SCIENTIFIC APPARATUS AND LABORATORY METHODS

A HOME-MADE ELECTRICALLY-DRIVEN PSYCHROMETER

BECAUSE of the inaccuracies of the hair hygrometers used in our work, the need has developed for an accurate and convenient means of making humidity determinations in small enclosures where a sling psychrometer can not be used. For this purpose an electrically-driven psychrometer was constructed (see Fig. 1), using the thermometers from an old station-

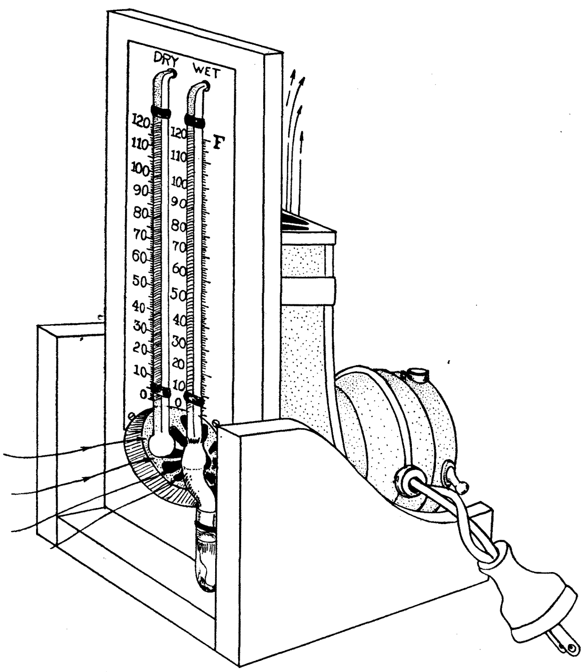

FIG. 1

ary psychrometer mounted on a frame to which is attached a small electric hair dryer. When the motor is running, air is sucked over both wet and dry bulbs, and readings may be taken after approximately two minutes.

Instruments operating on this principle are on the market, but those that have come to our attention are high in price and too large for our needs. This home-made instrument, the parts of which cost less than $10, was assembled for the purpose of testing its convenience for our work, but without attempting to perfect it as a precise laboratory instrument.

Many improvements are obviously desirable. The thermometers should be at least as accurate as those of a good grade sling psychrometer, and graduated on a scale to be read to one half degree F. The mercury columns should be easy to see under unfavorable conditions, as through the glass door of an incubator. For compactness the scale should cover only the usual temperature range of the work. A suitable suction device is of primary importance for furnishing an air current of as high velocity as possible, consistent with small size and freedom from excessive heating. As pointed out by Carrier and Lindsay[1], the wet bulb error may increase markedly at reduced air velocities. In assembling the instrument the thermometers should be so placed as to prevent evaporation from the wet bulb wick influencing the dry bulb, or either of the bulbs being influenced by motor heat. If the air is drawn over the bulbs from a direction other than that of the operator, the chance will be largely removed of influence from body heat or moisture when the instrument is used in the open laboratory.

The electric psychrometer was checked against a sling psychrometer under varying conditions and found in close agreement, particularly as to wet bulb temperatures. The discrepancies that occurred were such as might be ascribed to the character of the thermometers of the electric instrument, which were difficult to read with accuracy closer than one degree, and which showed errors in the dry bulb readings when checked in our chemistry department against an accurate laboratory thermometer. The influence of motor heat on the thermometers did not become apparent until some time after the maximum wet bulb depression, and then chiefly in enclosed spaces. An increase of one degree in both the dry and wet bulb readings was observed in a small incubator after five minutes' operation, but this would obviously make but little change in humidity determinations.

Our use of the instrument has been mainly in checking the hair hygrometers in our breeding cages and incubators. It has been found desirable to check each hygrometer individually under the usual conditions where it is kept. This avoids the possibility of disturbing the adjustment by handling, and makes it unnecessary to keep the hygrometer out of use for several hours for complete response to changed humidity conditions before an accurate test can be made. As some of the hygrometers have shown large errors in scale readings when calibrated over a wide range of humidities, and as it is not yet known whether these errors remain constant for any length of time, it has seemed best to make tests frequently and at the usual incubator humidity.

