distribution, but of more frequent occurrence than the intrastelar secondary thickening described above. In appearance it may be compared to the secondary activity seen in the cortex of *Isoëtes*.

These points, with other matter not mentioned here, will be fully dealt with in a joint paper to be published shortly.

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NOTE ON SOME GRAFTING EXPERIMENTS.—The following results are the outcome of a series of experiments to test the possibility of obtaining improved varieties of cultivated plants by employing the process of grafting.

The experiments of Daniel seem to show conclusively that the stock and scion mutually affect one another, and that, in some cases at all events, the changes so induced become hereditary¹. So far my experiments have not been carried on for a sufficient time to reach this stage, but as they confirm several other points brought out by Daniel, and introduce new ones, they are of interest.

The most successful grafts were obtained by using seedling plants with from three to six leaves both for stock and scion. In the majority of cases tongue-grafting was used, and the scion fixed in position with a strip of thin gutta-percha wound round twice, and fastened with a ring of lead wire. Such a bandage is readily thrown off by the plant as the root or stem grows. If the operation is carried out in sunny weather, shading for three or four days is almost essential, and the leaf surface should be reduced to check transpiration.

One of the easiest plants to experiment with is the Beet (*Beta vulgaris*), as one can rely on almost every graft being successful.

The varieties used have been Sutton's Mammoth Long Red, Sutton's Yellow Globe, Sutton's Tankard, the Kleinwanzlebener sugar-beet, and the crimson beet. These are readily distinguished by their leaves, petioles, colour, and shape of the roots. In every case (42 plants) the boundary line between stock and scion was sharply marked; the white of the sugar-beet, for instance, did not gradually pass over into the crimson of the Mammoth Red—so affording a striking demonstration of the indiffusibility of the coloured cell-sap.

¹ Daniel, Ann. d. Sci. Nat., 1898, p. 1.

In no case could the slightest difference be detected between the control plants of either the stock or scion except in size, the grafted plants being slightly dwarfed.

Scions taken from year-old plants and grafted on stocks of the same age have flowered and produced seed which appears to be fertile.

In the case of *Tropaeolum majus* grafted on *T. canariense* and *vice versa*, the results were much the same, both stock and scion retaining their original characters unaltered. The plants were, however, very dwarfed, the *T. canariense* only growing to the height of three feet in the sturdiest specimen. Their flowering period was also retarded for 6 or 8 weeks, and so far the only plants to produce seed have been those grafted on the roots which have been able to acquire a small root-system of their own. The grafted plants, moreover, were peculiarly liable to the attacks of slugs and caterpillars, while the control plants were rarely attacked.

Not only the callus but all parts of the plants were liable to attacks of this kind, probably owing to an accumulation of reserve materials in the scion through an interruption in the process of translocation at the junction with the stock.

The dwarfing effect of grafting was also noticeable in experiments with radishes, *Raphanus raphanistrum*, and the plants were so late in flowering, that an early frost spoiled all prospects of a crop of seed.

The other Cruciferae used were Kale grafted on Drumhead Cabbage, Broccoli on Cabbage, Brussel Sprout on Cabbage, Kohlrabi on Kale, and *vice versa* in each case. The operation was generally successful, but all the plants (96) were killed, apparently by the nematode *Tylenchus devastatrix*.

Various grafts were also made among the Leguminosae. *Trifolium repens* was grafted on *T. pratense* and *T. hybridum*, *T. pratense* on *T. repens* and *hybridum*, and *T. hybridum* on *T. repens* and *T. pratense*.

The stock has flowered in one or two cases this season, but so far the scions have made relatively little growth.

Medicago sativa has also been successfully grafted on to *T. pratense* and *T. pratense* on *Anthyllis vulneraria*. In this case the scion and stock belong to strikingly different genera.

This series of experiments then confirms Daniel's results that the effect of grafting is often to dwarf the plants, retard their flowering season, and in some cases render them far more liable to the attacks of animal pests. None of them though show any visible signs of the

scion and stock affecting one another¹. This, however, is well shown in a series of potato grafts². The operation was performed by paring off a thick piece of skin containing an eye, or a shoot an inch or two long, from one potato and binding it tightly over a similarly shaped pared patch on another tuber; all the other eyes were then destroyed, leaving only the scion to develop. One set of potatoes (*A*) had thin, smooth-green skins, and numerous deeply sunken eyes, while the other (*B*) was readily distinguished by its thick, rough, brown skin and its few shallow eyes. *A* was grafted on *B* and *B* on *A*. The resulting crop of tubers was the same in each case. From one and the same plant, tubers of type *A* and *B* were obtained (often with their characteristics much exaggerated, e. g. the russet skin cracked so as to resemble a truffle or the eyes exceedingly deep, &c.), and tubers one end of which resembled *A*, the other *B*. In many cases there was a sharp constriction between the *A* and *B* ends, but in some the yellowish-green skin gradually passed over into the rough corky skin, and the tubers were regular in shape. In every instance the 'rose-end' (distal end) of the tuber was of the *A* type, and the heel (proximal end) of the *B* type. Tubers in which the two types were blended never occurred.

Such tubers showing characteristics belonging to both scion and stock have long been recognized as typical 'graft-hybrids,' and they afforded Darwin no small amount of evidence for the theory of pangenesis. In describing them as hybrid, however, stress must be laid on the facts that if halved transversely each portion is indistinguishable from one of its parents, and that the tuber itself shows all the characteristics of its parent and not only certain dominant ones³. The graft hybrid then is not comparable with the sexually produced hybrid in this respect, and in the present state of our knowledge it seems impossible to give any adequate explanation of these phenomena.

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¹ Cf. Lindemuth, Gard. Chron., 1902, vol. xxxi, p. 61.

² For literature see Darwin's Variation of Animals and Plants under Domestication, p. 420.

³ Cf. Mendel, Journ. Roy. Hort. Soc., 1901, vol. xxvi, p. 1.

Biffen, Roland H. 1902. "Note on some grafting experiments." *Annals of botany* 16, 174–176. <https://doi.org/10.1093/oxfordjournals.aob.a088867>.

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