ing. And the experimental results apparently contained considerable evidence that was not deduced from them, concerning some of the most fundamental questions of physiology. For example, it is not very useful to know rates of water or nitrate absorption from a soil as the authors express these, but it would be very enlightening to have these data expressed on the basis of the soil volume, or simply as absolute weights. What I have in mind, in this instance, is the question whether the solvent water of the soil solution carries the solute nitrate into the roots at its own rate of capillary or imbibitional flow, or whether the nitrate enters more or less rapidly than its solvent. A little more logical analysis and more attention to the deeper and somewhat hidden meanings implied in the experimental results might have strengthened the presentation very much. These suggestions are not made here, however, as serious adverse criticisms of the book I am reviewing. They are introduced, rather, with the idea that they may be a bit helpful in preparing the way for studies that will carry our knowledge of root ecology far beyond the present conceptions of any of us. The experimental methods employed by the authors involve essentials that are very promising indeed, and the results here published form an excellent beginning toward the illumination of one of the darkest corners of physiological ecology.

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SPECIAL ARTICLES

SOME ALGAL STATISTICS GLEANED FROM THE GIZZARD SHAD

IN a recent paper[1] the writer called attention to the desirability of using the gizzard shad, *Dorosoma cepedianum* Le Sueur, as collectors of the plankton algæ. These "living tow nets" do not get caught on snags and roots, the string does not break, and the algal collection is very representative of the body of water from which the fish were taken. It is necessary only to catch the young fish and examine their stomachic and intestinal content to secure a proportionate concentrated sample of the plankton. In aquatic areas where the gizzard shad are common these fish are well worth considering as aids in the collection of the plankton algæ.

Through the courtesy of its director, Dr. Stephen A. Forbes, the laboratory of the Illinois State Natural History Survey sent me some months ago several specimens of gizzard shad, collected in certain streams and ponds of Illinois during the late spring and summer of 1899 and 1900. Rather extensive collections of gizzard shad from Ohio, made during the summers of 1920 and 1921, gave some interesting statistics regarding the distribution and abundance of the non-filamentous algæ in various localities of the state. A comparison of the results of an examination of the stomachic and intestinal content of the fishes from Ohio and Illinois reveals similarities and differences in the algal flora of ponds and streams of the two states and in addition warrants some conclusions concerning the algal food of the gizzard shad in general.

1. The total number of species and varieties in an identifiable condition in the gizzard shad from the two states is a hundred and fifty. Very nearly identical forms indicate the phytoplankton similarity of the habitats from which the fish were taken.

2. The amount of mud present in the digestive tract is in some cases considerably more abundant in the Illinois fishes. It is not, however, in either case a matter of selection on the part of the fish but rather a direct function of the number of suspended mud particles present in the water, *i. e.*, it depends upon what enters with the water as the fish swims along with its mouth open.

3. Diatoms are relatively much more abundant in the Illinois fishes than in those taken in Ohio. When a microscopic mount is made of the intestinal content of some of the Illinois specimens, little else except diatoms can be seen. In this connection one might almost improve upon the epitome of Dr. Mann:[2] "No diatoms, no hake," for in that case it was necessary to have herring and copepods as

[1] *The Ohio Journal of Science*, 21, No. 4, p. 113, 1921.

[2] *Ecology*, 2, No. 2, p. 79, 1921.

intermediaries. Here, however, is a chain of two links, obviating the necessity of the "middle man," and five words tell a complete story: "No diatoms, no gizzard shad." In some fishes from Ohio another story is told by changing diatoms to *Pediastrum;* still another, if one puts in *Scenedesmus;* for most of the young fishes examined the complete story reads: "No phytoplankton, no gizzard shad."

4. Flagellate forms, species of *Euglena* and *Phacus* in particular, are less common in the Ohio fishes.

5. The relative abundance of the different forms of the phytoplankton of the bodies of water is revealed by the algal content of the gizzard shad found there.

6. In general, algal species belonging to the order *Protococcales* form more commonly a larger portion of the food of the gizzard shad than do either flagellates or diatoms. Sometimes, however, the condition is reversed; but this is apparently purely a matter of the plankton content of the water.

7. The fewness of the zooplankton forms is somewhat less marked in the specimens from Illinois than in those from Ohio. This may again be due to the predominance of the phytoplankton over the zooplankton in the localities where the fish were obtained.

8. The paucity of stream phytoplankton in comparison with that of ponds and lakes is shown by the relative algal content of the digestive tract of the gizzard shad taken from running and quiet waters. The excessive diatom content of stream water at certain periods—producing the so-called "pulses" of Kofoid[3]—when there is a marked rise in temperature is only temporary and may be explained, as Professor Transeau suggests, by the rapid dissolving of the mucus and a consequent breaking up of the chains and colonies of diatoms. This usually takes place in the small tributaries where the individual diatoms are thus freed from their places of attachment; and the main stream is merely the recipient of the contribution, not the source of the sudden "pulse."

9. There is a continuation of the above story in which the gizzard shad plays an important rôle: it feeds the game fishes, and the game fishes feed man. Thus, the gizzard shad is making useful for man the energy stored in plant forms which occupy no land areas, which do not interfere with the ordinary disposition or utilization of bodies of water (except the occasional contamination of water for drinking purposes by some algæ), which involve no labor of cultivation on the part of man, and which are of no value for direct human consumption.

10. The world's population in the last hundred years has increased about 150 per cent. Along with this increase has had to come a corresponding increase in the world's food supply. One of the ways in which this necessity has been met is the securing of new acres of soil in which to grow crops. It is easily seen, however, that there is a limit to new acreage. In the future, therefore, we may have to turn more of our attention to the cultivation of the waters for food supplies. We may have to develop an industry of aquiculture as we have developed an industry of agriculture. The time is rapidly approaching when fish will be more highly prized as food and more extensively used than now. As that time comes, the cultivation of algæ will be a first step toward greater fish production. A second step may be the introduction of fish like the gizzard shad into fish ponds and lakes to make more readily available the phytoplankton for fish food.

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[3] *Bulletin of the Illinois State Laboratory of Natural History,* 6, pp. 226, 569, 571, 1903.

THE SEX CHROMOSOMES OF THE MONKEY[1]

PREVIOUS studies on the spermatogenesis of the opossum ('22) and on man (in press) have

[1] Contribution No. 159, Department of Zoology, University of Texas. The present work has been aided by a grant from the National Research Council—Committee for Research on Sex Problems. In view of the crowded condition of our journals which greatly delays publication, the author is presenting in this brief way the essential facts of general interest to biologists. The completed study will give the detailed evidence. Painter, T. S.: 1922, "The Spermatogenesis of the Opossum," *Journ. Exp. Zool., Vol.* 35.