from the possibility of observation, for the reason that observation itself requires transfer of physical influence (quanta) from one atomic system to another and eventually to the sense organs of the observer. The inner conditions determining the precise time and direction of any such transfer are themselves outside the range of possible observation. If we regard the physical as that which is externally or publicly observable (directly or indirectly), there would seem to be implied in such a view a transition to unknown factors of the metaphysical world. Since science aims, above all, at clearness and intelligibility, such a reference might seem inadmissible to many biologists. But we must not overestimate the finality of our present methods. Philosophical considerations have their place in science, although, as Needham everywhere insists, in the work of investigation itself reliance can be placed only on methods of precise and (where possible) quantitative observation and formulation.[2]

The presswork and bookmaking of these three volumes are admirable, and they are remarkably free from misprints. We have noticed a misplaced decimal on p. 793, where the isotonic concentration of a salt solution is given as 8.5 per cent. instead of .85 per cent.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A DEVICE FOR MEASURING THE MASS OF SMALL AQUATIC ANIMALS

IN the course of experiments concerning the density and growth of populations of certain small fishes (*Lebistes reticulatus* Peters),[1] it became desirable to obtain an accurate measure of the total mass of living material without injury to the specimens. The common method of estimating such a quantity, by means of noting the simple increase on introduction into a graduated measure partly filled with water, proved to be insufficiently accurate. This was chiefly because of the irregular introduction of drops of fluid which occurred if very small fishes were handled with sufficient rapidity to avoid injury.

In order to circumvent these difficulties, the device illustrated in Fig 1 was constructed. A reservoir "R" contains water identical in temperature and chemical condition with that from which the specimens to be measured were taken. A membrane filter "F," minus the membrane but retaining the perforated porcelain strainer, forms a receptacle for the fishes. These two elements are connected by a three-way cock "C" to a two-way burette "B." The measuring chamber of "F" is marked by two horizontal lines H_1 and H_2 which may be located at any convenient place. The volume contained in the chamber between H_1 and H_2 must be somewhat less than the capacity of the burette. The operation is as follows:

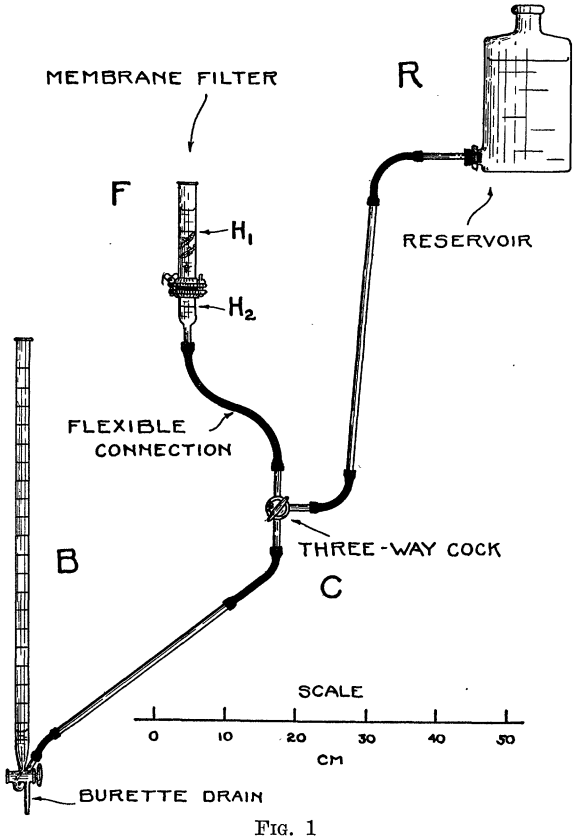

FIG. 1

Chamber "F" is nearly filled with water from "R" by means of cock "C." The fishes to be measured are introduced into "F." The water level in "F" is then lowered to H_1 by means of cock "C," the cock on the burette being in such a position as to be open to its connection with "C." There should be enough water admitted to the burette in this manner to allow it to rise to at least the first graduation. When H_1 has been reached, the burette cock is closed and a reading taken. Cock "C" is left open. The burette cock is now opened again, allowing the water to rise in the

[1] The specific problem on which this apparatus found its chief use was discussed under the title "A Preliminary Study of Population Stability and Sex Ratio in *Lebistes*," at the May, 1932, meeting of the American Society of Ichthyologists and Herpetologists, in Washington, D. C. This paper is to appear in an early number of *Copeia*.

