The Open Court

A MONTHLY MAGAZINE

Devoted to the Science of Religion, the Religion of Science, and the Extension of the Religious Parliament Idea

Editor: Dr. Paul Carus *Associates:* E. C. Hegeler. Mary Carus.

VOL. XVIII. (no. 4) April, 1904. NO. 575

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HUGO DE VRIES.

Professor of Botany in Amsterdam.

Frontispiece to The Open Court

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A NEW THEORY OF THE ORIGIN OF SPECIES.

BY J. ARTHUR HARRIS, PH. D.

OF the making of theories there is no end, but of theories very few are destined to influence profoundly all phases of thought throughout the civilized world. Such a one was that, proposed by Charles Darwin about the middle of the century just gone, which attempted to explain the origin of species by natural selection and the survival of the fittest. Merely a theory, it explained so many facts otherwise inexplicable and explained them so logically and clearly and satisfactorily that it found, immediately, champions of the greatest ability. And while it seems hard, indeed, to suggest an hypothesis which cannot be proven to the perfect satisfaction of a large number of people, the ability of the men who upheld it, the rapidity with which it spread and made its influence felt and the bitterness with which it was opposed, at once clearly proved that the theory proposed by the now illustrious naturalist did not belong to the same class as those conceived, accepted, and championed by fanatics, but that it was to be a consideration of the most universal and vital importance. That opposition has ceased no one who is at all acquainted with the facts would suggest, any more than he could deny that for years among those whose opinions are most worth consideration the Darwinian theory in its broad sense has had almost universal acceptance. At first, besides those whose general learning or special knowledge of the subject in hand lent no weight to their bitter denunciations, there were many of the older and most able of scientists who accepted the new explanation of the development of organisms only in the most conservative way or who opposed it altogether, but time has since taken these men from the

ranks of the world's scientific investigators and their peers who now occupy the scientific chairs in the great universities of Europe and America accept in one form or another the theory of the evolutionary development of the forms of animals and plants, not as a working hypothesis but as a well established theory, or, to be perhaps more exact, they think of the *fact* rather than the *theory* of evolution. That "Evolution" is accepted by all or even a moderately large majority of people, especially in many localities, is certainly not true, but it has passed the period of bitter controversy, being so generally accepted among well-educated people as to cause little discussion, while those who might oppose it most bitterly are often so ignorant of the subject as to be unaware that the little discussion they hear is not due to lack of interest, but to the fact that the theory in its broad sense is almost universally accepted, and that now the attention of scientists is being devoted to profound investigation of the method of evolution rather than to controversies to establish its possibilities.

While few scientists of note of our present day have doubted the general correctness of Darwin's theory, there have been many who have been very conservative in accepting it just as he left it. Darwin recognized a universal variability in the animal and vegetable kingdoms. He laid great stress upon the fact of the generation of more individuals than could possibly develop to maturity and emphasized the idea that those which were weakest—that is to say, the most poorly prepared to meet their life conditions—would be the first to perish, while those which fortuitously varied in a way to fit them for life in the conditions under which they lived would reproduce their kind, and so, by a slow and gradual process, species with sharply differentiated hereditary characteristics would develop. In nature it was impossible to observe this process, but in domesticated plants and animals, where a much keener artificial selection might be supposed to replace the slower process of natural selection, the great modifications suffered by characteristics were easily demonstrated and advanced in illustration of the process which might occur more slowly in nature. Of course other points are considered, but this is the central idea. Since the appearance of the *Origin of Species* many attempts have been made to prove or disprove the possibility of the origin of species by such a process. Some have insisted with greater boldness than Darwin that natural selection in the production of species and artificial selection in the production of garden varieties are similar processes, while others have maintained that the step from natural to artificial selection is one entirely

too great—"the true danger reef of the Darwinian theory is the transition from artificial breeding selection to natural selection."

It has been supposed that the theory of the origin of species by an evolutionary process must rest on comparative studies—that is to say, it must remain merely a theory, since the process by which species originate by natural selection is so exceedingly slow that the changes are below the limits of direct observation. The strongest point of those who have opposed the Theory of Evolution has always been that the origin of a species has never been observed. I think I have the quotation not far from correctly stated: "Natural selection may explain the survival of the fittest but it cannot explain the arrival of the fittest."

