The Carnegie Trust for the Universities of Scotland.

EVEN a cursory perusal of the twenty-fourth annual report of the Executive Committee of the Carnegie Trust leads to the conclusion that the beneficial influence exercised by the Trustees for nearly quarter of a century in furthering the cultivation of science in the Scottish universities shows no sign of abatement. Moreover, the financial support afforded by the Trust is not confined to the universities, but is now extended to a number of colleges and institutions which are more or less closely associated with the universities and are doing work of equivalent standard. About one-half of the income of the Trust is utilised partly in the endowment of research in all branches of science and partly in assisting the universities and other institutions to provide buildings and equipment for libraries and scientific laboratories, to endow professorships and lectureships, and to develop the social side of student life by the erection of unions and hostels.

As regards the first object, a sum of more than 18,000*l*. was expended in the academic year 1924–25 in the provision of teaching fellowships, the holders of which are expected to devote most of their time to research, research fellowships and scholarships, and research grants to members of the staffs and other investigators. Grants were also made to the Scottish Marine Biological Station at Millport, the Rowett Research Institute at Aberdeen, and the Animal Breeding Research Department at Edinburgh.

For the academic year 1925–26, 20 teaching fellows, 10 research fellows, and 31 research scholars have been appointed, while in addition, grants in aid of research have been given to 36 individuals. During the year 1924–25, 17 scientific papers were published by teaching fellows, 28 by research fellows and scholars, 27 by recipients of research grants, and 13 by investigators working in the laboratory of the Royal College of Physicians; in these papers the following subjects are represented: Mathematics, physics, chemistry, geology, botany, zoology, anatomy, palæontology, physiology, pathology, medicine. The judgments of the experts appointed by the Trust to report on the work of fellows and scholars are uniformly favourable, and it is recorded that many of those who in former years were thus assisted to pursue their scientific careers now occupy prominent positions in the academic or industrial world.

With respect to the provision of opportunities for the prosecution of scientific research in the Scottish universities, the operations of the Carnegie Trust have brought about a marked change for the better. Previous to Mr. Carnegie's munificent donation, there were very few post-graduate science scholarships, and many of the most promising students were compelled, by the necessity to earn a livelihood, to leave the universities as soon as they had graduated. Now a selected number of graduates are enabled to enter upon courses of research, vastly to their own advantage and to that of the universities. Moreover, as is evidenced by the following quotation from the report, the activities of the Trust have also benefited the universities in a less direct manner: "... it is evident that the cause of University education commands to-day the consistent confidence and support of private benefactors and of public bodies. On more than one occasion the Committee, in intimating their quinquennial grants, have expressed the hope that these would act as an incentive in stimulating local effort to supplement the Trust's contributions, and hasten the completion of many important purposes to which the Trust were able to give only partial assistance. It is gratifying to find that a large measure of help has been forthcoming. During the past Quinquennium alone private benefactions to the four Universities have exceeded 800,000*l*. Yet large as are the sums now devoted to University work in Scotland, there are few sections which do not call for some further advance, and the help which the Trust has been able to give is to be regarded as only an indication of the opportunities which still exist to benefit the people of Scotland through the Universities."

The Genetics of Cereals.

THE study of the cytology of cereals has come to have an important place in agricultural plant breeding. In both wheat and oats, diploid, tetraploid and hexaploid species are known, the haploid number of chromosomes being seven. In rye and barley the fundamental number is the same, but polyploid varieties have so far not been discovered. But as much less work has been done with the latter cereals, it is not improbable that polyploid species may yet be found in them. Dr. K. V. Stolze[1] has published a summary of our present knowledge on this subject, in which all the earlier work is reviewed.

