HUGO DE VRIES.

BY HENRI HUS.

Among the scientists who have followed in the footsteps of Darwin is one whom the future will hail as his rightful successor, one who at the present time is reckoned among the foremost botanists. This is the author of the "Mutation Theory," Professor Hugo de Vries, of the University of Amsterdam, Holland, whose visits to the United States in 1904 and 1906 brought him into personal contact with many who formerly knew him by name only. To these, among others, a brief account of the life and works of this genial scientist will perhaps be welcome.

The son of a statesman of note, Dr. G. de Vries, consecutively Member of Parliament, Prime Minister, and Member of the Council of State, Hugo de Vries was born at Haarlem, Holland, on the 16th of February, 1848. His father as well as other members of the family had given evidence of splendid brain-power, but their energies had been directed chiefly along juristic and theological channels. Yet from the earliest days did Hugo de Vries display a fondness for the lovely children of nature, for the flowers which grew so abundantly in the immediate neighborhood of his childhood home. Already at the age of twelve, de Vries was sufficiently acquainted with the local flora to successfully take part in a competition for the best collection of dried plants growing in the vicinity of his native town. This, at the present time, with an abundance of pocket-guides to local floras, is no exceptional feat for a boy of twelve to perform, but in those days it was hardly possible to gain access to useful botanical works, rendering the identification of plants a matter of no little difficulty.

When twelve years old, de Vries exchanged the primary school for the gymnasium* where most of his time was devoted to the

*In Holland a distinction is made between secondary schools where more attention is paid to literary work, especially to the classics, and those where
study of the classics, in the knowledge of which he attained pre-
eminence among his fellow-students. Six years later he entered
the College of Natural Science at the University of Leiden. But
before this could be accomplished, parental objections based on the

slight promise of social success held by the future for a student of
botany, had to be overcome. It required much pleading to be al-
lowed to give up the College of Law for that of Natural Science.

science is chiefly taught. The latter school is called "Hoogere Burgerschool,"
the former, "Gymnasium."
And even when this had been successfully accomplished, new obstacles were encountered.

At that time the late W. F. R. Suringar was professor of botany at the University of Leiden, devoting his entire attention to systematic work. Naturally he desired his students to do the same and promptly assigned to de Vries a systematic study of the lichens of Holland. And though it cannot be said that de Vries, at any time, in any way, did underestimate the value of systematic botany, yet he felt himself far more attracted by the study of the living plant. And when, during his second year at the University, he acquired a German translation of Darwin's *Origin of Species*, it but strengthened his desire to become more fully acquainted with the phenomena of plant life.

Few can realize what it meant in those days to acknowledge oneself a believer in the theory of descent as propounded by Darwin in his great work which had appeared some years earlier (1859). Among the scientific men who filled important chairs at the University of Leiden, none were ready to accept the new doctrine. It was only among the younger men that a belief in the new theory obtained. It was only among the fellow-members of de Vries's club, most of whom in different fields have attained distinction and renown, that the new theory was thoroughly discussed, at least until the late Selenka accepted the chair of Zoology at Leiden.

In March 1869 de Vries received his degree of *candidatus philosophiae naturalis* and in the same year wrote an essay: "On the Influence of Heat on the Roots of Plants," for which the Senate of the University of Groningen (Holland) awarded him a gold medal. The experiments necessary to obtain data for this paper were conducted under great difficulties. The laboratory at Leiden afforded no opportunity, so recourse was taken to the garret of the house of the young naturalist's father, where without gas or running water, constant temperatures, in some cases for days, had to be maintained by means of oil-lamps. It was only then that the elder de Vries realized the genius of his son Hugo and became fully reconciled to his chosen calling.

To the study of physics and chemistry, so essential to work in plant-physiology, much time was devoted by de Vries. His contemporaries at the University speak of him as one thoroughly versed in what was then the new chemistry. That he is a first-class chemist is well proven by the fact that he succeeded in discovering a method for determining, with the microscope, and by aid of what he termed *isotonic coefficients*, the atomic weight of raffinose. This
proved a great aid to science, for three opinions regarding the molecular weight of raffinose existed at the time. Berthelot and Ritt-hausen believed it to be 396, Loiseau and Scheibler placed it at 594, while Tollens and Rischbiet regarded it as 1188. De Vries proved the opinion of Loiseau and Scheibler to be the correct one and the formula to be $C_{18}H_{34}O_{18}+5H_{2}O$.

