As the taste for horticulture is spreading, we may expect that those who devote themselves to raising seedlings will increase in number: and consequently the evil, if not checked, will increase. We should think it very hard to be obliged to put up with two or three bad eggs because the dozen had to be made up; and why should we put up with a like absurdity in flowers? It all arises from greediness. The grower is greedy, for he wants to have ever so many new things each year; the sender-out is greedy, for it is very tempting to be able to get double or treble the price for a plant because it is new.

I say nothing of the raiser, because he oftentimes knows but little about the matter, and is only the unconscious victim in the hands of the person who takes these little matters off his hands. We must, then, agitate for a reform. Great changes have taken place. The time for letting out Pelargoniums at five guineas has long since gone by. Even the guinea and a half has fallen to a guinea. But, as I have said, the reform we want is not so much in the price of the flowers as in their number; and the nurseryman who will set his face against the present system will indeed be a public benefactor.—D., *Deal.*

PHENOMENA IN THE CROSS-BREEDING OF PLANTS.

[HAVING received the following letter from Mr. Darwin we forwarded it to Mr. Beaton, and now publish it with his reply.

"Will Mr. Beaton, who has made such a multitude of most interesting observations on the propagation of plants, have the kindness to state whether varieties of the same species of Composite plants frequently cross each other by insect agency or other means? For instance, will any of the Cinerarias, if kept apart from other varieties, breed true? but if standing near other varieties, will they generally, or almost certainly, produce a much greater diversity of coloured seedlings?

"I saw an allusion by Mr. Beaton to this subject in THE COTTAGE GARDENER of last year with respect to Zinnias; and from this allusion I infer that Zinnia sports much when kept separate.

"As I am begging for information on the natural crossing of plants, I will likewise venture to inquire whether the great raisers of Hollyhocks find it necessary to keep each variety far separate from the others for raising seed. The late famous horticulturist, the Hon. and Rev. W. Herbert, when I visited him at Spofforth many years ago, remarked that he was much surprised (considering the structure of the flower and the relative periods of maturity of the pollen and stigma) how true some sorts of Hollyhocks bred, even when growing close to other varieties. I have found this to be the case with some of the varieties, and cannot understand how it is possible. Mr. Beaton might, if he pleased, write an article, very valuable to physiological botanists and of some practical utility, on the natural crossing of varieties. He might indicate in which genera crossing most commonly occurred, and in which it seldom or never occurred. For instance, I have observed Sweet Peas during several years and believe that they never cross; and it is not easy to make an artificial cross, though I succeeded at last, but got no good in a horticultural point of view.—CHARLES DARWIN, *Down, Bromley, Kent.*"]