In certain forms of wheat and oats eight pairs of chromosomes have been described. Some of these records may be due to error, but certain of them are probably correct. Stolze suggests that such forms, which are indistinguishable from the normal, have arisen through transverse segmentation of one chromosome. This is more probable than the alternative method of origin through non-disjunction as in *Œnothera lata*, since in the latter case external differences appear. But the author himself figures in rye a homotypic nucleus with six chromosomes, which is an indication that non-disjunction occurs in this species.

The author recognises that the determination of whether, in any case, a transverse or a longitudinal split has occurred, depends largely upon comparative measurements of chromosomes and nuclear volumes. The usual view has been that in the wheats the polyploid conditions have arisen through longitudinal splitting of the chromosomes, probably accompanied by crossing. Stolze favours the view that fragmentation of the chromosomes has been concerned. Further investigations alone can settle this question. It seems very probable that both longitudinal and transverse splitting of the chromosomes have occurred in different genera of plants, but in the wheats the view of multiplication by a transverse split encounters serious difficulties, both genetical and cytological. The determination of this point would throw further light on the relationships of the various forms.

A dwarf form of wheat, which originally appeared in experiments of de Vilmorin, has since been carefully studied by Messrs. Engledow and Wadham (*Journ. Genetics*, vol. 16, No. 1), with interesting and important results. It was known that the dwarfs gave rise to talls which bred true and dwarfs which continued to 'split' in a ratio which might be interpreted as 1 : 2 : 1, including certain bushy plants

[1] "Die Chromosomenzahlen der hauptsächlichsten Getreidearten nebst allgemeinen Betrachtungen über Chromosomen, Chromosomenzahl und Chromosomengrösse im Pflanzenreich." Von Karl Viktor Stolze. (Bibliotheca Genetica, Band 8.) Pp. iii+71. (Leipzig: Gebrüder Borntraeger, 1925.) 9.60 gold marks.

which never flowered. Also, the talls and dwarfs could not always be distinguished by their heights. It was found that in each generation dense-eared plants (a safer character to deal with than dwarfness) gave (1) lax-eared, (2) dense-eared, (3) short plants with one stem and no ear, and (4) bushy pigmy plants with no ear. The last, when grown under special conditions, produced ears which were found to be denser than the normal dense-eared form. Dense-eared plants showed wide fluctuation in height, which made classification on a height basis impracticable. Usually, height and ear-density are inherited independently and are hence presumably determined by different chromosomes. It is therefore suggested that in this ever-splitting race there may have been a fusion of these two chromosome pairs, this being a part at least of the mutational change to which the dwarf form owed its origin. A number of ever-splitting races of cereals are discussed. It is hoped that a cytological investigation of this peculiar dwarf will be made, which may help to clear up the genetic peculiarities of such ever-splitting races.

In another paper in *Journ. Genetics*, vol. 16, No. 1, Messrs. Engledow and Hutchinson give some results of crossing between *Triticum turgidum* and *T. durum* or rivet and Kubanka wheat. Since these are both tetraploid species, there is no sterility in the hybrids. The F_1 plants from this cross showed the vigour of heterozygosis. In previous experiments with wheat the endosperm characters of the seed have appeared to show maternal inheritance, in spite of the fact that double fertilisation takes place, which might be expected to lead to the phenomena of xenia, or paternal influence on the endosperm. In *T. turgidum* × *T. durum* the grains were larger than in either parent, but while intermediate in certain features, the vitreous texture and extreme hardness of the durum endosperm were dominant. Moreover, the grains on each F_1 were uniform, although the endosperm really belongs to an F_2 generation and might be expected to show recombinations. In the F_2 plants the same condition held, but in addition to the plants with endosperm like *turgidum* or like *durum*, there were other plants in which the grain showed various mixtures of the two kinds of tissue. The striking difference between the phenomena of xenia in maize endosperm and maternal inheritance in wheat endosperm leads to the suggestion that since in wheat seeds the endosperm cells are already dead, the paternal character determined by the male nuclei has not had a chance to express itself. But the same conditions would appear to obtain in the maize seed, where xenia occurs.

