in vertical distribution of their physical and chemical qualities.

On the basis of our recent results, it is tentatively concluded that, throughout the entire basin of the western North Atlantic, regardless of existing vertical density gradients, there is a significant eddy transfer of phosphate from the rich mid-strata to the impoverished surface layers. This, in general, is opposed to previous ideas that, in the open ocean, well-developed discontinuity layers restrict vertical transfers of dissolved nutrient substances from the rich underlying midstrata.

It is apparent that, in the open ocean, the consequence of the eddy transfer of nutrient substances to biological fertility will depend on the extent to which plant activity is confined above the principal thermocline; for, if photosynthetic activity should, for example, occur within the illuminated part of the thermocline of tropical waters, then there would be available for plant growth a supply of nutrient substances as great as occurs anywhere in the oceans. However, the vertical distribution of oxygen and phosphate in this region[2] suggest that, in general, the depth of plant activity is limited principally to the water overlying the thermocline, even in low latitudes where the latter extends well up into the illuminated part of the water column. This idea is, at least, not refuted by the few results of phytoplanktonic investigations in mid Atlantic.

That some factor other than light may limit the depth of photosynthesis seems probable; hydrographic conditions in the western North Atlantic suggest that temperature may bar access to tropical latitudes for plant species adjusted to low temperatures, and thus restrict phytoplankton to the warmer water over the thermocline. In mid latitudes the great thickness of the overlying warm water (Fig. 1) would, for lack of light, prevent a continuous phytoplanktonic distribution between surface strata in high latitudes and subsurface illuminated strata of similar temperature in the tropics. Phytoplanktonic communities in the tropics would thus tend to be limited to 'high temperature' species; and the lower and cooler parts of the photic layer would be left barren of plants unless some development of 'low temperature' organisms had taken place there independent of any direct connexion with similar 'low temperature' communities in high latitudes to the north or south.

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# Scientific Research in China

## The Academia Sinica

By V. K. Ting, Secretary-General, Academia Sinica, Nanking, China

'ACADEMIA SINICA' is the official designation for the Central Research Organisation established by the National Government in Nanking in 1928. According to its charter, it is the highest institution for scientific research in China. In the mind of its founders it is to be a sort of Academy of Sciences, Department of Scientific and Industrial Research, and Kaiser-Wilhelm-Gesellschaft combined. Unlike all the other institutions, it is independent of political control, for it does not come under any Ministry or Board, but is directly responsible to the National Government, which means the President of the Republic. It also functions as the highest national organisation for conferring honours upon individuals and institutions both at home and abroad that have distinguished themselves in science. For the purpose of directing and co-ordinating scientific activities in China, there is a council consisting of thirty members, selected from among the scientific workers of the country, and a certain number of ex-officio members who have also the right to elect candidates for the presidency of the Academia Sinica.

So far, however, its work as a group of closely connected and co-ordinated institutes for the purpose of carrying out original research has been more important than its other functions. As it

is constituted at present, it controls ten research institutes, including physics, chemistry, engineering, astronomy, meteorology, zoology and botany, psychology, geology, history and philology (including anthropology and archæology), and the social sciences. Thus the scope of research is extremely wide; for, on one hand, it includes such routine service as meteorology; on the other, it embraces the social sciences as well as history and philology, which are usually considered to belong to the 'humanities'. The following brief account will give some idea of the work being done in these institutions.

