SCIENCE IN CHUNGKING

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THE present article is a continuation of the two recent contributions describing scientific work now going on in Yunnan province (south-west China). It will be followed by contributions on West Szechuan, on Kweichow and Kuangtung provinces (south-east China), and on the far north-west. It is hoped that by this means the mutual isolation of Chinese, British and American scientific workers may be mitigated.

Strictly speaking, Chungking itself is not a scientific centre any more than Westminster. The city, situated in a splendid position on a series of hills between the two great rivers where the Djalang joins the Yangtse, maintains its pride, and temporary houses have sprouted like bamboo-shoots all over the much-bombed areas. It has so often been described that a detailed account here is unnecessary, but the innumerable air-raid shelters blasted in the rock of the hillsides must be mentioned with praise. Life in the city is not so uncomfortable as is sometimes pictured, and always made agreeable by the un-failing good humour and spontaneous charm of the Chinese people themselves.

Among the Governmental organizations concerned with science, the National Resources Commission, presided over by the Economic Minister (himself a geologist), Dr. Wong Wen-hao, assisted by the able Mr. Chien Chang-chao, employs 165,000 workers up and down the country, and 12,000 administrative and technical personnel. Of the latter, more than 80 per cent are less than thirty-five years of age, including about 5,000 university graduates and about 400 technical and scientific experts who have spent many years in the West. The National Resources Commission is opening up natural resources everywhere in Free China, and its functions are to develop, operate and control basic industries, important mining enterprises, important electrical power enterprises, and also to administer other industrial enterprises as assigned by the Government. Like the Department of Scientific and Industrial Research in Britain, it subsidizes research in many universities, as well as research institutes. Then the National Health Administration, situated in a suburb, Bridge-town (place-names are purposely translated and garbled for security reasons), under Dr. Chin Bao-Shan, carries out the same functions as our Ministry of Health, and controls a National Central Medical Research Institute, to which I shall refer later.

In order to visit the important scientific work going on in the neighbourhood of Chungking, it is necessary to go out into the country some two hours motor ride in different directions. At Sandy Hook, for example, some distance up one of the great rivers which meet at Chungking, is to be found the National Central University, formerly at Nanking, but now occupying a site within the campus of the Szechuanese Chungking University. Both these universities push on with the teaching of scientific subjects in the face of rapidly dwindling supplies of essential chemicals and apparatus. In the chemical laboratory of the National Central University work is proceeding, under Prof. Kao Chi-Yu, on the paracetic acid and on the effect of acids, bases and salts on the optical rotation of organic compounds; besides studies on oil paints

and lacquer for aeroplane finishing. In the plant physiology and pathology department, Dr. Shen Chih-I (secretary of the Chinese Natural Science Society, an organization somewhat resembling our Association of Scientific Workers) studies the virus diseases of Chinese crop plants and the peculiar water requirements of rice varieties. In the biological department, Prof. Ouyang Chu pursues the studies on brain histology which he began with Oscar Vogt in Germany in former days, much handicapped by the damage which his microtomes suffered during the journey from Nanking. The physicists are also active. Dr. Sze Se-Yuan invents new cuprous oxide rectifiers, and means of making storage batteries locally, while also studying the production of permanent magnets with tungsten steel. Good work is proceeding, too, on the ultra-violet spectrum of the carbon monoxide molecule excited by bombardment with electrons (Messrs. Chao Kuang-Tseng and Yang Chun-Chung). Nor is mathematical physics neglected. Dr. Chang Tsung-Sui (formerly a pupil of Sir Ralph Fowler) is actively working on the theory of the meson, and papers by him have very recently been communicated to Great Britain through the British Scientific Mission in China.

Of the other institutions at Sandy Hook, Chungking University specializes in chemical engineering, in which subject Dr. Peng Shou-Ling (formerly with Sir Alfred Egerton at the Imperial College of Science and Technology, London) takes a prominent place. There is also the National Central Technical College, a Government institution for the training of working mechanical engineers, under Wei Yuen-Kuang as director. Among the laboratories of this College is one for hydraulic engineering and irrigation, reminiscent of what the friends of the Cambridge Geography School are accustomed to refer to irreverently as the 'mud-pie department'. But nothing could be more important for China, and this laboratory is suitably situated in Szechuan, the legendary home of the Great Yü, China's earliest irrigation engineer, who 'mastered the waters' at the dawn of history, and worked so hard that 'in ten years he passed the door of his house three times yet did not enter in'. Finally, the famous Nankai Institute of Economics is also situated at Sandy Hook.