In 1870 de Vries received his doctor's degree from the University of Leiden, on a thesis entitled "The Influence of Heat on Life-phenomena in Plants." For a thesis it is a bulky volume and

THE DOUBLE FLOWERED CORN-MARIGOLD (CHRYSANTHEMUM SEGETUM PLENUM.)

B. A flowerhead of the original cultivated variety; C. the first result of selection; D. the first sign of doubling, E. a typical double flowerhead.

embodies the result of a continuation of the experiments on which his first paper was based. The reader cannot fail to notice two things, i. e., the evidence of an exceedingly large amount of reading by the young student, and the clear manner of presenting the subject to the readers. Both erudition and facility of address, as well as a genius for solving experimental difficulties incidental to scientific research were then as now distinctive characteristics of this eminent scientist.
Seeing far ahead of his fellow-students, he realized the need of university migration. Shortly after receiving his doctorate Hugo de Vries left for Heidelberg, there studying during the historic winter of 1870-71 with the famous botanist Hofmeister. The sum-
mer of '71 de Vries spent at Würzburg. Here he met the great plant physiologist Sachs, who, though at that time a comparatively young man, had the greatest influence on de Vries's later work. The study of heredity had to yield to the study of physiology. During the next ten years his entire attention was devoted to this subject.

From 1871-75 de Vries was instructor in natural history at the Hoogere Burgerschool at Amsterdam. Notwithstanding the many obstacles to private work, he continued his experiments, partly at home, partly, during the holidays, at Würzburg. So strong was Sachs's attraction for de Vries, that on the very day the vacation began he took the train for Germany, to return only at the last minute.

In 1875 de Vries left Amsterdam to devote his time entirely to study with Sachs. During this stay at Würzburg he wrote, at the request of the Prussian Department of Agriculture, a series of monographs on various plants of economic importance. Two years later de Vries became privat docent at the University of Halle. Before this was possible he had to take a doctor's degree in Germany and present an essay for habilitation, for which he selected the subject Ueber die mechanischen Ursachen der Zellstreckung, (Leipzig, 1877), which afterwards became one of his best-known works.

His residence at Halle was not of long duration, an appointment as lector in plant physiology at the newly created University of Amsterdam, resulting from the reorganization of the Athenaeum Illustre, founded in 1632, following in the same year. In 1878 de Vries was appointed Professor Extraordinarius of botany at the same university and one and a half year later Professor Ordinarius this last to induce him to decline the offer of the chair of plant-physiology at the Landwirtschaftliche Hochschule at Berlin. And though at various times different European and American universities have offered him the greatest inducements to join their faculties, until this day he remains in the town of Amsterdam, of whose university he was Rector Magnificus during 1897-98, an office which he inaugurated with an address entitled "Unity in Variability, and which has been translated into various languages, being his first paper to be published in America.*

We cannot dwell in detail on the work de Vries has done in widely separated fields of investigation. But to give an idea of the immense capacity for work possessed by this indefatigable student

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of nature, it may be stated that the approximate number of books and pamphlets written by him up to 1902 is 150, of which 62 are devoted to plant-physiology, 9 to agriculture, 6 to histology, 42 to variability and heredity, and 38 to various scientific subjects, while in addition he has published two text-books and numerous popular articles, the latter chiefly on horticulture.

