VARIETAL MUTATION IN THE TOMATO.

THE following remarks refer to the origination by mutation * of a strongly marked and distinct variety of tomato from seed of an old and well-known variety, under ordinary cultivation in an isolated garden plot; and to the subsequent duplication of that case of mutation upon the same ground and under the same conditions of cultivation, but in plants produced from other seed of that old variety, which was grown in a different and distant region. The mutation in these two cases is remarkable in that it was uniformly manifested in every plant of each of the two crops in which it occurred; that it produced plants which were widely different from the parent plants; that the second case was an exact repetition of the first, and that it occurred in both cases under circumstances that preclude the probability that it was the result of cross-fertilization.

My observations in these cases were made in connection with amateur gardening upon my house-lot in Washington, a statement of the results of which follows in narrative form. I chose the Acme variety of tomato for cultivation because of its long-known excellence, and the cases referred to occurred unexpectedly in the variety thus chosen. In the spring of 1898 I purchased a dozen young plants which had been produced from seed by a gardener in the vicinity of Washington, and transplanted them in my garden plot. As the plants matured and fruited they showed all the recognized varietal characteristics of Acme, a description of which is herewith given for the purpose of comparing it with other varieties presently to be mentioned. The plants were large and diffuse, the color of the foliage being a medium shade of green; haulms slender, somewhat numerous, some of them reaching a length of more than six feet; the petiole-midrib long and slender; leaflets moderately narrow, distant, petiolulate and only slightly rugose; fruit depressed-globular in shape, with an occasional tendency to become transversely oval, uniformly ripened, fleshy and well flavored; and in ripening the change from the chlorophyl-green to crimson, passing through more or less of yellow.

I selected seeds from one each of the earliest and most characteristic fruits of several vigorous plants of this crop of 1898, and made a mixed packet of them. These seeds I planted in 1899, expecting to produce true Acme plants, because of my care in selecting and preserving the seeds, because of the comparative stability of that variety, and because no other tomato plants were grown with them, or in their neighborhood, from which cross-fertilization might have occurred. To my surprise, however, all the plants which grew from these seeds were distinctly different from the parent plants of the year before, both as to habitus and as to fruit, and all were uniform in their new characteristics. They were sturdy and compact plants with foliage of a deeper green than that of the parent plants; haulms few and strong, the more vigorous reaching a length of about four and a half feet, or an average of about two-thirds the length of the parent plants; petiole-midrib short and strong; leaflets moderately broad, not distant, sessile or nearly so, and strongly rugose; fruit similar to that of the parent plant in size, shape and consistence, but more delicate in color, which changes from the chlorophyl-green to cherry-red or light crimson through a neutral or flesh color, a yellow tint seldom appearing. It is also singularly free from the pronounced tomato flavor of the common kinds. The seeds which I saved from this new variety were accidently destroyed

* In this article I use the term 'mutation' in the phylogenetic sense that has been given to it by Professor Hugo de Vries in his exhaustive work, 'Die Mutationstheorie,' Leipzig, 1901.

and I supposed the variety was therefore lost; but two years later I recovered it upon the same ground and under the same conditions of isolation and cultivation, but from a new source as to seed.

In the spring of 1900 I bought from a Philadelphia company of seed-growers a packet of their 'selected Acme Tomato' seed, grown and gathered on a Pennsylvania farm in 1899. From a part of these seeds I grew thirty plants to maturity, every one of which was true to the Acme variety as described in the second paragraph of this article. In this case also there was no probable source of cross-fertilization, and I carefully saved a mixed packet of seed selected from typical fruits of several of the best plants, as I did in the former case. These seeds I planted in my garden plot in 1901, not doubting that they would produce true Acme plants, notwithstanding my former experience. On the contrary, however, all the plants grown from those seeds were not only quite different from the parent Acme plants, but they were in all respects, both as to habitus and as to fruit, like those which grew upon the same ground in 1899, which are described in the third paragraph of this article, and which variety I believed was lost at the end of that year. That is, in 1900 and 1901 I exactly repeated my experience of 1898 and 1899, the second experience having been with seed from an entirely new source, as already stated. The new variety belongs to a group of varieties of which the two known to gardeners as the 'Potato-leaf Honor Bright' of Livingston and the 'Dwarf Champion' of Ferry, respectively, may be taken as types. It is quite a different group in several respects from that to which the Acme belongs. For convenience of reference I will designate this new variety as the 'Washington.'

