Grafting and Evolution

Is the Success of Grafting a Criterion of the Relative Parentage of the Species?

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THE Ancients maintained that it was possible to graft to each other two vegetable plants very dissimilar in character. The Moderns treated these affirmations as legends and thought they could show that grafting is only possible between species of one order or between species of different orders but belongisg to one family. Now the Ancients made use of both Siamese or parabiose grafting (Fig. 1) which consists of a simple fusion of tisues, and ordinary or olobiose grafting (Fig. 2) which determines a mutual parasitism more or less complete in the grafted plants in addition to the preliminary fusion of the tissues.

We can understand that success with these two types of symbiosis is not obtained with equal facility and that the manner in which the physiological functions of each conjoint are put into practice is by the no means the same in the two cases. It has been shown to-day, experimentally, that it is possible to obtain parabioses between plants very differently classified, such as the cabbage and the tomato, for example, but such anatomical combinations cannot be changed into ordinary grafts without causing the death of at least one of the grafted plants. It follows from this that the Ancients and the Moderns were right according to their points of view. They made a mistake in not thoroughly defining their subject and their disagreement comes from the fact that they gave the same name to combinations very different in nature.

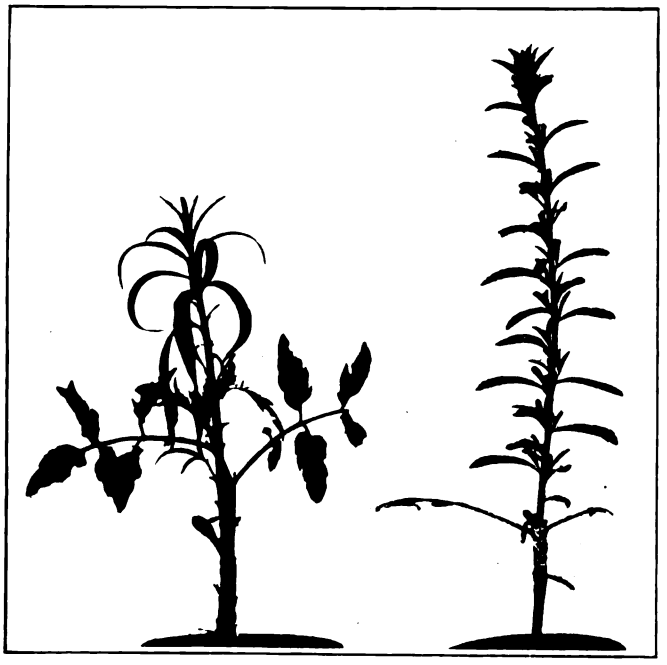

FIG. 1. PARABIOSI OR SIAMESE GRAFTING OF TOMATO AND GILIA (*POLÉMONIACEÆ*)

FIG. 2. OLOBIOSIAN GRAFT OF STEIRA PURPUREA AND XANTHIUM

When it is a question of ordinary grafts, almost exclusively employed in every-day practice, their success has almost always been confined to the family to which they belong, and often, in the majority of cases indeed, successful results have only been obtained between species of the same class. It is this which led de Candolle to consider successful grafting as the true criterion of the relative parentage of groups and species and to recommend the use of grafting as a means of solving the much disputed question of classification. This was to subordinate the reproductive characteristics, until then considered as dominant, to the anatomical and physiological characteristics, to which the naturalists generally attach very little importance because they vary so readily under the influence of changes of surroundings.

Now this criterion has not the importance thus attributed to it and experiments have proved it clearly. One single fact thoroughly proved in actual practice would suffice to show it.

The pear-tree is easily grafted on the quince-tree but the quince-tree cannot be grafted on the pear-tree. In these two types of grafting the parentage of the species has remained unchanged. This example is not unique. There are other ligneous and herbaceous plants, the inverse graftings of which do not succeed with equal facility.

Besides it is sufficient to try a grafting of two species more or less separated and taken from classes of different groups belonging to the family, in order to show that the success of the operation has no close connection with the parentage of the species. Although we are unable to state the exact cause, there are in one family and sometimes in one class, convenient species which graft easily, and other species more independent which will accept a dual life with difficulty, and which die rather than enter into contact with a strange plant.

Among the genus *Solanum* the species which lends itself most readily to symbiosis is the tomato. It grafts not only with species of the genus *Solanum* but also with the *Atropa*, *Physalis*, *Nicotiana*, *Nierembergia*, *Petunia*, *Datura*, *Lycium* etc.

