the farm and the great losses of feeding-stuffs, caused by the prevalence of mastitis and contagious abortion, were stressed by Dr. W. R. Wooldridge. Individual farmers in the same area may get widely different yields with the same crop. Dr. W. K. Slater asked how great the increase in our productivity would be if every farmer were as skilful as the best farmers, but no one was prepared to answer the question.

The various conflicting interests that have conditioned agricultural policy in the past were considered by Sir John Russell. In the first place the cheapest type of farming in Great Britain would be extensive ranching with few workers and much processing; for, except on a strip up the east coast, our best crops are grass and trees. The essence of planning is that we should decide what is wanted and then guarantee the farmer a market for that crop, otherwise he naturally tends to play for safety and farm in the cheapest way possible. Mr. Halnan had said earlier that the conversion of Great Britain into a "dormitory and exercise ground for animals" is sound economics when imported fodder is cheap, and Dr. F. Yates had explained how a labour shortage tends to encourage stock-feeding. Under planned agriculture half our food should be home-grown, but this does not mean that half of each particular food should be; there should be a great extension in milk and vegetable production. This would mean a decline in home production of wheat, butter and other commodities that keep well and so can be easily transported from abroad. It was noteworthy that the policy of increasing the wheat acreage, except as a purely war-time measure, found no support from any speaker at the meeting; instead there was substantial unanimity that Great Britain should adopt a policy somewhat similar to the peace-time policy of Denmark.

In summing up the results of the meeting, Sir Joseph Barcroft pointed out that, whereas a Government committee consists of men who have been carefully selected for reasons not always connected with their scientific attainment, it was open to anyone with knowledge to have his views heard at meetings such as this. He suggested that a channel should be established through which any agreed plan of action could be brought to the attention of the Government. The speakers who had urged on those responsible for the planning of diet the need for making that diet appetizing had his wholehearted agreement. The Society presumably claims no particular originality for this point of view, an earlier authority having remarked:

> Now, good digestion wait on appetite,
> And health on both!

## UNITED STATES ANTARCTIC EXPEDITION, 1939–41

A SYMPOSIUM on the scientific results obtained by the United States Antarctic Expedition, 1939–41, was arranged by the American Philosophical Society at Philadelphia on November 21 last.

Prof. F. Alton Wade, professor of geology, Miami University, and senior scientist of the U.S. Antarctic Service, gave an introductory paper, in which he stated that one of the primary purposes of the Expedition was to carry on a comprehensive programme of scientific observations and research. A great portion of the programme was carried to completion by the twenty-one members of the scientific staff; due to an unexpected termination of the expedition, some phases were only partially completed. Detailed observations were made and programmes of research were conducted in the following fields: auroral phenomena, bacteriology, botany, cosmic rays, glaciology, magnetism, medicine, meteorology, micropalæontology, ornithology, petrography and petrology, physiography, physiology, radio, seismology, structural geology and zoology. Among the reports in preparation are the following: observations and height determinations of the aurora australis; the physiographical features of the Ross Shelf ice; the geology of the Weddell coast of Palmer Peninsula south of 68° S.; the geological features and formations in the vicinity of East Base; the sedimentary rocks of the Edsel Ford Mountains; the petrography and structure of the Rockefeller Mountains; ornithology report, which will include observations of bird life at both bases, at the Melchior Islands and along the ships' routes; the petrography and structure of the Melchior Islands; a correlation of radio receiving and transmitting conditions with magnetic phenomena and auroral displays.

Paul A. Siple, of the U.S. Antarctic Service, said that geographical exploration was carried on from West Base in 1940 by means of five reconnaissance field parties and two aircraft. The routes used followed but extended considerably beyond those opened first by the Byrd Expeditions of 1929 and 1934. The field parties' operations were limited to the hinter-coastal mountains east of Little America from long. 164° W. to long. 136° W. The parties were occupied mainly with surveying, geology, biology and meteorology. Aerial reconnaissance and surveying extended eastward to long. 120° W., including the major land features to nearly 200 miles south of the coast. This was accomplished by six flights, making more than a thousand usable aerial survey photographs available of the area.

Exploration to the west of Little America included three major flights over previously explored portions of the Ross Ice Shelf, crossing in each case into meridians of east longitude in the vicinity of lat. 78° 30′; 79° 20′; 81°; 83°; and 84°. Four newly discovered areas of internal disturbance were studied and fifteen bays and inlets were photographed in the continuous aerial survey of about four hundred miles of Barrier face from an altitude of 7,000 ft.

Southern exploratory operations were confined mainly to filling in the gap of mountains in the Austral Cordillera between Beardmore and Live Glaciers. However, the character of land formations east of the 120th meridian west indicated that there is no sea-level connexion between the Ross and Weddell Seas.

Other geographical accomplishments included glacial studies of the formation and physiography of shelf ice, problems of human adaptation to the climate of Antarctica, and studies of the cooling power of the wind.

An account of the geology of the large ranges around Little America was given by Lawrence A. Warner, of Johns Hopkins University.

The physical aspects of shelf ice were described by Prof. Alton Wade. The first detailed investigations of shelf ice were made at West Base during 1940. Included in the programme were the following: the variation of the density of the firn with depth, sub-

surface temperature measurements to a depth of 41 m., variations in the snow surface-level over a period of eleven months, horizontal and vertical movements within the firn, variations in the size of the constituent grains in various zones, stratification and horizontal banding. The results, presented in tabular and graphic forms, were compared with those obtained from investigations of the physical aspects of other types of glaciers; namely, valley glaciers and the Greenland Ice Cap. The lack of summer melt-water in the Ross Shelf ice eliminates what had been considered the most important factor in the process of firnification. However, without the aid of melt-water, the process does proceed with much the same results. An explanation of the firnification process in regions where the air temperature seldom rises above freezing was advanced.