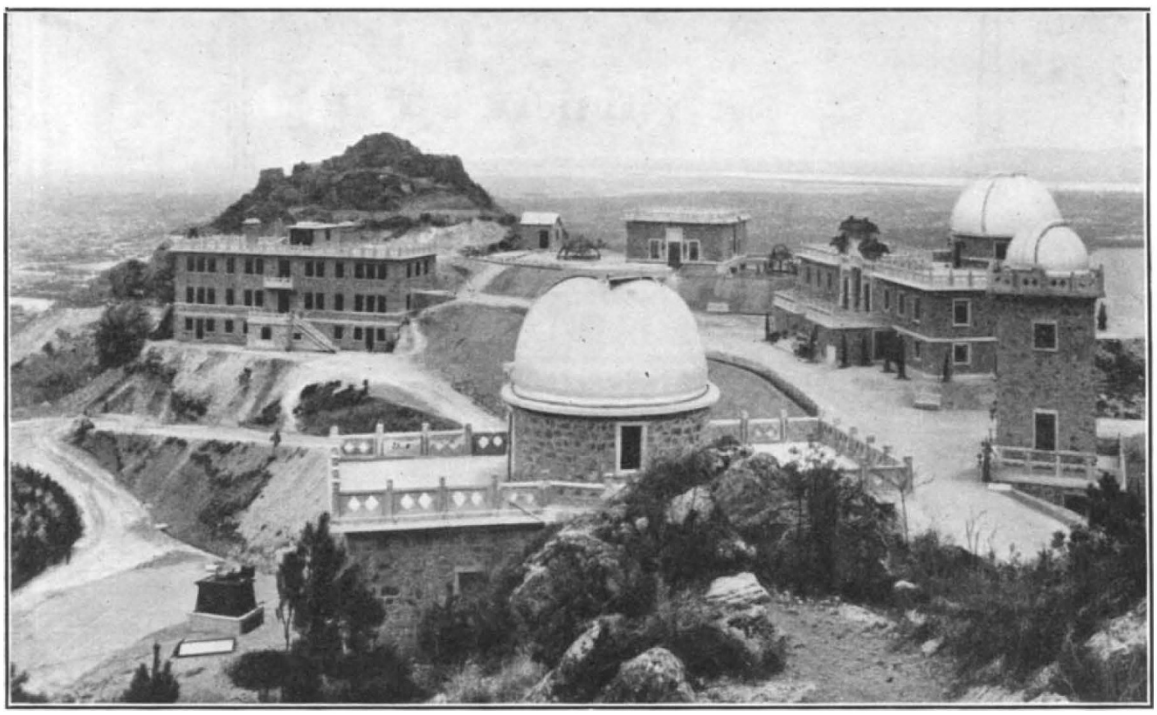

FIG. 1. Astronomical observatory of the Academia Sinica, on the Purple Mountain, near Nanking.

The Institutes of Astronomy and Meteorology are both located in Nanking. The former is built on one of the peaks of the Purple Mountain, 900 ft. above the plain just outside the east gate of Nanking (Fig. 1). It is one of the best equipped observatories in the Far East, having at its disposal one 600 mm. reflector, one 135 mm. meridian circle and one 200 mm. equatorial refractor with a 150 mm. astro-camera. In addition to compiling the almanac, supplying time service and determining geographical co-ordinates, the Institute of Astronomy carries out regular photometric and spectrophotometric studies of the sun, the planets and stars, makes observations of the variable stars, and studies solar activity with a Hale spectrohelioscope. The Institute of Meteorology is situated on another hill in the city. It is called Observatory Hill because an observatory was built there in the year 1341, and continued to exist down to the beginning of the seventeenth century. The present Institute possesses up-to-date equipment, and maintains in addition a seismological station. It has a radio-transmitting station of its own, and broadcasts its forecasts daily. It keeps in close touch with the provincial meteorological stations all over China, and maintains several branch stations of its own, including one at Kokonor and another at Lhasa. For the purpose of upper air investigation, weekly flights are made by arrangement with the Bureau of Aviation.

Three more institutes are located in Nanking: namely, those of geology, zoology and botany, and history and philology. The Institute of Geology has four sections: namely, stratigraphy and palæontology, petrology and mineralogy, economic and dynamic geology, and geophysics. Thus in scope it does not differ much from the National Geological Survey of China, which is an older institution under the Ministry of Industry, but more attention is paid to the theoretical side of geology. In co-operation with the National Geological Survey, it has also done considerable mapping, especially in the Yangtze Valley. Its publications, although less voluminous than those of the National Survey, have also gained international recognition. Its director, Dr. J. S. Lee, at the invitation of the Universities' China

Committee in London, has recently lectured on the geology of China before the Geological Society of London and in various universities of Great Britain.

The Institute of Zoology and Botany was originally the Metropolitan Museum of Natural History, which devoted itself exclusively to faunal and floral studies, especially of south and south-west China. With the organisation of a comprehensive National Museum under the joint auspices of the Academia Sinica and the Ministry of Education in 1934, it has been reorganised into the present Institute in order to avoid unnecessary duplication. At present the Institute concentrates its efforts on marine biology, especially fisheries, economic entomology and plant pathology.

