grossly underestimated. Mr. Foss directed attention to the fact that these lapses are more frequent in the neurotic and the fatigued; but many experiments, including those of the long series of judgments reported by Dr. Hopkinson, show that even the experienced subject will on occasions show a wide departure from his average judgment. If the 'average man' appreciated that his errors of judgment might on, say, one occasion in fifty involve him in a potentially fatal situation, he might exercise more caution—but equally he might still take the risk.

In any experiment or situation involving subjective judgments, the apparent inevitability of big random errors must not be neglected. If a large number of observers can make the judgment, these errors can be expected to cancel out. In practice it is often difficult or impossible to obtain sufficient observers; the work has to be done with a small team, and Dr. Hopkinson's paper dealt with some of the problems which arise in such a case. Experience of the experimental situation clearly has an effect. In the case of glare discomfort, there is a demonstrable increase in sensitivity from day to day, apart from the random errors. After this 'sensitization period' is passed, the subject appears to maintain his criterion of sensation over a very long period, with a fairly constant variance. It is therefore possible to decide the number of observations necessary from this observer in order to eliminate, to a predetermined degree of probability, the random errors in his observations. Consequently, an experiment employing a team of observers can be designed with a certain precision. It remains to link the results with those which would be expected to be obtained from a representative selection of the population under the same conditions. This has been done for a few of the important situations, and it has been found that about four-fifths of the general population are satisfied, or more than satisfied, with the average opinion of the team of experienced subjects. This applies, of course, to the particular problem of glare in lighting, but the same procedure is applicable to other perceptual situations.

The exact reason for this 'experience effect' in subjective judgments did not emerge from the discussion. It may be some form of accumulative memory-trace effect which should be capable of explanation. It might well link up with studies of modern information theory. The techniques of the Building Research Station experiments, which demand the control and variation by the subject of the physical variable governing the sensation, involve the feed-back of information of the situation, which must necessarily influence the judgment. These factors need study and explanation. The judgment is certainly influenced by the environment. This has been shown to be true in the judgment of spatial direction, as was demonstrated in the paper by Miss M. A. Phemister, of the Psychology Department, Queen's University, Belfast. There are preferred frames of reference, which assist judgment. If the body is vertical, the subject can judge position and direction accurately, but if it is tilted, this facility is to some extent lost. The apparent size of an object depends not only on the angular subtense of the object at the eye, but also on its position in the frame of reference. The moon near the horizon looks bigger than when well up, to such an extent that all kinds of explanations of the effect are made in terms of refraction distortions—another example of the inclination of some trained scientists to search for an objective rather than a subjective explanation of a phenomenon.

One would have hoped that some discussion would have arisen on the training of subjects to make judgments: whether such training is advisable, and if so, what form it should take. This important point was unfortunately not taken up. Mr. Foss, in his paper, gave a clear lead in his suggestion that 'intuition' is a facility that should be recognized as a valuable ability in clinicians and interviewers, for example, and that persons of good intuition should be found and trained, over and above the need, already recognized, for the training of subjects to make finer discriminations of a situation with greater accuracy. Dr. Hopkinson suggested that observers should have certain valuable personal characteristics. They should have a social conscience, and give of their best, without needing to be encouraged by a knowledge of the trend of their results—indeed, they must not have any preconceived theory about the experiment on which they are asked to make judgments; otherwise their 'coefficient of involuntary mendacity' may cause deviations or over-compensation. Their social conscience should extend only to a desire for the success of the experiment, and not to an interest in its result. Personal characteristics may also influence the kind of criteria which form the basis of the judgment. Mr. Foss suggested that some subjects may work better with broad categories; others may prefer to exercise their abilities to make fine discriminations within narrow categories, and hence these people may be suitable for different experiments from the former. This is a valuable and interesting suggestion which may merit close attention by those engaged on the development of the discipline of subjective judgment experiments.

