

Mutation and Evolution*

Some Interesting Recent Experiments by Van der Wolk

By R. H. France

IT must be admitted that the doctrine of evolution no longer awakes the burning interest which it did some fifty or a hundred years ago. It now divides human interest with many other fields of knowledge—perhaps indeed with all of them. At a time when electricity was not a matter of common knowledge to every peasant boy through the electric light and the dynamo, but was familiar only in physical laboratories through a few chosen experiments which now-a-days appear to be not only simple but even childish in nature, many people found not only physical but spiritual thrills even for a life time in its phenomena, as one may read in the *Memoirs of the Duke of Lauzun*. Before the day when every neurologist became capable of exercising hypnosis, but when Mesmer alone professed to evoke “magnetic sleep,” all Europe hung breathless upon this strange affair as upon the founding of a new religion.

Taken by and large mankind is both ungrateful and short sighted. It turns with burning zeal to those matters which it does not understand and loses interest in them as soon as they are explicable and useful. Being in a certain measure disenchanted they remark languidly, “Oh, that’s easy to explain like this,” etc.

The same thing has happened to the theory of evolution; when Haeckel and Huxley, following in the hesitant steps of Darwin, laid down its laws in bold clear lines, it was an event of European importance. And yet at that time their opinions concerning it were of as hypothetical a character as ours today concerning the canals of Mars. More than fifty years have passed since that time and today everything definitely known and worthy of belief in regard to the theory of evolution has again become a mere “technical matter”; the “fight over Darwin” is stilled, at any rate, so far as the public is concerned. In its place there has come to the fore during the last decade or so a “fight about the mutation theory” which, at least, with respect to the great material value which it involves deserves the attention of the general public.

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The concept of mutation, which first made its appearance in 1903 in a work published by the Dutch botanist, Hugo D. Vries, has after some hesitation been pretty generally accepted as furnishing an explanation for the sudden appearance of new and inheritable characteristics in the animal and the plant. The significance of this view resides primarily in the inheritability of such characteristics and neither in the fact that they are peculiarly striking nor in the fact that they are absolutely new. For example, the moss rose constitutes a mutation which once appeared in a garden and which can be perpetuated both by grafting and by seeds. The merino sheep presents another case of mutation. In 1838 an English ewe gave birth to a lamb having long silky hair, which character was inherited by its progeny. In the same manner

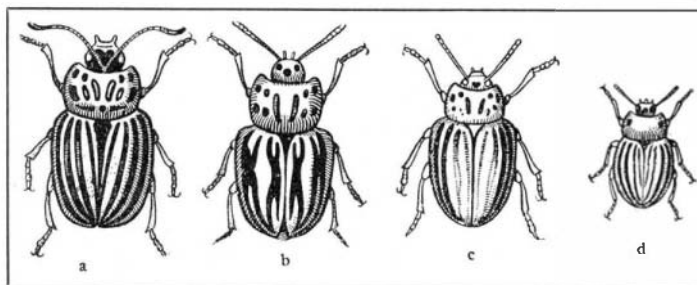


FIG. 1. MUTATION OF THE COLORADO POTATO BUG (*LEPTINOTARSA DECEMLINEATA*)

The type shown at a; b, c, d show varieties produced experimentally, but which also make their appearance among local native species and become stable under certain conditions, through heredity. (After Tower.) About 2½ diameters.

the much admired cactus dahlia suddenly made its appearance in Germany, in a plant grown from American seeds.

The divergent races of a certain Colorado potato bug (*Leptinotarsa decemlineata*) also represent mutation; these were first obtained experimentally by Tower and then were discovered in nature; their characters which are pictured in Fig. 1, are inheritable.

Mutations have been found in every group of the plant and animal kingdoms from the bacteria to the domestic animal, and this vast material enables us to gain a certain insight into the laws which govern their appearance. Such mutations occur with especial frequency in years which are unusual with respect to climatic conditions; a second exciting cause is recognized in the transplantation of an organism into a new environment, the most famous example of which is the classic example of all mutations, that of the evening primrose (*Oenothera*) which was discovered by De Vries growing wild in a locality near Amsterdam. A third group consists of cases found among plants and animals subjected to domestication, and a fourth among those unhappy guinea pigs used for experiments, who often exhibit sudden alterations.

