The references, perhaps more than any other characteristic of the book, are outstanding. The author has had the originality and the fortitude to add numerous recent citations, many from current periodicals, to her literature lists, so that students may travel farther afield and may also realize that plant science offers wide opportunities for investigation.

Every book reflects the personality of its author, and this is especially true of the present volume. It is written with verve and with feeling. At times it portrays the author's philosophy, and it may be preferred, because of this, in Catholic institutions. Scientifically it is a thoroughly sound and very creditable work.

The Plant World. By HARRY J. FULLER. xi + 592 pp. 306 figs. New York: Henry Holt and Company. 1941. $3.25.

"THE PLANT WORLD" is intended especially for students "registered in elementary botany courses principally because of the cultural and general educational value of the subject, rather than because of its usefulness as a prerequisite to a professional botanical career." As such, it fills a definite niche on the library shelf.

The book is divided into four parts. The first is a brief discussion of twenty-five pages dealing with such topics as the history of botany, the importance of the subject, the nature, "explanation" and origin of life, and the differences between animals and plants. In part two, which comprises considerably more than half the volume, the cell is considered, as are the structure and functions of roots, stems, leaves and flowers. The final chapter is devoted to variation, heredity and plant breeding. Then, in part three, the groups of the plant kingdom are rather briefly discussed. The last part is concerned with various aspects of evolution, and the final chapter is on ecology. The appendix contains "A Modern Classification of the Plant Kingdom," prepared by Dr. O. Tippo, and a glossary of some twenty pages.

If the students read and learn the material presented here, they will have a good understanding of the subject, for the author does not pull his punches, even though the book is addressed more specifically to nonprofessional students. All the main subjects usually considered in elementary courses are treated adequately, and the more general "cultural" topics, such as evolution, are emphasized. The style is simple, clear and direct. Modern research work is embodied in the discussions, and a definite attempt is made to show the importance to man of many topics such as wood, grafting, plant diseases, plant breeding, etc.

A large number of the illustrations are photographs and photomicrographs; they are well selected and clear, and most of them are new in text-book circles.

"The Plant World" is a readable digest of the thoughts of men who have been pondering this kingdom and of the human application of these thoughts.

Plant Biology. By PAUL WEATHERWAX. vi + 455 pp. 182 figs. Philadelphia: W. B. Saunders Company. 1942. $3.25.

THIS volume is intended for use in a short course in botany. It is cast largely in the traditional mold. The first part deals with the structure and functions of leaves, roots, stems and reproductive organs. Considerable emphasis is placed on physiology; there are separate chapters, among the total of twenty-seven, on "The Sources of Food," "The Utilization of Food," "Metabolism, Transport, and Food Storage," "Growth" and "Responses to Stimuli." There is a clear chapter on "Heredity."

Somewhat less than half the book is devoted to the groups in the plant kingdom. This treatment is more adequate than that in many larger texts. The author finds opportunity to discuss and illustrate such plants as *Marsilea, Salvinia, Azolla, Isoetes, Psilotum, Lepidodendron, Ginkgo, Ephedra* and *Welwitschia.* Individual chapters toward the end of the volume are devoted to "Evolution," "Pollination," "Dormancy and Dispersal" and "Migration, Communities, Succession." There is a twenty-five page glossary. With very few exceptions, the illustrations are from the pen or the lens of the author, and they are clearly and carefully prepared.

"Plant Biology" is a sound book, substantial in its contents, direct in its style. It is the work of a mature scientist who has the ability to present to students the botanical heritage of the past set in the focused light of the present.

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SPECIAL ARTICLES

DENSITY AND SIZE OF INFLUENZA VIRUS A (PR8 STRAIN) IN SOLUTION[1]

INFORMATION regarding the density and the size of virus particles in solution can be obtained from measurements of rate of sedimentation of the particles

[1] This investigation was supported through the Commission on Influenza, Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army, Preventive Medicine Service, Office of the Surgeon General, United States Army, and in part by a grant to Duke University from the Lederle Laboratories, Inc., Pearl River, N. Y.

through media of different densities. Measurements of this sort have been made on the elementary bodies of vaccinia[2, 3, 4, 5] and on influenza virus A (WS strain)[4] with solutions of materials such as sodium chloride, sucrose, urea and glycerol. Under these conditions, however, the rate of sedimentation of the viruses in the concentrated solutions changes rapidly and appreciably with time, due probably to change in virus particle size and density in the solutions of high osmotic pressure. Because of this, the values obtained for particle density have been considered to be greater than the true values and those of the calculated particle sizes correspondingly too small. A possible means for obviating this difficulty would be the use of solutions of a material of high molecular weight and thus of low osmotic pressure in the range of density desirable for study. In the present work use has been made of solutions of bovine albumin for studies on the density in solution of the influenza virus A (PR8 strain).

