foreground of grass stems against a dark background. He has also made a valuable study of the evolution of wing pattern within single families—a veritable comparative anatomy of pattern and its elements.

To return to ecology, the leading animal ecologist in the U.S.S.R. is Formosov. Unfortunately, he and his staff were away in the field at the time of our visit, so that I had no opportunity of hearing of their current researches, nor did I make contact with Sinskaya or other plant ecologists. Attached to the Zoological Gardens in Moscow is a small but interesting institute, the Laboratory of Experimental Ecology, under Kalabukhov. He and his assistant Afonska are making quantitative studies of the activity, temperature preferences, respiration, and oxygen consumption of various mammals—bears, foxes, field mice, hamsters, martens, etc.—and finding adaptive correlations with local environmental conditions. Work is also being done on the change of colour to winter white in *Cricetulus* and *Lepus*.

At the Museum Darwinianum in Moscow, in addition to the remarkable exhibition methods (which include a large number of striking paintings and sculptures by the artist Vatagin), Kohts, the director, has an extraordinary collection of aberrations in various species of birds and mammals. The most interesting are in blackcock, where more than 200 million specimens from the markets for some four hundred years had been gone through! As a result, Kohts is able to say that a dilute ('blue') form occurs once in about $2\frac{1}{2}$ million specimens, a form with checked black-and-white belly once in 10 million, and so on. Mme. Kohts is continuing her work on the behaviour of chimpanzees (a subject which is also being studied, with interesting results, at the Pavlov Institute at Koltushi).

Boris Zavadovsky also has a Museum of Evolution in Moscow, but this is more popular and takes in more general biology. It comprises a number of living exhibits. Zavadovsky writes a good deal on theoretical biology and on Marxism in biology, as well as doing practical work on artificial insemination, on pregnancy tests, and tests for the sex of unborn mammalian offspring.

In general, much less research is being carried on in university departments than in the special institutes of the Academy of Sciences and other non-university institutions. However, the disparity does not seem to be so great in biology as in the physical sciences. Genetics is at present taught only in the University of Moscow: specially able students from other universities may be sent to Moscow to take this course. Genetics is studied during the last two and a half years of the five-year undergraduate course in biology; there are now about twenty genetics specialists. During their final year, students are encouraged to do small pieces of research under guidance. The courses in plant and animal genetics are different, but all genetics students do some work with *Drosophila*, as well as cytology, biometry and phenogenetics.

As we only had a short time in the U.S.S.R. and did not visit many cities, the above account of work in progress is very incomplete (though it appears that a large percentage of the more important research is concentrated in Moscow and Leningrad). Thus I was unable to see anything of the work in agricultural genetics, notably the genetical research being carried on in the huge agricultural institution, the Timiriazev Academy near Moscow (where I understand much valuable work on polyploidy and on the genetics of cereals is in progress under Academician Jebrak); nor could I see that in the equally huge Forestry Research Institute near Leningrad, or the work on polyploidy in Breslavetz's department at the Botanical Garden of the University of Moscow. Karpechenko, the well-known plant geneticist, is unfortunately missing, presumed dead.

I had not the time to discover what had happened to the remarkable programme of work on the evolution and genetics of crop plants initiated by Vavilov (except that some of the seed-collections left at Leningrad were eaten during the siege). The abundant and valuable work in palæontology is being described by Prof. D. M. S. Watson and Dr. Edwards. Here I will only record the excitement of seeing a fossil Paleoniscid fish larva from the Jurassic, with eyes and yolk-sac beautifully preserved.

In general, I may sum up my impressions as follows. In spite of the insistence during the last four years that Russian biologists, like other men of science in the U.S.S.R., should do some work of importance for the war effort, pure research seems to have been kept going to a somewhat greater extent than in Britain during the War (and, according to some of the American delegation, than in the United States.)

In some branches of Russian science, a certain spirit of scientific nationalism is to be observed. There is little of this, however, in general biology, apart from the efforts made in certain quarters to elevate Michurin from the position of an agricultural and horticultural empiricist to that of a great scientific pioneer and discoverer (there is even a town which has been re-christened Michurinsk, where much of Lysenko's work is now being carried on).

