

On the External Morphology of the Stems of *Calamites*, with a Revision of the British Species of *Calamophloios* and *Dictyocalamites* of Upper Carboniferous Age. By E. A. NEWELL ARBER, M.A., Sc.D., F.L.S., and F. W. LAWFIELD, B.A.*

(PLATES 23-25.)

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1. Introduction.

IMPRESSIONS or casts of the external features of Calamite stems are still very little known in comparison with the pith casts of the same plants. As fossils they are not only much rarer but usually more fragmentary than the medullary casts, and for this reason little attention has been paid to them hitherto. Examples of external impressions of these plants have been figured from time to time by various authorities, including Stur†, Weiss‡, and Solms§, and, in quite recent years, especially by Jongmans|| and Kidston¶.

In all four of the large monographs which we now possess on the Calamites by Stur, Weiss, Kidston, and especially Jongmans, by far the greater number of the figures relates to pith casts. As a rule examples of both medullary casts and impressions showing the true external features of the stem are mixed together in confusion and are all referred to a common genus—*Calamites*. Neither from the generic nor the specific names employed, can one distinguish whether one is dealing with pith casts or with the rarer external surfaces of these stems.

In the largest and most recent monograph of this genus, that by Kidston

* Owing to the death of Dr. Arber the final revision of this paper has devolved entirely upon the junior author.

† Stur (1887).

‡ Weiss (1876) (1885).

§ Solms (1891) p. 317.

| Jongmans (1911), Jongmans & Kukuk (1913).

¶ Kidston & Jongmans (1915).

and Jongmans*, an advance copy of the text of which we have had an opportunity of studying, thanks to the kindness of Dr. Kidston, the same arrangement still holds, though here for the first time a systematic attempt is made to discriminate between the two forms of preservation.

It is hardly necessary, however, to point out that incrustations of the external features of the stems of these plants are of an entirely different morphological nature from the medullary casts. It was for this reason that the senior author† of the present paper proposed, in 1916, a new form genus *Calamophloios* for their reception, with the exception of the very distinct type *Dictyocalamites*‡. There are also other considerations to which we shall refer more fully at a later stage (p. 513) which lead us to adopt these genera here, though as will be seen they admittedly involve some difficulties as regards the specific nomenclature.

In the present paper we are concerned rather with the morphology than the taxonomy of these fossils, though since our conclusions on the latter point differ somewhat from those of Kidston and Jongmans in their recent work (1915), we have added a short systematic revision of the British members of these genera which are best known to us. The synonymy of these types is pure in the sense that it excludes all examples which are simply pith casts or at any rate not incrustations of the true external surface.

We take this opportunity of expressing our thanks to Dr. Kidston for the negative of one of the figures here reproduced.

2. *The External Morphology of Calamite Stems.*

It may perhaps be well to commence our study of the external morphology of Calamite stems by some brief reference to the pith casts, the characteristics of which are now; in the light of petrified material, very thoroughly understood. Pith casts always show the following features:—

1. *Nodes* or constrictions of the stem at regular or irregular intervals.
2. *Internodes* or intervals between nodes. These may be long as compared with their breadth or *vice versa*, regular or irregular in size, or again periodic in the arrangement of a series of longer or shorter internodes.
3. *Internodes ridged and grooved*. The ridges may be of all degrees of fineness or coarseness, sharp or flat, broad or narrow. In most Calamites the ridges of one internode alternate in position with those of the internodes next above and below.

In addition, true pith casts, as opposed to sub-medullary casts, may show:

4. *Infranodal canals*. Small prints, formed by the openings of infranodal canals into the pith, one on each rib just below the nodal line.

* Kidston & Jongmans (1915).

† Arber (1916).

‡ Arber (1912).

5. *Branch scars*. These may or may not be present. Where they occur, they are situated just above the node.

Three types of pith casts may be distinguished by the presence or absence of branch scars, and their distribution :

- (a) *Eucalamites*: branch scars occur on every node.
- (b) *Calamitina*: branch scars occur in periodic whorls, each branch-bearing node being separated from the next by a variable number of nodes without branch scars.
- (c) *Stylocalamites*: branch scars absent, or rare, or irregular in distribution.

It has also been pointed out by one of us* that sub-medullary casts are frequent among Calamites. The surfaces of these casts do not represent the periphery of the pith, but a more external region within the secondary wood. These sub-medullary casts are characterised by very broad ribs corresponding to the medullary rays and by the absence of infranodal scars. Since they represent a region external to the pith, they naturally do not show the prints of the openings of the canals into that region. Such sub-medullary casts are specifically indeterminable.

Specimens have also been figured by various authors which show the impression of the secondary wood, and which are neither medullary nor external casts. These need not detain us here. Such examples are easily recognised by the absence of nodes, though in Eucalamitean types one row of branches passing outwards clearly indicates the position of these regions.

