Ophioglossum simplex, Ridley.

BY

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With Plate XV.

IN May, 1900, I received from Professor Groom, to whom my grateful thanks are due, a specimen of a plant which had been collected in Sumatra, in 1897, by Mr. Ridley; his description of it is as follows:—

‘A NEW SPECIES OF *Ophioglossum*.

‘The very remarkable little species of *Ophioglossum* I am about to describe was found by me in a dense wet forest on the banks of the Kelantan River, near Siak, in Sumatra, in December, 1897. I was only able to find three plants, for it is very inconspicuous, and as I was still far from camp, and it was very late when I perceived the plants, there was not sufficient time to search thoroughly the locality, which is one by no means easy of access. I would describe it as follows:—

‘*Ophioglossum simplex*, n. sp.¹ Terrestrial, rhizome short, and tuberous, with few roots. Fertile fronds solitary, or two together, slender flattened, with a blunt apex, 4 to 6 inches long, $\frac{1}{8}$ th inch wide, dark green, sterile division represented by a very small lateral process, or quite absent. Fertile portion about an inch long.

‘*Hab.*—Dense wet forests on the Kelantan River, Siak, Eastern Sumatra.

‘The affinity of this curious plant is with *O. Bergiana*, Schlecht, of South Africa, and with *O. pendulum*, L., an epiphytic plant common in Eastern Asia. The almost complete suppression of any trace of a sterile portion of the frond, and the consequent reduction of the plant to the very simplest elements, is the most peculiar feature in this species. Its habitat is very peculiar for the genus, for though there are two indigenous species of terrestrial *Ophioglossum*, viz. *O. nudicaule* and *O. reticulatum*, to be found

¹ This name has already been used by Rumphius in 1750 (Herb. Amb. vi, p. 152, Tab. 68, Fig. 1), but the plant so described falls under *O. pedunculatum* (Prantl, Beiträge z. Syst. d. Ophioglosseen, p. 329).

here, besides the epiphytic *O. pendulum*, L., none of these are forest plants, occurring only in open grassy spots ; while even the epiphytic one inhabits open woods, or grows on trees where there is plenty of light.'

Professor Groom examined the plant himself, and found its characters, so far as observed, to be those of *Ophioglossum* ; he then kindly forwarded it to me for further analysis. The description now given is based on only the one specimen ; two others were collected by Mr. Ridley, but they are said to be incomplete, and are at Singapore. The whole description must therefore be considered as provisional, and open to amendment when fresh material is available.

The specimen sent by Mr. Ridley was figured by Professor Groom in its unaltered state ; his drawing is shown in Fig. 1. The plant consists of a short stock, bearing three appendages of different ages. The largest is almost mature, and shows a structure like a fertile spike of *Ophioglossum*, with the lateral rows of sporangia almost mature. The second is similar in outline, but the sporangia are so young as to be barely perceptible ; still there can be no doubt that it is also of the nature of a fertile spike. The third is a small conical body of oblique position, and forced out of shape by the pressing. A careful external examination of the two largest appendages discloses no part which could be compared with the sterile lobe, or lamina of a subtending sporophyll, of other *Ophioglossaceae*. The leaf-stalks were examined throughout their length for scars or other traces of the insertion of a sterile lobe, but none was found. It is true there were scars of a reddish and rough appearance at various points on the stalks, but they are very irregular in form and position, and are not to be taken as scars of insertion of a withered sterile lobe, notwithstanding that one of them is near the base of the oldest leaf.

This is clearly seen in Fig. 2, which shows the base of the plant on a larger scale ; it would seem probable from the small size of the stock, its form, and from the entire absence of roots (with the exception of the small conical body which will be shown below to be a root) that the underground parts had been partially broken away in removing the plant from the soil. This was shown in the sections subsequently cut from the stock ; the insertions of roots which had been broken away while still actively functional were found. After the specimen had been soaked out in water, the stalks became sufficiently transparent for the vascular strands to be visible ; and it is clear that the course of the strands does not countenance the idea that the large scar above noted is of the nature of the insertion of a sterile lamina with a vascular supply. Moreover, scars of similar apparent texture, but of different outline, are found most irregularly scattered on the leaf-stalks, and are probably due to some pathological state. The fact that the scars do not correspond in position on the several leaves shows also that they are not constant morphological features. Thus

the external observation of the mature parts of the specimen affords no evidence of any sterile lobe or lamina, as in the known Ophioglossaceae. Mr. Ridley speaks of the 'almost complete suppression of any trace of a sterile portion of the frond'; I find in the specimen sent to me no need for the qualifying word 'almost.'