I am not aware that any two species of Composite plants under cultivation have ever been crossed by man, or through the agency of insects. Mr. Penny, who first broke down Cineraria cruenta in the Messrs. Young's nursery at Epsom, said he got it to cross with another species, I think, from Teneriffe. It is more in accordance with the experience of cross-breeders, however, that superior cultivation induced the disposition to vary, as in the Dahlia. The Swan River Daisy, Brachycome iberidifolia, is the last instance we have of this in the garden; while Zinnia is the last variable Composite plant that has been turned into double flowers, so called. This last change is said to have been effected in India; and if it is really so, the effect may be ascribed to climate more than to high cultivation. We know the Port Natal Gladiolus (natalensis or psittacinus) could not be crossed here, or on the Continent, with any of the old Cape species or their seedlings; but in Australia, at Sydney, the cross was easily effected—Gandavensis being the first seedling of that cross; but as soon as that cross got into the hands of European cultivators they experienced no more difficulty in pushing on their crosses in the strain of natalensis. These are three recent instances of the undoubted influence of cultivation and climate over genuine wild species. For the first seven or eight years of high cultivation the Swan River Daisy kept to its original colours—blue and white, then varied into lilac and purple and minor shades. When a flower or species thus varies from the effects of cultivation or climate, the variation is also variable in degree. Some of the varieties reproduce themselves quite true from seed from the first; others, on the contrary, take some years before the colour or habit is "fixed," as gardeners say when a variable plant comes true from seeds after sporting for some years; and some never get fixed, or have not done so yet, and Zinnia is an instance of it. In all these instances some people attribute the changes to cross-fertilisation; they have been crossing their flowers, and they have seen results, and account for them that way, deceiving themselves. But those who have studied and experimented on the effects of cross-breeding, as against the results of the effects of climate and cultivation, have long since arrived at the conclusion that crossing has no power on fixing any two plants which naturally sport—that is to say, on fixing a seedling from their union combining so much of the qualities of each of the parents as is generally the case when two permanent kinds or species, which always reproduce themselves or their like, are united. That conclusion strikes at the root of the fallacy which obtains in respect to the best means of improving all our domestic fruits; and yet crossing is an element of great value in improving flowers and fruit, which seems a contradiction, but is explained thus:—Some seedlings from plants that have been crossed for a generation come quite true from seeds, some half true, and some on which no reliance whatever can be placed, or, in our language, they always sport from seed. On those which this sport-crossing has no effect—such, however, as come half true and half sport-crossing—there is a chance of an intermediate condition, and those merest varieties which come true from seeds crossing is just as effectual with them as with two genuine wild species. One would think, therefore, there were no natural limits or difference between a species and a permanent variety—that is, one which comes true from seed, like the large-flowering variety of the Mignonette. In practice there is no landmark whatever between such a variety and a wild species. The garden Cinerarias are sporting plants as much as the Dahlia, yet among a thousand seedlings of each, one may turn up which will come half true from seeds, and when one finds such a seedling in any of the sporting families of common plants he keeps it for a breeder, even if it were the worst-looking in a large batch of seedlings. The way with Cinerarias more than with most plants is this—by a careful selection of kinds under high cultivation one gets a superior strain, as we say, or superior flowers, which, although they will not come true from seed, will produce more good seedlings, or less bad ones, than an inferior strain: therefore, if a good flower or good strain of Cineraria is exposed to the pollen or influence of a bad strain, the good breed is immediately deteriorated in the sporting offspring. I am not aware that any of the garden Cinerarias come true from seeds, or if any of them could now be crossed with the nearest wild species. The only Composite flower on which I ever spent time is Dahlia scapigera, the pretty little lilac dwarf Dahlia with small shining foliage, and I think I can venture to assert that in our climate it is impossible to cross it with any of the garden Dahlias. It is just the same among Primulas: notwithstanding the freedom with which Auriculas and Polyanthuses will sport among themselves, you cannot drive a seedling from all their races by the pollen of their nearest kindreds. When Primula Palinuri and sinensis, which were introduced the same year (1816) came into general cultivation, I was initiated into the mystery of crossing flowers, and these two were of the number which raised the hopes of the cross-breeders, particularly Palinuri, which, to a common observer, is nothing beyond a huge Auricula; but none of the wild species of Primula would touch each other or the garden varieties. Then you see no end of sport seedlings in the Dahlia and in the Primula, in two distinct species of Primula and two botanical species of Dahlia; and yet the rest of their families obstinately hold aloof from each other, and from the sports of their respective kinds.

The old Hollyhocks, or some of them, were fixed varieties; but whether they were so fixed from the first, or induced to fix by a long course of culture by propagation of the roots we do not know, but the fact is well known that some of the old kinds would come true from seeds. A long course of one uniform culture renders some plants barren altogether, as Crocuses, and a long period of years intervenes between the birth of some seedlings and their coming to the age of puberty—to the age of producing seeds, although they may have flowered from the second or third year from the seed. Ribes sanguineum flowered six or seven years before it began to seed; and Dr. Herbert records an instance in which a certain seedling bulb flowered fourteen years before it produced pollen or would seed.

