XXV. — *On Lepidophloios, and on the British Species of the Genus.* By ROBERT KIDSTON, F.R.S.E., F.G.S. (With Two Plates.)

(Read July 4, 1892.)

INTRODUCTION.

Though the genus *Lepidophloios*, in regard to species, is a comparatively small one, yet it derives considerable importance from its occurring throughout the whole of the Carboniferous Formation, as well as in the peculiar characteristics of the plants comprised in it.

The fragmentary condition in which the specimens are usually found has given rise to the creation of several genera, which can all be shown to merely represent different conditions of growth and preservation of one generic type. There are, also, other points in the structure of *Lepidophloios* which require further investigation, and the object of the present paper is to attempt to clear up some of these, about which much confusion still exists.

The genera which must be united with *Lepidophloios*, Sternberg, are *Lomatophloios*, Corda; *Halongia*, Lindley and Hutton; *Pachyphlæus*, Göppert; and *Cyclocladia*, Goldenberg (not L. and H.).

The natural way of treating this subject would have been to deal with each of the above-mentioned genera separately; but in the literature of the subject, which is very extensive, such a mode of treatment would lead to a considerable repetition of references, as most authors mention more than one of the genera under discussion. I have, therefore, deemed it better to treat this part of my subject chronologically.

REVIEW OF THE LITERATURE OF THE SUBJECT.

1720. VOLKMANN. *Silesia subterranea*, p. 129, pl. xxii. fig. 4.

This author gives the earliest known record of the genus *Lepidophloios*, and figures a small fragment of bark, fusiform in shape, which he mistook for a larch cone, with which he identifies his fossil.

1826. STERNBERG. *Essai flore monde prim.*, vol. i. fasc. 4, p. 13.

STERNBERG here founds his genus *Lepidofloyos*, which he defined as follows:—

“Caudex arboreus rudimentis petiolorum squamatus, cicatrice triglandulosa sub-squamis.”

STERNBERG originally placed *Lepidophloios* in *Lepidodendron* (*Lepidodendron larinum*, *ibid.*, vol. i. fasc. 1, p. 23, 1820), but subsequently recognising its important generic differences, founded for it his genus *Lepidophloios*.

1833. LINDLEY and HUTTON. *Fossil Flora*, vol. ii. pp. 11 and 14.

The authors of the *Fossil Flora* had very indefinite ideas as to the affinities of their genus *Halonia*. Their first described species is *Halonia tortuosa* (pl. lxxxv.), though the generic characters are more fully stated in their description of *Halonia gracilis** (pl. lxxxvi. p. 14). They state, in explanation, "the genus *Halonia* is proposed to comprehend all those fossils, in which to the surface of *Lepidodendron*, is added the mode of branching of certain Coniferæ, and which, it is therefore to be inferred, were of a nature analogous to the latter."

It will presently be shown that the leaf-scars and cushions of *Halonia* are quite distinct in structure from those of *Lepidodendron*, and that its ramification is dichotomous as in other Lycopods. The genus has, in fact, no affinity with the Coniferæ.

On their *Halonia tortuosa* the leaf-scars are not shown, and on their *Halonia gracilis* (which I much doubt being generically identical with their *Halonia tortuosa*), they are also indistinct; hence their statement in the generic description "to the surface of *Lepidodendron*," can only have been an assumption on their part.

1836. PACHYPHLEUS, GÖPPERT. *Die foss. Farrnkräuter*, p. 468.

Under this name GÖPPERT places fragments of two distinct genera. His figures 1-4, pl. xliii., are referable to *Lepidophloios*, but his figure 5, though found in the same block, had no organic connection with the examples which form the subjects of his figures 1-4, and is a Ulodendroid scar, which may probably belong to a *Lepidodendron*.

1845. LOMATOFLOYOS, CORDA. *Beitr. z. Flora d. Vorwelt*, p. 17.

CORDA thus describes his genus:—†

"Truncus arboreus medullusus, columnaris; ramis tetrastichus spiraliter positus. Cortex squamosa, squamis spiraliter spositis quaternariis ($\frac{1}{4}$), carnosus, crassis, truncatis, erecto-patentibus imbricatis, phyllophoris, dein cicatricibus rhomboideis infra appendiculatis, fasciculis vasorum ternis centralibus horizontalibus ornatis, obtecta. Corpus corticale medullosum, crassum, fasciculis vasorum percursum. Corpus ligneum cylindricum, cavum, tenuissimum, e vasis scalariformibus simpliciter compositum, radiis medullosis cellulisque lignosis nullis. Medulla centralis farcta, transversa striata. Folia linearia; nervo medio simplici. Fructus simplex (?) nucleiformis, supra acuminatus."

* This species appears to me to be much more probably a *Lepidodendron*, with unequally developed dichotomy, than a *Halonia*.

† First proposed by CORDA in STERNBERG, *Flora d. Vorwelt*, vol. ii. p. 206, 1836. Not having had access to CORDA's addition to STERNBERG, I base my remarks on *Lomatofloyos* from CORDA's description and figures in this work.

Certain parts of CORDA's generic description—that relating to the structure of the cylinder which occurred in his specimen and the fructification—may be left out of the discussion as to the generic relationship of *Lomatophloios* with *Lepidophloios*. There is really no conclusive evidence that the *Sternbergia* pith, which was inserted in the stem studied by CORDA, belonged to the bark which enclosed it, and, on the other hand, there is much evidence that it did not, and this view has been taken by SOLMS-LAUBACH.*

Anyone who has examined transverse sections of the large trunks of Lycopods, which occur in an upright position at Laggan Bay, Arran, and which contain in the infilling volcanic ash numerous vascular bundles of different plants which had been floated into them after the original tissue which had composed the stem had disappeared by decay, can easily appreciate the unsatisfactory nature of the evidence on which CORDA has associated an axis with a STERNBERGIAN pith with a plant having the known bark of a Lycopod; and that a mistake has been made here is, I think, conclusively proved by the fact that the specimen described by Professor WILLIAMSON as *Lepidodendron fuliginosum*† has been shown by an example on which the bark was preserved to be the *Lepidophloios acerosus*, L. and H., sp.,‡ with which I believe CORDA's *Lomatophloios crassicaulis* is synonymous.

In none of the specimens of *Lepidodendron fuliginosum* which were described by WILLIAMSON was there a STERNBERGIAN pith, but in all respects the structure of the stem conforms to the ordinary type of structure of the Carboniferous *Lepidodendrea*.

Therefore, in comparing the generic characters of *Lomatophloios* with those of the older genus *Lepidophloios*, we must dismiss from our minds all characters derived from the STERNBERGIA axis, which CORDA found within his specimen.

Leaving out, therefore, those characters adopted by CORDA, but which do not belong to the outer envelope of his specimen, the generic characters of *Lomatophloios* would then be—

. Bark scaly, leaf-bearing scales placed in $\frac{1}{4}$ spiral series attached below, fleshy, thick, truncate, erecto-patent, imbricate, with rhomboidal cicatrice provided with three vascular cicatricules, horizontally placed, central. Leaves linear with single medial nerve.

The whole difference, then, between the genus *Lepidophloios* and the genus *Lomatophloios* rests on the position of the leaf cicatrice: in the former it is situated at the base of the cushion, and in the latter at the top. In other words, to put the matter more correctly, in *Lepidophloios* the leaf-cushions are directed downwards, and in *Lomatophloios* they are directed upwards. Upon this single difference the two genera stand, and it appears to me to be far too insignificant a character for the separation of allied species into different genera, even if the character were constant; but I hope to show that this supposed difference does not hold, even specifically.

* *Fossil Botany*, p. 212, Oxford, 1891.

† *Proc. Roy. Soc.*, vol. xlii. p. 6.

‡ CASH and LOMAX *Rep. Brit. Assoc. Leeds*, 1890, p. 810 (1891).

But irrespectively of the scientific aspect of this subject, from the practical side of the question a grave difficulty arises, when the great majority of the specimens one has to deal with only show fragments of the bark. How, under such circumstances, is it to be determined whether the leaf-cushions were directed upwards or downwards, as this can only be determined in any given species by the discovery of branching specimens or examples on which the leaves are still attached to their cushions, for whatever the position the leaf-cicatrice may hold in relation to its cushion, whether the cushion were directed upward or downward, the *leaf always rises upwards*.* In illustration of these remarks, I may cite the case of *Lepidophloios Dessorti*, Zeiller,† the *downward* direction of whose leaf-cushions is shown by the *upward rising* of a still attached leaf. As a species of which it is impossible to determine whether the leaf-cushions were directed upwards or downwards, *Lepidophloios tumidus*, Bunbury, sp.,‡ may be mentioned. In such a case as *Lepidophloios tumidus*, how are we to decide as to whether the species is a *Lepidophloios* or a *Lomatophloios*? It certainly belongs to one of these two genera, but to place it in either could only be guess-work, as it does not afford any *data* for generic determination if we regard as of generic value the upward or downward direction of the cushions; and further, it will be shown presently that, in one species at least, the leaf-cushions on the young branches are directed upwards, while those on the old stems are directed downwards. I should not have entered so fully into this subject were it not that some recent writers still treat *Lepidophloios* and *Lomatophloios* as distinct genera, and have, further, included plants under one or other of these genera which the original generic descriptions could in no case embrace.

1849. DENNY, H. "A Glance at the Fossil Flora of the Carboniferous Epoch, with especial Reference to the Yorkshire Coal Field," p. 36, pl. i. (A paper read before the Geol. and Polytech. Soc. of the West Riding of Yorkshire, at Wakefield, March 8, 1849.)

Mr DENNY here figures an excellent specimen of *Halonia*, showing four dichotomies. In his description of the fossil he says, p. 36—"Of the genus *Halonia*, which, like *Lepidodendron*, probably holds an intermediate place between the *Lycopodiaceæ* and the *Coniferæ*, four well-marked species occur, the *gracilis*, *regularis*, *tortosa* (? *tortuosa*), and *tuberculosa*, at Low Moor and Dewsbury,—of the last species, one specimen in the possession of the Philosophical Society, procured from the Sandstone at Potternewton, is the most perfect example I have ever seen, and possesses peculiar interest, as not only exhibiting the mode of branching of the genus, a point upon which nothing positive was known, but also, apparently, combining the characters of the genera *Halonia* and *Knorria*;

* When the direction of the leaf-cushions has once been determined in any given species, of course in the case of fragments which do not themselves give any evidence of the direction of the cushion, if they are of *corresponding age*, their direction may safely be inferred from the known direction, determined on more perfect specimens.

† ZEILLER, *Flore foss. bassin houil. et perm. de Brive.*, p. 77, pl. xiii. fig. 1, and 1 B, 1892.

‡ *Lepidodendron* (?) *tumidum*, Bunbury, *Quart. Jour. Geol. Soc.*, vol. iii. p. 432, pl. xxiv. fig. 1.

the extremities of the branches belong to the former, and the base or main stem to the latter."

I give this long extract, as I shall have occasion to refer again to this specimen, which has more recently been refigured by Professor WILLIAMSON.*

1848. HALONIA, HOOKER. "On the Vegetation of the Carboniferous Period, as compared with that of the Present Day," *Mem. Geol. Survey of Great Britain*, vol. ii. part ii. p. 423.

Sir J. D. HOOKER merely gives the opinion expressed by Mr DAWES, who was "inclined to regard the species of *Halonía* as roots of *Lepidodendron*, on which opinion I have no remarks to offer."

1849. LEPIDOPHLOIOS, BRONGNIART. "Tableau des genres de végét. foss., p. 43. (In *Dictionnaire universel d'histoire naturelle*, vol. xiii.)

BRONGNIART unites *Lomatophloios*, Corda, and *Pachyphlaeus*, Göppert, with *Lepidophloios*, and, while accepting CORDA's description of the internal structure of *Lomatophloios crassicaule*, he states his opinion that the STENBERGIAN-like axis described by CORDA as the pith-cast of *Lomatophloios*, was not a true *Sternbergia* (= *Artisia*, Sternb.).

Halonía is here treated by BRONGNIART as a distinct genus.

1852. HALONIA, GÖPPERT. *Foss. Flora d. Übergangsgebirges*, p. 192.

This author considers *Halonía* an autonomous genus, and describes several species, founding his specific characters on the scars and the position of the knots, especially in the number of the series they form on the branches.†

1854. ETTINGSHAUSEN. *Steinkf. von Radnitz*, p. 57.

ETTINGSHAUSEN treats *Lomatophloios* as a distinct genus, and regards the occurrence of *Sternbergia* as sufficient evidence on which to record the genus *Lomatophloios*.

