grow cold, and cramps were felt in the calves."

Dr. Schaumont and Dr. Péborde gave to the sick a draught composed of six drops of ether and eight drops of tincture of opium dissolved in a little water, and followed this up by some tea. In the morning there was a very noticeable improvement in all the patients. On the 21st only 36 were sick; on the 22d, 27; on the 23d, 16; the 24th, 15; the 25th, 14; the 26th, 7; and on the 27th, 4, who were all convalescent on May 1.

After having administered the most urgent remedies, Dr. Schaumont inquired what had occurred on the 19th, and learned that the men had gone to target practice in the afternoon. None of them had experienced the least inconvenience before dinner, although the heat on that day was excessive.

In the evening they had taken their principal meal, composed of codfish, potatoes fried in lard, and wine. In the morning of April 20 several dishes containing some of the food which had not been touched since the evening were taken to the pharmacy of the military hospital to be subjected to an analysis, as well as samples of the wine, lard, and codfish from the stores of the commissary of the Foreign Legion. It was found that neither the wine nor the lard (which was white and free from bad odor) contained any poisonous matter. The potatoes were in perfectly good condition. No copper utensil had been used in cooking any of the victuals. But when the dishes were opened an exceedingly strong and very disagreeable odor was noticed at once, reminding one of putrefying matter.

The sample of codfish from the commissary was examined next. By its external appearance it might deceive an unskilled eye. When subjected to a careful examination, and broken into two parts its entire length, it showed towards the middle a grayish portion, measuring almost six centimeters [ $2\frac{1}{2}$  inches] in diameter, and completely decayed. When opened it exhaled a sickening odor. No poisonous substance was discovered in this analysis. It was, therefore, an evident case of spoiled codfish.

From the above facts Dr. Schaumont arrived at the conclusion that the cases of sickness which occurred in the night of April 19 were caused by accidental poisoning by putrid codfish, which opinion was confirmed by the circumstance that none of the officers, who had a mess of their own and had not partaken of codfish, were in the least indisposed.

(4) *Case reported by Dr. Bertherand, of Algiers.*

While on a tour of inspection of the military grocery stores, Dr. Bertherand ate codfish with a white sauce, which produced colic and diarrhea. The symptoms consisted in "violent pain in the stomach, incessant bilious vomiting, frequent attacks of diarrhea, accompanied by a very painful tenesmus; general collapse, excessive thirst, dysphagy, acrid taste, a burning sensation along the entire esophagus, general cramps, and very cold extremities."

The examination of this codfish showed that it had a faint putrid odor, and that all along the backbone, on the surface and even in the thick part of the flesh round the backbone, there was a very pronounced vermilion color.

Several other persons who had partaken of codfish having a similar red color, and a certain putrid odor, experienced similar attacks of sickness.

(5) *Case reported by Dr. Heckel, of Marscilles, in 1878.*

In 1878 Dr. Heckel visited a family of fifteen persons, who had all been poisoned by a spoiled codfish which had the red color above referred to. The symptoms were similar to those already described, and all the persons suffering from these attacks were quickly cured.

(6) *Case on the flag-ship of the practice fleet in December, 1880.*

This case, witnessed by Dr. Bérenger-Féraud, director of the naval health service at L'Orient, was briefly as follows:

On December 10, 1880, the practice fleet, commanded by Vice-Admiral Garnault, was engaged in gun exercises out at sea between Fréjus and Toulon. After this very tiring exercise, the crew partook of codfish at 10 a. m. At 8 p. m. a sailor from the admiral's ship, the *Colbert*, became indisposed, experiencing violent colic, accompanied by vomiting. Soon after, and during the course of the night, 35 others from the same vessel were taken sick. On the following day and the day after, 16 more were similarly affected, and in all 52 men were taken sick out of a force of 710 men, composing the crew of the *Colbert*.

The symptoms were exactly like those already mentioned, but were not quite so serious, "because convalescence or a perfect cure was effected after a few hours. Even the person who suffered from the most violent attacks was only excused from service for two days.

"On board the five other ironclads and the two transports where codfish from the commissary at Toulon had likewise been used, there were 50 cases of sickness like the one described, but none of them was serious. In all about 100 persons were affected, and none of these suffered more than one to two days."

(7) *Case in the fleet at L'Orient, on October 3, 1884.*

This case, observed and carefully described by Dr. Bérenger-Féraud, is of the greatest importance, and we believe that it really has been the determining cause of the recent ministerial circular prohibiting the sale of red codfish. It is, therefore, proper that we should give it somewhat more in detail.

The first report on this case was published by Dr. Bérenger-Féraud in the *Archives de Médecine navale* (vol. for 1884-'85) under the title, "Étude d'un empoisonnement multiple survenu à L'Orient par l'usage de

morue altérée. (Study on cases of poisoning at L'Orient by spoiled codfish).

In a more recent treatise, published in the *Annales d'Hygiène publique et de Médecine légale* (October, November, and December, 1885) under the title *Recherches sur les accidents que provoque la morue altérée* (Investigation of cases of poisoning caused by spoiled codfish) Dr. Bérenger-Féraud, has grouped together all similar cases which have come to his knowledge, and has produced a remarkable monograph, showing the question as it stands at present in all its features.

The number of cases which he describes is 7, and they are not all of equal importance. We reproduce the description of the last, in point of time, as given by Dr. Bérenger-Féraud.

On October 3, 1884, a number of cases of sickness, occasioned by eating codfish from the naval commissary at L'Orient, occurred among the crew of the fleet stationed at that port. Of 387 men composing the crew of the frigate *Vengeance*, 175 were taken sick; 114 of these within twelve hours after partaking of codfish at the noonday meal.

At the same time similar cases occurred on board the *Aubette* and among the marines; but none of these were as serious as the first mentioned. On board the *Aubette* there were only 19 cases of sickness out of a total number of 978 men, and among the marines only 17 were sick out of a total of 746 men; the largest proportion of sick (45 per cent.) was on board the *Vengeance*; and to these Dr. Bérenger-Féraud gave his special attention.

We should state right in the beginning that most careful investigations very clearly determined the causes of the sickness, as neither the utensils in which the food had been cooked nor the water, bread, coffee, wine, or the oil used in the preparation of the codfish showed the slightest traces of poisonous matter.

In most cases the following symptoms were observed soon after the persons had been taken sick: Stomach-ache, nausea, vomiting, attacks of diarrhea, sometimes accompanied by the passage of blood, and coldness in the lower extremities. Cramps in the lower extremities were not observed in all cases. All these symptoms were of a very pronounced bilious character. The first period of the sickness, lasting from two to ten hours, generally was followed by a period of reaction, accompanied by great lassitude. Convalescence was very rapid, and even those who suffered from the most serious attacks did not have to stay in the hospital more than eight to ten days. In fact, in all these cases of poisoning the first symptoms were very alarming, but the consequences were not serious. A commission of competent men, appointed by the vice-admiral commanding at L'Orient, made a careful examination of the codfish furnished by the naval commissary at L'Orient on October 3, and found that some of it was perfectly sound, while some was spoiled.

