CLASSIFICATION, BREEDING AND PRESERVATION OF THE POTATO

A SYMPOSIUM, at which recent investigations on the classification, breeding and preservation of the potato were discussed, was arranged by the Association of Applied Biologists and held in London on October 3.

The South American potatoes, their classification, affinities and value to the potato breeder were discussed by J. G. Hawkes. It was pointed out that breeders are turning more to the indigenous potatoes of the American continent in their attempts to solve problems of disease resistance and adaptation to new environments. The co-operation of the systematist, the cytologist and the geneticist is needed when dealing with the transference of the useful properties from the wild potatoes to the domestic varieties.

Mention was made of the potato-collecting expeditions in South America and especially of the British Empire Expedition sent out by the Imperial Agricultural Bureaux in 1939. An outline was given of the collection brought back by this latter expedition and the work in progress at the Empire Potato Station at Cambridge. Its use in conjunction with Empire potato breeders was also discussed. The distribution of the wild potatoes and their varied type of habitat indicate their possible use in breeding new varieties suited to climates where the potato of commerce will not at present grow.

An outline followed of the method of classification of the wild species into groups, and the valuable economic characters to be found among them. Resistance to blight, frost, viruses and Colorado beetle, together with a form of immunity to potato root eelworm, are to be found among the wild species. Some cultivated potato species are frost-resistant; others possess a very short dormancy and ability to grow at higher temperatures; others, again, are promising in respect of vitamin C and protein contents.

Many of the valuable characters are to be found in potatoes only distantly related to the cultivated varieties of Europe. Studies on chromosome numbers and on the 'crossability' of the various species are giving more exact information on their relationships and helping in the transference of the valuable disease resistance from the wild potatoes into our domestic varieties.

W. Black dealt with blight in potato breeding. Potato seedlings bred from the immune wild species *Solanum demissum* have been tested for resistance to the common strain of blight, *A*, and two new strains, *B* and *C*. Although *B* and *C* are more virulent than *A*, they differ qualitatively from each other. A fourth strain, *D*, appears to be slightly less virulent than *C* and to differ from it quantitatively. The fungus is considered to exhibit plasticity and it is thought that its virulence can be built up or modified by the degree of resistance of the host plants on which it is grown.

Studies on the inheritance of resistance indicate that, with the *A*, *B* and *C* strains, blight resistance behaves as a dominant, appearing to be controlled by four major genes, *Ra*, *Rb*, *Rc* and *R₃*, conferring immunity from strain *A*, *B*, *C* and all three respectively. It is also considered that minor genes may be present which act as modifiers in the resistant varieties and determine the degree of susceptibility in the susceptible varieties. In genetical studies the

ratios obtained always show an excess of recessives. This is thought to be due either to chromosome homologies leading to multivalent production, or more probably to the presence of incompatibility factors contributed from the wild parent.

Tests were described for ascertaining the genetical constitution with regard to blight immunity in parent varieties, and evidence was presented that suggested an increase in the virulence of the *B* strain of blight.

In the afternoon session, A. R. Wilson spoke on methods of potato storage in North America, basing his remarks on information gained during a tour under the auspices of the Agricultural Research Council in consultation with the Department for Scientific and Industrial Research and the National Farmers' Union.

Various types of storage building were described, ranging from an ordinary farm basement to a refrigerated and air-conditioned store built specially for the purpose. Partially or completely sunk stores, depending for their heat insulation chiefly on the soil banking around them, are capable of several modifications. Some are of the deep bin type with bins 18–25 ft. deep—to be found chiefly in the colder areas—whereas others are of the shallow (8–12 ft.) bin type found in the warmer areas.

Surface stores, usually of the shallow bin type, are heavily insulated, especially on the roof, to prevent sudden fluctuations of temperature and water condensation with consequent dripping on to the tubers. Various types of bins with different methods of partitioning and detachable front boards for unloading were detailed.

Ventilation and air circulation seem to be very variable in these stores, and are either of the gravity or of the forced-draught type, with the air circulating through the potatoes or passing in the floor, back and sides of the bins—the so-called 'shell' type. On the evidence available, it would appear that the shell type is the slower though more thorough method of cooling. Methods of bulk transport and of temperature control were treated also. Permanent storage accommodation has a future in Great Britain, but the American methods need careful trial here before they are adopted.

A survey of Scottish seed tuber problems was given by C. E. Foister, dealing chiefly with the methods used in attempting to reduce tuber diseases. Mention was made of the certification scheme, which distinguishes three grades for freedom from virus and trueness to type. A registration scheme is also in force to stimulate the production of varieties immune or resistant to disease. Stress was laid on methods of handling potatoes; it is thought that most farmers pay insufficient attention to dressing out diseases and abnormalities in the tubers before dispatch.

The potato work at the Seed Testing Station at Corstorphine was outlined, and the tests for blight resistance on seedlings raised by private breeders were mentioned. It is believed that there is approximately a 75 per cent correlation between foliage and tuber resistance to blight. The co-operative scheme of dry-rot investigations was also mentioned. Since there are no immune varieties at present known, it is hoped that resistance to dry-rot may be found among the South American potatoes in the Empire Potato Collection. Similarly, no varieties immune to skin spot or to scab are known in Britain, and here again the Empire Potato Collection may prove of value.

Mention was made also of black-leg, blind tuber, and a possible outbreak of potato stem eelworm in Scotland this year.