In a theory advanced by Professor De Vries it is maintained that the experimental treatment of the problem of the origin of species is not impossible but that this important process may be the subject of direct observation.

The title of this paper is misleading in so far as it might suggest that it deals with a proposition entirely new, but its use is considered legitimate since it is only within the past few months that an exhaustive work devoted to the promulgation of a theory of the origin of species fundamentally different from that generally held has been given to the public. This work, *Die Mutationstheorie. Versuche und Beobachtungen über die Entstehung von Arten im Pflanzenreich,* by Hugo De Vries, Professor of Botany in Amsterdam, is certainly one of the greatest importance and universal interest—an epoch-making work, perhaps,—so that a review of the salient points of the theory which it so carefully elaborates may be well in place. In the first volume is considered the theory of the origin of species by mutation, while the second volume is devoted to Elementary Hybridity, a subject which I do not care to discuss at this time, so that the theory in its essential points is now open for consideration.

The sense in which the term *species* is used by the elaborator of the present theory is a restricted one. It is a fact recognized by everyone that species, as such, do not exist in nature, but that they are simply artificial groups of forms of individuals, the limits of such groups depending upon the judgment of the author. After the more noticeable groups in the flora of any region have been observed and characterized in the systematic literature, a careful study of the more adequate herbaria available as the region is more thoroughly explored, and especially field study of the living plants, showing many clearly defined characteristics which are lost in the

preparation of material for herbarium purposes, reveals the fact that the species in its wider sense is composed of a large number of forms showing small but clearly defined differences, not of one organ alone, but often of many or all the parts, so that a careful description must often be quite extensive. So long as the problem is one of purely descriptive systematic botany there seems to be no way of definitely determining what rank should be accorded to these forms, and the matter must necessarily remain one of judgment on the part of the person occupied with the elaboration of any group; and how widely at variance such opinions may be is only too well known to those acquainted with the literature of systematic botany, for the "species question" has always remained one of the most vexed. Long ago an attempt was made to solve accurately some of the questions by experimental means, and many of these minor forms were brought into the garden and cultivated for sometimes many years and it was found that under this treatment the offspring showed itself perfectly true to the parental characteristics, and the conclusion was warranted that the "small species" or "varieties" just as truly merit the designation of *species* as do the larger group of forms. Probably the best known example of this kind is that of the European *Draba verna*, a species described by Linnaeus himself, which has been split up into about 200 minor species, the most of which have shown themselves true to seed under cultivation. It is of the origin of these minor species, "small species," which Professor De Vries treats in the large volume just published. He does not insist that general systematic works should be made too cumbersome for use by increasing their size five or ten-fold to include ample descriptions of all the clearly differentiable forms which compose a species in the Linnean sense, but he does emphasize the idea that "species," as they are commonly recognized, are only groups of a greater or less number of clearly distinguishable forms which are true to seed, just as genera and the higher groups are only artificial conveniences.

A sharp distinction must be made between the origin of species in the broad and in the limited sense. In its limited interpretation the species is the smallest differentiable unit which is true to its characteristics in reproduction. In its broader sense the species is a group of such forms which have been united under a generic and specific name for convenience of reference. The origin of one, the origin of specific characters, ought to be, if one accepts the Mutation Theory, capable of experimental treatment; while the other, being an historical process, as will be explained later, can never be a

matter of direct observation. Many examples to illustrate this point are known to systematists. Many species are "compound" in that they are composed of a number of forms distinguished by small but clearly defined differences. When material is scant only certain of these forms may be available to the botanist, and since his series of material show great gaps in places where those which have not been collected are absent, he must make two or more species each containing one or more of the smaller units. But collection in other regions, sometimes hundreds of miles distant, may bring to light the missing elements and the whole becomes one complete series of very slightly differing types and must be recognized as *one* species, even though it shows a wider range of form than do all the other species of the genus to which it belongs. The Mutation Theory is concerned with the origin of these minor species, or of specific characters, not with the origin of the species in its broader, Linnean, sense, for this must be an historical process and consist in the breaking of the continuity of the slightly differing series by an elimination of some of its parts.

It may be readily seen that a number of separate groups of forms might originate by the loss of certain regions of a large and quite uniform series. This may account for the origin of species in the broader sense as it is considered in historical or morphological descent, but the origin of the differences in the original series must be explained. To do this it is necessary to examine very carefully the constancy and variability of plant characteristics.