1854. GEINITZ. *Flora d. Hainichen-Ebersdorfer u. d. Flochaer Kohlenbassins*, pp. 47, 48.

In speaking of *Lepidophloios laricinus*, GEINITZ says "that we can no longer doubt that *Lepidophloios* is a true *Lepidodendron*;" and he further states that the leaf-scar is placed at the top of the cushion and not at the lower end, as supposed by STERNBERG. This appears to be an error, as far as *Lepidophloios laricinus* is concerned.

1855. CYCLOCLADIA, GOLDENBERG. *Flora Saræpontana foss.*, Lief. i. p. 18.

This genus is synonymous with *Halonía*, L. and H. GOLDENBERG's *Cyclocladia* must not be mistaken with the *Cyclocladia*, L. and H. (1834), *Fossil Flora*, vol. ii. pl. cxxx., which is a *Calamitina*.

* *Phil. Trans.*, part ii. pl. xxxiv., 1883.

† The *Lepidodendron sexangulare*, Göpp., *loc. cit.*, p. 171, pl. xliii. fig. 4, is a *Lepidophloios*.

1855-1862. GOLDENBERG. *Flora Saræpont. foss.*

LEPIDOPHLOIOS. Lief. i. p. 20, 1855.

HALONIA. Lief. i. p. 20, 1855.

LOMATOPHLOYOS. Lief. i. p. 22, 1855 ; Lief. iii. p. 25, 1862.

GOLDENBERG regarded these three genera as distinct, believing that the evidence on which they had been united was not conclusive. He refers *Artisia approximata* and *Artisia distans* to *Lomatophloios crassicaule* as its pith-cylinder.

He figures some most interesting specimens, which will be referred to again more fully.

1859. GÖPPERT. *Foss. Flora d. Silur. Devon. u. unter Kohlenf.*, p. 105.

Halonia is here treated as a separate genus.

1860. EICHWALD. *Lethæa Rossica*, LEPIDOPHLOIOS, vol. i. p. 156 ; HALONIA, p. 148.

EICHWALD regarded *Lepidophloios* and *Halonia* as distinct genera. He figures some interesting specimens of *Halonia tuberculata*, Brongt., on his pl. xi. figs. 1-4, but of these his figs. 1, 2 are the most instructive. Fig. 1 shows a bifurcation of a Halonian branch, which shows the usual characters, but the impression on the matrix, a small portion of which is exhibited by the removal of the stem, shows the *Lepidophloios* leaf-scars. Owing to the absence of enlarged details, the species of *Lepidophloios* to which this Halonian branch belongs cannot be determined. But the evidence these two specimens afford is clearly in favour of the opinion that *Halonia* is the fruiting branch of *Lepidophloios*.

1868. DAWSON, LEPIDOPHLOIOS. *Acadian Geology*, 2nd. ed., p. 454.

It may be best to quote DAWSON's own words here—

“*Lepidophloios*.—Under this generic name, established by STERNBERG, I propose to include those Lycopodiaceous trees of the Coal Measures which have thick branches, transversely elongated leaf-scars, each with three vascular points, and placed on elevated or scale-like protuberances, long one-nerved leaves, and large lateral strobiles in vertical rows, or spirally disposed. Their structure resembling that of *Lepidodendron*, consisting of a *Sternbergia* pith, a slender axis of long scalariform vessels, giving off from its surface bundles of smaller vessels to the leaves, a very thick cellular bark, and a thin dense outer bark, having some elongated cells or bast tissue on its inner side.”

“Regarding *L. laricinum* of STERNBERG as the type of the genus, and taking in connection with this the species described by GOLDENBERG, and my own observations on numerous specimens found in Nova Scotia, I have no doubt that *Lomatophloios crassicaule* of CORDA, and other species of that genus described by GOLDENBERG, *Ulodendron* and *Bothrodendron* of LINDLEY, *Lepidodendron ornatissimum* of BRONGNIART, and *Halonia punctata* of GEINITZ, all belong to this genus, and differ from each other only in conditions of growth and preservation. Several of the species of *Lepidostrobus* and *Lepidophyllum* also belong to *Lepidophloios*.”

From the above, it will be seen that DAWSON uses the genus *Lepidophloios* in a very different sense from that proposed by its author, and, in fact, includes in it plants which are now known to belong to several well-defined genera, for *Ulodendron*, L. and H., contained individuals referable in part to *Lepidodendron* and *Sigillaria*; and *Bothrodendron* has been conclusively shown by ZEILLER * to be an autonomous genus.

In illustration of my remarks, it may be added that DAWSON's *Lepidophloios parvulus*† is *Sigillaria (Ulodendron) discophora*, König., sp., his *Lepidophloios tetragonus*‡ is probably only an older condition of the same species,§ and his *Lepidophloios platystigma* is apparently *Sigillaria Brardii*,|| Brongt.

1869. HALONIA, ROEHL. *Foss. Flora d. Steink. Form. Westphalens*, p. 139.

ROEHL favours the view that *Halonina* may form a separate genus of the "*Lepidodendrea*."

LOMATOPHLOIOS. *Ibid.*, p. 146.

LEPIDOPHLOIOS. *Ibid.*, p. 149.

ROEHL also treats these two genera as distinct, figuring as representing the former two *Sternbergia* piths.

1871. WEISS. *Foss. Flora d. jüngst. Stk. u. Rothl.*, pp. 150 and 215.

Recognising that the leaf-cushions may be directed upwards or downwards, WEISS unites *Lomatophloios* with *Lepidophloios*. He enters critically into the various aspects of the question, and describes very minutely the structure of the "phyllodes," the leaf-scar and its cicatricules. He accepts CORDA's description of *Lomatophloios crassicaule*, in which he ascribes to it a STERNBERGIAN pith, and accepts the evidence afforded by the occurrence alone of *Sternbergia* (= *Artisia*) as a sufficient voucher for recording *Lepidophloios crassicaule*.¶

1872. SCHIMPER. *Traité d. paléont. végét.*, vol. ii.

Lomatophloios is here united with *Lepidophloios* (p. 49), while *Halonina* (p. 53) and *Cyclocladia*, Goldenberg (not L. and H., p. 55), are treated as distinct genera.

1872. BINNEY. "Observations on the Structure of Fossil Plants found in the Carboniferous Strata," part iii., pp. 82-96, pls. xv.-xviii. (*Palæontographical Society*).

Mr BINNEY describes the internal structure of several specimens of *Halonina*, which he believes to be the *Stigmarian* root of *Lepidodendron Harcourtii*. Subsequent investi-

* *Bull. Soc. Géol. de France*, 3^e sér. vol. xiv. p. 168.

† *Loc. cit.*, p. 490, fig. 170, g.

‡ *Loc. cit.*, p. 490, fig. 170, d.

§ See KIDSTON, *Annals and Mag. Nat. Hist.*, 1885, vol. xvi. p. 255, pl. vii. fig. 13, a.

|| *Loc. cit.*, p. 490, fig. 170, e and f.

¶ *Loc. cit.*, p. 156.

gations have shown that the association of *Halonia* with *Lepidodendron* as its root, is utterly untenable. *Halonia* will be dealt with more fully further on in this communication.

1873. CARRUTHERS. "On *Halonia*, Lindley and Hutton, and *Cyclocladia*, Goldenberg," *Geol. Mag.*, April, p. 145.

Mr CARRUTHERS here figures and describes some very interesting specimens of *Halonia*, one of which he justly names *Lepidophloios laricinus*,* but in regard to the fossil given by him at fig. 1, he mentions it as confirming GOLDENBERG's opinion that a *Halonia* branch may grow out of a *Lepidodendron*. The specimen on which Mr CARRUTHERS made this remark is in the collection of the British Museum, and I have frequently examined it. This supposed *Lepidodendron* branch, which bears a *Halonia*, is beyond all doubt a *Lepidophloios*,† and to this specimen I will refer again more fully. Mr CARRUTHERS further states (p. 151),—"It seems to me not improbable that *Ulodendron* may be the main stem of plants of which *Lepidophloios* and *Halonia* were the younger portions." "I have no doubt that *Halonia* was a fruit-bearing branch."

In regard to uniting *Ulodendron* and *Lepidophloios*, I have already shown that the so-called *Ulodendron*, L. and H., contained plants belonging in part to *Sigillaria* and *Lepidodendron*, but in no case to *Lepidophloios*.‡

Mr CARRUTHERS gives a figure (woodcut, p. 151) of "*Halonia gracilis*, L. and H." This specimen is also in the collection of the British Museum, and is certainly a small branch of *Lepidodendron ophiurus*, Brongt., which, in my *Catalogue of Palæoz. Plants*, I united with *Lepidodendron Sternbergii* in error. Such unequally dichotomised *Lepidodendroid* branches as that figured by Mr CARRUTHERS as *Halonia gracilis*, L. and H., though by no means common, are occasionally met with; but, as I have already suggested, in all probability the plant figured by LINDLEY and HUTTON as *H. gracilis* is really a *Lepidodendron*, and quite distinct from the other plants they placed in their genus *Halonia*.§

1875. HALONIA, FEISTMANTEL. *Vers. d. böhm. Kohlenab.*, Abth. ii. pp. 13 and 19.

This author believes that *Halonia regularis*, L. and H., and *Halonia (Bothrodendron) punctatum* should be referred to *Lepidodendron (Lepidophloios) laricinum*, and his specimens of *Halonia* (pls. v. fig. 6; vi.; vii. figs. 1, 2; viii. fig. 1) show the *Lepidophloios* leaf-scar. That these specimens belong to *Lepidophloios* there can be no doubt, and probably to *Lepidophloios laricinus*, but the figures do not admit of a satisfactory specific determination. His figure of *Halonia punctata*, however (pl. xviii. p. 20), clearly does not belong to *Lepidophloios laricinus*, but to one of the *Ulodendroid* scar-bearing Lycopods (*Sigillaria*, *Lepidodendron*, or *Bothrodendron*), but his fossil is too imperfectly preserved to admit of any closer determination.

* P. 150, pl. vii. fig. 3.

† *Ann. and Mag. Nat. Hist.*, vol. xvi., 1885.

‡ See KIDSTON, *Catal. Palæoz. Plants*, p. 171.

§ KIDSTON, *Proc. Roy. Phys. Soc.*, vol. x. p. 365, 1891.

FEISTMANTEL unites *Lomatophloios* with *Lepidodendron*, in which he places *Lepidophloios*. He seems, however, to have confused the species, for under the name of *Lepidodendron dichotomum* (pl. iii. figs. 3 and 5) he gives two figures which are the *Lepidophloios acerosus*, L. and H., sp.*

1877. GRAND' EURY. *Flore carbon du Départ. de la Loire et du centre de la France*.

Lepidophloios and *Lomatophloios* are here united (p. 141), but *Halonina* is treated as distinct (p. 145).

1877. STUR. "Die Culm-Flora d. Ostrauer u. Waldenburger Schichten," p. (327) 231, *Abhandl. d. k. k. geol. Reichsanst.*, Band. viii. heft 2.

STUR gives here a long description of the *Lepidophloios* leaf cushion and scar, the genus *Lepidophloios* being regarded by him as a bulbil-bearing condition of a *Lepidodendron* stem.

To understand his description of the *Lepidophloios* leaf cushion and scar, it is necessary to give his views of the structure of the *Lepidodendron* leaf-scar.

The leaf-scar of *Lepidodendron*, which is situated somewhat above the centre of the leaf-cushion, contains, according to Dr STUR, three vascular cicatricules. Immediately above the leaf-scar is a small cicatrice, which he names the *ligule-scar*. At the uppermost angle of the cushion is another small scar, which he names the "*insertion-point of the sporangium*." Immediately beneath the leaf-scar, and on each side of the medial line, are generally two small oval depressions or points, which he calls the "*vascular glands of the leaf-cushion*." † (See here Pl. II. fig. 10, and explanation to figure.)

In the *Lepidophloios* leaf-cushion and leaf-scar, STUR describes all these parts except the "*insertion-point of the sporangium*," which in *Lepidophloios* he had not observed, and STUR is thus led to unite *Lepidophloios* with *Lepidodendron* as its "bulbil-bearing" portion, quoting such figures as that given by GOLDENBERG ‡ in support of his views. This view of the relationship of *Lepidophloios* to *Lepidodendron* I believe to be thoroughly erroneous.

In regard to the various parts of the leaf cushion and scar to which he applies the names of *ligule-scar*, *point of attachment of sporangium*, *vascular glands of the leaf-cushion*, and the two *lateral*, as well as the *central cicatricule*, STUR classes all as connected with the vascular system. From the increase in our knowledge of the structure of the leaf-scar of *Lepidodendron*, knowledge mostly acquired since STUR wrote this work, it is not necessary to go into the question of the connection of these parts with the vascular system, as it has been shown from specimens whose structure was preserved that

* The figure of *Lepidodendron dichotomum* given in STERNBERG, *Vers.*, vol. ii. pl. lxxviii. fig. 1, appears to me much more like a *Lepidophloios* than a *Lepidodendron*, and it is quite probable that the two figures given by FEISTMANTEL, to which I have referred above, may be the *Lepidodendron dichotomum* of PRESL in STERNBERG, pl. lxxviii. fig. 1; but are not the plant of the same name given on STERNBERG's pls. i., ii.

