Change by Gradual Modification not the Universal Law.

By Thomas Meehan, of Germantown, Pa.

Natura non facit saltum has been accepted as a grand canon by most naturalists, and the evident absence of connecting links has been thought fatal to theories of evolution. My studies in plant life lead me to the belief that one form will spring from another essentially different, and without any gradual or insensible modifications uniting them.

In any theory of evolution morphology must take an essential part. In the transformation of leaf blade to the various organs of a plant, the change is sometimes gradual, as in the passage from leaves to bracts in some orders, or from sepals to petals, petals to stamens, or stamens to pistils in others; but the cases where the change is from one form of structure to another of very different character are by no means rare, if indeed it is not the general rule; and if it can be proved that change with gradual modification, and change by the sudden appearance of a distinct form, are both good morphological laws in plant life, there is no reason why both laws may not operate in any scheme in which morphology is called to act.

How suddenly the parts of plants often change is well illustrated in most coniferous plants. In *Pinus* on the first pushing of the axis from the cotyledonous condition of the plant, flat leaves are developed often an inch or more in length. After some time these leaves are suddenly arrested, and the axillary buds as suddenly develop into fascicles of needles as they are popularly called. So when the plant reaches its floral condition, the transformation of leaf and stem into the various parts which constitute a cone comes on with wonderful suddenness. The leaf, which we saw so suddenly arrested in early life, now becomes a bract; the fasciculi combine and form the scale, and the axis suddenly ceases to elongate, and gives form to the whole. The one in search of missing links would be sadly puzzled here. This sudden change of folial organs to organs of inflorescence is very common. In the change of one portion of a leaf structure to another Magnolia and Liriodendron afford an interesting example. In many plants the regular leaf blade is metamorphosed and forms the petal; but in these as soon as the plant reaches its flowering stage, the leaf blade is suddenly and entirely arrested

in the formation of the petals, and the stipules are as suddenly developed. The petals are in fact highly developed and transformed stipules, and all without the slightest trace of gradual modification. So in sexual transformations the modifications are by no means always gradual. One who had never seen the maize growing would hardly believe the tassel and the ear were from one plant; yet they are formed morphologically on the same plan, and once in a while we find male flowers gradually merging into females, and females to males, in the respective domain of each, but this is the great exception to the general rule. *Natura non facit saltum* is not true of individual plant life.

Now we come to variations from specific form and here I find great changes with no transitional forms between. I have a *Halesia* from seed of *Halesia tetraptera* which any one might be pardoned for placing in a new genus. It is much farther removed from its parent than *H. diptera* is. The corolla is not drawn up into a funnel-like tube as in the original, but is cupular and barely the length of the stamens. The leaves are broadly ovate, and rugose, and no one at first glance would take it for a *Halesia*. When I first saw it in the seed bed I supposed it to be a young apple tree. I have on my grounds large quantities of *Yucca filamentosa*. Hundreds of plants throw up their flower spikes and open their first blossoms within twenty-four hours of each other. But some years ago one struck off to have a more branching panicle, and to open its flowers *two weeks* before the others, which characters remain and are continued in the progeny. This two weeks was not gained gradually day by day through successive generations, but in one great leap. So with raising peach and other variety of fruit. Though the progeny usually take to the general habits of the parent, there will be once in a while very late varieties from seeds of early ones, and very early from late kinds. In Delaware and New Jersey *Azalea viscosa* varies to a form having glaucous saliciform leaves. I have not raised these up from the seeds, but I have seen an extreme form, with leaves looking rather like the English woodbine (*Lonicera Periclymenum*) than an ordinary *Azalea viscosa*, growing under circumstances which left no doubt on my mind that it sprung without any intermediate links from the other form. *Glyptostrobus* is another remarkable case. I exhibited, at our meeting at Chicago, branches from a tree raised from seed of the *Taxodium distichum*, and branches from an acknowl-

edged *Glyptostrobus pendulus* and no one could separate them. Here is a leap at once to a new genus. Moreover I have a *Thuja* growing which the highest authorities insist is a *Retinospora* but which I know was raised directly from *Thuja occidentalis* without any intermediate parent whatever. Some genera seem very variable — take our common ox-eye daisy (*Chrysanthemum leucanthemum*) for instance; and then, say in *Staphylea*, we may examine hundreds of plants without any apparent variation: but in the variable genera it is a mistake to suppose that these variations are by gradual modifications, though one can often place them so as to appear like gradually approaching links. It is wonderful how many variations there are in the common ox-eye daisy. I have studied them closely for years and find that the most divergent forms are often parent and child. Steady-going species act in the same way. I do not know anything that more exactly repeats itself than *Glycine frutescens*. Every leaflet is exactly ovate with an upward turn from the midrib: but in its variety, known in gardens as *G. magnifica*, the leaves are regularly attenuated and reflexed, and the whole manner so different that some have supposed it a distinct species with the name as above.

Not only do strikingly distinct forms come suddenly into existence, but once born they reproduce themselves from seed, and act in every respect as acknowledged species. The peach in its general form has its branches at a very acute angle upwards. I never saw a plant with branches approaching a right angle, but some thirty years ago one came into existence with a strong angle downwards — a weeping variety, and seeds of this reproduce this form exactly in every respect. So with color. The peach is of a uniform green, no tendency to vary its shade; but ten years ago a deep blood-leaved variety appeared. The deep blood-leaved beech is also a rapid jump from the green, and reproduces the blood-leaved character from seeds. The Siberian arbor vitæ is another great leap from the *Thuja occidentalis*, and reproduces itself from seeds as do all the striking forms in which this species abounds. Indeed I think I may close this branch of my subject by the statement that in over a quarter of a century of experience among living plants, I have rarely known any striking form to have originated by gradual modifications, but always by one great leap. The slight changes are generally in efforts backwards; as when we sow purple beech seed, some few are a trifle

paler than their parents; there is little of this hesitation in the forward leap.