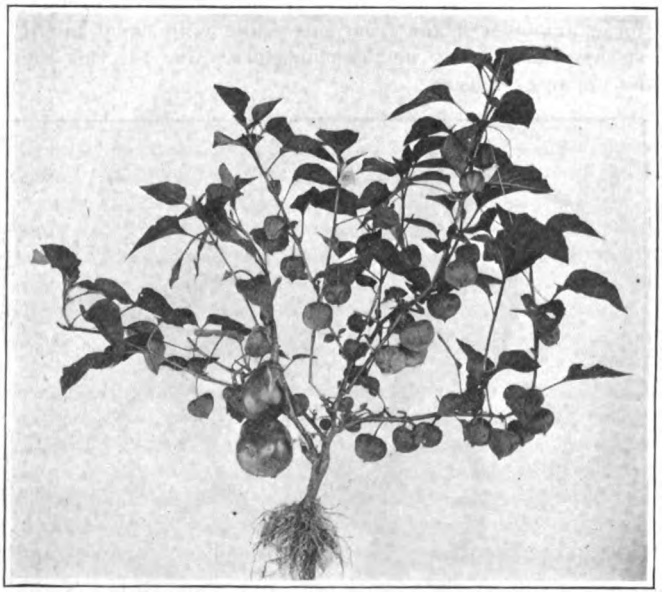

FIG. 3. GRAFTING OF *PHYSALIS FRANCHETI* ON *SOLANUM MELONGENA* (EGGPLANT)

Two fruits of the eggplant can be seen on the twig left on the graft-supporter. The graft has many characteristic fruits

In other words it grafts with herbaceous or frutescent plants, annual or perennial, with cycles of development very different from its own. The case is almost identical with tobacco and eggplant, which allow their graftings to reach normal height (Fig. 3). However, certain species belonging to the Cestrum and Fabiana classes refuse to live in common with the tomato. Others, however, produce very antagonistic associations, growing with difficulty and destined to a premature death. This is the case of pimento whether it serves as subject plant or as a graft. It is, however, with the tomato that

it succeeds the best (Fig. 4) but the latter yields no fruit even in the case of the most successful graftings.

The thorn-apple and the deadly night-shade are not so exacting as the pimento, but they are capricious at times. Grafted on the datura the tomato grows splendidly. The deadly night-shade grafted on the datura under the same conditions develops poorly and produces plants more or less weak according to the specimens taken (Fig. 5).

It is often the case also with the potato, which, in certain cases, is reduced to a tubercule which caps the plant in a very curious manner. The inverse grafting of the datura on the potato succeeds better as a rule, and the plants form a varying number of tubercules. However, the tomato, the potato, and the deadly night-shade are three species of the genus *Solanum*, closely related which ought to take with equal facility on the datura.

In the family of compound plants, anomalies still more pronounced and still more curious are to be found. We know that the *Xanthium Strumarium* belong to the Ambrosiaceæ related to the compound plants. But certain botanists have called it Urticacean, and others have placed it in the category of the Heliantheæ and consequently in the compound plants. It was therefore a case in which to apply the principle of the botanist de Candolle to this much disputed phenomenon. Now it happens that *Xanthium* like the tomato, is a plant which lends itself easily to grafting and unites with plants very different in nature. For example it can be grafted on the *Vernonia praealta*, and the *Stockesia cyanea* which are *Vernonieae*, with the *Stevia purpurea* which is a *Eupatoriea;* with the *Helianthus, Cosmidium, Cosmos, Ximenesia*, and *Bidens* which are Heliantheae; with the *Artemisia camphorata* which is an *Artemisieae*, etc. In which of these categories therefore are we to place it? This is not all. In one single group, that of the Heliantheae for example, it is far from succeeding with equal facility on species belonging to neighboring classes and for this there is no apparent reason.

Thus the *Helianthcii* grafted on *Xanthium* hardly grow at all and bear no flowers. The *Tagetes* and the *Madaria* remain stunted but produce flowers and bear fruit (Fig. 6); the *Cosmos* develop fairly well although they remain smaller; the *Bidens* on the contrary become very rich (Fig. 7).

These examples show that even when ordinary grafting only is used, successful grafts taken as a criterion of parentage would result in very strange groupings contradicting the best suppositions already established by means of the natural method. Among the plants the anatomical and physiological parentage which determines the success of grafting does not always coincide with the parentage of reproductive organisms which forms the basis of our classifications at the present day.