† STUR (for figure showing these points), *loc. cit.*, pl. xix. (xxxvi.), fig. 1.

‡ *Flora sarap. foss.*, pl. xvi. fig. 6.

the vascular system has only connection with the central of the three cicatricules of the leaf-scar.

In regard to the small scar which STUR calls the *ligule-scar*, and the *point of attachment of the sporangium*, I do not see on what sound evidence these terms have been applied to the structures indicated; and though I am unable to explain their function, the terms appear to me very misleading.

In *Lepidodendron* and *Lepidophloios* the sporangia are borne on the bracts—not attached to the stem—and there is no *ligule* associated with the sporangia; hence such terms as those adopted by STUR for small scars on the leaf-cushion seem to be quite misplaced; and further, they do not appear to be present on all species of *Lepidodendron*.

1880. LEPIDOPHLOIOS, SCHIMPER. "Zittel. Handbuch der Palæontologie," Abth. ii. *Palæophytologie*, p. 193.

SCHIMPER here treats provisionally as distinct genera, *Lepidophloios* and *Lomatophloios*, and in regard to the latter, owing to the sparseness of material, does not state any decided opinion as to its relationship with *Lepidophloios*, leaving the subject an open question.

1880. LEPIDOPHLOIOS, LESQUEREUX. *Coal Flora*, vol. ii. p. 418.

Lomatophloios, Corda (*ex part*), is here united with *Lepidophloios*. The genus seems to be very rare in the United States, and the specimens LESQUEREUX has been able to examine were fragmentary and imperfect; hence, for his knowledge of the genus, he was largely dependent on the writings of others. Of the species LESQUEREUX described, many of his specimens are very imperfect, and it is doubtful if some of them really belong to this genus.

1880. THOMPSON. "Notes on *Ulodendron* and *Halonia*," *Trans. Edin. Geol. Soc.*, vol. iii. part iii. p. 341.

In his concluding remarks, he says—"That *Ulodendron* and *Halonia* were closely allied Lepidodendroid plants; that, on presumptive evidence, Professor WILLIAMSON's suggestion may still be maintained, viz., that *Ulodendron* and the biserial '*Halonia*' may *possibly* represent portions of one and the same form; and that, in this case, the specimens denominated *Halonia* formed the terminal or young branches of *Ulodendron*."

I have merely to remark that I have never yet seen a "*biserial*" *Halonia*, nor am I aware where such a specimen is described. It is true that MORRIS described a fossil *Halonia disticha*, but his fossil is in reality a specimen of *Sigillaria discophora*, König, sp., and not a *Halonia*, as he supposed.*

* *Trans. Geol. Soc. Lond.*, 2nd ser. vol. v. pl. xxxviii. fig. 1, 1840.

1882. LEPIDOPHLOIOS, RENAULT. *Cours d. botan. foss.*, deux. année, vol. ii. p. 44.

Lepidophloios is treated as including *Lomatophloios*, but in the generic description, as given by RENAULT, the leaf-cicatrice is placed at the upper angle of the cushion, and he therefore places in *Lepidophloios* the *Lomatophloios crassicaule*, Corda.

In dealing with the latter species (p. 48), he accepts some remarkable views in regard to a dimorphic condition of stem in certain species of *Lepidophloios*. In addition to the ordinary form (*i.e.*, the species conforming to *Lepidophloios*, Sternb., and *Lomatophloios*, Corda), there exists, according to RENAULT, another condition in which the stem bears large Ulodendroid scars. For this statement there is adduced no evidence except a "restored" figure (his pl. xi. fig. 1). How such a figure has been produced is difficult to understand, and the only explanation one can suggest is, that a piece of *Lepidophloios* bark must have been superimposed on a Ulodendroid stem; but it is much to be regretted that the "restored" stem has not been accompanied by the original evidence, for that there has been an error of observation here seems unquestionable. Without further evidence than a figure which is said to have been "restored," one cannot accept the conclusion to which RENAULT has arrived.

RENAULT therefore ascribes to *Lepidophloios* a condition in which the stems, in some cases, bear Ulodendroid discs, to which were attached caducous bulbils, the other condition being the production of cones at the ends of the smaller branches (p. 48).

He also takes the liberty of altering the position of the leaf-scars on the scales of the specimen given by GOLDENBERG on his pl. xvi. fig. 6, which, thus altered, RENAULT gives on his pl. ix. fig. 1. In GOLDENBERG's figure the leaf-scars are at the lower end of the leaf-cushions,* but in RENAULT's figure they occur at the top! This figure, which RENAULT describes as "rectified," is inaccurate and misleading.

HALONIA. *Ibid.*, p. 53.

The genus *Halonía* is treated by RENAULT as containing plants of two distinct classes. Some of these he treats as branches, as *Halonía tuberculata*, Brongt. Other members of the genus he regards as rhizomes of *Lepidodendron*, as *Halonía regularis*. That all *Halonía* are fruiting branches of *Lepidophloios* is shown by their possessing leaf-scars equally well formed with those of the branches. There is no data from which to conclude that the so-called *Halonía* belong to two classes—whatever one *Halonía* is, so is the other.

* Morphologically, I believe, the leaf-scars are always at the top of the cushion, but in certain species of *Lepidophloios* (if not in all at a certain stage of development), the leaf-cushions become deflexed, and then the leaf-scar appears to be at the base—more correctly, is directed downwards.

1883. MACFARLANE. "On *Lepidophloios*, a Genus of Carboniferous Plants," *Trans. Bot. Soc. Edin.*, vol. xiv. p. 181.

Dr MACFARLANE here points out the true relationship of *Halonia* to *Lepidophloios*, and in support of his views figures several specimens of *Lepidophloios Scoticus*, Kidston (*Lepidophloios laricinum*, Macfarlane, not Sternb.). The general points at issue are fully brought out, though some of his proposed unions of species and genera do not appear to be tenable.

1884. WEISS. *Aus der Flora der Steinkohlenformation* (2nd ed.), p. 8, pl. v. fig. 33.

WEISS here reproduces a part of GOLDENBERG's figure of *Lomatophloios macrolepidotum*,* which he names "*Lepidostrobus macrolepidotus* (hitherto named *Lomatophloios macrolepidotus*, Gold.), which must be regarded as a large cone." WEISS' previous mistake in regarding a small fragment of the stem of *Lepidophloios*, in which the structure was partially preserved, as a *Lomatophloian* cone,† has evidently originated the opinion on which he here acts, in placing what is evidently a fragment of a *Lepidophloios* bark in the genus *Lepidostrobus*.

1884. LEPIDOPHLOIOS, LESQUEREUX. *Coal Flora*, vol. iii. p. 781.

LESQUEREUX adds nothing here to his remarks made in vol. ii. p. 418.

1886. KIDSTON. *Catalogue of Palæozoic Plants*, pp. 171–173.

I here treat *Halonia* as a fruiting branch of *Lepidophloios*.

1888. LEPIDOPHLOIOS and HALONIA, SCHENK. *Die fossilen Pflanzenreste*, pp. 66, 67.

This author gives a general review of the subject without expressing any conclusive opinion on the several points in dispute. He, however, unites *Lepidophloios* and *Lomatophloios*, and rejects CORDA's opinion as to *Lomatophloios* having had a STERNBERGIAN pith.

SCHENK seems to adopt the views promulgated by the late Dr WEISS, who mistook portions of the bark of *Lepidophloios* for cones, which he referred to that genus as its fructification. *Halonia* he also treats in the same manner, and does not express an individual opinion as to its systematic position.

1888. LEPIDOPHLOIOS, DAWSON. *Geological History of Plants*, p. 157.

Sir WM. DAWSON's views regarding *Lepidophloios* are here modified, in so far as he states, in explanation of the genus, that "species with long and drooping leaf-bases have been included in *Lepidophloios* and *Lomatophloios*, species with short leaf-bases and cone scars in two rows have been called *Ulodendron*, and some of these have been

* GOLDENBERG, *Flora sarap. foss.*, pl. xiv. fig. 25.

† *Zeitsch. d. deutsch. geol. Gesell.*, vol. xxxii. p. 354.

included in *Sigillaria* (sub-genus *Clathraria*)," though he still includes all these under his *Lepidophloios*.

1888. LEPIDOPHLOIOS, ZEILLER. *Flore foss. d. bassin houil. d. Valenciennes*, p. 470.

ZEILLER describes the genus as having the leaf-cicatrices always placed below the middle of the cushion, or even at the inferior angle.

With *Lepidophloios* he unites *Lomatophloios* and *Halonia*—the latter as its fruiting branch.

He treats *Halonia*, however, as a provisional genus, simply from the circumstance that we can seldom identify the *Halonian* branches with their parent stems, on account of their bark being so seldom preserved, and consequently, from its absence, the necessary characters for a specific identification are wanting (*loc. cit.*, p. 475).

1889. WILLIAMSON. "On the Organisation of the Fossil Plants of the Coal Measures," Part XVI., *Phil. Trans.*, vol. clxxx. p. 200.

Prof. WILLIAMSON here supports the view that *Halonix* are fruiting branches. The tubercles on *Halonia* are the result of arrested plant-growth, and are morphologically identical with the Ulodendroid scar.

1890. LOMATOPHLOIOS, RENAULT. *Flore foss. le terr. houil. de Comentry*, deux. part, p. 507.

RENAULT here treats *Lomatophloios* as distinct from *Lepidophloios*, accepting the upward directed leaf-cushions, with leaf-cicatrice at their upper extremity, as the outstanding point of separation of *Lomatophloios* from *Lepidophloios*, where, in the latter genus, the leaf-cushions are bent downwards, and the leaf-cicatrice placed at their lower extremity. According to this author, the leaf-cushion is also less developed in *Lepidophloios*, but this character we shall find does not hold good. He also unites to *Lepidophloios* the genus *Halonia*, which he regards as the fruiting condition, the cones having been attached to the mamelons.

1890. HALONIA, GRAND' EURY. *Géol. et paléont. du bassin houil. du Gard.*, p. 235.

Without expressing any conclusive opinion, GRAND' EURY seems to favour the opinion that *Halonia* is a rhizome of *Lepidodendron*.

1890. SEWARD. "Notes on *Lomatophloios macrolepidotus* (Gold.)," *Proc. Cambridge Phil. Soc.*, vol. vii.

Mr SEWARD here shows that the specimen described by the late Dr WEISS (*ante*, p. 540), from Langendreer, Westphalia, and which WEISS regarded as a cone of *Lomatophloios*, was in reality a part of the bark of that plant, and not a cone.

1891. LEPIDOPHLOIOS and HALONIA, SOLMS-LAUBACH. *Fossil Botany* (English Translation), p. 210.

I should have liked to make some long quotations from this author, but must restrict myself to a short epitome of his views.

He unites *Lomatophloios* with *Lepidophloios*, and regards the leaf-scar in all the species as placed at the base of the cushion. He figures *Lepidophloios* (*Lomatophloios*) *crassicaulis*, Corda (fig. 21), with the leaf-cicatrices at the base of the cushion, thus reversing the position given them by CORDA. He also rejects CORDA's opinion that it had a *Sternbergia* pith, believing that he referred this axis to it in error.

Cyclocladia, Gold. (not L. and H.) (p. 213), he unites to *Halonina*, and states that it is closely related to *Lepidophloios*, but does not definitely accept their union.

I shall again have occasion to refer to this author in regard to the fructification of the genus.

FRUCTIFICATION.

GOLDENBERG* figures on his plate xvi. figs. 7, 9, and 10, certain cones which he refers to *Lepidophloios laricinus*, but not being attached to their parent stems, their identity with *Lepidophloios* is very uncertain.

The same objection may be raised in regard to the cones which LESQUEREUX ascribed to *Lepidophloios*.†

That the fructification of *Lepidophloios* consisted of a cone is shown by the figure of *Lepidophloios Scoticus*, Kidston (*Lepidophloios laricinus*, Macfarlane, not Sternb.), given by Dr MACFARLANE,‡ for there the cone is still attached to its parent stem, which bears all the characters of the species.

The small specimen with partially preserved structure from Langendreer, Westphalia, which WEISS supposed to be the cone of *Lomatophloios*,§ has been shown by SEWARD|| to be a small fragment of a branch of *Lepidophloios macrolepidotus*, Gold. ¶

It probably arises from the mistake that WEISS has made in the interpretation of this specimen that he includes, in his *Aus d. Steink* (2nd ed., pl. v. fig. 33), a copy of portion of GOLDENBERG's figure of *Lepidophloios macrolepidotus*, under the name of *Lepidostrobus macrolepidotus*.