The virus was obtained in purified preparations from virus-infected chorio-allantoic fluid of chick embryos[6, 7] and dispersed in appropriate concentration in Ringer-$CaCl_2$ solution.[6] The bovine albumin was a solution of a crystalline fraction which Dr. Hans Neurath obtained from the Armour Laboratories, Chicago, Illinois, through the courtesy of Drs. E. J. Cohn and H. B. Vickery, Harvard Medical School. The albumin was added to the virus preparation, and sedimentation rates of the virus were then measured in the air-driven ultracentrifuge employing the Lamm scale optical system.

The effects of bovine albumin in solution on the sedimentation rate of the virus with respect to the time of exposure are shown in Fig. 1. The concentration of albumin was 12.5 per cent. and of the virus 2.0 mg per ml. The sedimentation rate of the virus in this system was measured at intervals over a period of 28 hours, during which the preparation was kept in a tube immersed in crushed ice. In Fig. 1, where the observed sedimentation rates ($S_{25°}$) have been multiplied by the absolute viscosity ($\eta_{25°}$)[8] of the albumin solution, it is seen that no significant change was observed in the sedimentation rate over a period of 2.5 hours. Subsequently a small increase (4 per cent.) was seen, and this vanished in 28 hours. For comparison, the effects of sucrose in 11 per cent. concentration, which contained the same salts and was of about the same density as that of the albumin solution, are shown also in Fig. 1. In sucrose the sedimentation rate of the virus increased rapidly from the start to attain

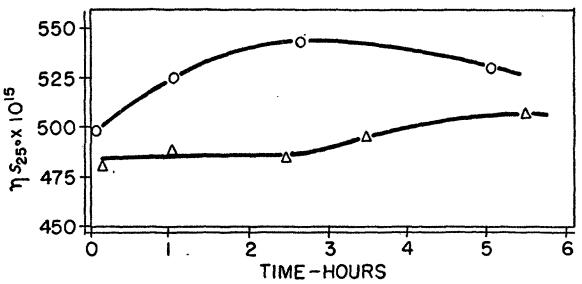

FIG. 1. Dependence of sedimentation rate of influenza virus A (PR8 strain) on time of contact with 12.5 per cent. bovine albumin solution (triangles) and with 11 per cent. sucrose solution (circles). η = absolute viscosity of suspending medium, *i.e.*, albumin or sucrose solution at 25° C. and $S_{25°}$ = observed sedimentation rate of the virus at 25° C.

in 2.5 hours a level approximately 10 per cent. greater than the value observed after the shortest interval of exposure compatible with the method of study.

With this evidence of lack of effect of bovine albumin solutions on the density and size of the influenza virus particles, a series of sedimentation measurements were made on solutions of the same virus and salt content but of albumin content varying from 0 to 25 per cent. Each study was made immediately after addition of the albumin to the virus preparation. In Fig. 2 the observed sedimentation rates, corrected as before for viscosity, are plotted in relation to the density of the albumin solution. The observed points (triangles) indicate that the relationship is linear. Similar results of another experiment with a different preparation of the influenza virus A are shown in the circles of Fig. 2. The line of Fig. 2 was drawn through the points of the two experiments by the method of least squares. Assuming that the relationship is linear throughout its course, the extrapolated line intercepts the abscissa to indicate a limiting density of the solvent medium of 1.104.

Electron micrographs have shown the influenza

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[6] A. R. Taylor, D. G. Sharp, D. Beard, J. W. Beard, J. H. Dingle and A. E. Feller, *Jour. Immunol*, 47: 261–282, 1943

[7] A. R. Taylor, *Jour. Biol. Chem.*, 153: 675–686, 1944.

[8] The viscosity measurements were very kindly made by Dr. John O. Erickson.