The small appendage at the base of the plant was removed with care, soaked out, and examined. It appears to have been compressed in drying, and after soaking the form is not recovered. As far as form is concerned there is nothing distinctive, while its oblique position on the specimen as received would allow of its being either a root or a young leaf displaced in the pressing. To decide the point, the whole appendage was removed and embedded; sections then showed that it is a root, and the following structural points were observed.

The stele appears to be of the usual type; it is diarch, and the xylems may remain separated by parenchyma-cells, which occupy the centre. The phloem forms an arc on either side, while even in these sections, which only partially recover from the pressing and drying, an endodermis can sometimes be traced. Outside this is a broad zone of cortical parenchyma, rather thin-walled; this merges into a peripheral band which contains the 'grumous' masses characteristic of mycorrhiza: notwithstanding the only partial recovery of the section from drying, there is no room for doubt that the root has been mycorrhizal, evidences of the presence of the fungus being seen in some four or five layers of the outer cortex. The periphery of the root is occupied by a layer of cells with their outer walls much thickened; the thickening sometimes extends to the inner walls as well: this layer appears to be of the nature of an exodermis, for at some points remains of an outer layer are still to be seen.

Comparison with *O. pendulum* shows that the details thus described correspond in the main to those there seen: the stele may, it is true, have more than two protoxylem groups in *O. pendulum*, but that character is known to be variable in that species. The characters of the cortex are very closely matched, including the mycorrhizal band and the layer (probably exodermis) with the thickened outer wall. These details serve to strengthen the comparison of our plant with *O. pendulum*¹.

Since the external form of the mature appendages gives no indication of the existence of a sterile lamina, it will be well at this point to consider what views are open to us as to their nature in this remarkable plant. Two alternatives are possible, (1) that the appendages are spikes pure and simple, without any structural evidence of the subtending lamina

¹ Compare Atkinson, Bull. Iowa Bot. Club, xx, 1893, p. 356, on Symbiosis in the roots of the Ophioglossaceae: also Janse, Ann. Jard. Bot. de Buitenzorg, xiv, p. 65, Pl. IX, Figs. 11, 12. I have not however in either species noted the infection as local; it appeared to me to extend all round the cortex.

having figured in their past history, or (2) that they are leaves of the ordinary Ophioglossaceous type, in which the sterile lamina has become entirely abortive; in the latter case the whole appendage would be of a composite nature, the upper part being the spike, the lower part being of the nature of a leaf-stalk. A decision can best be approached on an anatomical basis, for there is between the sterile leaf and the fertile spike the general difference of orientation of the vascular strands: the xylem in the former being on the adaxial side, in the latter it is inverted, and facing the abaxial side.

The following notes on the distribution of the vascular strands in the leaves of certain species of *Ophioglossum* may be of use, as a basis for comparison.

In *O. Bergianum*, Schlecht, the leaf-trace originates, as in all the Ophioglossaceae hitherto examined on that point, as a single strand; in most species this single strand branches early, but in *O. Bergianum* it remains at first unbranched. The vascular supply for the fertile spike comes off as two lateral bundles from the margins of the leaf-trace; these fuse together to form the single bundle of the base of the fertile spike. This single strand may branch as it passes upwards, so that the transverse section of the fertile spike may show two, three, or even four strands, but they are always orientated with the xylem directed to the abaxial side. In the upper region there is only one strand, which passes through the rows of sporangia to the extreme tip¹. The branchings in the sterile leaf are few and irregular, but the number of strands commonly seen is three, with the xylems on the adaxial side. This is the simplest species of the genus structurally, but the leading features are the same in the more complex. A slightly increased complexity is seen in *O. lusitanicum*, where the vascular supply of the sterile leaf branches into three, and the supply from the spike comes off from the lateral strands (Prantl, loc. cit. Pl. VII, Fig. 1).