SOLMS-LAUBACH,** referring to fossil Lycopodiaceous cones, says :—"Remains of cones

* *Flora sarcep. foss.*

† *Coal Flora*, vol. ii. p. 427, pl. lxxviii. figs. 6, 7; vol. iii. p. 782, pl. cv. fig. 1.

‡ *Trans. Bot. Soc. Edin.*, vol. xv. pl. viii. fig. 1.

§ WEISS, *Zeitsch. d. deut. geol. Gesell.*, vol. xxxiii. p. 354, 1881.

|| SEWARD, *Proc. Cambridge Phil. Soc.*, vol. vii., "Notes on *Lomatophloios macrolepidotus*, Gold."

¶ The specimens figured by Mr SEWARD, *loc. cit.*, pl. iii., are probably the *Lepidophloios acerosus*, L. and H., sp.

** *Fossil Botany*, p. 235, 1891.

of very great size, remarkable for the immense thickness of the axis, are classed by LESQUEREUX with *Lepidophloios*. WEISS also has described a similarly colossal cone of *Lomatophloios macrolepidotus*, but unfortunately there is no detailed account of it. The enormous size of the axis in these specimens gives rise to the suspicion that the fructification was not confined to special fertile shoots, but might occasionally appear on the leaves even of the main stem, which then increased in thickness, much as we see in the present day in the female flower of *Cycas*, and *mutatis mutandis* in *Lycopodium selago*. We naturally ask, on what sort of scars could such cones be seated as lateral organs?"

I have quoted in full the above passage from SOLMS-LAUBACH, as it shows how a mistake may become more deeply imbedded in the literature of a subject. Though admitting the difficulties that lie in the way of accepting as the cones of *Lepidophloios* the specimens described by WEISS and LESQUEREUX, he tries to explain them away without any satisfactory *data* to support the suggested escape from the improbabilities of the case.

Firstly, we must remember here that the specimen with a very thick axis which WEISS originally classed as the cone of *Lomatophloios* has been conclusively shown by Mr SEWARD to be a stem, and apparently upon the mistaken support derived from this specimen (for he states none other), WEISS places a large piece of the bark of *Lomatophloios macrolepidotus* into the genus *Lepidostrobus*.* When the evidence on which WEISS acted has been shown to be utterly erroneous, the whole theory falls to the ground. There is then no evidence whatever that the cones of *Lepidophloios* had a very thick axis; on the contrary, the only ones which have been attached to their parent stems, and consequently the only specimens that can be referred with certainty to *Lepidophloios*, have a comparatively slender axis.† SOLMS-LAUBACH, apparently accepting the erroneous conclusion arrived at by WEISS, remarks, "that the enormous size of the axis in these specimens gives rise to a suspicion that the fructification was not confined to special fertile shoots, but might occasionally appear on the leaves even of the main stem, which then increased in thickness."

When it has been shown that these supposed enormous cones are actually stems, and have no direct connection whatever with the fructification, the difficulty as to the "sort of scars" that could bear cones of such size—with the disappearance of the cones themselves—melts away.

GRAND' EURY gives a most interesting specimen of *Lepidophloios*, which he refers to *Lepidophloios laricinus*.‡ This example shows a portion of a stem from which are seen to spring four small branch-like structures. One of these is flattened on the surface of the stem, and does not show well its structure, but the other three project past the margin of the fossil and are clearly exhibited. These are regarded by GRAND' EURY as

* WEISS, *Aus d. Steink.*, 2nd ed., 1881, p. 8, pl. v. fig. 33.

† MACFARLANE, *Trans. Bot. Soc. Edin.*, vol. xiv. pl. viii. fig. 1.

‡ *Géol. et paléont. d. bassin houil. du Gard.*, p. 234, pl. vi. fig. 17, 1890.

pendicles to cones, and are covered with obovate scales, apparently different from those occurring on the branches.

The number of rows of tubercles on *Halonia* vary considerably. Four rows have frequently been stated as the number, but on many examples the number is greater.

Some authors refer to the scars on *Halonia* as being cup-shaped. On decorticated specimens of *Halonia* I have never seen them assume this form—as far as my experience goes, they are always in the form of tubercles, and any figures that I have seen with cup-shaped scars, which have been referred to *Halonia*, have belonged to one or other of the Ulodendroid Lycopods, never to *Halonia*.*

LEAF-CUSHION AND POSITION OF THE LEAF-CICATRICE.

GOLDENBERG figures (*loc. cit.*) two specimens of *Lepidophloios laricinus* from which the position of the leaf-cicatrice can be discovered. That given on his pl. iii. fig. 14, shows a bifurcation, and the leaf-cushion is seen to bear the leaf-scar at its lower extremity. The two large scars on this stem—one on each fork—may indicate the position of branches which have been broken off. The other figure given by GOLDENBERG, which shows the natural position of the branch, is that on his pl. xvi. fig. 6, which clearly shows the leaf-cicatrice at the lower end of the cushion, or what might perhaps be more correctly described as the leaf-scar situated at the top of the *downward directed cushion*. This specimen is a most interesting one, and seems to represent the *Halonia* condition of the plant.

In the figure of *Lepidophloios Scoticus* given by Dr MACFARLANE,† the leaf-cushions are also directed downwards. His specimen likewise shows the *Halonia* condition. I shall have occasion presently to refer to the arrangement of the leaf-cushions on the cone pedicels of this species, whose leaf-scar is situated at that end of the cushion which is directed upwards towards the cone.

Among other characters, CORDA distinguished his genus *Lomatophloios* from *Lepidophloios* by the upward directed leaf-cushions, whose leaf-cicatrice is situated at the upper extremity. We shall also find that this position of the leaf-scar is found on *Lepidophloios acerosus* L. and H., sp., with which CORDA's *Lomatophloios crassicaule* appears to me to be identical.

The direction of growth of the leaf-cushion I cannot accept as of generic importance, especially as it will be shown presently that the direction of the leaf-cushion differs on the younger and older branches of *Lepidophloios Scoticus*.

In GOLDENBERG's figure, however,‡ the smaller branches which spring from the main stem of *Lepidophloios laricinus* have the leaf-cushions and cicatrices placed in the same position as that which they are found to occupy on the main stem.

* *Halonia disticha*, MORRIS, *Trans. Geol. Soc.*, 2nd ser., vol. v. pl. xxxviii. fig. 1, is *Sigillaria discophora*.

† *Trans. Bot. Soc. Edin.*, vol. xiv. pl. vii.

‡ *Loc. cit.*, pl. xvi. fig. vi.

INTERNAL STRUCTURE OF LEPIDOPHLOIOS.

1848. DAWES.

Mr DAWES while describing the internal structure of *Halonia*, as observed in some specimens in his possession, remarks :—"These few observations will be able to show that the fossil in question belonged to the vascular *Cryptogamiæ*, and that when compared with the other plants of the coal measures, the nearest affinity is with the *Lepidodendron*."

1872. BINNEY (*loc. cit.*). *Palæontographical Soc.*

The structure of *Halonia* is fully gone into by Mr BINNEY in this Memoir, and illustrated by several plates.

1872. WILLIAMSON. "On the Organisation of the Fossil Plants of the Coal Measures."

Part II. *Lycopodiaceæ, Lepidodendron, and Sigillaria, Phil. Trans.*, p. 222.

Professor WILLIAMSON here states—"I have little doubt but that the *Halonia* was a fruit-bearing branch of a *Lepidodendron*, and that from each of the tubercles there was suspended a cone." In a footnote, p. 222, after mentioning that the usual form of *Halonia regularis* represented a semi-decorticated condition, he says, on p. 223,—“It thus appears that these outer layers of the bark, having an aggregate thickness of from three-eighths to half-an-inch, filled up the deep valleys separating the conical hillocks of *Halonia*, and almost reduced the entire surface of the plant, when living, to a uniform level.* These determinations bring the minute and geometrically arranged punctations covering the surface of the *Halonia* into homological relations with similar markings seen on other semi-decorticated *Lepidodendroid* plants.”

The first part of this footnote expresses exactly what is seen on specimens of *Halonia* whose outer bark is preserved, but such specimens show that *Halonia* is the fruiting branch of *Lepidophloios*, not of *Lepidodendron*.

A considerable space is occupied in this Memoir with a description of the internal structure of *Halonia*, and from the structure of the vascular bundle which passes to the tubercles, Professor WILLIAMSON infers “that the vascular bundle, thus originated, proceeded to some modification of a branch, but which modification was of smaller dimensions than branches usually attained to, and which, consequently, requires a less abundant supply of vascular tissue than ordinary bundles need. Such a modification would, I imagine, only be found in a Strobilus, which must be regarded as a branch that has undergone an arrested development at a very early stage of its growth.”

* See the figure given in this communication, Pl. II. fig. 5, which confirms this statement.

1883. WILLIAMSON. "On the Organisation of the Fossil Plants of the Coal Measures," Part XII., *Phil. Trans.*, p. 466.

The chief point of interest in this communication in regard to the subject under discussion, is the figure of the specimen of *Halonia* in the Leeds Museum, of which a figure had previously been given by Mr DENNY.* Professor WILLIAMSON referring to this specimen says—"It is yet more perfect than Mr CARRUTHERS' specimen,† since its lower extremity exhibits much more markedly than his corresponding ones do, the elongated foliar cicatrices characteristic of *Lepidodendron*." "At the lower part of the branch (A on Professor WILLIAMSON's plate xxxiv.) these leaf-scars have exactly the same form as those of *L. selaginoides* and *L. elegans* of LINDLEY and HUTTON." "After its first bifurcation, the two branches still contain much of the *Lepidodendroid* features, though the leaf-scars gradually become less elongated vertically." After further description of this specimen in the Museum of the Leeds Phil. Soc., he sums up as follows—"In my second Memoir (*Phil. Trans.*, 1872, p. 222), read in June 1871, I said, 'I have little doubt but that *Halonia* belongs to the upper branches of a *Lepidodendroid* tree, consequently it cannot be a root;' secondly, we learn that *Halonia* is a specialised branch of a *Lepidodendroid* tree that is not itself a *Halonia*." These conclusions are very similar to those arrived at by Mr CARRUTHERS in 1873 (*loc. cit.*), where, in speaking of one of the specimens he described, he says—"With *Bergeria* must go *Halonia* as a separate genus, seeing that it is only a condition of *Lepidophloios* and it may be of other *Lepidodendroid* plants." "The specimen now described is unquestionably not a *Lomatophloios* but a true *Lepidodendron*." I am sorry I must entirely dissent from the interpretation of the affinities of the two specimens described and figured by Professor WILLIAMSON (*loc. cit.*, pl. xxxiv.) and Mr CARRUTHERS (*loc. cit.*, pl. vii. fig. 1).

Firstly, in regard to that figured and described by Professor WILLIAMSON. This specimen I most carefully examined in 1886, while studying the fossil plants in the Museum of the Leeds Phil. Soc., and it is correctly described by DENNY as "apparently combining the characters of the genera *Halonia* and *Knorria*" (*loc. cit.*, p. 37).

Now *Knorria* may arise from *Lepidophloios*, *Lepidodendron*, and *Bothrodendron*, or even the Clathrate *Sigillaria*; it is only a condition of imperfect preservation—a state in which the outer surface of the stem has been removed, and hence such specimens as that described by DENNY, and more lately by Professor WILLIAMSON, *do not and cannot possess the characters necessary for a generic determination*. Professor WILLIAMSON has himself pointed out that *Halonia* is a semi-decorticated condition (*ante*, p. 545). Hence this specimen, on which Professor WILLIAMSON places so much importance, proves *absolutely nothing*, either for or against his opinion on the relationship of *Halonia* to *Lepidodendron*. The relationship of *Halonia* to its parent stem *can only be determined from specimens, on which is preserved, not only the Halonia tubercle, but the form and*

* See *l. c. ante*, p. 532.

† This specimen is figured on my Pl. II. fig. 8. It is a *Lepidophloios*, not a *Lepidodendron*.

structure of the leaf-scars, for the characters derived from the latter afford some of the most important points by which *Lepidophloios* is separated from *Lepidodendron*.

Secondly, in reference to the specimen described by Mr CARRUTHERS, as supporting a similar view, viz., that *Halonia* was a branch of a true *Lepidodendron*, the whole evidence afforded by that specimen shows that Mr CARRUTHERS has been mistaken in his observations. This example (Pl. II. fig. 8), which is an impression, is in the collection of the British Museum, and while preparing my *Catalogue of the Palæozoic Plants* in the Geological Collection, I had every opportunity of carefully examining it, and to enable me to confirm the opinions I then formed of its true relationship, at my request, Dr HENRY WOODWARD, F.R.S., kindly sent me a cast taken from the impression of the specimen. An examination of this cast confirms the description which I gave of the fossil in my *Catalogue*.* The leaf-scars on the specimen are characteristically those of *Lepidophloios* (Pl. II. fig. 8A, 8B), and show conclusively that *Halonia* is a fruiting branch of *Lepidophloios*. Of the two specimens, then, which by British authors have been brought forward to prove that *Halonia* was the fruiting branch of *Lepidodendron*, one, owing to its imperfect preservation, gives no evidence in favour of any particular view, while the other is a typical *Lepidophloios*.

