preliminary work) without any fighting at the period of observation or any traces of injury at other times.

The apparent explanation is that the males are already inhibited against fighting the females. Since no fighting takes place after handling, they quickly associate not fighting with handling and are inhibited by the latter. There being no fighting at the first meeting, the inhibition probably tends to become permanent.

The same pair of males was then transferred to separate parts of a large multiple escape pen (planned as in Fig. 1) and isolated for at least fourteen days. Following the lead of Ginsburg and Allee,[2] who found that animals fought best if successful in fighting, these males were trained to fight by introducing a belligerent animal of the same strain and removing it before either mouse was hurt. This was done on at least five successive days. Immediately after the last training period the mice were allowed to enter each other's pens, this time without handling. A fight soon started, usually after one male had made a sexual attempt on the other, or had found the path to his home pen blocked. The result was that one of the males soon became the victor and chased the other round and round the two pens. This, a clear case of temporary social dominance based on fighting, was seen with each of the six pairs used.

The development of this organization was watched over a longer period after all other passages in the multiple escape pen were opened; the losing mouse is soon killed if left in the same small area. Each compartment had at least three avenues of escape, and only one mouse was killed while in the large pen. If the mice met while the observer was present, the winning mouse chased the other through the passageways, sometimes making several rounds but finally losing contact. This semi-permanent type of dominance was seen to persist as long as 33 days but gradually tended to die out unless training was repeated from time to time. In one case where a day elapsed between training and the first fight, fighting and dominance could only be reobtained by further training.

Here the explanation appears to be that the mice become conditioned to fight any mouse which the observer puts into the pen. After the first unchecked fight the winning mouse is conditioned to chase and and the loser to run away. When these responses are not reinforced by the introduction of a fighting mouse, they tend to die out.

The probability of getting such consistent results by chance is very small. These and consistent preliminary data make it highly probable that the theory of determination of social organization by social behavior is correct in so far as social dominance based on the fighting of male mice is concerned.

J. P. SCOTT

WABASH COLLEGE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A FLOWMETER FOR USE IN AIR SAMPLING PROCEDURES[1]

RECENTLY developed procedures for quantitative collection of air-borne bacteria and glycol vapors which utilize the Moulton atomizer sampler and the Folin aeration tube bubbler[2, 3, 4] depend upon accurate measurements of the air-flow. Most air flowmeters employ the Venturi or orifice principle by which the change in static pressure of an air stream during or after passage through a constriction is used as an index of the rate of air flow. The latter is defined in terms of unit volume of air per unit of time at standard conditions of atmospheric pressure and room temperature. The calibration of these flowmeters is usually carried out by connecting them in series with a standard instrument (wet gas-meter, spirometer bell, standard Venturi meter, etc.) so that these standard conditions are approximated.

It is not widely appreciated, however, that such flowmeters may give rise to erroneous air flow measurements when these standard conditions are not maintained. Flowmeters, connected downstream to a sampling device possessing high intrinsic resistance to the passage of air (*e.g.*, Moulton atomizer sampler) will give readings exceeding by as much as 70 per cent. the true rate of air-flow.[5] The actual value can be determined only by placing the flowmeter upstream to the sampling apparatus, where it will operate under conditions similar to those employed during calibration. Commercially available orifice flowmeters are usually unsuitable for use on the upstream side of air

[2] B. Ginsburg and W. C. Allee, *Phys. Zool.*, 15: 485–506, 1942.

[1] This investigation was aided in part through the Commission on Air-Borne Infections, Board for the Investigation and Control of Influenza and other Epidemic Diseases in the Army, Preventive Medicine Division, Office of the Surgeon General, U. S. Army.

[2] S. Moulton, T. T. Puck and H. M. Lemon, SCIENCE, 97: 51–52, 1943.

[3] H. Wise, T. T. Puck and H. M. Stral, *Jour. Biol. Chem.*, 150: 61, 1943.

[4] H. M. Lemon, *Proc. Soc. Exper. Biol. Med.* (in press).

[5] Downstream from a high resistance a considerable decrease in air pressure and therefore air density must occur; as a result a given mass of air will occupy a correspondingly increased volume. Compared with standard conditions, this air mass under diminished pressure must travel with increased velocity through the orifice if it is to pass through the meter in the same period of time, and hence an erroneously high static pressure difference will be observed.

sampling devices, since they may retain some of the material to be collected. Furthermore, they are expensive and fragile and their design is not adapted for sampling in locations difficult of access, such as air ducts.

