These figures indicate that the flora of the southern Ethiopian highlands is more closely related to that of the British East African highlands than to that of northern Ethiopia, in spite of the formidable obstacle to the spread of highland plants now presented by the low arid country of northern Kenya.

In a paper on "Some Aspects of the Vegetation of Ruwenzori", Mr. R. Ross (British Museum, Natural History) gave some observations made on the recent expedition to Ruwenzori of which he was a member, discussing particularly the zonation of vegetation. He recognizes the following zones: 1,200–2,100 m., *Pennisetum* savannah. 2,100–2,600 m., montane forest: probably complex, much affected by climatic and biotic factors—for example, elephants. 2,600–3,100 m., bamboo zone: divisible into four topographical types, two characterized by Ericaceae, thus simulating the true ericaceous zone higher up. 3,100–3,300 m., *Rapanea-Hagenia* forest: a tree lobelia and senecio occur. 3,300–3,900 m., ericaceous zone: *Philippia longifolia* forest dominant, mostly about 10 m. high, sometimes less; a bog vegetation of tree senecio and lobelia occurs, to be distinguished from similar communities higher up. 3,900–4,800 m., alpine zone: a mosaic of *Alchemilla* heath, *Helichrysum* scrub and tree senecio forest; these may be intermingled where the soil is continually wet. Above 4,800 m., glaciers.

Mr. Ross particularly noticed a repetition at different altitudes of communities similar in appearance but floristically different.

J. P. M. BRENNAN

GENETICS AND PLANT PATHOLOGY

THE breeding of resistant strains offers a valuable means of reducing the loss of production caused by disease in our domestic plants; but if his work is to be efficient and successful the breeder must enjoy the co-operation of the plant pathologist. A welcome opportunity for a joint discussion of their common problems was provided for pathologist and breeder at the meeting of the British Mycological Society held at Birkbeck College, London, on October 16. The subject was "Genetical Aspects of Plant Disease" and the chair was taken by Dr. C. J. Hickman.

In the introductory paper, Prof. K. Mather sketched in the nature of the host-disease relation from the genetical point of view. Host and pathogen are in permanent conflict: resistance in one puts a selective advantage on virulence in the other, while virulence in its turn puts a premium on new resistance. The situation is seen almost diagrammatically with bacteria and their phages. Exposure to the phage will select out the few resistant mutants from a colony of susceptible bacteria. The resistant colonies grown from these will in their turn select out mutants with new powers of attack from the, to them, otherwise innocuous phage; and so on. In bacterium and phage these changes are attributed to fresh mutation, but in higher plants and fungi a store of variation exists as a permanent feature of populations and species, both in the wild and in domestication. The variation affects properties of resistance and pathogenicity as well as all the other characters, morphological and physiological, of the plant, so that the selection of new mutant forms of the crop or virulent

strains of the disease need not wait on the chances of mutation.

The mode of storage of the variability and its availability to selection depend on the system of variation of the species. In crop plants it may exist within varieties where cross-breeding is the rule, or between varieties of inbreeders, or in wild relatives of the domestic species. The breeder may draw on any of these for the raw materials of improved resistance. The systems of variation in fungi are less well understood; but there can be little doubt that variation for pathogenicity is common in the wild. The variation may be stored by genic balance within nuclei and released by sexual recombination, or it may be hidden by balance between nuclei in heterokaryons and released by sorting out in asexual spore production. The reaction of the fungal population in producing new pathogenic strains to the introduction of resistant host varieties must clearly depend on the system of variation. A fuller understanding of these systems in fungi is therefore a prime requisite for an adequate programme of breeding for disease resistance.

Mr. E. W. Buxton then gave an account of his investigations into the variation of *Fusarium oxysporum*, the imperfect fungus which causes the yellows disease of *Gladiolus*. Variation was observed in respect of both morphological characters and pathogenicity in cultures of the fungus isolated from diseased *Gladiolus* plants. Although some mutation appears to occur, it is too infrequent to account for the variation to be seen in the cultures, which must therefore have been present in the original isolates from the host plants.

While the older cells of the hyphae generally contain but one nucleus, the tip cells have an average of seven nuclei, and anastomoses are common between adjacent hyphae. Thus all the requirements for the formation of heterokaryons are present, and heterokaryons can indeed be readily synthesized in experiment. The nuclear ratio of a heterokaryon has been shown to vary characteristically with the carbon content and carbon/nitrogen ratio of the medium on which it is grown, adjustment to the medium taking place in a matter of a few days. There can be little doubt that heterokaryosis is an important factor in the storage of variation for morphological characters, and that it has complicated the taxonomy of this fungal group. Though there is less experimental evidence about variation in pathogenic properties, such variation undoubtedly occurs in the wild and it appears to be uncorrelated with the morphology of the fungus. Heterokaryosis may well be important also in regard to these pathogenic properties, and a number of questions, such as whether the hyphae in the soil and those which invade host tissues are heterokaryotic, suggest themselves for further study.