K. G. Hopkinson

BOTANY OF FLAX

In introducing a meeting on the "Botany of Flax", held in Belfast on September 8 by Section K (Botany) of the British Association, Major G. O. Searle, of H.M. Norfolk Flax Establishment, referred to the importance of the flax plant as a major factor in building up the prosperity of Belfast and Northern Ireland in general. Although in Ernst Schilling's "Die Faserstoffe" more than nineteen hundred plant species are listed as being capable of yielding fibre of industrial use, the best of all—that is, *Linum* spp.—were utilized in the Middle East seven thousand years or more ago. It has been suggested by some that *Linum angustifolium* Huds. was the species first used for the manufacture of linen; but it is clear that for many centuries *Linum usitatissimum* L. has held the field; the taller fine-stemmed varieties are used for the production of fibre, and the shorter branching-varieties for linseed. The chief interest of linen flax lies in its fibre system and in the attempt to produce improved types by breeding, the quantity and quality of the fibre being the salient factors concerned. From 1880 onwards, flax growing in the British Isles has been mostly centred in Northern Ireland where, owing to the practice of 'dam retting', the seed is lost. Consequently, all sowing seed was imported from Russia and the Baltic countries or from Holland. Distinctive varieties as such were not available, and the brands of seed largely used were known as Riga

or Pernau Crown. Often the seed was first imported into Holland, where it was grown once, and the produce exported to Northern Ireland as Riga Child or as Dutch seed under a merchant's brand. Some of these brands were exceptionally good; but they are not now obtainable owing to the changed conditions of flax culture in Russia and the Baltic countries since the Revolution of 1917.

Planned flax breeding was commenced in or about 1911 by the Department of Agriculture in Dublin and by Vargas Eyre at Wye College, Kent. Eyre had visited Russia and the Baltic countries in that year and had brought back seed from some of the best flax districts. These stocks were maintained in England until 1920, when they were taken to Northern Ireland and made available for the flax breeding programme commenced by the Linen Industry Research Association at Lambeg. It was then known that taller varieties of flax could be isolated by single-plant selection from existing commercial strains, and the early work was based on this knowledge. In order to short-circuit the lengthy procedure of bulking large numbers of pure line selections for field and mill trials, Searle and Davin developed a section-cutting, staining and fibre-measuring technique for assessing the likely value of selected plants. As a result of this work, the well-known series of Liral varieties of fibre flax were produced. Liral Monarch and Liral Crown were single-plant selections from a Dutch brand of seed; Liral Prince was a hybrid between a Dutch selection and one of the original Russian strains produced in 1911; Liral Dominion, a selection from imported Riga seed, has been extensively grown in Canada, while a short but more resistant variety, Liral Duke, has given satisfaction in Egypt when grown on irrigated land. Similar success attended the work carried out at the Plant Breeding Station of the Northern Ireland Ministry of Agriculture, where such popular varieties as Stormont Gossamer, Stormont Cirus and Stormont Motley have been produced. Some promising varieties have appeared on the Continent of Europe in recent years, but with the exception of Concurrent, a white-flowered flax which has been favoured by Continental growers for its standing and crop-yielding qualities, their popularity has not tended to be lasting.

Thus, during the past thirty years pure-line strains of flax have been produced which, according to the official trials, yield up to 50 per cent or more fibre per acre than the older commercial brands. Yet it is generally agreed both in Britain and on the Continent that the yields and grades of fibre are not so high as they were fifty years ago. The true explanation for this may lie in the inevitable decline in standards as fibre flax production slowly changed from a peasant handicraft to a semi-mechanized mill industry, and the outstanding problem is to devise ways and means for reversing this decline.

The future of flax breeding may be influenced by a study of yarn quality made in recent years by the Linen Industry Research Association. Here a significant correlation has been shown to exist between diameter and length of straw and spinning quality, indicating a relationship between fineness of straw and fineness of fibre. If it be assumed that fibre strands with fine ultimate fibres having thick walls and a small lumen are stronger than those having large ultimate fibres and a large lumen, then it would seem as if the search for strength may be linked with the search for fine quality, since the taller fine-stemmed varieties tend to have more and finer fibres and the thick-stemmed varieties coarser fibres with a tendency to a large lumen. These findings may be put to the test in trials with the three new purple-flowered varieties, Norfolk Earl, Norfolk Prince and Norfolk Mandarin, which appear to possess the characters required in the search for both quality and quantity of fibre.

