

the shadow round it, and the green aureole—as if they were all revolving with great rapidity round a common axis. And what more likely than that this should be the case, since, as has already been mentioned, the arc is revolving at the rate of 450 revolutions per second at the moment that it starts hissing?

As regards the carbons themselves, the only important modification of the *negative* carbon that appears to be due to hissing is the formation of the well-known "mushroom" at the end of that carbon with a *short* hissing arc. This mushroom, of which a good example is seen in Fig. 5, is well named, not only because of its shape, but also because of the rapidity of its growth, which is so great that, while it is forming, the carbons often have to be *separated*, instead of being *brought together*, to keep the length of the arc constant.

(To be continued.)

HYBRIDISATION.¹

OUR first duty, and a very pleasant one it is, is to welcome our foreign guests, our friends from across the sea, as I prefer to call them, to thank them for their presence here to-day, and to express a hope that their sojourn among us may be both agreeable and profitable. At the same time we regret that some, such as Dr. Focke, the historian of hybridisation, has not been able to preside over this meeting, as we had hoped he might have done. Nor can we at such a meeting do other than express our abiding regret at the loss, though at an advanced age, of the great hybridiser Charles Naudin.

Our next duty is to thank the Council of the Royal Horticultural Society for this opportunity of meeting once more in these time-honoured gardens to discuss what I venture to think is one of the, if not the most, important subject in modern progressive experimental horticulture. I use the words *progressive* and *experimental* because I believe that the future of horticulture depends very greatly on well-directed experiment.

So far as the details of practical cultivation are concerned, we are not so much in advance of our forefathers. We have infinitely greater advantages, and we have made use of them, but if they had had them they would have done the same. We are able to bring to bear on our art not only the "resources of civilisation" to a degree impossible to our predecessors, but we can avail ourselves also of the teachings of science, and endeavour to apply them for the benefit of practical gardening. We are mere infants in this matter at present, and we can only dimly perceive the enormous strides that gardening will make when more fully guided and directed by scientific investigations. One object of this conference is to show that cultural excellence by itself will not secure progress, and to forward this progress by discussing the subject of cross-breeding and hybridisation in all their degrees, alike in their practical and in their scientific aspects.

To appreciate the importance of cross-breeding and hybridisation we have only to look round our gardens and our exhibition-tents, or to scan the catalogues of our nurserymen. Selection has done and is doing much for the improvement of our plants, but it is cross-breeding which has furnished us with the materials for selection.

A few years ago by the expression "new plants" we meant plants newly introduced from other countries, but, with the possible exception of orchids, the number of new plants of this description is now relatively few.

The "new plants" of the present day, like the roses, the chrysanthemums, the fuchsias, and so many others, are the products of the gardeners' skill. From peaches to potatoes, from peas to plums, from strawberries to savoys, the work of the cross-breeder is seen improving the quality and the quantity of our products, adapting them to different climates and conditions, hastening their production in spring, prolonging their duration in autumn.² Surely in these matters we have out-distanced our ancestors.

But let us not forget that they showed us the way. I do not

¹ Substance of the address by Dr. Maxwell T. Masters, F.R.S., delivered on opening the proceedings of the International Conference on "Hybridisation," Tuesday, July 11.

² See some interesting observations of MacFarlane on the period of flowering in hybrids as intermediate between that of the parents, *Gardeners' Chronicle*, June 20, 1891; and on the structure of hybrids, May 3, 1890.

propose to dilate on the share which Camerarius, Millington, Grew, Morland, and others, at the close of the seventeenth century had in definitely establishing the fact of sexuality in plants, but I do wish to emphasise the fact that it was by experiment, not by speculation, nor even by observation, that the fact was proved, and I do wish to show that our English gardeners and experimenters were even at that time quite aware of the importance of their discovery, and forestalled our Herbert and Darwin in the inferences they drew from it. In proof of which allow me to quote from a work of Richard Bradley, called "New Improvements of Planting and Gardening, both Philosophical and Practical," published in 1717, cap. ii. After alluding to the discovery of the method of the fertilisation of plants, he says (p. 22):—

"By this knowledge we may alter the property and taste of any *Fruit* by impregnating the one with the *Farina* of another of the same class; as, for example, a *Codlin* with a *Pearmain*, which will occasion the *Codlin* so impregnated to last a longer time than usual, and be of a sharper taste; or if the *Winter Fruits* should be fecundated with the *Dust* of the *Summer kinds*, they will decay before their usual Time; and it is from this accidental coupling of the *Farina* of one with the other, that in an *Orchard* where there is Variety of *Apples*, even the *Fruit* are gathered from the same *Tree* differ in their Flavour and Times of ripening; and, moreover, the *Seeds* of those Apples so generated, being changed by that Means from their Natural Qualities, will produce different kinds of *Fruit* if they are sown.