Undoubtedly the greatest scientific centre is a small town, Windbox Gorge, lying on another of the great rivers. Here there are no fewer than eighteen scientific and educational institutions, most of them of great importance.

To begin with, there are two Institutes of Academia Sinica, the Institute of Biology and the Institute of Meteorology. The former, under the leadership of Dr. Wang Chia-Chi, is extraordinarily active, with some twenty scientific workers fully occupied. Dr. Wang himself is a well-known protozoologist, and besides being head of the Institute, he directs the protozoology department. The head of the department of vertebrate systematics is Dr. Wu Hsien-Wen; they are concerned especially with the taxonomy of the fishes, but also study fish ecology and physiology. Thus Chang Hsiao-Wei is studying interesting adaptations to life in mountain torrents (for example, the 'stone-climbing fish'), and Liu Chien-Kang the chloride-secreting cells in the gills of the paradise fish. Dr. Chen Shih-Hsien heads the entomology department; here work is proceeding on insect systematics, physiology (respiration, excretion, stridulation, etc.) and on the control of mosquito

larvæ by fishes and the insect-catching plant *Utricularia* (Miss Tan Chuan-Chieh). Dr. Rjao Chin-Chih, the algologist, heads the department of botany, which deals largely with the systematics of the higher plants, notably the *Umbelliferae*. A visitor, admiring the situation of the Institute high above the great river, and viewing the work going on in it, feels that it has the true research atmosphere of the world's best laboratories.

The Institute of Meteorology is rather a charming contrast to that of Biology. It stands on a high hill-top far from the river, looking out over terraced rice-fields on all the slopes, and it needs much fewer workers. Under Dr. Lü Chung (director) and Chen Tze-Cheng, however, it is extremely efficient in amassing observations by regular balloon ascents, etc., and has an excellent library.

No less important than these institutes, and on a much larger scale, is the Chinese National Geological Survey. Its present director is Dr. Li Chun-Yü, and as the successor of the internationally known V. K. Ting (who presided over the discovery of Peking man) he has a distinguished position indeed. The Survey has three Divisions: that of Geology, which includes Palæontology, Mineralogy and Petrology, Geophysics and Seismography, and a Cænozoic Laboratory; that of Cartography; and that of Soil Science. The cartographical work (under Dr. Tseng Shih Ying) is very active, as also is the geophysical side. Here Dr. Li Shan-Bang has shown the greatest ingenuity in constructing seismographs, a pendulum apparatus for the measurement of g , and accurate clocks, literally with pieces of scrap metal and whatever can be got in Free China's west. He is now held up for photographic registering paper, which the British Scientific Mission (among very many similar efforts) is trying to secure for him. The palæontologists are constantly engaged in working over the very large numbers of specimens which the field expeditions of the Survey are always bringing in. Dr. Yin Tsan-Hsun described, for example, immensely rich triassic finds newly brought from Kweichow province.

The library of the Geological Survey, situated some miles away from the main building, on a hilltop in most beautiful country, is one of the largest and best equipped which I have seen anywhere in Free China.

Two other Government organizations of the first importance are to be found at Windbox Gorge. One is the National Bureau of Compilation and Translation (under the Minister of Education, Dr. Chen Li-Fu), and the other is the National Institute of Industrial Research. The first of these, presided over by the eminent scholar, Dr. Chen Ko-Chung, conducts an enormous work of standardization. For scientific men, its most important function is the settling of Chinese versions of scientific terms, a matter of great difficulty in view of the wide divergence between Chinese language and thought and that of the West, where modern science originated. Of these standard dictionaries, fifteen have already appeared (dealing with astronomy, mathematics, physics, mineralogy, embryology, and the like), thirty-two more are nearly ready to print, and thirty-three more are still in card index form. The method adopted is interesting. First, all the technical terms are card-indexed, with their various Chinese versions, then a choice is made, and finally the whole is sent out in the form of mimeographed ledgers to all the experts in the subject in question, who indicate

