

XLIV.—ON THE NATURE OF THE PECULIAR REDDENING OF SALTED CODFISH DURING THE SUMMER SEASON.*

By W. G. FARLOW, M. D.

Prof. S. F. BAIRD:

DEAR SIR: At your request, I have made an examination of codfish for the purpose of ascertaining the cause of the peculiar redness which is found on the dried fish during the hot and damp weather of summer. The red fish, as is well known, putrefy comparatively quickly, and this fact, taken in connection with the disagreeable, and, in fishes, unusual color, renders them unfit for the market, so that, in seasons when the redness prevails, dealers suffer a loss which is certainly considerable, although exact statistics with regard to the amount are wanting.

For the purpose of examining fresh material, and in order to make a personal inspection of the drying apparatus and storehouses, I went to Gloucester in the beginning of September, 1878, at which date the weather was hot and damp, and the codfish then being prepared for market were largely affected by the redness, the cause of which it was my object to discover. With the assistance of Captain Martin, of the United States Fish Commission, I was able not only to procure an abundance of the red fish for study, but also to examine several different buildings used in salting and packing fish, as well as a schooner which had just returned from a voyage to the banks.

Before speaking of the immediate cause of the redness, I may say that all persons of whom I made inquiry agreed in stating that the redness makes its appearance to such an extent as to be troublesome only during the hot weather, and that it disappears with the return of cool weather. I ascertained farther that the redness in most cases does not appear until the fish have been landed from the vessel. In some cases, however, the fish become red while in the vessel, but this happens only when the weather has been unusually hot at the time of catching.

A microscopic examination shows that the redness is owing to a very minute plant, known to botanists by the name of *Clathrocytis roseo-persicina*. The plant consists simply of very minute cells filled with red coloring-matter and imbedded in a mass of slime. The cells, as usually seen, are arranged without order, but under the most favorable conditions of observation they are found to be grouped in spheroidal masses. In relation to the botanical characteristics of the plant nothing more need be said in the present connection. Its development has been studied by several well-known botanists, who agree in considering

* As observed more particularly at Gloucester, Mass., during the summer of 1878.

it closely related to *Clathrocystis æruginosa*, a common species growing in fresh-water ponds, which has lately come into public notice in consequence of the so-called *pig-pen* odor which it exhales when decaying.

The *Clathrocystis* in question belongs to the lowest group of plants, the *Schizophyta*, many of which are the cause of decomposition or putrefaction of different animal and vegetable substances. *Clathrocystis roseo-persicina* is very widely diffused, being known both in Europe and America. It is found in summer along our shores, and at times is so abundant as to cover the ground with a purplish tinge, as one may see in the marshes near Lynn. It is also known in dissecting-rooms, where it grows in tubs in which bones are macerating. Wherever found it does not flourish nor increase rapidly at a temperature below 65° Fahr.

The next point to be considered is the manner in which the *Clathrocystis* is communicated to the fish. An examination of several different packing-houses and the wharves on which the fish are landed showed that the *Clathrocystis* was present in large quantities on the wood-work of all kinds; on walls, floors, and the flakes on which the fish are laid. How it might have been originally introduced into the buildings is a question easily answered when we consider how abundant the plant is on the marshes in the vicinity of Gloucester. It might have been brought in on the boots of fishermen, on sea-weed, on grass, or in other evident ways. Once in the buildings it would grow and increase on the damp wood-work, which contains usually more or less animal matter coming from the fish in process of drying. Why the plant is found at times on board the fishing-vessels themselves admits of explanation in two ways. It will easily be seen that, when it is common in and around the buildings on the wharves, it would be carried on the feet of fishermen on board the vessels. But there is also another reason why it should be found on the vessels. Large quantities of salt are of course used in packing the fish in the hold of the vessels. The two kinds of salt most commonly used by the fishermen of Gloucester are the Cadiz and the Trapani. I procured specimens of both kinds and submitted them to microscopic analysis. The Cadiz salt has a slight rose-colored tinge; the Trapani is nearly a pure white. The microscope shows that the reddish color of the Cadiz salt is owing to the presence in considerable quantities of precisely the same minute plant which is found in the red fish. The Trapani is a much purer salt, and the *Clathrocystis*, if it is found in it at all, exists in very small quantities. What must happen then is plain. The Cadiz salt, as it comes into the hands of fishermen, is already impregnated with a considerable quantity of the *Clathrocystis*. It is sprinkled in large quantities upon the fish as they are packed in the hold of the vessel, and if the weather is warm enough for the favorable growth of the plant, which, fortunately for the fishermen, is not the case in this latitude except for a short period, the fish must inevitably be affected during the voyage. As soon as the fish are landed, the circumstances are

much more favorable for the rapid growth of the *Clathrocystis*. The temperature is higher, more salt is added, and the fish are exposed either in buildings or on flakes which are themselves more or less covered by the red plant.