According to the report of this commission, the change in the cod-

fish, which were found to be spoiled and which had caused the cases of sickness, "consisted in an abnormal coloring of the muscular tissue of the fish. This color varied from a tender rose color to an orange-red, and seemed to follow certain portions of the flesh, leaving others close by entirely sound. This change was noticed in the two muscular bands lying along the backbone and in the neighborhood of the head. The more intense the color, the more deeply did it penetrate into the tissues. In codfish which had some pale rosy spots it went only to the depth of half a millimeter [one-fiftieth inch], while in some which had an orange-red color it went to the depth of 3 or 4 millimeters, and even half a centimeter [.12 to .20 inch]. In these last-mentioned fish the spoiled portions exhaled a putrid odor, and at the same time the muscular fiber crumbled to pieces, having lost all consistence."

The above are the symptoms of cases of poisoning by spoiled codfish, observed and described by Dr. Bérenger-Féraud.

In spite of the most exhaustive bibliographic researches made by us in regard to this subject, we have not been able to find in the numerous medical publications consulted by us any other cases, and, as far as our knowledge goes, we have not learned that any cases of this kind have ever occurred at Bordeaux. Our city, however, is the principal port of importation of codfish, and an enormous quantity of this fish is consumed in Bordeaux.

Cases of poisoning by codfish are therefore extremely rare, considering the vast quantity of codfish consumed throughout the world. Such cases have only been observed among troops or on board a fleet, where it is well known the food is not always of the first quality, and where the culinary arrangements often leave much to be desired.

## II.—CHARACTERISTICS OF THE CODFISH PRODUCING CASES OF POISONING.

In endeavoring to ascertain the characteristics of the codfish which have produced cases of poisoning like those described, we find that in 4 out of the 7 cases the codfish did not show any red color (on the gunboat, on the practice fleet, case reported by Dr. Hermann, and the case which occurred in the Foreign Legion at Sidi-Bel-Abbès.)

In the St. Petersburg case—the only one where the symptoms were violent enough to cause death—the codfish had a deep yellow color, a bad flavor, and a bad odor; its flesh crumbled to pieces; in short, it showed unmistakable signs of putrefaction.\*

The same, or very nearly the same, physical characteristics were observed in the case which occurred in the Foreign Legion at Sidi-Bel-

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\*It seems proper to state here that the only case of death resulting from spoiled codfish was one caused by the cod caught and prepared by the Norwegians, and termed "stock-fisch." But "stock-fisch" never turns red. The mode of curing it is entirely different from that followed in France. The "stock-fisch" is cod dried, hardened, and rolled out into sticks, which are left to dry in the open air for two or three months. The French fishermen never cure codfish in this way.

Abbès. When the lids were removed from the dishes which contained the codfish an exceedingly strong and disagreeable odor arose at once, in every respect like the odor from putrid animal matter. The codfish taken from the commissary might deceive an unskilled eye; but when subjected to a careful examination, and broken in two along its entire length, it showed towards the middle a grayish part, measuring hardly 6 centimeters in diameter, and completely decayed. This part when broken open exhaled a sickening odor.

In the first four cases of poisoning, therefore, which are the most important on account of the larger number of individuals attacked (460), no red codfish was the cause. On the contrary, this red color was noticed only in the three other cases, in which the total number of individuals attacked was only 227 (case of Dr. Bertherand, in Algiers; case of Dr. Heckel, in Marseilles; case on the fleet at Lorient).

The codfish described by Dr. Bertherand had along the backbone a very pronounced vermilion color; but it had at the same time a faint putrid odor. The codfish which Dr. Heckel examined at Marseilles in 1878, and by which fifteen persons were poisoned, had likewise a red color.

As regards the codfish which caused the more recent cases of poisoning on board the fleet at L'Orient, they showed an abnormal color, from a tender rose-color to a deep red-orange, and this color was found principally in certain parts of the fish (the two muscular bands lying alongside of the backbone), leaving here and there portions which were entirely sound. Especially in those codfish which had an orange-red color the spoiled portions exhaled a putrid odor; the muscular fiber crumbled to pieces, and had lost all consistence.

It will be seen that in the three cases where the red color was noticed there was observed at the same time a putrid odor and a crumbling of the muscular fiber—plain indications that the flesh of the codfish had become decayed.

It appears from the brief examination of the physical character of poisonous codfish that in two-thirds of the cases observed there was no red color, while the putrid odor and the crumbling of the flesh were observed in all cases.

There is, therefore, no reason to assume that the red color of codfish is an indication of their being poisonous, because on the one hand the most numerous and most serious cases of sickness have been caused by codfish which did not have its red color, and because, on the other hand, in cases of sickness caused by red codfish there was at the same time noticed a putrid odor and the crumbling of the flesh—the only indications (we must repeat it) common to all cases, and the only ones which can be considered in the etiology of cases of poisoning of this kind. In short, these codfish did not cause cases of poisoning because they were red, but because they were more or less decayed or putrified.

Although there is no absolute identity of symptoms between the cases



of poisoning caused by spoiled codfish and cases of poisoning produced by other spoiled fish, or by fresh or preserved meats which have begun to decay, there is good reason to believe that all these cases must be attributed to special poisonous substances produced by the putrefaction of animal matter.

### III—NATURE OF THE RED SUBSTANCE IN CODFISH, ITS CHARACTER, DEVELOPMENT, AND PREVENTION.

Since it has been deemed proper to prohibit the sale of red codfish, it is evident that in the opinion of the ministry which has taken this measure, the red codfish is the principal indication that the flesh has undergone a hurtful change. But what proofs are there, and what experiments can be cited, to show that the red color of the codfish possesses any poisonous qualities? We shall endeavor to answer these questions.

In the first place, what constitutes the red color of the codfish? The few authors who have studied this subject do not agree among themselves. It seems, however, pretty well established that this red color is produced by the development of a fungus, whose name varies according to the different authors who have described it. Thus, Mr. Fonsagrives calls it the *Penicillium roseum*; Mr. Heckel, the *Coniothecium sanguineum*; and Mr. Mégnin, the *Coniothecium bertherandi*. In an article published in the Madrid Imparcial, March 20, 1886, and cited by Prof. Alex. Layet, it is stated that some years ago (in 1878) attention was called at Gloucester and some other places in the United States to the red color of the fresh and dried codfish, which appeared during the summer months. Prof. W. G. Farlow was commissioned to investigate the causes of this coloration, and it is stated in the Imparcial that Professor Farlow found that it was caused by an alga of the family of the *Nosto chaccæ*, namely, the *Clathrocystis roseo-persicina*.\* Mr. Carles, who has recently published the results of his researches in the Bulletin des travaux de la Société de Pharmacie de Bordeaux (February, 1886), thinks that the red color of the codfish is caused by the evolution of various parasites of a very primitive organization, belonging to the micrococci.

This is also, we believe, the opinion of Mr. Gayon, professor of chemistry at the faculty of sciences at Bordeaux and chief chemist of the custom-house, who for about two years, in conjunction with Mr. Carles, has been engaged in the cultivation of these small organisms. He writes the following:

“When one examines under the microscope the red spots of a codfish one sees among the loose muscular fibers and the sea-salt crystals numerous organisms of various kinds, young and live specimens of the micrococcus. The red color is attenuated through their enlargement.