The third paper, by Mr. P. R. Day, also dealt with an imperfect fungus, *Cladosporium fulvum*, which is a serious pest of the tomato. Three resistance genes are known in the tomato, so that 2³ physiological races of the fungus can be distinguished by all-or-none tests of infectivity. Of the eight possible races, seven have been recognized in Canada and five of these have been found in Britain. The fungus may be heterokaryotic but inoculation tests have so far proved inconclusive and the controlled synthesis of a heterokaryon has yet to be achieved. Marker mutations have been induced in the fungus by irradiation but, perhaps for technical reasons, no mutation affecting pathogenicity has yet been found, even though loss

mutation could bring about specialization should immunity of the host spring from a reaction induced in it by the attacking fungus. The radiation-induced markers were used to follow the effects of competition in a susceptible host between races of the fungus differing in their levels of host specialization. It has been claimed that, in the blight fungus, races with wider host ranges have lesser virulence—a relation which would be of great importance in the conservation of variation in natural populations—but the results with *Cladosporium* were not fully consistent. Mr. Day concluded by suggesting the growing of genetically mixed stands of host plants to control the spread of the disease fungus.

The remaining two papers took up the story from the point of view of the host crop. Dr. H. W. Howard described work on breeding potatoes for resistance to disease, especially late blight. In first reviewing the general considerations which the plant breeder must have in mind, Dr. Howard pointed out that a decision must be taken as to which of the many diseases must be given pride of place in the breeding programme; that sources of resistance must be sought within the crop itself and in wild relatives; that some knowledge of the genetics of resistance is valuable, though it need not be precise; that easy methods of testing resistance are desirable even though not essential; and that a knowledge of variation in the pathogen is essential but may not come along until resistant varieties of the host plant are available.

Cultivated potatoes differ quantitatively in their degrees of attack by late blight (*Phytophthora infestans*). The related species, *Solanum demissum*, is field immune in Great Britain, though it suffers from blight attacks in its native Mexico. Up to now blight resistance has been sought by the transfer of major genes for resistance from *S. demissum* to the potato. These varieties of potato with new properties of resistance, however, tend to go down under the attack of new physiologic strains of the fungus showing the specialization necessary for the successful attack of the new varieties. Indeed, where mixed stands of potatoes have been grown, they have served to reveal the simultaneous presence of all the strains of fungus necessary to attack the host plants with their various types of resistance. Thus the variation for pathogenicity is present in the natural population of the fungus, perhaps as a simple mixture of genetic types, perhaps in heterokaryons. Immediate mutation can scarcely account for the presence of the many strains, for although occasional mutation of type has been seen in culture, the fungal strains are in general stable in respect of their pathogenic properties. But whatever the way in which these fungal strains appear, the future of the *demissum* type of resistance in potato breeding is far from certain: it may have to be reinforced, or even replaced, by selection of the quantitative type of resistance found in *tuberosum* itself.

The fifth and last paper of the meeting was a fascinating account of his work in breeding strawberries resistant to the red core fungus, *Phytophthora fragariae*, by Mr. R. D. Reid. When the breeding work was started it was not even known with certainty that red core was due to a *Phytophthora*. With the isolation and description of the fungus by Dr. Hickman, the first great step forward was taken. Mr. Reid then described how he had sought for sources of genetic resistance, how these had been found despite many disappointments and difficulties,

and how the resistance had been combined with good plant characters; how specialized races (of which some ten have now been identified at least tentatively) have appeared in the picture, and how the search for sources of genetic resistance is still going on with the aim of using them to keep the strawberry ahead of the fungus. Again the question, as yet unanswered, of the origin and rise of the new strains of fungus is at the centre of the breeder's problems.

Discussion was opened by Mr. G. G. Samuel, who began by pointing out the great economic importance of breeding for disease-resistance. Biffen's wheats and Reid's strawberries, for example, show what immense rewards can result from successful breeding—at least for the grower if not for the breeder. Great needs still exist: the breeding of potatoes able to stand up to the root eelworm could, for example, save up to £2,000,000 a year in the potato crop of Britain. Genetics—in the present connexion fungal genetics, particularly Jinks's study of heterokaryosis—is now coming to the aid of the breeders seeking to produce disease-resistant types, and it promises to be an ally of the utmost value. But, despite the breeding successes of the past, are we working on the necessary scale? Where we now work in thousands, should we not think in terms of, and plan for, tens and even hundreds of thousands of seedlings annually, as do breeders in some other countries? Should we not aim at a bigger effort? A general discussion, ranging over such diverse topics as the genetical requirements of mycologists, technical aspects of assessing disease resistance and methods of controlling the spread of new pathogenic strains of fungi, then concluded the meeting.

K. MATHER

RECRUITMENT FOR THE CIVIL SERVICE

REPORT OF THE COMMISSIONERS FOR 1949–52

AT the Universities and Industry Conference organized by the Federation of British Industries at Ashorne Hill in October 1952, Sir John Maud expressed the view that, although the Civil Service requires a larger proportion of first-class graduates than it has been having, it is probably in the national interest that more, at any rate, of those of marginal first-rate standard should go into industry or trade rather than into the Civil Service. The report of the Civil Service Commissioners for the period April 1, 1949–March 31, 1952*, suggests that this may now be happening. At the beginning of the period the Commissioners did not find enough candidates of good quality for the administrative class. Although afterwards there was no difficulty in filling the vacancies—about sixty each year—throughout the period, they were unable to fill all the vacancies in the senior branch of the Foreign Service and in the special departmental classes (mainly inspectors of taxes), in which there were more posts to be filled than before the War. The Commissioners have formed the general impression that the number of outstanding candidates who wish to join the Home Civil and Foreign Services is smaller than it used to

* Report of Her Majesty's Civil Service Commissioners for the Period 1st April, 1949, to 31st March, 1952. (Being the Eighty-Fifth Report of the Commissioners.) Pp. 61. (London: H.M.S.O., 1953.) 2s. net.