Comments and Communications

Inspection of Simple Relations among a Number of Variables[1,2]

EXAMINATION of all interrelations among measured variables is difficult, and the difficulty increases as the number of variables increases. Thus, 45 simple correlations exist among 10 variables, but 780 among 40. To detect striking correlations between any two variables in complex data more readily, a device has been developed that permits visual inspection of coded data (Fig. 1).

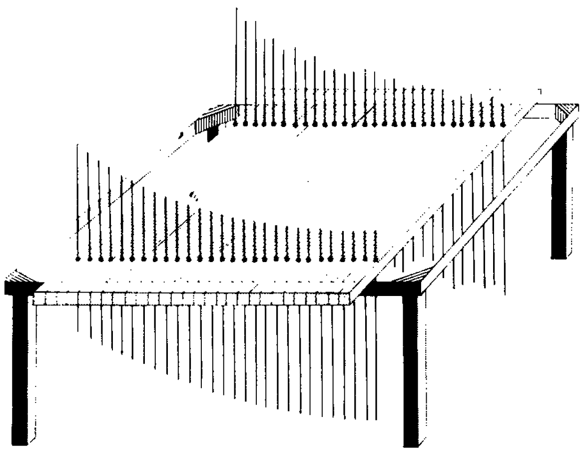

FIG. 1. Pinball device. Only two variables measured for each of 28 objects are shown; i.e., 28 bars are shown.

The device consists of a rack, or frame, on which rest the ends of a number of slotted metal bars. Each bar represents one of the objects, or organisms, or units of any kind on which measurements were made. Each bar carries a number of pins mounted in little balls that are free to slide along the slot. Each pin represents one variable in one object. The length of each pin protruding above a bar is adjusted to represent the measured value of a variable in one object. The same variable occupies a similar position on each bar. The slots in the bars are long enough so that any two sets of pins (i.e., two variables) can be slid far enough from the other pins that their protruding lengths can be visually compared without interference from other pins. In Fig. 1, for the sake of simplicity, only the front and back rows of pins are shown.

In use, all pin lengths are first adjusted to represent the measurements obtained. One variable is selected as the basis for the first series of comparisons. The bars are then arranged so that the pins representing that selected variable are in the order of their protruding lengths, ascending or descending. This is illustrated by the front row of pins in Fig. 1. The back row in Fig. 1 represents a variable that is, in this illustration, closely related to the selected variable. The other variables (omitted) are then compared, one at a time, with the selected variable. Each comparison is made by sliding each set of pins away from the others so that the newly isolated set may be inspected for any possible regularity in length. Findings are entered on a check list. Next, a second variable is selected as the basis for the second series of comparisons. The bars are rearranged so that the second set of pins is in the order of their protruding lengths. As the work proceeds, the number of new comparisons possible for each rearrangement of the bars decreases.

This device has been useful in inspecting data from a number of measurements made on each of a series of animals. We have observed regularities and curvilinear correlation that would be obscured in calculation of correlation coefficients, the usual assumption being homoscedasticity of data.

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A Thermal Precipitator for Aerobacteriology

THE phenomenon involving the precipitation of small airborne particles on a cold surface from the influence of a warmer surface has been known for some years. Aerosol samplers based on this principle have been referred to as thermal precipitators. With

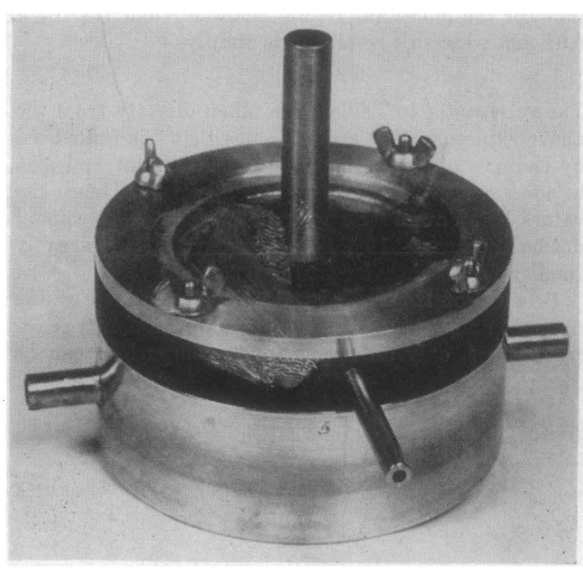

FIG. 1.

one exception (*1*), these samplers have all operated at low flow rates, generally between 5 and 10 cc/min. Although the thermal precipitator is believed to have a very high effectiveness in the collection of small particles from the air, such a low flow rate has greatly limited its use.

