five large lobes, which are again more or less parted, an oblong sorus terminating each of the divisions in the fertile portions. When there are no sori, the tips of the segments are shallowly toothed. The fronds are deciduous. It will be a very elegant garden plant, as the accompanying illustration shows (fig. 5). We understand that it thrives best in a cool stove temperature, and during summer and autumn we have seen it growing vigorously in a house entirely without fire-heat. Our figures were derived from one of Mr. Williams' plants, which we are informed were collected in Peru, by M. Roezl.

A. speciosum, as we have said, was imported by Messrs. Veitch & Sons, and is represented by our accompanying figure 6. It has a creeping rhizome, from which arise stout triangular deciduous fronds, with a lamina nearly as broad as long, and very distinct in character from the elongated lamina of the fronds of A. palmatum. The fronds are at least tripinnate, the lowest pinnæ fully 10 inches long, with the first anterior pinnule 2 inches long, and the first posterior one 4 inches, thus forming an unequal-sided triangle. The ultimate pinnules on fronds of this size are from 1 to 1¼ inch across, the terminal one being wedge-shaped at the base, and the others more or less truncate, but in the more leafy fronds of a younger stage of development there are often pinnules of 2 or 3 inches in breadth. The pinnules are deeply lobed in about three or four divisions, the lobes themselves being again deeply parted, and the sori oblong, crossing the tips of these ulterior lobes. The pinnules are covered with short dense hairs, which give them a woolly feel. Messrs. Veitch's plants were introduced from Peru. *T. M.*

## THE FERTILISATION OF PLANTS.

MR. DARWIN's new book,* like its predecessors, is a perfect mine of facts and generalisations; and it has been no easy task to digest it. I, however, purpose endeavouring to give as concisely as possible some of the chief facts and conclusions which are of more especial value to horticulturists.

In the introductory chapter Mr. Darwin describes the plans pursued, which were as follows. Confining his observations almost entirely to cultivated and conspicuous flowers, he protected by a net the parent plants. Several flowers were fertilised with their own pollen, the seedlings resulting being called "self-fertilised plants." Other flowers on the same plant, the stamens not being removed, so that Nature might be closely followed, were fertilised with pollen from a distinct plant of the same stock, growing, however, under the same conditions. Their seedlings he calls "intercrossed plants." I shall limit the word "crossed" to plants derived by a cross with an entirely new stock. As the two kinds came up, whenever one of each kind appeared simultaneously, they were planted one on each side of a pot. Proceeding thus until from six to twenty or more pairs were established, the remaining seedlings were planted thickly in a large pot or in the open ground, often thus having to struggle for existence, with results to be mentioned hereafter. Conditions of soil, light, moisture, &c., were made as exactly alike as possible.

To determine the results, the relative heights of the fully-grown plants were compared, and a long table (A) in chapter vii. gives them for fifty-four species of thirty orders; the height of the intercrossed being fixed at 100—the mean of all the self-fertilised is 87. Mr. Darwin, however, omits certain cases which are more favourable to the latter kind; thus, while inserting all ten generations of Ipomœa, he omits all mention of the wonderful self-fertilising and tall variety he named "Hero." Again, of Mimulus, while inserting the first to the third generations, he omits the fourth to the seventh inclusive, when the self-fertilised exceeded the intercrossed in height: for while the average difference for the first three generations is shown by the proportion of 100 : 65, in the subsequent years the ratios were as 100 : 110, 100 : 126, and even as 100 : 137; neither has he inserted the second year's growth of Eschscholtzia, viz., 100 : 100, nor that of Lobelia fulgens, viz., 100 : 167—the self-fertilised being in these vastly superior to the intercrossed! Had our author added these—and I cannot see any good reason for their omission—the resulting mean ratio would have been as 100 : 118! Height, however, as Mr. Darwin confesses, is not always a satisfactory nor even trustworthy test; for it shows only one element of vigour; and if a plant be unnaturally "drawn," as occurred with Dianthus, not even that. The weight of the entire plant, had it been possible to ascertain it in all cases, would have been more desirable. Some few plants were weighed, and a table (B) is added, and the difference is often striking. Thus the height of intercrossed plants of Brassica oleracea is to that of the self-fertilised as 100 : 95, that is practically the same; but their respective weights were as 100 : 37; giving a difference between the percentages of fifty-eight! That difference is exceptionally great; for if we take the eleven plants that were weighed, a similar difference between the weights and heights of the mean is twenty-six. Unfortunately weighing could not be always done; and, as might be expected, the heights in some cases gave adverse results, *i.e.*, the self-fertilised grew exceptionally taller than the intercrossed. The reverse, however, was the general rule. Hence it is concluded that intercrossed plants grown under the same conditions have, at least for the first few generations, a decided advantage; unless the plant, like Pisum sativum, has been cultivated for many years and propagated solely by self-fertilisation, for in such a case intercrossing does no good. This advantage is shown in the greater vigour of the intercrossed, especially under competition, though it does not always show itself from the very first, the self-fertilised seedlings being often equal to if not taller than the others; but soon after the preliminary stage is past, then the intercrossed begin to surpass their rivals, and ultimately evince greater luxuriance, darker foliage, greater fertility, and brighter tints in the flowers. But after several generations of close interbreeding, the latter become more uniform in colour. This fact is associated with another—viz., that although intercrossing is beneficial at first, subsequently it does no good at all; and then closely interbred and related plants become equal to, if not inferior to, plants of the same kind which have been repeatedly self-fertilised. Mr. Darwin more than once attributes the slight differences between certain self-fertilised and intercrossed plants to the deterioration of the latter through constant inbreeding; but he does not observe that actual self-fertilisation is a still closer form of inbreeding; hence such results tell in favour of the "lasting" powers of self-fertilisation—that they have not deteriorated, at all events, in the same ratio as the intercrossed. This, again, is analogous to the fact that intercrossing distinct flowers on the same plant often does no good, or else gives results inferior to self-fertilisation; excepting in the case of some nearly self-sterile plants. Thus, Mr. Darwin speaks of Ipomœa:—"That the self-fertilised plants grew a little taller, were heavier and generally flowered before those derived from a cross between two flowers on the same plant." A few cases, such as Digitalis, Eschscholtzia, Corydalis cava and Oncidium are mentioned, in which a slight advantage accrued to the offspring of flowers fertilised with pollen from others on the same plant. It is an observable fact that these four plants are nearly self-sterile, so that it would seem that the flowers on the same plant had become more and more highly individualised in some way, though it would be dangerous to generalise from so few cases, especially as it was not the case with some other self-sterile plants. An interesting case, not recorded by Mr. Darwin, is the Victoria regia, which is said to have yielded 25 seeds only when naturally self-fertilised; 60 when artificially self-fertilised; 100, when by pollen from a different flower on the same plant, and as many as 300 seeds when intercrossed with pollen from a separate plant.

