VARIEGATION OF LEAVES.

BY JAMES HOGG.

At the meeting of the Association of Nurserymen in Chicago, last July, one of our prominent horticulturists described leaf variegation as a disease. Incidentally this brought up the question: Does the graft affect the stock upon which it is inserted?

Much confusion of ideas exists upon this subject, largely due to a loose application of the term disease. Strictly speaking, this term is only applicable to that which shows the health of the plant to be impaired. It should be distinguished from aberrant or abnormal forms, for these are not necessarily indicative of disease. Nobody thinks of saying that red or striped roses are diseased because they are departures in color from the white flower of the type species; or that white, yellow, or striped roses are diseased when the color of the type species is red. Nobody thinks of saying that double flowers are evidences of disease in the plant, or that diminution in the size of leaves or variation in their form is a disease. Why then should it be said that because leaves may become of some other color than green, or become party-colored, therefore they are diseased? If it be said that flowers are not leaves, and that therefore the analogy is not a good one, the reply is, that flowers in all their parts, and fruits also, are only leaves differently developed from the type. This fact is a proven one, and so admitted to be by all botanists and vegetable physiologists of the present day. If it be objected that by becoming double, flowers lose the power of reproducing the variety or species, the answer is, that this loss of power is not necessarily the result of disease, but may arise from various other causes. Because an animal is castrated, it surely will not be claimed that therefore it is diseased. In man and in the higher animals the power of reproduction ceases at certain ages, but it cannot therefore be said that such men or animals are diseased. Neither is a redundacy of parts an unequivocal evidence of disease.

Topknot fowls and ducks are as healthy as those which do not have such appendages, and a Shetland pony is as healthy as a Percheron horse, notwithstanding the difference in their size and weight. Again, color in block or in variegation is not positive evidence of disease in animal life. The white Caucasian is as healthy as the negro, the copper-colored Malay as the red Indian. The horse, ox, and hog run through white and red to black both in solid and party-color, and all are equally healthy; so with the rabbit, dog, cat, and others of our domestic animals. In wild animals, birds, reptiles, fishes, and insects, it is the same, so that mere difference in color or combinations of color are not *prima facie* evidence of disease.

But some will say this may be true of animal life, but not of plant life. That there is a strong and evident analogy, the one with the other, is now universally admitted by physiologists. Formerly many physiologists considered leaf variegation a disease, because it generally ran in stripes lengthwise of the leaf or in spots. In the former case it was supposed to originate from disease in the leaf cells of the leaf stalk, which, as the cells grow longitudinally, naturally prolonged it to the end of the leaf. But the originating of varieties in which the variegation did not assume this form, with other considerations, has done much to upset this theory. In the variegated leaved snowberry we have the center and border of the leaf green, separated the one from the other by an isolated white or yellow zone. In the zebra-leaved eulalia and the zebra-leaved juncus, from Japan, we have the variegation of the leaf transversely instead of longitudinally, so that according to the old theory we have the anomaly of a healthy portion of the leaf producing an unhealthy portion, and that again a healthy one, and thus alternately along the whole length of the leaf.

When we dissect a leaf in its primal development, we find that its cells contain colorless globules, by botanists called chlorophyl or phyto-color; these undergo changes according as they are acted upon by light, oxygen, or other agents, producing green, yellow, red, and other tints. This chlorophyl only exists in the outer or superficial cells of the parenchyma or cellular tissue of the leaf, and thus differs from starch and other substances produced in the internal cells, from which the light is more or less excluded. It is a fatty or wax-like substance, readily dissolved in alcohol or ether. The primal color of all leaves and flowers is white or a pale yellowish hue, as can readily be seen by cutting open a leaf or flower bud. The seed leaves of the French bean are white when they come out of the earth, but they become green an hour afterward under the influence of bright sunshine. A case is on record where in a certain section, some miles in extent, in this country, about the time of the trees coming into leaf, the sun did not shine for twenty days; the leaves developed to nearly their full size, but were of a pale or whitish color; finally, one forenoon the sun shone out fully, and by the middle of the afternoon the trees were in full summer dress. These facts show that the green color of leaves is due to the action of light. Variegation is sometimes produced independently of the chlorophyl, as in *Begonia argyrostigma* and *Carduus marianus*, in which it is produced by a layer of air interposed between the epidermis or outer skin of the leaf and the cells beneath; this gives the leaf a bright, silvery appearance.

