ber of meteors must fall on the equatorial than on the polar regions of the sun, making the former the hottest. The meteoric theory will also account for the currents in the sun's atmosphere observed by Mr Carrington. He finds that the spots in the lowest latitudes drift most rapidly from W. to E. Were the sun's atmosphere, like the earth's, acted on by no other motive-power than the unequal heating at different latitudes, the relative direction of the currents would be the reverse of this, in virtue of the well-known principles of the trade-winds and "counter-trades," and this would be true at all depths in the sun's atmosphere. But if meteors are constantly falling into the sun's atmosphere, moving from west to east with a velocity scarcely less than that of a planet at the sun's surface, and in greatest number in its equatorial regions, there is a motive power which is adequate to drive its atmosphere round it from west to east, and with greatest velocity at the equator. The intensely bright meteor-like bodies, which Mr Carrington and another observer simultaneously saw traverse the sun's disc, moved from west to east, and they were almost certainly asteroids falling into the sun."

Remarks on the Sexuality of the Higher Cryptogams, with a Notice of a Hybrid Selaginella. By John Scott, Royal Botanic Garden, Edinburgh.*

Modern researches, on the reproductive phenomena of Cryptogams, have induced a number of botanists to accept the doctrine of their sexuality, this function being attributed to the organs known as the Antheridia and Pistillidia. Amongst those botanists who deny the sexual hypothesis, as applied to Cryptogams, a difference of opinion exists; one class attributing a sexual function to the above organs as occurring in the genera Pilularia, Marsilea, Salvinia, and Isoetes, but strangely arguing, that such an import cannot possibly be attributed to these organs in the other orders; while another class,—with a more consistent scepticism,—

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refuse to attribute a sexual import to these organs in any order of the class, and regard all as strictly agamic.

It would be mere surplusage, on my part, to give to the Society even the briefest *resumé* of the nature of the evidence on which the sexuality of Cryptogams is based, inasmuch as the writings of Henfrey, Berkeley, Suminski, Hofmeister, &c., have rendered it sufficiently familiar to all, and must satisfy all who have accepted the doctrine that nothing short of hybrids, artificially produced between distinct species of Cryptogams, will induce a universal acceptance of the hypothesis of sexuality as applied to these plants.

Several supposed instances of hybridity have been recorded by authors, but these not being results of direct experimentation, do not by any means place the question beyond the reach of doubt. For example, Hofmeister, in his work "On the Higher Cryptogams," p. 181, states that Bayrhoffer "suggested certain mosses, found by him growing wild, were hybrids between *Gymnostomum pyriforme* and *G. fasciculare* on the one side, and *Funaria hygrometrica* on the other side." Hofmeister, however, remarks that he "has not yet succeeded in producing such hybrids experimentally, although he brought together antheridial plants of *Gymnostomum pyriforme* and plants of *Funaria hygrometrica*, with their antheridial shoots cut off. The mutilated plants of *F. hygrometrica* always perished."

In the case of ferns, it has been asserted that true hybrids exist in the genus Gymnogramma. Braun, in his "Plantarum novarum et minus cognitarum adumbrationes," notices several supposed hybrids belonging to the above genus which have appeared in gardens; and similar notices have from time to time appeared in the "Gardeners' Chronicle." That now well known segregative individualising power of the fern-spore—if I may term that subordination of the specific formative tendencies in that organ to those casual variations of the segments or pinnæ upon which it originates—ought to make us extremely cautious in ascribing a hybrid origin to any forms that may appear amongst these plants. Furthermore, the hermaphrodite nature of the prothalli, and the juxtaposition of the antheridial and archegonial cells,

render the occurrence of hybrids, in the *true* ferns, much less probable, I believe, than in any other order of Cryptogams. The Botrychiums and Ophioglossums, as shown by Hofmeister and Mettenius, afford much higher facilities for successful casual hybridization than occurs in the true ferns. Inasmuch as in the former the antheridial and archegonial cells occur on opposite sides of the prothalli, so that an equal, or even higher facility, is thus afforded for the con junction of distinct individuals than the pure hermaphrodite conjunctions. In the latter—or true ferns—on the other hand, where the antheridial and archegonial cells are produced upon the same side of the prothallus, and this being the under, an examination of the individual relations of the prothalli in a single pot will, I think, suffice to show that the crossing of distinct individuals must here be a most exceptional occurrence ; unless, indeed—as so generally occurs in the higher plants—nature has provided certain external agents.

