

31.—EXPERIMENTAL HYGIENE—OBSERVATIONS ON THE RED FLESH OF THE CODFISH.*

By Dr. ALEXANDRE LAYET.

[Report made to the Mayor of Bordeaux.]

Fish-dealers acknowledge that the redness in codfish has only recently made its appearance, and attribute it to the use of Mediterranean salt. This leads us to a consideration of the methods of preserving fish by salting it, and of the influence which the degree of salting may have on the development of parasitic germs in albuminous substances. Practical observations have revealed certain facts which appear to show the influence of the method of salting on the appearance of parasitic germs in such substances as the red flesh of the codfish and the Norwegian sardines; and facts brought out by actual experiments have proved that sea-salt has an influence on the development of such germs. Miquel has shown conclusively that in proportion to the quantity of salt used in preserving articles of food, parasites appear in greater or less quantity; a certain proportion of salt favors their evolution, whilst another proportion entirely prevents it.

On the other hand, facts gathered from actual observation relating exclusively to the sanitary side of the question, show that there have been actual cases of poisoning from codfish which had become changed without turning red or by turning red. The cases of poisoning by changed codfish which had not turned red are among the earliest known and the most common; whilst the cases where the codfish had turned red are very rare. The first cases of this are those reported by Dr. Bertherand, of Algiers, in January, 1884. The hygienic commission of Algiers had recognized the necessity of withdrawing the red codfish from the market. This is the only precedent which can be quoted.

A second case produced by red codfish is that reported by Mr. Berenger Féraud, where 200 of the 380 men composing the crew of the man-of-war Vengeance, at Lorient, became more or less seriously indisposed after having eaten codfish from the naval provision bureau (October, 1884). This fact has probably drawn special attention to the red codfish and has caused the recent prohibitory measure.

The cases of indisposition caused by partaking of spoiled codfish resemble in every particular those produced by using animal food which has undergone a certain degree of decomposition. We invariably find the same series of gastro-intestinal, cholera like symptoms, accompanied by more or less clearly defined disturbances of the nervous system. It is generally agreed that these symptoms are caused by the formation in articles of food of a poisonous alkaloid. Brieger (1884-1885), who has

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made experimental researches regarding such alkaloids (*ptomaine*) developed in spoiled codfish, has discovered in such fish, besides the alkaloids generally found in decayed animal articles of food, a particular kind of *ptomaine*, the *gadinine*. Other authors, among them Anrep and Bocklisch (1885), have also made an investigation of the *ptomaine* found in the decayed flesh of fish.

As regards the red codfish, it should be stated that the reports on cases of indisposition caused by red codfish also make mention of a putrid odor of the flesh, of its softening, and its tendency to crumble to pieces. The red codfish which produced these cases of indisposition was certainly spoiled, the symptoms observed being those produced by animal articles of food which to a certain degree had become decomposed; but the redness has been given as the cause only in as far as one has been led to consider it as favoring a change of the flesh of the codfish. It may, however, be asked if this redness does not also show itself in codfish whose flesh is sound; and, in our opinion, this is generally the case. The redness is really an external phenomenon. Among a large number of codfish in which redness had shown itself there were found, just as among codfish which showed no redness, sound, comparatively sound, and spoiled fish.

These are the first results of investigations made by us at the laboratory of hygiene of the Medical School, assisted by Mr. Artigas, professor at this school, and Mr. G. Ferré, superintendent of histological experiments.

This first report is confined to the nature of the red color of the codfish, to the manner in which it spreads on the surface and inside the tissues, and to the relations which may exist between the presence of this red color in the interstices between the bundles of muscles and the change or decay observed in these bundles.

The only observation known to science as regards the nature of the red color in the codfish was made by Mr. Mégnin, a distinguished authority on micrography, to whom Mr. Bertherand had forwarded samples of the red codfish which had caused the cases of indisposition at Algiers in 1884. Mr. Mégnin considers the redness as a fungus growth of the family of the "*Protomycètes*," and of the variety "*Coniothecium*." The characteristics attributed by him to these minute organisms are the following: "Round spores of a very pale rose color, with granular contents, and a small kernel measuring from six to ten thousandths of a millimeter in diameter; the largest of these spores are divided into two or four equal parts, which become new spores; a short mycelium, hardly discernible, in most of these diminutive spores."

