was made to determine whether or not this 1:1 ration was actually realized, but XXY individuals were found without difficulty in the material put up for cytological study.

Discussion.—The evidence is not yet sufficient to indicate the exact relationship between the chromosomes of the two species considered here, but it does indicate that either the chromosomal resemblances are merely superficial or that the sex determining element (gene? or genes?) has been transferred from one chromosome pair to another. A comparison of the sex-linked mutant characters in the two species ought to throw some light on this question. It has not done so up to the present, however, for although we have obtained 27 such characters in willistoni they show so little resemblance to any in melanogaster (either sex-linked or non sex-linked) that they give no clue to chromosomal relationships.

The observed frequency of secondary non-disjunction in willistoni (average 1.7%) was less[5] than that found by Bridges in melanogaster (4.3%). There is no indication at present as to why this should be the case unless the size of the sex chromosomes be considered a factor.

[1] The "m" chromosomes are often difficult to detect. They may be lacking entirely in willistoni.

[2] D. willistoni Sturtevant (D. pallida Williston).

[3] Dr. Bridges kindly informs us that he has subsequently verified this conclusion.

[4] We are indebted to Dr. José Nonidez for making the drawings for figures 3–10.

[5] Line D may possibly be an exception but the small numbers make this doubtful.

[6] Bridges, C. B., *Genetics*, **1**, 1916 (16–52, 107–163).

[7] Metz, C. W., *J. Exp. Zool.*, **21**, 1916 (213–276).

AN APPARATUS FOR DETERMINATION OF THE GASES IN BLOOD AND OTHER SOLUTIONS

BY DONALD D. VAN SLYKE

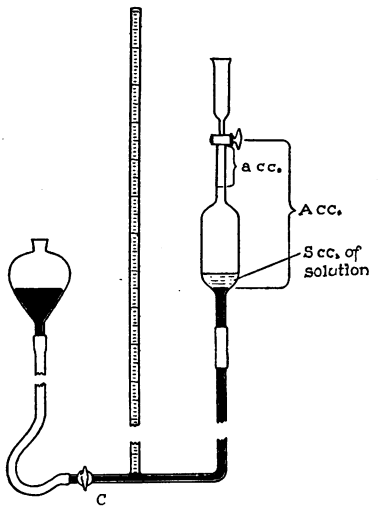
HOSPITAL OF THE ROCKEFELLER INSTITUTE, NEW YORK

Communicated July 5, 1921

The apparatus consists of a pipette with the upper stem closed by a stopcock, the lower connected with a glass tube. The latter descends 800 mm., then turns at a right angle to connect with a levelling bulb and a mercury manometer open at the upper end. The pipette is calibrated at two points to hold *a* and *A* cc., respectively, as shown in the figure.

For an analysis the pipette is filled with mercury. The solution to be analyzed, followed by the reagents to free the gases (e.g., acid for CO_2 in carbonates) is admitted with slight negative pressure through the upper cock, displacing mercury in the pipette. A Toricellian vacuum is created by lowering the levelling bulb, and the meniscus of the mercury in the

pipette is allowed to fall to the mark indicating A cc., as shown in the figure. Cock c is closed, and the pipette is shaken for the time required to establish equilibrium of the gases between the solution and the free space above it. One to two minutes usually suffice. Mercury is then readmitted at cock c until the gas volume in the pipette is reduced to a cc. Cock c is closed and the height of the mercury column in the manometer is read (m mm.). The zero point is then determined after expelling the gases from the apparatus, or after absorbing one or more of them by introduction of small, measured volumes of gas-free absorbent solutions (KOH for CO_2, pyrogallol for O_2) through the upper cock under slight negative pressure. After the gas has been removed the pressure is lowered until the free space above the solution is again a cc., and the zero point for the determination is read on the manometer (n mm.).



The volume, V, of gas reduced to 0°, 760 mm., contained in the solution analyzed is calculated as:

$$V = a\,\frac{m-n}{760}\left(\frac{273}{T} + \frac{S\alpha}{A-S}\right)$$

T = absolute temperature, S = volume of water solution in the apparatus, α = solubility coefficient of the gas in the solution (the cc. of gas, reduced to 0°, 760 mm., dissolved by 1 cc. of solution in equilibrium with the gas at 760 mm. tension).

The term $\frac{S\alpha}{A-S}$, which corrects for the portion of gas remaining in solution when equilibrium is reached, may be negligible for the less soluble gases, such as oxygen and nitrogen, but not for CO_2. The term is derived as follows. If V_S = volume of gas (measured at 0°, 760 mm.) held in solution by the S cc. of solution, and p = partial pressure of the gas

$$V_S = S \times \alpha \times \frac{p}{760}$$

$$p = (m-n) \times \frac{a}{50-S}$$

$$V_S = a\,\frac{m-n}{760} \times \frac{S\alpha}{A-S}$$

In case x cc. of absorbent solutions are introduced, a correction to n is necessary. It is ascertained by determining m for S and for $S + x$ cc. of water, respectively, the dissolved gases being removed by expulsion.

The solubility of CO_2 also makes an empirical correction necessary for reabsorption of the gas while the volume is undergoing reduction from $50 - S$ cc. to a cc. In our apparatus, where $S = 50$ cc., $a = 2$ cc., the factor is approximately 1.020, the reabsorbed CO_2 being 2 per cent of the total. For the less soluble gases reabsorption may be kept negligible.

No correction for vapor tension is required, since it is practically the same at the reading of both m and n.

For a given gas volume the value of the pressure change $(m - n)$ is inversely proportional to that of a. a may accordingly be so chosen that for the gas volumes obtained the percentage error in measuring a cc. of gas will be of the same order of magnitude as that in measuring the accompanying $(m - n)$ mm. of pressure change. The total volume A of the pipette chamber is a matter of convenience, but it is desirable to have it so large that the greater part of the dissolved gases shall be extracted. For analysis of 1 cc. of blood convenient magnitudes are $A = 50$, $a = 2$, $S = 2.5$. At 20° 1 volume per cent of gas under these conditions gives a reading of $m - n = 3.9$ mm., so that if $m - n$ can be determined within 0.4 mm. the error is 0.1 cc. of gas per 100 cc. of blood.

ADAPTIVE RADIATION AND CLASSIFICATION OF THE PROBOSCIDEA[1]

BY HENRY FAIRFIELD OSBORN

AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY

Read before the Academy, April 26, 1921

In 1900 the author predicted that the source of the mammalian order of the Proboscidea would probably be discovered in Africa. In 1901 Beadnell and Andrews revealed, through the Geological Survey of Egypt, the rich fauna of the Fayûm, southwest of Cairo, in which were found the remains of three proboscidean genera, named by Andrews *Mœritherium*, *Palœomastodon*, *Phiomia*, confirmed by subsequent exploration and research to be the oldest proboscideans thus far known. Animals similar to *Mœritherium* and *Phiomia* have since been reported by Pilgrim in southern Asia. These animals are now found to belong respectively to three distinct lines of the Proboscidea, namely, the moeritheres, the true mastodonts, the long-jawed bunomastodonts, as indicated in black on the accompanying diagram. They point, however, to a long antecedent origin and radiation. This is part of the evidence for an ancient adaptive radiation process by which it now appears that the proboscideans, like other hoofed mammals, were broken up into several great primary stocks way back in Eocene times, namely:

An *amphibious stock*, adapted to rivers and swamps, of limited migration.

A *mastodont stock*, adapted to forests and savannas, of wide migration.