From this alone it is possible to deduce a certain conclusion; to employ the terms which best express our modern perception of the nature of life these mutations make

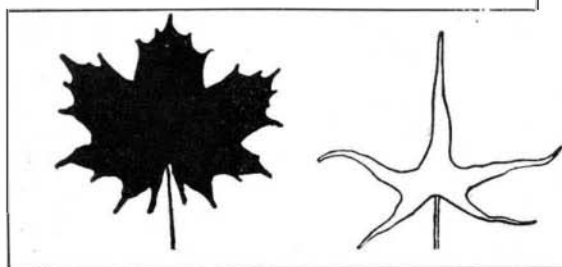


FIG. 2. AN ORDINARY MAPLE LEAF AND ON THE RIGHT ALTERED FORM OF WHITE MAPLE LEAF

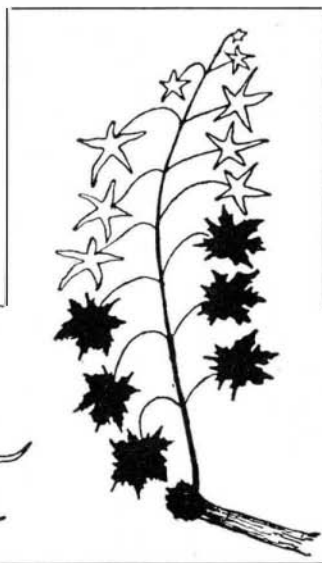


FIG. 3. GREEN TWIG WHOSE TIP HAS BEEN ARTIFICIALLY INFECTED

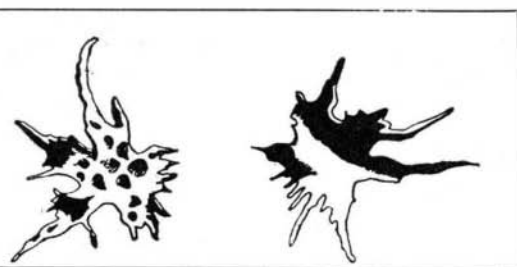


FIG. 4. HYBRID PRODUCED BY CROSSING ORDINARY MAPLE LEAF WITH DISINFECTED WHITE MAPLE

their appearance as "responsive reactions." In other words they represent the responses given by the plant to certain definite and extraordinary alterations in environment differing from the usual adaptation to environment only in the fact that they have become definitely fixed and are, therefore, transmitted from parents to offspring. The Vienna biologist, Paul Kammerer, a very successful investigator in this field, expresses this fact in the following neat sentence: "*Mutations are acquired hereditary characters.*"

De Vries makes the statement that mutations are due to internal causes which he expresses in the following manner: "Shocks to the molecular structure of the germ plasm"—this, however, is a mere description and, moreover, a description of a purely hypothetical occurrence. Just here lay the weak point of the entire doctrine of mutation. The mutation appeared to be merely a violent mingling of character already present in the plant and the supporters of this theory had no conclusive answer to the objection that all mutations might possibly be merely the hybrids of parents and progenitors unknown to us.

At this juncture of the question Mr. P. C. Van der Wolk published (in *Cultura*, 1919), some noteworthy observations on the study based upon the investigations of nine years.

An ordinary maple shown in Fig. 2 was pruned in the autumn, whereupon in many places the marks of the pruning shears exhibited the appearance of rot. In the neighborhood of these points the tree sent out shoots bearing leaves not only different in form but in color, the latter being white while the former suggested the *Lanciniatus* form of the gardeners. These sprouts bore blossoms and these flowers differed from the ordinary bi-sexual flowers of the maple by being mono-sexual. Here then we have a case of a classic variation by saltation or "jumping" without any transition process; furthermore, this modification contrary to the usual rule proved to be permanent. In short we have here a case of a new kind of maple produced by a sudden mutation. It occurred to Van der Wolk that this apparition of a new form might be connected with the rottenness affecting the wounds received from the pruning shears. He therefore made a bacteriological examination of these injuries and succeeded in isolating a certain bacillus therein. When normal green boughs were inoculated with this micro-organism they put forth white leaves. Thus we have an instance of an artificial production of an alteration of color, as shown in Fig. 3. When normal seeds were planted in ground which had been inoculated with these same organisms they produced plants of altered character. Here then we have at hand a simple means of producing mutation by means of bacterial inoculation and this obviously constitutes a vital stage of progress in the doctrine. Moreover, the supporters of this view will rejoice at a further proof that the vital phenomena of plants may be regarded as a logical series of reactions.