We should add, from a practical point of view, that neither Mr. Mégnin nor the other persons who have studied the sanitary side of this question have made practical experiments by making animals eat of red codfish. We must say the same as regards ourselves.

Mr. Berenger-Féraud, in his very remarkable clinical examination of the cases of indisposition observed at Lorient among the crew of the *Vengeance*, has not made any personal investigation of the nature of the red codfish. He attributes it, according, as he states, to the few authors who have occupied themselves with this question, to the presence of a small fungus, the *Penicillium roseum*. But, to begin with, what is this *Penicillium roseum*? In the investigations made by us at the laboratory of hygiene at the Medical School of Bordeaux we made strenuous efforts to throw aside all preconceived notions and to describe only what we had occasion to personally observe.

The question before us was really not so much to specify the nature of the small organisms which constitute the redness of the codfish as to determine the conditions of their presence in the different samples of codfish submitted to us for examination. In making a general examination of the redness in articles of food, we find that the small organisms containing erythrogen found in articles of food occur in greatly varying forms, from the *Micrococcus prodigiosus* common in albuminous and amylaceous articles of food, to the numerous *Bacilles erythrospores* found in decaying albuminous substances, and from the isolated micrococcus to the composite forms, composed of two, three, or four elements, like the *Micrococcus aurantius*, or the gelatinous aggregations composed of numerous elements, like the *Bacterium rubescens*.

The red on the surface of the codfish shows itself in the shape of granular matter, developing in moist streaks in the folds and furrows or mingling with the outer layer of salt, as may be observed especially in the kind of codfish called "green codfish." In laying bare the lower layers one finds absolutely no redness in the flesh.

On the dry codfish, that which belongs to the large red kind, for instance, the colored matter shows itself on the surface in diffused forms of a whitish and rosy appearance; and when the outer layer has been removed, it is found again in the form of an infiltration in the interstices between the bundles of muscles and having a bright blood-red color. In cutting into the codfish we find these red infiltrations in all the fissures, depressions, and interstices, more particularly in the interosseous and latero-vertebral furrows. It is this condition of being almost entirely penetrated by the red color which gives to the dry codfish, when held before a bright light, a very marked rosy transparency.

In examining the red substance 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; (5) special elements, which we shall describe below.

(1) The crystals of sea-salt do not show anything of special interest; by the side of them we find some rusty fragments which appear to belong to the particles of iron sometimes found among sea-salt.

(2) The lanceolate lamellæ originate in cavities found in the layer of codfish immediately underneath the red part. These cavities where the lamellæ develop are formed at the expense of the muscular tissue. The lamellæ are colored by carmine; they are the result of a transformation of the muscle. They are certainly not composed of a fatty substance, for they do not turn black by an application of osmic acid, and even in muscles which were cut and to which this acid was applied, the cavities inclosing the lamellæ remained light whilst the muscular substance of the codfish turned completely black. This coloring of the muscle of the codfish is caused by its being impregnated with an oily substance.

These cavities, when beginning to form, are entirely filled with lamellæ; later when they increase in size they begin to open out in a level with the red which enters them, and their center becomes granular. By the side of these cavities others are found which are empty and which look as if they had been cut with a sharp instrument. They are scattered throughout the entire tissue of the codfish, both in that portion which comes in contact with the red and in that which is next to the skin.

(3) The granular substance appears to be composed of detritus mixed with elements in which three or more form a sort of an organism, and with the special elements which we are going to describe. The color of this substance is light yellowish.

(4) The muscular elements terminate in irregular borders of a granular nature, which appear corroded. They are probably the result of the breaking of the muscular tissue consequent upon the growth of the cavities filled with lamellæ and a granular substance. These muscular elements have preserved their striation. They float in the liquid produced by decomposition, and probably aid in forming the granular substance described above.

(5) We now come to the description of the special elements which enter into the composition of the red, properly so called. These elements approach, as to form, the elements called sarcodes, found in decaying substances but also in sound substances. They represent quarters of a sphere united by a common diameter. There are some in which the segmentation of one-half of the sphere has not taken place, and which therefore show the form of two quarters of a sphere and a half-sphere joined on the flat side, whilst others are two half-spheres, whose segmentation is not complete. These elements are refringent, and appear at first sight to be homogeneous. When dissolved, however, or rather when brought into contact with a solution of osmic acid (1 per cent. of acid), each element assumes a brown color, and spherical granulations make their appearance and a double outline.

