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tion had been discovered. The form known as Oenothera gigas owed its origin to the doubling of the number of chromosomes of the nucleus, and, therefore, could not be attributed to the recombination of characters of the hybrid parent. Another interesting case was the five-leaved race of red clover (Trifolium pratense) obtained by De Vries. He found a wild plant which bore an occasional four-lobed leaf. He subjected two of those plants to most elaborate selection, and from them obtained a race in which the majority of leaves showed five lobes, while some had six and even seven leaflets. Dealing with the Shirley poppy, he said that species was developed by the Vicar of Shirley (Rev. W. Wilks) in 1880 from a wild form of field poppy. The Shirley poppy differed from its wild prototype in two respects. It was pale pink in colour as compared with the scarlet colour of the corn poppy, and it had lost the black central portion of the flower that was so characteristic of the wild corn poppy. The black central portion of the flower had been changed to yellow or white. It had proved a prolific source for developing an amazing variety of beautiful and distinctive poppies of various colours (white, pink, purple, and red) and of structure (single and double flowers).

So far as cereals were concerned, occasionally one met with striking variations which gave rise to new varieties of great commercial value. Many of their varieties of cereals originated in that way. In 1889, Dart, of Lucindale, was harvesting a crop of wheat, and his attention was arrested by a white plant of remarkable character. He pulled up that solitary wheat plant, sowed it in a small plot, and from it produced the variety Dart's Imperial, which had been a most popular variety for the past 35 years. The dense-eared Squarehead variety now so largely grown in western Europe was discovered in 1868 in a comparatively long lax-eared variety known as Victoria. It had proved a most prolific variety. The renowned Chevalier barley, so largely grown in Europe and Australia for malting, arose from an extraordinarily fine ear observed and selected from a field of barley by a farmer employed in harvesting Dr. Chevalier's crop in Suffolk.

In 1886 there was founded at Svalof, in Sweden, a plant breeding institute that was now world famous. It owed its inception to a group of agriculturists who formed an association for the improvement of seeds in Sweden. The station had developed a method of selection for cereals which had resulted in a large number of improved varieties of wheat, oats, and barley. The method of selection rested on the discovery and isolation among hundreds and thousands of individual plants comprising a field crop of a few outstanding individuals showing heritable variation. The method used was single plant selection. Each selection was sown separately in rows. Most meticulous care was taken to thoroughly test out the merits of each individual selection over a period of years. When the tests were completed, the best strains were propagated and distributed as new varieties. The institute had been remarkably successful, and the new varieties produced had been highly valued and extensively used through northern Europe.

Two interesting illustrations of selection could be considered—(a) Improvement in the protein and oil content of corn, and (b) improvement in the sugar content of beet. The classic experiments carried on by Hopkins and Smith with maize at the University of Illinois for more than 25 years had given most remarkable results.

In 1896 Hopkins selected 163 ears from a crop of Burr's white maize, and, after making an analysis of a few grains from each ear, divided them into four classes—high and low oil content and high and low protein content. At the commencement of the experiments the average oil content was 4.7. Aftr 10 years selection for high oil the strain gave an average of 6.65, the average of the low oil strain having fallen to 2.98 per cent., a difference of 3.6 per cent. At the end of 20 years selection the average of the high oil strain had risen to 8.02, the oil content of the low strain being 2.03—a difference of 6 per cent. In 1921, i.e., after 25 years' selection, the high oil plots averaged 9.94 per cent., the low oil plots 1.70 per cent., a difference of 8.24 per cent. Similar, though less marked, results had been obtained by repeated selection for high and low protein. Tests had shown that the different strains maintained their distinctive chemical compositions when grown side by side.

Sugar-Beet.