[2] This is also Driesch's contention (*loc. cit.*, p. 70): "The sciences of nature with their rigorous method are the treasure of true knowledge."

burette and fall in the chamber "F." When H_2 is reached, cock "C" is quickly turned to connect "R" with "F." This cuts off the burette and returns the fishes to their native element quickly and with a single operation. The second burette reading may now be taken at leisure. By operating in this manner, the living material is removed from the water only an extremely short time, and in the species used no injurious effects have thus far been detected.

After the reading has been made and the fishes removed from chamber "F," by pouring out, the flexible connection between "F" and "C" allowing of this, the burette is drained through its other outlet by means of the lower cock and the device is again ready for operation. All parts except the reservoir "R" are mounted on a narrow vertical board, more compactly than shown in the diagram.

The second reading is subtracted from the first, the result representing the number of cc of fluid in the chamber "F" between H_1 and H_2 minus the mass of the fishes. Subtracting this figure from a "blank" run under similar conditions (representing the capacity of "F" between the two levels) the mass of fish in cc is obtained.

It is evident that this device could be applied to a wide variety of aquatic laboratory animals, and for many statistical purposes concerning such problems as growth, respiration, population concentration, *et cetera*. The degree of accuracy attainable is largely a matter of design. For very fine work, the burette "B" may be replaced by a chamber slightly smaller than chamber "F," on which may be mounted a microburette. The smaller the diameter of chamber "F" at H_1 and H_2, the greater accuracy attainable. This diameter, which must be based on the material to be used, is clearly the limiting factor for the accuracy of the readings.

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EXPANDING THE TYPEWRITER

PROBABLY every one engaged in scientific work has felt the need of typewriter characters other than those found on the standard keyboard. Special typewriters have been built, but are not satisfactory on account of the human element involved; typists have learned the touch method of operating the standard keyboard and as a rule refuse to use a special machine. In my own work the need has been met by a simple attachment that permits the use of any number of special characters.

A pillar AB in the diagrams is slipped onto the guides C, between which any type bar D must pass before striking the ribbon R. It is held in place by

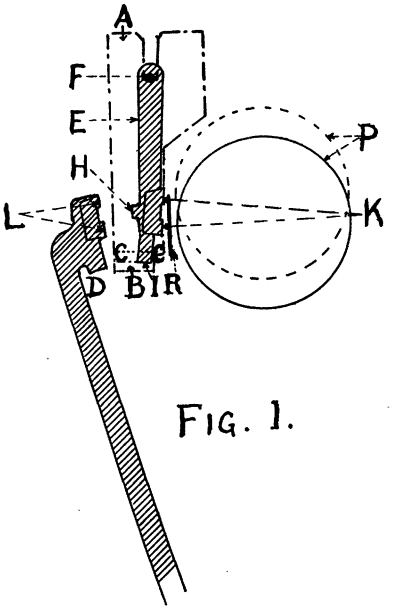

FIG. 1.

friction and can of course be removed easily when the machine is to be used for ordinary correspondence. Even when in place on the guides, it does not entirely spoil the "visibility" of the typewriter. The special characters are soldered to bars such as E designed to be supported by the pillar. Each bar has near one end a rather long axle FG, about which rotation can take place; the projecting ends of the axle provide a convenient means of handling the bar. Each bar carries two characters K; one will print when the typewriter mechanism is in its normal position and

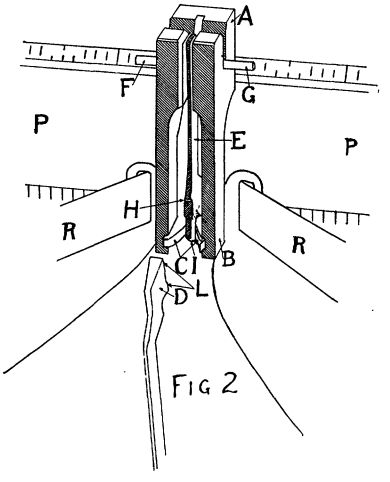

FIG 2

the other when the "shift" key has been depressed. The bar must be set in motion by a blow so that one of its characters may strike the ribbon R and print in the usual manner. The most convenient method of