A. E. W. Boyd described some recent results of dry-rot research, indicating the very severe losses in the variety Doon Star with this disease, and the enormous decrease in the acreage grown during the last few years. It was pointed out that dry-rot is caused by the wound parasite *Fusarium coeruleum*, and that the degree of infection is directly proportional to the percentage of wounding. The parasite can also enter through lesions of powdery scab. Rough handling of the potato bags and riddling of the tubers has a very marked effect in increasing the incidence of the disease, and road transport also increases infection with previously riddled tubers.

Methods of control were dealt with in some detail. Dipping in an organic mercury preparation or 1 per cent formalin gives a good measure of control if done at lifting time, though the disadvantages of wet treatments at the busy harvest season are obvious. Thymol at the rate of 5-6 oz. (made up to 10 lb. with kaolin) per ton of potatoes has been found to be the best all-round method of control. Occasionally, however, the thymol exhibits a marked phytocidal effect on the tubers, though generally only a part of each tuber is damaged and the remainder can grow and yield normally. Application of thymol both at lifting and riddling was recommended, since these are the times of maximum damage when infection generally takes place. In the discussion which followed, the merits of the proprietary compound 'Fusarex' were discussed, together with its advantage in delaying sprouting.

J. G. HAWKES

RHEOLOGY OF MINERALS

ANNUAL CONFERENCE OF THE BRITISH RHEOLOGISTS' CLUB

THE annual conference of the British Rheologists' Club was held at Hulme Hall, University of Manchester, during September 11-13. The inaugural address was given by Prof. Harold Jeffreys, of Cambridge, who spoke on the strength of the earth; Dr. Markus Reiner, of Jerusalem, was in the chair. Prof. Jeffreys pointed out that in geophysics it is usual, as a first approximation, to assume that most of the earth is a perfectly elastic solid (transverse elastic waves from earthquakes travel freely through it to a depth of nearly half the radius, corresponding to five-sixths of the volume). Decisive evidence was given that the earth is strongly condensed towards the centre, which consists probably of liquid iron. Prof. Jeffreys discussed geological strains associated with fracture and continuous flow, and spoke on experimental work done on the behaviour of rocks under large stresses. The effective rigidity can be reduced to a half by long loading; but the fact that the Pyramids still stand is evidence that the strain tends to a finite limit. Treating the problem of fracture by dynamical methods, it can be shown that fracture can occur under the pressures existing at 650 km., the deepest earthquake focus recorded, a fact against the many theories that postulate a finite viscosity under stress differences however small. The crushing strengths of granite and basalt, as measured in the laboratory, are about 10^9 dynes/cm.². Sir George Darwin, studying a harmonic distribution of

load resembling a set of parallel mountain chains, found that the stress difference would reach a maximum at a depth $\frac{1}{2}\pi$ of the wave-length and be equal to e^{-1} times the range of load; for the Himalayas, this would suggest stress differences of the order of 10^9 dynes/cm.², and the great ocean deeps could be supported by similar strengths. It is known that there are widespread disturbances of gravitational fields that are not noticeably correlated with height; these imply genuine variations of mass per unit area, and therefore of load on the lower layer, which cannot be in a hydrostatic state.

A paper on the mechanical properties of soils and their relation to engineering practice was read by A. W. Skempton, University reader in soil mechanics and assistant professor at the Imperial College of Science and Technology, London. The mechanical properties of sands, gravels, silts and clays—referred to as soils in civil engineering—are of importance in many practical problems, including foundations, earth dams, retaining walls, roads and runways. An analysis of many practical problems was given, together with a quantitative description of the main classes of soils. This was followed by an outline of our present knowledge on the shear strength characteristics, with particular reference to clays, and the various problems in which shear strength plays an essential part. The consolidation of clays was also considered, together with some of the results which have been obtained in recent researches on the electro-physical properties of clays and silts.

In the morning session of September 12, Prof. Jeffreys in the chair, papers were read by Prof. F. C. Phillips, Herdman professor of geology in the University of Liverpool, on preferred orientation of minerals and the mechanism of rock flow, and by Dr. G. M. Lees, chief geologist, Anglo-Iranian Oil Co., Ltd., on the formation of salt domes and the flowage of rock salt. Prof. Phillips in his paper pointed out that the primary flow of igneous rocks, consolidating from a melt, may frequently be traced in a linear or platy parallelism of phenocrysts or included fragments in flow layers. Unconsolidated sediments, too, may show primary flow structures in the sense that they may flow by reason of their high water content. Rocks are found folded to a degree varying from gentle flexures to the recumbent overfolds, or nappes, of mountain systems, such as the Alps, with amplitudes of many miles; these have responded to compressional stress by flowing in the sense that they have acquired a permanent deformation without loss of cohesion. Prof. Phillips discussed in detail the actual means by which rock flow is achieved, and gave evidence of dimensional and lattice orientation of individual fabric elements. The fabric of fine-grained rocks such as slates can be studied suitably by X-ray methods. The fact that in most deformed rocks some degree of preferred orientation is present suggests that at some stage a new mechanism of translation gliding operates which allows further deformation without continued rotation. This movement is similar to that in glacier motion and has been ascribed variously to the displacement of rigid masses along shear planes, to local melting and regelation, to inter-granular movement and to translation gliding of the crystals.

There is good evidence for translation gliding in minerals such as mica, and twin-gliding in calcite, but there is still no certain evidence of the real mechanism by which the apparent plasticity of quartz is achieved; an artificial orientated quartz fabric has been