term durability. At the conference it was reported that a set of unstressed polyester–glass test pieces showed no deterioration in strength after exposure to English weather for two and a half years, and static-water tanks of the same material have now been in use for the same period with little apparent deterioration.

When loaded to higher stresses, test pieces subjected to cycles of wetting and drying and to increase and decrease in temperature show deterioration in properties. Epoxides are generally superior to polyester under such conditions. Further research is necessary to produce a better understanding of the nature of the deterioration.

The behaviour of plastics reinforced with glass under cyclic loading is interesting. Glass alone withstands a cyclic loading for about the same time as it withstands a steady load equal to the maximum occurring during the cyclic loading. This delayed fracture under steady load is known to be caused by attack of the atmosphere. With plastics reinforced with glass, once the adhesion between glass and polymer has failed, atmospheric attack can take place, especially if the polymer has crazed; but deterioration under cyclic loading may also be associated with damage to the glass surface when it slides in the polymer matrix or rubs against another fibre and with local non-uniformity of the distribution of load among the fibres.

Plastics reinforced with glass fail under cyclic loading in a shorter time than would produce failure under static loading of the same intensity. They therefore display a definite fatigue effect as well as delayed fracture. The relatively high resistance to propagation of cracks is shown by cyclic loading tests on notched test-pieces. For a given notch and nominal stress cycle, the number of cycles to failure may be higher for the plastic than for aluminium alloy.

In plastics reinforced with fibre, each fibre contributes to strength and stiffness only in the direction of its length, and it has been calculated that a two-dimensional isotropic mat of fibres should have strength and stiffness equal to one-third of that of the longitudinal strength of an array of parallel fibres. In principle, glass flakes, if of equal breaking stress, should form a sheet material three times as strong and stiff as a material reinforced with fibre. Preliminary experiments with glass flake material reported at the conference showed considerable increase in stiffness, but the expected increase in strength was not achieved, probably because of damage at the edges of the flakes.

Originally developed for aircraft radomes, plastics reinforced with glass are finding increasing application in a wide variety of components. These include boats (including ship's lifeboats), car bodies, bus and railway wagon-tops, translucent building panels, ventilation ducting, tanks for the chemical industry, partitions for aircraft and ships, and jigs and press tools. Their development has been a co-operative effort of physicists, chemists and engineers. Their further development will depend on the invention of stiffer glass, of resins more stable chemically and on research into the mechanism of deterioration and fracture.

C. Gurney

WHEAT GENETICS

DURING the ninth International Congress of Genetics, held at Bellagio in 1953, a small group of participants resolved to organize in the future special meetings at which the objects, results and techniques of current research in wheat cytogenetics could be discussed, and at which workers in the field could be brought into personal contact. As a result, the first International Wheat Genetics Symposium was held during August 10–15 at the University of Manitoba, Winnipeg, Canada. Some 150 participants from twenty-nine countries assembled to join in the formal sessions and in informal discussions, and to see something of the famous wheat-growing region of Manitoba.

The formal meetings were held under the general chairmanship of Dr. H. Kihara (Japan), who, in his opening remarks, recollected that it was exactly forty years since the correct chromosome numbers of the polyploid series in wheat were determined by Sakamura and by Sax. The intervening years had seen intensive research in the sub-tribe Triticinae, and this work had contributed to making the cytogenetic composition of common wheat, *Triticum vulgare*, better understood than that of any other polyploid species. Among the themes of the symposium were some of those which have been most prominent over the years in wheat cytogenetics, notably the investigation of the inheritance and the utilization of disease resistance, the study of the genetic make-up of wheat using aneuploids and the study of interspecific crosses.

In distilling the essence of many years of research into the application of backcrossing to plant breeding, and particularly to breeding for disease resistance, Dr. F. N. Briggs (United States) emphasized that these methods could only be applied when suitable recurrent parents were available and where improvement was required over only a limited sector of the total range of genetic variation. Combination of backcrossing with any other method, although sometimes necessary, meant departing from the security of a tested genotype.

Backcrossing is being used by Dr. N. E. Borlaug (Mexico) to produce multi-line varieties of wheat designed to combat stem rust, the biggest single disease hazard to world wheat production. Numbers of different rust resistant parents are backcrossed into a common, generally useful, but rust susceptible, recurrent-parent variety. When the recurrent variety has been reconstituted in each backcross line to such an extent that there is little difference between them, except the source of their disease resistance, seed of the lines can be mixed in various proportions to form multi-line varieties. Since the multi-line variety includes several genetically distinct types of disease resistance, it is likely that during a rust attack some of its component lines will be resistant to the prevalent races of the pathogen. The risk of catastrophic crop failures will therefore be minimized, both on account of the yield returned by the resistant lines and because the lower proportion of susceptibles will limit the build-up of the epidemic. The actual composition of a variety may be changed from time to time to counteract altered frequencies of rust races, and as many as eight lines may need to be included in one variety. The first trials suggest that even in the absence of disease there may be some advantage in growing the multi-line varieties primarily designed to restrict rust.

