

FERTILISATION OF PLANTS.*

I remain devoted to this and the remaining contributions to self-fertilisation. Before, however, making out my case, I would wish to guard against being misunderstood; for my criticisms here, I fear, led readers to imagine I would undervalue Mr. Darwin's laborious investigations and their important results. This would be far from my intention. The chief of these results may be briefly summed up thus:—1. Crossing with a distinct stock usually gives enormous advantages, which are continued into subsequent, often many generations. Every element of vigour and prosperity is enhanced. That is clearly established. 2. That more moderate advantages accrue from an intercross with another plant of the same stock, and that the relative advantages of such, over self-fertilisation, gradually disappear in successive generations. 3. The crossing of different flowers on the same plant generally does little or no good, such benefit being mostly (?) in the case of self-sterile plants. 4. Self-fertilisation. This last, Mr. Darwin says, is "injurious," and produces "evil results." Now, it is here where I am compelled to differ from his conclusions, and my previous criticisms have been mainly directed to this point. Allowing for individual exceptions, I maintain that, as a broad general principle, self-fertilisation in the vegetable kingdom is not "injurious" in any ordinary sense of the term. I may be wrong, but that is my conviction, and the present communication will supply my reasons for so thinking.

On p. 26, while recommending his readers to study certain cases in particular, in which "the crossed plants are superior to the self-fertilised to a marked degree," Mr. Darwin adds:—"An instance of self-fertilised plants being equal or superior to the crossed, the experiments on *Barbarea*, *Canna*, and the common *Flea* ought to be read; but in the last case, and probably in that of *Canna* (and he might have added *Barbarea*, for the plants were certainly), the want of superiority in the crossed plants can be explained; the explanation being, that as *Canna* and the *Flea* have been long cultivated by self-fertilisation, intercrossing did little or no good. But there are other

insects, such as the case of "Hem." *Mimulus*, *Epilobium*, *Euphorbia*, &c., to which this case does not apply, and which very much exceeds its intervarietal rank.

I will now quote three passages of importance:—"We should always keep in mind the obvious fact, that the production of seed is the chief end of the act of fertilisation; and that this end can be gained by hermaphrodite plants with incomparably greater economy by self-fertilisation than by the union of several stamens belonging to two distinct flowers or plants" (p. 11). In speaking of the necessity of self-fertilised seedlings I quote in two raised from flowers fertilised by pollen taken from other flowers on the same plant, he says:—"This is a remarkable fact, which seems to indicate that self-fertilisation is in some measure more advantageous than crossing, when the crossing being with it, is in generally the case, some decided and predominant advantage" (p. 10).

Lastly, Mr. Darwin observes:—"The most important condition to which I have alluded, is that the union of seed is that of two of the same. The good results on the self-fertilised which are crossed differing slightly in constitution" (p. 25).

Considering them in detail, I shall endeavour to show how self-fertilised plants can do this and the conditions have been spoken of by Mr. Darwin.

The following are some of the chief facts connected with the self-fertilisation of plants:—

1. The majority of flowering plants are self-fertilised, and very few are known to be physiologically self-fertilised.

2. Many are morphologically, but not physiologically self-fertilised.

3. Both physiologically and morphologically self-fertilised plants become self-fertilised under changed conditions.

4. Flowers may become self-fertilising (1) by the withering of the corolla; (2) perhaps by its rotation; (3) by closing; (4) by remaining closed, some having opened; (5) by the absence of insects; (6) by increasing power to a different extent; (7) by reduction of temperature.

5. Highly self-fertile varieties may appear under cultivation.

6. Self-fertilisation may be secured by special construction adaptations.

7. Uncrossed and chimeric flowers are naturally and highly self-fertile.

8. Self-fertility does not decrease, but may increase in successive generations.

9. Though plants may acquire increased constitutional vigour by crossing, self-fertile plants may gain the same by transportation to colder climates.

10. Of plants requiring insect agency and of self-fertilised, the latter are best fitted to survive under neglect.

11. When free from a copious, self-fertile plants are equal and often superior to the intercrossed.

12. There is no waste of energy with self-fertilised plants, as much in the production of a production of pollen by intercrossing and cross-fertilisation.

13. Highly self-fertile and long cultivated self-fertilised lines derive little or no benefit from an intercross, and may even lose from a cross with a new stock.