“If the surface of a red spot is dissolved in some drops of boiling water, and if the liquid obtained is carefully stirred in codfish broth or

\* See F. C. Report for 1878, p. 969, and F. C. Bulletin for 1887, p. 95.

poured on moist pieces of muscle of codfish, it will be found that after having been kept in a stove heated to from 30° to 35° C. [89° to 95° F.] red color develops and gradually covers all the parts exposed to the air. The microbes causing this coloration are, therefore, aërobies (produced by the action of the atmosphere).

“By successive experiments, and by varying the physical and chemical conditions, Messrs. Carles and Gayou succeeded in eliminating a large number of live organisms; and when they closed their investigations there were only two kinds left, a bacillaria and a micrococcus, which, when mixed, invariably produced the red color, although it could not be determined which part each took in this process. It is remarkable that these infinitesimal organisms can live on sea-salt; they even develop on salt crystals which are merely moist, but not on all kinds of salt.”

On the other hand it appears from recent investigations made in the hygienic laboratory of the medical school of Bordeaux, by Drs. Layet, Artigalas, and Ferré, that “in examining the red matter of the codfish under the microscope we find, after it has been dissolved in water or glycerine, that it is composed of (1) crystals of sea-salt; (2) lanceolate lamellæ; (3) a granular substance; (4) muscular elements; and (5) special elements, resembling in shape the elements called sarcines, found not only in decaying but also in sound substances. They represent quarters of a sphere joined by a common diameter. Taken by themselves, each one of these elements is transparent and colorless, but when grouped in masses, forming several layers, it can easily be seen that the center has a rosy color. The coloration, therefore, seems to be due to the greater or less quantity of these elements. One of the gentlemen who made these experiments was of opinion that the red color was produced exclusively by the sarcinoid elements.

The three gentlemen arrived at the following conclusions as the result of their microscopical examination:

(1) There are, on the surface of the codfish showing a red color and in the interstices between the bundles of the surface muscles, special organisms of a vegetable nature which constitute the coloring elements.

(2) These elements are found in masses, together with a granular substance composed of single or double grains, zooids, and detritus.

(3) These colored masses are particularly dense round the salt crystals, appear to penetrate with them into the interstices between the bundles of muscles, and to reach small cavities when these open on their level.

It was important to know whether these small cavities were found in the sound codfish, without red color. This could easily be ascertained. Cuts made in a sound codfish showed these cavities formed of radiating lamella, more or less filled with detritus. They are, as in the red codfish, found in the first central muscular layer, in the shape of grains producing a screeching noise when rubbed on a plate of glass.

This kind of corrosion of the muscular fibers must, therefore, be attributed to an entirely different cause than the development of the red color. It is probably a normal production in the codfish during the salting process.

In the red codfish no other change is noticed in the muscular tissue, except the formation of small cavities which are found in the salt, white, sound codfish; but the red color penetrates into the flesh, continues to develop, and gains in intensity.

In an additional note, Dr. Layet states that the small organism composing the red part of the codfish is not a fungus, but rather an alga, belonging to the family of the *Bacteriaceæ*.

We shall not say any more regarding the composition and nature of the red of the codfish, as we desire that our article shall keep the character of a practical hygienic treatise. Whatever may be its nature, the red is evidently a parasitic growth in the flesh of the codfish. So far as our knowledge goes, there is not a single proof of the poisonous character of this parasite, while proofs of the contrary abound.

We first give the opinion of Dr. Dumas, of Cette, vice-president of the hygienic council of Hérault, as given in the treatise of Mr. Bérenger-Féraud. Dr. Dumas says: "This fungus is not poisonous in itself, which fact has been sufficiently proved by direct experiments made by the codfish dealers of Cette, who, as well as their employès, have many a time eaten rose-colored and red codfish, which was otherwise perfectly good, without being in the slightest inconvenienced thereby."

Mr. Bérenger-Féraud adds that the employès of the commissary's department at L'Orient have frequently made the same experiment with exactly the same result. He does not believe in the poisonous character of the red of the codfish, and bases his opinion on the circumstance that he has many a time seen people eat rose-colored and even red codfish which had no putrid odor without causing any indisposition, and on the fact that Mr. Degree, principal pharmacist of the navy at L'Orient, has frequently found this same fungus in otherwise perfectly sound codfish, and that fish containing these fungi have repeatedly been eaten without causing any disturbance of the digestion, so that it can certainly not be termed a poisonous fungus. Mr. Mégnin is, as far as we know, the first who has given red codfish to live animals (dogs and rabbits). The result of his experiments was entirely negative, as these animals showed no symptoms of indisposition. He, therefore, reached the conclusion that this fungus is not poisonous.

Dr. Carles, of the School of Medicine of Bordeaux, also maintains that the red of the codfish is not injurious to health. He calls to mind the fact that the city of Bordeaux, which for the last two years has been right between two dangerous cholera centers, has remained entirely free from any case of sickness resembling cholera, in spite of the enormous quantities of red codfish from the suburban drying establishments which were consumed in the city every day.

Professor Layet, in his recent "*Note sur le rouge de la morue*" (notes on the red of the codfish), states that "the red in itself cannot be considered as the cause of poisoning by spoiled codfish, but that the poisonous character depends entirely on the state of putrid decay of the fish." For more than a week he fed two cats exclusively on red codfish, and these animals were not in the least inconvenienced thereby.

We have fed two hunting dogs of medium size on a codfish which was strongly tainted with red, and neither of these dogs experienced any disagreeable consequences. The codfish was given to them mixed with bread soaked in tepid water. It should be stated, however, that this fish when split open along its entire length did not emit any putrid odor, and that its flesh had preserved its normal consistence.

We ourselves have repeatedly eaten red codfish without being inconvenienced, and we know many places in the southwest of France where the codfish sold by the small dealers frequently has a red color.

If one considers, on the other hand, that the greater portion of the codfish received in our colonies, in the Antilles, in Réunion, and in eastern countries has always more or less of a red color, produced by the influence of the great heat, and that the people of these countries have been in the habit of eating such codfish every day, from time immemorial, without experiencing any injurious consequences, we are forced to the conclusion that the red color of the codfish has nothing to do with the poisonous nature of the decaying flesh.

But, it will be said, if red codfish are not injurious to health, why has their sale been prohibited, as a hygienic measure? Here the question becomes somewhat complicated.

Mr. Bérenger-Féraud says in his treatise: "If the red is not poisonous in itself, it seems certain that, when closely examined, it acts in a powerful manner in producing or aiding the decay of the codfish, and the decay always began, as far as the codfish served to the garrison at L'Orient is concerned, coincident with the appearance of the reddish color. In those parts which first turned red, and in their immediate surroundings, the flesh was first noticed to become soft, moist, and crumbling, and finally the putrid odor first began to show itself in these parts."

Further on the same author states: "In my opinion, therefore, the codfish sometimes undergoes a change whose first indication is the growth of the red cryptogam referred to. It is true that this cryptogam, in itself, has not the property to render the flesh poisonous, but it will, under certain special conditions—for instance, when the weather has for some time been moist and hot—favor a putrid decay of a greater or less portion of the codfish."