The development of the sugar content of the beet was a remarkable example of how selection might be used to increase the quality of a farm crop with great advantage to an industry. Since the introduction of beet culture in Europe by Napoleon, the sugar contents of beets had been gradually improved from 7 per cent. to over 18 per cent. Most of the progress had been done during the past generation, and progress was rapid when breeders isolated and bred those strains of beet which not only possessed high sugar content, but which transmitted the high sugar content to their progeny, i.e., when breeders began the systematic isolation of heritable variations with high sugar content. Owing to the improvement in the sugar content of the beet, which implied greater production of sugar per acre, the beet sugar industry had made remarkable progress, and now more than 50 per cent. of the world's sugar was produced by white labour from beets grown in the temperate regions of Europe and the United States. For selection to succeed, it was

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necessary that the plant-breeder should be able to recognise the variations as soon as they appeared—the variations which it was desirable to preserve. Large variations, e.g., changes in the colour and shape of flowers, the appearance of giant or dwarf forms, were readily recognised, even by the novice. The small morphological peculiarities, e.g., slight differences of habit, earliness of maturity, rust resistance, and other subtle features which might be the starting point of valuable modifications, could only be discovered by the experienced eye.

To be Continued.

REGISTER. 30. 7. 25

SCIENCE AND AGRICULTURE

New Varieties of Plants.

Value of Mendel's Work.

No. 6.

Resuming his lecture on the creation of new varieties of plants in connection with the University extension lectures, Dr. A. E. V. Richardson (Director of the Waite Agricultural Research Institute) referring to the DeVries theory of mutation, said that DeVries attacked the question of the kind of variation which furnished the material for evolution. He affirmed that the small continuous variations were of slight value in evolution, and advanced the hypothesis that large, discontinuous variations or sports, i.e., mutations, furnished the basis for evolution. According to that view, species were not slowly and gradually changed into new forms, but new and distinct types arose suddenly from the parent form. The variety as a whole continued unchanged, but produced aberrant individuals or mutations which bred true to type, and were the real source of all progress. He based his theory on the peculiarities of certain seedlings of the evening primrose (Oenothera Lamarckiana) which he found growing wild at Hilvershun in Holland, and the large body of evidence which he brought forward did much to convince biologists that discontinuous variations were far more common than was formerly supposed. They now knew that sports, mutations, and discontinuous variations were frequent, and that they were remarkably stable and bred true to type. Examples of mutations were the five-leaved clover (obtained by DeVries from cultures of a four-leaved clover), the Shirley poppy, the star primrose. The mutation theory did not deny the importance of selection as a means of improving agricultural plants, for even if a mutation did appear, it might still be improved in its lesser features by careful selection.

Mendel's Law of Heredity.

The law which Gregor Mendel formulated in 1865 was regarded as the greatest of biological discoveries. It furnished the starting point from which the modern study of genetics had developed, and provided a scientific basis for plant breeding. Mendel sought to discover the law of inheritance in hybrid varieties of peas, and concentrated his attention on the mode of transmission of pairs of unit characters, e.g., tallness and dwarfness through several generations. Mendel communicated the results of his now world-famous experiments to the local scientific society of Bruun, but strangely enough they lay unnoticed till 1900 when they were rediscovered and independently confirmed by DeVries, Tschermak, and Correns. Mendel realized that the failure of the early hybridizers to elucidate the general principle of inheritance from the results of crossbreeding was due to the fact that they did not concentrate their attention on definite characteristics of the plant and trace their inheritance through a sequence of generations. After much experimentation, he decided to use the common garden pea for his investigations. A close examination of the different varieties in cultivation enabled him to separate 22 distinct types. He arranged those pure races into pairs of opposite or contrasting characters, and crossed representative plants of each pair separately. Thus he crossed tall peas with dwarf peas and peas with coloured flowers with those possessing white flowers. He carefully preserved all the progeny of every crossbred plant and planted them separately each year. In the case of the cross between the tall pea and the dwarf the progeny in the first generation were all talls. That character of tallness Mendel described at dominant, while the opposite attribute dwarfness which appeared to be masked he described as recessive. The plants of that generation were allowed to fertilize themselves, and the offspring of each plant were sown separately. In the second generation it was found that there were three times as many tall plants as dwarfs. The tall plants were dominant. The tall plants did not, however all breed true, but some gave rise to pure tall plants, while others gave mixtures of talls and dwarfs. A statistical examination of the second generation progeny showed that there were three talls to every dwarf, and that only one-third of the tall plants bred quite true to type.