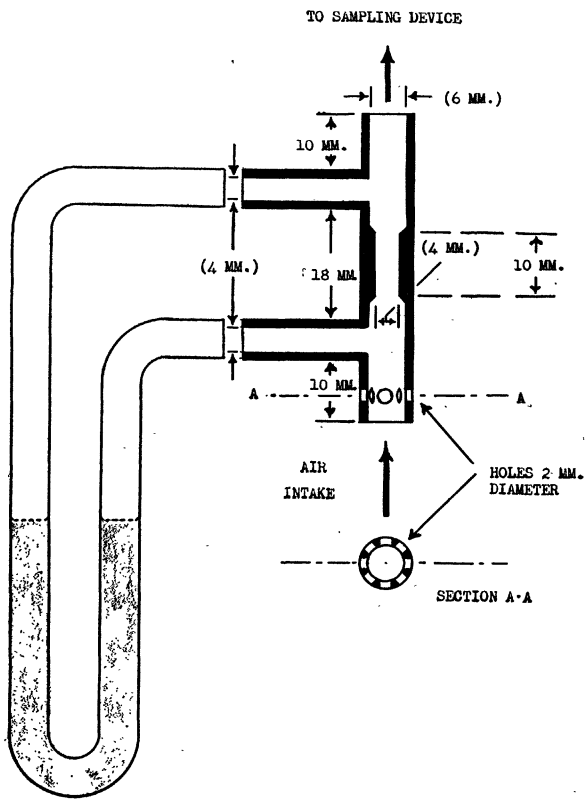

FIG. 1.

To avoid these objections the small flowmeter shown in Fig. 1 was developed. It is designed to be attached to the upstream end of any sampling device. A constricting orifice of 4 mm inside diameter and 10 mm length in a tube of 6 mm inside diameter and 48 mm in length will give a satisfactory change in static pressures for air-flows between 0.33 and 1.30 cu. ft. per minute. This change in static pressure is measured by a glass manometer (4–5 mm inside diameter and 120–150 mm long) filled either with water or a 1 per cent. solution of a suitable detergent with a few drops of phenol red added for coloring; the latter solution inhibits mold growth and improves the wetting of the glass. Graph paper ruled in millimeters backed by a wooden tongue depressor blade and bound to the manometer with transparent cellulose tape provides a simple scale. Any non-corroding metal or chemically inert plastic, such as Plexiglas, may be used in the construction of the flowmeter.

For calibration the flowmeter should be attached upstream to a standard wet-gas meter or a previously calibrated Venturi meter. The calibration curve shown in Fig. 2 has been reproducible within ±5 per cent. by either calibration method.

The eight 2-mm holes drilled 45° apart into the intake end of the meter maintain the static pressure

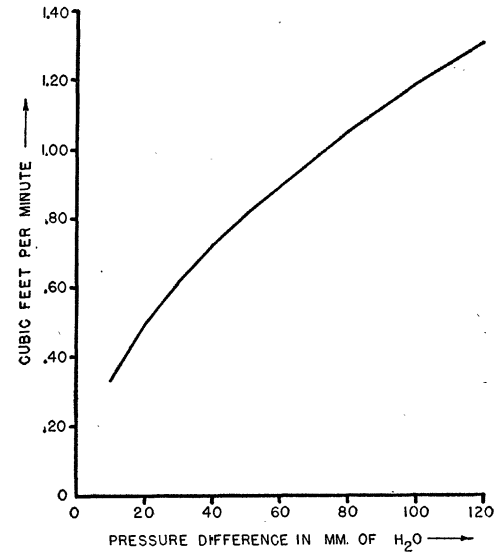

FIG. 2. Calibration curve for flowmeter (mean of 120 determinations) maximum deviation ±5 per cent.

difference within 1–2 mm of water for a given airflow when the flowmeter is transferred from still to rapidly moving air;[6] without these holes a drop in pressure of 5–10 mm of water occurs.

It is especially designed for accurately measuring air-flows through the Moulton atomizer sampler and Folin aeration tube. Since it is readily cleaned, it does not interfere with determination of air-suspended microorganisms or glycol vapors. It is sufficiently compact and durable so that air samples may be taken in a wide variety of locations.

HENRY M. LEMON,
1st Lieut., M.C., A.U.S.
HENRY WISE
DEPARTMENT OF MEDICINE, DOUGLAS SMITH FOUNDATION FOR MEDICAL RESEARCH, AND THE BARTLETT MEMORIAL FUND OF THE UNIVERSITY OF CHICAGO

[6] Velocities up to 2,500 ft./min.

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