According to Dr. Bérenger-Féraud, therefore, the red, although not poisonous in itself, is one of the determining causes of the putrid decay of the codfish. It probably (the author is not absolutely sure) hastens the putrid decay of the flesh; and this is the only effect of the kind which it produces.

This opinion appears to us to be based on an inaccurate interpretation of the facts. We agree that this is only a supposition, but the authoritative character attaching to it from the high standing of the author has caused it to be accepted as true in government circles. The minister reasoned in the following manner: Because the red color of the codfish causes and aids its putrid decay, we shall prohibit the sale of red codfish, and thus cause all danger of poisoning to disappear on the well-known principle that when the cause is removed the effect will cease. This mode of reasoning would be correct if the basis on which it rests were sound, but so far the relation supposed to exist between the red color of the codfish and its poisonous putridity has not been sufficiently proved.

If the opinion of Mr. Bérenger-Féraud is well founded, the degree of poison in the flesh of a codfish should be in the direct ratio of the extent and intensity of the red color. But the very contrary is the case, because in by far the larger number of cases of poisoning by spoiled codfish and in the most serious cases there was no red color. In a second category of facts, it is true, the codfish which had been eaten were red, but we believe to have shown sufficiently that these fish did not produce cases of sickness, because they had this abnormal color, but because they were at the same time spoiled and partly putrid.

In short, the more or less advanced stage of putrid decomposition of codfish, no matter whether they are red, gray, yellow, or white, is, in our opinion, the sole cause of the poisonous character of their flesh.

In order to maintain authoritatively, as Mr. Bérenger-Féraud has done, that the red color—although inoffensive in itself—favors the putrid decomposition, and should be considered as the first cause of the poisonous nature of the flesh, it ought to have been proved, in the first place, that all the codfish which produced cases of poisoning were more or less impregnated with the fungus referred to above. But this proof has not been furnished. On the contrary, it has been clearly shown that this cryptogamic vegetation has been observed only on a small number of the codfish which produced cases of sickness; from which we think we can draw the conclusion that the presence of the red color on these fish is simply a coincidence and a sort of unimportant phenomenon.

Although the red color is found both in sound and spoiled codfish, it is none the less true that, from a commercial point of view, to which we shall soon have occasion to return, codfish which have that color are slightly depreciated in value in our French markets, where whiteness of the flesh is the principal recommendation of a codfish. It seems that this was not always so, for we read in a popular almanac for the year 1838 that red codfish was at that time considered the best; a proof that the popular taste changes in course of time, and that red codfish are not a new thing. In hot countries, especially in the Antilles and in Réunion, consumers even to this day give the preference to red codfish, which they term "*saumonée*" (salmonified).

Endeavors have been made to find what might be the cause of the red color in codfish. It has been noticed more frequently during the last twenty years. Sometimes it is found in all the codfish of one consignment, and sometimes there is not one which has a red color. It seems that moist heat favors its development. It has been observed that entire cargoes of codfish which had kept white during the voyage from Newfoundland to Bordeaux rapidly turned red only a few days after their arrival at the latter port.

According to Dr. Dumas some dealers have observed "that the rose color shows itself most frequently when Mediterranean salt has been used in salting codfish, while the salt from the west of France produces the contrary effect, and they think that this result is due to the presence in the salt from the west of France of a larger quantity of small earthy particles. These particles, although rendering the salt less pure, would therefore have at least this advantage, that they prevented the codfish from turning red. But as this salt gives to the codfish a yellowish color, which is not very agreeable to the eye, most people prefer to use the Mediterranean salt."

This opinion regarding the special influence of the Mediterranean salt on the development of the red color is not shared by all dealers; but it is nevertheless interesting to note, because it raises the question as to the influence of the salting on the production of parasitic germs in albuminous matter.

According to Dr. Layet there are facts, proved by actual practical observation, which seem to show this influence of the different methods of salting on these small organisms in other substances than the red of the codfish, as for instance, the appearance of red color in the Norwegian sardines; and there are likewise facts, proved by experiments, which clearly establish the influence of sea-salt on the development of microbic germs. Miguel has clearly shown that, according to the quantity of salt added to the liquids which serve as elements of cultivation for *schizomycetes*, these show themselves in greater or less quantity; a certain quantity favors their development, while a different quantity almost entirely prevents it.

We have already given the opinion of Professor Farlow regarding the red color of the codfish. According to the Spanish journal which has published Professor Farlow's opinion, he examined the Cadiz salts, which showed a slight rose-colored tinge, and arrived at the conclusion "that the Cadiz salt, as it comes into the hands of fishermen, is already impregnated with a considerable quantity of the *clathrocystis*," and that this plant develops on the codfish whenever the temperature is sufficiently high (above 65° F.)

Let us now hear what Mr. Carles has to say on the subject:

"It is a very delicate matter to show precisely whence come the germs of this red coloring, especially in the absence of samples of the different substances with which the codfish has come in contact from the time it

is caught till its arrival in the port of destination. But everything leads us to suppose that the origin of the trouble is in the salt; and if the germs develop on salt fish with an intensity which varies in different years—*i. e.*, according to the temperature, the condition of the atmosphere, etc.—the codfish must, in order to become a fertile soil for the parasite, have commenced to spoil on the surface.”

In short, it may be said that all the naturalists who have occupied themselves with this question and the codfish dealers agree in considering the salt as one of the principal causes of this cryptogamic vegetation. But so far this is only a supposition, which, in spite of its great probability, needs to be confirmed by experimental investigations conducted on scientific principles. We know that Messrs. Layet, Artigalas, and Ferré, of Bordeaux, and Dr. Heckel, of Marseilles, have undertaken this task, and we shall probably soon learn the results of their investigations.

Several means have been proposed to prevent the development of red in the codfish, but so far none has proved sufficiently practical to be employed. Salicylic acid, borate of soda, sulphite of soda, a freezing process, etc., all have been mentioned. By a ministerial circular of February 7, 1881, the application of salicylic acid to articles of food was prohibited. This method, therefore, could not be employed. As regards borate of soda, by which it has been proposed to replace the salt, and the freezing process, it must be said that these methods are too expensive to be employed to any extent.

As far as we are concerned, and until something better is found, we freely give the preference to the means indicated by Mr. Carles, which, if they do not altogether kill the germs, at least prevent their spread. These means are the following:

(1) Careful washing of the fresh codfish, so as to remove all impurities from the intestines.

(2) Using salt obtained from mines, which is free from all germs, and contains fewer deliquescent magnesian salts.

(3) Washing and disinfection of the vessels by fumigation with sulphurous gases.

(4) Disinfection, by the same means, of the material, the ground, and the walls of the drying-houses.

(5) Removing at once from the drying-houses all organic detritus produced by the washing of the fish and their immediate disinfection by sulphates of iron or copper.

(6) A final washing of the fish in water from which all organic products and deliquescent salts have been carefully removed.

