After a subsidence dome is once established, the air above the surface of the dome sinks and spreads. At upper levels in the atmosphere, where the effects of turbulent exchange and radiation are small, the process is adiabatic—the potential temperature of each subsiding particle of air remaining constant. A discontinuity of lapse rate within the atmosphere guides the vertical flow of air, since the isotherms of potential temperature represent stream lines of flow. This is evident from the principles of stability. Any horizontal relative movements of the air particles on either side of the inversion will thus be along the particular potential isothermal surfaces on which they lie. The tendency, then, is to maintain a constant potential temperature at the base and top of the inversion. However, small variations do occur, and they may be accounted for by three factors that tend to produce variations in the potential temperature along the surface of subsidence, namely, (1) divergence (and convergence) above and below the inversion, (2) radiation and (3) turbulence.

This comprehensive paper on subsidence should be read carefully by all meteorologists.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

NEW ARRANGEMENT FOR REGULATING FLOW OF LIQUID INTO A CULTURE VESSEL

MAINTENANCE of a specified composition of liquid medium in a culture vessel, as for solution culture experiments with plants, may be satisfactorily accomplished only through employment of some device by which fresh liquid is allowed to flow continuously into the vessel at a suitable rate, with a like rate of waste discharge. This was first emphasized by Trelease and Livingston.[1] Unknown and unpredictable effects of differential absorption by the cultured organisms are thus avoided, as are also the effects of accumulation of substances or ions extruded by the organisms or produced in the vessel. One needs to be able to increase or decrease the rate of flow at will. It should be but little more rapid than is necessary and it needs to be automatically maintained for long periods.

Continuous-flow plant cultures were used by Nobbe as early as 1865,[2] and Schloesing[3] employed an automatic intermittent renewal of solution in some of his experiments. Continuous flow has been increasingly employed for solution cultures and sand cultures of plants since the appearance of Trelease and Livingston's paper; more recent writers on this sort of experimental technique are: Allison and Shive,[4] Prianischnikow,[5] Johnston,[6] Shive and Stahl,[7] Pirschle,[8] Zurbicki,[9] Zinzadze,[10] Pierce,[11] Ungerer,[12] Mehrlich,[13] Trelease and Thompson.[14] Some of these give additional references. Several arrangements for the control of solution flow have been shown at recent annual science exhibitions of the American Association, by Dr. J. W. Shive and by Dr. Sam F. Trelease.

From a comparative study of many different arrangements, the writer has developed the new form of simple continuous-flow apparatus to be described in the present paper, in the preparation of which he has had the benefit of valuable criticism and cooperative help from Professor Burton E. Livingston, Mr. W. Luther Norem, Dr. Theo. C. Scheffer and Mr. Karl A. Grossenbacher, all of this laboratory.

The rate of flow of a liquid through a small orifice is determined partly by the viscosity of the moving liquid within the orifice, partly by the hydrostatic-pressure difference between the entrance and exit of the orifice, and partly by the resistance introduced by the orifice walls. The viscosity of a stable liquid nutrient medium may be satisfactorily maintained by keeping its temperature nearly constant, but this consideration of temperature influence has apparently not yet received attention in the present connection.[15]

The hydrostatic-pressure difference that drives the liquid through the orifice may be satisfactorily maintained if a small constant-level tank is introduced between reservoir and orifice (as in the arrangement of Trelease and Livingston, for example). It is well to equip the reservoir as a Mariotte flask, closed above and with air inlet near the bottom.

This Mariotte arrangement alone, without accessory tank, suffices to maintain a practically constant hydrostatic head excepting that pressure at the entrance to the orifice is somewhat excessive during periods when the temperature of the confined air in the reservoir is rising. For any combination of orifice resistance

1 SCIENCE, 55: 483–486, 1922.
2 *Landw. Verssuchst.*, 7: 68–73.
3 *Ann. Sci. Agron.*, 1: 315–359, 1899.
4 *Amer. Jour. Bot.*, 10: 554–566, 1923.
5 *Ergebn. Biol.*, 1: 406–446, 1926.
6 *Plant Physiol.*, 2: 213–215, 1927.
7 *Bot. Gaz.*, 84: 317–323, 1927.
8 *Planta*, 14: 583–676, 1931.
9 *Plant Physiol.*, 8: 553–558, 1933.
10 SCIENCE, 79: 480–481, 1934.
11 *Ibid.*, 80: 339, 1934.
12 *Ztschr. Pflanzenernärung, Düngung u. Bodenk.*, A, 36: 15–26, 1934.
13 *Plant Physiol.*, 10: 169–177, 1935.
14 SCIENCE, 81: 204, 1935.