If in the U.S.S.R. no outstanding discoveries appear to have been made, no new principles established, in the field of general biology during the last few years (again I defer any discussion of Lysenko's work until later), yet the work has been of high quality, many-sided in its approach, and of great volume (though not so voluminous as, for example, in geology or agriculture).

In spite of the War, my Russian colleagues seem to have managed to obtain rather more knowledge of British and American results than we did of their work, though their supply of foreign and scientific books and especially journals is still very inadequate. They all showed the greatest courtesy and friendliness and were anxious to tell us of all they had been doing and thinking. They are hoping for a rapid improvement in the facilities for interchange of personnel, as well as of reprints, journals and books.

The U.S.S.R. is taking its place as one of the foremost countries in biological research, and I anticipate that they will soon be leading the world in some fields, notably in the relation between ecology, field study, taxonomy, genetics and evolution, where their vast continuous territory, with its extremes of environmental conditions, provides them with unrivalled opportunities.

CRYSTALLOGRAPHY

By Dr. W. A. WOOSTER

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ONE of the evil effects of the War has been the virtual isolation of scientific workers from their colleagues in foreign countries, and it was a particularly welcome invitation which the Russian Government extended to British crystallographers. During the War the laboratories in Moscow and Leningrad

were largely evacuated to Kazan and other places in the east, and the resettling process is not yet complete. In spite of these difficulties, much fundamental and applied work has been carried on during the whole of the war period. The laboratories under the Academy of Sciences are well equipped with apparatus and have many trained scientific workers on their staffs.

The laboratory for morphological crystallography is in the Crystallographic Institute in Moscow. Part of the work of this laboratory consists in the routine examination of crystals derived from the numerous mineral deposits of the U.S.S.R. X-ray crystallography is carried on in at least four departments in Moscow. The substances studied in the Institute of Crystallography and in the Karpov Institute for Physical Chemistry are mostly minerals or inorganic substances. Among the former is included dioptase, the structure of which has recently been worked out, and among the latter, a number of cyanides, ferrocyanides and compounds containing other complex ions (Belov, Zdanov, Boky, Popova). Electron diffraction apparatus is being used for the study of crystals which occur in very thin flakes, for example, cadmium iodide and clay-forming minerals (Pinsker). Work, both theoretical and experimental, on certain inter-metallic phases and on the structure of thin metallic films is being carried on in the Physical Institute of the University under Prof. Konobievsky. The study of the influence of the state of chemical combination on the X-ray absorption edges and on the emission lines of certain elements is conducted by Prof. Borovsky in the Department of Petrology.

Crystal physics is much studied in the U.S.S.R. The school established more than twenty years ago by Academician A. Joffe has pursued its study of the properties of crystal and other solids with undiminished vigour. The work of Mrs. Joffe and other members of the Physical-Technical Institute in Leningrad, under the direction of Joffe, has shown the existence of new types of semi-conductors. A systematic survey of oxides and sulphides, particularly those of titanium (TiO_2), copper (Cu_2O), vanadium (V_2O_5), tungsten (WO_3), lead (PbS) and tantalum (Tl_2S), has shown that much more efficient rectifiers and photo-cells can be made with new combinations of metals and semi-conductors than can be obtained from the usual selenium-iron combination. The current per unit light intensity obtained with a tantalum sulphide – iron combination is twenty-five times greater than that given by the selenium – iron combination. Such photo-cells have now become sufficiently efficient to make it practicable to set up large batteries of them in desert places for the conversion of solar radiation into electrical energy.

It has also been shown that lead sulphide may give electronic or hole-conduction according as there is an excess or a defect of lead in the crystal structure, and that conductivities up to a thousand times that of the pure substance may be obtained with the material containing non-stoichiometric proportions of lead and sulphur. Work on these semi-conductors may have far-reaching effects on the manufacture of photo-cells and dry rectifiers.

