relation is an important one, and that, during normal ripening, an enzymatic agent is at work effecting the coagulation. If this be true, the rôle of carbon dioxid may be less direct than above indicated, and that its business lies in hastening the secretion or the activity of the responsible enzyme.

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FUNDULUS AND FRESH WATER

In a series of papers[1] published in 1906 and 1907, I presented the results of experiments in which fishes of a number of species (particularly *Fundulus heteroclitus*) had been subjected to various modifications of the salt content of the containing water and to various other abnormal conditions. Contrary to the previously published statements of Loeb[2] and of Garrey,[3] I found that in the great majority

[1] *Biological Bulletin,* May, 1906; Bulletin of the Bureau of Fisheries for 1905 (May, 1906); *American Journal of Physiology,* June, 1907. Further data were reported in a paper before the seventh International Zoological Congress in 1907 (to be published).

[2] *American Journal of Physiology,* Vol. 3, 1900, pp. 327–338. I regret to say that my criticism of this writer was framed in language which, though not intended offensively, I now recognize to have been in poor taste.

[3] *Biological Bulletin,* Vol. VIII., 1905, pp. 257–270.

of cases *Fundulus heteroclitus* died, either in distilled water or in ordinary fresh water, drawn from the water supply of New York or of Woods Hole. In my own experiments with healthy adult fishes, placed in ordinary "tap" water, death commonly occurred after an interval of from one day to two weeks, although individuals frequently lived for a considerably longer period, sometimes as long as they were kept under observation. In some of the experiments the earliest deaths occurred too soon to make it possible to attribute them to bacterial or fungous disease, while in the great majority of fishes there was no visible evidence of such disease to the last.

I have been very careful to avoid making the claim that *Fundulus* of this species could not, *under any circumstances,* live for an indefinite period, either in fresh or distilled water. Indeed, as regards the former, I cited trustworthy reports of cases in which this fish had become landlocked in ponds, etc., probably through a slow process of acclimatization. I have, however, laid emphasis upon the fact that adult specimens *do commonly* die within a few days after transfer to water entirely devoid of their accustomed salts. From recent conversations with Professor Loeb, I am led to understand that this has likewise been his own experience.[4] Indeed, in a paper[5] published during the present year he distinctly affirms that only five per cent. of his grown individuals show sufficient powers of resistance ("diese grosse Widerstandsfähigheit") to live for five weeks in distilled water. On this point, then, the difference between us seems to be merely a matter of emphasis. Loeb, for his purposes, has laid stress upon those cases in which the fishes have survived; I have laid stress upon the fact that, except for brief periods, they commonly do not survive.

In itself, it would seem to be a matter of small scientific importance whether or not any given species of fish can be transferred with impunity from one medium to another. We all know that some fishes can, while many can not, endure such a transfer. But since the experiments, both of Loeb and myself, in this field, have dealt very largely with the question whether or not this particular species would survive various experimental conditions which have been employed by us, it is of considerable importance to recognize its *ordinary* behavior in fresh water.

In a recent article[6] already referred to, Loeb has made much of the fact that I admittedly used commercial distilled water in my experiments, and would clearly have his readers believe that the death of the fishes in these experiments was due to impurities in the water. It seems hardly necessary for me to state that my use of water of this sort was deliberate and was done with a full knowledge of the fact that ordinary distilled water has been found harmful to some organisms. I used this sort of water for the simple reason that I was not, at the time, in a position to obtain sufficient quantities of chemically pure distilled water. I believe, however, that the validity of my results was not affected by the character of the distilled water employed, and this I hold for several reasons: (1) These fishes likewise died in ordinary "tap" water, in which true fresh water species lived perfectly well. Loeb's suggestion that disease germs may have caused the deaths in such cases is negatived by the fact that death oftentimes occurred within less than a day. (2) The baneful effects both of the distilled water and of the tap-water were abolished by the introduction of a very small percentage either of sea-water or of pure NaCl, as will be pointed out below.[7] (3) I must repeat Loeb's own ad-

[4] If I am mistaken in this, I trust that Professor Loeb will set me right.

