

the making of 230 pilot balloon ascents, revealed the prevailing summer-time wind at high levels to be south-west or west-south-west, not north-west as had previously been assumed. On the surface, observations covering an entire year were obtained, eleven months of them on a complete 4-a-day basis. Barograms were obtained in duplicate for the entire time, and thermograms except when winter cold stopped clocks. Complete wind records minute by minute were obtained from April 10 to camp abandonment on February 1.

Ernest E. Lockhart, of the Massachusetts Institute of Technology, described physiological investigations which were undertaken. An attack on the problem of acclimatization by white men in the antarctic was made by studying the effect of sudden changes in temperature on blood pressure, heart-rate and respiration-rate. This work was extended with data on 'normal' body temperature, blood pressure, heart- and respiration-rates and metabolism under basal conditions. A study of blood sugar levels was also made. Although pulse pressure is not effected significantly, systolic and diastolic pressures increase 25-35 per cent when a sudden change in temperature is the stimulus. Both the respiration-rate and the heart-rate are decreased somewhat. Under 'normal' basal conditions, pulse and respiration-rates, blood pressure and body temperature are slightly lower than normals recorded in temperate climates. Basal metabolism averages 10-15 per cent lower than that reported for temperate climates. Blood sugar levels, on the other hand, are slightly above the normal limit of 120 mgm. per cent.

Although the results presented should be extended, those now at hand indicate that acclimatization does take place in white men when subjected to the extreme conditions prevalent in the antarctic. It is suggested that the acclimatization process is begun by the continual pressor action of the low temperature. This primary stimulus, when repeated frequently, as is this case, induces hypo-effects in the several endocrine systems principally involved in metabolism.

Other papers were by Herwil F. Bryant, of the National Research Laboratory, Anacostia Station, Washington, D.C., on biological problems at East Base, J. E. Perkins, of the U.S. Biological Survey, on the biology of the West Base region, and Richard H. Black, of the U.S. Department of the Interior, on operations in Palmer Land.

## CRYSTALLOGRAPHY AND PLANT VIRUSES

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OF the many techniques introduced into research on viruses during recent years, none has aroused more interest than those of the crystallographer. The value of these techniques in such work is amply shown by three recent papers\* by Prof. J. D. Bernal and Dr. I. Fankuchen. The authors describe these papers as "only a preliminary and rough survey" and state that "many more years of

work will be needed before exact and reliable interpretations can be expected". No doubt this is true. Nevertheless, what has already been done has greatly widened our understanding of viruses, in addition to bringing to light unsuspected properties of colloidal aggregates.

Before 1936 it was tacitly assumed that all viruses were incompressible spheres, and all calculations of their sizes were made on this basis. A cursory examination of the optical properties of purified preparations of tobacco mosaic virus was sufficient to show that this assumption was invalid and that the virus particles were anisodimensional. X-ray analysis soon showed that they were rods at least ten times as long as they were wide. Their width was found to be 152 Å., but their length was too great to be measured by X-rays, although by means of specially designed cameras, spacings greater than 1000 Å. were measured. Later work on sedimentation and diffusion constants, viscosity and with the electron microscope have all confirmed the size and shape first indicated by crystallographic studies.

One of the most interesting properties of solutions of tobacco mosaic virus of sufficient purity and concentration is their separation into two liquid layers, the separation occurring at increased dilutions with increasing purity. The denser phase is also the more pure. It is formed by the fusion of tactoids, and the suggestion offered by Prof. Bernal and Dr. Fankuchen that the cusps of the tactoids are occupied by particles of impurities explains many of the observed phenomena.

X-ray measurements have been made on dried preparations of tobacco mosaic virus and on solutions of varying concentrations. The pattern obtained falls into two parts: one of large spacings obtained with cameras working at very low angles, and the other of smaller spacings obtained with high-angle photographs. The first part of the pattern varies, the spacings depending on the pH and concentration. At the same pH, the spacings increase with increasing dilution, and at a constant concentration they decrease as the pH approaches the iso-electric point. Variations in the amount of water separating the virus particles are clearly responsible for these differences.

These patterns give us information on the effective size of the virus particles and also reveal previously unsuspected regularities in the structure of solutions. They show that the distance between the rods is inversely proportional to the square root of the concentration by volume, and that the particles are distributed in a hexagonal array so as to fill the available space as uniformly as possible. This regularity of packing of the long virus particles is typical of all orientated purified preparations, whether as fluid, gels or as the crystal-like needles produced by precipitation with acid or salts. In all states the particles are equidistant and parallel, but there is no evidence of any regular arrangement in the direction of the length of the rods. This is in striking contrast with the condition inside the infected plant, where true crystals with a three-dimensional regularity occur, and confirms other evidence that the processes of purification alter the viruses, probably by causing them to aggregate end-to-end.

The high-angle photographs give us our main information on the internal structure of the virus particles; surprisingly enough, the clearest have been given by orientated solutions of tobacco mosaic virus. The patterns from these photographs show that the particles have an internal regularity similar

\* 1. "Introduction and Preparation of Specimens"; 2. "Modes of Aggregation of the Virus Particles"; 3. "X-Ray and Crystallographic Studies of Plant Virus Preparations", *J. Gen. Physiol.*, **25**, 111-65 (1941).

to that of crystals. Thus the virus preparations are in a sense doubly crystalline, for the components of the particles, in addition to the particles themselves, are regularly arranged. Their structure is more complicated than the anisotropic protein myosin but less so than pepsin. There is a spacing along the length of the particle of 11 A., and the virus seems to be composed of piles of sub-molecules with dimensions of 11 A. cubes. The spacings in the high-angle photographs are independent of the water content of the preparation, showing that even in solution the particles contain no appreciable amount of water. It is their internal regularity, lack of water and chemical simplicity that separate the viruses most sharply from the simplest recognized organisms.

