58.—THE KEEPING OF SALMONIDÆ FOR PURPOSES OF EXHIBITION.

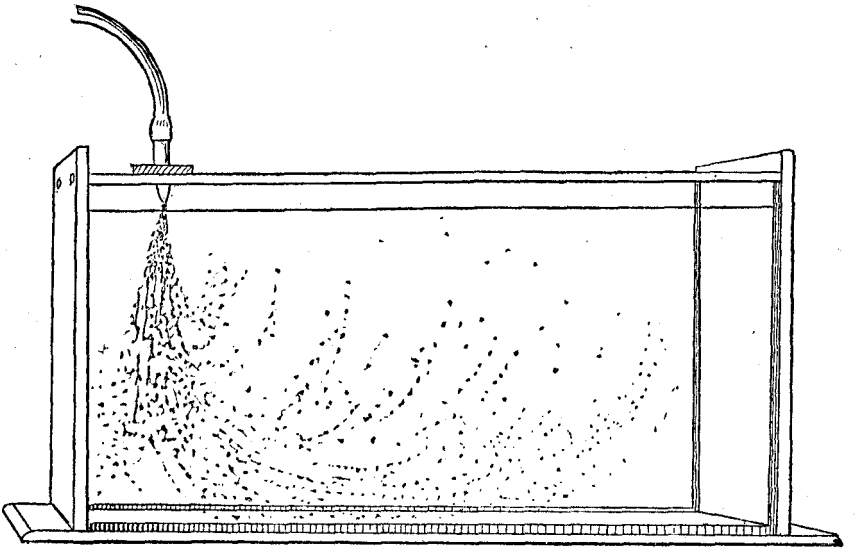
By WILLIAM P. SEAL.

Exhibitions of live specimens of the salmonidæ in aquaria, except during the winter months, are so generally attended with great expense, from the supposed necessity for a low temperature and the consequent use of a large amount of ice, as well as the expenditure of much care and labor, that they are considered as not being worth the outlay. Some recent experiments at Central Station, Washington, and in connection with the exhibit of the U. S. Fish Commission at Cincinnati, have demonstrated that all the members of the trout family may be kept much more easily and at a much higher temperature than has been supposed.

It is well known that water takes up and retains in suspension atmospheric air in direct accordance with its temperature. Water is said to be capable of holding in suspension for each 16° of lower temperature about double the volume of air, so that inversely the expulsion of half the volume of air in a given quantity of water would follow a rise of 16° of temperature. This, then, is the cause of the necessity for keeping salmonidæ at a low temperature—as ordinarily kept in limited quantities of water not aerated as in nature by tumbling over rocks and falls and swirling rapidly about, drawing in large amounts of air—the fact that the water does not contain enough air to satisfy their necessities.

The experiments mentioned consist simply in a change in the method of water supply, by which, with the use of a small amount of water, a large proportion of air is introduced well dispersed in very minute bubbles, in which shape it is rapidly absorbed by the water. The method consists in the use of very fine nozzles of from one-sixteenth to one-eighth inch orifice. The point of the nozzle is fixed close over the surface of the water either straight or obliquely. The stream of water impinging on the surface of the body of water in the tank, with force, carries in with it a large amount of air, which is very minutely divided and dispersed, thus keeping the water well charged with air. This of course requires force, which is always available where there are systems of water-works. Elsewhere it would be necessary to have an elevated tank and some means of pumping water thereto to get the necessary pressure. An elevation of 20 feet will give sufficient pressure to force a one-sixteenth-inch stream of water to the bottom of a body of water 3 feet deep. A number of such streams might be found necessary, varying with the size of the tank, the number or kind of fish, etc. In an ordinary-sized aquarium tank, say 18 by 18 by 48 inches, or 24 by 24 by 48 inches, one, or at most two, streams would probably be found sufficient. The large amount of air thus constantly forced into the water gives the fish the needed supply of oxygen at a comparatively high

temperature, which is apparently more enjoyable to them than a lower one, as they are undoubtedly more active and playful. By this means trout may be kept at a temperature of 70° without noticeable discomfort to them, although, perhaps, 60° to 68° is a safer and surer limit, in view of possible accidents. The accompanying figure will illustrate the method in question.



The great efficiency of this method of water supply over any other has been fully demonstated in the keeping of marine fishes at the marine station of the Commission at Wood's Holl, Mass. Many marine species require even more oxygen than the salmonidæ, and thus the system has received substantial tests, and can be confidently recommended not only on account of the introduction of a large amount of air and a saving of ice and labor, but on the score of economy of water also, which is very often a matter of considerable importance. When the temperature rises above 70° it can be cooled by introducing the necessary amount of ice directly or by passing the water through a coil of pipe surrounded by ice. The retardation of the stream of water by the use of the very small nozzles gives it ample time to cool, and it can be brought down to a very low temperature. As ordinarily used the pipe coil has been a failure, because the water passed through it too rapidly to be cooled. At the Cincinnati Exhibition the water in an aquarium tank 18 by 18 by 48 inches was kept at a temperature of 48° by passing it through 70 feet of one-fourth-inch lead pipe coiled in an ice-chest 18 inches square, and from that through about 30 feet of rubber tubing wrapped with newspapers, passing into the tank in a one-sixteenth-inch stream.

In changing trout from iced water to aquaria operated in this way it

would be necessary—at all events safer—to bring the temperature up gradually.

At the Cincinnati Exhibition the temperature was raised from 59° to 70°, a change of 11° in the course of five or six hours, without any noticeable effect, on a lot of brook, Loch Leven, and brown trout.

59.—AN INQUIRY AS TO THE PROPER METHODS FOR THE CARE OF LIVING THINGS HELD FOR POPULAR AMUSEMENT AND INSTRUCTION OR FOR PURPOSES OF BIOLOGICAL RESEARCH.

By WILLIAM P. SEAL.

The object of this paper is simply to provoke inquiry as to the proper methods of confinement and treatment of living things—aquatic or terrestrial—whether held simply for popular amusement or for the higher purpose of biological research.

The subject of biological research is one of rapidly-growing importance. Aside from the demands of specialists for facilities for pursuing their investigations, the value of such work in the interest of general education is meeting with wide-spread public recognition, and it is now only a question of time when extensive aquaria and vivaria will become important and necessary adjuncts to the biological laboratory.

In the more practical domain of fish-culture there is a great and as yet untouched field and vast possibilities in the introduction and acclimation of foreign fishes and in experiment leading to the possible transfer of valuable salt-water species to fresh water by gradual change of density, as well as the opportunity for the study of their complete life histories.

Candor compels the acknowledgment that a retrospective review of the scientific results attained through the media of zoological gardens and large aquaria generally, since their first establishment, would show nothing commensurate with the immense outlay involved, and it is a question in the minds of many persons of experience in such matters whether better results are possible. The writer has arrived at the conclusion that nothing better can be expected under existing methods.

As before suggested, the object of this paper is simply to provoke discussion, leading, if possible, to the establishment of other and better methods. The observations of the writer upon animals held in confinement have led him to the conclusion that for purposes of biological research—involving the normal discharge of the natural functions—psychological influences must be taken into consideration as well as those of a purely physical nature, the one having a direct bearing on the other. In other words, animals must be provided with homes adapted to their varied requirements, instead of being held in what can only be termed prison-pens.