In *O. vulgatum* the origin of the vascular supply of the spike is here again as two lateral strands, one from either marginal bundle of the sterile leaf². These strands branch again as they pass upwards, and five strands usually appear in the transverse section, an arrangement which may be very nearly matched by some sections near the base of the leaf-stalk; but the distinction is always easily drawn by their inverted position: the xylem of the fertile spike being on the abaxial side. In *O. reticulatum*, L., the arrangement is similar to that in *O. vulgatum*, as regards the fertile spike, and it is probably the type general for the ordinary ground-growing species.

The similarity of *O. simplex* to *O. pendulum* in certain external points,

¹ See Prantl, Beitr. z. Syst. d. Ophioglosseae, Jahr. d. k. bot. Gart. Berlin, iii, p. 297. Also Bower, Studies in the Morphology of Spore-producing Members. II. Ophioglossaceae, p. 68.

² See Prantl, l. c., Taf. vii, Fig. 2.

and in the structure of the root, suggested a fresh examination of the vascular supply to the leaf and spike in that species. Prantl¹ in his diagnosis of the three sections of the genus gives for § *Euophioglossum*, 'petioli fasciculi basi tres': this section includes the bulk of the species of the genus. For § *Ophioderma* (including *O. pendulum*), and § *Cheiroglossa* (including *O. palmatum*), 'petioli fasciculi numerosi.' It is true that there are three bundles at the base of the leaf-stalk in *Euophioglossum*, but on entering the axis they fuse to one, before insertion on the main system². Hitherto this insertion as a solitary strand has been found uniform in the Ophioglossaceae examined: but in *O. pendulum* it is not so, as the following description of a definite example will show; but it is possible that in a species which varies so greatly in size, the vascular complexity may vary also. The leaves in this species differ in vascular supply according as they bear spikes or are sterile. In the latter case the transverse section of the leaf-base in the specimen examined shows an open arc of some seven bundles (Fig. 3), which are reduced by fusion to five; these remain as distinct strands, till they insert themselves individually upon the system of the axis (Figs. 6 to 13, leaf to the left). In the case of leaves which bear spikes, the transverse section of the leaf-base shows a complete ring of bundles with their xylems facing inwards (Fig. 4); fusions on the adaxial side show that the distinction of the two margins near the base is not always maintained. As the base of the leaf is approached this foliar ring opens on the adaxial side—with or without some previous fusions on that side (compare Figs. 6 to 13). The strands which are reduced in number by further irregular fusions are then inserted *individually* upon the system of the axis. This, which is at times in form of an almost complete ring (Figs. 6, 7, 8), opens to receive the foliar strands upon the margin of the gap.

This vascular system is in itself not very uniform in detail, and differs from that of other Ophioglossaceae in the leaf-trace not being united at the base to a single strand.

In the sterile leaf the strands pass upwards from the system of the axis as a single curved series (Figs. 2-17, leaf *a*), showing occasional reticulations: the series is open on the adaxial face. As the strands enter the flattened region of the lamina the curve is flattened out also, with the xylems directed upwards. In the leaves which bear spikes the strands on passing from the system of the axis form a circular series, closed on the adaxial face (Fig. 4): irregular branchings and fusions are often seen between the bundles at the opposite margins of the curve, so that those strands which occupy the adaxial side are connected indifferently with both

¹ Beitr. z. Syst. d. Ophioglosseen, p. 299.

² Holle, Vegetationsorgane der Ophioglosseen, Bot. Zeit., 1875, p. 269; Rostowzew, Recherches sur l'*Ophioglossum vulgatum*, p. 21, Pl. I, Fig. 5.

margins. Proceeding up the leaf the ring flattens, and as the margins of the lamina become defined strands pass right and left from the ring; the circular series thus becomes broken up into the supply for the sterile lamina on the one hand, and the supply for the spike on the other. The latter consists of five or more strands, with their xylems directed abaxially, while the strands of the former are more numerous, and have their xylems directed adaxially (Fig. 5). Occasional connexions are found higher up, between the strands of the two systems, after their separation. The vascular supply of the spike may thus be held to be mainly, though not always exclusively, a product of marginal branching from the original vascular supply of the leaf-base, as in *Euophioglossum*.

