of oyster culture, and, by the education of the community, to hasten the time when wiser laws will render our natural advantages available for the benefit of our people.

The most economical method of constructing floats must, of course, be determined by practical experiments, but a float constructed by connecting two old ship-masts together by string-pieces, with a bottom of coarse galvanized iron netting, would have sufficient buoyancy and enough resistance to water to support a large quantity of submerged shells and oysters for two or more seasons, and a coating of copper paint each year would protect the timbers from worms.

The floats should be open at the ends, to permit free circulation, and they should be moored in such a way as to swing with the current.

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### 131.—SOME OF THE LIFE-NEEDS OF FISH.*

**By Dr. OTTO ZACHARIAS.**

Water is the main condition of the life and well-being of fish. The water should contain food in the shape of infusoria, snails, worms, and insect larvæ, but people trust to kind nature to furnish a constant supply of these. In the vast majority of cases this confidence is somewhat well placed, but as a general rule nature will supply only the absolute needs. If a good harvest of fish is to be a certainty, the needs and habits of fish should be thoroughly studied, and care should be taken to remove everything which will interfere with these needs and habits.

Fish breathe through their gills, which consist of four double rows of cartilaginous leaflets. The blood-vessels distributed through them give to the gills a bright red color. Four bony arches support the double lamellæ, which exercise their important functions under a piece of horny skin called the "gill-cover." For the purpose of breathing the fish passes water into the branchial chamber; here it comes in contact with fringe-like leaflets, which it supplies with oxygen. The water makes its escape by the gill-opening. If you take a fish out of the water its breathing process is interrupted, the gill-leaflets begin to shrink, and become dry, when they are unable to absorb the needed air from the atmosphere.

Any one who has carefully examined the gill-fringes of a whiting or pike must be convinced that these tender organs will be injured by muddy or impure water, just as our lungs are injured by inhaling bad air or air filled with particles of dust. The first point to be observed, therefore, should be to prevent water, in which fish are to be kept, from becoming impure by the refuse from factories, mines, &c. Refuse floating in the water will exercise some chemical, but principally a mechanical, influence by constantly irritating the respiratory organs. In this

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* "*Ueber die Lebensbedürfnisse der Fische.*" From *Mittheilungen des Westpreussischen Fischerei-Vereins*, No. 5, Dantzic, March 4, 1886. Translated by H. JACOBSON.

respect the refuse from wood-turning establishments must be considered as dangerous, for the fine particles of wood-fiber will easily adhere to the gills and form a basis for fungous growth. This may easily affect the entire fish, and if a river contains a great quantity of small particles of wood-fiber, there is danger that all the fish in it will perish. Trout are particularly liable to be affected by this kind of refuse, and many cool and clear brooks would contain a much larger number of these fine salmonoids if there were fewer paper factories and wood-turning establishments in their valleys. If the refuse contained in the water is not of a soft and flaky character, but is hard, the fish are exposed to hurtful influences of another kind. One of our most prominent zoologists, the late Professor Von Siebold, of Munich, has proved that fish kept during continued rainy weather in a fish-tank, through which passed the water of a brook rendered impure by mud containing small particles of quartz, became totally blind. In this case the constant mechanical irritation produced by small particles of quartz had caused inflammation in the eyes of the fish. They had also received actual injuries in their gills.*

It will be evident that water, as well aerated as possible, and as clear as possible, is the first and self-evident condition required wherever rational fish-culture is to be carried on. The water, however, is not merely the medium of breathing, but is the bearer of food to the fish. If they are to prosper and increase they need a superabundant quantity of food, consisting mainly of living organisms. These in turn need food themselves. But this can be furnished only if the banks are fringed with aquatic plants and if the mud settling at the bottom contains a great deal of humus, so that it may form a food-supplying substratum for numerous microscopic algæ (*Desmidiaceæ*, &c.). All the numberless infusoria and lower crustaceans (varieties of *Cladocera* and *Cyclops*) contained in our waters find their food in this microscopic vegetation, and are, therefore, directly dependent on it. As the young fish live principally on the above-mentioned crustaceans and infusoria, it is evident that anything which causes a decrease in the vegetation of the waters (beyond a certain degree) must exercise an injurious influence on the life and increase of fish. The various organisms in nature are dependent upon each other to a wonderful and complicated degree, and the great in nature is by various ways and means connected with the smallest. When we see refuse and impure fluids from a factory pass into the beautiful clear water of a brook, we think in the first place only of the direct injuries to which fish will thereby be exposed. But the indirect injuries are much greater, because they extend not only to the present generation, but to the organic conditions of life, which, if endangered, will make it questionable whether any fish will in the future be able to live in such water. By the settling of insoluble mineral particles at the bottom of a river its microscopic vegetation is gradually killed, and the

* From a valuable pamphlet on the pollution of water, by Dr. Leuckart, the famous Leipsic naturalist, published by Friedrich Schell, Kassel, 1886.

immediate consequence of this will be that those animals which live on fresh or decayed vegetable matter will disappear. In consequence of this the young fry, if any is raised, is insufficiently fed, and comparatively few fish reach sexual maturity. In this way the fish of our brooks and rivers are constantly decreasing, and, as we have seen, from natural causes, which can be misjudged only by persons who have never studied the needs of fish.

The degree to which the abundance of fish in large water areas is dependent on very small (partly microscopical) animals, which entirely escape the attention of the casual observer, may be observed in the large diluvial lakes in the north of Germany. Last summer I investigated the waters of Holstein, Mecklenburg, and Pomerania, and am able to state, as the general result of my investigations, that those lakes which, among the rural population, had the reputation of being particularly rich in fish were also particularly rich in crustaceans, worms, and infusoria. With a fine gauze net one can in a few minutes catch myriads of small crustaceans and rotifers, so as to cover the bottom of the net to the depth of over an inch with a thick mass consisting entirely of diminutive animals. A person who has not seen the great mass of these little animals brought up at a single haul has no idea of the enormous quantity of living beings contained in a lake with an area of several square miles. An inexhaustible wealth of life moves in the clear waters of such a basin; and in exact proportion to the quantity of small crustaceans and infusoria will be the product of fish.

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### 132.—CALIFORNIA TROUT FOR THE OZARK MOUNTAIN REGION.

**By MARSHALL McDONALD.**

This species (*Salmo irideus*), which inhabits a restricted geographical range on the west coast, has been largely introduced into the streams of the Eastern and Middle States through the agency of the U. S. Fish Commission. In the spring of 1880, 10,000 eggs of this species were allotted to the Missouri Fish Commission. These were hatched out at the State hatchery and the fry planted in the headwaters of the Gasconade, Osage, and other streams of Southwest Missouri, having their sources in the clear, cold, large flowing springs that abound in the Ozark Hills. Three thousand were planted in the headwaters of Spring River, a tributary of the Arkansas.

A careful inspection of the stream, made in the summer of 1885 by the commissioner of Missouri and others who were familiar with the appearance of the rainbow trout, showed the presence of at least three generations resulting from the original plant. The largest in size weighed between 4 and 5 pounds; those of the second size measured from 15 to 17 inches in length; while the sources of the stream swarmed with thousands of the young from 4 to 5 inches in length.