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SPECIAL ARTICLES

AN INTERPRETATION OF ELEMENTARY SPECIES

THE original idea which led to the development of the theory of so-called elementary species is found in Darwin's gemmules. Existence of these gemmules was proposed to explain the supposed transmission of acquired characters. Weismann, acting on Darwin's idea as a suggestion, developed a very elaborate theory of heredity. To consider the relation of Weismann's philosophy to the subject in hand would take us too far from our present object, though this relation is important. De Vries, going directly back to Darwin and doing away with that part of Darwin's theory which postulated the migration of gemmules of the various cells of the body to the germ cells and assuming that the germ plasm is composed of these gemmules—or as de Vries calls them, pangens, has developed a very elaborate theory, not only of heredity, but also of evolution, based on the assumption that the individual is merely an assemblage of parts, each of which constitutes an hereditary character and each of which develops from a particular pangens in the original germ plasm of the fertilized egg. He conceives a definite species to be made up of a definite number of these hereditary characters. The addition of a new kind of pangens to the germ plasm causes the developed organism to differ more or less from other individuals which preceded it. If this difference relates to a single pangens, then the new and modified form of the organism is looked upon as an elementary species. It differs from its congeners by an elementary difference. The ordinary species may contain within it a large number of elementary species, each differing from those nearest related to it by the possession of a single pangens not possessed by its nearest relatives.

The work of Nilsson in Europe and of

Shull in this country have been considered as strengthening the idea of elementary species. Nilsson has been able to obtain varieties of wheat and other plants that may be assumed to be absolutely uniform except for such differences as are caused by environment. Some of the distinct strains differ very little, but this difference is absolutely constant, and the different individuals within one of the elementary species are as like each other as so-called identical twins. They offer no further chance of improvement by selection. Shull has, in like manner, obtained supposedly elementary species of corn which breed true, the various individuals of a given strain being as much alike as identical twins. He was led to look upon a corn field as simply a heterogeneous collection of these elementary species and hybrids between them.

These so-called elementary species can easily be accounted for on the old Darwinian idea of gradual evolution, as will be shown below. They are, therefore, in no wise a confirmation of the pangens theory of de Vries. The demonstration is as follows: Let *A*, Table I., represent a Mendelian character which is more or less variable in the different individuals in which it appears, these differences being hereditary. Let *B* and *C* represent other Mendelian characters similarly variable. The variations in these characters may have come about gradually, as Darwin supposed variation to occur, or they may have come about in any other manner. Suppose A^1 represents the first character as it appears in a particular homozygous individual. A^2 may represent this same character in another homozygous individual, the difference between A^1 and A^2 being so slight as not to be certainly discernible. In like manner A^3 differs from A^2 so slightly that the two can not be certainly distinguished, but A^3 differs from A^1 sufficiently to be distinguished. So with the other *A*'s. Any one of them in the series from A^1 to A^{10} differs so slightly from adjacent *A*'s as not to be certainly distinguishable from them, but may be distinguished with more and more certainty as we recede from the selected *A* in the series. The exponents of *B* and *C* have

a similar meaning. While we have assumed the series A^1 to A^{10} to be continuous, this series may have gaps in it not bridged over by *living* intermediate forms. Each of these "allelomorphs" is supposed to be phylogenetically related to the others in the same series, and the differences between them may be supposed to be analogous to the differences between the individuals of a large and variable species. We have merely taken the case in which the series is continuous to show that such continuity is consistent with the phenomena under consideration.

TABLE I

A^1	A^2	A^3	A^4	A^5	A^6	A^7	A^8	A^9	A^{10}
B^1	B^2	B^3	B^4	B^5	B^6	B^7	B^8	B^9	B^{10}
C^1	C^2	C^3	C^4	C^5	C^6	C^7	C^8	C^9	C^{10}

TABLE II

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A^1A^5 :	A^1	A^1	A^1	A^1	A^5	A^5	A^5	A^5
B^3B^8 :	B^3	B^3	B^3	B^3	B^8	B^8	B^8	B^8
C^2C^6 :	C^2	C^6	C^2	C^6	C^2	C^6	C^2	C^6

TABLE III

(1) × (1)	A^1A^1 ,	B^3B^3 ,	C^2C^2 .
(2) × (2)	A^1A^1 ,	B^3B^3 ,	C^6C^6 .
(3) × (3)	A^1A^1 ,	B^3B^3 ,	C^2C^2 .
(4) × (4)	A^1A^1 ,	B^3B^3 ,	C^6C^6 .
(5) × (5)	A^5A^5 ,	B^3B^3 ,	C^2C^2 .
(6) × (6)	A^5A^5 ,	B^8B^8 ,	C^6C^6 .
(7) × (7)	A^5A^5 ,	B^3B^3 ,	C^2C^2 .
(8) × (8)	A^5A^5 ,	B^8B^8 ,	C^6C^6 .