The electric instrument would appear to make practicable the use of a stationary psychrometer in

[1] "Temperatures of Evaporation of Water into Air," W. H. Carrier and D. C. Lindsay. *Trans. Am. Soc. Mechanical Engineers,* 1924, vol. 46, p. 739.

an incubator in which the air circulation is constant, by establishing the difference between the wet bulb reading at the regular incubator air velocity and the maximum wet bulb depression. This difference applied as a correction to the observed stationary wet bulb reading should give an approximate humidity determination. Frequent checking would be advisable to correct for any changes in air velocity or reduced evaporation from the wet bulb wick. If the incubator temperature and humidity vary only in narrow limits, a few readings at various points should form the basis of a simple chart for approximate corrections. If the air movement is not subject to variation by reason of material introduced into the incubator, the stationary psychrometer may be placed at any convenient point. Otherwise it should be located close enough to a fan to insure a constant current over the bulbs, regardless of changes of air circulation in the main body of the incubator. With low air velocities, it is particularly important that the thermometer bulbs be protected against any varying source of heat, as from the fan motor or the incubator heating elements. A stationary psychrometer has been in use in this way in an incubator for a short period with apparent success. The humidity determinations with this instrument may be more accurate, and certainly less erratic, than those obtained with our hair hygrometers, particularly in an incubator in which the frequent opening of the door tends to keep the hair instrument continually out of adjustment during the day.

For general use about the laboratory or insectary the electric instrument has advantages over the sling psychrometer in reducing the danger of breakage, and in ease of reading, as the thermometers may be read while the motor is running and the wet bulb held constant by the air current. Its special adaptability for use inside small enclosures makes it seem an instrument that is worth perfecting for entomological work.

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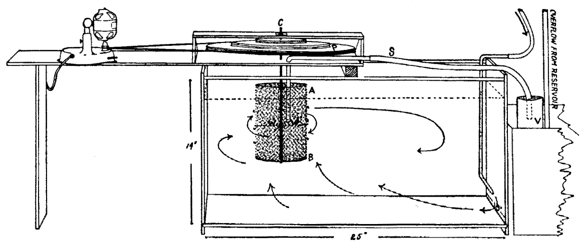
THE CURRENT ROTOR

LAST summer, while engaged in a study of post-embryonic development of mackerel and other marine fishes at Woods Hole, Massachusetts, the authors used a simple device which enables one to change water without losing small organisms that live in the aquarium. The essential feature of the apparatus is a cylinder, A, of 60 mesh or finer monel metal screen suspended in a tank and rotated by means of an electric motor. Rotation of the cylinder when placed at one end of an oblong aquarium sets up a complex system of currents the direction of which is indicated



in the accompanying illustration. Strong circular currents are formed in the immediate vicinity of the cylinder, while at the far end the water moves very gently. There is also a noticeable upward motion from the bottom of the tank.

The speed of rotation and the corresponding strength of currents may be regulated by the speed of the motor controlled through a rheostat and by means of a set of pulleys of different diameters. The dimensions of the cylinder also affect the strength of the current produced and therefore should vary according to the size of the aquarium used. The cylinder shown here is 4 inches in diameter and 6 inches long. About one inch is left above water. The tank is $25 \times 15 \times 14$ inches. The bottom of the cylinder, B, is a celluloid or monel metal disk. Non-corrosive material should also be used for the suspension rod, C, and brace wires, W. The diameter of the pulley, P, is 12 inches.

The water can be withdrawn from the tank through a siphon, S, the upper end of which is placed inside the revolving cylinder. When the cylinder is in rotation small organisms never are actually drawn against its wall, because the centrifugal force throws them away from it. They are then caught up in the circular currents and soon find themselves in quieter waters at the far end of the aquarium. In this manner the water in the tank can be changed without losing its inhabitants.

When it is desirable to supply a constant flow of water this can be accomplished by placing the lower end of the overflow siphon, S, in a vessel, V, adjusted so that the top of it is level with the water in the aquarium. The water is introduced from a reservoir, in which it is kept at constant level. If necessary the water from a laboratory faucet can be filtered through glass wool to remove sediment and other foreign matter.

The revolving cylinder not only provides for changing water without losing small organisms that are kept in the aquarium, but also by setting the water in motion it prevents the accumulation of the organisms and their sticking to the bottom. In this respect it can be used instead of a plunger jar.

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