This question of the influence of the salt on the production of the red color in codfish naturally leads us to speak of the codfish termed “soft-salted;” that is, insufficiently salted. It is certain that these codfish spoil more easily than others, and may therefore cause cases of poisoning similar to those which have been described. Otherwise they are

much less subject to being infected by red color than those which have been well-salted. When fresh—and even when dried—they exhale, according to the statements of dealers whom we have consulted, a very strong odor of garlic; their flesh is soft, and an impression made with the finger will remain. When cooked they exhale a putrid odor, characteristic of their decay, which generally prevents people from eating them.

There are “soft-salted” codfish which accidentally have been badly salted at the fishing stations. Their number, however, is small; but there are large quantities of badly salted codfish simply owing to the fact that the fishermen, with the view to making greater gains, have been too saving with their salt. Insufficiently salted codfish keep a much larger quantity of water in their flesh than well salted ones, and consequently weigh heavier when they reach the French ports, where they are sold by weight.

This method of insufficiently salting codfish can not be censured too severely, and dealers can not be too careful in this respect, as both from a hygienic and from a commercial point of view the consequences may be most deplorable.

#### IV.—NATURE OF THE POISONOUS SUBSTANCE CONTAINED IN PUTRE- FIED CODFISH.

The cases of poisoning observed, which we have described in the first part of this treatise, prove beyond a doubt that spoiled codfish contains a poisonous substance which, when eaten, is liable to cause in human beings more or less serious cases of sickness resembling cholera in its symptoms. We deem it proper to enter somewhat into detail regarding the nature of this poison; and it may be stated here that there are weighty reasons for supposing that the poisonous substance of putrefied codfish is a cadaveric alkaloid or ptomaine.

This last-mentioned word was introduced to science in 1872 by Professor Selmi, of Bologna, who first of all toxicologists called attention to the existence of small quantities of poisonous alkaloids which could be extracted from human bodies, which had not been poisoned, after having lain in the ground for some time. He proposed for these poisonous substances the name *ptomaine* (from the Greek word *πτῶμα*, cadaver), and pointed out the possibility of confounding these substances with vegetable alkaloids. In 1870 Selmi's attention was for the first time directed to the existence of these alkaloids. He produced, according to the method of Stas, from the entrails of a man who was supposed to have been poisoned an alkaloid which he could not identify with any of the poisonous alkaloids hitherto known. But it was only in 1874, and later, in 1878, that Selmi again took up this question and made experiments on a large scale on human bodies which had been buried for several months. By these experiments Selmi established, beyond the shadow of a doubt, the fact that poisonous alkaloids will develop in the course of putrefaction.



This study of the ptomaines from a toxicological point of view has been continued in France by Messrs. Brouardel and Boutmy. In 1881 Messrs. A. Gauthier and Etard, taking up Selmi's work, isolated the products from a large number of putrefying fish from the volatile bases belonging to the pyritic series, which were the first of these interesting compounds to be analyzed. The physiological action of these alkaloids varies greatly; some are only poisonous for animals, while others produce symptoms similar to those produced by strychnine, morphine, and veratrine.

Our knowledge of these substances, some of which are extremely poisonous, is still very rudimentary. A large number, however, of new and well-established facts have increased our knowledge since 1850, when Stas, in connection with the celebrated Bocarmé affair, discovered a method of separating the alkaloids, which bears his name. But, on the other hand, many new alkaloids have been discovered since that time whose poisonous character has hardly been demonstrated, or which as yet has not been shown at all. Mr. Duvillier, professor of chemistry in the medical school of Algiers, has discovered a large number of these cadaveric alkaloids in the flesh of spoiled codfish, which Dr. Bertherand had submitted to him for analysis in 1878. This chemist by following the Stas method succeeded in obtaining the characteristic reaction of ptomaines (precipitate of Prussian blue by prussiate of potash and perchlorate of iron).

Mr. Degorce, principal pharmacist of the navy, did not obtain the same result in his examination of spoiled codfish from the port of L'Orient. He says in his report to Mr. Bérenger-Féraud: "50 grams of codfish, taken from those parts of the fish which were rose-colored, were treated according to the Stas' method, and did not show any traces of organic alkaloids or ptomaines." This negative result is not surprising. It is, on the contrary, only another proof that the poisonous substance of spoiled codfish is not found in its red portions; and it is more than probable that, if this chemist had sought for ptomaines, not in the red portions, but in the positively putrid flesh of the codfish, he would have found them.

Other experiments have confirmed the presence of ptomaines in putrefied codfish. Brieger discovered, besides the alkaloids which are generally found in spoiled articles of animal food, a particular ptomaine, which he has called *gadinine*. Mr. Brieger has made experiments on ptomaines developed in digested fibrine, in spoiled milk, putrefied fish, spoiled cheese and gelatine, and putrefied yeast. According to him, putrefied milk produces a poisonous base *neurine*, and a non-poisonous base *neuridine*. The poisonous quality of *neurine* is ten times stronger than that of choline. *Neurine* is the characteristic alkaloid of putrefied meat. In the long run, these alkaloids are destroyed by the process of putrefaction. Decayed fish produces *neuridine*, *diamine-ethylene*, *muscarine*, similar to that of mushrooms, and a new base, *gadinine* and

*trimethylamine*. Most of these ptomaines have been reproduced by synthesis.

Professor V. K. Anrep, of Kharkov, Russia, had occasion to observe several cases of poisoning by salt sturgeon, five of which were fatal, and found on investigating the nature of the poison that it was a ptomaine. He examined matter drawn from the gastro-intestinal canal of one of the victims (blood, liver, brain, and milt of the sturgeon), and likewise the urine of one of the persons who had died, and he found in both cases a substance identical in its physical and chemical properties as well as in its physiological action on animals. This ptomaine appeared in the shape of a solid amorphous substance, having strongly pronounced alkaline properties, and of an exceedingly strong, poisonous character. Not very soluble in water it produces salts of a very great solubility. Its principal characteristic is its great firmness.

When given to animals (dogs, rabbits, frogs) it very soon produced the same symptoms which had been observed in human beings. In human beings the eating of poisonous fish invariably produced in a few hours (never more than twenty-four) great lassitude, a sensation of cold with violent pain in the stomach, vomiting, dryness of the mouth and tongue, excessive thirst, a weakened sight, ptosis, and dilation of the pupil of the eye, cold extremities, difficult respiration, præcordial anxiety, a slow pulse, considerable prostration, and gradual diminution of the temperature of the body. In fatal cases the cardiac and respiratory functions do not recover their normal condition and the sight becomes very weak. These symptoms are followed by cyanosis of the face, paralysis of the bladder and intestines, and great difficulty in speaking or even uttering sounds. Death occurs on the second day, or sometimes on the third or fourth.

Bocklisch found that codfish and perch undergoing a process of putrid fermentation yielded different products. He also made an investigation regarding herring, which frequently, when decayed, cause cases of poisoning. He succeeded in extracting from the brine of herring the following bases: *trimethylamine*, *dimethylamine*, and *methylamine*. In the flesh of a decayed herring he found *cadaverine* (discovered also by Brieger), *diamine-ethylene*, *gadinine* (discovered by Brieger), and *putrescine*, as well as *methylamine* and *trimethylamine*.