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Besides tallness and dwarfness, other contrasted pairs of characters were experimentally determined, and it was found that in all cases they obeyed the law of inheritance. Thus, coloured flowers were dominant to white. One naturally wondered what would happen if two plants possessing two pairs of contrasted characters were crossed together. When the tall, coloured pea was crossed with the dwarf white pea the progeny of the first generation were all tall, coloured plants, for tallness was dominant to dwarfness, and coloured flowers were dominant to white. When that hybrid was self-fertilized the second generation gave four kinds of plants, viz., coloured talls, coloured dwarfs, white talls, and white dwarfs. Further, it was found that the coloured flowers were three times as numerous as those of the plants with white flowers. Similarly, there were three times as many talls as dwarfs. In the second generation the four forms were present in the following proportion:—Nine coloured talls, three white talls, three coloured dwarfs, and 1 white dwarf. And was the only ratio which could satisfy the condition that the coloured flowers should be to the white as 3-1, and at the same time the talls to the dwarfs as 3-1. Those results might be concisely summarised as follows:—When two plants exhibiting two pairs of contrasting characters were crossed together the progeny in the first generation consisted of plants bearing the two dominant characters, while in the second generation the characaters segregated in the following proportion:—Nine plants possessing the two dominant characters, three plants exhibiting one dominant and one recessive, and one plant exhibiting the other dominant and the other recessive. This principle may be extended to three or more characters.

Mendel's Explanation.

Mendel advanced an hypothesis to account of the observed facts. He assumed that each germ cell or gamete could carry a factor which would give rise to one or other of the differentiating pair of characters, e.g., a given gamete, either ovule or pollen grain, could carry the attribute or factor either of tallness or dwarfness, but not both. The two attributes were mutually exclusive so far as the gametes were concerned. When a pure tall plant produced germ cells, i.e., pollen grains and ovules, each bore the attribute of tallness. When the tall pea was crossed with the dwarf pea, a germ cell bearing the factor for tallness mated with a germ cell bearing the attribute for dwarfness. Inasmuch as the factor for tallness was dominant, the hybrid progeny would be in appearance similar to the pure tall plant. That hybrid plant, however, would differ markedly from the pure, tall plant when it formed germ cells. Mendel assumed that when it formed germ cells the elements representing tallness and dwarfness segregated from one another, and of the total number of germ cells—male or female—one-half contained one factor, and the other half the second factor. That was to say, when the hybrid plant formed its germ cells—pollen grains and egg cells—one-half of the pollen grains would possess the dominant character, and one-half the recessive character. Similarily, one-half of the egg cells (ovules) would carry the dominant factor, and one-half, the recessive. If the hybrid plant was self-fertilized there were four and only four combinations possible, and on the average the mating must be DD plus 2DR plus RR, which agreed with Mendel's law.

Value of Mendel's Work.

Mendel's results had been confirmed by many different workers in widely different fields of investigation. His law was a great contribution to evolution and to the science and practice of breeding. One great advance had been made possible by his discovery. The individual might be regarded as built up of so many definite unit characters each of which was independently inherited in accordance with a definite scheme of inheritance. The final character of an organism depended on the number of factors existing in the two germ cells responsible for its formation. The Darwinian account of the origin of species assumed that variations were continuous and that any variation could be transmitted to the offspring. Neither of those assumptions was justified. Batson and DeVries had shown how prevalent discontinuous variations, or sports, or mutations, were in Nature, and Mendel and his followers had shown that heritable variation had its basis in the germ cells. From the standpoint of cutology, they might regard the chromosomes of the nucleus as the bearers of the heritable factors. The number of chromosomes for each species was constant, and their form and individuality were characteristic. Each chromosome was considered to be the bearer of the hereditary factors or the so-called "genes" of the biologist. Natural selection did not create a new variation because it was decided by the presence of certain definite factors in the germ cell. Natural selection merely decided whether the new type was to survive or to be eliminated in the struggle for existence. It was worthy of note that the presence of a small number of factors or genes carried with it the possibility of an enormous range of variation. They had seen that the presence of two pairs of factors, e.g., awns or absence of awns, and black and white colour in barley, there would be four pure-breeding forms produced by hybridisation. With 10 pairs of characters there would be 1,024 distinct pure-breeding forms produced in crossing, all of which could be isolated and raised in pure cultures. Thus the almost infinite variety in nature could therefore be accounted for