In these crosses the inheritance of solidness of straw has also been studied. The "lodging" of cereals is believed to be due to lack of elasticity, rather than lack of strength, in the stems. Solid straw has greater elasticity. In different varieties of wheat various kinds of solidness were found, and these were in general unifactorial differences; but the results were influenced by other factors for size of straw.

From these crosses it should be possible to produce a rivet wheat with high yield, hard, 'baking' endosperm, and solid, non-lodging straw.

R. RUGGLES GATES.

Dielectric Constant and Molecular Structure.[1]

THE physical methods for investigating the structure of molecules are principally five in number: (1) the ratio of the gaseous specific heats at constant pressure and constant volume; (2) the arrangement of atoms in crystals found by X-ray diffraction methods; (3) the molecular band spectra as interpreted by the quantum theory; (4) phenomena indicating strong fields of force around certain types of molecules; (5) refractivity and dielectric properties. The connexion between dielectric constant and molecular structure was to some extent realised by Faraday, but the theory has been developed by Lorentz, Debye, J. J. Thomson, Gans and Pauli. Recent tests have confirmed the basis of the theory.

The electrons in a molecule are displaced in an electric field, causing the appearance of an electric moment. Account must also be taken of the facts that not all electrons are similarly situated in the molecule and that an effect is produced on the field of its neighbours by the displacement of an electron. The effect produced on the displacement of any electron by that of other electrons in the same molecule must also be considered. If each molecule is a permanent electric doublet of moment μ, there is a tendency of molecules to orient themselves with their electric axes in the direction of the field. This is hindered by the thermal agitation and a statistical average degree of alignment results, depending on the moment of the doublet, the strength of the field and the temperature. All these factors are included in the equation of Debye:

$$\frac{\epsilon-1}{\epsilon+2}=4\pi N\left(\frac{e^2}{3}\sum_1^n \nu_p r_p L_p+\frac{\mu^2}{9kT}\right)=\left(A+\frac{B}{T}\right)D.$$

[1] Abstract of an address by Prof. K. T. Compton, of Princeton University, retiring vice-president of Section B (Physics) of the American Association for the Advancement of Science, delivered at the Kansas City meeting on December 30, 1925.

In this ϵ is the dielectric constant; N the number of molecules per unit volume; e the electronic charge; ν_p the number of electrons of type p in the molecule; r the binding constant; L_p a factor to take account of the effect produced on the displacement of any electron by that of other electrons in the same molecule; k Boltzmann's gas constant; T the absolute temperature; A, B are constants, and D is the density.

In the case of gases the equation has only recently been tested with sufficient accuracy; ϵ is very near unity. One of the experimental methods, used by Herweg and improved by Zahn, consists in amplifying the electrical beats between two differently tuned oscillating circuits, one of which contains the experimental condenser alternately filled and emptied of gas. The electrical beats are made audible by a telephone receiver and produce acoustical beats with the sound from an electrically driven tuning-fork. This method is capable of measuring a change in capacity of one part in two millions. By plotting $(\epsilon-1)vT$, where v is $1/D$, a straight line is obtained, from which A, the binding constant r and B, or the permanent electric moment μ of the molecule, may be computed. The values of μ so found vary from $1\cdot03\times10^{-18}$ for hydrogen chloride to $0\cdot06\times10^{-18}$ for carbon dioxide. In the case of liquids, the values vary from $0\cdot20\times10^{-18}$ for benzene to $2\cdot15\times10^{-18}$ for amyl alcohol; the value for water is $1\cdot98\times10^{-18}$. The application to liquids is not very good, probably on account of the mutual actions between molecules not allowed for in Debye's formula, and Gans has derived a much more complicated formula. C. P. Smyth has shown that it may be combined with the Lorentz dispersion formula to permit at least an *approximate* calculation of the electric moment in many cases. In some cases the moment varies with temperature, apparently due to association.