"No two individuals of any planting are entirely alike" expresses the universal variability of living forms, but variability must be divided into two kinds—variabilty in its narrow sense, and mutation. The first is known as common, individual, fluctuating, or gradual variability, and from it mutation is distinguished by occurring not flowingly but in steps, without transition, and by being much more rare than the common variations universally present. In common variability there is present a continuous series of forms, while mutation occurs in steps or starts and transition forms connecting the parental and daughter forms are absent. "The contrast between the two kinds at once appears if one considers that the attributes of organisms are built up of fixed and sharply defined units. These units combine in groups, and in the kindred of species the same units and groups are reproduced. Every addition of a unit to a group constitutes a step, originates a new group, and separates the new form sharply and fully as an individual species from the one out of which it has been produced. The new species is at once

such, and originates from the former species without preparation and without gradation."

In evolutionary speculation so much stress has been laid on the evidence offered by domesticated forms that a consideration of this subject is necessary. There are to be distinguished in artificial plant breeding two different processes, the improvement of races and the production of new forms. The improvement of races may occur by crossing with a type more desirable in some respects or by selection of only the best individuals for the purposes of propagation. By the latter process forms may be very greatly improved, as may be well illustrated by the sugar beet in which the perecentage of sugar contained has been about doubled in half a century. In the improvement of cultivated plants by selection, however, the process is not a uniformly gradual or unlimited one. The greater part of the betterment may be secured in a very few generations, after which the smallest desirable change is obtained only with the very greatest difficulty. In the case of the sugar beet the most of the remarkable modification was in the first few of the fifty years of selection, while to maintain the high percentage of sugar which has been secured during this time requires the keenest selection, hundreds of thousands of specimens being polarized each year for the purpose of choosing examples for propagation in a large sugar manufactory. What is true of the sugar beet seems to be true of other forms brought into cultivation—a very great improvement may be obtained in the first few generations, after which any further improvement is secured only by means of the most careful and persistent selection. In general, from three to five generations is sufficient to bring the betterment of any characteristic to its maximum, after which selection can maintain the degree of perfection attained, but cannot carry the modification on indefinitely, so that by natural or artificial selection the origination of a new characteristic is impossible. After the attainment possible in the first few generations, selection can only maintain what has already been secured and so soon as this persistent selection is removed the subject reverts, in the same time or less time than that required for its improvement, to the original type. In general, little more than a doubling of the value of any characteristic can be obtained by selection, and no matter how sharp or long the selection this value drops to that of the original type so soon as selection ceases to act.

With the improvement of forms by hybridization we need be concerned no further than to call attention to the fact that this means is one of great importance and that many of the examples

which have been offered of common variability exceeding the limits of specific characters may be referred to accidental crossing.

The origination of new forms in horticultural work is a matter quite different from the improvement of races. This is entirely beyond the direct control of the plant breeder. Sometimes the new form may occur as a bud variation, one branch showing characteristics markedly different from the others, in which case propagation is continued by cuttings in a purely vegetative manner, or there may occur among a large number of typical plants one or more individuals with distinct characteristics, in which case they may be freed from crosses with other forms and propagated by seed. In either case the origin of the new form is an unexpected and unmediated one. All the cultivator knows of his find is that it is there and may be preserved and will reproduce true.

Before leaving the discussion of cultivated plants, attention may be directed to one point upon which Professor De Vries in his book lays great emphasis. This is the danger of drawing scientific conclusions from work which is carried on merely for practical ends. The plant breeder wants new and improved sorts and cares nothing about the way in which they originate so long as they are satisfactory and profitable. For the most part his extensive experiments are carried on without adequate record for any scientific conclusions, and except where data are complete and unimpeachable there should be the greatest hesitancy in using as evidence in theoretical biology results which have been obtained for other purposes and by methods which gave thought only to the practical side of the result and not to its theoretical significance.

Since in cultivation the materials offered to selection in the form of common or universal variability cannot form the basis of new and constant characteristics while many examples of sudden and unmediated appearance of new and sharply distinguished forms which reproduce true are known, the idea that species have originated in nature in this same manner, by mutation, seems very suggestive.

