that produced by air, being only about 6·6 volts, or about 3½ volts lower than when the hissing was caused by air alone.

In order to exclude all possibility of doubt as to the effect of the various gases, I repeated the experiments with the arc entirely enclosed in one of the fire-clay crucibles, so that the only gases that could reach the crater were those blown down the tubular positive carbon. The current was distinctly below the hissing point, being only 10 or 11 amperes, and the arc was from 2 mm. to 3 mm. long.

The results were exactly the same as with the open arc, except in the case of hydrogen. For air and oxygen produced hissing and a sudden diminution of the P.D., and nitrogen and carbon dioxide had no such effect, even when the current was very much increased. But whereas, as has been previously stated, hydrogen produced a distinct hissing of its own when blown down the positive carbon in the *open air*, it produced *none* when used in the same way with the arc *enclosed* in the crucible.

To prove that, in order to produce the sudden diminution of P.D under discussion, it was necessary for the active gas to actually *touch* the crater, a tubular *negative* carbon was used, and each gas was blown up through it in turn, gently enough not to force the gas directly against the crater.

In *no* case was there any sudden diminution of the P.D., whatever gas was employed, and whether the arc was open or enclosed. On the contrary, there was generally a small increase, probably due to the lengthening of the arc by its being blown on one side. If oxygen or air were blown *very hard* up the negative carbon, they would either produce hissing, or blow the arc out, or both; for in that case some of the gas got to the crater uncombined with the carbon vapour, and acted exactly as if it had been blown down the tubular positive carbon.

The case, then, stands thus:

(1) When the arc begins to hiss in the ordinary way, the P.D. between the carbons diminishes by about 10 volts.

(2) If the air is excluded from the arc, this diminution of the P.D. does not take place, even when the current is nearly three times as great as would cause hissing in the air.

(3) If, however, while the air is excluded, puffs of air are sent against the crater, the diminution of the P.D. *does* occur, even with currents much *smaller* than would cause hissing in the air.

(4) If, instead of air, *oxygen* is sent against the crater, the P.D. is diminished to exactly the same extent as when air is used.

(5) If, on the other hand, *nitrogen* is sent against the crater, *no* diminution of the P.D. is observable.

(6) If air or oxygen is gently blown through the *negative* carbon, so that it cannot get direct to the crater, *no* diminution of the P.D. follows.

Thus there can be no shadow of doubt that *the sudden diminution of P.D. that accompanies the hissing of the open arc is due to the oxygen in the air getting directly at the crater and combining with the carbon at its surface.*

It only remains to show how the actual hissing *sound* may be produced by the burning of the surface of the crater. The moment this burning begins, a cloud of gas, formed of the products of combustion, must spread over the crater, protecting it momentarily from the action of the air as effectually as the carbon vapour had hitherto done. When this gas is dispersed, the air will again come in contact with the crater, a fresh cloud will form, and the whole action will start *de novo*. Thus a series of rushes and stoppages of the air will take place, setting up an irregular vibration of just the kind to cause a hissing noise. Not only this, however, but since the crater must cease to burn each time that it is protected by the gas, the diminution of P.D. must also cease to exist, since its cause is removed, and the P.D. will therefore rise momentarily. Thus an oscillation of the P.D. between the carbons, and, consequently, of the *electric* current, must be created, corresponding with the oscillation of the *air* current.

These oscillations of both air and electric currents do actually exist with the hissing arc. The first I have proved by means of a fine asbestos fibre fastened at one end to the hole in the crucible (Fig 8) through which the positive carbon moved. The asbestos ring was raised, and the space between the carbon and the crucible was left clear, and was made large enough to allow the free end of the short fibre to stretch out horizontally between the two. When the arc was silent, the fibre scarcely moved, but the moment hissing started it set up a vigorous vibration, instead of being sucked into the crucible as it would have been if there had been a steady inward current of air.

Messrs. Frith and Rodgers (*Phil. Mag.*, 1896, p. 420) showed, in 1896, that the *electric* current was oscillatory with the hissing arc, and Messrs. Duddell and Marchant (*Journ. Inst. Elec. Engs.*, vol. xxviii. p. 84) in the account of their beautiful experiments with the oscillograph, have given actual curves of the P.D. and current with the direct current hissing arc, showing distinctly the oscillations in both.

