

John Robinson read from a notice in the "American Cultivator," of Darwin's new work, "Cross and Self-Fertilization of Plants," an account of some interesting experiments with Indian corn, to test the comparative vigor of cross and self-fertilized plants. These were planted in two rows, and "when fully grown the ten tallest plants in each row were selected and measured to the tips of their highest leaves, as well as to the summits of their male flowers. The crossed averaged to the tips of their leaves 54 inches in height, and the self-fertilized 44.65 inches, or as 100 to 83; and to the summits of their male flowers 53.96 and 43.45 inches, or as 100 to 80." The aggregate height of fifteen cross-fertilized plants raised in pots was 302.88 inches, and of fifteen self-fertilized plants, on opposite sides of the same pots, 263.63 inches. The practical points deduced by the editor of the "Cultivator" from these and other experiments by

Mr. Darwin, and which Prof. Robinson thought excellent, were as follows: "We here see how gardeners can improve their plants by sowing mixed seeds of a variety, a result easily attained by purchasing peas, beans, or other seeds, from three or four seedsmen whose seeds of the same variety were produced in different localities, instead of purchasing all of any given variety of one seedsman. This may cause a little more trouble, but, as Darwin, Gower, and Lecoq have demonstrated, the results thus attainable are worthy of extra care in culture. By all seed-growers, for trade purposes, this book of Darwin's should be specially studied, and to them we most cordially recommend it."

Prof. Robinson thought it an outrage to apply the term "sensational" as Mr. Hovey had done, to the writings of such a man as Mr. Darwin, who was acknowledged by every one to be a most accurate observer and a careful and thorough experimenter. Mr. Hovey thinks cross-fertilization the exception and self-fertilization the rule. Others differ from him, and when we see plants arranged like the orchids and willows, where self-fertilization is rendered impossible, we cannot think it strange that they should differ. Prof. Robinson here read from a review of Mr. Darwin's book, in the "American Journal of Science and Art," by Prof. Asa Gray— "That cross-fertilization is largely but not exclusively aimed at in the vegetable kingdom, is abundantly evident. As Mr. Darwin declares, 'it is as unmistakably plain that innumerable flowers are adapted for cross-fertilization, as that the teeth and talons of a carnivorous animal are adapted for catching prey, or that the plumes, wings, and hooks of a seed are adapted for its dissemination.' That the crossing is beneficial, and consequently the want of it injurious, is a teleological inference from the prevalence of the arrangements which promote or secure it—an influence the value of which increases with the number, the variety, and the effectiveness of the arrangements for which no other explanation is forthcoming. That the good consisted in a re-invigoration of progeny, or the evil of close-breeding in a deterioration of vigor, was the suggestion first made (so far as we know), or first made prominent by Knight, from whom Darwin adopted it." Many persons, prominent among them Thomas Meehan, are continually bringing up instances to show that plants are close-fertilized. This is not denied by any scientific man of any repute. In the words of Prof. Goodale, "What is claimed, and what is in perfect consonance with such statements is

this, namely, most plants can be in some way cross-fertilized, and this cross-fertilization, *even in those species which can be close-fertilized*, ensures greater vigor in the progeny."

Prof. Robinson remarked that Mr. Darwin's conclusions were derived from actual experiments, with hundreds of plants, those with some species extending over a period of eleven years. Prof. Goodale mentioned only a very few of the many instances that might be given, of arrangements for preventing self-fertilization.

Mr. Hovey remarked that the bean, so long cultivated and not easily self-fertilized, had never become mixed.

Mr. Ware corroborated this remark. He had never found hybrids among beans.

The Chairman mentioned the squash family as plants which mix easily.

Mr. Ware again alluded to the fertilization of corn, which he thought peculiarly interesting. To illustrate further than before, he mentioned a farmer who had a very superior variety of corn, which his neighbors desired to obtain, but which he refused to part with. To keep it pure he planted it away from all his other corn, but, unfortunately for himself, he planted some on the bank of a river, and a neighbor planted some corn on the opposite side, which was fertilized by the superior variety, and thus seed possessing most of its characteristics was obtained. Mr. Ware also knew a farmer who was famous for his excellent crop of corn, and who would go to any one who had superior corn and get a few ears, which he would plant with his other corn, regardless of the appearance produced by the intermixture; but although the crop would not present a uniform appearance, Mr. Ware thought it a question whether the mixing did not add to the vigor of the plants.

