Biologisches Centralblatt.

Unter Mitwirkung von

Dr. K. Goebel und Dr. R. Hertwig

Professor der Botanik Professor der Zoologie

in München,

herausgegeben von

Dr. J. Rosenthal

Prof. der Physiologie in Erlangen.

Der Abonnementspreis für 12 Hefte beträgt 20 Mark jährlich.
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Die Herren Mitarbeiter werden ersucht, alle Beiträge aus dem Gesamtgebiete der Botanik an Herrn Prof. Dr. Goebel, München, Luisenstr. 27, Beiträge aus dem Gebiete der Zoologie, vgl. Anatomie und Entwickelungsgeschichte an Herrn Prof. Dr. R. Hertwig, München, alte Akademie, alle übrigen an Herrn Prof. Dr. Rosenthal, Erlangen, Physiolog. Institut einsenden zu wollen.

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East, E. M. and Hayes, H. K. Heterozygosis in Evolution and in Plant Breeding.

U. S. Dept. Agr., Bur. Plant Industry Bull. 243: 1—58. 1912. Plates 8.

This paper is a resumé of experiments on the effects of crossbreeding and inbreeding begun in 1906 by the senior author at the Connecticut Agricultural Experiment Station and since prosecuted both there with the aid of the junior author and at Harvard University. The material used was maize, representing a typical cross-fertilized plant, and various species of Nicotiana, representing self-fertilized plants.

The thesis defended is that 1. the effect of inbreeding is merely an isolation of homozygous types when from natural or artificial cross breeding there has arisen a physiological mixed race, and that 2. the effect of crossbreeding is to bring about greater vigor through a stimulus to development which is the direct effect of characters being present in the heterozygous condition. This stimulus to development is found to be “cumulative up to a limiting point and varies directly with the number of heterozygous factors in the organism, although it is recognized that some of the factors may have a more powerful action than others". Granting the truth of this conclusion, every phenomenon observed in inbreeding and crossbreeding is that which is to be expected from the action of Mendel's law of heredity.

The extraordinary frequency of observations of hybrid vigor by early authors, including as they do the pteridophytes, the gymnosperms and 59 out of 85 families of the angiosperms in which artificial hybrids have been made, is fully discussed in the historical abstract. Darwin's work is shown to agree with the authors' hypothesis, by a fairly detailed analysis of the results published in "Cross and Self Fertilisation in the Animal Kingdom".

The experiments on the effects of inbreeding included the selfing of over 30 varieties of maize for from 1 to 7 generations, and the crossing of selfed strains with each other. Selfing was always followed by a loss of vigor, using that term to mean a somewhat less rapid cell division or slower growth and a smaller total amount of cell division resulting in smaller plants and plant organs, but not to mean a pathological degeneration. This should be the result if vigor is an accompaniment of heterozygosis through the tendency of inbreeding to produce homozygosis, the probable number of homozygotes and any particular class of heterozygotes in any generation r being found by expanding the binomial $[1 + (2^r - 1)]^n$ where n represents the number of character pairs involved.

It was concluded that inbreeding a naturally crossbred plant, has these results:

"1. There is a partial loss of power of development, causing a reduction in the rapidity and amount of cell division. This phenomenon is universal and therefore cannot be related to inheritance. Further, it continues only to a certain point and is in no sense an actual degeneration.

2. There is an isolation of subvarieties differing in morphological characters accompanying the loss of vigor.

3. There is often regression away from instead of toward the mean of the general population.

4. As these subvarieties become more constant in their characters the loss of vigor ceases to be noticeable.

5. Normal strains with such hereditary characters that they may be called degenerate strains are sometimes, though rarely, isolated.

6. It is possible that pure strains may be isolated that are so lacking in vigor that the mechanism of cell division does not properly perform its function, and abnormalities are thereby produced."

Crossing these inbred types invariably produced a great increase in vigor in the first hybrid generation, vigor that again decreased with self fertilization.