their agreement or disagreement. If deadlocks occur, conferences are called. The Bureau employs no fewer than 200 workers, of which 130 are university men, including some very distinguished scholars, ex-presidents of universities. This work by no means exhausts, however, the Bureau's activities. It is also responsible for examining the text-books used in elementary schools, middle schools, etc., for compiling new encyclopædias and dictionaries, for translation of books (both from and into Western languages), for issuing collected editions of the classics, and for producing booklets of popular education for the masses. It is safe to say that no other Government, save perhaps that of the Soviet Union, supports such a wide programme of purposive scholarship. In the view of the Chinese Government, moreover, the Bureau needs enlarging to at least double its present size. Among the books officially translated have been Stebbing's "Modern Introduction to Logic", de Broglie's "Theorie de la Quantification dans la nouvelle Mecanique", Haas's "Einführung in die theoretische Physik", Crowther's "Tons, Electrons, and Ionizing Radiations", Howell's "Textbook of Physiology", Truscott's "Treatise on Ore-Dressing", and Sidney and Beatrice Webb's "Soviet Communism: a New Civilisation".

Imposing also in size is the National Institute of Industrial Research, which has other centres besides the main one at Windbox Gorge. Under the directorship of Dr. Ku Yu-Chuan, it comprises sixteen laboratories (fermentation, oils and fats, pure chemicals, motor fuels, analytical, colloid, cellulose, ceramics, plastics, tanning, machine design, electrical textile, strength of materials, heat power, forest products, sugar, salt and alkali). We can only glance at a few of these. In the fermentation division, Dr. Chin Pei-Sung manages the Chinese National Collection of Type Cultures, and much work is being done on acetone, alcohol and butyl alcohol fermentations. The pure chemicals division (Dr. Li Erh-Kang) produced five tons last year of all kinds of pure acids, alkalis and salts, but this is, of course, not nearly enough for China's research and production needs. In the forest products division, a remarkable effort has been made to recover the wood tar from the innumerable peasant charcoal-kilns all over the province. These have been fitted with bamboo condensers, with the result that many tons of valuable acetone and acetic acid have been made available, thus laying the foundations of an important decentralized wood-tar industry. The peasant coke-ovens are now being dealt with in the same way, which will be even more important. The plastics division has done pioneer work in the use of soya-bean oil-press cake as a basis for plastics, and many articles are now in production from indigenous waste protein and carbohydrate sources. The motor fuel division (Dr. Ku Yu-Djen) is doing fine work in the cracking of vegetable oils and the purifying of the gasoline so obtained. This Institute corresponds, therefore, to all the activities of the Department of Scientific and Industrial Research and the Research Associations of Great Britain rolled into one, but following our former analogy, the National Physical Laboratory and the Fuel and other Research Stations must all be considered as having been transferred, with the loss of most of their equipment and no locally existing facilities, to the shores of Loch Assynt!

The last important Government organization at Windbox Gorge is the National Agricultural Research

Institute, with its divisions of potato husbandry (in which the well-known American geneticist, Dr. Theodore F. Dykstra, is now working with Chinese colleagues), rice husbandry, soil science and plant pathology. In the last-named division, Dr. Chu Feng-Mei has constructed a very ingenious apparatus, almost entirely out of bamboo, for the separation of the round nematode-infested grains of wheat from the healthy elongated ones. In this way the parasites are not perpetuated when the seed is sown.

We come now to three non-Governmental institutions in this same place. First, the Science Society of China has its biological laboratory there in a secluded valley. It is actively engaged, under the veteran Dr. Chien Tsung-Su, on plant and animal systematics. This was the society which for many years published the Chinese equivalent of *NATURE* and *Science*, *Ko Shioh*. The editor, Lu I-Tao, is now in Chungking, and hopes are entertained of its early revival. Then there is the All-China Institute of Geography, an organization supported by the Sino-British Board of Trustees. Prominent in this Institute are Ling Chao (a former pupil of Prof. P. M. Roxby at Liverpool), who is shortly leaving for an expedition in Sinkiang, and Yang Kai-I (from Edinburgh) is also going as secretary to the head of the scientific survey of that province. Finally, there is Fudan University, relatively small in numbers of students, but with a high academic reputation. Its laboratories are mainly devoted to teaching, but in biology Dr. Hsieh Fen is working on the growth-rate of cyprinid fishes.