1891. CASH and LOMAX. "On *Lepidophloios* and *Lepidodendron*," *Report Brit. Assoc. for 1890*, p. 810.

Mr LOMAX kindly showed me the specimen which was subsequently the subject of this paper. The specimen is a small stem of *Lepidophloios*—*Lepidophloios acerosus*, L. and H., sp., I believe—whose internal organisation was preserved, and whose structure was identical with the specimens described by WILLIAMSON as *Lepidodendron fuliginosum*, which therefore must be classed as *Lepidophloios*.

1892. WILLIAMSON. "On the Organisation of the Fossil Plants of the Coal Measures" (Abstract), *Proc. Roy. Soc.*, London, vol. 50, p. 469.

This paper, of which only an abstract has as yet been published, deals with many important points on the structure of *Halonia* and *Ulodendron* cone-scars, also on the structure of the leaf-cushion and leaf-scar.

Referring to *Halonia* and *Ulodendron*, he mentions that their relationship to each other is "still in a state of serious confusion." He further states that the scars in *Ulodendron* are usually defined as biserial, being arranged in two longitudinal rows, whereas in *Halonia* the rows are more numerous and the scars quincuncially arranged.

It is true that confusion appears to exist in the minds of some botanists, regarding the distinctions between "*Ulodendron*" and "*Halonia*," but not only do the two so-called genera differ in the arrangement of the cone-scars, but also in the form and structure of the leaf-scar and cushion. Further, as I have pointed out before, *Ulodendron* does not exist as a genus, but as a *condition* or *state* of more than one genus. But even

* p. 171.

if it is necessary to define a difference between the *Ulodendron condition* and the *Halonial condition*, even in the absence of the bark they can be separated, the former having two vertical rows of alternate (usually) cup-shaped scars, and the former having more than two rows of (usually) conical tubercles, spirally arranged.

I perfectly agree in the conclusion to which Professor WILLIAMSON arrived, and have always contested for the same issue, viz., "These two names, *Halonial* and *Ulodendron*, have no longer any value, but the terms Halonial and Ulodendroid may be conveniently retained as adjectives applicable to appropriate specific forms." These terms are convenient for distinguishing a condition, though the *Halonial condition* is always referable to the genus *Lepidophloios* and to that genus alone, while the *Ulodendron condition* may belong to *Bothrodendron*,* *Sigillaria*, or *Lepidodendron*, and when the leaf-scars are not preserved in such a state as to admit of a generic identification, the term "Ulodendroid condition" is of distinct value.

In the same communication, Professor WILLIAMSON refers to the structure of the three-leaf cicatricules, and for the two lateral, which are not connected with the vascular system, but which are probably glandular, adopts the name of *parichnos*, which has been applied to them by M. HOVELACQUE.† The central cicatrice only belongs to the vascular system. Professor WILLIAMSON rejects the term "ligule"-scar, first applied by STUR to the cicatrice on the leaf-cushion immediately above the leaf-scar, "on the ground that he cannot identify the fossil structure with the organ bearing the same name in *Isoetes* and *Selaginella*," a conclusion with which I concur.

I have not made any remarks on the internal structure of *Lepidophloios*, as I have nothing to add to that given by DAWES, BINNEY, and WILLIAMSON, in their Memoirs.

I would only remark that the internal structure of *Lepidophloios* is of the same type as *Lepidodendron*, and unless the stems show the Halonial tubercles or leaf-scars, they cannot be distinguished from *Lepidodendron*, which is seen from the circumstance that the plant originally described by Professor WILLIAMSON as *Lepidodendron fuliginosum*, has been proved by the occurrence of a specimen showing the leaf-scars to be a *Lepidophloios*. Of course there are specific differences in the structure of the stem, but nothing amounting to what could be regarded as of generic importance, and this is quite what might be expected in two genera which hold such close affinity to each other.

From what has now been stated, it is seen that some writers regard *Lepidophloios*, *Lomatophloios*, and *Halonial* as distinct genera. *Cyclocladia*, Goldenberg (not L. and H.), has been accepted generally as synonymous with *Halonial*. Others unite *Lepidophloios* and *Lomatophloios*, while they keep *Halonial* separate, and some have united all these genera under *Lepidophloios*.

It has also been proposed to unite *Halonial* with *Lepidodendron*.

It has, further, been supposed by some that the leaf-scars in all species of *Lepidophloios* were situated at the lower end of the cushion; by others, that they occupied

* In *Bothrodendron*, the umbilicus is eccentric, in the others, it is almost or quite central.

† *Comptes rendus*, vol. cxiii., 13th July 1891; also *ibid.*, 15th Aug. 1891.

the upper end of the cushion ; and by a few, that in some species the leaf-scar was at the upper end, and in other species that it was at the lower end of the cushion.

These remarks show that, up to the present, much confusion exists as to the relationship of these genera to one another, and this has induced me to go fully into the subject, and to give the evidence which has led me for some years to believe that *Lomatophloios*, *Halongia*, and *Cyclocladia*, Goldenberg (not L. and H.), must be united to *Lepidophloios*.

The differences of opinion on the affinities of these fossils, to which reference has already been made, arises, in great measure, from the imperfection of the material examined, and I hope to show, from the specimens I now describe,—

- I. That *Lomatophloios*, Corda, *Halongia*, L. and H., and *Cyclocladia*, Goldenberg (not L. and H.), belong to *Lepidophloios*, Sternberg.
- II. That the fruit was in the form of cones, borne on the *Halongia* branches.
- III. That, in some species (as far as at present demonstrable), the leaf-cicatrices were situated at the upper end of the leaf-cushions ; and, in other species, at the lower end of the leaf-cushions ; and that, in one species at least, the direction of the cushion (and consequently of the leaf-scar) alters with the age of the plant.*

DESCRIPTION OF SPECIMENS bearing on the relationship of *Halongia* to *Lepidophloios*.

Reference has already been made, when reviewing the literature of this subject, to the specimens described by EICHWALD, FEISTMANTEL, GOLDENBERG, WILLIAMSON, MACFARLANE, and others. I shall now describe some examples which have come under my personal observation.

Specimen figured and described by Mr Carruthers.† (Pl. II. figs. 8, 8A, 8B.)

I have already shortly referred to this specimen,‡ but as it has been regarded as proving that *Halongia* was the fruiting branch of *Lepidodendron*, I must describe it here more fully.

I am indebted to Dr HENRY WOODWARD, F.R.S., for a plaster cast of this fossil, which consists of a portion of a stem about 12 inches long that bifurcates about 5 inches above its base. The fork on the right, which is almost in a line with the undivided portion, is somewhat thicker than the fork to the left. Immediately below the fork the stem is about $2\frac{3}{4}$ inches wide ; the right-hand fork of the dichotomy is about 2 inches thick, while that on the left increases slightly in width upwards, and at its thickest part is rather over $1\frac{3}{4}$ inches. The stems are little compressed, having, in section, a rounded

* This alteration of the direction of the scales or cushions may occur in all the species, but we do not at present possess the proof that such is the universal rule in this genus.

† *Geol. Mag.*, 1873, p. 145.

‡ *Catal. Palæoz. Plants*, p. 171, 1886.

contour, but the leaf-cushions in the line of the axis, on the most raised part of the larger branch, have suffered more from pressure than the leaf-cushions on the lateral portions of the stem, or those on the smaller branch. The smaller branch shows only a few *Halonial* scars as it is broken-over a short distance above the point at which they begin to appear,—the lower half of the arm showing no such scars.*

Both on the *Halonial* branch, and the other parts of the fossil, the characteristic leaf-cushions of *Lepidophloios* are shown. Those on the *Halonial* branch hold their normal position to the stem, the leaf-scar being at the lower end of the downward directed cushion. Pl. II. fig. 8A, *a*, *b*, show two cushions, $\times 2$, drawn in their actual position to the axis of the stem.† Those on the main stem, and on the other fork, from some cause which I cannot fully explain, are so twisted round from their normal position that the two lateral angles of the leaf-cushion lie parallel with the axis of growth, and consequently the leaf-cicatrice also holds an abnormal position, and thus appears to occupy one of the lateral angles of the leaf-cushion. (Pl. II. fig. 8A, *c*; 8B, *d*, *e*.)

These points are illustrated in the figure, $\frac{2}{3}$ natural size, given on Pl. II. fig. 8. A is the stronger and larger branch, which has suffered more from pressure than B, on which the *Halonial* scars occur. On the arm B the leaf-cushions are directed downwards, as in typical *Lepidophloios laricinus*. Figs. 8A, *a*, *b*, show some of the leaf-cushions as they occur on the stem, and the arrows on fig. 8 show their position on the fossil. On the stem A, fig. 8, at *c*, the leaf-cushions are swung round, and the leaf-cicatrices point outwards. I think this has been brought about by pressure acting in the direction of the axis, which has twisted the leaf-cushions outwards on each side. It must also be observed, in connection with this, that the cushions lying on the central and more elevated part of the stem form a flattened band along its axis. This curious alteration in the natural direction of the cushions has caused their longer axes to lie parallel with the axis of growth, and thus in their general outline they simulate the leaf-cushions of *Lepidodendron*. The leaf-cushions are also swung from their natural position on part of the lower portion of the branch B, and are directed outward in a similar manner to that already described, as at fig. 8, B, *c*. From the characters possessed by this fossil, there cannot remain any doubt as to its being a *Lepidophloios* bearing a *Halonial* branch.

I have already referred to the specimen of *Lepidophloios Scoticus*, Kidston (*Lepidophloios laricinus*, Macfarlane (not Sternberg), given by Dr MACFARLANE in the *Trans. Bot. Soc. Edin.*, vol. xiv. pl. vii., and I have a similar specimen in my possession, from the Midlothian Oil Shales, which shows the union of *Halonial* and *Lepidophloios*. Of this specimen I give a figure, reduced to about $\frac{1}{3}$ natural size, on Pl. II. fig. 6. At fig. 6A are shown the leaf-cushions, $\times 2$.

At Pl. II. fig. 5 is given, natural size, a portion of a *Halonial* branch of another

* It might be argued from this specimen that, as only one row is seen, the branch had not more than two rows of *Halonial* scars in all, but it must be remembered that they commence irregularly and are spirally arranged.

† All the other figures of leaf-cushions, $\times 2$, figs. 8A, *c*; 8B, *d*, *e*, are also drawn in their present position in regard to the axis of the specimen.

specimen of *Lepidophloios Scoticus*. At the points where the stalked cones were attached, the leaf-cushions are bent back, and form a rosette of scales, at the centre of which is seen the point of attachment of the branch. Similar "rosettes" are seen on Pl. II. fig. 6.

Dr MACFARLANE shows a cone of this species attached to its stem, but the base of the stem is broken off.* The basal portion of a similar cone-stem is shown, natural size, on my Pl. II. fig. 7, where it is seen to terminate in a funnel-like expansion which fitted into the "rosette" on the parent stem. When in life, these "rosettes" would not be so flat as shown on the fossils—always more or less compressed—but would form shallow cup-like depressions, caused by the upward rising of the leaf-cushions, into which would fit the base of the stem shown at fig. 7.

Associated with these specimens from the Midlothian Oil Shales, the ordinary Halonial condition is found, and one is shown in the accompanying woodcut, about half natural size.

Lepidophloios Scoticus, Kidston. Halonial condition. From Straiton, near Edinburgh. About half natural size.

This example shows a portion of a stem (α) which dichotomises, but from the stronger growth of the left fork (b) the right fork (b') is thrown to the side; the left fork (b) again dichotomises, and the left fork (c) is thrown to the side; this fork (c) again divides,

* *Trans. Bot. Soc. Edin.*, vol. xiv. pl. viii. fig. 1.

and on its two arms (*d* and *d'*) the Halonial condition occurs, as well as on the branch *c*. On the other portions of the fossil, as also on the Halonial branch, are seen the small dots, which indicate the points at which the vascular bundles passed to the leaves. Of course there is no character on this specimen to prove that it belongs to *Lepidophloios Scoticus* other than the presence of the Halonial branch, and the fact that it occurred in the same beds as those specimens on which the *Lepidophloios* leaf-cushions were associated with the Halonial condition in organic union; and as *Lepidophloios Scoticus* is the only species of *Lepidophloios* known to occur in these beds, we are justified in referring this specimen to that species. We further know that *Halonial*, when semi-decorticated, has prominent tubercles, the hollows between which, when corticated, were filled up with the bark, which raised the whole surface of the stem to a common level, as shown at Pl. II. figs. 5 and 6.