To what, then, are we to ascribe leaf variegation? I think that it is entirely due to diminished root power; by this I do not mean that the roots are diseased, but that they are either in an aberrant or abnormal state; but disease cannot be predicated upon either of these states. To explain: everybody knows *Spirea callosa* to be a strong growing shrub, having umbels of rosy-colored flowers and strong, stout roots; the white flowered variety is quite dwarf, is more leafy and bushy than the species, and has more fibrous and delicate roots than the type; the crisp-leaved variety is still more dwarf, very bushy, and very leafy, and has very fine thread-like roots. This would indicate that the aberrance is in the roots; the two varieties are much more leafy in proportion to their size than the species, so that if the leaves controlled the roots, the latter should have been larger in proportion than those of the species. Again, once when, in the autumn, I was preparing my greenhouse plants for their winter quarters, I cut back a "Lady Plymouth" geranium, which chanced to be set away in a cool and somewhat damp cellar. When discovered the following February and started into growth in the greenhouse it produced nothing but solid green leaves, and never afterward produced a variegated leaf. This I attributed to its having gained greater root power during its long season of rest. By this I mean that the roots had grown and greatly increased in size, although there had not been any leaf growth. That roots under certain circumstances do so is well known. The roots of fir trees have been found alive and growing forty-five years after the trunks were felled. The same has occurred in an ash tree after its trunk had been sawn off level with the ground. A root of *Ipomea sellowii* has been known to keep on growing for twelve years after its top had been destroyed by frost; and in all that time it never made buds or leaves, yet it increased to seven times its original weight. The tuberous roots of some of the *Tropæolums* will continue to grow and increase in size after the tops have been accidentally broken off; and potatoes buried so deep in the earth that they cannot produce tops will produce a crop of new potatoes.

On the other hand, I have had an oak-leaved geranium overlooked in a corner of the greenhouse until it was almost dried up for lack of water. When its branches were pruned back and it was started into growth only one branch showed the almost black center of the leaf, all the rest were clear green. This was an evident case of diminished root power, but the plant grew as thriftily as ever. The lack of the dark marking in the leaves was equivalent to the variegation in other varieties, only in a reverse direction.

In practice, when gardeners wish to produce an abnormal condition in a tree or plant, they will, if they wish to dwarf it, graft it on a species or variety of diminished root power, and contrariwise, if they wish to increase its growth, will graft it upon a stock of strong root power. But in neither case can the graft be said to be diseased by the action of the roots of the stock.

When this root power is so far diminished as to produce complete albinism, the shoots from such roots appear to partake of this diminished power, and to lose the power of making roots, and thus become very difficult to propagate. It is sometimes said that albino cuttings cannot be rooted at all, but this is a mistake, for I have succeeded in striking such cuttings from the variegated leaved *Hydrangea*. It required much care to do it; they did not, however, retain their albino character after they rooted and started into growth.

Albinism and white variegation in leaves appear to be due to the chlorophyl in such leaves being able to resist the action of the three (red, yellow, and blue) rays of light. What we call color in any subtance or thing is due to its reflecting these different rays in various proportions of combination and absorbing the rest of them, the various proportions giving the various shades of color. White is due to the reflection of all of them, and black to the absorption of them. In some plants with variegated foliage we have the curious fact that the cells containing chlorophyl reflecting one color produce cells which reflect an entirely different color. In the coleus "Lady Burrill," for instance, the lower half of the leaf is of a deep violet-crimson color, and the upper half is golden yellow. In other varieties of coleus, in *Perilla nankiensis*, and other plants, we have foliage without a particle of green in it, and yet they are perfectly healthy. This shows that green leaves are not absolutely necessary to the health of a plant.

As a proof of leaf variegation being a disease, the speaker alluded to cited a case in which a green leaved abutilon, upon which a variegated leaved variety had been grafted, threw out a variegated leaved shoot below the graft. This can easily be explained. The growth of the trunk or stem of all exogenous plants, or those which increase in size on the outside of the stem, is brought about by the descent of certain formative tissue called cambium, elaborated by the leaves and descending between the old wood and the bark, where it is formed into alburnum or woody matter. Some think that it is also formed by the roots and ascends from them as well as descending from the leaves. Be this as it may, there is no doubt about its descent. In such comparatively soft-wooded, free growing plants as the abutilon the descent of the cambium is very free and in considerable quantity, so that the stock would soon be inclosed in a layer of it descending from the graft. When being converted into woody matter it also forms adventitious buds which under certain favorable circumstances will emit shoots of the same character as the graft from which it was derived. The graft is such cases may be said to inclose the stock in a tube of its own substance, leaving the stock unaffected otherwise. The variegated shoot in this case was in reality derived from the downward growth of the graft and not from the original stock, which was not therefore contaminated by the graft. In cases where the stock is of much slower growth than the graft, or the graft is inserted upon a stock of some other species, the descending cambium does not inclose the stock, but makes layers of wood on the stem of the graft, which thus, as is frequently seen, overgrows the stock, sometimes to such an extent as to make it unsightly. Nobody ever saw an apple shoot from a crab stock, a pear from a quince stock, or a peach shoot from a plum stock. This is one of the arguments in favor of the view that cambium also rises from the roots.