Thus the direct contact of the oxygen of the air with the crater of the positive carbon is capable of producing, not only the diminution of the P.D. between the carbons of the arc, which is the most striking accompaniment of hissing, but also every other important manifestation connected with it, including the sound itself.

HERTHA AYRTON.

THE INTERNATIONAL CONFERENCE ON HYBRIDISATION AND CROSS-BREEDING.

IN this country where the application of biological principles to the industries which they underlie is left as a rule to private enterprise or the half-hearted interest of County Councils, any means whereby the scientific worker is shown to be useful to the practical man is a help towards a better state of things.

For this reason alone the Conference on Hybridisation suggested by Mr. W. Bateson, and held on July 11 and 12, under the auspices of the Royal Horticultural Society, may have more importance in the future than Prof. Henslow claimed for it in the present. The more immediate results that will accrue are those which the Society foresaw must arise if the attempt to call forth papers, remarks and exhibits dealing with hybridisation was at all successful. Two days were not many to devote to the meeting, and it is a matter of surprise that such an amount of work was done in the time. When, however, the whole of the contributions, whether read or unread at the conference, are published in the form of an illustrated report, the Royal Horticultural Society should be more than satisfied.

Nevertheless the question of hybridisation is so large, as Mr. Engleheart said in the discussion, that "whole sets of subjects" (graft hybrids, for instance) could not even be touched upon, and the suggestion made in several quarters, but by the American delegates in particular, that a supplementary conference be held in another country should be taken up seriously.

Before discussing the chief points of the meetings it may be of interest to give a list of the speakers and their subjects.

Tuesday, July 11, in the Society's Gardens at Chiswick:—

(1) Maxwell T. Masters, F.R.S., Introductory remarks as Chairman.

(2) W. Bateson, F.R.S., "Hybridisation and Cross breeding as a Method of Scientific Investigation."

(3) A. de la Devansaye, "Hybrid Anthuriums."

(4) Prof. Hugo de Vries, "Hybridisation as a means of Pangenetic Infection."

(5) The Rev. Prof. Henslow, "Hybridisation and its Failures."

(6) C. C. Hurst, "Experiments in Hybridisation and Cross-breeding."

Wednesday, July 12, at the Town Hall, Westminster.

(1) The Rev. Prof. Henslow, Introductory remarks as Chairman.

(2) Herbert J. Webber, "Work of the United States Department of Agriculture in Plant Hybridisation."

(3) Dr. J. H. Wilson, "The Structure of certain New Hybrids (*Passiflora*, *Albuca*, *Begonia*, &c.)"

(4) R. Allen, "Hybridisation viewed from the Standpoint of Systematic Botany."

(5) Henry de Vilmorin, "Hybrid Poppies."

(N.B.—Nos. 2 and 3 were illustrated by means of lantern slides, and No. 5 by large water-colour drawings.)

(6) Discussion; Prof. Henslow, Mr. Burbidge, Rev. G. H. Engleheart, Mr. George Paul, Mr. Bunyard, Dr. Masters, Mr. Willet Hays, and Mr. W. Cuthbertson.

The United States was represented by Mr. Herbert Webber, of the Department of Agriculture, his colleague Mr. Swingle, and Mr. Willet Hayes; France by MM. de la Devansaye

and Vilmorin; while among other "friends from across the sea" were hybridists from Germany, Holland and Switzerland.

With regard to the main body of our own countrymen who attended the conference, it must be said that horticulturists were very well represented, but that, with the exception of the readers of papers, biologists were few and far between.

Among papers of interest that were not read at the conference, but will appear in the report, the following may be mentioned:—

Prof. L. H. Bailey, "Progress of Hybridisation in the United States of America."
F. Morel, "Hybrids of *Clematis*."
P. Chappellier, "Essay on the Hybridisation of *Dioscorea*."
Émile Lemoine, "Hybrids of the Common and Laciniated Persian Lilacs."
L. Henry, "The Records of Hybridisation Experiments made at the Paris Natural History Museum between 1887 and 1899."
Charles T. Druery, "Fern Crossing and Hybridising."
Dr. Charles Stuart, "Hybrids of *Mimulus*, *Viola*, *Acquilegia*, &c."

During the first day's proceedings a fine show of hybrid plants and intergrafted genera was exhibited in the vinery at Chiswick.

Turning now to the material laid before the conference, it will be best to consider details under special headings.[1]

I. The Question of Species.

Significance of the Conception.—As the word hybrid ordinarily means the result of a cross between two species, it follows almost necessarily that the question of what a species is was several times raised. Prof. Henslow was so bold as to give a definition, saying that "it is known by a collection of presumably constant characters taken from any or all parts of the plant."