Prof. Robinson remarked that cross-fertilization does not always cause variation. He illustrated Prof. Goodale's views as to the influence of cross-fertilization in suppressing vagaries, by supposing, in a case where seeds of a plant A, produced progeny A, B, and C, that A should exactly resemble the parent, B varying in one direction, and C in the opposite. Should these be self-fertilized they would tend to form three quite marked varieties, whereas should they cross, each with the others, the variation would be broken up, and the third generation would tend to go back to the original, A, especially should B cross with C, the average being A. We find where a race mixes with other races, like the English nation, that

tempered with self-fertilization—which is the commoner case—is practically the best, on the whole, under ordinary circumstances—is the compromise between the two risks, viz. : failure of vigorous and fertile posterity on the one hand, and failure of immediate offspring on the other. Get fertilized, cross-fertilized if you can, close-fertilized if you must—is Nature's golden rule for flowers." Mr. Hovey agreed with Prof. Gray in his later views—he thought cross-fertilization desirable, but carried on at great expense.

The Chairman said that Prof. Goodale's statement was much stronger than Prof. Robinson's. He (the Chairman) had thought the flowers of the *Kalmia* arranged for self-fertilization, but according to Prof. Goodale, it was one of the instances going to prove the rule of cross-fertilization.

John B. Moore said that he had raised three hundred seedlings from the Rivers' Eliza strawberry, and had in every instance reproduced the parent, or else had got a variety not quite equal to it. The case was the same with the Large Early Scarlet, though both these varieties were growing with twenty others. He had found that the simplest and easiest way of producing new varieties was to select a pistillate kind, and plant it away from all others except that with which he wished to fertilize it. In this way he was sure of getting a cross. Corn is one of the easiest plants to operate on. The spindles should all be cut from the variety which you wish to make the mother, before they have fertilized it.

Mr. Moore agreed with Mr. Hovey that Darwin is sometimes romantic and fanciful, and mentioned as an instance the account given by him, and quoted with approval by Prof. Chadbourne at a late meeting of the Massachusetts Board of Agriculture, of an apple tree at St. Valery, "which, from the abortion of the stamens, does not produce pollen, but being annually fertilized by the girls of the neighborhood with pollen of many kinds, bears fruit 'differing from each other in size, flavor, and color, but resembling in character the hermaphrodite kinds by which they have been fertilized.'" Mr. Moore said that an experience of sixty years in the culture of fruit forced him to differ from Prof. Chadbourne. He did not believe anything he saw in a book unless it appeared reasonable to his own mind.

Mr. Wetherell also agreed with Mr. Hovey that Darwin was sometimes romantic, and thought his book on "Cross and Self-Fertilization," the most practical work he had written. This sub-

ject has a practical side, of much interest both to seed growers and seed planters.

The Chairman inquired whether any one had any facts to present in regard to fertilization under glass.

F. L. Harris replied that he had had some success in crossing *Dracænas*. He had fertilized *Mooreana*, a species having a self-colored, deep bronze leaf, with *regina*, and produced twenty-five plants of which no two were alike, and all partook of the properties of both parents. One of them had a leaf larger than that of either of its parents, and several of them were really superior to either parent. Mr. Butler, gardener at Wellesley College, has crossed *regina* and *terminalis stricta*, and the progeny was much superior to Mr. Harris' seedlings. These were both variegated kinds, instead of a self and a variegated, and more vigorous, yet he produced pigmies, which made most beautiful table ornaments. Mr. Harris operated artificially, first removing the stamens, which he believed to be the true way. He had found *Dracæna congesta* fruit readily, while other species do not; the *congesta* may have been fertilized by insects, and yet this is doubtful, for it fruited in winter when no insects were around. Tropical plants do not fruit readily in greenhouses; he did not believe that a cucumber ever fruited under glass without artificial aid. He thought that grapes had the power of fertilizing themselves so as to produce fruit, but European gardeners declare that it is necessary to syringe the Muscat. He thought the failure to produce fruit under glass might be owing to the absence of insects.

Mr. Hovey said that a breeze was needed to start the pollen. As a general rule the house is kept rather close. The Muscat of Alexandria grape requires heat to burst the anthers. He did not think that each flower would fertilize itself.

Mrs. Wolcott said Mr. Hovey's remarks implied that cross-fertilization would be produced by the current of air.

Mr. Wetherell alluded to the danger of cross-fertilization among plants of close affinity, as the cabbage, squash, and other families. Darwin planted a white kohlrabi, a purple kohlrabi, a Portsmouth broccoli, a Brussels sprout, and a sugar-loaf cabbage near together and left them uncovered. Seeds collected from each kind were sown in separate beds; and the majority of the seedlings in all five beds were mongrelized in the most complicated manner, some taking more after one variety and some after another. The

the neighborhood, some of which came into the house. A current of air is not sufficient.

Mr. Hovey said that it was well to know what we wanted to arrive at, and the question was whether cross-fertilization was necessary to keep up the vigor of the race. He admitted the facts stated in regard to the *Dracæna* and the strawberry. Moisture is unfavorable to the dissemination of pollen.