But even reversions are not always gradual. Some years ago the common Babylonian willow sent out branches suddenly which bore singularly curved leaves, just as the nectarine is said to have suddenly sprung from the peach. The cuttings grew and maintained the character. It is known as *Salix Babylonica annularis*. A few years ago I saw a tree, perhaps twenty-five years old, push out the regular weeping willow leaves and I have heard of one in Boston which did the same.

This fact in regard to the willow suggests another great principle. Forms are not only called into existence suddenly, widely different from parents, and can reproduce themselves from seed, but they come into existence without seed agency, and the same or similar form in widely separated localities, and not all necessarily by seed from one individual. I have had sent me from five different localities, two in Pennsylvania, one in New York, one in Illinois and one in Indiana, flowers of *Viola pedata* in which the two upper petals were of the beautiful maroon characteristic of the pansy. Then I have given what I think good reasons, in Proc. Ac. Nat. Sciences, for believing that identical forms of blackberries and raspberries originate in distinct localities. Again a whole change of character will occur suddenly in many individuals through a large extent of country. This season, in our part of the world, at least half the leaves of the Liriodendron are from five to seven-lobed, when, as is well known, the three-lobed character has been almost specific in former years. We are accustomed to say about these changes that they are "caused by climate," but this expression proves nothing. We have in Pennsylvania a form of *Viola cucullata* usually growing in wet places, which always causes the breast of the young botanist to thrill with the idea that he has a new species. The paler color and more delicate growth when the plants are seen in the aggregate are very striking. But when the plants and flowers are analyzed, no difference is found that can be described in words. Those to whom reason comes rapidly tell us at once that the difference is "caused" by the plant growing in wet places; but we soon find the deep purple form coming down as it were from the high ground to the swamp and the pale one working up to the high ground, yet each retaining its little peculiarity. There is a

gradual modification of location going on, a gradual modification of circumstances, but no gradual modification of form to correspond.

In suggesting that species come suddenly into existence, not always from one parent, and not only in one locality, I wish to confine myself mainly to facts, and to facts within my own observation; but I cannot forbear suggesting how much nearer such a theory coincides with possibilities, than the theory of descent by gradual modifications from a single parent; where, surrounded by innumerable foes, not even the "fittest" could survive. As a host of Liliputians could finally subdue a single Brobdignagian, so the sheer crowd of individuals in an old form in the struggle for life would crowd out the solitary new one, no matter how much better fitted it might be, *per se*, to survive. Insect agency alone, as I have shown in a paper on *Linaria vulgaris* in Proc. Ac. Nat. Sciences, and I believe Dr. Asa Gray before me in Silliman's Journal, is a powerful force in the crushing out of any departure from a parent form.

Again a theory deserves consideration when it will explain phenomena in which others fail. In 1862-I discovered the identity of relative characters in allied species of European and American trees. Mr. Darwin frankly admits in his work on "Animals and Plants under Domestication," that the facts given in my paper are unexplainable by his theory of natural selection; and St. George Mivart makes strong use of them against Darwin in his "Genesis of Species." That the variations of allied plants should be all on one plan is not consistent with any idea that the selection of their forms should be for the purpose of a struggle with one another, if they had any such power of selection. The American hornbeam (*Carpinus Americana*) differs from the European (*C. Betulus*) amongst other points, in being less sharply and deeply serrate. But on examining hornbeam leaves it is seen that though simple, they are on the road to pinnation. The lateral veins are typical midribs of pinnules. In the American there are from five to ten small serratures between each main one that terminates the main rib, while in the European there are but from two to five. The American has more nearly approached a pinnate form, and bearing the case of the Liriodendron in mind we see how this can be brought about without the necessity of going through any gradual modification from a single parent, but in obedience probably to

some law of nutrition regulating form which may operate at times on a large number of individuals, and at others on a single cell. That form is in some way dependent on nutrition is demonstrated not only by my papers before this Association, on the laws of sex, but by the operation of various fungi, which as they attack plants, each in its own way, produce fixed abnormal forms in these plants, each after its own kind. The whole habit of a plant will sometimes change under these attacks. In the Rocky Mountains I have seen a Euphorbia, probably *E. humistrata*, or a form of *E. maculata*, usually creeping, become wholly erect, when an *Æcidium* was growing on it. The attack of course interferes with nutrition and we may therefore say that in some cases nutrition governs form. Sudden cosmical disturbances, acting on nutrition, would therefore constitute a factor equal to great specific changes of form, and we are not compelled to look solely to gradual modifications of form from single individuals for the explanation of all the phenomena we see.

A review of the facts I have presented shows, I believe, the following truths:—

1. Morphological changes in individual plants are by no means by gradual modifications.

2. Variations from specific forms follow the same law.

3. Variations are often sudden and also of such decided character as to be deemed generic.

4. These sudden formations perpetuate themselves, and act in all respects the same, as forms which spring through gradual modifications.

5. Variations of similar character occur in widely separated localities.

6. Variations occur in communities of plants simultaneously by causes affecting nutrition and perhaps by other causes.

Arguing from these, new and widely distinct species may be suddenly evolved from preëxisting forms without the intervention of connecting links.