In the Selaginellas, the only genus of the Lycopodiaceæ whose reproductive phenomena are known,* the greatest possible facilities are afforded for hybridization by the unisexual characteristics of their spores, and their production in distinct organs ; one kind of spore—microspore—producing spermatozoa; the other—macrospore—producing the archegonial cells. From these relations of the reproductive organs, it might be supposed that hybrids would be easily raised experimentally between different species. The only points to be studied being a slight regard to systematic affinities, and the relative time required for the development of the

* Hofmeister has the following remarks on the above point :—" The reproduction of those Lycopodiaceæ which bear powdery spores of one kind only, is still a mystery. Repeated sowings of the spores of *Lycopodium clavatum*, *inundatum*, and *Selago*, have yielded me no results ; but I have lately often observed, that in spores of *Lycopodium Selago*, which had been sown for from three to five months, numerous small spherical cells had been formed, similar to the mother-cells of the spermatozoa of *Selaginella helvetica*. I have not yet found spermatozoa inside these vesicles. De Bary has lately discovered that the spores of *Lycopodium inundatum* produce a body composed of a few cells, whose structure is not unlike that of the archegonium of a fern. It is probable, from these observations, that the similarly formed spores of Lycopodium, Psilotum, &c., are of different sexes, and, as in *Equisetum arvense*, produce partly *archegonia* and partly *spermatozoa*."—" On the Higher Cryptogams," p. 398.

spermatozoa and archegonial cells.* I have found, however, that this is far from being the case; for, after numerous experiments, the subject of the following remarks is the only one to which I can with certainty assign a cross origin. The history of this plant may be thus briefly told:—I placed *thirty macrospores* of *Selaginella Danielsiana* on the surface of a pot of moist sand; over these I strewed thickly the *microspores* of *Selaginella Martensii*, and then closely covered all with a small bell-glass. In case of differences in the time required for the perfect development of the male and female organs of the respective species, for some time after the first sowing, I frequently added fresh microspores of the latter species, *S. Martensii*. Ultimately *one* of the macrospores produced a *germ-plant, all the others proving abortive.* The gradual development of this germ-plant I have watched with interest, and I have now the pleasure, through the kindness of Mr M'Nab, of placing it and its parent forms upon the table for the examination of this Society.

Previous to my noticing the individual and relative characteristics of hybrid and parents, there are one or two other points on which I beg to make a few remarks, by way of obviating certain objections which may be advanced against the hybrid nature of my seedling; they are as follows:—A. Braun ("Plantarum novarum et minus cognitarum adumbrationes," 1857, Appendix, p. 16) considers that *Selaginella Martensii* and *S. Danielsiana* are conspecific; and taking the former for the normal or typical form of the species, calls it *S. Martensii normale;* the latter *S. M. compacta.* Three other forms, considered by some as distinct species, have also been referred by Braun to *S. Martensii* under the following names:—*S. M. flaccida*, *divaricata*, and *congesta.*

* A single illustration will show the necessity for attending to the period required for the development of the spermatozoa and archegonia in the species tried. Thus, in the closely allied *Selaginella denticulata* and *S. helvetica*, the spermatozoa and archegonial cells are developed in the former species about six weeks after sowing; whereas, in the latter species, according to Hofmeister, the *microspores* lie *five months*, and the *macrospores* between *six and seven months*, before they produce their respective spermatozoa and archegonia. We thus see that here, as elsewhere, in the vegetable kingdom, other points than recognised systematic affinities must be attended to in hybridizing.

Mr Moore informs me by letter that he is inclined to agree with Braun in uniting under *S. Martensii* the forms he has so placed; and furthermore, considers that the seedling form which I have raised goes to confirm this view, by showing that varying forms are capable of being produced from the spores; that, in fact, so far as he could judge from the pressed specimen (which I sent him for examination), I had merely produced *S. M. normale* from the *S. M. compacta.* Mr Moore continues, however, that in plants so peculiar as these Lycopods, a good deal of their natural appearance is lost under pressure. In the present instance, the Society will observe, by a comparison of the hybrid and parent plants with the pressed specimens upon the table, the truth of Mr Moore's remarks, as respects the affinities in judging from the dried specimens alone, and, moreover, the need for that express reservation added to the above view, inasmuch as it is at once obvious by a comparison of the living plants, that though nearer *S. Martensii* in the characters of the leaves, it—the hybrid—has much more affinity with *S. Danielsiana* in its general habit.