Under our hypothesis all the various forms of A will be allelomorphic; likewise those of B and those of C . In order to have a concrete case, suppose that the three characters considered are characters of the corn plant. A may govern the length of the tip on the corn husk, the various exponents indicating the relative development of this tip. B may represent breadth of leaf and C length of internode. It is to be understood, of course, that we are referring now only to differences which are hereditary and our exponents refer to degrees of difference which are hereditary. Now let us select an individual corn plant at random from a field. Suppose the gametic constitution of the plant selected is that shown in the first column of Table II. With reference to

the length of the husk tip it is heterozygote, one of the allelomorphs tending to produce a very short tip, the other a tip of medium length. With reference to the breadth of leaf, our selected plant is also heterozygote, one of the allelomorphs tending to produce a moderately narrow leaf, the other a moderately wide leaf. With reference to the length of internode, the allelomorph C^2 would correspond to a short internode, while C^6 corresponds to a moderately long one. Now on the well-known behavior of Mendelian character pairs, when our corn plant, after close fertilization, produces reproductive cells, we shall obtain, with reference to the three characters considered, eight types of gametes, as shown in Table II. The fortuitous union of these eight types of gametes produces sixty-four fertilizations, consisting of twenty-seven different types, eight of which are homozygote with reference to each of the characters concerned. These eight homozygote types are shown in Table III. Now, if we neglect any evolutionary changes which may have occurred in each of these hereditary characters during one generation, each of these types shown in Table III. will reproduce so true to type that there will be no variation at all except that due to environment; and we have eight so-called elementary species, each reproducing as true to type as branches from the same twig of an apple tree.

It is very clearly seen that each of these elementary species is merely a cross-section of the real variable species, and that the major part of the variation in a corn field is accounted for simply as a result of the recombination in each generation of Mendelian characters, each of which may vary between wide extremes just as a species varies under the Darwinian theory of evolution. For instance, the first elementary species in Table III. is a cross-section of the species through A^1 , B^3 and C^2 of Table I.

By properly selecting the parent plant we could get other so-called elementary species intermediate between any two of those shown in Table III. An interesting example of this arose at the recent meeting of the American Breeders' Association. Dr. Shull reported his

work in which he had selected out the elementary species produced by a self-fertilized corn plant. With reference to number of rows of grain on the cob some of the forms he happened to get showed a strong tendency to produce ears with ten rows and others with fourteen rows. None had twelve for their mode, and he had been led to the belief that amongst the elementary species of corn none of them, when purely homozygote, tends to produce twelve rows. Dr. E. M. East, of New Haven, who had done some similar work, had happened to get a cross-section of the species which tended strongly to produce twelve rows and not ten or fourteen, which is just what one would expect if the present view of elementary species is correct.

Under this view, a so-called elementary species is simply a completely homozygous form, which necessarily reproduces itself with almost absolute fidelity. The number of such forms possible in a species depends on the number of independent Mendelian characters present, and the degree of variability of these characters. The various forms under which one of these characters exhibits itself may represent a continuous series such as we have assumed above, or the series may be broken at various points, leaving gaps which are bridged only in the ancestral lines of the allelomorphs having a common descent, just as we find the case to be with large and variable groups of organisms.

It is seen, therefore, that if Darwin's idea of the manner in which evolution occurs is true, then *the results secured by the breeder of so-called elementary species are a necessary result of Mendelian behavior of Darwinian characters.* The remarkable fidelity with which so-called elementary species reproduce themselves is thus seen to be in entire accord with the theory of gradual variation taught by Darwin.

The work of Nilsson, Shull, East and others who have segregated these forms that propagate as true to type from seed as cuttings, is of great importance to biological theory, as well as to the art of the breeder. Nilsson is making commercial use, on a large scale, of the principle involved. Tracy, in breeding

seedling varieties of cassava, is doing the same thing on a smaller scale, though his work is only just beginning to show positive results. The seedlings of the cassava plant are ordinarily about as variable as those of the apple. Some three years ago, Professor S. M. Tracy, at the request of the writer, undertook to secure homozygote forms of cassava at Biloxi, Miss. He now has a few varieties nearly completely homozygote, and it is believed that within one or two seasons their culture on a commercial scale will be an accomplished fact. This, it is hoped, will rejuvenate an industry which had died because of the uncertainty of propagating cassava from cuttings.

At least in self-fertilized species, these completely homozygote forms offer splendid material for studying evolutionary changes, and especially for studying those changes induced by change of environment. They should soon become the starting point for some fundamentally important investigations.

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CURRENT NOTES ON METEOROLOGY AND CLIMATOLOGY

KASSNER'S "DAS WETTER"

A VERY useful little book has just been published by Professor Carl Kassner, observer at the Royal Prussian Meteorological Institute in Berlin, and Privatdocent at the Technische Hochschule in that city ("Das Wetter, und seine Bedeutung für das praktische Leben," 8vo, Leipzig, Quelle und Meyer, 1908, pp. 148). The plan of the volume is rather different from that of other books dealing with the same subject. Its aim is to set forth, for the information of the average reader: (1) The historical development of weather forecasting; (2) the basis of modern weather forecasting and (3) the relations of the weather to the every-day life of man. The section dealing with the historical development of forecasting summarizes briefly the results of Hellmann's investigations into meteorological folk-lore and literature. Special attention may be directed to the third section, which is