When, in the spring of 1901, I planted the seed of the Acme plants which I had grown in 1900, I at the same time planted the remainder of the Pennsylvania packet of Acme seed, carefully keeping separate both the seed and the resulting plants. The second portion of the Pennsylvania seeds produced true Acme plants, as did those of the first portion in 1900, and, although they grew vigorously, their fruit was more than two weeks later in ripening than was that of the Washington variety, thus adding another element of difference between the two varieties. This second planting was fortunate because it gave excellent opportunity to compare the two varieties with each other in all stages of their growth. As the plants of both varieties matured their differences of habitus became very conspicuous; indeed, it was readily observable with the appearance of the first leaves of the plantlets.

While all varieties of cultivated plants which are reproduced from seed are notably unstable in their varietal characteristics, some varieties, of even the same species, are more unstable than others. This varietal unstability of cultivated plants is manifested in both mutation proper and atavic reversion. The first is regenerative, and divergently progressive, especially in respect of results desired by the horticulturist, and the second, degenerative and convergently retrogressive. The tendency to mutation proper in cultivated plants is generally manifested in connection with selective cross-fertilization, but in view of my experience herein recorded, and of that of other persons in other cases, it cannot be doubted that it often occurs spontaneously in plants that have been fertilized only by pollen from those of their own variety. The tendency toward degenerative change in cultivated plants is apparently an inevitable result of promiscuous cross-fertilization, and is toward the primitive, uncultivated condition of the species. I, of course, assume that the Washington variety of tomato

herein described originated by spontaneous, saltatory mutation, without cross-fertilization, and that this form of mutation differs only in degree, not in kind, from the saltatory origin of new species which has been elaborately described and demonstrated by Professor de Vries in his work already referred to.

This manner of origination of the Washington variety of tomato is assumed for the following reasons: (1) No probable source of cross-fertilization was discovered by careful investigation; (2) all the new plants were identical with one another in their varietal character; and (3) the mutation in question was exactly repeated in a succeeding crop under like conditions of isolation and cultivation. If my Acme plants had received adventitious fertilization by pollen from any other than flowers of their connate crop-associates, the cross-fertilization would doubtless have been incomplete as to the whole crop and various as to the kinds of hybrids produced. Even if it were credible that the first case of complete mutation of my whole crop might have been the result of cross-fertilization from some unknown source, it would still be too much to believe that exactly the same result could have been produced a second time in succeeding years by such adventitious means.

Saltatory mutation may be said to have both a predisposing and an exciting cause, the former being always present, at least latently, and the latter acting only under the stimulation of changed conditions; but I do not propose to discuss the nature of either of them. While the exciting cause of saltatory mutation in plants very often acts in connection with the process of cross-fertilization, it sometimes, as has been shown, acts independently of it. In such cases as that which is here recorded one naturally seeks the exciting cause in some peculiarity of the physical conditions under which the plants grew. I by no means assume that the exciting cause of the mutation which produced the Washington variety of tomato will be found in the physical conditions of my garden and its vicinity, but the following mention is made of those conditions, that they may be considered in any inquiry that may be made concerning it. My ground is in a northern suburb of Washington and, before the Civil War, it was part of a worn-out farm of stiff clayey soil. It is somewhat dry, but was watered freely with Potomac river water, especially during the hot summer months. It was fertilized with stable manure, lawn-mowings (used also as mulching) and crude sodium nitrate, the last about half an ounce to the plant, applied in weak solution near the roots. Besides the evident obscurity of the exciting cause of the case of mutation in question, when considered with, as well as aside from, reference to these conditions, it should also be mentioned that no similar case has been reported from other gardens around Washington in which tomatoes are grown, although practically the same conditions prevail in many of them that exist in mine.