14. Self-fertilised plants are in every way as healthy as the normally intercrossed plants.

15. A. Plants may be physiologically or else morphologically self-fertile, or both combined, but under certain circumstances may, and probably all such plants acquire or regain the power of self-fertilisation. Mr. Darwin records several cases, as, for example, the Brazilian *Echtholobium*, of which he says, "their self-fertility had certainly increased greatly by being reared by two generations in England." It was similar with *Abutilon Darwinii*. Some plants of *Raphis arvensis*, as Darwin states, are self-fertile, while other plants are self-fertile. Verhagen's phloxes were fertile in the same way, and while V. Thapsus is self-fertile, V. signatum is self-fertile. *Lobelia fulgens* was self-fertile in Germany, but Mr. Darwin found it self-fertile. This, like the Brazilian *Echtholobium*, he supposed to become self-fertile in consequence of the lower temperature of England. For the above because other plants are self-fertile. Orchids may be both morphologically and physiologically self-fertile, while even in some cases the pollen acts as a poison on the stigma of the same flower.

Mr. Darwin regards such self-fertility merely as an "incident," and not that it bears relation to present self-fertilisation.

Plants adapted for insect agency may be, and generally are, however, self-fertile. The cross with many Leguminosae; *Fuchsia*, which is heterostylous, as in *Passiflora* weight, but F. *multiflora* has not yet yielded the pollen, and a self-morphologically self-fertile. Again, *Delphinium* flowers, such as pale varieties of *Delphinium*, *Fuchsia* and *Delphinium*, may gradually become self-fertilising by crossing their stamens and pistil together.

In speaking of the "immature cause" of self-fertilisation, Mr. Darwin alludes to the "condition" "condition." Thus, I think, should be called the "prevention" cause, the immediate or ultimate cause being, as I conceive, the preponderating influence of the corolla and surrounding sheath, which leads to the pollen grains destroy the equilibrium between the female organs. Whatever, therefore, may be the cause of work which checks the growth, or development, or energy, in whatever way shown, by the corolla, sheath, and stamens, and perhaps in part the stigma, that some energy is now directed towards the stigma, which then matures simultaneously with the stamens, and, therefore, earlier than it would otherwise have done. What led me to draw this conclusion was an examination of the style of the "conspicuous," as well as the subsequent growth of the floral organs of a large number of plants; each order being frequently as follows with flowers having conspicuous corolla:—*Empetrum*, *Antennaria* &c. in two which, that opposite the pistil, stands first, that that opposite the pistil, and lastly the corolla. The latter grow subsequently very rapidly, and the corolla, which then matures simultaneously with the stamens, and, therefore, earlier than it would otherwise have done. What led me to draw this conclusion was an examination of the style of the "conspicuous," as well as the subsequent growth of the floral organs of a large number of plants; each order being frequently as follows with flowers having conspicuous corolla:—*Empetrum*, *Antennaria* &c. in two which, that opposite the pistil, stands first, that that opposite the pistil, and lastly the corolla. The latter grow subsequently very rapidly, and the corolla, which then matures simultaneously with the stamens, and, therefore, earlier than it would otherwise have done.

Under heading No. 4 I have given six cases, and possibly there may be others which may that being such self-fertilisation. Mr. Darwin alludes in his writing of corolla of *Viola tricolor*, and I can not do better, for I found lower buds of *Tradescantia virginica* in September last with the corolla shrivelled and wasted round the ovary, thus keeping the style bent down upon it and the stigma in contact with the ovary; a number of capsules formed, and the seeds contained perfectly formed embryos. Mr. Darwin alludes to *Stenopogon* very generally upon this; in all cases it is suggestive the flowers which close at dusk or night in *Antipathis arvensis*, *Manisphoranthus*, *Dianthus*, &c., in the evening, or at night, may do so in the same way.

The above observations led me to deduce the supposition that if the corolla were cut out, the preponderance of otherwise sterile flowers might become self-fertilising; and I was now expressly surprised to find cases recorded by Mr. Darwin which exactly fulfilled my prediction, though the experiment was performed for a different purpose. In "Notes on the self-fertilisation of plants," Mr. Darwin records the case of a considerable number of flowers, and these yielded seeds. Flowers which are self-fertile would naturally produce seeds under these circumstances, but I am greatly surprised that *Delphinium consolida*, as well as another species of *Delphinium* and *Viola tricolor*, should have produced a fair supply of seeds when their corolla were removed. Now, with a view to study ourselves of the power of self-fertilisation, but I hope to see it fully this year, and would be extremely glad if any one would send me in doing so by this time, removing the corolla together with some of the surrounding parts at some, especially before dawn, and carefully protecting those flowers thus mutilated from the approach of insects. Of course I need only be done in the case of pot-cultivated forms.

