

should be placed, and (2) the volume of water to be used in proportion to the weight of the fish. Should the dishes used be broad and shallow, or should they be tall and narrow? Should large quantities of water be used in proportion to the bulk of the fish, or should comparatively small quantities be used?

The answer to the first question was obtained by repeating the following experiment a number of times. Two rock bass (*ambloplites rupestris*) of equal weight were placed in separate vessels, each vessel containing  $3\frac{1}{2}$  litres of lake water. One vessel was an ordinary agate-ware baking pan,  $13\frac{1}{4}$  inches long,  $9\frac{1}{2}$  inches broad, and  $1\frac{1}{4}$  inches deep. The other vessel was a tall, cylindrical museum jar (external diameter 6 inches), the water in which stood  $8\frac{3}{4}$  inches high. The experiment began at 10 a.m. At 5 p.m. the one in the tall vessel was lying on its side in a dying condition. The next morning at 10 o'clock it was dead, while the fish in the shallow pan was quite lively. The same result occurred whenever this experiment was repeated.

Such experiments evidently show that ventilation or aeration of water is as important in fish respiration, as ventilation of air is in mammalian respiration. They show that ventilation goes on naturally and easily in the shallow water of a broad, flat vessel. In such a vessel a large surface of water is exposed to the air. As the oxygen dissolved in the water gets used up by the fish, fresh oxygen is absorbed from the air, the absorption being facilitated by the movements of the fish, which agitates the water and exposes a fresh surface to the air.

On the other hand, the water in a tall narrow vessel has a comparatively small surface exposed to the air, and a fish, usually lying at the bottom, does not agitate the surface so as to promote aeration of the water.

This experiment evidently explains how trout can live so well in a very small trout stream in dry weather, and also explains how minnows can be kept alive by turning them loose in water in the bottom of a fishing boat.

The second question, should large quantities of water be used in our experiments, is not so easily answered. The proper quantity will depend upon the extent of ventilation. If artificial ventilation be applied to the water during the experiment, then a relatively small volume of water will do. If no artificial venti-