In consequence, then, of this view of Braun and Moore, respecting the conspecificness of the parent forms, I can only give a provisional significance to the hybridity of my seedling; satisfied, however, that even by an ultimate agreement amongst systematists as to the genetic affinities of the parent forms, it will simply cause a substitution of the term "mongrel," for that of "hybrid," at present given. And thus, that in either case, it will afford a stronger argument in support of the sexuality of the higher cryptogams than any, so far as I am aware, which has yet been recorded.*

On the supposition, however, that Braun has rightly regarded the parent forms of my seedling as conspecific, it may

* Mr Moore, in answer to a query as to the occurrence of undoubted hybrids amongst the above plants, writes me as follows:—"I am not aware of any well authenticated instances of hybridization among Cryptogams. I have always regarded the varieties of Gymnogrammas (which do sometimes present an appearance intermediate between two known sorts) as sports—chiefly, however, from the want of any direct evidence of hybridity."

be argued that as the *S. Danielsiana—S. M. compacta*—is the more incipient form of the two experimented upon, it may yet have a *tendency* to produce, by a *truly parthenogenetic process*, a varying offspring from its spores. To this I can answer only as follows, but the answer, I think is satisfactory. *First*, When the *macrospores* of the *S. Danielsiana* and *S. Martensii* are sown *alone*, *neither*—and I speak from an extensive series of experiments—*will produce a* SINGLE *plant;* clearly demonstrating, as I think, a sexual reproduction dependent on the mutual action of both kinds of spores. That consequently *parthenogenesis*, in so far as my experience goes, *does not occur in either of these forms;* nor indeed *in any of the species of Selaginella which I have tried, if sufficient care be taken to exclude the microspores.* Again, *secondly*, When the *microspores* and *macrospores* of the *S. Danielsiana* and *Martensii* are each purely commixed and respectively sown in distinct pots, they reproduce themselves perfectly, as I have in several instances proved by experiments. That the Society may be enabled to judge as to the truth of this statement, I have placed upon the table seedling plants of both forms, all of which betray at once their respective parents. Conjoining, then, the latter with the foregoing evidence, *i.e.*, the non-development of the macrospores when sown alone, and the facility with which both forms reproduce themselves when *the two kinds of spores* are mixed; and comparing them with the previously given history of the presumed hybrid, we are thus, as I am inclined to think, afforded, *firstly*, most conclusive evidence of the existence of true sexual organs in these plants; and, *secondly*, indubitable proofs of the mixed origin of the seedling plant.

Let us now see in how far this view of the mixed origin of the seedling plant is supported by an individual and comparative examination of the morphological characteristics of the latter and its parent forms. First, for the individual characteristics:—

1. *Selaginella Martensii.—Spike* sessile, linear, somewhat attenuated, from 8 to 10 millimetres long. *Bracteas* ovate, acuminate, denticulate. *Microsporangia* ovate, subtruncate, tumid, $\frac{3}{4}$ of a millimetre. *Microspores* reddish-orange, $\frac{1}{30}$ of a millimetre, somewhat wrinkled and granulated.

Macrospores, greyish-white, $\frac{1}{3}$ of a millimetre, reticulated. *Stem* ascending, flexuose at the extremity, branches spreading. *Leaves* oblong-ovate, oblique, falcate, somewhat blunt, 3 to 4 millimetres long; anterior base sub-dilated, margin ciliated, posterior base rounded, margin denticulated. *Stipuliform leaves* oblong or oblong-ovate, acuminate, denticulate, carinate, recurved, 2 millimetres long; exterior base auricled, and bordered with a few long hairs; interior rounded, and nearly entire.

2. *Selaginella Danielsiana.—Spike* sessile, short and thick, 6 to 7 millimetres long. *Bracteas* ovate, acute, denticulate. *Microsporangia* oblong, tumid, $\frac{3}{4}$ of a millimetre. *Microspores* brownish-grey, wrinkled and granulated as in *S. Martensii*, $\frac{1}{2\frac{1}{5}}$ of a millimetre. *Macrospores* white $\frac{2}{5}$ of a millimetre, reticulated. *Stem* ascending, branches short, rigid, erect, sub-fastigiate. *Leaves* ovately-oblong, 4 to 5 millimetres long; anterior base dilated, and sparingly fringed with long hairs; posterior base sub-truncate, margin entire. *Stipuliform leaves* ovate, acuminated, carinate, recurved, 3 millimetres long; exterior base auriculate, margin sparingly ciliated; interior base rounded, margin entire.