Experiments on plants naturally self fertilized showed that there existed: a) plants so different that they will not cross; b) crosses that produce seed that contain no proper embryo; c) crosses that produce seed with embryo, but which go no further than the resting stage of the seed; d) crosses less vigorous than either parent; e) crosses more vigorous than the average of the parents; and f) crosses more vigorous than either parent. Fertile crosses are nearly always more vigorous than the average of the parents, sterile crosses are often more vigorous than the average of the parents, but as the differences between the parent types becomes greater a critical point is reached beyond which the cross is less vigorous than either parent. The phenomenon of vigorous hybrids, exhibited by crosses between plants usually self-fertilized naturally is therefore the same phenomenon as the decline in vigor of plants naturally cross-fertilized when they are inbred.

The characters affected by hyterozygosis are only those which are an expression of rapidity and amount of cell division. Even some of these, such as size of flower, which might be expected to respond to the action of heterozygosis, are not affected.

After an analysis of the results in terms of modern genetics is given, the same theories are shown to hold for the animal kingdom.

The value of the vigor due to heterozygosis during the process of evolution is thought to be as follows: "It can hardly be doubted that heterozygosis did aid in the development of the mechanisms whereby flowers are cross-fertilized. Variations must have appeared that favored cross-fertilization. These plants producing a cross-fertilized progeny would have had more vigor than the self-fertilized relatives. The crossing mechanism could then have become homozygous and fixed, while the advantage due to cross-fertilization continued. But was this new mechanism an advantage? It must have been often an advantage to the species as a whole. In competition with other species, the general vigor of those which were cross-fertilized would aid in their survival. But the mechanism may not have been useful in evolving real vigor in the species, because of the survival of weak strains in combination. In self-fertilized species, new characters that weakened the individual would have been immediately eliminated. Only strains that stood by themselves, that survived on their own merits, would have been retained. On the other hand, weak genotypes in cross fertilized species were retained through the vigor that they exhibited when crossed with other genotypes. The result is, therefore, that self-fertilized strains that have survived competition are inherently stronger than cross-fertilized strains. On this account weak genotypes may often be isolated from a cross-fertilized species that as a whole is strong and hardy."

The paper closes with an account of the practical utilization of the vigor of heterozygosis in practical plant breeding.

The experiments and conclusions reported in this paper are paralleled by the excellent work of Dr. G. H. Shull. Shull's work and that of the writers, started at about the same time and kept up until the present date, have been corroborative in every detail.

The authors' wish to express their regret that they were ignorant of the paper by Burck[1]). Our attention was called to the oversight by the kindness of Prof. Dr. Goebel.

Das Biologische Museum des Zootomischen Instituts der Universität Dorpat.

Von Prof. K. Saint-Hilaire.

Wenn ein naturhistorisches Museum wirklich ein Bildungsinstitut sein soll, so muss man sich bei seiner Einrichtung von vornherein von irgendeiner grundlegenden Idee leiten lassen. Die Zeiten der Raritätenkammern, die vornehmlich die Phantasie der Besucher zu beflügeln geeignet waren, die Kenntnisse des Publikums aber auf keinem Gebiete der Naturwissenschaften erweiterten, sind ja längst vorbei. Solche grundlegende Ideen sind denn auch tatsächlich in jüngster Zeit bei der Einrichtung von Museen ausschlaggebend gewesen. Ich nenne nur das Museum für Meeresforschung in Berlin und das Ozeanographische Museum in Monaco, in denen alles zusammengetragen ist, was auf die Erforschung des Meeres Bezug hat, und das Phylogenetische Museum in Jena, das der Abstammungslehre dient.

Auch bei der Einrichtung meiner Sammlung, die namentlich für die Demonstration in den Vorlesungen über „Allgemeine Zoologie" in Betracht kommt, habe ich mich an den obigen Grundsatz gehalten. Ich habe mir zunächst den ganzen Plan der Sammlung ausgearbeitet, von dem ich mich leiten lassen wollte. Im Sinne dieses grundlegenden Planes arbeitete ich mir einen Katalog aus, dem ich nun bei der Anfertigung der Präparate und bei dem Ankauf neuer Museumsgegenstände stets folge. Der Einrichtung meiner Sammlung liegt das „biologische" Prinzip zugrunde. Die Objekte

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1) Burck, W. Darwin's Kreuzungsgesetz und die Grundlagen der Blütenbiologie. Biol. Centralbl. XXVIII: 177—195, 1908.