ebony eyeless, followed by back-crosses of the F_1 males to flies of the same stock.

In a preliminary experiment (irradiation of March 15) 165 of the F_1 cultures tested for lethals yielded 4 lethals (2·4 per cent), while 125 tested for translocations yielded none. Irradiations of April 19–21 led to 213 cultures with 7 lethals (3·3 per cent) and 305 cultures, from flies irradiated with half this dose, with no translocations. The later irradiations have given a total of 1,070 ClB cultures with 22 lethals, or 2·1 per cent, and 2,449 cultures tested for translocations, with not one case of the latter. 579 control cultures (not treated) gave only one lethal, and infra-red rays, in semi-lethal dose, gave 1 lethal in 252 F_1 cultures. The latter results show that the great majority of the lethals in the treated series had resulted from the ultra-violet irradiation.

Our tests with X-rays[5] have shown that the above represents a frequency of lethals such as is produced by about 600 r. and that with this dose there are some 0·8 per cent of translocations produced in spermatozoa (more exact tests are in progress). With the above numbers of F_1 cultures tested for translocations, then there would have been some 13 to 26 translocations in all, instead of none, had X-rays of the same gene-mutation-inducing dose been used. The difference between this and the result obtained (0) is statistically significant. Moreover, 28 of the ultra-violet lethals, tested for crossing over, showed none to involve gross rearrangements, although the same number of lethals, if it were produced in spermatozoa by X-rays giving the same mutation frequency, would usually include several rearrangements. All in all, then, there can be no question of the difference in the genetic action of ultra-violet and X-rays in *Drosophila*, or of the existence of a difference in the mechanism whereby the 'point changes' leading to gene mutations and gross rearrangements, respectively, are produced.

Spectrometric determination of relative intensities of different spectral regions in the case of the two alternative filters indicated that approximately the same amount of genetic effect was produced by the two filters when the dosage between wave-lengths 280 and 300 mμ was held constant, even though in that case the Chance filter transmitted (during the total time it was used) 50 per cent more of the longer wave-lengths than the U.G.2. If confirmed, this would mean that wave-lengths longer than about 300 mμ were relatively ineffective genetically (cf. Noethling and Stubbe[10,14] and Stadler and Uber[12]). This question is being investigated further.

It will be of especial interest to know whether or not ultra-violet light, as compared with X-rays, discriminates between the production of minute rearrangements and gene mutations. Work on this problem is now in progress.

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The Mathematical Association

Annual Meeting

THE annual meeting of the Mathematical Association was held at King's College, London, W.C.2, on January 2 and 3. At the business meeting, Mr. W. C. Fletcher was elected president for the ensuing year and officers were elected as follows: *Treasurer:* Mr. K. S. Snell; *Secretaries:* Mr. G. L. Parsons and Mrs. E. M. Williams; *Librarian:* Prof. E. H. Neville; *Editor of the Mathematical Gazette:* Mr. T. A. A. Broadbent. Special reference was made to the work done for the Association by Miss M. Punnett, who retired from the office of secretary after twenty-seven years. Miss Punnett was elected a vice-president of the Association. A revised set of rules, proposed by Prof. E. H. Neville, was carried.

The report of the Council gives the number of members as 1,714 and refers to the activities of the branches. A new branch at Sheffield has recently been formed. Several sub-committees of the Teaching Committee are at present working on different aspects of mathematical teaching, including one on trigonometry and another on mathematics for evening technical students. The report further refers to the recently issued "Second Report on the Teaching of Geometry", to the Library and the Problem Bureau, and to the decision of the Council to recognize approved student societies as junior branches. A student society at Cambridge has already been recognized under this rule.

The presidential address was given by Mr. W. Hope-Jones of Eton College, who chose as his subject "Simplicity and Truthfulness in Arithmetic". His first plea was for 'checkability', and he claimed that a well-done piece of work is easier to check by reading it than by doing it again. He also criticized some current practices such as 'cancelling', undue use of improper fractions, loose wording notation in percentage examples and the 'unitary' method. He claimed that teachers were to blame for these defects, since boys have not enough ingenuity to invent their own bad methods, and he attributed

his own progress in arithmetic to avoidance of dodges for making easy things difficult. Finally, he dealt with tables, with special reference to difference-columns, and gave an instructive comparison of the relative accuracy of different methods of constructing and using these tables. The address was delivered in an extremely witty and amusing style, and was greatly appreciated by the crowded audience.

The next address was by Prof. W. L. Bragg, on "Crystallography". Prof. Bragg first dealt with the symmetry of patterns in two dimensions, and, having explained the division of two-dimensional patterns into cells, proceeded to enumerate the seventeen different types of symmetry, of which illustrations were given. He then considered space lattices in three dimensions and illustrated the fourteen distinct types, which give rise to 230 different varieties of three-dimensional symmetry. He illustrated this by reference to one particular group, namely, the space-groups of the orthorhombic lattice. Prof. Bragg concluded by explaining how these types of symmetry enter into crystal structure so as to give rise to the thirty-two classes of crystal symmetry. The lecture was illustrated by slides and was keenly followed by a good audience.