It is necessary to have some idea for working purposes, but Dr. Masters came rather nearer to the mark when he said that the species once considered sacred, to-day practically represented the personal opinion of some man who had paid special attention to it.

Mr. Bateson again still clung to the opinion that species were often definite, but breeding work alone, he said, could throw light upon the subject. He contended that this had already shown that under the title of species and varieties "whole sets of (physiologically) distinct phenomena are confused together," and taking it as proved that species arise from discontinuous variations, he gave three instances where the same deviation from type was kept up discontinuously, but in three different ways:—

(*a*) The hairy wild form of *Matthiola incana* from the Isle of Wight was crossed with the smooth wallflower variety of the stock.
The offspring fell into two groups, and from the same capsule came one hairy and three smooth plants.

(*b*) The usual hirsute type of *Lychnis vespertina* and the hairless form cultivated by Prof. Hugo de Vries were bred together.
The offspring were all hairy, but on being left to fertilise each other, the second generation gave some hairy, some smooth individuals.

(*c*) The variations of *Biscutella laevigata* which occur in Switzerland, one with hairs and the other without (connected by but few intermediate forms), were lastly joined together.
The offspring were glabrous or intermediate in character, but as they became adult the latter forms lost all their hairs.

The experiments quoted are some made by Miss E. R. Saunders, of Newnham College, Cambridge.

So-called Species sometimes Wild Hybrids.—The fact that a number of so-called species occurring in nature have been reproduced by the crossing of other wild species was considered by Mr. Rolfe as of interest to systematic botanists, who must now recognise wild hybrids and the work of hybridists.

So-called Species which are Garden Hybrids.—During the discussion Mr. Burbidge showed what great confusion had arisen through the giving of Latin names to garden hybrids of whose origin no record had been kept. Matters would not be improved, one would fancy, through the practice of some nurserymen whom Dr. Masters alluded to in his address, and who, in the earlier days of hybridisation, imagined a foreign locality for their own productions in order to overcome the prejudice then prevalent against hybrids. Mr. Burbidge's suggestion was to give no classical names to hybrids; but if perforce the habit must be continued, let such parts of the parents' names be conjoined as would indicate the origin of the new form. In his paper M. Lemoine traces the previously obscure origin of a lilac by hybridisation experiments; while M. Henry suggests that the conference should undertake similar work, and mentions a number of plants to begin with whose garden history requires elucidation.

II. The Limits of Hybridisation and Cross-breeding.

In general.—Mr. Hurst gave statistics showing that up to date twenty-seven genera of Orchideæ, several belonging to different tribes as arranged by the systematic botanists, had been connected together by hybridisation. In other families so much has not been accomplished, but the same speaker noted five species of *Rhododendron* and four of *Gladiolus* that had been linked together. He said that the breeder might reasonably expect to be successful within the limits of a tribe; while, on the other hand, it was urged during the conference that an experiment is easy, and it is better to make it than to argue its non-success instead.

Dr. Wilson, in speaking of his results, said that he had hybrids of *Albuca*, in whose bodies five, if not more, original species were combined.

It can easily be seen that differences in structure may prove insurmountable barriers to hybridisation, but constitutional differences may often be disregarded. For instance, to quote Mr. Hurst, annuals can be crossed with perennials [M. de Vilmorin's poppies], deciduous trees with evergreens [Mr. Herbert Webber's oranges], plants from the tropics with plants from within the Arctic circle.

Special Cases.—Prof. Henslow discussed the question of some allied species which unaccountably will not cross, and he smilingly pointed out how much trouble would be saved if only one could tell plants' capabilities in the way of hybridisation from their outside appearance. Sometimes, he said, species of the same genus from different climates and habitats formed no hybrids, while even within the limits of a single species the red "geraniums" (*Pelargonium*) of France would not cross with English races; and certain strains of *Primula sinensis*, also mentioned by Mr. Hurst, and raised by Messrs. Sutton and Sons, were not fertile *inter se*.

Non-reciprocity.—Though many reciprocal crosses were recorded in the course of the conference, many failures, it was pointed out by the last-mentioned speaker, are known, but no further light was thrown upon the matter.