I have endeavored to ascertain whether a similar trouble arising from the growth of *Clathrocystis* has been observed in the fisheries of other countries, but I have not been able to obtain any information on the subject from the botanists who are best informed in these matters. Such questions, however, are not often discussed in scientific journals, and the trouble may perhaps be known to fishermen, although it has not yet, as far as I know, been called to the attention of scientific men. In Norway, where the cod-fisheries are of great extent, we might expect the redness to occur, but we must remember that in the region of Bergen and northwards the temperature is rarely high enough to favor the rapid growth of *Clathrocystis*.

Having ascertained the cause of the redness, let us consider the means of preventing or diminishing the evil. Nature herself, in bestowing upon the New England coast a cold climate, has practically set a limit to the trouble, and has enabled the inhabitants of our coast to carry on the business of curing fish with a degree of success which would be quite impossible in a more southern latitude, no matter how abundant the fish might be. In attempting to diminish the trouble in New England, we must bear in mind that the disease, if we may call it so, is transmitted to the fish from the wood-work and drying-apparatus, and, in some cases at least, from the salt used. The question, in short, is how to get rid of the pest already established in our fish-houses.

To speak, in the first place, of the treatment to be pursued in purifying the drying-establishments on shore: The conditions of life of the *Clathrocystis* are such that it could be killed by a temperature equal to that of boiling water, by applications of strong solutions of carbolic acid, of the mineral acids, &c. As a matter of fact, however, it is very doubtful whether the application of boiling water or of steam, if possible, would be serviceable. It is difficult so to saturate the different parts of a drying-house with boiling water as to be sure that the different parts have really been raised to the boiling point. Generally a great part of the wood-work fails to reach anything like a temperature of 212° F. The application of carbolic acid, or the mineral acids, is expensive and troublesome, and, unless judiciously managed, the remedy might prove worse than the disease. What is wanted is some means so simple that it can be applied without trouble and without much expense. It is useless to try to eradicate the trouble completely; one can only expect to diminish it perceptibly; and for the purpose I can think of no practical way better than scraping, painting, and frequent washing with hot water. In midsummer the houses used for curing fish are not always kept as clean as they should be. Unpainted wood is generally used, and every one knows how difficult it is, by

washing, really to clean wood which has been softened by the action of salt substances. The wood-work of all kinds, floors, walls, &c., should be thoroughly scraped several times a season. At present this is not the case, for one sees at Gloucester many gratings on which wood-mosses (lichens) have begun to grow, and even attained considerable size, proof positive, to any one who knows how slowly such plants grow, that no thorough scraping nor cleansing has been attempted for a long time. I should recommend that everything made of wood used in the curing should be painted at least once a year with white paint, and that it should be washed at frequent intervals with hot water. It is easier to paint than to scrape wood, and wood-work which has been painted white can be cleansed by washing with hot water with a thoroughness which is never the case with unpainted wood. Rough, unplanned wood should never be used, as the roughnesses are sure to be filled with a growth of *Clathrocystis* in course of time. Everything should be smooth and painted, so as to give as little possible chance for the lodgment of foreign matter, and so that washing can be surely and quickly accomplished. Iron or metallic instruments, of course, should be frequently washed and scoured, but I am inclined to think that the cleanliness of these is better cared for than in the case of wood-work.

With regard to the fishing-vessels themselves, apart from the salt which is used (which will be considered presently), not very much can be said. They are not generally exposed to as high a temperature as the wharves and buildings, and in them the *Clathrocystis* does not often develop to a marked extent. What has been said about the painting and scraping of wood-work applies, however, with practical modifications, to vessels, but, of course, at sea one cannot be as neat as on land.