This question, which is still but little known and has not been sufficiently studied—that is, the question of poisons produced in decaying organic matter—has been treated from a more general point of view by Mr. Netter in an excellent treatise published by him in 1884 in the *Archives générales de Médecine*. The author attributes to these poisons, the study of which has hardly been begun, the cases of poisoning known as *bolotism* and *allantiasis*, which sometimes occur after partaking of certain articles of food, especially preserved meats and spoiled sausage. The following are, according to Mr. Netter, the symptoms of *bolotism*:

“Two stages may be distinguished; one of irritation and one of paralysis. Eighteen hours after the food has been partaken of the

patient complains of an uncomfortable feeling, general lassitude and pain and a heavy feeling in the epigastrium. He has no appetite; but instead nausea, attacks of retching and vomiting. There is pain in the abdomen, which is frequently swollen and extended. Sometimes diarrhea sets in at the very beginning, but it is soon followed by constipation, which generally is very severe. There is an extraordinary dryness in the mouth and throat, which frequently rises to a burning sensation. Only in rare cases these symptoms are accompanied by chills. The head aches.

“On the second or third day the paralytic stage commences. At first this shows itself by attacks of vertigo, an uncertain step in walking, and heavy respiration. The sight becomes dim and the pupil of the eye is dilated. On the third or fourth day the upper eyelid falls down, the pupil is immovable and insensible. Then follow attacks of choking and cough, reminding one of croup. From the fourth to the tenth day dysphagy becomes more pronounced, and it now becomes impossible to swallow anything. All secretions are suppressed, with the exception of the urinary secretion; constipation becomes settled, the faintness of sight becomes amaurosis, and the hoarseness becomes speechlessness; the sense of touch is entirely lost. The patient can no longer move the tongue. The paralysis of the members becomes complete; the skin is cold, the pulse slow and feeble, and the beating of the heart can no longer be noticed. One fainting spell follows another, and respiration ceases. Finally the patient dies with every indication of complete and utter exhaustion. Sometimes death is accompanied by convulsions.

“This is the course in fatal cases. Death, which follows in one-third of all the cases, occurs during the first ten days. At the autopsy nothing can be discovered but a congestion of most of the viscera. Rigidity sets in slowly, and putrefaction likewise makes its appearance very slowly.”

These morbid phenomena of *bolutism* differ far too much from those of poisoning by spoiled codfish to allow us to draw the conclusion with Bérenger-Féraud that they both are produced by the same cause, by a poisonous substance having varying effects, according to its different degree of strength. It seems much more natural to suppose that the putrefaction of animal matter produces different poisonous substances, according to the nature of the matter in which they are developed.

This appears very clearly from all the recent researches and from the different symptoms which have been observed both in cases of accidental poisoning by decayed food substances of animal origin and in physiological experiments.

Mr. Bérenger-Féraud himself recognizes the decided difference of the symptoms of the two cases. “In cases of poisoning by spoiled codfish,” he states, “we notice immediate attacks resembling that of cholera, and after this first stage has been passed the condition of the patient improves very regularly and rapidly. In *bolutism*, on the other hand,

there are two stages, one of irritation and the other of paralysis, and after a short and deceptive period of improvement the special symptoms begin to show themselves—paralysis of the limbs, eyelids, etc.; symptoms which have never been known to follow the eating of spoiled codfish.” It is truly astonishing that the author, after making the above statement, nevertheless arrives at the conclusion that there is a complete etiological identity between the two cases.

For our part we can not share this view; and we find a new proof of the decided difference between the two poisonous substances by examining the different symptoms by which these two cases of poisoning are followed.

Poisoning by spoiled codfish, which we propose to designate by *gadinism*, in order to distinguish it from other cases of poisoning of the same kind, has only resulted in death in a single case (in St. Petersburg) among 700 persons who had been poisoned. *Bolutism*, on the other hand, very frequently causes the death of the victims, as will be seen from the following facts from Mr. Netter's treatise already referred to:

In 1799, on a farm in Suabia, 5 persons were taken sick from eating spoiled meat-balls, and 4 of them died. In 1808, Jaeger observed 25 cases, in 11 of which death followed. In 1820, Kerner observed 76 cases, of which 37 were fatal; and in 1822, 155 cases, in 86 of which death occurred.

The objection might be raised against these statistics that they are of ancient date, of foreign origin, and that the study of these cases doubtless left much to be desired. But the opinion which we have advanced regarding the probability of the existence of different poisonous substances in decayed articles of food of animal origin is not merely based on a comparison of the symptoms of *bolutism* described by Mr. Netter and the symptoms observed in cases of poisoning by spoiled codfish and on the different course of the illness following these two kinds of poisoning; it is also based on the comparative examination of a certain number of more recent cases of poisoning by animal substances of the most varied character, in which the symptoms showed essentially different characteristics.

It is impossible to give in this place a detailed account of all these cases without exceeding the limits allowed for this article. We shall content ourselves to enumerate them and to indicate the sources from which they have been taken, so that our readers, if they desire it, may study these sources, and ascertain the truth of our assertions:

(1) Cases of poisoning produced by the eating of mussels, communicated by Dr. E. Monod at the session Society of Public Hygiene of Bordeaux, December 5, 1883 (*Revue sanitaire de Bordeaux*, January 25, 1884).

(2) Case of poisoning by eating Portuguese oysters during the month of August, observed by Dr. Mérau (*Revue sanitaire de Bordeaux*, January 25, 1884).

(3) Case of poisoning from eating the roe of flounder, reported by Dr. Rondot (*Revue sanitaire de Bordeaux*, January 25, 1884).

(4) Case of poisoning from eating preserved turkey which had become spoiled, communicated by Mr. Darnet, a pharmacist of Soulae at the session of the Society of Public Hygiene of Bordeaux, December 5, 1883 (*Revue sanitaire de Bordeaux*, January 10, 1884).

(5) Poisoning by the flesh of a goose, reported by Brouardel in Hoffmann's *Traité de Médecine légale*.

(6) Poisoning by the spoiled flesh of a turkey, communicated to the Academy of Medicine of Dublin at the session of January 18, 1884. (*Revue sanitaire de Bordeaux*, March 10, 1884). In this connection the author recalls other cases of poisoning by spoiled meat, observed by Van der Corput, Klein, and Ch. Cameron.

(7) Case of poisoning by small mussels; reported by Dr. J. Turle in the *Sanitary Record*, January 15, 1884. This was a case of the death of a person who had eaten about a handful of these small shell-fish, bought in the Finchley market. Four hours after eating them he was taken with violent attacks of colic, followed by utter prostration, and death after thirty hours.

(8) Poisoning by eating snails; reported by Dr. Dumas, of Cette, in 1873. Several persons who had partaken of snails were taken with intestinal troubles, nervous symptoms, vertigo, headache, delirium, etc. (*Revue sanitaire de Bordeaux*, March 10, 1884).

(9) Poisoning by spoiled meat. This case occurred at the Bordeaux fair in October, 1884, in a family of strolling actors, three of whom died (*Revue sanitaire de Bordeaux*, October 10, 1884).