SPECIMENS ILLUSTRATING THE DIRECTION OF THE LEAF-CUSHIONS.

The specimen of *Lepidophloios* figured by GOLDENBERG,* and of *Lepidophloios Scoticus* given by Dr MACFARLANE, as well as the specimens of *Lepidophloios laricinus* and *Lepidophloios Scoticus* described by myself here, prove beyond doubt that the stems of some species of *Lepidophloios*, under certain conditions at all events, were clothed with downward directed leaf-cushions. Some authors believe that this was the position of the leaf-cushion in all species; others think that in some species the leaf-cushions were directed upwards, and by those who still retain CORDA's genus, *Lomatophloios*, this is the chief or only point by which it is separated from *Lepidophloios*.

From the description of the following specimens it will be seen that the direction of the leaf-cushion is not constant, and, in one case at least, varies even in the same species.

To refer again to the figures of *Lepidophloios Scoticus* given by Dr MACFARLANE (*loc. cit.*) on his pl. viii. fig. 1, he shows a cone attached to its stem. If this figure be carefully examined, it will be seen that the leaf-scars are at the summit of the *upward directed* cushions, and consequently that the enlargement (fig. 4) of the same plate is shown in reversed position. As the fig. 1 was drawn by myself, I can vouch for its accuracy; but the specimen is not an isolated case, for I possess several cones of *Lepidophloios Scoticus* attached to their stems, which show the same character.

In every respect the structure of the leaf-cushion and scar is identical with those occurring on the larger stems, but in the latter case they are always directed downwards.

At Pl. II. fig. 7, I show the base of the stalk of one of these cones, which had very long stalks in *Lepidophloios Scoticus*; and I have a specimen from Grange Quarry, Burnt-island, with the base of the cone attached, whose stem is rather under $\frac{1}{4}$ of an inch thick and about $7\frac{1}{2}$ inches long, but its full length is not preserved. I have another specimen whose stem is about $\frac{1}{2}$ inch thick, but still they can scarcely have grown upright. The stems are always more or less bent, and their small size precludes the idea that they

* *Loc. cit.*, pl. xvi. fig. 6.

could have supported the weight of the terminal cone in an upright position. I therefore presume that the cones were pendent.

The chief point to which I now wish to direct attention in connection with fig. 7 is the upward directed leaf-cushions. That they are directed upward is shown by the truncate funnel-shaped base of the stem, which corresponds to its Halonial attachment on the parent branch. If it were possible to have any doubt about the direction of the leaf-cushions on this example, the stems with cones attached conclusively settle the point in showing the same character.

But not only on the cone-branches of *Lepidophloios Scoticus* were the leaf-cushions directed upwards. At Pl. I. fig. 3 is given a figure of a small specimen, $\frac{4}{5}$ th natural size, which was collected by the late Mr C. W. PEACH at West Hermand, West Calder. This shows a small bifurcated stem by which the direction of the growth is easily determined. As seen here and in the enlarged drawing, fig. 3a, $\times 4$, the leaf-cushions are directed upwards.

On a small fragment of stem in my collection, about $\frac{1}{2}$ inch thick, the leaf-cicatrices appear as if directed outwards; * but on no single specimen have I ever seen any transition from the upward to the downward directed leaf-cushion. On the smaller branches they are always directed upwards, and on the larger branches they are always directed downwards, while on the intermediate-sized branches, as that mentioned above, the leaf-scars appear to be directed outwards. Most probably, then, the change in the direction of the leaf-cushion took place gradually, and could only be traced on much larger and more perfect specimens than those usually met with.

These are the facts, as supported by specimens in my possession; and from their study one can only conclude that in *Lepidophloios Scoticus* in the young condition the leaf-cushions are directed upwards, but as the plant increases in age and size they gradually become deflexed; but it must be borne in mind that, whatever was the position of the leaf-cushion, the leaf was always directed upwards.†

The downward directed position of the leaf-cushions on the other branches of *Lepidophloios Scoticus* is seen at Pl. II. fig. 6. Another portion of a branch, which shows the whole width of the stem, is shown, natural size, at Pl. I. fig. 2. The same position of the leaf-cushion of *Lepidophloios laricinus* is seen at Pl. II. fig. 8.

Of *Lepidophloios acerosus*, L. and H., sp., I have only seen a single specimen from which the direction of the leaf-cushions could be determined. This example is shown, natural size, on Pl. I. fig. 1. In this case the leaf-cushions are certainly directed upwards, as in *Lomatophloios crassicaule*, Corda, which, however, I regard as synonymous with *Lepidophloios acerosus*, L. and H., sp. It may also be noted that the attached foliage seems to correspond to the *Lepidophyllum majus*, Brongt.

* Reg. No. 1805.

† See ZEILLER, *Lepidophloios Dessorti*, *Bassin houil. et perm. de Brive, Flore foss.*, 1892, p. 77, pl. xiii. fig. 1.

STRUCTURE OF THE LEAF-CUSHION.

I reproduce on Pl. I. fig. 11 a leaf-cushion of *Lepidophloios crassicaule*, as given by STUR,* on which he shows the *ligule-scar* (*a*) and the *vascular glands* (*c*) on each side of the medial line, similarly to what occurs in *Lepidodendron*. In respect to this figure, which, he says, is a cushion on a specimen of *Lepidophloios crassicaule*, Corda, in the Prague Museum, I can only say that I have never seen these structures, as represented by Dr STUR, on any of the very many specimens of *Lepidophloios* which I have examined, nor am I aware that any other writer on *Lepidophloios* has been more fortunate than myself. I am, therefore, forced to conclude that there is some error in Dr STUR's observation, for, were it otherwise, surely it would have met with corroboration. It is on this evidence that STUR treats *Lepidophloios* as a condition of *Lepidodendron*.†

At Pl. II. fig. 9, I give a leaf-cushion of *Lepidophloios acerosus*, L. and H., sp., from the Lower Coal Measures, Tullygarth, Clackmannanshire. This specimen shows immediately beneath the leaf-scar, and terminating the medial keel, a small tubercle,‡ in which is placed a small sub-triangular pit. I have never observed any other scar or cicatrice (other than this and the leaf-scar) on the cushions of *Lepidophloios*, and I have no doubt that, morphologically, this small tubercle corresponds to the two small oval pits seen on the cheeks of the leaf-cushion of many species of *Lepidodendron*. They are situated one on each side of the medial line, immediately beneath the leaf-scar, but from some species of *Lepidodendron* these two small pits beneath the leaf-scar are *constantly absent*. In *Lepidophloios Scoticus* no tubercle beneath the leaf-scar has yet been observed on any of the many specimens I have examined.

From what has now been stated, I think it must be conceded that *Lepidophloios* forms a well-marked genus, essentially distinct from *Lepidodendron*, but with which *Lomatophloios* must be united, and whose fruit-bearing branches are the well known *Halonias* L. and H.

BRITISH SPECIES OF THE GENUS LEPIDOPHLOIOS.

Lepidophloios, Sternberg, 1826.

1826. *Lepidophloios*, Sternb. *Ess. flore monde prim.*, vol. i. fasc. 4, p. xiii.

1833. *Halonias*, L. and H. *Fossil Flora*, vol. ii. p. 14.

* *Culm. Flora d. Ostrauer u. Waldenburger Schichten*, pl. xix. (xxxvi.) fig. 2b.

† For the purpose of comparison, I give a figure of a *Lepidodendroid* cushion and leaf-scar copied from STUR (*loc. cit.*), pl. xix. fig. 1. STUR describes it as follows:—*rb*, rhomboidal leaf-scar; *b.g.*, the three points of the leaf vascular bundles; *l*, the ligule-scar ("Ligulagrube"); *s*, point of insertion of the sporangium; *m*, medial line of leaf-cushion; *w*, the line of the field ("Wangenlinie" of STUR); *b.p.g.*, vascular pits of the cushion ("Gefässdrüsen des Blattpolsters").

The reasons have already been given for the rejection of the terms "ligule-scar" and "point of attachment of the sporangium." Of the three cicatricles within the leaf-scar, the two lateral—the *parichnos* of HOVELACQUE—are probably glandular; the two little pits beneath the leaf-scar, one on each side of the medial line, are also apparently glandular in function, and have no connection with the vascular system.

‡ This tubercle is not always present, but the majority of specimens possess it.

1836. *Pachyphloeus*, Göpp. (in part). *Die fossilen Farrnkräuter*, p. 468.
 1838. *Zamites*, Presl. in Sternb. (in part). *Vers.*, ii. fasc. 7, 8, p. 195.
 1855. *Cyclocladia*, Goldenberg (not L. and H.). *Flora Saræp. foss.*, heft. i. p. 19.
 1867. *Lomatophloios*, Corda. *Flora d. Vorwelt*, p. 17.

Generic Characters.—Arborescent lycopods, with dichotomous ramification. Stems and branches bearing much developed scale-like leaf-cushions, at or near whose summit is placed the leaf-cicatrice. Leaf-cushions imbricated, pedicel-like, upright or deflexed, exposed portion with straight sides or rhomboidal in outline, smooth or carinate; sometimes provided with a small tubercle immediately beneath the leaf-cicatrice. Leaf-cicatrices transversely oval, rhomboidal or rhomboidal-elongate, lateral angles rounded or acute, upper and lower angles generally rounded, sometimes pointed; within leaf-cicatrice are three punctiform cicatricules, of which the central is largest and sometimes sub-triangular in form. Fructification consisting of cones, stalked (? or sessile), borne on specialised branches which show when decorticated, spirally arranged protuberances (*Halonis*); in corticated condition the Halonial scars rise little above, or are on a level with the bark, and are represented by a rosette of deflected leaf-cushions. Medulla of delicate cells surrounded by a primary vascular axis composed of scalariform vessels which diminish in size from within outwards, exogenous vascular zone only developed in specimens advanced in age, bark consisting of three zones—the innermost of small cells, the middle of larger and irregular dense cells, and the outer composed of narrow, dense, prosenchymatous tissue (= *Lepidodendron fuliginosum*, Williamson).

In Britain—in the *Upper Carboniferous*—*Lepidophloios* is very rare in the Upper Coal Measures, but common in the Middle and Lower Coal Measures; of the two divisions of the *Lower Carboniferous*, *Lepidophloios* is extremely rare in the Carboniferous Limestone Series, but frequent in the Oil Shales and associated rocks of the Calcareous Sandstone Series.

The following species occur in Britain :—

- Lepidophloios laricinus*, Sternberg.
Lepidophloios acerosus, L. and H., sp.
Lepidophloios, cf. *macrolepidotus*, Goldenberg.
Lepidophloios Scoticus, Kidston.

Lepidophloios laricinus, Sternberg.

Pl. I. fig. 4, 4A; Pl. II. fig. 8, 8A, and 8B.

1820. *Lepidodendron laricinum*, Sternb. *Esse flore monde prim.*, vol. i. fasc. 1, pp. 23 and 25, pl. xi. figs. 2-4.
 1854. *Lepidodendron laricinum*, Geinitz. *Darst. d. Flora d. Hain.-Ebersd. u. d. Floehar-Kohlenbassins*, p. 47, pl. xi. figs. 4-8.
 1875. *Lepidodendron laricinum*, Feistmantel. *Vers. d. böhm. Kohlenab.*, Abth. ii. p. 17, pl. iv. figs. 1-3 (fig. 4?); pl. v. figs. 1-4 (fig. 5?) (not pl. xviii.) (including var. *insigne*, Feistm.).