Prantl's section *Cheiroglossa*, including only *O. palmatum*, is described as having 'petioli fasciculi numerosi.' The following observations on their relations to the spikes were made on a specimen sent to me by Mr. Fawcett from Jamaica. Transverse sections about the middle of the stalk show the vascular strands arranged, as in *O. pendulum*, in a ring, with their xylems directed centrally: they number about fifteen, and are of very variable size. Material was wanting for tracing the system downwards into the axis. Following it upwards no marked change took place at first, there being no obvious distinction of those strands which will enter the spikes till immediately below their insertion. Where the spikes are large, as in my leaf from Jamaica, and apparently also in that investigated by Professor Bertrand¹, a number of strands enter each spike. Immediately below the insertion of the lowest spike, though even the outline of the section shows where the stalk of the spike will be inserted, the ring of strands in the leaf-stalk remained undisturbed (Fig. 14); further up the ring opened, and with sundry branchings, four strands—subsequently reduced by fusion to three—passed out into the spike. Here as in other Ophioglossaceae the vascular supply appears to originate from both margins of the parent leaf, and not from one margin only (Figs. 14, 15, 16). The ring of strands in the leaf-stalk having thus opened, it did not again close (Fig. 17), but flattened out with the flattening expansion of the lamina into a wide arc; and in the leaf in question the vascular supply for the higher spikes came off from the margins of the arc, as shown in Figs. 18 to 23 (compare Bertrand's Fig. 97, l. c.).

In those specimens of *O. palmatum* where the spikes are numerous and small, their vascular supply appears to be only a single strand; this originates as a branch from one of the vascular strands, which may subsequently take a course distinctly intra-marginal in the lamina².

The characteristics of the vascular arrangements in the appendages

¹ Travaux et Mémoires de l'Univ. de Lille, Tome x, p. 189, Fig. 97.

² Compare Studies in the Morphology of Spore-producing Members. II. Ophioglossaceae, Pl. VIII, Figs. 120, 121; Pl. IX, Figs. 126, 127.

of the species of *Ophioglossum* investigated may then be summed up thus:—

(1) *The xylem in the strands of the leaf-stalk at first faces directly or obliquely to the adaxial surface*: in sterile leaves they constitute a more or less extended arc, open on the adaxial side; but in the fertile leaves¹, and especially clearly in *O. pendulum* and *palmatum*, as the strands pass upwards from the base *the arc closes in, and the strands together constitute a ring*, the margins of the arc being indistinguishable, and they may be related to one another by fusions. In the lamina the ring again opens out into a flattened arc, the opening taking place at the insertion of the spike, or of the lowest spike where there are several.

(2) *In the spike the strands are always arranged with their xylems directed abaxially, in a flattened arc, never in a closed circle.*

Thus diagnostic characters, though of a somewhat imperfect sort, exist, marking off the spike from the leaf-stalk. It remains to attempt the application of this diagnosis in the case of *O. simplex*, with a view to deciding the question of the morphological nature of the appendages which it bears. The following considerations as regards probable affinity may help towards the concentration of the problem down to a definite issue. Mr. Ridley suggests that the affinity of our plant is with *O. Bergianum* and with *O. pendulum*: the former affinity I should regard as doubtful, on the grounds of form as well as of anatomical character; the latter affinity seems for similar reasons more natural. But the nearest similarity in form is with the ground-growing plant designated *O. intermedium*, Hook., found by Lobb, near Sarawak, Borneo². This plant was doubtfully included by Prantl in *O. pendulum*³. I think that these three plants constitute a natural group, or section of the genus, which may be designated with Prantl, § *Ophioderma*, and be held to consist of three species, viz. *O. pendulum*, L., *O. intermedium*, Hook.⁴, and *O. simplex*, Ridley.

If the probable affinity of our plant be, as suggested, with *O. pendulum*, the anatomical issue assumes some degree of definiteness; for we know that in *O. pendulum* the vascular supply in the spike is in the form of a flattened arc, with the xylems directed abaxially, while that of the leaf-stalk shows the strands arranged in a complete ring, with their xylems directed centrally. The question may therefore be put thus: if we find in *O. simplex* that the strands are in a flattened arc and the xylems

¹ Compare Rostowzew, l. c., Text fig. 2, p. 7.