The third series of experiments brought out the most important result of all—that when either intercrossed or self-fertilised plants were crossed with pollen from plants raised from an entirely new stock, the ancestors of which had grown at quite different localities, then the resulting "crossed plants" vastly superseded the self-fertilised, and very greatly, though to a less extent, the intercrossed plants of nearly related origin. Every element of vigour was usually enhanced, and colours became much more varied and pronounced. These experiments thus strongly corroborate the custom of seed growers and propagators, of introducing fresh seed from distant localities. Here, then, we may see how Nature brings to her aid various means to effect this. Insects do the first office in intercrossing the closely related plants growing in the same district; and the strong persistency in Nature would imply that all the individuals of a species growing in the same locality were not only closely related, but were seldom crossed with pollen brought from a great distance. This is the first step in the progress of improvement. As the species spread into other areas, birds, especially, perhaps, "of passage," will carry about seeds from different stocks, and having introduced them into new areas, insects will then fertilise the old long-residents by means of the newly bird-imported seedlings; while the fact that insects and birds often feed more or less exclusively on one and the same kind of plant respectively, will favour such crossing. Illustrations will be hereafter given of the benefits which result from crossing distinct stocks.

It may be interesting to the reader to know that Dean Herbert long ago anticipated these results of Mr. Darwin, for he says (*Amaryllideæ*, p. 371):—"I am inclined to think that I have derived advantage from impregnating the flowers from which I wished to obtain seed with pollen from another individual of the same variety, or, at least, from another flower rather than its own . . . and especially from an individual grown in a different soil or aspect."

Though self-fertilisation does not usually produce such marked results as intercrossing, nor the latter such benefit as crossing with a distinct stock, yet it must not be supposed that, therefore, plants cannot fertilise themselves. The known number of self-sterile plants is very small, *i.e.*, plants in which the flower's own pollen is inefficient on its own stigma; and even these would probably become self-fertile under certain climatal conditions, as some are known to do, especially on the reduction of temperature. Moreover, in several instances amongst Mr. Darwin's experiments the self-fertilised were more prolific and more vigorous than the intercrossed and in some genera highly self-fertile forms appeared and transmitted their self-fertilising properties to their descendants: so that, as was the case with Hero in Ipomœa, they did not even profit from a cross with a distinct stock! Then again many plants possess "cleistogene" flowers as the Violet; *i.e.*, minute nearly apetalous and closed flower-buds, which produce an abundance of good seed; while on the other hand conspicuous flowers adapted for intercrossing often set no seed at all in the absence of insects. Lastly, a considerable number of our wild genera with very inconspicuous self-fertilising flowers, such as Chickweed, Knotweed, Fumitory, &c., are abundant in individuals, prolific, and very rapid seeders, vigorous in growth for their size, and when transplanted into other regions of the globe, as Polygonum aviculare into New Zealand, grow to much larger dimensions, and, what is more remarkable, completely invert the rule deduced from Mr. Darwin's observations on cultivated plants—for they oust the native population, and are wonderfully vigorous in the struggle for life! On the other hand Mr. Darwin's experiments on cultivated plants clearly show the great superiority of intercrossed, and especially crossed, plants when under competition with self-fertilised individuals. Mr. Darwin, though often speaking of the "evils" of self-fertilisation (a term which I hope to show requires a relative interpretation only), is obliged to confess "that self-fertilisation is in some measure more beneficial than 'crossing,' unless the cross bring with it some decided and preponderant advantage; and this is only to be acquired by different constitutions in the parents."

Some horticultural importance lies in the fact that the colouring of self-fertilised plants always tends to become extremely uniform in successive generations. This tendency already appeared in the later generations of closely related intercrossed plants subjected to the same environing conditions; but it is even more marked in the case of self-fertilised plants; and an obvious fact issues out of this—that if horticulturists wish to retain and render permanent any particular "strain," they should carefully select it, and then endeavour to fix it by securing self-fertilisation as much as possible, accompanied by entire freedom from competition.

The first chapter of Mr. Darwin's work being introductory, is followed by five chapters in which are recorded the results of his experiments on a large series of plants, the seventh chapter containing tables and a summary of these results. I propose in the next communication to select some of the more interesting cases. The subsequent contributions to the *Gardeners' Chronicle* will treat of the various matters dealt with by Mr. Darwin in the remaining five chapters of the book. *George Henslow.*

(*To be continued.*)

* *Cross and Self Fertilisation of Plants.* By C. Darwin. Murray.

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