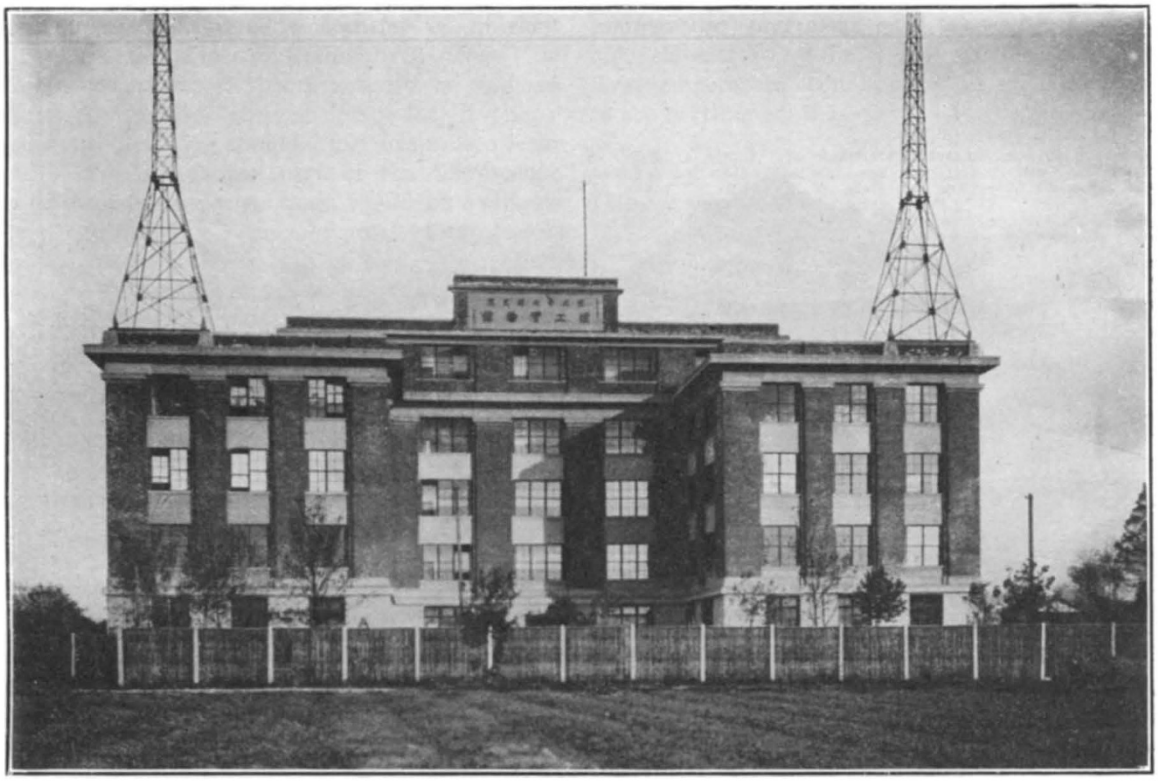

FIG. 2. Laboratory for Physical Sciences and Technology, Shanghai, housing the Institutes of Physics, Chemistry and Engineering of the Academia Sinica.

Of all the institutes, that of history and philology is the best known outside China because of the important discoveries at Anyang in north Honan province, made by the Section of Archæology. For the first time, ancient Chinese history is being checked by carefully planned and executed excavations. The site was the capital of the Shang Dynasty (1500–1200 B.C.), and had been known since 1899, when bones inscribed with archaic characters were first brought to the antiquarian market. Since 1928, excavation work has been going on without interruption. An enormous number of inscribed bones and shells, bronze, pottery, stone implements and stone carvings belonging to different cultural periods have been uncovered, and buried palaces and mausoleums have been carefully unearthed and mapped. Some of the treasures are to be shown at the coming Exhibition of Chinese Art in London. International recognition came in the form of the award of the *prix de Stanilas Julien* by the French Academy. No less important although less spectacular are the works of the historical and the linguistic sections, both of which have issued a number of publications.

The Institute of Social Sciences was also founded in Nanking. It had four sections: those of law, economics, sociology and ethnology, the last of which has been the most productive. A number of monographic studies have been made on the primitive tribes in north-east and south-west China. In 1934 it was amalgamated with the Institute of Social Survey of the China Foundation for the Advancement of Education and Culture, and its head-quarters moved to Peiping. Thus reorganised, the new Institute devotes itself entirely to economic studies, and the old section of ethnology has been changed into that of anthropology and put under the Institute of History and Philology.