3. *Selaginella Danielsiana-Martensii.—Spike* sessile, short and thick, 3 to 4 millimetres long. *Bracteas* ovate-triangular, shortly mucronate, denticulate. *Microsporangia* ovate-oblong, half a millimetre long, tumid. *Microspores* brownish-grey, finely granulated, *size very variable*, from the 38th to 30th of a millimetre; *a high percentage apparently imperfectly developed*. *Macrospores* white, $\frac{1}{4}$ of a millimetre, obscurely reticulated. *Stem* ascending, branches numerous, short, rigid, erect, and sub-fastigiate. *Leaves* oblong-ovate, bluntish, slightly oblique, 2 to 3 millimetres long; posterior margin denticulated; anterior margin entire. *Stipuliform leaves* lanceolate-ovate, shortly mucronate, carinate, 1 to 2 millimetres long.

Again, *secondly*, by a relative comparison of the hybrid and parent forms, we have something like the following results:—*First*, in the short, erect, rigid, and somewhat fastigiate branches (destitute of any principal or leading shoots) of the hybrid plant we have a marked characteristic of the female parent, the *S. Danielsiana*. As in the latter species, the right and left forks of the terminal bud are in

general imbued with an equal degree of the vegetative force, so that both forks being developed alike, the plants thereby assume a dwarf, compact, bushy habit. In the male parent—*S. Martensii*—on the other hand, the right and left forks of the terminal bud are alternately more vigorously developed, so as to give rise to an apparently principal axis, or leading shoot, with a right and left series of branches, and a lax, somewhat spreading habit to the plants. *Secondly*, In the form of the leaves, and their somewhat lax rachidal disposition, the hybrid exhibits more affinity with the male than the female parent, the only difference being a decreased size. In the denser cellular structure of these organs, however, and likewise in the deep lustrous green, with the brownish-tinted stems, the hybrid again approaches the female parent. In the form of the stipuliform leaves and bracteas, it differs from either parent, and here approaches another of the forms which Braun has referred to the *S. Martensii*, viz., *S. M. congesta*. *Thirdly*, In respect to the characteristics of the organs of fructification, there is a great similarity in the three forms, those of the hybrid being the smallest. There is one point, however, in connection with them, worthy of a passing notice, namely, the relatively great variability in the sizes of the microspores of the hybrid—a high percentage of which are badly developed—as compared with those of the parents; while the macrospores, though smaller than those of the latter, present in general very trifling relative differences, and so far as I can judge, until I have time to test their germinative capabilities, perfectly developed. We have here a curious and interesting—real or apparent—analogy, with that which occurs in the phenomena of sterilisation in the hybridisation of the higher plants. Hybridists have shown, that in the latter class of plants, the pollen is more susceptible to the sterilising action than the ovules, and that in general, perhaps invariably, as has been maintained, we find that if the anther-cases contain a few grains of perfectly developed pollen, the ovaries also will contain a higher percentage of ovules capable of fertilisation.*

* I believe an exception, of which I will satisfy myself at the approaching

On the Chemical and Natural History of Lupuline. By M. J. Personne. Translated by George Lawson, LL.D.,* Professor of Chemistry in Dalhousie College, Halifax, Nova Scotia. (Plate II.)

Note by Translator.—Considering the great importance of the hop in an economical point of view, we might expect our scientific and manufacturing works to contain a somewhat satisfactory statement of the chemical products of the hop, and of the nature and development of the remarkable organ by which these products are secreted. This, however, is far from being the case; and intelligent brewers in Canada, puzzled by the contradictory statements that have been put forth, have frequently applied to me for information on this as on other scientific points connected with their art. I have therefore thought that a translation of M. Personne's Memoir, published some years ago in the "Annales des Sciences Naturelles," might not be without its use. In some of its bearings, the subject is of much interest in a strictly scientific point of view. It is obvious, likewise, that an acquaintance with the chemical properties of Lupuline is important, not only to the brewer, but to the hop-grower, the exporter, the manufacturer of hop-extract, and, indeed, to every one who has to handle an article so prone to change its character, and, consequently, its commercial value, from apparently trifling causes. The Canadian brewers having a favourable grain-market, and an unlimited supply of excellent water in the great lakes, almost entirely devoid of organic matter, have the means of manufacturing excellent beer. But much of the hops used requires to be imported from England. Canadian hops are grown to some slight extent at Kingston, more abundantly about Picton, and Belleville, C. W., and especially farther to the westward; but the best qualities of hops are always imported. The Canadian hop gives greater

flowering period, to the above law, occurs in the bigeneric hybrid of the *Rhododendron Chamæcistus*, and the *Menziesia empetrifolia*—the *Bryanthus erectus* (Graham), inasmuch as I have found apparently well-developed pollen grains in the anther-cases, yet I have repeatedly failed in fertilising this plant with its own pollen, or that of either parent.

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