During the last few years much stress has been laid on the principle outlined by de Candolle, in order to establish the parentage of some of the higher animals with man. The excellent research work of Dr. Carrel is known in connection with animal grafting, and we know also that he succeeded in placing in the human body organisms belonging to the moneky, the dog, the sheep and the cow. The parts taken from the monkey did not take nearly so well as those taken from the other three animals and as a result of which the following conclusions were drawn:

"The most recent scientific discoveries tend to reject Darwin's theory rather than to confirm it. For many years many men with great scientific knowledge have declared that the analogy existing between the human structure and that of the monkey, proved directly that the former must be a more advanced variety of the family to which both belong. According to their theory, generation succeeding generation, brings about in the anatomy of the monkey modifications and improvements which bring the quadrumane gradually nearer and nearer the human type.

But the science of physiology and anthropology takes up a different point of view. It considers the formation of different tissues and glands, their resemblance, their natural longevity,

FIG. 4. TOMATO GRAFTING (*SOLANUM LYCOPERSICUM*) ON PIMENTO (*CAPSICUM ANNUM*)
The graft bears one fruit and has not branched out

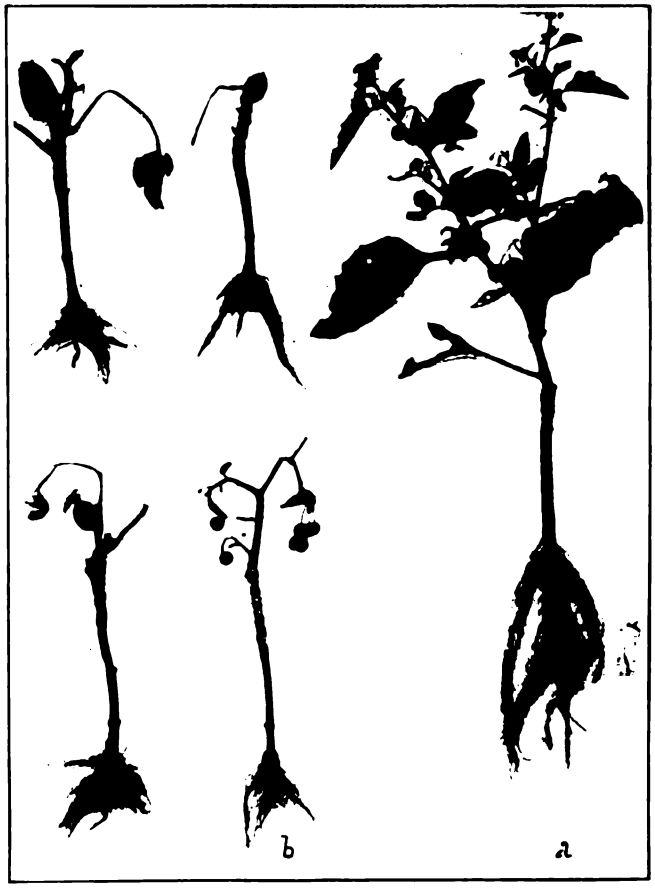

FIG. 5. GRAFTING OF DEADLY NIGHT-SHADE (*SOLANUM NIGRUM*) ON PIMENTO
Potato graftings (*Solanum tuberosum*) on Pimento are shown at left

FIG. 6. GRAFTING OF *TAGETES* ON XANTHIUM

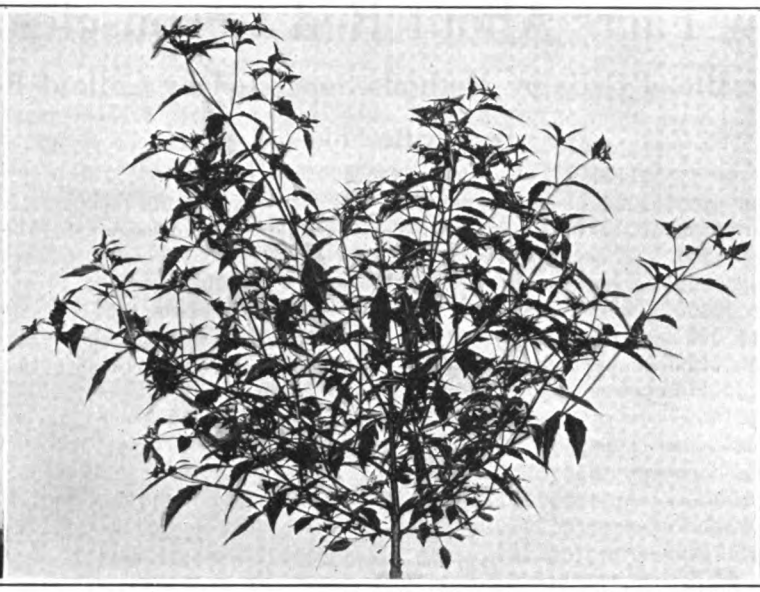

FIG. 7. GRAFTING OF *BIDENS CERNUA* ON XANTHIUM STRUMARIUM SHOWING A VERY RICH AND FULL DEVELOPMENT

FIG. 8. POTATO GRAFTED ON TOMATO, BEARING TUBERS ABOVE GROUND

their aptitude for growth, when transformed to another being, as the fundamental basis of all comparative study. Now this method once adopted as the true criterion of reasoned study, it is absolutely impossible for man to have ever had for this prehistoric ancestor a monkey of any kind."