Van der Wolk recalled an observation to the effect that plants which are attacked by fungi produce an increased amount of calcium oxalate, succeeding thereby in killing the parasite. He proceeded to inoculate young maple boughs with calcium oxalate without obtaining any result in the first instance except that the cell sap of the branches thus treated was no longer susceptible of forming bacterial cultures. The inoculation appeared to kill the bacteria. But it was a remarkable fact that when the progeny of white-leaved plants which had been thus disinfected was crossed with normal green-leaved plants the result was the appearance of *spotted hybrids* (Fig. 4) whereas when the white and green plants were crossed without the previous disinfection of the former the offspring always consisted of *white plants only*.

In Van der Wolk's opinion these results indicate with absolute certainty that the doctrine of mutation is no longer in danger of being overthrown by the theory of hybridization. If these experiments are repeated, varied, tested, and confirmed, still more important conclusions may be drawn from them.

Mutations may finally be regarded therefore as the re-

sponse made by the organism to a disturbance of the harmonious development of the life process, and thus fall into the vast domain of *adaptations*, especially of heritable adaptations.

It would thus appear that one of the most violently debated questions in the doctrine of evolution, *i.e.*, the *inheritance of acquired characteristics*, upon which is based the entire recent view concerning the phenomena of life, is here decided experimentally. And this is a far weightier matter than the phenomenon of mutation itself, interesting as the latter undoubtedly is.

For if it be true that acquired characteristics can be inherited, then every thing that the organism is now or may become is the heritage of experience and the work of its progenitors, and this furnishes us with a key wherewith we may unlock the thousandfold chambers of the evolution of the organic world.

And this first fruitful piece of work along the path of an *experimental doctrine of evolution* justifies us in hoping for the final success of the belief that *adaptation is the product of work done and of that eternal logical connection between cause and effect which rules the universe*.

For the first time man is able not merely to form a theoretic concept of the creation of life, but beholds the law governing that creation. And he would not be the self-seeking creature he is and must be to support his position between the upper and nether millstones of existence did he not at once begin to dream that through his knowledge he may become the lord of this law.

PHYSIOLOGY OF THE APPLE

THE trees used in the study were from a 7-year-old orchard on sandy soil near Exeter, N. H., of the Golden Ball variety. Two trees were taken for analysis, the analyses being separately made in each case. Samples for analysis were collected (1) during dormancy; (2) at the awakening of vegetation; (3) when in bloom; (4) as soon as active growth ceased, and (5) at leaf fall. During the dormant period the roots contain more starch than the trunk and limbs, the limbs contain least, but during the budding season the branches contain most. During the 4th period the trunk contains relatively more starch than the roots or branches, and at the 5th the roots again contain more. Sucrose is present in all parts of the tree at all times. During dormancy it is most abundant in the small roots; then follow in decreasing order, 1-year-old branches, then 3-, 4-, 2- and 5-year-old branches. At the budding period the 1-year-old branches are relatively much richer, while the roots have lost heavily, the older branches are slightly poorer. At blossoming time and at the close of growth the roots are richer. The changes in sucrose content of the different parts of the tree are very largely independent of the starch. It is concluded that sucrose is primarily a reserve food material and not simply an intermediate stage in starch hydrolysis. At the beginning of vegetation reducing sugar is formed, at the expense of sucrose, the hydrolysis being more marked in the small roots. The reducing sugars accumulated in the small roots are translocated to the growing parts prior to blossoming, when they are utilized in tissue formation. Reducing sugar appears to be the main migration form of the carbohydrates. Fats are always present in the apple and apparently function as reserve food material since they disappear from the roots during the early stages of growth and accumulate in the 1- and 2-year-old branches. The nitrogen reserve materials are stored mainly in the younger branches from which they pass to the actively growing regions upon the awakening of vegetation. The phosphorus required in building new tissues at the awakening of vegetation is mainly obtained from the younger branches, while the translocation of potassium occurs mainly from older parts than those that supply the needed phosphorus and nitrogen.—Abstracted through *Chemical Abstracts* from *Tech. Bull.* 13 (1920), of New Hampshire Agr. Expt. Sta.