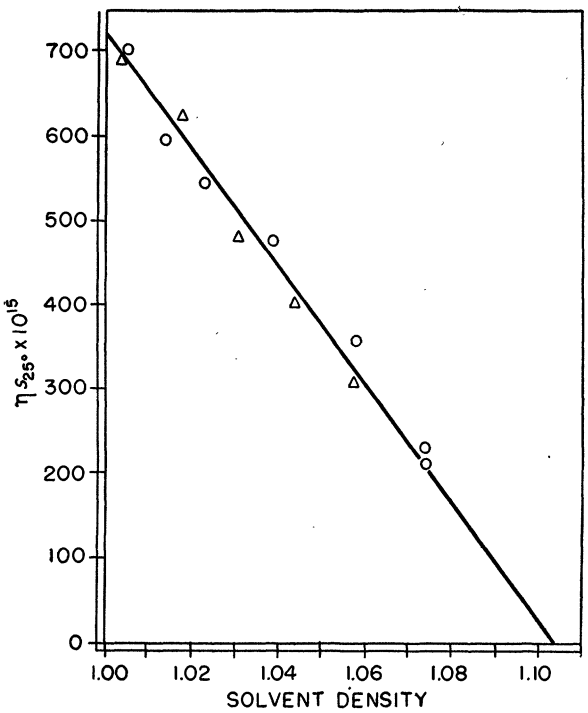

FIG. 2. Data from 2 different specimens of influenza virus A (PR8 strain) (triangles and circles, respectively) showing the linear dependence of $\eta S_{25°}$ on solvent density as the latter is varied with bovine albumin in concentrations of 0 to 25 per cent. The value of the density at the intercept at the base is 1.104.

virus A (PR8 strain) to consist of rounded or ovoid particles[6] which would be expected to sediment as spheres subject to retardation according to Stokes's law. The particle radius "r" can then be derived from the particle density ($\rho = 1.104$ from the intercept of the line of Fig. 2) and the sedimentation constant, $S_{20°}$, at infinite virus dilution.[9]

$$\tfrac{4}{3}\pi r^3(\rho_v - \rho_s)\,\omega^2\,R = 6\pi\eta r\frac{dR}{dt} \qquad (1)$$

where ρ_s = solvent density, ω = angular velocity, and R = distance from the particle to the axis of rotation. Inasmuch as $S = \frac{dR}{dt}\frac{1}{\omega^2 R}$, equation (1) for particle radius in solution then becomes

$$r = \sqrt{\frac{9}{2}\frac{\eta_{20°}\,S_{20°}}{(\rho_v - \rho_s)}} \qquad (2)$$

where the viscosity of water at 20° C. is $\eta_{20°}$. For influenza virus A (PR8 strain) $S_{20°} = 742 \times 10^{-13}$ [9], which gives for the radius of the sedimenting particle the value 57.7 m μ.

In previous reports[6,9] of estimates of the particle size of influenza virus A (PR8 strain) from sedimentation data, the density value employed in the absence of other data was the reciprocal of the partial specific volume ($\frac{1}{v}$) of the dry virus determined in the pyknometer. The diameter found in this way was 80 m μ. The density of the virus particle measured in solution in the present work, 1.104, was much smaller than $\frac{1}{v}$, 1.215, and the average diameter of the particle calculated with the present value was 115 m μ. This diameter is slightly larger, as might be expected, than that recently reported, 101 m μ, from electron micrographs[9] after direct calibration of the electron microscope by a method other than standardization on the basis of the width of tobacco mosaic rods.

It would appear that the procedures employed here provide a relatively simple method for the direct determination of the density of virus particles in solution. Further, the difference in the density of the dry virus and that of the virus in solution gives an estimate of the quantity of water associated with the particle of influenza virus A, namely, about 66 per cent. by volume. It is of interest to note that this amount of water is greatly in excess of that considered to be associated with protein molecules as water of hydration but is similar to the quantity found in organisms of complicated biological structure.

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THE POSSIBLE EXISTENCE OF A MICROBIOLOGICALLY INACTIVE "FOLIC ACID"-LIKE MATERIAL POSSESSING VITAMIN ACTIVITY IN THE RAT

IT is well established that certain nutritional deficiencies can be produced in the rat by incorporating various sulfonamides in otherwise adequate highly purified diets.[1, 2, 3] The depression of growth rate and the development of pantothenic acid deficiency, which are seen under these circumstances, can be effectively counteracted by dosage with crystalline biotin and con-

[9] D. G. Sharp, A. R. Taylor, I. W. McLean, Jr., D. Beard and J. W. Beard. To be published.

[10] Fellow in Virus Research, Division of Medical Sciences of the National Research Council.

[11] Consultant to Secretary of War and member, Commission on Acute Respiratory Diseases, Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army, Preventive Medicine Service, Office of the Surgeon General, United States Army.

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