(10) Poisoning by spoiled English preserved beef, March 26, 1881, on board the English pleasure yacht *Amy*, in the harbor of Villefranche. This was observed and described by Bérenger-Féraud in his treatise *Sur les accidents que provoque la morue altérée* (cases of sickness caused by spoiled codfish).

(11) Poisoning by cheese, in Michigan (*Revue sanitaire de Bordeaux*, January 25, 1885).

(12) Poisoning by meat from a sick calf (*Echo vétérinaire belge*; *Art médical de Bruselles*, June, 1885, and *Revue sanitaire de Bordeaux*, September 25, 1885). In this last-mentioned case 10 persons were poisoned, and 1 died. The man who died, and a woman, showed typhoid symptoms. The others, whose cases were not so severe, were attacked by headache, violent diarrhea, and intense colic for two days. The patients, moreover, suffered from a very painful dysury, and the urine, which flowed out drop by drop, was as black as ink.

(13) Numerous cases of poisoning by mussels; communicated to the Berlin Society of Medicine by Dr. Virchow, at its session of November 18, 1885.

The cases occurred in one of the docks of Wilhelmshafen on the North Sea. After two vessels had entered the dock, and after the water had

been let out, it was noticed that these vessels were covered with an innumerable quantity of mussels. The workmen gathered them, had them cooked, and partook of them with their families. After a few hours 19 persons (13 men, 5 women, and 1 child) were taken seriously ill. Four died; the first, three-quarters of an hour after having eaten the mussels; the three others several hours later. We should state that these two vessels were not covered with copper.

The symptoms observed after eating only from five to six mussels were in all cases the same. The teeth of the patients seemed blunted; they experienced an itching sensation in the hands and feet, but no headache. An excitement like the one produced by alcohol soon gave way to a feeling of depression; the pulse varied between 80 and 90; the temperature of the body did not increase; the pupil of the eye became dilated, but the vision did not become dim; convulsive movements of the hands were noticed, great feebleness in the lower extremities; no diarrhea. During the last stage there were general chills, anxiety, a feeling of oppression, and finally the patients died, without having lost consciousness for a single moment.

At the autopsy the intestines showed symptoms of inflammation of the bowels, which confirms the opinion of Orfila as to the irritating action of the poisonous substance.

Professor Virchow gave some of these mussels to dogs, cats, rabbits, and frogs; and all these animals died after having eaten a very small quantity. Thus, the largest dog had only eaten from six to seven mussels. A cat licked a very small quantity of the liquor from the mussels left in a dish and was taken violently sick. The poison must, therefore, have been very strong. Dr. Schmidtman, the physician of Wilhelmshafen, who observed all these cases of poisoning, believes that it was ptomaine. Virchow is inclined to consider it as a chemical poison. In either case it must be admitted that the mussels produced this poison.

In the Japan seas there is a species of fish which for several months during the year becomes poisonous, while during the remaining portion of the year it may be eaten with impunity. Does not this fact agree with the supposition of a kind of virulence showing itself at the time of reproduction, and might not this virulence be the result of the development of a normal or accidental ptomaine, resembling the substance described by Balbaud (in *Études sur l'empoisonnement par les moules*, Paris, 1870), and termed by him *molluscine* (?)

It is probable, however, that mussels may also become poisonous by the beginning of the putrefying process, which would agree with the circumstance that these cases of poisoning are more frequent during the hot season. However this may be, the variety of symptoms observed in most of the cases justifies the opinion that spoiled articles of food of animal origin contain ptomaine or different chemical poisons. The clinical observation therefore agrees entirely with the chemical observation, which has already isolated and characterized several of these

poisonous substances. Much remains, doubtless, to be done, both from a chemical point of view and from that of physiological experimenting, in order to throw full light on this but little explored field of the toxicology of cadaveric alkaloids; but the results which have been reached thus far justify the hope that science will finally succeed in solving all the knotty problems of this question.

We will close this chapter by the report of a personal experience regarding the eating of putrefied codfish: During the first days of April two reliable codfish dealers of our city furnished me, at my request, with a number of dried codfish which had been more or less tainted with red; and three of the oldest and most decayed codfish which could be found among the refuse of their drying-houses.

These three codfish, three years old, and destined to be sold as grease, showed all the signs of putrefaction—a putrid odor, and flesh which throughout was of a brownish color, and easily crumbled to pieces. The outside showed many red spots scattered irregularly over the entire body.

I gave these three old codfish, raw, and without being prepared in any way whatever, to three dogs of the physiological laboratory of the Faculty of Medicine, which Professor Oré kindly placed at my disposal. None of these three dogs were inconvenienced thereby. They neither vomited, nor had they attacks of diarrhea, or any other symptoms of sickness; and still the codfish of which they had eaten was old and thoroughly decayed.

May we conclude from this experiment that the eating of such codfish would not produce cases of sickness in a human being? I do not believe it. Dogs are in the habit of eating all sorts of impure matter, and putrefied substances, without suffering any bad consequences.

The same would hardly be the case with man, whose stomach is of a much more delicate organization; and one should be careful not to draw any conclusion as regards man, as to the harmless character of spoiled articles of food, from cases in which dogs ate such articles with impunity. To make the experiment complete, I should also have eaten of the spoiled codfish, but I freely confess that I did not have the courage to let my scientific devotion go so far. I contented myself by eating red, but otherwise sound, codfish at two consecutive meals; and I can state that I digested it perfectly without the least trouble, like all the members of my family who partook of it with me.

It may, therefore, be considered as settled that the red codfish has no hurtful quality, and that dogs could eat, without being in the slightest inconvenienced, raw codfish, three years old, intended to be used for grease, and showing every sign of putrefaction. Should we admit that the poisonous products of putrefied codfish do not act on dogs, or that these products, poisonous at a certain given time, are finally destroyed by the process of putrefaction? These questions can only be solved by new researches, and by much more numerous experiments.

## V.—COMMERCIAL ASPECTS OF THIS QUESTION.

The cod fisheries are carried on on the coasts of Iceland and Newfoundland from April till the middle of September, and more than 12,000 of the best class of fishermen and sailors are engaged in these fisheries.

The codfish are not caught in the same manner near Iceland as near Newfoundland. In Iceland fishing is going on while the vessel is moving, drawing the fishing-lines after it. The fishermen constantly raise these lines, and the codfish pass direct from the sea into the vessel which is to take them to France. When they reach the deck of the vessel the head is cut off and the abdominal viscera are removed, among which is the roe, which is to be used as bait in the sardine fisheries, and the liver, from which oil is to be extracted. Then the fish are cut open and a portion of the backbone is removed; whereupon they are washed, salted, and piled up in the hold of the vessel.

Near Newfoundland the fisheries are carried on in a different way. Lines with hooks are immersed in the water and left there from one tide to the other. At each tide small boats are sent out from the vessel to raise the lines. The codfish are at first received in these small boats, or dories, which convey them to the vessel. There is therefore a double handling, which does not take place in the Iceland fisheries. As regards the methods of preparing the codfish, they are the same in both countries. We should also bear in mind the fact that the temperature of Iceland is much colder than that of Newfoundland.

These details are of importance regarding the question before us, for they may have to be taken into account in explaining the fact, which has been duly observed, that the codfish caught near Iceland turn red more rarely than those caught near Newfoundland.

