this time the majority of the tails were free of venous sclerosis.

We believe the above technique renders practicable the multiple intravenous injection of mice.

A Simple Self-leveling Drinking Well for Laboratory Animals

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The continuous supply of clean drinking water in adequate amounts to larger groups of rats and other small laboratory animals is both important and difficult of achievement. Automatic watering devices (*2*) are cumbersome, confine the cages to certain definite locations, and hence are rarely employed. Open water trays or cans are used by rats for "bathing" and are soon polluted with feces and urine. The water bottle with drinking stem (*3*), usually fastened outside the cage, eliminates this drawback but introduces many others. The size of the bottle is ordinarily limited to correspond with the dimensions of the cage and the amount of weight that can be safely suspended from its walls. As a rule, drinking bottles do not hold more than 50–300 ml of water. If 10 rats are placed in one cage, even the largest bottle of this type hardly accommodates the quantity of water required in one day, since, under the conditions of a moderate climate, the normal adult albino rat will drink about 30–35 ml of water in 24 hrs. Hence, the water bottle has to be dismounted, filled, and remounted at least once daily. Moreover, under certain experimental conditions the water demand often increases to a multiple of the normal intake. Rats with chronic tubular damage, for instance, frequently excrete up to 75 ml of urine per day (*4*) and consequently consume far more than 100 ml of water in 24 hrs.

In addition, many models of drinking bottles employed at present are not the commercial all-glass type (*1*), which, incidentally, are particularly difficult to fill although they are otherwise quite adequate, but consist of simple rubber-stoppered bottles which are attached to the cage in an upside-down position. A straight or bent glass tube which penetrates the stopper is introduced in the interior of the cage as the drinking stem. Not infrequently these tubes "run dry," and in the morning one may find the animals assembled around the empty stem of a full water bottle, frantically trying to obtain the much-needed supply of fluid. On the other hand, damage or loosening of the stopper will cause the water to drip out overnight; this water may be collected as "urine" by the zealous experimenter, causing him to ponder gravely on the sudden unexplained "diuresis" of his experimental animals.

It should also be kept in mind that drinking by licking the open end of a glass tube, which thereupon "hesitatingly" surrenders its contents drop by drop, is not a natural procedure and requires considerable effort. Apparently easily learned by the healthy rat and mouse, this form of drinking represents a heavy burden for the animal with a strongly increased water demand; it may become extremely difficult, if not impossible, to the sick or "drugged" animal which is frequently unable even to assume the typical position necessary for obtaining water from a tube. Animals so handicapped may still be able to drink from an open tray, placed close to the bottom of the cage. Obviously then, a full water bottle is no reliable indicator for the adequacy of the water supply in many toxicological and therapeutic studies. So-called unexplained discrepancies in toxicity figures and other observations reported by workers from different laboratories may be due in part to such hidden deficiencies in the supply of drinking water.

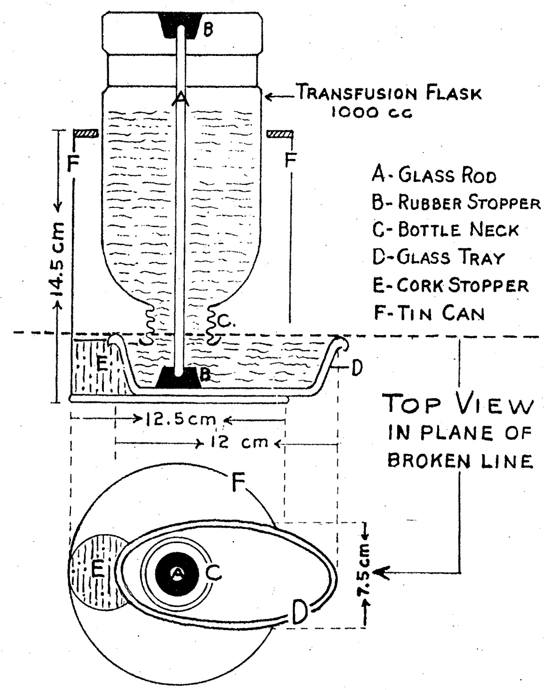

Fig. 1

This paper describes a simple drinking well which has proven its value after years of testing under varied experimental conditions. Basically, the well consists of a large, wide-mouthed glass bottle, such as a transfusion flask (capacity 1,000 cc or more), an old tin can (best with a removable cover), which just fits loosely over the flask, and an oval glass tray for bird feeding (obtainable in many 5- and 10-cent stores).