Prof. Schubnikov (Institute of Crystallography, Moscow) has developed a new field by the study of piezo-electric textures. A cloth or wire gauze is stretched on a frame and molten Rochelle salt is brushed on, the direction of movement of the brush being always the same. In this way a plate looking rather like a plaster plate is built up in which the needle-shaped crystals of the salt are preferentially orientated in the direction of movement of the brush. Such a plate when coated with tinfoil or other electrodes forms a piezo-electric element suitable for the acoustic range of frequencies. Its internal damping is too high for it to be used in the supersonic range, but it can be used satisfactorily for microphones. Such plates may be made with the preferential orientation in one direction only or in two directions according to whether the plate is to be used for bending or twisting. These plates are strong and can be made of almost any size. Prof. Schubnikov has given the necessary extension of the theory of piezo-electricity to cover these preferentially orientated textures. Methods have also been found in the same laboratory of growing large single crystals of substances suitable for piezo-electric apparatus, for example, Rochelle salt, potassium dihydrogen phosphate and cane sugar. In relation to the latter crystal, it has been shown (Scheftal, 1941) that a change in the degree of supersaturation from 2·4 to 2·1 per cent makes all the difference between the development of a bad or a good crystal.

The mechanical properties of crystals have been studied intensively in the U.S.S.R. in recent years. A number of investigations by Miss Classen-Nekludova have demonstrated many of the fundamental facts concerning the plastic deformation and the rupture of rock-salt and certain metallic crystals. She has shown that rock-salt, when subjected to intense compression in one direction at a high temperature, twins according to a spinel law. Further studies on artificial corundum have shown how to determine the orientation of the crystallographic axes by optical means, what strains are present in the boules and how these strains influence the breakage of the specimens. A novel development in the study of the plastic properties of metals has been introduced by Stepanow (Physical Technical Institute, Leningrad), who uses fused silver chloride as a 'transparent metal'. The elastic and plastic properties of this substance have been shown to be of the same type as those of a metal. It shows a photo-elastic effect in polarized light, and this opens up possibilities of new studies on the plasticity of metals. A special plastic called 'Escapon' has been developed during the War, and it has excellent electrical and mechanical characteristics. It is made from butadiene rubber by compression at 20–50 atmospheres and between 16° C. and 200° C. according to the hardness required in the final product. A development which Joffe described as the 'vulcanization' of cellulose consists in acting on cellulose with certain quaternary ammonium bases to form oxygen bridges between the cellulose chains. Filter paper subjected to the action of these bases is rendered incapable of disintegration by water and it retains its strength even when immersed in hot water.

The following text-books in Russian have appeared recently: "The Elements of Crystallography", by A. V. Schubnikov, E. E. Flint and G. B. Boky (1940); "Elementary X-Ray Structure Analysis", by G. S. Zdanov (1940); "X-Ray Analysis of Metals", by G. S. Zdanov and Y. S. Umansky (1941); "Symmetry", by A. V. Schubnikov (1940); "Quartz and its Applications", by A. V. Schubnikov (1940); "New Apparatus for Crystal-Optical and Petrographic Investigations", by the staff of the Institute of Crystallography, Moscow (1940); "Crystals", by M. Shaskolskaya (1944); and "Analysis of Crystals by their Optical Properties, Part I", by G. B. Boky (1944).

In conclusion, it may justly be said that the study of the properties of crystals is in a very flourishing state in the U.S.S.R. at the present time, and it is to be hoped that the move towards co-operation so generously started by the Soviet Government will be reciprocated in the coming years.

PEDOLOGY

By Dr. ALEX MUIR
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THE development of pedology or soil science owes much to the initiative of Russian men of science, foremost among whom was V. V. Dokuchaiev, who laid the foundation of modern methods of soil classification. It is appropriate, therefore, that the principal centre of soil study in the U.S.S.R., the Dokuchaiev Soil Institute of the Academy of Sciences, founded twenty years ago, should bear his name. Many well-known figures in soil science have been associated with this Institute—Glinka, Gedroiz, Neustruev, Lebedev—and the British soil workers attending the recent Academy celebrations have had close contacts with the Institute since its foundation. We were given a great welcome on our arrival, and made honorary members of the staff for the duration of our stay so that we could come and go as we pleased. The present director, Academician L. I. Prasolov, and his staff had made careful preparations for the visit, and all the accounts of work in progress were fully illustrated with maps, diagrams and apparatus.