1826. *Lepidophloios laricinum*, Sternb. *Ess. flore monde prim.*, vol. i. fasc. 4, p. xiii.
 1855 and 1862. *Lepidophloios laricinum*, Goldenberg (in part). *Flora Saræp. foss.*, Lief. i. p. 22, pl. iii. figs. 14, 14A (1855); Lief. iii. p. 30 (pl. xv. fig. 11 ?), pl. xvi. figs. (1 ?) 2, 3, 4, 5, 6 (1862).
 1870. *Lepidophloios laricinus*, Schimper. *Traité d. paléont. végét.*, vol. ii. p. 51, pl. lix. fig. 4; pl. lxiv. fig. 4 (5 ?), 6, 8 (not pl. lx. figs. 11, 12).
 1871. *Lepidophloios laricinus*, Weiss. *Foss. Flora d. jüngst. Stk. u. Rothl.*, p. 154, pl. xv. figs. 6, 7, and 9.
 1873. *Lepidophloios laricinus*, Carruthers. *Geol. Mag.*, vol. x. p. 150, pl. vii. fig. 3.
 1880. *Lepidophloios laricinus*, Zeiller. *Végét. foss. d. terr. houil. de la France*, p. 113, pl. clxxii. figs. 5, 6.
 1882. *Lepidophloios laricinus*, Renault (in part). *Cours d. botan. foss.*, vol. ii. p. 44, pl. ix. figs. 5 and 7.
 1886. *Lepidophloios laricinus*, Zeiller. *Atlas Flore foss. d. bassin houil. d. Valen.*, pl. lxxii. figs. 1, 2 (1886); Text, p. 471 (1888).
 1890. *Lepidophloios laricinus*, Renault. *Flore foss. terr. houil. d. Comentry*, part ii. p. 514 (?? pl. lxi. fig. 1).
 1866. *Lepidophloios Acadianus*, Dawson. *Quart. Jour. Geol. Soc.*, vol. xxii. p. 163, pl. x. fig. 54 (? pl. xi. fig. 51).
 1868. *Lepidophloios Acadianus*, Dawson. *Acad. Geol.*, 2nd ed., p. 489, fig. 171 (p. 457).
 1888. *Lepidophloios Acadianus*, Dawson. *Geol. Hist. of Fossil Plants*, p. 166, fig. 44 (p. 121).
 1871. *Lepidophloios acuminatus*, Weiss. *Foss. Flora d. jüngst. Stk. u. Rothl.*, p. 155, pl. xv. fig. 8.
 1874. *Lepidophloios acuminatus*, Schimper. *Traité d. paléont.*, vol. iii. p. 537.
 1872. *Lepidophloios intermedius*, Schimper (not Goldenberg). *Traité d. paléont. végét.*, vol. ii. p. 51, pl. lxiv. figs. 4–8.
 1884. ? *Lepidophloios dilatatus*, Lesqx. (in part). *Coal Flora*, vol. iii. p. 781, pl. cv. fig. 2.
 1857. ? *Sigillaria Menardi*, Goldenberg (not Brongt.). *Flora Saræp. foss.*, Lief. iii. p. 24, pl. vii. fig. 1.
 1855. *Knorria*, Goldenberg. *Flora Saræp. foss.*, Lief. i. pp. 17 and 37, pl. ii. fig. 8a.

Specific Characters.—Leaf-cushions elongated, imbricate, scarcely keeled, directed downwards; exposed portion of cushions rhomboidal or elongated transversely; lateral and upper angles acute, lower angle generally rounded. Leaf-scar placed at the summit of the downward directed leaf-cushion, or only slightly below the summit,* rhomboidal, or transversely rhomboidal-elongate, lateral angles very sharp and prominent, upper and lower angles slightly rounded; within the leaf-scar are three cicatricules placed centrally, or slightly above or below the centre, the two lateral punctiform, the central punctiform or subtriangular. When the leaf-scar is placed slightly below the apex of the deflexed cushion, two lines run from its lateral angles, which meet the margin of the cushion a short distance below the leaf-scar. The leaf-cushion frequently bears, immediately beneath the leaf-scar, a small tubercle with a circular or subtriangular depression. Fructification borne on Halonial branches.

Remarks.—There can be no doubt that, morphologically, the leaf-scar is placed at the apex of the cushion, whether the cushions remain upright, as in *Lepidophloios acerosus*, L. and H., sp., or become deflexed, as in *Lepidophloios Scoticus*. In *Lepidophloios laricinus*, though I have not seen any specimens showing the leaf-cushions directed upwards (i.e., on specimens from which their true direction could be discovered),

* These leaf-scars are usually described as being at the base of the cushion, and they certainly on impressions appear to be at the base, but in reality they are at the summit of a deflexed cushion. I am led to this conclusion from what has been said when describing specimens of *L. Scoticus*, ante, p. 552. The deflection of the leaf-cushions may take place at a very early stage of development.

still one cannot resist the conclusion that, as in *Lepidophloios Scoticus*, so in *Lepidophloios laricinus*, the cushions become deflexed, and their true apex becomes directed downwards.

The leaf-cushions, in all the species, increase in size with the growth of the stem, and hence the relative proportions of their width to their length varies with the varying age of the plant.

Probably the cones of *Lepidophloios laricinus* were stalked, but absolute proof is wanting on this point, though the example figured by GOLDENBERG on his pl. xvi. seems to represent the fruiting condition (*Halonia*) of the species with the cone-stems still attached.

The *Sigillaria Menardi* given by GOLDENBERG on his pl. vii. fig. 1, has a great resemblance to *Lepidophloios laricinus*, but when one takes into consideration the enlarged figure 1B, it certainly cannot be the latter plant, though it is difficult to understand how this fig. 1B could be derived from fig. 1. Possibly only a portion of the specimen is given at fig. 1, and fig. 1B may be taken from a part not shown in the portion figured.

Lepidophloios dilatatus, Lesquereux, as far as fig. 2* is concerned, does not appear to differ in any essential character from *Lepidophloios laricinus*. There do not seem to be any reasons given why the figs. 1, 3, and 4 of the same plate are placed under the same name as fig. 2, from which they appear to differ. It is, in fact, difficult to understand on what grounds such specimens as fig. 1 could be referred to *Lepidophloios* as its cone. Such relationship appears to me to be purely conjectural.

I believe that the specimen figured by WEISS as *Lepidophloios laricinus*† is my *Lepidophloios Scoticus*. The figure is scarcely enough to determine the point, but it has all the characters of this species, and originates from the same horizon.

Lepidophloios laricinus is very rare in Britain, and hitherto I have only seen it in the Middle Coal Measures.

Middle Coal Measures.

Yorkshire.—Low Moor, near Bradford. Davis.

Horizon.—White Rake Bed and Black Bed Coal.

Derbyshire.—Claycross. Dr Pegler.

Horizon (?).

South Wales Coal Field.—*Locality* (?). Carruthers. (*Geol. Mag.*, vol. x. p. 150, pl. vii. fig. 3, 1873.)

Horizon (?).

* *Coal Flora*, pl. cv. fig. 2.

† *Aus. d. Steink.*, pl. v. fig. 31.

Lepidophloios acerosus, L. and H., sp.

Pl. I. figs. 1, 1a; Pl. II. fig. 9.

1831. *Lepidodendron, acerosum*, L. and H. *Fossil Flora*, vol. i. pl. vii. fig. 1; pl. viii.
 1890. *Lepidophloios acerosus*, Kidston. *Trans. York. Nat. Union*, No. 14, p. 49.
 1891. *Lepidophloios acerosus*, Kidston. *Proc. Roy. Phys. Soc. Edin.*, vol. x. p. 351.
 1854. *Lepidodendron brevifolium*, Ett. *Steinkf. v. Radnitz*, p. 53, pl. xxiv. figs. 4, 5; pl. xxv.; pl. xxvi. fig. 3.
 1870. *Lepidodendron brevifolium*, Schimper. *Traité d. paléont. végét.*, vol. ii. p. 22.
 1845. *Lomatophloios crassicaule*, Corda (in part). *Flora d. Vorwelt.*, p. 17, pl. i. figs. 1, 2, 3, 7, 8, 9; pl. ii. fig. 2 (exclude central core); pl. iv. figs. 1, 2, 3, 4, 5, 6; pl. v. fig. 1.
 1855 and 1862. *Lomatophloios crassicaule*, Goldenberg (in part). *Flora Saræp. foss.*, heft i. p. 23, 1855; heft iii. p. 26, pl. xiv. figs. 7, 12, 13, 14, 15, 16, 17, 1862.
 1870. *Lepidophloios crassicaulis*, Schimper. *Traité d. paléont. végét.*, vol. ii. p. 50, pl. lx. figs. 13, 14.
 1871. *Lepidophloios crassicaulis*, Weiss. *Foss. Flora d. jüngst. Stk. u. d. Rothl.*, p. 156.
 1891. *Lepidophloios (Lomatophloios crassicaulis)*, Solms-Laubach. *Fossil Botany*, p. 212, fig. 21.
 1871. *Lepidophloios carinatus*, Weiss. *Foss. Flora d. jüngst. Stk. u. Rothl.*, p. 155.
 1886. *Lepidophloios carinatus*, Kidston. *Catal. Palæoz. Plants*, p. 172.
 1869.(?) *Lepidodendron dichotomum*, Roehl (in part) (not Sternb.). *Foss. Flora d. Steink. Form. Westph.*, p. 125, pl. xi. fig. 2.
 1875. *Lepidodendron dichotomum*, Feistm. (in part) (not Sternb.). *Vers. d. böhm. Kohlenab.*, Abth. iii. p. 14, pl. iii. figs. 3 and 5.
 1862. *Lepidophloios laricinus*, Goldenberg (in part). *Flora Saræp. foss.*, heft. iii. p. 45, pl. xv. fig. 9. (Named on plate *Lepidophloios macrolepidotus*.)
 1869. *Lepidophloios laricinus*, Roehl (in part). *Foss. Flora d. Steink. Form. Westph.*, p. 150, pl. xxviii. fig. 9.
 1870. *Lepidophloios laricinus*, Schimper (in part). *Traité d. paléont. végét.*, vol. ii. p. 51, pl. lx. figs. 11, 12.
 1862. *Lepidophloios macrolepidotum*, Goldenberg (in part). *Flora Saræp. foss.*, heft. iii. pl. xv. fig. 9.
 1882. *Lepidophloios macrolepidotus*, Renault (in part). *Cours. d. botan. foss.*, vol. ii. p. 45, pl. ix. fig. 4.
 1890.(?) *Lepidophloios macrolepidotum*, Seward. *Proc. Phil. Soc. Cambridge.*, vol. vii. pl. iii.
 1837. *Lepidostrobus pinaster*, L. and H. *Fossil Flora*, vol. iii. pl. cxcviii.
 1838. *Cycadites Cordai*, Sternb. *Flora d. Vorwelt.*, vol. ii. Lief. 7, 8, p. 196, pl. lv.
 1854.(?) *Lepidodendron crassifolium*, Ett. *Steinkf. v. Radnitz*, p. 55, pl. xxi. figs. 4, 5.

Specific Characters.—Leaf-cushions directed upwards, rhomboidal, elevated, strongly and prominently keeled; keel generally terminating immediately beneath the leaf-scar in a small tubercle, in which is situated a small circular or sub-triangular depression. Leaf-scar situated at the summit of the cushion, rhomboidal, lateral angles acute, upper and lower angles rounded; inner cicatricules three, placed in the centre of the leaf-scar, or slightly above or below the centre, punctiform, the central slightly larger than the others.

Remarks.—The only specimen I have seen, on which the direction of the leaf-cushions could be determined, is that shown on Pl. I. fig. 1, but whether, in age, the leaf-cushions become deflexed, as in *Lepidophloios Scoticus*, cannot at present be determined.

The types of *Lepidophloios (Lepidodendron) acerosus*, L. and H., cannot be

discovered, but, from the examination of the figures given by LINDLEY and HUTTON, and other specimens of the species in the "Hutton Collection," their plant is clearly shown to be a *Lepidophloios*.

The type of *Lepidostrobus pinaster*, L. and H.,* is preserved in the "Hutton Collection," Newcastle-on-Tyne. The leaf-scars are well preserved on this example, and the two lateral and central cicatricules are well seen. The supposed bracts that spring from the *Lepidostrobus pinaster* (which is drawn upside down, as shown by my fig. 1) are not organic, but splinters in the matrix. The original is quite unlike a cone, and it is difficult to conceive how such a figure of the fossil could have been produced.

I do not see any point by which *Lepidophloios crassicaulis*, Corda, can be separated from *Lepidophloios acerosus*. A comparison of the figures given by STERNBERG under the name of *Cycadites Cordai*, in his vol. ii. pl. lv., especially his fig. 3, and that given by CORDA on his pl. i. fig. 2, with the *Lepidophloios acerosus*, L. and H., sp., prove the identity of the species.

The *Lepidodendron dichotomum*, Roehl (not Sternb.), perhaps belongs to *Lepidophloios acerosus*; it differs in the leaf-scar having *four* cicatricules, which, however, is most probably an error of the draughtsman, and should have no importance attached to it. The leaves, however, are very long and narrow, whereas on the specimen which I give on Pl. I. fig. 1, which shows the termination of a branch, they are much broader and shorter, and in fact seem very similar to the *Lepidophyllum majus*, Brongt.

Several specimens which I believe to be referable to *Lepidophloios acerosus* have been figured under the names of *Lepidophloios laricinus* and *Lepidophloios macrolepidotus*.

Lepidophloios acerosus, L. and H., sp., is widely distributed in the Middle and Lower Coal Measures.

Middle Coal Measures.

England:—

Lancashire.—St. Helens. *Hor.* Ravenhead Coals.

Shropshire.—Highley Colliery, 6½ miles south of Bridgenorth. *Hor.* Above Brooch Coal. (J. Rhodes.)