There remains the important question with relation to the salt used. As I have before said, I have carefully examined specimens of Cadiz and Trepani salt, and I have no reason to suppose that the specimens examined were other than fair samples of what are in general use by fishermen. Microscopic examination shows conclusively to my mind that the Trepani is more free from impurities, and that the Cadiz salt contains a decided amount of the *Clathrocystis*, which, when communicated to the fish, is so detrimental to its sale. Judging from the examination which I have made, I should certainly advise the use of Trepani salt as less likely to produce the redness in the fish themselves. I have no means of ascertaining how the amount annually saved by using Cadiz salt instead of Trepani compares with the amount annually lost by the "red fish." If it is the case that more is saved by the use of Cadiz salt than is lost by the unmarketableness of "red fish," then, of course, it will be useless to advise the use of Trepani salt.

I have delayed transmitting to you my report in the hope that I might learn something concerning the prevalence of "red fish" in Europe, but having made numerous inquiries without obtaining any information having any economical bearing, I present the results at which I have

arrived from my own examination of the subject, without being able to add to it the results of the experience of others. The question, after all, is one of dollars and cents, but looking at it abstractedly, as I have been obliged to do, I think that my statement of the cause of the trouble and of the examination of the two kinds of salt most generally used should furnish useful hints to those who, from their occupation, are most directly interested in the matter.

Yours, respectfully,

W. G. FARLOW.

CAMBRIDGE, MASS.,

June 22, 1879.

NOTE.—With regard to the presence of *Clathrocystis roseo-persicina* in salt coming from the Mediterranean, perhaps the following may have some significance: In the *Annales des Sciences Naturelles*, series 2, vol. 9, p. 112, is an article entitled “Extrait d'un Mémoire de M. F. Dunal, sur les algues qui colorent en rouge certaines eaux des marais salins Méditerranéens.” In this article an attempt is made to explain the presence of a red substance in the salt works at Villa Franca. M. Dunal denies that the redness is owing to the remains of the crustacean *Artemia salina*, and maintains that the redness is due to a minute plant, *Protococcus salinus* Dunal, found in the bottom of the tanks. It is not impossible that the *P. salinus* of Dunal may be what is now known as *Clathrocystis roseo-persicina*. The development of the last-named species has occupied the attention of several botanists and zoölogists, and the reader interested in such matters is referred to Cohn's *Beiträge zur Biologie der Pflanzen*, vol. 1, part 3, p. 157, and to an article on “A peach-colored Bacterium,” by Prof. E. Ray Lankaster, in the *Quarterly Journal of Microscopical Science*, vol. 13, new series, p. 408, and to articles by the same writer in subsequent numbers of the same journal.

Besides the *Clathrocystis* which was found on the red codfish at Gloucester, another form of microscopic plant was observed, which deserves at least a passing notice. Small colonies of cells, destitute of coloring matter and arranged in fours, were not unfrequent on the infected codfish. The absence of color and the arrangement of cells in fours at once suggests the genus *Sarcina*, of which *S. ventriculi* is found in the fluids vomited in certain diseases of the stomach, in the lungs, and occasionally in other tissues. The species in question, however, differs materially from *S. ventriculi*. The individual cells are larger and the colonies are irregular in outline and not arranged in regular cubes as in *S. ventriculi*, nor does the membrane inclosing the cells contain any silicate, as is said to be the case in that species. Treated with strong acids, as nitric acid, the cells at once expand and soon disintegrate. On seeing the species on codfish, the first thing that struck me was the strong resemblance which it bore to *Glæocopsa crepidinum* Thuret, except in the absence of coloring matter. The *Glæocopsa* is common on the wood-work of wharves at Gloucester near high-water mark, and it might easily have been com-

municated to the fish. When growing and in good condition, however, it always has a brownish or yellowish-brown color. The species on codfish was always colorless, and yet it seemed to be alive and in good condition, and I am inclined to reject my first belief that the form was a discolored *Glæocopsa crepidinum*, but think it rather an undescribed species of *Sarcina*. My stay at Gloucester being short, and having other things which demanded my attention, I was unable to make any continued observation on this curious form, which may be described as follows:

SARCINA ? *MORRHUÆ* n. sp. *Cells colorless, cuboidal, 5-8^m in diameter, united in fours and surrounded by a thin hyaline envelope. Colonies 10-20^m in diameter, formed by division of the cells in three dimensions. Colonies heaped together in irregularly-shaped, lobulated masses.*

HAB.—On putrifying codfish, in company with *Clathrocystis roseo-persicina*, Gloucester, Mass., September, 1878.