The activities of the Institute include research work on theoretical problems of soil science such as the genesis, geography and cartography of soils, soil systematics and classification, soil chemistry, physical chemistry, biochemistry and physics; but the practical side is not forgotten, and there are departments of agrochemistry and soil erosion, while saline soils and their utilization receive considerable attention.

Prasolov, who recently celebrated his seventieth birthday and forty years of scientific activity, is ably assisted by some 116 scientific and technical workers. A number of the senior members hold chairs in other institutions, which ensures close collaboration between the different organizations. In addition to this overlapping of staff, the Dokuchaiev Institute has a number of affiliated institutes in the various republics and some out-stations for the study of soils *in situ*.

Prasolov himself directs the work of the section on geography, cartography and classification, the activities of which are not confined merely to Russian soils. The Russians have long been interested in the application of their ideas of soil zonality to the rest of the world, and Prasolov has recently produced a new soil map of the world for inclusion in the Large Soviet Atlas. More detailed studies of the literature on the soils, vegetation, etc., of other regions have led to the production of new soil maps of Africa, South America and Australia. These maps and their accompanying memoirs, when they become generally available, should give a good picture of the extent to which the Russian conceptions of soil types can be applied to the more tropical countries.

For the U.S.S.R., one of the principal tasks of the cartography department is the preparation of a soil map of the Union on the scale of 1 : 1,000,000 which will be the standard map for the whole country. During the War, the surveys of the Institute were found of great use in the transfer of agriculture to the eastern regions, and considerable work is being done in the Urals, Kazakstan and Uzbekistan. While general soil surveys form an important part of the Institute's work, special surveys in connexion with erosion and salinization are also made and form the basis for the study of these phenomena and of methods of dealing with the practical aspects.

The weathering of rocks and minerals is the first stage in soil formation and is receiving considerable attention in the Institute. An interesting study is being made of the ash content of plants and the rock or soil on which they grow, and it has been shown that in the red Georgian soils there is a considerable movement of aluminium between the soil and certain plants in the natural vegetation; for example, hornbeam, beech and rhododendron. This fact has an obvious bearing on the relative movement of the soil constituents during development of the soil. In a study of rock weathering and soil formation under lichens, it is concluded that biological influence may be an important factor in the formation of clay minerals of the montmorillonite type.

The study of the nature and distribution of the clay minerals in soils has received close attention and a large body of data has been obtained. In addition to the usual X-ray and thermal methods of examination, use is being made of an electron diffraction method with some success. Other laboratory studies include exchange reactions, the nature of soil acidity, soil solution by high-pressure extraction and the nature of soil aggregates. The study of aggregates is made from the physico-chemical aspect with the view of elucidating their structure and origin in the various soil types, and also from the purely physical aspect to obtain a measure of their resistance to the destructive influences of erosion. The first aspect is an elaborate study involving microscopic examination of the aggregate at the different stages of the chemical treatment. The interesting result of the case of chernozem aggregates is that the clay minerals seem to be wrapped round the organic matter, resulting in a very stable aggregate.

Of the out-stations set up for the study of soils *in situ*, the best equipped, namely, those in the podzol and chernozem-zones, suffered greatly during the War and work on them has had to be begun afresh. Some valuable results had, however, been obtained. It has been found that there is a seasonal shifting of the carbonate horizon of the chernozem up and down in the soil, the range of movement depending on meteorological conditions, but in one year reaching as much as 17 cm. This seasonal migration of carbonates impedes the loss of calcium from the rooting zone and so results in the chernozem being an extremely stable type.

While this account of the work going on in the Dokuchaiev Institute is necessarily brief, mention must be made of the soil museum which is still housed in Leningrad. It is one of the most complete collections of Russian soils and forms a valuable guide to the soil geography of the country. Since soil excursions were not possible during our visit, it was a most useful refresher to be conducted round the museum by its curator, Miss Shokalskaya, and have its contents explained by her in excellent English.

Recent articles in *Nature* have referred to the very fine geochemical studies being carried out in the U.S.S.R., and since these have an obvious bearing on