The two principal groups of investigations which have made de Vries's name famous, are his studies on turgidity and those on heredity. Shortly after the publication of his doctor's thesis, de Vries began to devote his entire attention to the study of the living plant-cell, and more particularly to the impermeability of the protoplast for dissolved substances. Extensive investigation taught him that water only could permeate the plasma-wall, and that in water, because of the strong attraction exerted upon it by the cell-sap, must be sought the cause of turgidity. De Vries expected much of a thorough knowledge of the nature of turgidity, since according to Sachs it exerted a great influence upon growth, i. e., on the lengthening of the cell. It was de Vries's opinion that to arrive at a satisfactory conclusion as to the importance of turgidity, a means must be found to temporarily suspend it. After a series of experiments a satisfactory method, i. e., the use of salt-solutions, was found. Their action upon the cell was called by de Vries plasmolysis.*

The value of the plasmolytic method to natural science can hardly be overestimated, and certainly cannot be done justice to in a few words. And a large part of de Vries's later work, on cell-growth, on the movement of growing stems, on root-contraction, his discovery of the tonoplast, is intimately connected with it.

It was not only the effect of turgidity, but also its degree, which received de Vries's attention. On his studies of isotonic coefficients, forming part of the article just mentioned, are based the electrolytic dissociation theory of Arrhenius as well as the law of van't Hoff (viz., that "dilute solutions obey the same law as gases") both of which in their turn form the basis of the physical chemistry of to-day. And van't Hoff, in a recent speech, when bringing thanks for the honor done him in awarding him one of the Nobel prizes, felt the need of acknowledging his great indebtedness to his friend and countryman, Hugo de Vries, at one time his fellow-member in the faculty of Natural Sciences at the University of Amsterdam.

However interesting these physiological studies may have been to de Vries, gradually a larger and larger share of his thoughts was claimed by heredity and variability. To his work along these lines he chiefly owes his growing popularity in America as well as in Europe. His first publication on this subject appeared in 1889, under the title *Intracel lulare Pang enesis*. It found its origin in the pang enesis theory of Darwin, yet differs from it in one important point. While Darwin attempted to account for the effects of use
and disuse, for the direct influence of the male cell on the female cell, and for the properties of graft hybrids by a transportation of gemmules thrown off by the individual tissue cells, and thereupon based his transportation hypothesis, de Vries believed to be able to dispense with this part of the theory, as the facts brought forward by Darwin allowed of other explanation. De Vries arrived at the same conclusion as Weismann, who showed that the seeming proofs, which thus far had been brought to bear upon the hypothesis of the transmission of acquired characters, proved to rest on a, for science, insufficient basis. He further believed that in all cells the same properties (represented by pangens) must be present since under certain circumstances every somatic plant cell may produce a perfect individual, possessing the same characteristics as an individual originated from the union of two germ-cells. His theory, in short, presents the nucleus as the bearer of all hereditary characters, active as well as latent. Latent characters might sooner or later become active and thus cause what is commonly known as atavism.

De Vries had an opportunity to make a study of active and latent characters in his cross-fertilization experiments. When crossing plants bearing blue flowers with those bearing white flowers, he obtained hybrids which showed the blue color only. That these plants really were hybrids was proven by the fact that their seed, when sown, produced some plants with blue and some with white flowers. On the basis of the numerical relation existing between these plants, supplemented by several experiments with others, de Vries formulated anew Mendel's law of the dissociation of hybrids, which for more than fifty years had been buried in the archives of the Brunn society, and extended it. It was in his experiments with di- and poly-hybrids that de Vries found full confirmation of the opinion expressed in his Intracellulare Pangenesi, that hereditary characters are built up of separate units, something which seems to be borne out by recent cytological investigations.

In connection with the above-mentioned experiments attempts at hybrid-fertilization of the endosperm were made. For a long time it had been asserted that the pollen had some influence on the endosperm and in many cases transferred to it the characteristics of the father. By fertilizing sugar corn with the pollen of the common Zea Mais, de Vries obtained ears of corn composed partly of starchy grains, partly of grains containing sugar, something which was especially easy to demonstrate in the dried corn-cob, when the latter grains lost their bulging outline and shriveled up. This phenomenon to which the name xenia has been applied served to bear out the
opinion of Nawaschin and Guignard, that a fertilization, both of the egg-nucleus and of the endosperm-nucleus takes place. This opinion was based on their own observations on double fertilization in some of the higher plants, observations made independently and

which initiated a new line of investigation yielding highly gratifying results.