[5] *Archiv für Entwicklungsmechanik,* Bd. 31, 1911, pp. 654–657.

[6] *Archiv für Entwicklungsmechanik* (*loc. cit.*).

[7] Here an appeal may be made to the antagonistic effect (discussed below) of the salts of sea-water upon various poisons, it being assumed that the distilled water had been contaminated by some metallic poison. Such an assumption could not be made, however, in the case of the tap water used, while the action of the NaCl in the two cases seems to have been identical.

mission, contained in the same paper in which he criticizes me, that all but five per cent. of the adult *Fundulus* died in his "double distilled" water. Why, then, assume that the water employed by me contained poisonous impurities? (4) Weighty evidence upon this same question is already afforded by an experiment which I have only recently commenced. At the date of writing this paragraph (Dec. 12), I have kept in distilled water for seven days eighteen specimens of *Fundulus heteroclitus,* taken from a fresh water stream and consequently habituated to the latter medium. The distilled water was prepared in an ordinary metal still. The fishes nevertheless all appear to be in perfect health, and no deaths have occurred in the lot since the first day, when two fishes died from causes having no bearing upon the present problem. This result is significant in comparison with that which had been obtained when salt-water specimens were used. The final outcome will be reported upon later.

As bearing on the question of the "protective" action of various salts, it may be relevant for me to point out that in 1906 I described experiments demonstrating the remarkable efficacy of even small percentages of sea-water in counteracting the fatal effects of fresh water upon *Fundulus.* I later showed[8] that this proportion need not exceed one part of sea-water to a hundred of ordinary fresh water. Experiments in which pure NaCl was employed, dissolved both in distilled water and in fresh ("tap") water, showed that this salt, in concentrations of 3 to 15 grams per liter (in some cases three tenths gram per liter), may preserve the lives of the fishes for three or four weeks or longer. Fishes kept in pure tap water, under otherwise similar conditions, all died within comparatively few days.

The fact that this fish will *endure* pure NaCl, in "very weak solutions," is now fully admitted by Loeb himself,[9] but he still appears to overlook the fact that, in such low concentrations, the salt in question is far from being a poison, but frequently preserves the fish from destruction.

Furthermore, we surely can not regard 15 grams per liter (a concentration tolerated by many of my fishes) as a "very weak solution." Indeed, it is roughly an $M/4$ solution, or one of more than half the concentration in which this salt occurs in sea-water.[10] Experiments in which sodium chloride was used in about the same concentration as in sea-water resulted in the death of all the (30) fishes used in from two to fifteen days.

In summing up this part of the discussion, I can but repeat my earlier statement that "In addition to such a toxic effect, however, the sodium chloride certainly has a potent *anti*-toxic effect, since, even in solutions which proved fatal, the rate of death was usually much lower than in pure fresh water. *In the aggregate, these experiments may be held to prove, therefore, that pure sodium chloride, in certain proportions, has nearly (if not quite) the same efficacy in counteracting the fatal influence of fresh water upon Fundulus heteroclitus as does the combination of salts contained in sea-water.* My previous experiments have abundantly proved, I think, that the action of this salt is not an osmotic but a chemical one" (1907, p. 73).

In a section of considerable length, entitled "The Toxicity of Certain Poisons as Affected by the Salinity and Osmotic Pressure of the Medium," I pointed out, among other things, that certain metallic salts (*e. g.,* copper chloride and sulphate, and mercuric chloride)

[8] *American Journal of Physiology* (*loc. cit.*, particularly pp. 68, 72, 73).

[9] *Archiv für Entwicklungsmechanik* (*loc. cit.*); also SCIENCE, November 17, 1911.