"'Tis from this accidental coupling that proceeds the numberless varieties of *Fruits* and *Flowers* which are raised every day from *Seed* . . .

"Moreover, a curious Person may by this knowledge produce such rare kinds of *Plants* as have not yet been heard of, by making choice of two *Plants* for his Purpose, as are near alike in their Parts, but chiefly in their *Flowers* or *Seed vessels*; for example, the *Carnation* and *Sweet William* are in some respects alike, the *Farina* of the one will impregnate the other, and the *Seed* so enlivened will produce a *Plant* differing from either, as may now be seen in the garden of Mr. *Thomas Fairchild*, of *Hoxton*, a plant neither *Sweet William* nor *Carnation*, but resembling both equally, which was raised from the *seed* of a *Carnation* that had been impregnated by the *Farina* of the *Sweet William*."

Here we have the first record of an artificially-produced hybrid, and you will remark that this was more than forty years before Kolreuter began his elaborate series of experiments. Fairchild was the friend and associate of Philip Miller, and of a small knot of advanced thinkers and workers who banded themselves together into a "Society of Gardeners."

"He is mentioned," says Johnson in his "History of English Gardening," "throughout Bradley's works as a man of general information, and fond of scientific research, and in them are given many of his experiments to demonstrate the sexuality of plants, and their possession of a circulatory system. He was a commercial gardener at Hoxton, carrying on one of the largest trades as a nurseryman and florist that were then established. He was one of the largest English cultivators of a vineyard, of which he had one at Hoxton as late as 1722. He died in 1729, leaving funds for insuring the delivery of a sermon annually in the church of St. Leonard's, Shoreditch, on Whit Tuesday, 'On the wonderful works of God in the Creation; or On the certainty of the resurrection of the dead, proved by the certain changes of the animal and vegetable parts of the creation.'"

Fairchild was thus not only the raiser of the first garden hybrid, but the originator of the flower services now popular in our churches.

We do not hear much of intentionally-raised hybrids from this time till that of Linnæus, in 1759 ("Amœn. Acad.," ed. Gilbert, vol. i. p. 212). The great Swedish naturalist, having observed in his garden a *Tragopogon*, apparently a hybrid between *T. pratensis* and *T. parvifolius*, set to work to ascertain whether this conjecture was correct. He placed pollen of *T. parvifolius* on to the stigmas of *T. pratensis*, obtained seed, and from this seed the hybrid was produced.

About the same time (that is, in 1760) Kolreuter began his elaborate experiments, but these were made with no practical aim, and thus for a time suffered unmerited oblivion.

Some years after, the President of this Society, Thomas

Andrew Knight, and especially Dean Herbert, took up the work, with what splendid results you all know.

It is curious, however, to note that objections and prejudices arose from two sources. Many worthy people objected to the production of hybrids, on the ground that it was an impious interference with the laws of nature. To such an extent was this prejudice carried, that a former firm of nurserymen at Tooting, celebrated in their day for the culture, amongst other things, of heaths, in order to avoid wounding sensitive susceptibilities, exhibited as new species introduced from the Cape of Good Hope forms which had really been originated by cross-breeding in their own nurseries.

The best answer to this prejudice was supplied by Dean Herbert, whose orthodoxy was beyond suspicion. He, like Linnæus before him, had observed the existence of natural hybrids, and he set to work experimentally to prove the justness of his opinion. He succeeded in raising, as Engleheart has done since, many hybrid narcissi, such as he had seen wild in the Pyrenees, by means of artificial cross-breeding. If such forms exist in nature, there can be no impropriety in producing them by the art of the gardener.

In our own time, Reichenbach, judging from appearances, described as natural hybrids numerous orchids. Veitch and others have confirmed the conjecture by producing by artificial fertilisation the very same forms which the botanist described.

It remains only to speak of another respectable but mistaken prejudice that has existed against the extension of hybridisation. I am sorry to say this has been on the part of the botanists. It is not indeed altogether surprising that the botanists should have objected to the inconvenience and confusion introduced into their systems of classification by the introduction of hybrids and mongrels, and that they should object to hybrid species, and much more to hybrid genera; but it would be very unscientific to prefer the interests of our systems to the discovery of the truth.

I may mention two cases where scepticism still exists as to the real nature of certain plants: *Clematis jackmani* of our gardens, raised, as is alleged, by Mr. Jackman, of Woking (*Gardeners' Chronicle*, 1864, p. 825), was considered by M. Decaisne and M. Lavallée¹ to be a real Japanese species, and not a hybrid. This may be so, but there is no absolute impossibility in the conjecture that the Japanese plant and the cultivated plant originated in the same way. Again, Mr. Culverwell's supposed hybrid between the strawberry and the raspberry has been pronounced to be no hybrid, but to be *Rubus leesii*. But what, we may ask, is *Rubus leesii*? It appears to be a sterile form more closely allied to the raspberry than to the strawberry. Is it not at least possible that Mr. Culverwell has produced it artificially?