Over fifteen years ago Professor De Vries, convinced of the validity of the hypothesis that elementary species originate by sudden starts, or mutations, and not by the selection of individuals varying gradually in some direction, began a search for material favorable for direct observation, and, while the task seemed almost a hopeless one, he has been successful in a very gratifying and convincing degree. About one hundred species of plants from the local and foreign flora were transferred to his garden, not for the purpose

of selection or horticultural improvement but merely to have them in a convenient condition for observation. The account of these experiments occupies a large part of the ponderous volume before us and can only be touched on here. One species, an Evening Primrose, *Oenothera Lamarkiana,* of American origin, seemed to offer favorable material for his purpose; so almost all the others were discarded and the most painstaking observations made upon this species for fifteen years. His results may be stated very briefly. During this time several new species were produced. These appeared suddenly, with no transition forms, and were so sharply distinguished from the typical plants that they could in some cases be recognized even in the seedling stage of development. Some forms occurred only a few times, others were produced anew year after year and in considerable numbers. Not only do these new species show themselves sharply distinguished from the parent type, but when fertilized with pollen from the same species reproduce true year after year with no tendency to revert to the type from which they were derived. The original species during this time shows no change, but the most of the offspring are true to the ancestral characteristics. The new forms are not produced from the old by gradual modification but are sharply differing side branches, so to speak, of the parent stem, given off year after year according to some law not yet understood, and capable of continuing their sharply defined characteristics generation after generation, just as the original species does.

Observations of great interest were also made on other subjects, especially abnormalities which usually originate suddenly and show themselves in a high degree heritable, but these cannot be discussed in this brief review.

While the discussion given here is inadequate as representing the scope of the volume which has appeared it indicates some of the more important considerations and must suffice, for the little space still available must be used in summarizing the principal conclusions and contrasting them very briefly with those of the prevailing theory.

Professor DeVries holds the view that a species is always subject to common or fluctuating variability, but only at certain times is it in a mutable condition. Most species are in an immutable condition, and, while selection may take the material offered by universal variability and produce local races or secure acclimatization, the development of new characteristics is impossible. But when a species enters the mutable state a large number of new species may

be produced from it in a comparatively short time. The length of this mutable period is not known, but in the Evening Primrose it was studied for fifteen years and this may represent but a small part of its duration. If one accepts the Mutation Theory the universal variability of organisms has no significance so far as the origin of species is concerned, while the statement, "species have originated by natural selection in the struggle for existence," falls into two parts for consideration. The struggle, or competition, for existence occurs between the individuals of one elementary species and also between the different species as such. In the first case individuals best adapted to their environment are least liable to perish, and so local races, or, where artificial selection replaces natural selection, improved sorts, are developed and acclimatization is possible; but so soon as the special selective influence is removed there occurs a reversion to the type of the constant species. In the second case the weakest species, as in the first the weakest individuals, are the first to perish. In the same way the classic expression, "the survival of the fittest," embraces two distinct and clearly defined propositions: the survival of the fittest individuals in the constant species, and so the production of local races or the securing of acclimatization by selection, and the survival of the fittest species. But in order to enter the struggle for existence—to come into competition for existence—or to survive, species, as individuals, must exist. These species originate not by the gradual modification of a parent type during the course of hundreds or thousands of years, but by sudden steps, and since the new characteristics which they show are in a high degree heritable the individuals of the new form multiply and a struggle for existence ensues in which the weaker species are rooted out. But the struggle for existence has nothing to do with the origin of the new form, for, if one accepts the Mutation Theory, species have not originated but perished in the struggle for existence. In the Evening Primrose studied some species were formed which were entirely too weak to survive in a life of competition, and it seems altogether probable that vast numbers of such have originated during past ages and have been crowded to the wall by stronger forms.

Each point might be considered in greater detail and with more elaborate statement of the data upon which it is based, but the essentials of the new theory which has been so carefully developed have been stated. What the ultimate decision of biologists as to its value may be, time only can tell. Here, I have made no attempt to give a criticism of the theory, but have sought to present it from

the point of view of the author. But whatever may be the ultimate judgment of the scientific world concerning the theory, it is presented in such an elaborate and painstaking form that it is bound to receive the careful attention of all concerned with evolutionary theory. While the acceptance of the Mutation Theory necessitates a very profound change in some of our ideas, one must not forget that it is simply a difference in the method of evolution which the new theory postulates, and, while the conception of the method of the origin of species is fundamentally different from that so generally held, the fact of the evolutionary origin of living forms still stands as ever.