That the mutation which produced my new Washington variety was not atavic, or retrograde, in character is shown by the horticulturally improved characteristics of the fruit, and by the fact that the entire habitus of the plant is unlike that of the parent Acme, and also unlike that of the plants from which the Acme was originally produced. In both fruit and habitus the new variety is also very unlike those common tomato plants and fruit to which all improved varieties sooner or later convergently revert under promiscuous cross-fertilization and careless cultivation. Although the Acme is one of the least unstable of the very many varieties of tomato which gardeners have recognized, its deterioration by atavic reversion is very common and is readily observable in the markets of Wash-

ington, where gardeners have brought the fruit during more than twenty years; but few of them have kept it pure. One may there trace the reversion through various grades from the typical to almost worthless kinds.

In view of all the facts that have here been stated, there seems to be no room for doubt as to the spontaneous, saltatory and phylogenetic character of the mutation which produced the Washington variety of tomato. Whether it will show the usual degree of varietal stability in future seed propagation, and whether any similar mutation will occur in other varieties of tomato under conditions similar to those of my garden, remain to be demonstrated.

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Smithsonian Institution,
October 3, 1901.

SCIENTIFIC BOOKS.

A Treatise on Zoology. Edited by E. Ray Lankester. Part III. The Echinoderma, by F. A. Bather, assisted by J. W. Gregory and E. S. Goodrich. London, A. and C. Black. 1900. Pp. vii + 344.

The student of zoology, if he wishes an elementary text-book, finds as great difficulty in making his selection as he does in buying a new bicycle or typewriter. Apparently the more advanced student will not be thus hampered by any embarrassment of riches, for it is doubtful whether any other work aims as high and attains as much as the volume under review.

The average worker who has added somewhat to his primary zoological training finds it a dreary and often fruitless performance to extract the new facts of science or the present state of knowledge on any particular topic from the almost endless collection of 'elementary' text-books, no matter how valuable they may be in fulfilling their true function. It is almost equally tiresome to sift out the same information from the great mass of technical papers on particular things. The present volume supplies in a large degree this deficiency for the Echinoderma, and is a most welcome addition to general zoological literature. The entire series is planned to include ten parts, of which this is the third. Each of the larger groups of animals is to be described by a separate author after a definite model, in order to secure uniformity in both scope and method.

The general systematic survey of the phylum Echinoderma, with its seven classes, is quite full and comprehensive and includes the main facts of ontogeny, phylogeny, anatomy and classification. The orders and families are all clearly defined and most of the prominent genera are reviewed or mentioned. One of the striking features of this volume is the fulness with which the fossil forms are treated, thus according them their true value in any general treatise on echinoderm morphogeny. Instead of the starfishes and sea-urchins constituting the entire program, or 'whole show,' as they do in the minds of the average student and in half the text-books, here they form but the last two of the seven classes recognized, and the length of their discussion is in proper proportion. It is sincerely to be hoped that similar true values will be given among other classes, whether extinct or not.

The phylum Echinoderma comprises two divisions or grades, the Pelmatozoa and the Eleutherozoa. In the first are the classes Cystidea, Blastoidea, Crinoidea and Edrioasteroidea. In the second grade are the Holothuroidea, Stelleroidea and Echinoidea. This arrangement shows the unequal value of the classes and does not express their phylogenetic relations. The latter probably would be more truly represented, according to Bather, by placing a primitive class, Amphoridea, at the base and deducing from it several lines of descent, namely, Edrioasteroidea, Anomalocystida, Aporita, Rhombifera and Diploporita. From the Edrioasteroid line, it is supposed, there sprang first Holothurians, then Stelleroidea, then Echinoidea. The Blastoids are included in the Diploporite line, and from them as a fresh development with a new lease of life arose the important class Crinoidea, whose discussion occupies, as is wholly proper, nearly one-third of the present volume.

The class Stelleroidea comprises the Asteroidea and Ophiuroidea, generally considered as quite distinct. Some recent genera, how-