Again, to show that the stock is not affected by the graft, or the graft by the stock, except as to root power, let any person graft a white beet upon a red beet, or contrariwise, when about the size of a goosequill, and when they have attained their full growth, by dividing the beet lengthwise he will find the line of demarkation between the colors perfectly distinct, neither of them running into the other.

The theory that leaf variegation is a disease has been held by many distinguished botanists and is in nowise new. But this theory has been controverted, and we think successfully, by other botanists, and it is not now accepted by the more advanced vegetable physiologists. There are now so many acute and industrious students and observers in every department of science, and the accumulation of facts is so rapid and so great, that very many of the older theories are being set aside as not in accord with the newly discovered facts. A student brought up in institutions where the old theories are inculcated has afterward to spend half his time in unlearning what he had been previously taught, and the other half in studying the new facts brought to his notice and testing the theories promulgated by men of science. Botanical science does not wholly consist in the classification and nomenclature of plants, but largely consists in a knowledge of vegetable anatomy and physiology, and these require much study and some knowledge of other sciences, such as chemistry, meteorology, geology, etc. Without such general knowledge it is difficult to form a harmonious theory in regard to any of the phenomena of plant life.

Vanilla, Cinnamon, Cocoanut.

The following interesting facts concerning the cultivation of the above products in the island of Ceylon, were given in Mr. H. B. Brady's recent address before the British Pharmaceutical Conference at Swansea:

The vanilla plant is trained on poles placed about twelve or eighteen inches apart—one planter has a line of plants about three miles in length. Like the cardamom, it yields fruit after three years, and then continues producing its pods for an indefinite period.

The cinnamon (*Cinnamomum zeylanicum*) is, as its name indicates, a native of Ceylon. It is cultivated on a light sandy soil about three miles from the sea, on the southwest coast of the island, from Negumbo to Matura. In its cultivated state it becomes really productive after the sixth year, and continues from forty to sixty years. The superintendent of the largest estate in this neighborhood stated that there were not less than fifteen varieties of cinnamon, sufficiently distinct in flavor to be easily recognized. The production of the best so injures the plants that it does not pay to cut this at any price under 4*s*. 6*d*. to 5*s*. per lb. The estate alluded to above yields from 30,000 to 40,000 lb. per annum; a uniform rate of 4½*d*. per lb. of finished bark is paid for the labor. Cinnamon oil is produced from this bark by distillation; the mode is very primitive and wasteful. About 40 lb. of bark, previously macerated in water, form one charge for the still, which is heated over a fire made of the spent bark of a previous distillation. Each charge of bark yields about three ounces of oil, and two charges are worked daily in each still.

The cultivation of the cocoanut tree and the production of the valuable cocoanut oil are two important Cingalese occupations. These trees, it appears, do not grow with any luxuriance at a distance from human dwellings, a fact which may perhaps be accounted for by the benefit they derive from the smoke inseparable from the fires in human habitations. The cultivation of cocoanuts would seem to be decidedly profitable, as some 4,000 nuts per year are yielded by each acre, the selling price being £3 per thousand, while the cost of cultivation is about £2 per acre. In extracting the oil, the white pulp is removed and dried, roughly powdered, and pressed in similar machinery to the linseed oil crushing mills of this country. The dried pulp yields about 60 per cent by weight of limpid, colorless oil, which in our climate forms the white mass so well known in pharmacy.

Learning to Tie Knots.

A correspondent suggests that it would be a handy accomplishment for schoolboys to be proficient in the handling, splicing, hitching, and knotting of ropes. He suggests the propriety of having the art taught in our public schools. A common jackknife and a few pieces of clothes line are the main appliances needed to impart the instruction with. He concludes it would not only be of use in ordinary daily life, but especially to those who handle merchandise and machinery. Any one, he adds, who has noticed the clumsy haphazard manner in which boxes and goods are tied for hoisting or for loading upon trucks, will appreciate the advantage of practical instruction in this direction. Probably a good plan, he further suggests, would be to have one schoolboy taught first by the master, and then let the pupil teach the other boys. Our correspondent thinks most boys would consider it a nice pastime to practice during recess and at the dinner hour, so that no time would be taken from study or recitation time.