"The relative periods of maturity of the pollen and stigma,"

seems to have been a wise law from the beginning for the preservation of the kinds of plants in their generations, for there is not a flower in a thousand that is fertilised by its own immediate pollen. The pollen is in advance of the stigma in the great mass of flowers, and the pollen from another flower on the same or neighbouring stalk is the fertiliser. And here another wise law is in operation: When the stigma is ripe it is exposed to the influence of the pollen of all the plants of its own kind which may be growing near it; and the law is, that the pollen of the flower, or of the plant which is the strongest or best developed, takes the lead in fertilising the stigma, and at the same time is able to neutralise any effects that may have been produced by an inferior pollen, or pollen from a weaker flower or sickly or stunted plant—a thing which can be proved any day in the summer by dusting the stigma with its own and sundry pollen, when one kind of pollen only will take effect. And that proves two things in addition to the proof that the best pollen takes the lead—proves superfœtation to be impossible, and also proves that the ideas of physiologists are not according to Nature as to the progress of the pollen to the ovary. They say the pollen passes through tubes of extreme tenuity to the ovules. If that were so, and more than one stigma supplied the necessary passage, more than one kind of pollen might find access to the ovules, and more kinds than enough would fertilise the embryo seeds, and superfœtation would necessarily result.

In the instance mentioned by Mr. Darwin of Sweet Peas never crossing, they belong to a class of flowers every one of which must, of necessity, be fertilised by its own pollen in the great majority of instances. The carina, or keel, or lower petal in pea-shaped flowers is, in reality, two petals joined at the edges. The joining is the keel; the ends of these two petals lap over or fold into each other, forming the imaginary bow of the boat; the stamens and the pistil are compressed within the folds forming the bow, and fertilisation is effected in the dark, and the stigma is perfectly safe from the intrusion of foreign pollen: therefore, no garden Pea can be naturally crossed more than a Sweet Pea, unless, indeed, a strong bee with other pollen on his legs has been struggling to get at the nectar in the stern of the boat. Some of the varieties of the garden Pea may be crosses resulting from a struggle of that kind, but the great majority of them are the results of the sporting tendencies of the plant itself. This is the true cryptogama of Nature, of which, however, there are many more perfect instances. The great bulk of the order of Bellworts, or Campanulas, are real cryptogams, their fertilisation is effected in the dark before the flower expands; but the Wheat might be said to be the most complete cryptogam of all the common plants. No kind of Wheat has ever been naturally crossed and never can be. When the Royal Agricultural Society talk about the Wheat being in blossom, they are just one month behind Nature. But what they and the bulk of the country people take for the flowering of the Wheat, is one of the most beautiful contrivances in Nature as means to an end, a departure from the law of Nature, as it were, to preserve food for man. The Wheat is in full flower, and the seed is fertilised while the ear is yet in the folds of the sheath before the Wheat is in ear. At that period the anthers might be said to be sessile, or to have hardly any length of stamens under them; but as soon as the pollen is shed, the husk of the anther might rot in such close confinement and endanger the safety of the staff of life now having just received vitality. To prevent famine for lack of Wheat, however, Nature alters her common process in this matter. As soon as the anther is emptied of the pollen the stamen begins to grow and to push up the husk of the anther away from the embryo seed; and by the time the ear is seen the husk is well nigh out of the scales which enclose the seed, but stops not there nor till the husk is dangling from a white thread far off from the entrance to the seed-case, and when all dangers are thus provided against, the farmer congratulates himself if the weather is propitious for his Wheat is in blossom!