Herbert G. Dorsey, jun., of the U.S. Weather Bureau, described some of the meteorological work. The programme at the East Base included the establishment of a completely equipped weather outpost more than a mile above sea-level on the plateau of Palmer Peninsula, Antarctica. Early in August 1940 a sledging party from East Base found a route to the plateau, making an ascent which previous explorers considered inaccessible to dog teams, and indicating the possibility of erecting a mountain weather station. Late in October, nearly 1½ tons of equipment were transported by four dog teams to the proposed meteorological outpost, located at 68° 7′ S., 66° 30 W. on a plateau knoll about 12 miles east of the main base. Lester Lherke and Robert Palmer occupied the plateau weather station during November and December.

Despite prevailing north-easterly storms of drifting snow, Messrs. Lherke and Palmer spent their time between living quarters in a sturdy tent and a meteorological 'office' in a snow cave. For the first time in south polar regions, detailed high-level weather data were obtained in a form suitable for comparison with nearby sea-level observations.

Six-hourly check readings on all data were taken concurrently with those at East Base, in addition to the continuous autographic records of wind, pressure and temperature. Snow accretion and ablation were measured. Pilot balloon observations of the winds aloft were especially valuable when there was a low overcast below the plateau.

The mountain station was in contact with the base twice daily by low-power radio, sending coded weather reports which were included in the East Base weather transmissions to South America. These data, and frequent special reports, were helpful in forecasting for aviation operations at East Base and provide interesting material for future research on the meteorological phenomena of Palmer Peninsula.

A preliminary report on the magnetic and seismic programme was given by Roy G. Fitzsimmons, of the U.S. Antarctic Service and the Carnegie Institution of Washington. During the period April 27, 1940–January 21, 1941, a LaCour insensitive magnetograph was in operation at Little America. Variations of the declination and the horizontal and vertical components of the earth's magnetic field were recorded. Control observations were made with a magnetometer and a dip circle. A general description of the magnetic observatory and the method of observation as well as a report on the preliminary magnetic results were given. During the period November 17–December 28, 1940, a McComb-Romberg seismograph was in operation at the Rockefeller Mountains. A report of the earthquakes recorded and analyses of them were given.

Prof. S. A. Korff, assistant professor of physics, New York University, discussed the cosmic ray programme, which was planned with the view of throwing further light on the connexions between cosmic rays and meteorology, and also on the effects produced by such high-energy rays passing through matter. The first part of the programme involved the operation of two meters at West Base throughout the antarctic winter and a correlation of the records obtained there with temperature, pressure and other effects such as magnetic variation; and also the operation of the instrument on board ship to obtain further data regarding the temperature coefficient and the latitude-variation. Finally, aeroplane flights to high altitudes were carried out, which were to be studied in connexion with *radio sonde* data. The second part, namely, studying the effects produced by the radiation, involved (*a*) operating a cosmic ray counter on shipboard for comparison with the electroscope data, (*b*) the operation of a neutron counter, and (*c*) measurement of all bursts in the cosmic ray intensity on the long-term records.

With respect to the first part, a pressure coefficient was determined from the data at West Base for each 15-day period of operation. It was found that the least-square solutions of the correlation between pressure and cosmic ray intensity gave a slope (pressure coefficient) and an intercept (the extrapolation of the cosmic ray intensity to zero pressure) both of which varied over somewhat wider limits than were anticipated. Further analysis showed that this variation was associated with changes in the height of the mesotron-producing layer, but that contrary to the usual procedure in temperature latitudes, this could not be represented as an external temperature effect. This was found to be due to the fact that the surface temperature was not a good indicator of the distribution of the atmosphere in the column of air above the instrument. Using the *radio sonde* data, a new dependence upon upper atmosphere conditions was computed, and better agreement was obtained. This was checked by the runs made on shipboard in zones of different surface temperatures. The reduction of the observations was partly supported by a grant from the Penrose Fund of the American Philosophical Society.

A report by Arnold Court, of the U.S. Weather Bureau, dealt with the complete disappearance of the tropopause during the antarctic winter. This was revealed by the 190 *radio sonde* observations made during April 25, 1940–January 15, 1941, as part of the U.S. Weather Bureau's share in the scientific programme of the Expedition.

Summer-time observations show a definite and rather warm (−50° C.) tropopause around 9 km., above which the stratosphere is −40° C. or warmer. Spring and autumn soundings clearly show the transition from the winter type, with no clearly defined stratosphere, and with temperatures to −80° C., to the summer condition. This hitherto unsuspected behaviour of the upper air apparently is due to seasonal differences in radiation, but no indications of such conditions have so far been reported in the northern hemisphere, despite daily soundings at Barrow, Nome, Fairbanks, and other Alaskan stations, and intensive work in the U.S.S.R. and Scandinavia. None of these stations, however, is so close to the pole as Little America III (800 miles).

Another phase of the meteorological programme,

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, Anacosita 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

By F. C. BAWDEN

Rothamsted Experimental Station

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 A., but their length was too great to be measured by X-rays, although by means of specially designed cameras, spacings greater than 1000 A. were measured. Later work on sedimentation and diffusion constants, viscosity and with the electron miscroscope 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 *p*H and concentration. At the same *p*H, the spacings increase with increasing dilution, and at a constant concentration they decrease as the *p*H 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).