An aperture in form of a trapezoid, with the smaller of its parallel sides pointing downward, is cut in the side wall of the can near the bottom; the opening should permit the protrusion of a small part (about one-fifth) of the glass tray, which is firmly fixed inside the can and at its bottom with the aid of a large cork stopper in the manner illustrated in Fig. 1.

The flask is now filled with water and the can, with the glass tray securely fastened at its bottom, is slid over the flask until the mouth of the latter is somewhat below the rim of the tray. Exact alignment is easily obtained by placing a glass rod, with rubber stoppers attached to both ends, into the flask. The rod should protrude from the mouth of the flask just sufficiently to arrest the tin can at the desired level. As soon as the tin can is correctly aligned over the filled water bottle, the device is quickly inverted. Water will immediately stream into the glass tray and fill it up to the height which is determined by the mouth of the flask (Fig. 1). The drinking well is now ready for use. In order to facilitate immediate reading of the water level in the flask, a vertical slit (length, 8 cm; width, 1 cm) may be cut into the wall of the tin can just below its upper rim. As soon as drinking has caused the water level in the tray to fall sufficiently to bare the mouth of the flask, air will enter the flask and water will stream down into the tray until the rising fluid level again occludes the opening. This play will obviously continue as long as there is any water left in the flask.

The drinking well in the dimensions indicated in Fig. 1 will easily fit inside the standard cage used for larger groups of rats or guinea pigs in many laboratories. By changing the size of the flask, tin can, and tray, the experimenter can adjust the capacity of the drinking well to his individual needs within a wide range.

The self-leveling drinking well has many advantages, since it combines the good features of the drinking bottle and the open tray without retaining the drawbacks of either. First and foremost, it makes available large reserves of drinking water, which are released automatically and in small quantities from an airtight, sealed container into an open tray located near the bottom of the cage; thus, comfortable and natural drinking is assured continuously, while the inaccessibility of the greatest part of the tray to the animal practically eliminates the danger of pollution. The amount of water consumed can be readily estimated with the help of the graduations on the transfusion flask. The fact that the water is in contact with glass only may become of special importance in some nutritional studies and in experiments using drinking fluids of certain definite composition. The self-leveling mechanism is foolproof and can be adjusted to maintain any desired height of the water level. Refilling is easy and will obviously have to be done far less frequently than with most of the watering devices used at present. In experiments entailing accurate collection of urine, no mistakes or disturbances will be encountered from leaking drinking tubes or spilled water cans. The well is sturdy and stable enough to resist overturning without fixation. Finally, the device can be readily and quickly constructed with materials available in abundance from the discards of every biological research laboratory or hospital, without special tools and at almost no expense.

References

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Book Reviews

Reading and visual fatigue. Leonard Carmichael and Walter F. Dearborn. Boston: Houghton-Mifflin, 1947. Pp. xiv + 483. $5.00.

This is a thoroughgoing report on an extensive experimental program and the scientific literature pertinent to its development. The research was sponsored by the Committee on Scientific Aids to Learning. Approximately the first half of the book is devoted to a summary of the literature related to visual fatigue and reading. This review is one of the main contributions of the book and should be valuable to persons undertaking work in this field. In discussing the general nature of fatigue, the authors are critical of the frequent analogy with machines because of the way exercise sometimes strengthens certain human functions. There follows a review of the results with the conventional photographs of eye movements, first, when the subject is voluntarily fixating different points, and then when he is actually reading. Especial attention is given to ocular behavior with prolonged work. Note is made of the controversial material dealing with rate of blinking as indicative of fatigue or visual efficiency, and the authors do not come to definite conclusions on this point. Reading behavior is discussed as related to various aspects of format such as length of line, type face, or leading. Reading is likewise considered with reference to degree of illumination—a rather controversial topic. The authors are inclined to tone down the seemingly excessive claims of some investigators as to the light intensity necessary for various types of visual work. This toning down seems to be in line with recent publications on this subject. Then follows a more extensive review of the methods of recording eye movements, leading up to the present experiment. The review covers the whole range from watching the eyes through peekholes, observing afterimages, feeling the eyeball, or having a capsule operated mechanically by the eyeball, to the extensive work on corneal reflection and, finally, devices