The proceedings of the second day were opened by Mr. A. Buxton, who spoke on "The Teaching of Applied Mathematics in Technical Colleges". He used the term 'applied' in its widest sense, as the students in such institutions require to learn mathematics in order to apply it to engineering, physical chemistry, optics, architecture, etc. The limited previous experience of these pupils and the small amount of time at their disposal (evening students outnumber day students by three to one), means inevitably that the content of the syllabus has to be reduced to a minimum. 'Short cuts' have to be developed wherever possible and formal proofs to a large extent have to be omitted. Mechanics has proved especially difficult, but Mr. Buxton showed how some of the difficulties can be overcome by the use of accurate graphical work and concluded with an interesting example of the use of a velocity diagram to find the velocity of a carried point.

Mr. H. W. Newton gave an interesting illustrated lecture on "Greenwich Observatory: some Aspects of its Work". He showed by a short historical sketch how the work of the Observatory has been mainly concerned with positional astronomy in accordance with its original charter and referred to the discovery of aberration as a result of this work. Illustrations were shown of the older buildings and instruments and also of the instruments now in use, especially those used in the determination of time by observing the transit of a star, a process which Mr. Newton described in some detail, and in stellar photography. He concluded his lecture by a reference to some of the work which has been done in observing the surface of the sun and in photographing, in hydrogen light, bright eruptions and other markings upon it.

The principal speakers in the discussion on the "Second Report on the Teaching of Geometry" were Mr. A. W. Siddons, Miss W. M. Lehfeldt (deputizing for Miss M. A. Hooke) and Mr. H. Beardwood. In the main, all these speakers commended the report. Mr. Siddons referred to some points with regard to the use of small letters to denote angles and to the method of distinguishing the cases of congruence. He also recommended that the idea of similarity should be introduced at an early stage. Miss Lehfeldt emphasized the necessity of a knowledge of geometrical facts rather than their proofs, and also referred to the need for partnership between the teacher and the class in 'rider' work. She referred to the section on the relation between geometry and geography, a region in which valuable chances of illustrating mathematical principles are frequently missed. Mr. Beardwood criticized the omission of any reference to the inter-relation of geometry and trigonometry, and the absence of any special suggestions for the geometry desirable for very weak pupils. In the subsequent discussion, valuable points were raised by Messrs. Kenworthy-Browne, Inman, Sheppard, Hope-Jones, Kearney, Snell, Roebuck, Broadbent and W. C. Fletcher.

The afternoon session was opened by Mr. W. L. Ferrar, who spoke on "Algebra in the Higher School Certificate". He stated that the ideas of general convergence of series and sequences are, in his opinion, introduced too early in the course, a procedure which leads to an excessive reliance on the 'ratio test'. The principal use of convergence at this stage should be in connexion with the series for $\log(1 + x)$, e^x and $(1 + x)^n$, and for these series *ad hoc* methods involving integrals should be used. He next referred to defects in the understanding of the logic of algebra, as, for example, the distinction between theorem and converse, and muddled ideas on the nature of proof by induction, a process in which the fundamental principles are easily obscured by the manipulations involved. He also dealt with some points concerning difference equations. The present situation in regard to higher algebra is, he said, becoming difficult, especially for the examiner. The casting out of some of the old items in the syllabus and the introduction of some new ones have reduced the syllabus to a collection of odd and unrelated scraps. He suggested the formation of a committee to put forward the views of the Association in this matter.

At the final meeting, Lord Stamp spoke to a large and interested audience on "Education and the Statistical Method in Business, with Special Reference to Railway Statistics". Lord Stamp considers that education can do more to prepare the student for business life, and gave a valuable list of topics of a statistical nature which might with advantage be introduced in the ordinary teaching of mathematics. He first referred to averages—with their adjuncts the standard deviation, the mode, the median and the quartiles—and to moving averages, in regard to which he made some useful suggestions about the choice of a scale, and to percentages, urging the use of examples from social and economic sources. He next considered various graphical methods to which pupils might be introduced, with some cautions as to possible errors. The ideas involved in the use of samples and of index numbers might also be introduced and explained. He referred also to price levels, correlation coefficients, graphical methods for eliminating short-period fluctuations, and units of cost and performance. A number of interesting examples were quoted in connexion with some of the above items, such as weighted averages and operating ratios. Lord Stamp concluded with some remarks on the difficulty of choosing a useful unit in which some types of performance could be measured, and illustrated his remarks by a further reference to railway problems.

A fuller account of the proceedings of the meeting will appear in forthcoming issues of the *Mathematical Gazette*.