² Hooker, Century of Ferns, Tab. xcv.

³ Prantl, l. c., pp. 331, 332.

⁴ I see no sufficient reason for sinking this species, as Prantl does doubtfully. The discovery of *O. simplex* seems to me an additional reason for its retention as a valid species. I have compared the type specimen of *O. intermedium*, at Kew: the habit of the lower part of the plant is very similar to that of *O. simplex*; the difference chiefly lies in the presence of the small sterile lamina, and winged stalk below its insertion in *O. intermedium*, and in a narrower tract of tissue between the rows of sporangia of the spike than in *O. simplex*, but the latter character is variable in *O. pendulum*.

abaxial, the part in question will be of the nature of a spike; if we find that the strands are in a complete ring with the xylems central, the part where that occurs will probably be of the nature of a leaf-stalk. Further, if the leaf-trace continues downwards as separate strands, till the insertion of those strands separately upon the vascular system of the axis, then not only will the affinity with *O. pendulum* be confirmed, as apart from the rest of the genus, but also there will be a strong presumption that the appendages of *O. simplex* are the true correlatives of those of *O. pendulum*, notwithstanding the absence of the sterile lamina, as above noted for our plant. It may be said at once that the question of orientation is difficult in the upper region of any elongated succulent part, having approximately cylindrical form; and especially will this be the case when, as here, the only specimen has been pressed and dried. Certain results as to orientation can, in the present case, be obtained only at the base, and especially at the point of insertion of the appendage upon the axis. With this caution the facts available may be stated as follows.

A transverse section of the stalk at point *A*, Fig. 1, shows the vascular strands five in number, forming an arc open on the flattened side, which will presumably correspond to the abaxial side in a normal *Ophioglossum* (Fig. 24); it is however impossible in this dried specimen to be certain that its direction is actually abaxial. The xylems are directed towards this flattened side, and the structural arrangements are such as to indicate that here we have a part corresponding to that of a normal spike—a conclusion which the external form with its rows of sporangia amply bears out. It seemed useless in the absence of precise knowledge of orientation to pursue the details continuously downwards throughout the stalk, so the next section was taken at level *B*, in Fig. 1. Here the transverse section was more rounded, and the number of strands was found to be as high as seven, arranged in a regular circle, with their xylems directed centrally (Fig. 25); this result coincides fairly with the observations on the stalks soaked out (Fig. 2): the number seven is slightly in excess of the number of strands there shown—possibly in the crushed stalk one of the strands may have overlain another. Comparing this result with the transverse sections near the base of the stalks of fertile leaves of *O. pendulum* (Fig. 4) and of *O. palmatum* (Fig. 14), it appears that the form of the section and the vascular arrangement are similar, though of a rather simpler type, as shown by the smaller number of the strands; and thus the structural evidence points to the lower part being of the nature of a leaf-stalk. It remains to trace these strands downwards to their insertion on the system of the axis. This is shown in the successive sections (Figs. 27, 28, 29) for *O. simplex*, and it is clear from these that though there may have been reduction in number by fusions, the strands do not unite as in most Ophioglossaceae into a single strand, but remain as some four or five

separate strands; these insert themselves individually upon the rather irregular ring of bundles of the stock, which opens by a lateral gap to receive them. A comparison with *O. pendulum* (Figs. 6-13) shows that the arrangement in *O. simplex* is virtually the same, though somewhat smaller and simpler—a fact which still further accentuates the affinity with that species.

We are now in a position to discuss the morphology of this curious plant, and the bearing which its existence may have upon the general theory of the Ophioglossaceous form. It seems clear that the lamina, commonly present, is practically absent here: not even any vestigial trace of it was seen, though if young specimens were available it is possible that such might be found. So far as observation has been possible the appendicular organ appears simple, and to be terminated by a normal fertile spike. Either of two possible views may be based on these facts: (1) that the appendages are simple spikes, which have not, and never had, a subtending sporophyll; (2) that they are leaves of the ordinary Ophioglossaceous type, in which the sterile lamina is entirely abortive.