The Institutes of Psychology, Physics, Chemistry

and Engineering are located in Shanghai. That of psychology is the smallest, and at present its work is largely confined to neural physiology and anatomy. It is being moved to Nanking. The three other institutes are, however, in their permanent quarters, which form a two-story building with a total floor space of 75,000 sq. ft. built in 1933 at the cost of £50,000 (Fig. 2). Both physics and chemistry possess excellently equipped laboratories. In addition to pure research, efforts are being made to study local problems. Thus, in chemistry, work has been done on Chinese drugs, paper and glass-making, metallurgy of certain rarer minerals; in physics on wireless, X-rays and geophysical surveying; and in engineering on ferrous metallurgy and ceramics, the aim being the better utilisation of China's resources in industrialisation. Both the Engineering and the Physical Institutes maintain standards testing laboratories; the latter fulfils partly the function of a bureau of standards.

The Academia Sinica as a whole receives from the National Treasury a grant of £100,000. Together with the income from its reserve fund and other grants, its budget during the last few years has averaged about £150,000.

# Obituary

## Prof. Edwin B. Frost

EDWIN BRANT FROST, who died on May 14, was born on July 18, 1866, at Brattlebro, Vermont. His father, Carlton Pennington Frost, was the seventh in descent from ancestors who had left Ipswich, Suffolk, in 1634 in order "to avoid the more savage oppression of England". They were shipwrecked off Yarmouth, but the family started again in 1635, and after a voyage of fifty-three days they reached Boston, and settled in New Hampshire, Vermont and Maine. Edwin Brant Frost derived his second name from the wife of his paternal grandfather Benjamin, who had married Mary Catherine Brant. His early home was in the green hills of the valley of the Connecticut River. His father was surgeon-major for some months in the Civil War and for three years after it, and in 1871 he was called to a professorial chair in medicine at Dartmouth College, Hanover, New Hampshire. Thus it came about that his two sons spent their learning years at Dartmouth College.

Edwin B. Frost, the younger son, graduated as A.B. in 1886, in physics. In the following year he accepted an invitation from Prof. C. A. Young to go to Princeton. Young was then engaged in writing his textbook on general astronomy, and Frost gave help in reading the proofs—an admirable way of taking a course in astronomy. He became A.M. in 1889, and then came to Europe to continue graduate studies, first at Strassburg under Kohlrausch, and later at the Astrophysical Observatory, Potsdam, under Prof. H. C. Vogel.

At Vogel's suggestion, Frost made observations with a thermopile to study the distribution of radiation over the sun's disc for comparison with Vogel's earlier study of ultra-violet radiation. Nova Aurigæ was discovered by Anderson in February 1892, and during Dr. Scheiner's temporary illness Frost photographed the spectrum of the nova with a small improvised spectrograph attached to the Repsold astrographic refractor. He also took a share with Scheiner in the measurement and reductions of the photographs of the cluster in Hercules, taken with the same refractor.

On his return from Europe in the autumn of 1892, Frost took up work as instructor in physics at Dartmouth College, Hanover, and devoted spare time to the translation of Scheiner's textbook "Die Spectralanalyse der Gestirne" (1890). This translation with extensions was published with Messrs. Ginn and Co., in 1894, under the title "Astronomical Spectroscopy".

His participation in the research activities at Potsdam, however, had made Frost aware of possibilities remote from pedagogy. He became professor at Dartmouth College in 1896, and two years later he was appointed to the chair of astrophysics in the University of Chicago. In 1898 he joined the staff of the Yerkes Observatory at Williams Bay under the directorship of Dr. G. E. Hale, and he had among his fellow workers Barnard and Burnham and Dr. W. S. Adams. When Dr. Hale was searching (1903–4) for a site for solar observations for the Carnegie Institution, Frost was called on to undertake the duties of deputy director. In 1904 Dr. Hale resigned the directorship of the Yerkes Observatory, and Frost succeeded him as director in 1905.

Hale had designed and constructed the Rumford spectroheliograph, which was mounted on the Yerkes telescope. To Frost had been assigned in particular the duty of designing and using the Bruce spectrograph (1902), to replace the earlier spectrograph used by Hale and Ellerman, on the 40-inch refractor in their study of the spectra of stars of the Fourth Type. The general design of the instrument was prepared by Frost and Dr. Hale, and it was carried out under the superintendence of Mr. Ritchey in the workshops of the observatory. With this instrument, Frost and Dr. Adams secured their observations of the radial velocities of twenty stars of the Orion type (helium stars). Thus whilst Dr. Campbell at the Lick Observatory was attacking with splendid success the task of measuring the radial velocities of stars with well-defined lines in their spectra, Frost devoted his attention to stars of class *A* with less-defined lines,