On the other hand, casts or impressions of the external features of the stems of Calamites show the following characters :—

1. *Nodes*. It is imagined that these correspond in position to the nodes of the pith, though this fact has not yet been demonstrated. Petrifications are almost silent on the subject of the external features of Calamite stems, since petrified Calamites have so far proved to be almost always decorticated, except in the case of very young twigs.
2. *Internodes*, which may be smooth or longitudinally striated, or partly smooth and partly ridged.
3. *Leaf scars* occurring on the node and representing the points of attachment of the leaves. These, however, are by no means always present.
4. *Branch scars*, which may or may not be present, and which if they occur follow the same types of distribution as are met with in pith casts. (See p. 512.)
5. Other features are *root scars*, frequently present on the nodes, and also in some cases scattered over the surface of the internodes.

We now propose to consider these features more in detail.

* Arber (1918).

Nodes.—The nodes of the external surface of *Calamites* vary somewhat in prominence. In many species they appear to be of the nature of constrictions or shallow grooves, as for instance in the examples of *C. britannicus* and *C. congenius* and other types figured here (cf. Pl. 23. figs. 1 & 2). In other cases the nodes appear to be strongly salient, especially in the case of those nodes which bear branch scars, e. g. *C. Sachsei* (Pl. 24. fig. 16) and *C. verticillatus* (Pl. 24. fig. 18).

Internodes.—The specimens figured on Pls. 23–25 are chosen primarily to exhibit the characters of the internodes in different types, and are not intended to represent the features of all the specimens of the external surfaces of *Calamites* known to us.

In studying the external features of *Calamites* one difficulty in particular is always present. It is often not easy to decide whether the features exhibited by a particular specimen represent a truly external surface or a somewhat decorticated example. It may in fact be found, when better and further examples of some of the types here described are available, that we have mistaken sub-cortical surfaces for the true external surfaces. Thus in the case of some species in which, on the present evidence, we are inclined to think that the external surface was distinctly ribbed and not smooth, it may eventually prove, when better specimens have been obtained, that we have been mistaken in this respect. For the same reason we have perhaps maintained a larger number of species than will eventually be admitted by other workers. With regard to the terminology, we propose, for the sake of convenience, to speak of the more internal surfaces as sub-cortical. It is quite clear from our knowledge of the petrifications of *Calamites* that the features with which we are concerned here are connected with the marked activity of a cork cambium. In fact they are, whether truly external or sub-cortical, botanically of the nature of cork, either periderm or, more probably, phelloderm.

It must also have been the case in regard to these trees, especially the older examples, that the outer corky layers were frequently exfoliated: or else destroyed by decay before preservation. In many cases, however, we think that the true external corky layer is still present.

In perhaps the majority of species of *Calamophloios* known to us the epidermal surface appears to be smooth, but it is nearly always possible to recognise by means of a lens a sub-cortical surface beneath, which is longitudinally striated—the striæ being usually fine, continuous or discontinuous.

This is the case in *C. britannicus* (Pl. 23. fig. 1), *C. rugosus* (fig. 3), *C. Sachsei* (Pl. 24. fig. 16), and *C. undulatus* (figs. 14, 15, and 17). This minute striation also occurs in the case of the foreign species *C. ohlsbachensis* (Sterzel)* and *C. dictyoderma* (Kidst. & Jongm.)†. In other types the

* Sterzel (1907) p. 435, pl. 67. figs. 1, 1a–1c.

† Kidston & Jongmans (1915) p. 50, pl. 50. figs. 1 & 2.

external surfaces of the internodes appear to be strongly striated longitudinally, especially in the case of *C. majus* (Pl. 23. figs. 5, 7, and 9) and *C. verticillatus* (Pl. 24. fig. 18).

This ribbing is even more marked in the foreign species *C. Parrani* (Grand'Eury)*.

In the case of *C. congenius* (Pl. 23. fig. 2) we appear to have a quite unique type so far as Britain is concerned, in which the internode has two distinct regions: a central, with a smooth external surface, and a sub-nodal, above and below the central area, in which the internode is strongly striated longitudinally. The same feature is also seen in the foreign specimen *Calamodendron striatum* of Renault †, and in some examples of *C. multiramis*, Weiss ‡.

In the case of *C. (cruciatus) Försteri* of Sterzel † the internodes between the nodal regions are not smooth, but are finely striated. The internodes are also, here, much longer than in *C. congenius*.

Beginning with those cases in which the external surfaces of the internodes are smooth, in the sense that they are not longitudinally striated, we have but few examples in which the surface is not relieved by ornamentation in some form or other. In the case of *C. Suckowi* (Pl. 24. figs. 11-12) the surface is smooth and featureless, but faint sub-cortical striations can be recognised. In the undetermined specimen shown on Pl. 24. fig. 19, which may possibly represent the external surface of *Calamites Cisti*, the surface is smooth with a delicate sub-cortical ribbing. In other species the bark is ornamented, as it were, in various ways. Sometimes large and well-marked cracks, or shallow grooves, essentially short and irregular, and disposed in various directions, are present. The finer examples of these grooves may be distinguished as wrinkles.

