

of water transpired by crops and the diffusion of water through the stomata are the subjects of important theoretical study. A satisfactory agreement has been found between the estimated rainfall, the estimated evaporation and the run-off from the relevant catchment area.

A study of the uptake of water during germination shows that this occurs in two stages in each of which the water content plotted against time gives an exponential curve. In the first phase, however, dead and living seeds behave alike, and the absorption of water is purely physical. The second phase is definitely associated with the living activity of the growing embryo.

The study of the intake of ions by excised roots may well lead to some better knowledge of the nutrition of plants in solutions and in soils. Consistently with the results of work elsewhere, it has been found that the soluble-carbohydrate content of roots affects, if it does not determine, the rate of uptake of potassium, phosphorus and nitrogen. These investigations, with an examination of the effects of concentration of the nutrients on the rates of uptake, are being continued.

Soil microbiology is still a very active sphere of work at Rothamsted. Research is in progress on nitrification and the relation of *Nitrosomonas* to glucose and to small amounts of metals, and there is considerable work on soil amoebæ, nodule bacteria and root secretions. Actinomyces have been found in the laboratory to give antibiotic secretions which inhibit the growth of certain fungi, and the possibilities of this in the soil are now being investigated.

In the study of clay minerals, considerable attention has been given to the technique of X-ray photography, particularly with the view of reducing the exposure time. It is now possible to obtain a photograph in ten minutes. The geological break between the Upper and Lower Devonian rocks is found to be reflected in clay mineral content—chloritic material characteristic of the Lower Devonian is absent in the Upper. This type of study is being pursued. Complexes of clays of the montmorillonite type with proteins and with pyridine are being examined and should give interesting results. Studies of the reduction of iron under waterlogged conditions as in the formation of 'gley' show that gleying is produced artificially by anaerobically fermenting grass, but this is not necessarily a microbial action since sterile fermented grass extract under anaerobic conditions produces a gleying effect.

Inoculation experiments have been continued in studying the range of hosts vulnerable to the stem eelworm and similar parasites, and some progress is reported in the search for a spring oat resistant to attack. It has been confirmed that the eelworm that attacks oats also attacks rye and vetches. It is impossible to survey all the work on nematodes and the technique of nematology, but one other piece of work that might be mentioned is the study of the movements of potato eelworm larvæ. Movements seem to be limited to a few inches, and the larvæ move upwards more easily than downwards. It has been shown that sufficient concentrations of D.D. mixture and of ethylene dibromide decrease the multiplication of eelworms caused by growing potatoes, but the multiplication was increased by very small dosages. Conditions affecting the eelworm population and potato tubers are being studied by the infestation of a heavy soil modified by sand, by peat,

by compost and by artificials. A 20 per cent increase in cysts in the first season affected the tubers where sand and peat were added, but not in the other pots, where compost and artificials increased the potato yield.

The nature, action and isolation of viruses occupy considerable attention at Rothamsted. An examination of the nucleoproteins specific to infected plants shows that only some of this is infective. In the isolation of viruses it seems that in some cases infectivity develops after the virus has been set free from the cell, and some preparations from sap increase in infectivity on standing. The movements and the feeding of aphides that transmit virus diseases are being studied, and the use of radioactive phosphorus in the nutrition of the beet and other plants used may prove helpful in some cases. Some experiments in recent years on the roguing of potatoes suggest that the amount of reduction in disease may not make roguing economical. A large amount of mycological work is going on, and in the course of the study of eyespot it was found, apparently for the first time, that the organism causing this in wheat may also cause a disease in oats.

Only a few of the activities at Rothamsted and its associated institutions have been mentioned in the foregoing paragraphs, but they will serve to exemplify the work recorded in the 1950 report. The report has two important special articles—one surveying fertilizer practice and the other reviewing work on potato root eelworm. There is also a list of 138 publications issued since the last annual report.

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

REPORT FOR 1950

THE report* of the Chemistry Research Board for 1950, which is accompanied by that of the Director of the Chemical Research Laboratory, records that the construction of a specially designed new building for radiochemical research has been commenced, and completion of this is expected to alleviate some of the difficulties from lack of space experienced in the Laboratory generally. The Radiochemical Group has made substantial progress in its work for the Division of Atomic Energy, Ministry of Supply, on the analysis and concentration of uranium in minerals and ores. Further research has been carried out on analytical methods, and a gravimetric method for the final determination of uranium in solutions purified by extraction methods in which cellulose pulp was added to the concentrated liquid before calcination at 800–900° gave rapid and satisfactory results. The separation of tantalum and niobium, and of zirconium and hafnium has been investigated, while the methods described in the recently issued "Handbook of Chemical Methods for the Determination of Uranium in Minerals and Ores" are based on experience with methods, including new chromatographic techniques, developed in the Laboratory. Besides further work on polarographic methods, in which the value of salicylic acid in giving polaro-

* Department of Scientific and Industrial Research. Report of the Chemistry Research Board with the Report of the Director of the Chemical Research Laboratory for the Year 1950. Pp. vi+104. (London: H.M. Stationery Office, 1951.) 3s. 6d. net.

graphic waves for some metals at convenient intervals has been established, the Group, in its Concentration Section, has also investigated methods for the extraction and recovery of uranium from minerals and ores and the mechanism of the reactions occurring in these processes.