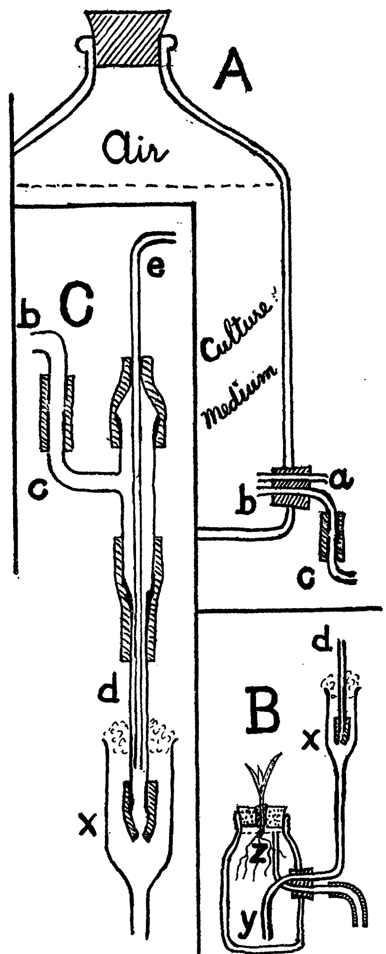

FIG. 1

and liquid viscosity, the rate of delivery is more or less excessive during such periods. In the arrangement described below this source of fluctuation is practically avoided without recourse to a constant-level tank.

The most satisfactory orifice previously used is simply a short length of suitable capillary glass tubing, but with such orifices clogging may result from trapping of undissolved particles[16] and orifice resistance can be changed only by stopping the flow, removing the capillary tube and replacing it with another one that offers the desired resistance. The new annular orifice is readily adjustable for different degrees of resistance without interrupting liquid flow, and it is not so apt to become clogged as other orifices.

A readily adjustable annular orifice, for either gas or liquid, was described by Gregory,[17] to whose paper the writer is indebted. It is simply the narrow space between two concentric glass tubes, the bore of the outer tube being but little greater than the external diameter of the inner one. The flowing liquid passes between the tubes. Resistance to flow is of course determined partly by the mean distance between the tubes and partly by the length of the annular space. The latter is easily adjusted by sliding the inner tube or plunger within the outer one.

The essentials of the writer's arrangement are shown in the diagrams of the accompanying figure, where, for the sake of clearness the orifice parts (C) are drawn on a larger scale than the other parts (A, B). The supply reservoir (A) is a 5-gallon glass bottle with a lateral shop-drilled perforation (25 mm in diameter) near the base. (Bottles and jars have been drilled at the Johns Hopkins University shop, at a cost of about 25 cents per perforation.) The mouth is regularly tightly closed with a rubber stopper. In the perforation is a 2-hole rubber stopper bearing two glass tubes. Tube *a* admits air in small bubbles, as the liquid level descends. When the bottle is opened, for refilling, the outer end of this tube is temporarily closed by means of a bit of rubber tubing with its outer end plugged. If the air pressure above the liquid in the reservoir tends to become excessive through rising temperature, pressure excess is promptly relieved by slowing down or cessation of air entrance and, in extreme cases, by the escape of some liquid through tube *a*. Such escape of liquid occurs only with pronounced and rapid temperature rise, especially when the air space in the reservoir is large. Liquid thus escaping may be caught in a small vessel. (Tube *a* may be at the side of tube *b* rather than above it and its outer part may be bent to one side. It should be slightly bent downward at its outer end.) Any slight decrease in the air pressure above the liquid (as by falling of temperature) causes air to enter somewhat more rapidly than liquid is passing out through the orifice, consequently such pressure decrease can not become significant. Alterations in the barometric pressure of the surrounding atmosphere would be similarly cared for if considerable.

The outlet tube is joined to the lateral arm of the 3-way tube *c*, the main part of which is vertical and has a bore of about 7 mm. The outer tube *d* of the annular orifice has a bore of about 5 mm and is about 10 cm long. It is attached, by means of a short rubber coupling, to the lower end of *c*. The inner tube or plunger (*e*) is about 20 cm long, being selected to fit closely within the outer tube but to slide freely. It extends up through and beyond the vertical part of *c*, the annular opening between them being closed above by means of a bit of non-adhesive rubber tub-

[15] See Christiansen, Veihmeyer and Givan, *Ecol.*, 11: 161–169, 1930.

[16] Johnston and Livingston, *Plant World*, 19: 136–140, 1916.