I have not, in this article, to give a decision for or against such and such hypothesis concerning the descent of the human race. But the results which have just been indicated concerning the Parabioses (anatomical grafts) and ordinary grafts (anatomical and physiological grafts) show that the criterion fixed cannot be applied to vegetable plants. It is quite possible that the same thing may be said in connection with animals. However interesting the graftings of Dr. Carrel may be, however strange certain vegetable fusions may be, we must not give them a philosophical importance or bearing which they do not possess. Scientifically they leave untouched the anxious problems of the origin and the evolution of the species.

A NEW METHOD FOR GROWING PLANTS

IN the *American Journal of Botany* Dr. J. M. Brannon describes an interesting new method for growing plants.

In growing plants under sterile conditions, says the author, investigators have employed either agar cultures or some other substratum of solid or semi-solid character placed in culture tubes, or else they have used water or soil cultures. In the water or soil cultures the roots only are maintained sterile, leaves and stems being exposed to the atmosphere.

In the course of investigations on the organic nutrition of plants, the author noted at various times that seeds would germinate and seedlings would grow even when entirely immersed in a liquid medium. As a result it was decided to test the possibility of using such liquid cultures for the investigations. Striking successes were obtained, and the superiority of this method for growing plants in the dark over the agar method or the water culture methods was at once apparent.

In a flask or culture tube, the size depending upon the plants to be grown and upon the duration of the experiment, is placed the culture solution. The depth of the solution should not exceed six centimeters. The vessels are plugged with cotton and then autoclaved. The seeds to be sown are then sterilized and the desired number sown in the culture solution. In the work reported by the author the seeds were sterilized by the calcium hypochlorite method of Wilson. This method of growing plants has been used with flax, alfalfa, corn, pea, and timothy. These were all grown in the dark.

The special advantage of this method is in the fact that the plants used will live and grow for a much longer period of time than by the other methods. It would seem, in the case of plants grown in the dark, that the sugars are either too slowly absorbed by the roots or that conduction of the sugars is too slow to satisfy the needs of the plant.

Another advantage over the agar method is the greater ease of analyzing the solution. In the agar method the agar must first be removed before the sugar determination can be made. Absorption phenomena inadvertently play a part in the precipitation of agar, thus another source of error is introduced.

THE LIFE OF THE CELL

THE capacity for functioning possessed by the body depends upon the delivery of nutritive substances to the cells, since it is these which not only build up the organs but, moreover, are intimately connected with the nervous impulse which is twofold in each cell—exciting and inhibiting. In each organ and demonstrably in each cell a double system of nerve fibers leads to the nucleus (the nucleim body, chromosome) the one springs from the original organizer of all living substance, namely, the sympathetic nerve system—*Nervus sympathecus.*

A recent German writer, Carl Schleich, calls this great sympathetic nerve, on account of its mysterious and unknown origin in the rhythm of the universe "The Marconi plate of the Universe" and he expresses the concept that all so-called intuitive impulses inexplicable antipathies and sympathies, forebodings, ideas of inventors, mediumistic and super-intellectual capacities, etc., are connected with the metaphysical functioning of the *nervus sympathecus.*

The other guiding system directing the inner activities of the cell springs from fibers coming from the later developed central nervous system (brain and spinal column). It controls the capacity for industrial orientation—the expression of the personal will, while the *Sympathicus* is the bearer of the race-will. The central nerve system is the forward, striving, exciting the rouser of the cell's activities.

It represents the dynamics of the double nervous system upon which the hormones secreted by the internal secretion glands make their presence felt. The shriveling or the reconstruction of cells, their atrophy or their overgrowth (hyperplasia) are the result of the interplay of these two cell registers.

Thus we can readily understand how the hormones both excite and inhibit. The hormones of the puberty gland stimulated by Steinach's process causes the entire system of cells to become once more capable of regeneration. . . . And so he attains artificial adolescence.