THE Association of Special Libraries and Information Bureaux has arranged a conference to be held on November 7 and 8 in the rooms of the Royal Society. The preliminary program, according to *Nature*, includes an address by Sir Richard Gregory on "International Systems and Standards," a symposium on the use of microfilm and papers on library training and on war-time books and periodicals.

DISCUSSION

RECENT EVIDENCE REGARDING THE NATURE OF VIRUSES

SINCE Stanley[1] discovered that highly purified tobacco mosaic virus may be obtained in a crystal-like state most workers have apparently believed that the particles of certain viruses are protein macromolecules that may multiply in their hosts by a process of autocatalysis. Bawden and Pirie[2] provided further evidence for this interpretation when they discovered that tomato bushy stunt virus particles composed of nucleoprotein may come together to form strikingly symmetrical bodies which certainly have the appearance of true crystals.

Although many workers have apparently accepted this interpretation, others[3, 4] have questioned it and have considered it more probable that the virus particles are organisms, each composed of numerous molecules, that multiplication occurs by growth, followed by division and that these small organisms may exhibit electrical phenomena similar to those of molecules which cause them to aggregate in an orderly arrangement to form crystal-like structures. Further evidence favoring this interpretation was provided by Kunkel,[5] who reported that he was able to culture certain filterable organisms and that these organisms produce birefringent colonies that resemble spheroid crystals.

As Lauffer[6] and Frampton[7] have indicated, one would expect that if each virus particle were a macromolecule, all the particles of a given virus should have the same size and form. The electron micrographs[8] of viruses having spheroidal particles, although not as clear as desired, have indicated a certain amount of uniformity in the size and form of the particles of a given virus. However, viruses having rod-shaped particles, although showing a marked uniformity in width, have shown great variation in length.[8, 9] Frampton[7] has reported measurements of the length of the tobacco mosaic virus particles shown in the electron micrographs of Stanley and Anderson[8] and Anderson and Stanley.[10] He implied that the lengths show sufficient regularity to indicate that the virus particles may be composed of units 37 mμ long, joined end to end. We can not agree with this interpretation of the results. It appears to us that his measurements do not show sufficient regularity to warrant this interpretation. We have accordingly also made measurements of the length of the tobacco mosaic particles in Figs. 1 and 2 of Anderson and Stanley[10] and Figs. 3, 4, 5 and 6 of Stanley and Anderson.[8]

The results were treated statistically[11] as follows: It was assumed that the virus particles have a length of K 35, where K = 1, 2, 3, 4, etc., and that the measurements would be normally distributed about these expected values with variance σ determined to be 8 mμ. The unit 35 mμ was chosen because it is a factor of 280 mμ, which has been reported[8] as the most common length of the tobacco mosaic particle and because it is close to the value 37 mμ suggested by Frampton as a unit. $\bar{\sigma}$ is the average of the best unbiased estimates of the σ of the measurements. Each particle was measured 3 times and only clearly defined particles were measured. Small particles resembling those of amorphous material were not measured because we could not be sure that they were virus particles.

The observed measurements were then compared with the theoretical distribution by means of a chi-square test. From this comparison it may be concluded that if the theoretical distribution is proper the chance of obtaining the observed values is less than 1 in 1,000 and that there is, therefore, no significant evidence of tobacco-mosaic virus particles being composed of visible uniform units around 35 mμ long.

A frequency curve of these length measurements is shown in Fig. 1. It is also evident from visual inspection as well as statistical treatment of the curve that there is little evidence of the larger particles being composed of shorter visible uniform units joined end to end. If the particles were composed of units 37 mμ long one would expect peaks at 111, 148, 185, 222, 259, 296, etc. Although some of the peaks occur near some of these points, this does not occur with sufficient regularity to be significant.

[1] *Am. Jour. Bot.*, 24: 59, 1937.
[2] *Brit. Jour. Exp. Path.*, 19: 251, 1938.
[3] T. E. Rawlins and W. N. Takahashi, SCIENCE, 87: 255, 1938.
[4] R. A. Gortner, SCIENCE, 87: 529, 1938.
[5] SCIENCE, 91: 422, 1940.
[6] *Report New Eng. Assoc. Chem. Teachers*, 4, 1941.
[7] SCIENCE, 95: 232, 1942.
[8] W. M. Stanley and T. F. Anderson, *Jour. Biol. Chem.*, 139: 325, 1941.
[9] F. O. Holmes, *Phytopath.*, 31: 1089, 1941.
[10] *Jour. Biol. Chem.*, 139: 339, 1941.
[11] We greatly appreciate the advice of Mr. Mark W. Eudey, of the Statistical Laboratory, regarding the statistical work and the help of Miss Barbara M. Kennedy, who has done much of the work reported.

