

lation be applied, then, of course, a much larger quantity of water should be used, and it should be placed in a large shallow dish.

In connection with this subject a number of experiments were tried for the purpose of determining the length of time that unit weight of fish (1 gram) would live in unit volume (1 cubic centimetre) of unventilated water. Fish were weighed and placed separately in sealed jars, completely filled with a known volume of water and the length of time they lived was then carefully observed. The following was a typical experiment :—

Weight of fish, 76 grams; volume of water, 5530 c.c.; lived 6 hours. Therefore 1 gram weight of fish lived in 1 c.c. of ventilated water for about 5 minutes.

Ten similar experiments on rock bass of different sizes gave 7 minutes as the average time during which unit weight of fish could live in unit volume of unventilated water—the range being 5 minutes as the minimum, and 9 minutes as the maximum. The temperature of the tap water with which these experiments were conducted was 22° c. When the water was cooled down to 4° c. the fish lived for a shorter time. When the temperature was raised above 22° c. they lived for a *shorter* time.

These figures for duration of life in fish confined in a limited quantity of water are interesting when compared with those given by Paul Bert,* for mammals breathing a limited quantity of air. Five experiments by this observer gave 8 minutes as the average length of time during which unit weight of mammal (1 gram) lived in unit volume (1 c.c.) of confined or unventilated air. From these data it will follow that mammals use 5 or 6 times as much oxygen as fish in the same unit of time; life is more intense in the higher animals.

These experiments suggested the possibility of determining the smallest amount of water in which a fish of a given weight could breathe for many hours, or even several days, on the supposition that this minimum quantity could be kept perfectly ventilated. Of course a fish requires something more to maintain life than ventilated water. Free movement is essential, not to speak of food; but apart from these and similar considerations it seemed worth while to conduct an experiment or two on the respiration of fish in a minimum amount of water.

*"Leçons sur la phys. comp. de la respiration," Paris, 1870. Page 510, quoted in Schafers text book of physiology Vol. I., page 743.