In 1885 the average quantity of codfish taken by each fishing vessel near Newfoundland was from 3,500 to 5,000 quintals. A boat manned by 24 men can take at each tide about 5,000 codfish. The largest fishing vessels can carry as many as 180,000 codfish.

It is probable that if Dr. Bertherand, of Algiers, had been acquainted with the above-mentioned fact when he read his treatise on the poisonous fungus at the meeting of the scientific societies held in Paris in April, 1884, he would not have proposed as a remedy for preventing the growth of this fungus, to arrange in the fishing vessels tanks in which live codfish could be conveyed to France. Without mentioning other impossibilities we must say that no vessel would be large enough to hold tanks for 180,000 live codfish, many of which are 3 feet long. It is true that the fish might be distributed among a number of vessels, but what an enormous fleet would be required to convey to France in tanks the 1,200,000 quintals of codfish which represent the annual yield of these fisheries. All the vessels of the French merchant marine would not suffice, not to speak of the enormous expense which this mode of transportation would involve.



We stated that the cod fisheries take place from April till the middle of September. The first vessels conveying fresh codfish from Iceland and the Newfoundland banks arrive in France about the end of May or the beginning of June, and from that time on ships continue to arrive every week in July, August, September, October, and November. A considerable quantity of codfish, therefore, arrives in our ports during the heat of summer. It is no rare case to see entire cargoes turn red from the influence of the heat, either during the voyage or when the fish are landed in the port of destination. But at that time the red spots are merely found on the surface.

As soon as the codfish are landed they are taken to the drying-houses. There they are piled up in enormous heaps in closed but well-ventilated rooms. They remain in this condition a longer or shorter period, according to the needs of the trade. They are termed "green codfish." Some are shipped in this condition, but by far the larger quantity is delivered to the dealers as "dried codfish."

According to the needs of the trade, the green are transformed into dried codfish in the following manner. They are brushed violently with a broom-corn brush, and washed in several waters, so as to get them as clean as possible. This operation frequently causes the red color to disappear. After they have been thus washed, they are hung in the open air to dry. In summer two "suns" suffice to dry them completely, but in winter and in wet weather they have frequently to hang much longer. The codfish hung to dry is carried to the warehouse every evening, and is not allowed to stay in the open air a single night. We have seen 30,000 codfish hung up to dry in a single drying-house at Bégles. This operation, of course, necessitates the employment of a very large number of persons.

The dried codfish generally leaves the drying-houses in good condition, but it passes through several hands before it reaches the retail dealers, and with these latter it is not always kept under conditions favorable to its preservation.

The following figures, derived from a reliable source, give an exact idea of the importance of the French codfish trade:

The whole of France receives every year from the Iceland and Newfoundland fisheries codfish valued at from 30,000,000 to 35,000,000 francs (about \$6,000,000). The share of Bordeaux alone in 1885 was 14,000,000 francs (about \$2,700,000). The average annual quantity received is 600,000 quintals.

In 1885 the Bordeaux merchants exported to Spain and Italy 150,000 quintals, Spain taking three-fourths of this quantity.

Some years ago (hardly six) France exported no codfish to Spain, Norway furnishing that country with all the codfish consumed. It seems that considerable difficulty was experienced in opening the Spanish market for French codfish, but at present the Norwegians again take courage, and, since the ministerial circular prohibiting the sale of red codfish in France, again ship large quantities of codfish to Spain.

The Spanish dealers say: "Don't buy any more French codfish, because they have turned red; and that this color is a proof of their bad quality is clearly shown by the recent circular of the French ministry prohibiting the sale of red codfish." A Bilboa paper has even gone so far as to insinuate that it is more than probable that it was the French codfish which last year carried the cholera into Spain, and that if these fish had been carefully examined specimens of Dr. Koch's bacillus would probably have been found.

All this evidently is not strictly scientific, but it will be seen how much in such matters the hygienic consideration influences the commercial side of the question; and it will be understood what great damage may be inflicted on commerce by an erroneous scientific opinion when it has been pronounced in an official way, especially in the shape of a prohibitory measure.

We have stated that the new minister of commerce, Mr. Lockroy, has suppressed the circular of his predecessor until the entire question in all its bearings has been made the subject of exhaustive investigations. We hope that soon sufficient light will have been thrown upon this question to cause the minister to revoke definitively the prohibitory measure referred to, and to proclaim positively in a new circular the absolutely harmless character of red codfish from a hygienic point of view. Such a declaration seems to be the only means of conquering the very considerable prejudice which has been created against these fish by the prohibitory ministerial circular of December 31, 1885.

#### VI.—CONCLUSIONS.

From all that has been said above we feel justified in drawing the following conclusions:

(1) Cases of poisoning from eating spoiled codfish are extremely rare, considering the enormous quantity of these fish consumed throughout the entire world.

(2) The exceptional cases which have been observed must be attributed to the eating of spoiled codfish which had already commenced to putrefy, which can always be recognized by the following two certain indications: A putrid odor, and the easy crumbling of the flesh. Every codfish showing these two indications should be condemned at once.

(3) The red color which often appears on these fish, both when "green" and when "dry," under certain conditions of temperature and the place where they are kept, is no indication of their injurious character; because, on the one hand, it is a well-established fact that from time immemorial people have eaten red codfish without experiencing any bad consequences; and because, on the other hand, animals (dogs and cats) have for several days in succession been fed on raw codfish, having a deep red color, without causing any sickness whatever. One may therefore eat without fear any codfish which has preserved its

normal odor, and the firm consistence of its flesh, no matter whether its color is more or less rosy or red.

(4) The red of the codfish is produced by a cryptogamic vegetation, the nature of which has not yet been fully determined. Some think it is a fungus, others an alga.

(5) This cryptogamic vegetation which develops both on spoiled and on sound codfish, seems to be aided in a special manner by the salting process; but it has nothing whatever to do with putrefaction.

(6) Only those codfish whose flesh is more or less putrefied contain a poisonous substance, which in man may produce symptoms similar to those of cholera.

(7) This poisonous substance has been isolated and characterized by several experimenters as a kind of ptomaine, or an alkaloid produced by putrefaction.

(8) Protection against all danger of such poisoning is easy, simply by not eating any codfish which has at all begun to putrefy. As regards sound codfish, they should invariably, before being eaten, be carefully cleaned, soaked in water, which should be changed several times for twelve hours, and above everything else should be well cooked. Thorough cooking of all articles of food of animal origin is in fact the best means of destroying all hurtful parasites and minute organisms which they may contain.

(9) In peremptorily prohibiting the sale of red codfish, which is absolutely harmless unless it is at the same time spoiled (a measure which can not be justified by any reasons, and which has done considerable injury to an important branch of our commerce), a product which has lost nothing of its alimentary value, and which is of great and every-day importance to the laboring classes, has been unjustly depreciated and condemned.

(10) We therefore consider it our duty to advise that, as soon as possible and in the most positive manner, this prohibitory measure be revoked, because it is based on a manifestly erroneous interpretation of facts.

BORDEAUX, FRANCE, *April 25, 1886.*