The importance of developing the disease resistance, and especially the rust resistance, of the wheat crop was underlined by two further contributions. Dr. D. R. Knott (Canada) has analysed twenty-nine varieties of wheat in which he has discovered seven different genes governing stem rust resistance. Some varieties had no genes for resistance, others had up to four, and moreover the genes differ in the level of resistance conferred and in their dominance relationships. By monosomic analysis, the chromosome on which each gene is carried has been determined, and now each gene is being separately studied, in the absence of all other genes for resistance, in a common genetic background. Dr. Knott's work, in conjunction with information on the spectrum of race reactions due to each gene, permits a more rational approach to the utilization of sources of rust resistance in breeding programmes than has previously been possible.

Indeed, this work comes part way to meeting the wishes of Dr. A. R. de Silva (Brazil), who pleaded for a more precise identification of genetic variation in the host and pathogen as a preliminary to the scientific incorporation of rust resistance in breeding material. He considered that host–pathogen relationships should be envisaged in terms of genes for resistance versus genes of pathogenicity, rather than in terms of rust races versus varieties differing in race response.

In discussing these papers, Dr. E. C. Stakman (United States) proposed that resistance was perhaps not simply attributable to single genes, since it depended on the overall physiology and morphology of the plant. Disease resistance was also among the criteria on which Dr. R. de Vilmorin (France) and Mr. H. C. Thorpe (Kenya) placed considerable value in breeding new wheat varieties for their own areas, but both emphasized that overall suitability of varieties was essential, and that this could not be neglected for the sake of particular characteristics.

T. vulgare is extremely tolerant of many aneuploid conditions in a way which forces recognition of the close genetic relationship between the three genomes of which it is composed. Dr. E. R. Sears (United States) has been prominent among those who have exploited the tolerance of aneuploidy in the cytogenetic analysis of wheat. His work commenced with the development of the twenty-one lines monosomic in turn for each of the chromosomes of wheat. By using the monosomic series in crosses with euploids in other varieties it has been possible to analyse some of the genetic differences between varieties. Additional genetic knowledge was obtained from studies of the nullisomic derivatives of monosomics. The seven homœologous groups of three chromosomes representing the equivalent chromosomes of each of the three genomes of wheat have been established by nullisomic–tetrasomic compensation, and the chromosomes in each genome have been determined by crosses of monosomics to stocks deficient for one or other complete genome. Dr. Sears's monosomic series has provided the basis for extensive aneuploid work in Canada which Dr. J. Unrau (Canada) reviewed. Monosomic series have been developed in more than eight wheat varieties, and some genetic analysis of disease and insect resistance and of certain morphological characters has been accomplished. The genetic breakdown of polygenically inherited characters by aneuploid techniques has now commenced. In the Canadian work the reciprocal exchange of intact chromosomes between varieties is a new source of genetic information, a striking example of which is that the substitution of a particular chromosome pair from another variety may increase the yield of the recipient variety by 50 per cent.

The extent of the genetical duplication, or triplication, in hexaploid wheat was stressed from results with induced mutations in diploids, tetraploids and hexaploids by Dr. J. Mac Key (Sweden) and by Dr. S. Matsumura (Japan). This underlined the pronounced triplication of genetic material which is indicated by the recognition of the homœologous groups by nullisomic–tetrasomic compensations. A puzzling problem has been to reconcile genetic triplication of this order with the purely diploid form of meiosis found in *T. vulgare*. However, Dr. R. Riley and Dr. G. D. H. Bell (England) were able to present evidence, confirmed by Dr. Sears, that the cytologically diploid behaviour of hexaploid wheat is controlled by genes on one chromosome, in the absence of which there is pairing between equivalent, homœologous, chromosomes of the different genomes. Thus, genetical triplication in hexaploid wheat can be associated with high fertility and genetical stability because of a genotype which imposes a bivalent-forming regime.

Aegilops squarrosa, the species which contributed the *D* genome of *T. vulgare*, would not be chosen by most plant breeders as a parent in a breeding programme. Yet its chromosomes are undoubtedly present in common wheat; a circumstance which Dr. L. Shebeski (Canada) considers may limit the advances to be made by breeding within the species. Consequently, he and Dr. B. C. Jenkins are producing entirely new sets of seven chromosomes, less restricting in gene content, to replace the *D* genome. The very vigorous amphiploids between tetraploid wheat and rye were made with similar objects by Dr. E. Sanchez-Monge (Spain), and their derivatives may have practical value in certain marginal environments where rye is at present the only suitable cereal crop.

The difficulties of handling the concepts of genome analysis were described by Dr. H. Gaul (Germany), and other considerations in the study of polyploids were discussed by Dr. R. Riley and Dr. G. D. H. Bell (England), who compared the behaviour of a range of synthetic amphiploids with that of related natural polyploids. This work includes studies on the cytogenetics and breeding value of lines in which single pairs of rye chromosomes are added to the full complement of wheat chromosomes, or in which a single pair of wheat chromosomes is replaced by a single rye pair.