[10] Referring to some of his experiments with young *Fundulus,* Loeb tells us (SCIENCE, *loc. cit.*): "I succeeded in showing that as long as the sodium-chloride solution is very dilute and does not exceed the concentration of $M/8$, the addition of KCl and $CaCl_2$ is not required. Only when the solution of NaCl has a concentration above $M/8$ does it become harmful and does it require the addition of KCl and $CaCl_2$." The difference between Loeb's results and my own—of which last Loeb does not seem to be aware—may be due to the difference in the age of the fishes employed.

were more toxic in fresh water than in certain strengths of salt water, and this *even to fresh-water fishes.* One obvious interpretation is that these poisons were merely neutralized chemically by the ingredients of the sea-water, outside of the body of the fish, but this explanation is rendered improbable by a variety of considerations which can not be discussed within the limits of the present article.

The employment of pure NaCl, instead of sea-water, in these last experiments, would not probably have affected the outcome, if we may judge by recent work of Loeb, in which he found that the poisonous effect of zinc sulphate upon *Fundulus* eggs was neutralized by the former salt.

Loeb's assertion that "salts alone have such antagonistic effects" certainly does not apply to adult fishes. I need only call attention to the fact that cane-sugar solutions of certain strengths were found by me to very clearly defer the fatal action of the copper salts, both upon *Fundulus heteroclitus* and upon certain fresh-water species. It had first been ascertained that cane sugar did not, in any concentration, take the place of sea salts or of sodium chloride in prolonging indefinitely the life of *Fundulus.* Whether or not these facts can be brought into harmony with Loeb's "tanning" hypothesis, I do not pretend to know.

And now, while I am unearthing some of these long-buried records of the past, I can not refrain from repeating one of my articles of faith therein expressed:

> The writer is not in the least in sympathy with the tendency, so often manifested, to explain the most complex of natural phenomena by a few simple chemical or physical formulæ. If the principles which I have invoked [referring to certain tentative hypotheses] operate at all in the way in which I have supposed, they operate in conjunction with other principles so obscure and complex that a complete solution of these problems is certainly very far distant.

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U. S. BUREAU OF FISHERIES,
WASHINGTON, D. C.,
November 28, 1911

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE 74th regular meeting of the society was held at the Cosmos Club, Tuesday, October 10, 1911, at eight o'clock P.M. In the absence of the regular officers, Dr. Albert Mann presided. Twenty-five members were present.

The following papers were read:

The Wilting Coefficient for Different Plants and its Indirect Determination: Dr. L. J. BRIGGS and Dr. H. L. SHANTZ. (Presented by Dr. Shantz.)

The Forest of Arden, a Dream: H. C. SKEELS.

The Forest of Arden is a 300-acre tract of native woodland, three miles east of Joliet, Ill., in the valley of Hickory Creek, and forms a part of the 2,000-acre estate, Harlow-Arden, of Mr. H. N. Higinbotham, of Chicago. The creek is dammed in three places, with locks through the two upper dams, giving a mile and a half of boating. Five miles of gravel drives have been laid out, the purpose being to display the landscape beauties of mixed meadows and woods to the best advantage. Along these drives, beginning with the ferns and following the accepted sequence of plant families to the composites, there has been planted a botanic garden of 2,000 species, room being left for as many more.

Each species is located by its place in the sequence, and by a map, cross-sectioned to square 100 feet on each side, accompanied by an index giving the plant names and the number of the square on which each will be found. There are no formal beds and no labels, but the species are there, to be seen by those interested.

The eleventh annual business meeting of the society was held on Tuesday, October 24, 1911. Officers were elected as follows: *President,* W. A. Orton; *Vice-president,* A. S. Hitchcock; *Recording Secretary,* Edw. C. Johnson; *Corresponding Secretary,* W. W. Stockberger; *Treasurer,* F. L. Lewton. The executive committee reported an active membership of 104, there having been nineteen accessions during the year.

The 75th regular meeting of the society, held November 14, 1911, in conjunction with the Washington Academy of Sciences, was devoted to a lecture by Dr. W. L. Johannsen, of Copenhagen. The subject of the lecture was "Heterozygosis in Pure Lines of Beans and Barley."

The 76th regular meeting was held at the Cos-