I do not know an instance "of the natural crossing of varieties." My own experience of variable plants was given last week, and I do not exactly comprehend what is meant by natural varieties, for all the so-called varieties in cultivation have been artificially obtained either by a change of cultivation, or by crossing with pollen such kinds or species as would sport from seeds under cultivation. These kinds I call variable plants, their own progeny being constantly variable in aspect, and just as variable when the pollen of another flower is applied to them. It is a difficult thing for a gardener to see or comprehend the meaning of what botanists call varieties, or natural varieties of plants, because there is no limit, or sign, or any other indication in their outward aspect to distinguish them from the oldest species on record, and there is nothing in the botanical structure of even a variable seedling to distinguish it from a genuine species. Professor Henslow proved that point long since in his comparative anatomy of a cross-bred Foxglove, or some such plant. I do not know of one plant that is a cross between any two plants in a wild state. I do not know that any one has obtained a true cross in any of the pea-flower plants—papilionaceous plants, nor yet any reliable cross among all plants of the Composite order. I know one thing on which many, if not most gardeners, put a great stress or value in knowing—that is, the conditions under which plants that are fit subjects for garden decoration are found in their natural habitats; but that knowledge is of little practical value, or may prove to be a hindrance to the proper cultivation of particular plants for some time, and yet might be the means of suggesting why and how plants may be, or have been, induced to cross in a wild state, or have sported into variations without crossing. That one thing needful is proved to be of so little value by the well-known fact that very many garden plants, or their immediate ancestors, did not, and do not at the present day, occupy those regions in the wilderness which were best suited to their natures. Their positions or habitats, as we say, are more often the result of necessity, not of choice. A plant that would thrive and be luxurious on the sea coast, on the plains, or in valleys in beds of alluvium, or in the shelter of high ridges, or precipitous rocks, can find no foot room in such luxury from the natural competition of more powerful neighbours, as was the case not many ages since among ourselves in the midst of civilised life; and from this competition the weaker plants must always go where they can vegetate and live a quiet life without rank or luxury—in the highways and byways of the savage wilderness, and in time they become the alpine and sub-alpine species of that part of the world, from sheer necessity. They may even become sterile from a long course of the starving principle. But now recover one of them from impending fate, give it to a florist or a fancy gardener who is above the vulgar prejudice, in his belief that all plants in a wild state must, of necessity, occupy the places best suited for their natures, and he will soon tell a different version of how the matter really stands, and might have stood in the wilds, if the plant could get admission to those parts for which its constitution was formed to enjoy. The plant is found to be a luxuriant grower, not at all like a mountain plant, or a rock plant, or ridge or the bare-places-of-the-earth-kind-of-looking plant one might expect from the description of its habitat. After a round of cultivation has brought it to that point from which it fell, from the competition in foreign parts, it begins to seed; and if it, or any of its seedlings sport for joy, why, a new race is born into the world, as has been the case at every revolution of the order of things since the world began to be clothed as it is now; or if it comes true from seeds, another flower of the same kind which have been already civilised, as it were, may cross with it or by it, and a generation of gentry is forthwith on the stage of the florists, or of that of the competition tent. But suppose the wild plant had found a place suited to its nature in the struggle with stronger plants, and that it inherited the property of sporting or of crossing with another, may we not believe that a new plant, or new race of plants might thus result by such natural means, as by the artificial process of the home cultivator? That is as far as the experience of gardeners and cross-breeders can account for natural crossing in a wild state.

The artificial crossing of pea-shaped flowers is easy enough. All that the operator has to do is to split open the bottom part of the keel-petal or united petals with the point of a pin: that relieves the stamens, which may then be extracted, and the pistil is free also to receive foreign pollen. Mr. Knight made an experiment for getting early Potatoes to seed by planting them on a ridge, and when the plants were ready to bloom he washed away the soil of the ridge to prevent them making young tubers, and so force the whole strength of the plants or roots into the stems and foliage to see if that would force them to seed. Another form of that experiment is applicable to all bulbs and tubers which form roots on the flowering-stems, as the Japan Lilies and others do. Pot such bulbs or tubers with the neck of the bulbs just at the surface, and when the stem is an inch or two put an empty pot over it, introducing the stem through the hole at the bottom of the pot, then earth up the stem, and when it roots and fills the upper pot separate from the bulbs, then cross it.

D. Beaton.