Most of the work has been done with tobacco mosaic or closely related viruses, but some photographs have been taken of potato virus X and tomato bushy stunt virus. The last has spherical particles and crystallizes as rhombic dodecahedra, from which patterns were obtained with both high- and low-angle photographs. Each virus gives its own distinct pattern, and differences were even detected between related strains of the same virus, but the different viruses resemble each other more than any other type of proteins yet examined by X-rays. The differences found are of the order to be expected from a knowledge of the chemical, serological and physico-chemical properties of the viruses examined.

It is obvious that this work has opened up a field of research that promises to be extremely fertile. In virus research these techniques will be limited in their application by the difficulties of preparing most viruses, because of their small concentration in the host and their instability, in a form suitable for crystallographic studies. But with the extension of X-ray analysis to spacings as great as 1000 A. and the improvements in the electron microscope, particles of all sizes from bacteria to atoms become capable of direct examination, and a serious gap in our techniques for the examination of colloidal particles has been filled.

## OBITUARIES

### Captain T. A. Joyce, O.B.E.

THOMAS ATHOL JOYCE, who died at Hoveton, Norfolk, on January 3, was born in 1878, and was the eldest son of Thomas Heath Joyce, editor of the *Graphic* and the *Daily Graphic*. He was educated at Dulwich and Hertford College, Oxford, where he took his degree in 1901 and then studied Egyptology. He entered the British Museum as an assistant keeper in the Department of British and Medieval Antiquities and Ethnography under the keepership of Mr. (later Sir) C. Hercules Read. From the first he specialized in anthropology and was the first Museum officer to give his full time to the Ethnographical Collections including the American antiquities. He introduced considerable rearrangements in the Ethnographical Gallery, and prepared the greater part of the first "Handbook to the Ethnographical Collections", published in 1910 (second edition, 1925), which was essentially a condensed text-book of ethnology, liberally illustrated by specimens in the Museum. Thus he may be said to have laid the foundations of an Ethnographical Department as a distinct entity, destined, one may

hope, to take ultimate shape as an independent Museum.

Joyce's attention was at first devoted principally to Africa, and by collaborating with the late Mr. Emil Torday, he secured for the Museum a splendid and well-documented collection from certain tribes of the Belgian Congo, principally the Bushongo, which surpasses both in quantity and quality any other single collection from the African continent in the Museum. Together with Torday he prepared two important monographs of these tribes, "Les Bushongo" (1910) and "Les Basonge, etc." (1922), published in the *Annals* of the Musée du Congo Belge. Afterwards his chief interest shifted to the archæology of Central and South America, where it remained for the rest of his life. These studies were stimulated by his friendship with Sir Clements Markham and Dr. Alfred P. Maudslay, and resulted in a series of authoritative text-books: "South American Archæology", "Mexican Archæology", and "Central American Archæology", which appeared in quick succession in 1912, 1914 and 1916. These were pioneer books, which for the first time presented to the student and general reader in a handy and condensed form a great mass of archæological data, hitherto scattered in a variety of monographs in different languages and not easily accessible. Although no longer wholly up to date, they remain standard works of reference, and have not been superseded.

During the War of 1914-18 Joyce's services were transferred to the War Office, where he became hon. lieutenant attached to the General Staff in 1916, and captain in 1917, receiving the O.B.E. in 1918.

After the War, and following on Read's retirement in 1921, he became deputy-keeper of the new Department of Ceramics and Ethnography, and reorganized the ethnographical section. He arranged for the transfer of the magnificent Maudslay Collection of Maya plaster-casts from the Victoria and Albert Museum, and for their exhibition in a special room in the British Museum, while he prepared the official "Guide to the Maudslay Collection of Maya Sculptures from Central America", published in 1923 (second edition, 1938). Of a more popular character was his "Maya and Mexican Art" (*Studio*, 1927), a most informative and attractively illustrated volume.

Joyce had always wanted to do field work, but the opportunity was late in coming to him. However, during 1926-1931, he organized a succession of expeditions to British Honduras on behalf of the Museum, four of which he led in person. These produced a rich harvest of finds, particularly from the "Old Empire" sites of Lubaantun and Pusilhá, including a number of inscribed stone stelæ and a large series of pottery whistle figurines of a new type. Illustrated reports of these expeditions were published in the *Journal of the Royal Anthropological Institute*.

Ever since 1902 Joyce had been closely associated with the activities of this Institute, of which he was honorary secretary and editor during 1903-1913, vice-president, 1913-17 and 1923-25, and president, 1931-33. Throughout this period he devoted much time and energy to furthering the aims of the Institute, attended its meetings, and was a frequent contributor of original articles and reviews to its *Journal* and to *Man*. He took an active part in organizing the exhibition of "Indigenous American Art" at the Burlington Fine Arts Club in 1920, the catalogue for which was prepared by him.