In dealing with the question of seed health in relation to flax, Prof. A. E. Muskett, of Queen's University, Belfast, outlined the work carried out in Northern Ireland for the purpose of providing techniques for the examination of seed for contamination with fungal parasites. In the case of flax, this work culminated in the Ulster method for seed examination as a routine procedure, and in proving the effectiveness of tetramethylthiuram disulphide as a flax-seed disinfectant. The disinfection of all sowing fibre flax seed produced in the United Kingdom has now become routine practice. The availability of the Ulster method allowed a health survey to be made for flax seed produced throughout the United Kingdom, and the survey has now been carried out for a period of ten consecutive years, three to four thousand seed samples being examined each year. The results may be expressed as follows.

(1) (*a*) The incidence of the fungal seed-borne parasites *Colletotrichum linicola* Pethybr. and Laff., *Polyspora lini* Laff. and *Phoma* sp. is highly significant in the northern and western areas of the United Kingdom. It is insignificant in the southern and eastern areas. (*b*) The incidence of the fungal seed-borne parasite *Botrytis cinerea* Fr. may be significant in flax seed produced in all areas of the United Kingdom. Its incidence tends to be highest in seed produced in some coastal areas.

(2) The results show clearly that seed contamination occurs much more readily in the wetter and cooler northern and western areas than in the drier and warmer areas of the south and east, where no build-up of parasitic fungi, with the exception of *Botrytis*, has been observed over a period of ten years. Rainfall, in so far as it may encourage a continuously humid atmosphere, is probably the major factor leading up to seed contamination, with temperature conditions playing their part.

(3) Investigations over a ten-year period show that the area to the south and east is well suited for the production of supplies of healthy flax seed of good quality. The remainder of the country is not suitable for seed production.

The results emerging from this survey show the possibilities which might emerge from similar surveys carried out not only in the United Kingdom but also on a world-wide basis with seeds of other agricultural and horticultural crops, with the object of ensuring supplies of seeds and planting stocks of proved good health. Such work might be of very great benefit in the more backward regions where so much still remains to be done to ensure more bountiful supplies of food and raw materials.

In presenting a paper on the physiological specialization of *Melampsora lini* (Ehrenb.) Lev. by Dr. A. G. Arif (formerly a research student of Queen's University, Belfast, and now in India), Dr. J. Colhoun, of Queen's University, said that studies of the reactions of sixteen differential flax varieties to pure cultures of *Melampsora lini*, the causal organism of flax rust, collected in various parts of the United Kingdom had resulted in the recognition of sixteen

physiological races of the parasite. Six of these races have already been recorded in North America or Europe; but the others are believed to have been hitherto unrecorded. One new race was also isolated from diseased flax sent from Pakistan. All the races found occurring in England, Scotland or Wales have been recorded as occurring in Northern Ireland. All the fibre varieties of flax commonly grown in the British Isles are susceptible to all the British races of the fungus. The fibre varieties, Textilshchik, U.S.S.R. No. 2, 1288/12 and Stakhanovets, developed for rust resistance in the U.S.S.R., as well as the rust-resistant variety Wada, bred in Australia, proved immune to all the British races. These results show substantial agreement with those previously obtained in Northern Ireland for the reaction of these varieties in the field, with the exception that 1288/12 was susceptible in field trials in certain years. It is suggested that the difference between the results of field trials and those where known races of the fungus were used for inoculation purposes may be attributed to more races being involved under field conditions than have yet been differentiated. These studies demonstrate that resistant varieties exist to provide the basis for the production of varieties which will combine the quality of rust resistance to British races of the parasite and high yield of good-quality fibre.