If the former be their real nature, then we see in *O. simplex* some support for the view put forward some years ago by Campbell¹. He compared the Ophioglossaceous spike with the sporogonium of *Anthoceros*, and remarked: 'If we could imagine such a sporogonium to develop a root fastening it to the ground, and thus rendering it entirely independent of the oöphyte, we should have the simplest possible form of a Pteridophyte.' The plant of *O. simplex* seems to consist of little more than two such 'sporogonia,' with root, or roots; in fact it would almost realize Campbell's forecast, and suggest more strongly than before that the Ophioglossaceae are, as he held, the most primitive Pteridophytes. If it were thus primitive it would point to the spike being the prior existent part, and the lamina a mere subsequent appendage upon it.

But in Celakovsky's view, which I have found reason to support elsewhere², the Ophioglossaceae are regarded as derivative forms from a Lycopodinous type of construction, in which a constant relation of the spore-bearing organ to the lamina existed throughout the descent. With such a type the condition of *O. simplex* could only be brought into conformity on a theory of abortion of the lamina, which subtends the spike in the usual Ophioglossaceous type: this is the alternative theory above suggested. Against this theory there can be no *a priori* objection, for in the Ophioglossaceae we see various degrees of abortion of the fertile spike, which lead to the condition of its complete absence; and there seems no reason to hold that what may happen to the spike may not equally

¹ On the affinities of the Filicineae, Bot. Gaz. xv, No. 1, Jan. 1890; also Mosses and Ferns, pp. 296, 297.

² Studies in Morphology of Spore-producing Members. II. Ophioglossaceae. Dulau and Co., 1896.

happen to the subtending leaf. As supporting this theory there is the fact of mycorrhiza in the root. We have at present no means of measuring from mere structural evidence the nutritive powers of mycorrhizal roots, or how far in any given case they may supplement or supersede the chlorophyll-nutrition. In proportion as the mycorrhiza is more effective a reduction of the assimilatory system may be anticipated, such as our theory demands, while the spore-producing parts would retain their dimensions, provided that the efficiency of nutrition be not diminished¹. A second point is the habitat, which Mr. Ridley specially describes as 'dense wet forests,' and pointedly compares it with the 'open grassy spots' where other ground-growing *Ophioglossums* are found. This seems to throw the onus of nutrition upon the mycorrhizal roots. Applying these considerations to our present case, it is physiologically possible to contemplate a reduction, or even a complete abortion, of the sterile lamina to such a condition as that shown in *O. simplex*.

And here the anatomical evidence detailed above will come in. It has been above pointed out that the upper part of the appendage in *O. simplex* shows structure as well as form characteristic of the Ophioglossaceous spike; also that towards the base the structure is comparable with that found at the leaf-base in *O. pendulum*, while the insertion of the vascular supply upon that of the axis is characteristic of the leaf of that same species: thus the structural evidence falls in with a theory of abortion of the sterile lamina. This, however, presumes that there is a transition from spike to leaf-stalk as the length of this apparently undifferentiated stalk is traversed. Any theoretical difficulty which such a presumption may occasion will be relieved by comparison of the case of the staminal flowers in the genus *Euphorbia*: there the transition from floral axis to filament (a transition which is not less essential than that from spike to leaf-stalk) is only marked in the slightest way by the well-known articulation. In both cases, on the view above put forward, the simple condition has been arrived at by a process of abortion.

Of the two explanations of *O. simplex* thus put forward, I am disposed to prefer the second, but in all the circumstances of this peculiar case it is not possible to come to any certain conclusion, one way or the other. This can only be done when more material shall be available. Meanwhile the case cannot be held to invalidate the view of Celakovsky, so far as to dictate its rejection.

The systematic position of *O. simplex* will be, according to the characters above described, in Prantl's § *Ophioderma*. But while accepting Prantl's division of the genus (l. c., p. 299), it would I think be well to add to the diagnosis the fact that the insertion of the leaf-trace differs in § *Ophioderma* from that in § *Euophioglossum*. In all species of the latter

¹ Phil. Trans. 1903, vol. cxcvi, pp. 228 and 233-4.