The conservation of natural variation in an economically prominent group like *Triticum* is clearly an important consideration, and the maintenance of collections of varieties potentially useful in breeding programmes was described by Dr. J. B. Harrington (Food and Agriculture Organization, Rome) and by Dr. L. P. Reitz and Dr. D. J. Ward

(United States). However, as Dr. A. T. Pugsley (Australia) pointed out, no system was in existence to co-ordinate the maintenance of wheat material of experimentally determined genetic constitution, and one of the practical accomplishments of the symposium was the formulation of a scheme to do this.

A useful session dealt with the application of the induced mutations to plant breeding, during which Dr. R. S. Caldecott (United States) considered the control of the mutation process.

The symposium illustrated the general realization that if the maximum benefit is to be obtained from common wheat which, with rice, is one of the world's most important food crop plants, the fullest understanding of its genetic architecture will be necessary. Already, however, the cytogenetic structure of wheat is better known than that of any other polyploid species, so that work on wheat is profoundly influencing general ideas on evolution by polyploidy and on the genetic functioning of polyploid organisms. The present position has resulted from combining the efforts of many workers over the years. Future progress will similarly be achieved by the accumulation of numerous individual contributions, and so will be most rapid and efficient if the people engaged are enabled to pool their ideas in the way which was possible at the first Wheat Genetics Symposium.

RALPH RILEY

INDIUM MONO-TELLURIDE

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SOME preliminary work has been carried out on the mono-telluride of indium. This revealed some anomalous properties of the compound, which is variously reported as semiconducting[1] and metallic[2]. The compound was prepared by direct fusion of stoichiometric amounts of the elements in sealed evacuated silica tubes. X-ray powder patterns of the compound showed only the lines reported by Schubert[3].

The resistivity and Hall coefficient were measured on four specimens at room temperature. They all showed a carrier density of 10^{18} holes cm.$^{-3}$ or more, and resistivities varying from 4×10^{-3} to 4×10^{-2} ohm cm. In an attempt to change the carrier type, specimens were prepared with 4 atomic per cent excess of each of the elements, respectively. The sign of the thermoelectric power of both these suggested p-type conduction.

The temperature coefficient of resistance was metallic from liquid nitrogen temperature to 440° K., at which point an anomaly was observed (Fig. 1). These measurements were made with increasing temperature. On cooling, the resistance at any given temperature was found to be dependent on time. This was investigated by holding a specimen at 463° K. for 16 hr. and cooling over a period of 15 min. to 358° K. The rate at which resistance at time t (R_t) approached its equilibrium value (R_∞) is shown in Fig. 2. It was found that measurements could be repeated provided adequate time for relaxation was allowed.

The thermal electromotive force was measured against copper, using an apparatus described elsewhere[4]. It varied from $1 \cdot 5 \times 10^2$ μV. °K.$^{-1}$ at 300° K. to $2 \cdot 2 \times 10^2$ μV. °K.$^{-1}$ at 580° K. without anomaly. A point-contact diode of the material showed no rectification for currents up to $\pm$ 100 m.amp.

Differential thermal analysis was carried out with a standard Gallenkamp apparatus using equal parts of tellurium and silica as a reference material. The results of two runs taken between 370° K. and 530° K. are shown in Fig. 3.

The thermal conductivity of the material was measured by holding one side of a thin disk at the ice point and the remote side in contact with a heated surface at temperatures varying from 290° K. to 490° K. The rate of heat transmission through the disk was deduced from measurements of the power necessary to maintain the heated surface at a given temperature θ with and without the disk in position. Each temperature was maintained for 15 min. These results are presented in Fig. 4 in the form of a graph of WL/A against θ, where W is the rate of heat transmission through the disk of thickness L and cross-sectional area A : the slope of this graph at any temperature yields the thermal con-

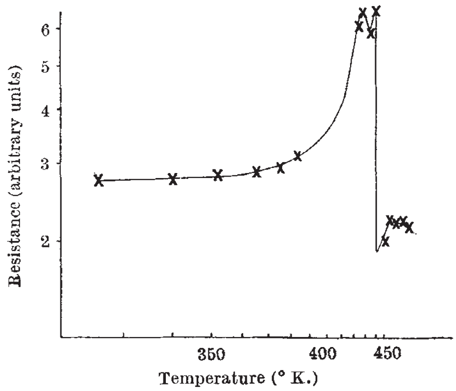

Fig. 1. Resistance versus temperature

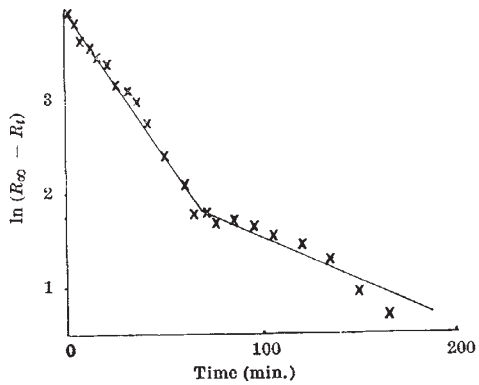

Fig. 2. Change of resistance with time