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by assuming the presence of a comparatively small number of genes or factors in the parent germ cells. The Mendelian germ conception of unit characters based on specific factors transmitted in accordance with a definite scheme of inheritance was of the greatest service to the plantbreeder. The breeder was seeking to improve the type of organism with which he was working. His final objective was the production of a type which would combine the greatest number of desirable characters. The desirable characters might be distributed among several plants. His task was to unite all those desirable characters into one variety. Before he could do that he must determine the inheritance of the factors upon which the characters depended. Once those factors had been determined they could be brought under control and associated or dis-associated at the breeder's will. He might combine in one plant the unit characters of two or more plants, and thus produce a new combination or variety. In hybridising plants with different unit characters, the plant-breeder was certain of two things:—(1) With a sufficient number of progeny in the second generation, every possible recombination of the characters present would be represented by at least one pure specimen; (2) those pure types, when self-fertilized, would breed true and produce a pure race.

(To be Continued.)

REGISTER. 31. 7. 25

ELECTROLYSIS OF WATER MAINS.

From EDWARD V. CLARK, University of Adelaide:—The Register's article of Tuesday on the pitting of water mains by electrolysis appears to cast a slur on the officers of the Waterworks Department of fifteen years ago which, I am sure, was unintentional on your part and undeserved by them. The corrosion of pipes due to the straying of electricity from the tramway rails, quickly became evident in the earliest days of electric traction; and long before the conversion of the Adelaide trams was thought of, the British Board of Trade drew up regulations, to be complied with by all electric tramways in Great Britain, to prevent undue trouble from electrolysis. Our Tramways Act provided, I believe, that the British Board of Trade regulations should be complied with; and costly provision was made to this end in the initial electrification, including Thermit welded joints to the rails and considerable apparatus in the converter stations to enable the requirements of the Board of Trade regulations to be met. I am quite sure that the engineers of the Waterworks Department, as also of the Gas Company and of the Posts and Telegraphs, were alive to the dangers of electrolysis. It would not be feasible, save at excessive cost, to eliminate all possibility of electrolysis from stray currents from electric tramways; and the Board of Trade regulations, drawn up after consultation with many interested parties, were designed to ensure that any electrolysis of pipes, and so on, should be so little as to entail comparatively little cost for maintenance. One may infer from your article that the damage by electrolysis to the gas and water mains of Adelaide during the 16 years in which electric trams have been running has been quite reasonably small.

REGISTER. 31. 7. 25

MIDDAY ORGAN RECITAL.

Music lovers find a profitable way of spending luncheon hours during the winter months in attending the midday organ recitals which are given by Mr. Harold Wylde, F.R.C.O., each week in the Elder Hall. The attendances have been gratifying to the organist, who spares no effort to submit a varied and interesting programme to suit the public taste. On Thursday Mr. Wylde's opening number comprised a suite of items by Boellmann—"Chant Gothique." The "Choral," an impressive and characteristic number, was followed by the dainty "Menuet Gothique," and the third piece, "Priere a Notre Dame," revealed rich melodies under the organist's interpretation. The "Toccata" made a fitting climax to the suite, and called for much applause. Mr. Wylde's second choice was "Evening harmonies" (Karg Ebert), and the soft tones of the organ did ample justice to the composition. Two attractive songs, "Youth" (Allitsen) and "Roadways" (Lohr), by Mr. Mostyn Skinner, constituted the vocal portion of the programme. The singer, who has an easy and sympathetic production, was enthusiastically applauded for his contributions, for which Mr. Wylde was an able accompanist. The organist rendered "Parvane" (Bernard Johnson), his next number, in an artistic and happy mood, and brought out the intricate passages with admirable effect. Cesar Franck's "Chant heroique" was Mr. Wylde's final selection, and proved to be an interesting and powerful composition, characteristic of the great French writer. The organist was accorded spontaneous applause at the close of each item, and a final ovation fittingly indicated the appreciation of the audience.

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Dr. Arthur D. Reid has been appointed a resident medical officer of the Adelaide Hospital. Dr. Bronte Smeaton has been appointed an honorary surgeon of the same institution, in place of Dr. A. M. Cudmore.