Mr. Wetherell alluded to the breeding of cattle as analogous to the breeding of plants,\* and said that the shorthorns of the Duchess family, bred in-and-in, are the most perfect animals of the cattle kind that the world has ever seen. He spoke of the Duchess cow, at the York Mills sale, that brought \$40,600. Though cross-fertilization may produce large and perfect plants, the question is whether individuality can thus be perpetuated. He thought crossing with inferior and unimproved varieties would impair the vigor of plants, and that the less there was of foreign pollen the more perfect would be the plants propagated from seeds.

The Chairman remarked that Darwin produced monstrosities by breeding in-and-in, and that the question is, what we call a perfect plant.

Mr. Wetherell asked whether it was not understood by botanists, that all plants in their original state are perfect, and that the garden varieties are monstrosities.

The Chairman replied, that technically they were, and referred to Darwin's illustration from the gooseberry. It is a fair question how far, in our efforts at improvement in particular directions, we interfere with the general development of the plant.

Mr. Hovey agreed with the Chairman that all plants and trees out of the common course are monstrosities. Cross-fertilization has not kept up the individuality of plants, but has changed it. Roses with a tendency to double, become entirely changed in three or four removes from the original. The wild touch-me-not is precisely the same as it was fifty years ago, but if removed to the garden it would doubtless have been changed. Mr. Hovey asked how such a pear as the Duchesse d'Angouleme, which was found growing wild, was produced. He thought cross-fertilization likely to lead away from the original type.

---

\*The following note is added by Mr. Wetherell: "Sexual reproduction is so essentially the same in plants and animals, that I think we may fairly apply conclusions drawn from the one kingdom to the other." Charles Darwin, in "London Agricultural Gazette," April 2, 1877, p. 324.

Prof. Robinson said that Mr. Hovey had confused cross-fertilization and hybridization. We should keep distinct the perpetuation of the race, and the improvement of varieties.

H. Weld Fuller asked whether Nature was not always exercising a strong recuperative power, and making an effort to protect herself. He thought this power was shown in the tendency of variegated plants to revert to their original type. Darwin is a most careful observer and a faithful recorder; if he believes that certain matter was created with innate power of reproduction, self-preservation, and indefinite renewal, the great Author of that power is not thereby ignored! Darwin does not destroy the necessity of a *first cause*. The endowment of a seed with the capacity of development into varieties remarkable for their beauty or use, is as wonderful as the creation of those varieties would be. Human ingenuity may contrive a clock which may run for a week or a year, but it can give no vitality or endless energy to its materials. It requires a God to construct one which will run through all ages, renewing itself continually and knowing no change or stop. Mr. Fuller thought the principles of hybridizing were well understood; the way is to get the best varieties of everything and breed from them.

The Chairman said that we should endeavor to preserve the distinction between cross-fertilization and hybridization. Prof. Goodale's point is that Nature adopts the principle of cross-fertilization largely for the purpose of suppressing changes.

Mr. Wetherell expressed his satisfaction that Prof. Robinson had made the distinction between cross-fertilizing for the perpetuation of the race and for the improvement of varieties.

Mr. Hovey remarked that the difference between hybrids and other crosses is that the former are not fertile.

The Chairman said that the close attention given to the discussion for two hours showed the practical interest of the subject. A motion was made to continue the discussion the next week, which was carried.



## MEETING FOR DISCUSSION.

SATURDAY, February 24, 1877.

W. C. Strong, Chairman of the Committee on Publication and Discussion, in the chair. The subject of Self and Cross-Fertilization, as presented by Prof. Goodale, being again assigned for consideration, the following outline of the lecture, made by Prof. Goodale, was read by the Secretary, that the position of the lecturer might be clearly understood.

I. By self-fertilization, or close fertilization, is meant the impregnation of a pistil by pollen from its own flower.

Conrad Sprengel, in the last century, and Andrew Knight, early in this century, showed that many flowers are incapable of fertilization without insect or other foreign aid.

Mr. Darwin, in England, Müller and Hildebrand in Germany, Axtell in Sweden, and Gray in America, have greatly enlarged the list of flowers which require insect aid to ensure their fertilization. These flowers are termed "cross-fertilized."

II. The mechanism of cross-fertilization may be said to be by

1st. Separation of the sexes.

2d. Different dates of maturity of stamens and pistil.

3d. Inaccessibility of the stigma, as in orchids, etc.

4th. Certain movements which ensure transfer of pollen.

III. Mr. Darwin, in his recent work on cross-fertilization, establishes the fact experimentally that plants which can be, and are, as a rule, self, or close fertilized, become in a few generations greatly impaired in vigor, as contrasted with the same species cross-fertilized, and unequal to contend with them in the struggle for life.

IV. Many disputants of late have asserted with reason, that a good many plants can be self-fertilized. This is not denied by any scientific man of any repute. What is claimed, and what is in perfect consonance with such statements is this; namely, most plants can be in some way cross-fertilized, and this cross-fertilization, *even in those species which can be close fertilized*, ensures greater vigor in the progeny.

It must be noticed that in some recent publications bearing upon close fertilization, the fact that experiments covering many years