III. Crossing a Matter of Conditions.

Some one alluded to the fact that, whereas it might be found impossible to effect a cross with the earlier produced flowers of an inflorescence, say, yet hybrids could be easily obtained from the blossoms that opened later. In connection with this, Dr. Wilson's hybrid *Passiflora* might be mentioned, where the first flowers to appear contained coronal rays, or else a second and miniature ovary within the walls of the usual one; but in the case of the flowers borne near the ends of branches the pistils were normal. The way in which it was again and again reported that a hybridising experiment had failed for one, two, three, up to seven years shows that successful crossing must depend in a great measure upon at present unknown conditions of nutrition, acclimatisation, temperature, or something else.

IV. Prepotency and the Character of Hybrids.

Non-prepotency of Sex.—Where a hybrid appears to take after one parent in the more obvious and striking parts of its organisation it may resemble the other in more hidden but not less important characters (Mr. Hurst and M. Mael). Again, when species A, on being crossed with species B, produces hybrids that are practically replicas of itself ("false hybrids" of Millardet), it does not follow that the prepotent species, A, must necessarily be male or necessarily female (Henslow). Furthermore, reciprocal hybrids may be identical.

[1] For a *seriatim* account of the papers, see the *Gardeners' Chronicle*, series 3, xxvi. Nos. 655 and 656 (July 15 and 22).

Partial Prepotency —This not very happy title is given by Mr. Hurst to a law which he puts forward as explaining, at least so far as the genus *Paphiopedilum* (= *Cypripedium*) goes, the varied results in the inheritance of characteristics. The law one takes to mean that in one part of an individual hybrid the mother, say, is seen to be prepotent; in another individual the same structure is inherited from the father; while in a third both parents are represented by an intermediate form of the special feature under consideration. We are then asked to imagine a real case where the combinations and permutations of all the component structures must be reckoned with. No doubt this brings the possibilities for variation very forcibly before us; but surely it is only giving another name to what must be expected whenever two parents representing two strains produce young. Although Prof. Ewart's zebra hybrids were mentioned by Mr. Hurst in another connection, yet little heed was given by any one to the possibilities of hybrid plants throwing back to ancestors in the dim past, as undoubtedly appears to be the case with animals.

Prepotency of Varieties, Species, and Genera.—Mr. Hurst's paper, which, indeed, was the only one that in any way systematically attacked the broad headings of hybridisation, contained much information deduced from the Orchideæ as to the inheritance by hybrids of the characters which are commonly valued as varietal, specific and generic. As might be imagined, the generic are most difficult to efface; the specific again are less lasting but more persistent than varietal, which are fleeting. Mr. Hurst had, however, to allow that distinct variations may transmit their qualities, and it would be difficult for him to do otherwise in the face of Mr. Bateson's examples; he gave exceptions, which he said are by no means rare—these come in when the variations are slight or the ancestry variable, and an abnormality he found to be transmitted either wholly or not at all. The case given by Prof. Hugo de Vries of the twisted variety of teasel (*Dipsacus sylvestris*) when crossed with *Dipsacus fullonum* being prepotent as regards the abnormality, exemplifies the former of these two alternatives. Prof. de Vries, it should be called to mind, explains it as a case of pangenetic infection. Finally, Mr. Hurst said that when the same variations are found in both strains, they may be traced in the second or following generations, but seldom otherwise. Prof. Vries' second experiment is at first opposed to this; but the latter stage confirms it. He desired to obtain artificially a hairless variety of *Lychnis diurna*, similar to one found in nature, and known as *L. presli*. To do this he crossed the ordinary hirsute variety with his glabrous form of *L. vespertina* already mentioned, and the hybrids were all uniformly hairy. The offspring of these again showed the characters of one or both parents in all degrees. Taking two glabrous examples and crossing them, a constant variety of *L. diurna* without hairs was forthwith obtained, starting with a batch of 390 plants, all glabrous.

Parthenogenesis and Polyembryony.—Prof. Henslow, among the many interesting details which he contributed, mentioned how pollen tubes are sent out even when the pollen of a pea is placed upon the stigma of a lily, and how on more nearly allied forms, although no fertilisation may take place, yet the irritation is enough to cause the empty ovary to swell and appear to contain seeds in a way comparable to the formation of galls (partial hybridisation). To explain cases where in crossing a species of one Orchid genus with others, *e.g. Epidendrum* with *Cattleya*, *Laelia* and *Sophronites*, the first was completely prepotent, Mr. Hurst advanced the theory that the occurrence was due to a kind of parthenogenesis, the pollen encouraging the egg-cells to develop into seeds without absolutely having the power to fertilise them.