[17] *Ann. Bot.*, 47: 427–428, 1933.

ing, through which the plunger may be raised or lowered to increase or decrease orifice resistance. At the lower end of the outer orifice tube (d) is a short bit of rubber tubing, into which the plunger tip fits when completely depressed, to close the orifice. The lower end of the plunger tube need not be sealed, but a suitable glass rod serves as well as a tube.

Liquid dripping from the orifice is caught in the funnel (x) and conducted to the culture jar through tube y. The opening around tube d in the funnel mouth should be closed, as with a cotton plug, to retard evaporation and exclude dust. The jar (of the "Mason" pattern) has a shop-drilled lateral perforation (25 mm in diameter) that bears a 2-hole rubber stopper and two tubes (y, z). The inner end of the supply tube (y) is bent downward, extending nearly to the bottom of the jar, while the overflow tube (z) is correspondingly bent upward, so as to terminate at the level where the free liquid surface in the jar is to be maintained. To the outer end of z is attached a rubber tube leading to a waste receptacle. The rate of withdrawal of liquid from the reservoir may be roughly estimated by observing the rate of bubble formation at the inner end of tube a, and the rate of discharge at the orifice may be ascertained by observing either the drip into the funnel or the rate of waste discharge.

This sort of annular orifice, whose details may be altered in many ways, may be used in connection with any form of reservoir that maintains a constant hydrostatic-pressure at the orifice entrance, as with the reservoir of Shive and Stahl or with that of Johnston, for example. Several orifices, with resistances that are either alike or different, may operate from the same reservoir.

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SPECIAL ARTICLES

A SECOND-GENERATION CAPTIVE-BORN CHIMPANZEE[1]

CHIMPANZEES of definitely known ancestry, birth-date and life-history, with the exception of fourteen in the breeding colony of the Yale Anthropoid Experiment Station in Florida, are rare indeed, and of second-generation births in captivity the first is now to be reported.

On April 11, 1935, a full-term, healthy male infant was born at the station to a primiparous female, whose distinction it is to be the first chimpanzee of known birth-date and history to mature sexually and to reproduce under scientific observation. The maternal grandparents as well as the parents of this second-generation infant are living and belong to the station colony. The new arrival has been named Peter; his number in the laboratory records is 41.

So far as known, the ancestral history of Peter reads as follows. His maternal grandfather Jim and his grandmother Mona, whose hypothetical birth-dates are 1900 and 1913, respectively, were known to the writer for many years as members of the Abreu primate collection in Havana. His father Bokar, whose hypothetical birth-date is 1925, was brought to the station from French Guinea in 1930 by Dr. Henry W. Nissen of the staff. His mother Cuba, daughter of Jim and Mona, was born in Havana on March 24, 1926. Jim, Mona and Cuba, among other chimpanzees, were presented to the Yale Anthropoid Experiment Station by Pierre Abreu in May, 1931.[2]

Of the four known and living ancestors of Peter, Cuba alone is of dated birth and reliably recorded developmental history. She first exhibited characteristic genital swelling in April, 1933. Menstrual bleeding occurred first on July 10, 1933, when she was seven years, four months, old. She was caged with a mature male from May, 1933, and she became pregnant August 9 ($\pm$ 5 days), 1934, at the age of eight years, five months.

These observations are unique in that, for the first time in the history of biology, they establish the age of a chimpanzee at sexual maturation and first impregnation.

Cuba's gestation continued for 245 $\pm$ 5 days. It was uneventful. Parturition was normal and easy, although accompanied by an exceptionally great loss of blood. Delivery must have occurred about 3 P. M., on April 11, 1935. It was not observed. According to Mr. M. I. Tomilin, Cuba showed no signs of discomfort or of the near approach of parturition at 2:10 P. M. At 3:20 P. M. the outcries of an infant in a cage adjoining Cuba's attracted Mr. Tomilin's attention, and the newborn infant Peter was discovered. His mother was then eating the afterbirth. This was completed, and she later drank much of the fluid, mostly blood, on the floor of the cage.

Mother and infant were observed continuously from 3:20 to 4:10 P. M., and both verbal and pictorial records were made of their behavior. As primiparous

[1] The following have contributed to the life-history records upon which this report is based: Mrs. Rosalia Abreu, Messrs. Pierre Abreu, O. L. Tinklepaugh, K. W. Spence, J. H. Elder and M. I. Tomilin.

[2] As Jim, then considered an old male, was not needed at the station as a breeder, he was presented to the Philadelphia Zoological Garden for use until death as an exhibition specimen.