Among de Vries's studies on heredity may be mentioned those on the heredity of fasciations, on torsion, on variability and Galton
curves. However important, the attention they attracted is entirely surpassed by that given to one of his latest books, *Die Mutations-Theorie*, which was published in 1901-1903, and of which Professor de Vries has recently published an English version, entitled *Species and Varieties; Their Origin by Mutation*, which practically comprises the lectures delivered by him during the summer session of 1904 at the University of California, and which enjoyed so great a popularity that this year a second edition became a necessity.

These books deal largely with experimental observation and control of the origin of species. The chief subject for the study was Lamarck’s evening primrose, *Oenothera Lamarckiana*, to the variability of which Professor de Vries has devoted the major part of his attention during the last eighteen years. His observations on fluctuating and sudden variability, and his experiments with *Oenothera Lamarckiana* have so recently been brought before the public that it is needless to here enter upon them. Suffice it to say that they have served as a basis for the splendid experimental work now carried on under the auspices of the Carnegie Institute, work which promises to bear rich fruit.

But it must not be thought that de Vries’s attention is entirely devoted to scientific research and that, by close application to experimental work, he has become a Dryasdust. On the contrary, he is a man among men, and one of many-sided interests. Everywhere he is welcome, in his charming family circle as well as at the gathering of his fellow-workers, among practical men as well as among men of science. He is that *rara avis*, the scientist respected by the practical man. For a time even he was the editor of a horticultural journal, besides being a member of the boards of control on primary and secondary education and at one time having a seat in the Municipal Board of Health.

As professor, Hugo de Vries is beloved by his students. His lecture room, though large, is always filled to overflowing and yet silence reigns supreme. But no wonder. His lectures, especially those on variability, are of the greatest interest, and even systematic botany, which so often is made dry and uninteresting, he knows how to invest with great charm. For he has the gift of making a subject popular, something well shown in the course of lectures delivered by Professor de Vries in 1904 during the summer session of the University of California.

We hardly realize how much it cost him to give up his entire summer to an American tour. This would not have been possible but for exceptional circumstances. On October 15, 1903, de Vries
celebrated the twenty-fifth anniversary of his professorship at the University of Amsterdam, which gave his friends an opportunity to show their appreciation of his work. Royalty, learned bodies, eminent colleges tendered their homage by conferring knighthood,
honorary membership and other expressions of appreciation. But that which touched Professor de Vries most was the presentation, on behalf of many of his friends and former students, of a considerable sum "to be expended in the furtherance of his great work." For many years Hugo de Vries has contended with the climate of Holland for the welfare of his evening primroses, and after many experiments how to protect his favorite flower, the only solution of the problem seemed to be an immense glass house of peculiar construction. But a few minutes had elapsed after the donation when Professor de Vries decided to devote the material recognition of his students to this special purpose.

The erection of the greenhouse was begun in the spring of 1904, and since this seriously interfered with work in that portion of the Hortus Botanicus at Amsterdam specially set aside for the investigation of mutations, experimentation on a large scale was given up for that year. Thus Professor de Vries was able to accept the invitation of the President of the University of California at Berkeley to deliver there a series of lectures.

De Vries had long desired to visit America and for various reasons. First of all America is the birth-place of Oenothera Lamarckiana. In the second place there were many American horticulturists, among them Luther Burbank, whose acquaintance de Vries either wished to make or to renew. Then there was the International Congress of Science held at St. Louis during the World's Fair of 1904. These reasons, though perhaps not the only ones, were sufficient to induce de Vries to accept the invitation. It is not necessary to recount the honors bestowed upon de Vries in the United States, both in 1904 and in this year, honors which are fresh in the minds of all. They, like the honorary membership of the Deutsche Botanische Gesellschaft—the greatest honor that ever botanist may covet—which was bestowed upon de Vries in 1891, are but a just recognition of the debt due to this patient worker who does not consider himself, neither his convenience nor his health, who counts no exertion too great, but cheerfully gives his all in the furtherance of his science.