which have been examined anatomically the leaf-trace unites at the base into a single strand before insertion on the system of the axis—a condition which would appear to be the more primitive, especially if the general view of the family be that they represent an ascending series from a small-leaved, polyphyllous ancestry¹. But in § *Ophioderma*, of which *O. pendulum* and *O. simplex* have been examined (it was impossible to investigate the unique specimen of *O. intermedium* anatomically), the leaf-trace does not unite into a single strand at the base, but the individual strands are separately inserted on the system of the axis: this would appear to be the derivative condition, on any phyletic theory of the family as an ascending series of leaf complexity. I should propose, therefore, to add to Prantl's diagnoses as follows:—for § *Euophioglossum*, 'petioli fasciculi basi tres, deinde in unum conjuncti, in rhizomae fasciculos insertum,' and for § *Ophioderma* 'petioli fasciculi numerosi, separatim in rhizomae fasciculos inserti.' The case is still open for § *Cheiroglossa*, in which I am not aware that the stock has yet been examined anatomically. The anatomical difference thus brought forward, though not one which can be readily applied in ordinary systematic work, is more distinctive and trustworthy than the number of bundles at the base of the petiole, and for this reason it is to be preferred, if such a character is to figure at all in the diagnosis of the sections of the genus.

The provisional conclusion which may be drawn from the study of this new species, together with the two others which are grouped with it, in the § *Ophioderma*, is this: that they form a natural group, anatomically distinct, which illustrates three phases of proportion of the spike to the subtending leaf-lamina: in *O. pendulum* the sterile lamina is large, and sometimes irregularly branched; in *O. intermedium* it is small and simple, while the spike is still of considerable dimensions; in *O. simplex* it is absent, at least in the mature state, while the spike is still large. These three species may illustrate either a descending or an ascending series; the more probable view seems to be that they illustrate a decrease of the sterile leaf, and the extreme condition of *O. simplex* is to be attributed to the presence of mycorrhiza, which makes nutrition of the large spike still possible in the dense, wet forest in which it grows, notwithstanding that the usual assimilating organ is functionally non-existent. Reduction is, however, not apparent in the spike itself, for, provided nutrition be kept up from whatever source, it would still maintain its character, being essentially a spore-producing, and not a nutritive member.

The specimen—at least what remains of it after the anatomical investigation above described—together with the original drawing by Professor Groom, will be deposited, according to the wish of Professor Groom, in the botanical department of the Natural History Museum, South Kensington.

¹ Compare Studies in Morphology of spore-producing members, Phil. Trans. 1903, B. vol. cxcvi, pp. 233-7.

DESCRIPTION OF THE FIGURES IN PLATE XV.

Illustrating Professor Bower's paper on *Ophioglossum simplex*.

Fig. 1. The only specimen available of *O. simplex*, from a drawing by Professor Groom, showing the two spike-like appendages, the short stock below, and small root. A. A. and B. B. indicate the levels at which sections were taken. Natural size.

Fig. 2. Base of the specimen on a larger scale after soaking out in water; the course of the vascular bundles in the appendages has been traced. $\times 4$.

Figs. 3-5. Transverse sections of leaf-stalks of *O. pendulum*: Fig. 3, from the base of a sterile leaf; Fig. 4, from the base of a fertile leaf; Fig. 5, higher up on a fertile leaf. $\times 8$.

Figs. 6-13. Successive transverse sections through the stock of *O. pendulum*, illustrating the mode of insertion of the leaf-trace upon the system of the axis. $\times 4$. Whether the leaf be a sterile one (as that on the left side of each of these figures) or a fertile one (as were the other two), the strands do not coalesce to a single strand before insertion, but remain distinct till they join those of the axis.

Figs. 14-16. Transverse sections of the leaf of *O. palmatum*, showing the origin of the vascular supply to the lowest of its four spikes. $\times 4$.

Fig. 17. Transverse section of the stalk of that spike.

Figs. 18-23. Successive sections higher up on the same leaf, showing the origin of the vascular supply into the second and third spikes. $\times 4$.

Fig. 24. Transverse section of the larger appendage of *O. simplex*, at the level A. A. shown in Fig. 1. $\times 8$.

Fig. 25. Transverse section at the level B. B. $\times 8$.

Fig. 26. Transverse section just above the insertion on the axis. $\times 8$.

Figs. 27-29. Successive transverse sections of the stock of *O. simplex* showing the insertion of the foliar strands upon the system of the axis. It will be seen that the foliar strands do not unite into one before insertion on those of the axis. $\times 8$.

Bower del.

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