A difficulty met with in the raising of hybrid races of oranges, which Mr. Webber described, is due to the fact that in the genus *Citrus*, adventitious embryos arise from the cells of the nucellus outside the embryo sac containing the normal egg. The result is that the latter only is affected by pollen, and from the seed arise several seedlings as shown in lantern pictures, only one of which can be the hybrid, the others reproducing the mother plant exactly.

Vigour.—The exceptional growth of hybrid plants being a well-known phenomenon was referred to again and again, and was put down by Mr. Hurst to the effect of out-crossing, as in-breeding he found in his experiments reduced the vigour at once.

Diminution of Fertility.—Dr. Wilson's results point to this being due to the poor development of pollen, and the lessened fertility of the male was shown by Mr. Hurst's statistics for *Paphiopedilum*. Of crosses in this genus between pure species 95·05 were successful; hybrids fertilised with pollen from pure species produced seeds in 91·82 per cent. of the cases; while pure species were only fertilised by the pollen from hybrids in 60 per cent. of the experiments. The case of male elephants being usually sterile in captivity seems worthy of mention in this connection. Mr. Hurst's generalisation that diminution of fertility is due to conditions of life rather than to any difference in the form or constitution of hybrids gains support, which is added to by the evidence given above under the headings II. (*Special cases*) and III.

Microscopic Structure.—Allusion was made to Dr. Macfarlane's work on the structure of primary hybrids, but what little was said about the microscopic conformation of secondary hybrids in *Albuca* (Dr. Wilson), and in *Rhododendron* (Prof. Henslow in the discussion), points to their possessing no internal characters of the importance of specific ones.

Hybrid Races.—That secondary hybrids differ more than primary ones from the parent species was the opinion of M. de la Devansaye and Mr. Hurst, and the latter speaker gave a series of figures showing the stability of the former kind; for out of 500 seedlings of a hybrid *Berberis*, 90 per cent. reproduced the immediate parent form, while in no instance was there complete reversion to either of the grandparent species. It is possible that many of our so-called wild species are stable hybrid races.

V. The Economic Side of Hybridisation.

Mr. Webber, in his remarks, and Prof. Bailey, in his paper, both told the same tale with regard to the United States. The bulk of the hybridisation on the other side of the Atlantic is carried on with a view to producing plants that will stand the particularly disadvantageous conditions of frost and drought, and so on, that occur in the wide tracts of land that must be cultivated, or to improving the yield or quality of special vegetable productions upon which many persons depend for their living. Ornamental hybrids are bought for the most part in Europe. The Government does a great part of the work of production, and the experiment stations carry out the work of testing new varieties, be they privately raised or otherwise, which at the same time allows the growers to see the value of the plants before they are distributed. Mr. Hays, in the discussion with regard to the little benefit accruing in this country to the raiser of a new plant, pointed out the opportunity given in America by the system just described for the said plant to be taken up. The Rev. G. H. Engleheart, as an amateur, and Mr. George Paul, as a nurseryman, talked of legislation whereby some sort of copyright should be established in new varieties. Mr. Bunyard pointed out objections, and showed how a man might raise sufficient stock before parting with any to ensure a profit he had calculated beforehand. This presupposes a fairly large sale, and might not be possible to the grower in a small way of business. Mr. Engleheart also alluded to there being no book in which the scattered facts so useful to the hybridist had been brought together.

Perhaps the time will come when there may be State authorities in this country to consider the scientific side of horticulture (as well as entomology and fisheries) in a modern way. At present the annual examination of the Royal Horticultural Society, upon the results of which certificates are granted, includes a theoretical test not only on the practical but on the scientific side. This certificate is the only recognised one which the gardener can obtain, and its value would be much enhanced if the examination were accompanied, or say followed, in the case of candidates who obtain a sufficient number of marks, by a practical examination in both branches of the subject.

WILFRED MARK WEBB.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. W. A. HOUSTON, has been appointed to the post of assistant lecturer in mathematics in University College, Liverpool.

THE Agriculture and Technical Instruction (Ireland) Bill was read a third time in the House of Commons on Monday, and a first time in the House of Lords on Tuesday.

THE *University College School Magazine* announces that Mr. R. Tucker, who has guided the mathematical fortunes of the