Taken separately, each of these elements is transparent and colorless, but when grouped in masses forming several layers it can easily be seen that the center of the mass is of a rosy color, the density of the

mass increasing from the periphery to the center. The color would, therefore, appear to be due to the greater or less quantity of these elements in the mass.

But we deemed it proper to ask whether the mass of granulations properly so called did not aid in producing the red color. One of our number thought that the red was formed exclusively by sarcoid elements. He ascertained in fact that there was no red granular mass without sarcoid elements, while a mass composed solely of these elements was invariably found to be more or less red. This is, however, still a subject of controversy between us, and we therefore reserve our final opinion on this point.

From the preceding facts, and following the micrographic examination, we have arrived at the following conclusions:

(1) There are on the surface of the codfish, tainted with redness in the interstices between the superficial muscular bundles, 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 become denser when in close proximity to the salt crystals, appear together with them in the interstices between the muscular bundles, and fill the small cavities which we have described when these open on a level with them.

An important point to be elucidated was whether in the sound codfish, without red, the cavities above described could be found. It was easy to ascertain this. Cuts made in a codfish of this kind revealed the cavities formed of ray-like lamellæ, and more or less filled with detritus. They are found, as in the red codfish, in the first ventral muscular layer in the shape of grains making a screeching noise under the glass plate when the preparation is pressed.

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

In the codfish tainted by the red no other change is observed in the muscular tissue except this formation of small cavities which are found in the salt, the white and sound codfish, only the red finally penetrates the fish, continues to develop, and gains in strength.

To sum up, it appears from this first series of experiments made by us that the red in itself cannot be considered as the cause of indisposition produced by spoiled codfish, and that the poisonous character of the codfish depends entirely on the state of its putrid decomposition.

In future reports we propose to give the result of our researches regarding the experimental culture of the diminutive organism which constitutes the red in the codfish, regarding its transmission and its development in sound and decayed codfish, and regarding the various conditions (salting, packing, storing) which, from a practical point of

view, may serve to protect the codfish against the development of the red.*

We cannot at present dwell any longer on this side of the question, for, as we have already stated, we shall in a future report give the results of our investigations regarding the different methods of salting, the examination of the different kinds of salt used, the packing and storing of the codfish. We shall merely state regarding the nature of the small organism composing the red in the codfish that we have never yet found the slightest trace of a mycelium. We therefore do not believe that it is a fungus, not even one of the family of the *Discomycetes*, like the *Protomyces* for instance. It is doubtless an alga, but it is an open question whether it is a *Beggiatoa* of the family of the *Nostocaceæ*, like the *Clathrocystis*, which Mr. Farlow considers as the cause of the red in the codfish.

BORDEAUX, FRANCE, March 24, 1886.

32.—REPORT OF OPERATIONS AT THE SHAD-HATCHING STATION ON BATTERY ISLAND, NEAR HAVRE DE GRACE, MD., DURING THE SEASON OF 1887.

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Superintendent of Battery Station.

Active operations in the production of young shad were very much delayed by strong freshets in the Susquehanna River and exceedingly cold weather, but preparations had been completed for the work some time before eggs could be obtained. It was not until April 26 that the first spawn was taken, and this was of inferior quality on account of low temperature, &c. It will be proper to say, therefore, that the season opened on May 1.

The seine operated in previous years was not used this season, as its results were not in proportion to the expenditures connected there-

* Our attention has been called to an article published in the *Imparcial*, of Madrid, of the 20th March, in which it is stated that some years ago, in 1878, a red coloring of the green and dry codfish was, during summer, observed at Gloucester and at other places in the United States. The Fish Commission requested Prof. W. G. Farlow to inquire into the causes of this coloring. Professor Farlow found (Fish Commission Report, 1878, page 969) that it is due to the presence of *Clathrocystis roseo-persicina*. "After having observed," the writer of the article in the *Imparcial* goes on to say, "that this hurtful vegetable growth was found on all the walls and boards of the salteries and on all the wooden implements used in them, it was considered safe to assume that only the salt could be the means of its transmission." The Cadiz salts, which have a light rose-color, were examined, and after this examination Professor Farlow arrived at this conclusion: "That the imported Cadiz salt is impregnated with a large quantity of *Clathrocystis*, and that this plant develops on the codfish when the temperature is favorable." The *Imparcial* becomes alarmed at this statement, and fears that the Spanish salts, which in America are all known by the name of Cadiz salts, may lose their reputation.