ness so that the time-table of the symposium was adhered to.

The first three papers were of a general nature and surveyed the problems of abrasion and wear from different points of view. The first speaker was Dr. F. P. Bowden (University of Cambridge), who in his paper on "The Friction and Surface Damage of Non-Metallic Solids" reviewed the present state of knowledge concerning dry friction and the concomitant surface damage. The similarity between the mechanisms of metallic and non-metallic friction, with the exception of such special cases as that of diamond, was demonstrated, and the influence of chemical constitution on friction was strikingly illustrated by samples of poly-tetrafluorethylene. Prof. H. Blok (Delft), under the title "War on Wear", stressed the economic aspect of wear in its most general sense (including, for example, soil erosion); he outlined briefly the prevalent methods of the prevention of wear, and advocated a concerted attack on the problems connected therewith. Prof. J. J. Broeze (Delft) discussed "Chemical Causes of Wear" under the following three headings: atmospheric pollution; chemical attack by the lubricant which may have become converted into an organic acid; and, in internal combustion machines, incomplete combustion of the fuel. Methods of combating these sources of wear were indicated.

The remaining five lectures were concerned with specific cases of abrasion. Dr. G. Salomon (Delft), in a talk on "Morphological Aspects of Abrasion and Wear", dealt with a microscopic study of the failure of natural and synthetic fibres, their relation to the wear of the corresponding textiles, and the physical and chemical causes of this type of damage. Dr. N. A. Brunt (Delft), talking on "The Abrasion Resistance of Paints", discussed mainly the abrasion of paints under the impact of small particles. According to theoretical considerations, a low modulus is requisite for a low rate of abrasion by impact, a prediction which was borne out by laboratory experiments.

The last three papers all dealt with the abrasion of rubber. Dr. A. Schallamach (Welwyn Garden City), in a paper entitled "Elementary Aspects of Rubber Abrasion", described experiments in which rubber was scratched with a needle in order to imitate the elementary abrasion process, and discussed also the significance of the abrasion pattern found on abraded rubber surfaces. J. M. Buist (Imperial Chemical Industries, Ltd., Manchester) proposed in his paper on "Abrasion and Wear of Rubber" a power law relating the rate of abrasion to the duration of the experiment in question, and explained the practical implications of this empirical equation. The last contribution, "Some Factors influencing the Road Wear of Tyres", came from Dr. R. D. Stiehler (National Bureau of Standards, Washington), who described comprehensive road-wear tests of tyres made both of natural and synthetic rubber, and the statistical evaluation of the results which made it possible to differentiate between the effects of the variables involved in the wear of tyres.

The symposium was wound up by Dr. de Decker, who, in a general survey of the proceedings, listed the various lines of attack on the subject of abrasion and wear, and then proceeded to assess in a well-balanced summary how far the speakers in the symposium had contributed to the body of existing knowledge. It was the general consensus of opinion among the participants of the meeting that, judged by all standards, the symposium had been a success and that it had achieved what it had set out to do, that is, to lead to new contacts and lively exchanges of experiences. Dr. Houwink, Dr. de Decker and all those who helped them are to be congratulated on an exemplary feat of organization. Finally, it should be mentioned that many of the visitors will have taken back with them happy memories of traditional Dutch hospitality.

For those who stayed in the Netherlands for the rest of the week, excursions were arranged to industrial and scientific laboratories.

A. Schallamach

ROTHAMSTED EXPERIMENTAL STATION

REPORT FOR 1950

THE report for 1950 of the Rothamsted Experimental Station* records another busy year of successful activities. Visitors to the Station during the year were numbered in thousands and came, individually or in organized parties, from some thirty different countries. It is gratifying to read, alongside this, that the members of the Rothamsted staff were able to visit other centres at home and abroad, for this coming and going must play a great part in maintaining the virility of the numerous and diverse research activities of the Station and in enabling the research workers to keep contact with up-to-date work and opinions elsewhere, and with the problems calling for investigation.

The classical beginnings of the work of Rothamsted centre around the use of fertilizers and the knowledge of their use that was brought to farmers a century ago. It is good to know that while field-work with fertilizers is often tedious and unspectacular compared with a good deal of present-day research, this work continues in relation to modern needs. An example arises from the fact that the quick-acting nitrogenous fertilizers often incur much loss by drainage, while, at the other extreme, certain waste products are too slow to be useful, and the search for something between these extremes is giving encouraging results. Formalized casein—a plastic waste product—has proved useful in experimental work, and there are other possibilities.

Silicophosphate has been compared with superphosphate (the use of which may be limited by restrictions on supplies of sulphur) and was found to compare favourably for use on swedes and re-seeded grassland. Experiments on the placing of fertilizers confirm that its practice enhances yield in the case of shallow-rooted and quick-growing crops, but shows little effect with deep-rooted crops.

Work on the transpiration of water by crops, and on the calculation of the amount of artificial watering as the excess of that vaporized over rainfall, is progressing well and is attracting a good deal of attention overseas. The use of irrigation water in the calculated amount has given some good results, although others, particularly some in which the same amount of irrigation water has given different yields, are the subject of further investigation. The amount

* Rothamsted Experimental Station: Report for 1950. Pp. 184. (Harpenden: Rothamsted Experimental Station, 1951.) 7s. 6d.

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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 amœbæ, 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.) 3*s.* 6*d.* net.

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