Another cause of self-fertilisation is the lowering of the temperature. *Abutilon* has already been made to this in the case of the Brazilian *Echtholobium*, which, though self-fertile in South America, became self-

fertile in England. Mr. J. Bates also called attention to the fact that some wild flowers, when they blossom in winter, do not open their corolla, and so self-fertilising in consequence, and I can corroborate his observations by many other instances. The corolla being, as I believe, that the production of temperature checks the growth of the corolla and the secretion of the pollen.

Again, certain white and pink coloured varieties are great seeders; and this, again, I suspect, is another cause of the same kind, for the whiteness represents loss of vigour. Mr. B. T. Brown alludes to this fact in his paper on the "Fusion between white and red" and found the greater fusion between white and red was desired of corolla, but it is evidently applying the colour retained—so important too, to which I would call the attention of horticulturists.

It is to be the true explanation of *procreancy* and self-fertilisation, the question is resolved. In one of the degrees of compression, and, as far as I know, has nothing to do with "preponderance" whatever. In fact, it is an accident has had the effect of "being" the plant to be self-fertile, as its ability of producing is therefore largely, if not wholly, checked.

Though I agree with Mr. Darwin that "the inefficiency of a plant's own pollen [self-fertilisation] is most often an accidental result of self-fertilisation," and has not been specially acquired for the sake of preventing self-fertilisation, I cannot agree with him in drawing a different conclusion on the morphology self-fertile plants, to be able:—"On the other hand, there can hardly be a doubt that self-fertilisation . . . that the history would not be certain whether it is only some mechanical structure, how all been acquired as to check self-fertilisation and to favour cross-fertilisation," and still he shows that when plants lose their delicacy they again give self-fertilising power, which he then considers to be an advantage to the plant. *Abutilon*, too, Mr. Darwin says "it is difficult to avoid the supposition, that self-fertilisation is in some respects advantageous."

My explanation is that it is simply an unavoidable result of the loss of equilibrium between the pistil and corolla and surrounding sheath. If, for example, a flower that is normally keeping up a sort of equilibrium at that region; the whole weight of the female organs throws upon the corolla. If it be a several flowers, the least slight in any petal or pistil, and making balance the flower to become regular; but if it is present only in one petal, or in the female side and so (I assume theoretically) will be as demonstrated or disproved) cause the corolla to be lateral, by determining a law of equilibrium to that part; though what means forest may regulate the special proportion of structure in different flowers is at present quite unproblematic.

The common tradition and the ordinary claim upon the successive organs most stimulate them to develop more and more, but as a man's own increases by work, or the machine may be made to work by prolonged periods; so that, in my view, it is not that some have gone to the flowers because they were less conspicuous, but have actually themselves acquired these compensations. The process may have been a slow one, only effected in many generations; the result has been that ornament has been delayed from the pistil, and the flowers have become in the majority of instances self-fertilising. On the other hand, in the absence of insects, there is no such increase of energy in the ovaries which is the expense of the pistil, so that the balance is restored and self-fertilisation ceases. *Geopelia* *Heaven*.

(To be continued.)

Home Correspondence.

The *Cucumber Disease* and "Salon."—MR. Mr. Worthington Smith kindly came in to my all in fighting the *Cucumber disease*? Starting in an entirely fresh line, everything went nearly as smoothly as could be expected, and I was very much surprised to find the disease appeared on *Tradescantia* *virginica*, *Viola tricolor*, and, in fact, plants, to make doubly sure, with both from a fresh plant. The plants were naturally put up and were. The plants were, however, very much of other varieties, and we are drawing each leaf, leaf, and speak of this annual with *Salon*, that sets through the same, and almost destroys them in a very short time. The *Salon* seems to penetrate through them, and seems to be a sort of ravenous bug, that eats them very. If it does not kill the young plants, the insect will eat them. We will be looking the means to prevent them.