As a result of study of the principles underlying the operation of the thermal precipitator (e.g., [*2*]), the members of our group decided that a warm horizontal plate facing downward would be more useful in a thermal precipitator than the hot wire ordinarily used. Since it was desired to design a sampler suitable for use in aerobacteriological studies, the primary objective was to obtain live organisms from the air in such a state that they could be counted and perhaps subsequently classified. With this in mind, several samplers were designed to precipitate airborne particles directly on the surface of Petri dishes, but the irregularity of the dish surface made this impractical. A more uniform surface was obtained by using No. 2 cover slips of 3-in. diameter (obtained from C. A. Hausser & Son). The sampler shown in Figs. 1 and 2 was designed to precipitate airborne particles and bacteria on the surface of such cover slips.

The details and operation of this thermal precipitator are rather simple. Fig. 1 shows the assembled sampler: The top tubes are for the passage of the air sample, which enters the larger center tube and leaves through the smaller offset tube. The two lower tubes are for the passage of water through the lower chamber in order to cool the cover slip. In Fig. 2 the sampler is shown disassembled; the round objects in the foreground are the three spacing shims, which are 5, 10, and 15 thousandths in. thick. When one of these is inserted into the sampler, it determines the thickness of the space between the hot and cold surfaces. In operation, the desired temperature of the hot body is obtained by adjusting the voltage of a variable transformer connected to the lugs on the upper plate (which is a commercial heating element). In general, temperatures between 80° and 100° C have been used for the upper plate; tap water or water cooled a few degrees is passed through the lower chamber. With a cover slip in the cavity of the lower half of the sampler and the proper shim in place, the sampler is then assembled and the wing nuts are screwed firmly down to insure airtight seals. The air sample can then be drawn through with any convenient device.

The unit is undergoing tests at the present time, and results thus far obtained indicate that it is effective at flow rates as high as 400 cc/min, and that particles suspended in the air sample are uniformly precipitated over the surface of the cover slip on which they are collected. The area covered by the particles on the slip depends on the flow rate, the distance, and the temperature difference between the hot and cold surfaces.

Because there have been so many inquiries and so much interest expressed by other groups working in related fields, we feel that the publication of a short description of this thermal precipitator is warranted

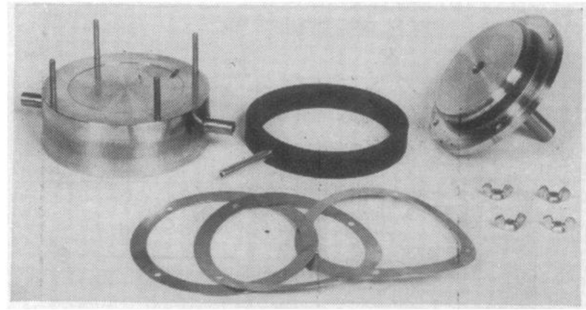

FIG. 2.

at this time, even though we have not completely proved its effectiveness. The advice and guidance of J. M. DallaValle in this work is gratefully acknowledged. The investigations leading to the designing of this sampler were supported in part by a grant-in-aid from the National Institutes of Health.

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References

1. BREDL, J., and GRIEVE, T. S. *J. Sci. Instruments*, **28**, 21 (1951).
2. WATSON, H. H. *Trans. Faraday Soc.*, **32**, 1073 (1936).

An Activity Analyzer for Small Animals[1]

INTEREST in the spontaneous and drug-induced activity of mammals has stimulated the development of numerous devices to record their motion (*1–15*). The so-called activity cages, with two exceptions (*12, 15*), are either modifications of Stewart's revolving cage (*1*) or variations of Szymanski's "aktographs" (*3*). The cage described here belongs to the latter class and was designed for rats. It is simple, compact, and sensitive. Four units may be arranged to record on one drum of a kymograph, and their sensitivity may be regulated to register movements ranging from respirations to jumps. Patterns for crawling, walking, staggering, jumping, and numerous other motions may be readily ascertained, as well as the total amount of activity.

The unit shown in Fig. 1 is made of appropriately braced, galvanized hardware cloth of ½″ mesh except for the bottom, which is ¼″ mesh. Its diameter and height are each 7″. The guide wires *D*, which are soldered to the center of the bottom of the cage, are made of 1/16″ brass stock and project perpendicularly to describe a rectangle approximately 8″ × 2″. Attached to the bottom of the cage, equidistant from the guide rods is a pole *C* made of ⅛″ aluminum rod, which extends 9″ past the edge of the cage. The top *A*, with its 50-ml watering tube, is attached to the cage by removable spring clips *B*. In action the cage is suspended from a spring. At rest it is supported by a 7″

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