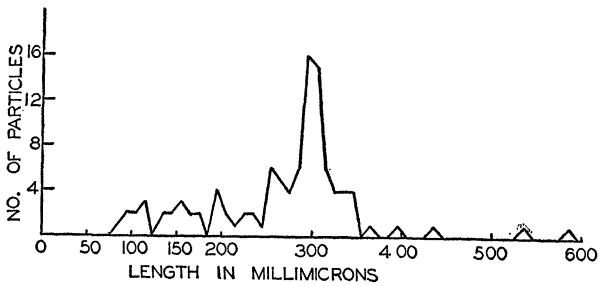

FIG. 1. Length distribution curve for tobacco mosaic virus particles.

The lengths of the particles of rib-grass strain of tobacco mosaic virus were measured on the electron micrograph shown in Fig. 2 of Holmes.[9] We have prepared a frequency curve of these lengths which is shown in Fig. 2.

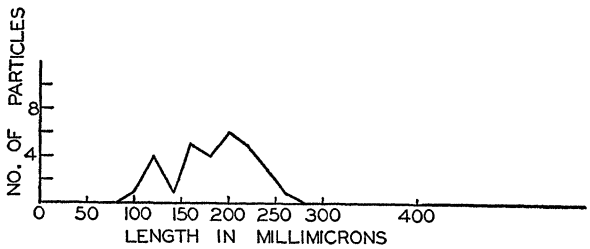

FIG. 2. Length distribution curve for particles of rib-grass strain of tobacco mosaic virus.

If one assumes that the particles of these two rod-shaped viruses are molecules and that the most common length is the most probable value for the molecular length it is evident that in each of the two rod-shaped viruses there are numerous particles too much longer and shorter than this molecular length for the difference to be due to error in measurement. It is also evident that the longer particles are not composed of 2 or more molecules of the most frequent length joined end to end.

The fact that virus particles of a given rod-shaped virus have various lengths and that the longer lengths do not appear to be multiples of the most characteristic length appears to indicate that they are not molecules.

There are several respects in which the micrographs of virus particles resemble those of bacteria. The particles of a rod-shaped virus, like many rod-shaped bacteria, are very uniform in width but vary greatly in length. The particles of a spherical virus, like most spherical bacteria, apparently have a relatively uniform diameter.

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ENZYME ACTION

THE very interesting investigation of H. C. Eyster[1] having for its purpose the explanation of the effect of narcotics on the luminous bacteria revives a problem which has been extensively discussed in the pharmacological literature. The displacement of adsorbed material from charcoal particles by narcotics was thoroughly studied by Warburg,[2] who demonstrated in several instances the adsorption of narcotics and consequent blanketing of active surfaces. Several attempts have also been made to explain the action of narcotics upon ferment action by the adsorption-theory of Traube and Warburg.[2]

The application of the results of these model-experiments on the narcosis of the living cells themselves meets, however, several difficulties. It is, for instance, demonstrated that narcotics which retard the action of the isolated diastatic ferment are markedly increasing the diastatic activity of the liver cells.[3] We doubt, therefore, whether by the experiments described by Mr. Eyster, the mechanism of the narcosis of the luminous bacteria can be satisfactorily explained.

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TRANSPARENT CALCIUM INCRUSTATION OVER ROCK PAINTINGS

ENOUGH has been written about American cave and rock shelter paintings to indicate that the different types of paintings were done throughout a long period of time, and some were made up to so late as the historic period.

In a site in Stephens County, Texas, situated ten miles northeast of Moran there is a rock shelter containing thirteen prehistoric paintings which show several unusual features. Four pictures are small, three are of problematical objects and one of a small human figure unlike the large ones. These four perhaps may have been made later than the large figures. The pictures of unusual interest are nine large red human figures. Several of these are three feet or more tall. The tallest is three feet and five inches.

Five paintings show the phallus and are of very flat-headed nude figures. Four are skirted figures with relatively more narrow heads. One of the skirted figures has the arms in position as though whirling in a dance. One of the male figures shows

[1] SCIENCE, 96: 2484, 141, 1942.
[2] A. G. Clark, "General Pharmacology," page 59. Berlin, 1937.
[3] Lesser and Zipf, *Biochem. Zeits.*, 140, page 435, 1923; E. Geiger, Proceedings 15th International Congress of Physiology, Moscow.