Yorkshire.—Parkhill Col., near Wakefield. *Hor.* Stanley Main Coal.

„ Woolley Col., Darton, near Barnsley. *Hor.* Barnsley Thick Coal.

„ Monckton Main Col., near Barnsley. *Hor.* Barnsley Thick Coal.

„ East Gawber Col., near Barnsley. *Hor.* Barnsley Thick Coal.

„ Cooper's Col., Worsborough Dale, near Barnsley. *Hor.* Barnsley Thick Coal.

„ South Kirby Col., near Pontefract. *Hor.* Barnsley Thick Coal. (W. Hermingway.)

South Wales Coal Field.—Abersychan, near Pontypool. *Hor.* Soap Vein (Lower Pennant Series).

* Vol. iii. pl. cxviii.

*Lower Coal Measures.**Scotland:—*

- Clackmannanshire.—Furnace Bank Col., Old Sauchie. *Hor.* (?)
 „ Devonside, Tillicoultry. *Hor.* (?)
 „ Tullygarth Pit, Clackmannan. *Hor.* (?)
 Lanarkshire.—Foxley, near Glasgow. *Hor.* Kiltongue Coal. (R. Dunlop.)
 „ Pit near Coatbridge. *Hor.* Lower Drumgray Coal.
 „ Calderbank. *Hor.* Kiltongue Coal.
 Fife.—Dysart. *Hor.* (?)
 Ayrshire.—Bonnyton Pit, Kilmarnock. *Hor.* Whistler Seam. (A. Sinclair.)
 „ Woodhill Pit, Kilmaurs. *Hor.* Durroch Coal.

England:—

- Durham.—Bensham Col. *Hor.* Bensham Seam.
 „ South Shields. *Hor.* (?)
 Lancashire.—Old Meadows Pit, Bacup. *Hor.* Gannister Mine.
 Yorkshire.—Bradshaw, Halifax. *Hor.* Hard Bed Coal. (J. Spencer.)

(?) *Lepidophloios macrolepidotus*, Goldenberg.

1855. *Lomatophloios macrolepidotum*, Goldenberg. *Flora Sarcop. foss.*, heft. i. p. 22.
 1862. *Lepidophloios macrolepidotum*, Goldenberg. *Ibid.*, heft. iii. p. 37, pl. xiv. fig. 25.
 1870. *Lepidophloios macrolepidotus*, Schimper. *Traité d. paléont. végét.*, vol. ii. p. 52.
 1882. *Lepidophloios macrolepidotus*, Renault (in part). *Cours d. botan. foss.*, vol. ii. p. 45, pl. ix. fig. 2.

Specific Characters.—Leaf-cushions rhomboidal, broader than long, very slightly keeled; leaf-scar (according to GOLDENBERG) at the summit of the downward directed cushion, transversely rhomboidal, lateral angles acute, upper angle rounded, lower angle rounded or acute, cicatricules three, punctiform.

Remarks.—Of this species I have very little experience. The only specimen I have seen which I could refer to *Lepidophloios macrolepidotus* was communicated to me by Mr H. M. CADELL. It agrees tolerably well with GOLDENBERG's figure, which, however, possesses little character, except in size, to distinguish it from *Lepidophloios laricinus*.

GOLDENBERG believed his plant was similar to the *Ulodendron majus*, L. and H., but this view I cannot accept.

In regard to the specimen I place under GOLDENBERG's name, I am not absolutely certain that it should be referred to his species, still there is no point by which I can separate it. My specimen is unfortunately not very well preserved; but it is evidently neither of the three species already mentioned in this paper; until, therefore, better examples are secured, the occurrence of *Lepidophloios macrolepidotus* in Britain must remain doubtful.

RENAULT figures some specimens which he refers to *Lepidophloios macrolepidotus* in *Flore foss. le terr. houil. d. Comentry*, deux. part, p. 507, pl. lviii. fig. 1; pl. lx. fig. 3, 4; but his fossils do not appear to me to be GOLDENBERG's species—their leaf-cushions are much more prominently keeled, and his specimens have, in fact, more of the character of *Lepidophloios acerosus*, L. and H., sp., though possibly they may not be referable to this species.

LESQUEREUX also figures a specimen which he refers to *Lepidophloios macrolepidotus*,* but I am also doubtful about the identification of this specimen.

The specific value of GOLDENBERG's *Lepidophloios macrolepidotus* has yet to be determined. It seems quite possible that it may be only an aged example of *Lepidophloios acerosus*, L. and H., sp.

*Carboniferous Limestone Series (Lower Carboniferous).—Loc. Ironstone Ball above
Craw Coal, No. 4 Mine, Grange, Bo'ness, Linlithgowshire.*

Lepidophloios Scoticus, Kidston.

Pl. I. figs. 2, 2*a*, 3, 3*a*; Pl. II. figs. 5, 5*a*, 6, 6*a*, 7, 7*a*.

1885. *Lepidophloios Scoticus*, Kidston. *Ann. and Mag. Nat. Hist.*, vol. xvi. p. 137, pl. vii. fig. 14.

1886. *Lepidophloios Scoticus*, Kidson. *Catal. Palæoz. Plants*, p. 173.

1883. *Lepidophloios laricinus*, Macfarlane (not Sternb.). *Trans. Bot. Soc. Edin.*, vol. xiv. p. 181. Pls. vii., viii. figs. 1 (? 2), 3, 4, 5*b*, 5*c* (not fig. 5*a*).

1882. (?) *Lepidophloios laricinus*, Weiss (? not Sternb.) *Aus d. Steink.*, 2nd ed., p. 8, pl. v. fig. 31.

Specific Characters.—Leaf-cushions on young branches directed upwards, on the older stems directed downwards, rounded, not keeled, exposed portion on older stems with straight or slightly convex sides, basal portion pointed, distal margin rounded. Leaf-scar placed at the apex of the cushion, transversely elongated, oval on young stems, lateral angles pointed or acute on older branches. Cicatricules three, punctiform, and placed a little below the centre of the scar. On young stems the leaf-cushion is much elongated, rounded and truncate, terminating in a transversely oval leaf-scar, cicatricules seldom preserved. Fruit a stalked elongate oval cone with leaf-cushions directed upwards, and borne on Halonial branches with downward directed leaf-cushions. At the point of attachment of the cone-stalks with the parent branch, the leaf-cushions are bent back on all sides, and thus form a rosette, in the centre of which is a small circular vascular scar.

Remarks.—Fig. 2, Pl. I. shows portion of a branch removed from its matrix, and illustrates the form of the leaf-cushion on the fully-developed plant. Pl. II. fig. 6 gives a reduced figure of the Halonial condition, and shows the rosettes formed by the backward turned scales, in the centre of which are the little points of attachment of the cone-stalks. Another specimen showing these characters more clearly is reproduced, natural

* *Coal Flora*, vol. ii. p. 424, pl. lxviii. fig. 2.

size, at fig. 5, Pl. II. On fig. 6, and all similar large specimens which permit of the true direction of the-leaf cushions to be determined, and of which I have seen several, the leaf-cushions are invariably directed downwards.

Fig. 7, Pl. II., shows the base of a cone-stalk, natural size, with the funnel-like expansion which fitted into the little rosette on the Halonial branch, and to which reference has already been made. On this little stem the leaf-cushions are clearly directed upwards, and if it were possible to question the direction of growth of this specimen, it is determined by many cones, in my collection, with their stems still attached (similar to that figured by Dr MACFARLANE), on which invariably the leaf-cushions are directed upwards. At fig. 3, Pl. I., is given a small branch, collected by the late Mr C. W. PEACH, about whose direction of growth there can be no doubt, and here it is seen also that the leaf-cushions are directed upwards. This specimen is evidently an ordinary branch, and not a cone-stem. When, then, we find on the young branches that the leaf-cushions are invariably directed upwards, and that on the older stems they are always directed downwards, one is forced to the conclusion that the leaf-cushions become deflexed as the plant increases in age, and this view is strengthened by occasionally finding specimens on which the leaf-scar seems to be directed outwards.

Lepidophloios Scoticus is easily distinguished from the other members of the genus, by its smooth rounded elongated leaf-cushions.

Calciferosus Sandstone Series (Lower Carboniferous).

Scotland:—

Midlothian.—Raw Camps, East Calder; Oakbank, Midcalder; Burdiehouse; Railway Cutting, Slateford; Hailes Quarry, near Edinburgh; West Calder; Straiton; West Hermand; Water of Leith, Slateford.

Linlithgowshire.—Shore, near Long Craig's Pier, Queensferry; Shore, Dalmeny.

Fife.—Kilmundy Limestone Quarry, 1 mile N.W. of Burntisland; Dodhead Quarry, 1 mile N.E. of Burntisland; Grang Quarry, Burntisland; Brosyhall Limestone Quarry, Burntisland.

Berwickshire.—Shore, Cockburnspath.*

From the evidence now adduced, it seems perfectly established, that the direction of the leaf-cushions cannot be regarded as of generic value, and that *Halonial* is the fruiting branch of *Lepidophloios* and not of *Lepidodendron*; and, further, that the fruit of *Lepidophloios* is a cone, and that in the only case where the fruit can be definitely referred to a given species, it is a stalked cone, which, if separated from its parent stem, would be placed in the genus *Lepidostrobus*.

* For examination of specimens from some of these localities, I am indebted to Mr BENNIE, the late Mr C. W. PEACH, and Mr J. GAUL.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. *Lepidophloios acerosus*, L. and H., sp. *Loc.* Abersychan, near Pontypool, South Wales. *Hor.* Middle Coal Measures (Lower Pennant Series). Specimen presented to the Bristol Museum, by Mr W. WOOD. Natural size.*

Fig. 1a. Leaf-cushion and scar, $\times 1\frac{1}{2}$, showing the cicatricules. From the counterpart of Fig. 1.

Fig. 2. *Lepidophloios Scoticus*, Kidston. *Loc.* West Calder, Midlothian. Natural size. *Hor.* Calciferous Sandstone Series. Reg. No. 529.

Fig. 2a. Cushions, $\times 2$.

Fig. 3. *Lepidophloios Scoticus*, Kidston. *Loc.* West Hermand, West Calder, Midlothian. Four-fifth natural size. *Hor.* Calciferous Sandstone Series. Reg. No. 1801. Specimen collected by the late Mr C. W. PEACH.

Fig. 3a. Cushions, $\times 4$.

Fig. 4. *Lepidophloios laricinus*, Sternb. *Loc.* Low Moor, Yorkshire. Natural size. *Hor.* "Black Bed Coal," Middle Coal Measures. Specimen communicated by Mr J. W. DAVIS. Reg. No. 1404.

Fig. 11. *Lepidophloios*. Copied from STUR, *Culm. Flora*, vol. ii. pl. xix. (xxxvi.) fig. 2b.

PLATE II.

Fig. 5. *Lepidophloios Scoticus*, Kidston. *Loc.* West Calder, Midlothian. Natural size. *Halonía* condition. *Hor.* Calciferous Sandstone Series. Reg. No. 1810.

Fig. 5a. Cushion, $\times 3$.

Fig. 6. *Lepidophloios Scoticus*, Kidston. *Loc.* West Calder, Midlothian. About $\frac{1}{3}$ natural size. *Halonía* condition. *Hor.* Calciferous Sandstone Series. Reg. No. 1798.

Fig. 6a. Cushions, $\times 2$.

Fig. 7. *Lepidophloios Scoticus*, Kidston. *Loc.* Hailes Quarry, near Edinburgh, Midlothian. Natural size. *Hor.* Calciferous Sandstone Series. Reg. No. 1814.

Fig. 7a. Cushions, $\times 4$.

Fig. 8. *Lepidophloios laricinus*, Sternberg. Two-fifth natural size. Cast of specimen figured by Mr CARRUTHERS in *Geol. Mag.*, vol. x. pl. vii., 1873. Reg. No. 1832.

Fig. 8A and 8B. Cushions, $\times 2$.

Fig. 9. *Lepidophloios acerosus*, L. and H., sp. *Loc.* Tullygarth, Clackmannan. Lower Coal Measures. Cushion, $\times 2$, showing the tubercle immediately beneath the leaf-scar.

Fig. 10. *Lepidodendron*. Scar copied from STUR, *Culm. Flora*, vol. ii. pl. xix. (xxxvi.) fig. 1.

* My thanks are due to the Council of the Bristol Museum for permission to figure and describe this specimen.

Note.—The Registration Numbers refer to specimens in the writer's collection.

MR. ROBERT KIDSTON ON LEPIDOPHLOIOS. — PLATE I.

FIG. 1. LEPIDOPHLOIOS ACEROSUS, L. & H. sp. FIGS 2-3. LEPIDOPHLOIOS SCOTICUS, Kidston.

FIG. 4. LEPIDOPHLOIOS LARIGINUS Sternb.