The important problem of weed control in the flax crop was dealt with by Mr. K. Holly, of the Oxford Unit of Experimental Agronomy, who emphasized the fact that flax cannot compete effectively with aggressive or perennial weeds. As it is the fibre in the stem of the flax plant which is the economic product, the use of selective herbicides for flax must be carefully studied for adverse effect on the straw as well as for effectiveness of weed control. In the course of experimental work with weedicides on crops in south and east England, sulphuric acid, ammonium sulphamate and ammonium thiocyanate were quickly discarded because of the excessive damage caused. Although, at equivalent dosages, cupric chloride had more adverse effect on flax than cupric sulphate, from three to five times as much cupric sulphate was needed to give a comparable degree of weed control. Dosages of cupric chloride of 10–20 lb./acre in 100 gallons of water had no adverse effect upon the yield of deseeded straw or scutched fibre at the 4–6-in. growth stage. Sodium dinitro-*o*-cresylate could be used at 6 lb./acre before the flax is 10 in. high without undue risk, and approximately the same finding held for the sodium salt of 2-methyl-4-chlorophenoxyacetic acid used at 1 lb./acre. Experiments on weed-free crops showed that the safety limits for cupric chloride and sodium dinitro-*o*-cresylate were small, whereas they appeared to be greater for sodium methyl-chlorophenoxyacetate. Since 1945 the work has been confined to a comparison of the effectiveness of commercial formulations of the sodium salts of 2-methyl-4-chlorophenoxyacetic acid and 2.4-dichlorophenoxyacetic acid. The use of the sodium salt of the methyl-choro compound at 1 lb./acre or less, with a maximum resistance when the crop was 4–6 in. high, was found to be safest for the variety Liral Prince. With the advent of low-volume spraying, further experiments showed that this method entailed a greater risk of damage than medium- or high-volume applications. The results of the work considered as a whole suggest the recommendation of the use of sodium methyl-chlorophenoxyacetate for weed control in the flax crop in England. A dosage-rate of ¾ lb./acre should not be exceeded, and it should be applied between the cotyledon stage and the attainment of a crop height of 6 in. Low-volume spraying is probably undesirable. These findings are not altogether in keeping with those for other countries, and, although the reason for this is not clear, it may be concerned with the flax variety grown. Apart from weed control, the effect of synthetic growth regulators upon the anatomy of the flax straw and the consequent effect upon the yield of fibre suggests a most interesting field of study.

In opening the discussion, Mr. E. V. B. Wilson, of the Plant Breeding Division of the Ministry of Agriculture, Northern Ireland, suggested that selection in flax is not aided by any known correlation of desirable economic characters with any constant and easily observable morphological characters, and that none of the nine standard Russian flax varieties is satisfactory for all economic requirements. Unfortunately, this also holds for the United Kingdom, where work by plant pathologists in Northern Ireland has shown that the popular modern varieties of fibre flax are very susceptible to disease generally and probably more so than the older brands referred to by Major Searle. Mr. Wilson was of the opinion that breeding for disease resistance in flax and other crops is most essential and that the closest co-operation between the breeder and plant pathologist is highly desirable. Dr. J. Ramsbottom emphasized the sudden character changes liable to occur, particularly in the parasite, which may render a resistant host-plant susceptible. A good example of this, he said, is presented by the cereal rusts; but it is a problem which has to be faced. Prof. Muskett said that one hopeful aspect of the work on flax rust in Northern Ireland is the fact that one or more of the Russian flax varieties used has shown immunity to all the physiological strains of the parasite employed. With regard to resistance to flax wilt, Major Searle pointed out that tests made in Northern Ireland show the variety Norfolk Queen to be highly resistant to this disease.

Further discussion was debarred owing to the shortage of available time, but it is clear that the meeting did much to bring to light the difficulties facing the breeder of improved flax varieties, especially in view of the changing methods adopted in the linen industry. It also showed the desirability of producing seed in areas where the seed-borne disease factor is relatively unimportant, and for disease resistance to be taken into account by the breeder. Although a considerable advance has been made in the investigation of spraying with selective herbicides for weed control, the solution of this problem still awaits completion.

OBITUARIES

The Right Hon. Lord Robinson, O.B.E.

By the sudden death in Canada on September 5 of Lord Robinson of Kielder Forest and Adelaide, Great Britain has lost its foremost forester. An Australian by birth and early upbringing, he was one of the first of the Rhodes Scholars and seldom, indeed, can the Rhodes Foundation have made a better choice. His academic forestry knowledge was acquired under that wise old forester, Sir William Schlich, then professor at Oxford, of whom Robinson often spoke in later days with affection and respect.