Something must now be said of the scientific work at another place, Singing Stone Valley, away in the sandstone mountains through which the river cuts its course. Here are located the National Central Hospital, the Shanghai Medical College, and the National Health Administration's Research Institute. This last corresponds closely to the British National Institute for Medical Research at Hampstead, but in subject is more akin to the Wellcome and Lister Institutes. Its buildings are new, with a particularly good auditorium, hidden away among the wooded rocky hills with the ricefields at their foot. Among the various divisions under the directorship of Dr. Chu Chang-Kan there are nutrition (Wang Cheng-Fa), sanitary chemistry and engineering, medical entomology (Ho Chi), parasitology (Yuan I-Chin), pharmacology and bacteriology (Mrs. Wang Rjo-Yü). Excellent work is going on in all these.

The Shanghai Medical College ranks very high as a medical school, with the famous Peking Union Medical College, Hsiang-Ya (Yale-in-China) Medical School, and the medical colleges at Chengtu. The able administration of the pharmacologist and expert in Chinese drugs, Dr. Chu Heng-Bi, stands for an exceptionally thorough grounding in the fundamental sciences underlying medicine, and for the provision of opportunities for scientific post-graduate work. In the present rural surroundings and with so little equipment, this last requirement can scarcely be adhered to, but the staff of chemists and physiologists is exceptionally good, and the student level as high as anything so far seen in China. Thus the biochemists, Chi Yueh-Feng and Rjen Bang-Chih, were pupils respectively of Profs. Treat B. Johnson (purines) and H. B. Lewis (sulphur metabolism) in the United States. Among the students here are many from the now exiled Hongkong University Medical School, and they have one of their professors, the obstetric surgeon, Gordon King, on the staff at Singing Stone Valley.

In conclusion, the persistence and success of Chinese institutions with so little help and facilities again clearly appears. British science and Government alike should spare no pains to send help to those who are, among the United Nations, in science's 'front line'.

NON-SOLAR PLANETS

By DR. A. HUNTER

THE possibility that other stars besides our sun may possess planetary systems is one that has been the subject of speculation for centuries. Double stars in plenty are known, of course, and the orbital separations of the components are often of planetary order. In these cases, if the system is fairly close to the sun, the component stars are easily separable in big telescopes, and their angular separation can be measured directly with a micrometer. But the immensity of cosmic distances ensures that all stellar companions which can be detected directly in this way are of stellar brightness. No planet reflecting as little light (relatively speaking) as, say, Jupiter could be seen or photographed from our solar system even if it accompanied our nearest stellar neighbour.

This is not to say, however, that we are precluded from discovering planetary systems attached to other stars. There is the possibility, for example, that the gravitational effect of a planet can be detected from careful observations of the position of its primary. From such observations bodies of stellar mass have already been discovered: perhaps the most famous case is that of the faint companion of Sirius, the existence of which was deduced from the perturbed motion of its primary more than ten years before it was detected telescopically. The difference between this case and that of perturbation by a planet is evidently one of degree and not of kind. Only recently, however, have observations of the requisite accuracy become available. These are the photographic observations made at many observatories all over the world for the purpose of determining stellar distances.

The principle employed is that of parallax displacement, as used in ordinary surveying, the baseline used being the diameter of the earth's orbit. Careful measurements of the apparent direction of a star on one night and of its direction six months later are combined with our knowledge of the size of the earth's orbit to give the distance of the star. In practice, the observations are delicate, for even the closest star has a parallax of less than a second of arc. The work must be spread over many years if small observational errors are to be reduced to a minimum, and in order to eliminate systematic errors of period one year, which would obviously vitiate the results, the measurements are made differentially, that is, the parallax displacement of the star is measured not absolutely but with reference to faint distant stars in the background. In practice, the observation consists in securing up to half a dozen photographs at each of five or more epochs of maximum parallax displacement. The photographs are then measured and the results analysed by introducing three unknowns—namely, a constant, the proper motion and the parallax—and solving by least squares.

But if the apparent motion of the star is not merely