The Microbiological Section of the Corrosion Group was established as an independent section in January 1950, and has since then been responsible for the maintenance of the National Collection of Industrial Bacteria. The emphasis in its work has been shifted from anaerobic microbiological corrosion to fundamental studies of sulphate-reducing and sulphide-oxidizing bacteria and their application, particularly in the disposal of refuse in wet pits and in the production of sulphur. Experiments carried out in collaboration with a local authority indicate that it should be possible to devise a method for tipping refuse into pits filled with water in such a way that sulphate reducers have no opportunity of developing on a scale sufficient to cause a nuisance. In May 1950 two officers of the Section made a thorough examination of the sulphur-producing Lake Ain-ez-Zauia in Cyrenaica and a cursory examination of three other lakes of this type. Although isolation of pure cultures of the sulphate-reducing bacteria from the samples obtained proved unexpectedly difficult, the Board is of the opinion that these investigations should be pushed ahead vigorously.

In the Corrosion Group the study of surface films has been extended by a new fundamental investigation for correlating the results of studies of oxidation of evaporated metal films at low temperatures with those of similar experiments on massive metal surfaces. The investigation of low-temperature oxidation of mild steel has continued, and the film-stripping technique has been applied to the examination of 'ferrous oxide layers' on iron. Further attention has been given to the improvement of both the high-speed and low-speed rotor techniques in studies of the corrosion of steel in moving conditions of immersion, while electrochemical studies of painted steel have thrown further light on the mechanism of the breakdown of paint in sea-water. Satisfactory reports continued to be received regarding the effectiveness in conventional cooling systems of vehicles of the 'mixed inhibitor' of sodium benzoate and sodium nitrite, but further investigations are required in systems with aluminium in juxtaposition with other metals. The mixed inhibitor has also been applied in wrapping materials, and an intensive study is now being made of the sodium salts of substituted aromatic acids as corrosion inhibitors. Further work has been carried out on the Becker-type accelerated atmospheric-corrosion test apparatus, and on the mechanism of atmospheric corrosion; excellent results have been obtained with compounds prepared from nitrogenous bases and carbon dioxide, such as cyclohexylamine 'bicarbonate', as vapour-phase inhibitors of corrosion, while work on the extensive bibliography of corrosion has been intensified.

Much of the work of the Inorganic Group on the minor metals has again been devoted to gallium; and its purification, particularly the elimination of alkali metals, has been thoroughly studied as a counterpart to the examination of its physical properties by the National Physical Laboratory. Greater attention is now being given to the preparation of pure germanium, particularly with regard to the use of this element as a semi-conductor. Exploratory work on the replacement of sulphuric acid wholly or

partly by nitric acid in the production of phosphate fertilizers is now virtually complete, and an investigation is proceeding on the conversion of rock phosphate to forms assimilable by plants by fusing with serpentine at about 1,400–1,600°. Rapid quenching is required to give satisfactory solubility in citric acid. Increasing demands on both the spectrographic and microchemical analytical services have limited work on the improvement of existing methods and development of new methods.

The work of the Organic Group has continued on similar lines to those of the previous year: neither staff nor space were available to implement fully a scheme for the preparation of chemicals, not otherwise obtainable, for use by research workers in universities. The Purification and Measurements Section is preparing a number of substances, including hydrocarbons and pyridine and its homologues, in extremely high purity for the measurement of thermodynamic constants in the National Physical Laboratory, and some 250 samples of hydrocarbons were distributed as mass spectrometric standards. The Organic Intermediates Section also prepared some isotopically labelled compounds, including urea containing carbon-14 and a salicylic acid derivative, at the request of the Medical Research Council; but there is no present prospect of a comprehensive service of special chemicals for all would-be users. Work on the vapour and solution absorption spectra of pyridine, α -, β -, and γ -picoline, and 2:6-lutidine has been completed, and in collaboration with the National Physical Laboratory water triple-point cells were constructed for daily use in checking the ice-point of the platinum resistance thermometer. An attempt to explore the effect of variation in chain structure in N-substituted piperidines on insecticidal properties showed that the dipiperidino-methane and mono- and di-piperidino-methylphenols obtained by the Mannich reaction from piperidine, phenol and formaldehyde had very low activity, while a series of N- Δ^{ω} -alkenylpiperidines was almost inactive. An attempt was made to obtain systemically-active esters by combining the N-alkylpiperidine and the *bis*-(dimethylamino)phosphonous acid groups, but the 3-piperidinopropyl ester is only slightly active and the quaternary and other derivatives are inactive. Other work was concerned with the hydrogenation of α -picoline to α -pipercoline, the preparation of anion-exchange resins containing quaternary nitrogen atoms and the construction of a fractionating column of the spinning bond type for use in the purification of long-chain fatty-acid esters.

The main effort of the High Polymers and Plastics Section has been devoted to studies of the ion-exchange and allied properties of high polymers. The preparation of a series of sulphonated polystyrenes of different degrees of cross-linking has been completed, and the marked dependence of the relative affinity-coefficients on both the composition of the resin and on the degree of cross-linking of the resin has been established. The general study of the kinetics of exchange on sulphonated cross-linked polystyrene has been continued, and it has been shown that the rates of exchange of cations with such polystyrenes depend on the degree of cross-linking of the resin structure. The extreme simplicity of the 'mixed-bed de-ionization' process for the preparation of water of very low specific conductivity has been confirmed. Osmometric methods for determining the molecular weights of polymers in solution are being examined.