The days when "species" were deemed sacrosanct, and "systems" were considered "natural" have passed, and Darwin, just as Herbert did in another way, has taught us to welcome hybridisation as one means of ascertaining the true relationships of plants and the limitations of species and genera.

Darwin's researches and experiments on cross-fertilisation came as a revelation to many practical experimenters, and we recall with something akin to humiliation the fact that we had been for years exercising ourselves about the relative merits of "pin eyes" and "thrum eyes" in primroses, without ever perceiving the vast significance of these apparently trifling details of structure.

It would occupy too much time were I to dilate upon the labours of Gaertner, of Godron, of Naudin, of Naegeli, of Millardet, of Lord Penzance, of Engleheart, and many others. Nor need I do more than make a passing reference to the wonderful morphological results obtained by the successive crossings and inter-crossings of the tuberous begonias, changes so remarkable that a French botanist was even constrained to found a new genus, Lemoinea, so widely have they deviated from the typical begonias.

For scientific reasons, then, no less than for practical purposes, the study of cross-breeding is most important, and we welcome the opportunity that this conference affords of extending our knowledge of the life-history of plants, in full confidence that it will not only increase our stock of knowledge, but also enable us still further to apply it to the benefit of mankind.

¹ Lavallée, "Les Clematites à Grandes Fleurs," p. 6 and p. 9, tab. iv.: *Clematis hakonenensis*.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. A. C. HOUSTON has been appointed Lecturer in Bacteriology at Bedford College, London, for Women.

DR. W. WACE CARLIER, at present Lecturer on Experimental Physiology and Histology in the University of Edinburgh, has been appointed Professor of Physiology in Mason University College, Birmingham.

THE Royal Commissioners for the Exhibition of 1851 have approved the nomination by the University College of North Wales of Mr. Robert Duncombe Abell to a Science Research Scholarship of the value of 150*l.* a year. Mr. Abell is about to enter the University of Leipzig, where he proposes to engage in a special research under the direction of Prof. Wislicenus.

THE following appointments abroad may be noticed:—Dr. James Ewing to be professor of pathology in the Cornell University Medical College; Dr. Charles W. Wardner to be professor of physics in Williams College; Dr. H. G. Byers to be professor of chemistry in the State University of Washington; Dr. Alfred H. Seal to be professor of chemistry in Girard College, Philadelphia.

THE new buildings of the London Hospital Medical College were opened on Tuesday last. They occupy the site of the old chemical theatre and laboratory, and comprise the following rooms and departments. On the basement is the department of public health, containing a large museum, professors' room, class rooms, &c.; on the ground floor, the biological laboratory, class rooms, and the materia medica museum; on the first floor, the chemical theatre and laboratories, and the balance room; on the second floor, the physics laboratory, the chemical laboratory for the diploma in public health classes, the operative surgery room, and a large anatomy class room leading from the dissecting room. On the third floor is the bacteriological department, with general laboratory, research laboratories, class rooms for public health work, sterilising room, &c. Other portions of the building have thus been left for additional development, and advantage has been taken of this to provide special class rooms for students studying for the preliminary scientific, the intermediate M.B., London, and other examinations. Additions have also been made to the present physiological department, giving rooms for original research and for special class work for the higher examinations. For all these departments special teachers have already been appointed, who are devoting their entire time to the particular subjects that they have undertaken. The new buildings, with their fittings, will cost altogether not less than 10,000*l.*

SCIENTIFIC SERIAL.

Bollettino della Società Sismologica Italiana, vol. v. No. 1, 1899-1900.—The rules of the Society and list of Fellows (forty-three national and ten foreign) are given.—Determination of the epicentre and time at the origin of earthquakes of unknown origin propagated along the earth's surface by means of four or five time-observations, by G. Costanzi. Equations for the above purposes are obtained on the supposition that the surface-velocity is constant.—Vesuvian notices (July-December 1898), by G. Mercalli. A monthly chronicle, with notes on the paroxysm of September, the central crater, and the excentric eruptive apparatus; illustrated by reproductions of two photographs.—Notices of the earthquakes observed in Italy (January 1-February 3, 1898), by G. Agamennone, the most important being the Ferrara earthquake of January 16, a distant earthquake on January 25, and the Asia Minor earthquake of January 29.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 15.—"On the Application of Fourier's Double Integrals to Optical Problems." By Charles Godfrey, B.A.

The disturbance received at any point from a luminous body is a vector, varying with the time. It may be defined by its resolved parts along three rectangular axes; let $f(t)$ be one of these resolute. In general $f(t)$ will not be a periodic function,