For instance, in *C. britannicus* (Pl. 23. fig. 1) there are two series of these furrows or wrinkles, the greater part of the internodes being wrinkled transversely, whereas below the node there is a series of short vertical grooves. In *C. rugosus* (Pl. 23. figs. 3 and 6) the ornamentation is delicate, and though characteristic is somewhat difficult to describe, the surface of the internode being faintly rugose with numerous crowded irregular shallow pittings. In the case of *C. paleaceus*, Stur §, the surface of the internode appears to us to be almost identical.

In *C. Goepperti* (Pl. 24. fig. 13) one of the features by which this species can be readily recognised is the presence of a number of vertical continuous or discontinuous deep cracks or furrows in the bark, the grooves being

* Grand'Eury (1890) p. 211, pl. 14. figs. 6-8.

† Renault (1890) [in Renault & Zeiller (1888)] p. 457, pl. 54. fig. 5.

‡ Kidston & Jongmans (1915) pl. 114. fig. 1, pl. 117. fig. 1, pl. 127.

§ Sterzel (1893) p. 59, pl. 7. figs. 5 & 6, pl. 8. figs. 1-3.

|| Kidston & Jongmans (1915) pl. 155. figs. 2-3.

unequally spaced. This feature is also seen in the foreign types *C. macrodiscus* Weiss *, and *C. Germanianus* (Goepp.) †.

In *C. undulatus* (Pl. 23. fig. 4, Pl. 24. figs. 15, 17) there are numerous discontinuous grooves or wrinkles, mostly transversely disposed.

These are the chief types of surface ornamentation known to us, and they appear to be often of considerable taxonomic value.

With regard to the species in which the external surface of the internode appears to be longitudinally ribbed there is little that need be said. The ribbing varies considerably in its coarseness. In *C. majus* (Pl. 23. figs. 5, 7, and 9, and especially Pl. 25. fig. 22) it is markedly prominent; in *C. verticillatus* (Pl. 24. fig. 18) the striations are also more or less strong and salient.

In the foreign type *C. pseudogermanianus* ‡ (cf. Pl. 25. fig. 24) the ribbing appears to be less prominent. In *C. discifer* (fig. 23) the striations are very fine and close.

With regard to the sub-cortical striations, which can generally be recognised, they are usually fine and sometimes discontinuous; but in *C. britannicus* they are apparently fairly coarse.

We have here confined our attention almost entirely to the larger stems of *Calamites*. Smaller leafy branches, however, sometimes occur and have been figured by many authors, including Weiss. Some of these show nodal diaphragms. So far as our limited experience of the internodes of these smaller branches is concerned, they appear to be invariably smooth in surface.

Leaf scars.—In our experience leaf scars of species of *Calamophloios* are only rarely distinct. In some types, such as *C. congenius* (Pl. 23. fig. 2) and *C. rugosus* (fig. 3), they are totally unknown. They are perhaps clearest in *C. Goepperti* (Pl. 24. fig. 13) and in the foreign types *C. macrodiscus* § and *C. equisetinus* ||. They are also fairly well seen in some specimens of *C. majus*. But we have observed no examples of the latter species in which they are as clear as in the Liverpool specimen, described a few years ago by Groom and Lewis ¶. We have, in fact, nothing to add to the account of these prints and their variation in shape and size as given by those authors. We may, however, remark that, as a rule, the scars are always approximated and chain-like in form.

Branch scars.—The branch scars on the external surfaces of the *Calamites* closely resemble those so well known on pith casts, and so far as we are

* Weiss (1884) p. 94, pl. 11. fig. 2.

† Kidston & Jongmans (1915) p. 79, pl. 69. fig. 2.

‡ Kidston & Jongmans (1915) pl. 64.

|| Weiss (1885) pl. 1. figs. 1 & 2.

§ Weiss (1884) p. 94, pl. 11. fig. 2.

¶ Groom & Lewis (1912).

aware their distribution is the same in both cases. In size and shape the individual scars vary not only in different species of *Calamophloios* but in different specimens of the same species. As a rule, where the branch scars are approximated they are not all of exactly the same size. They appear to be typically quadrate in form with a central umbilicus. Where the scars in a whorl are crowded the form is sometimes more or less oval or circular. Among British specimens there are, so far as we are aware, no great differences as regards the shape of the branch scars, as there are, for instance, among certain foreign species, especially *C. semicircularis*, Weiss.

In many examples the limits of the branch scars are ill-defined or the details are obscure (cf. Pl. 25. fig. 24).

Root scars.—The prints of root scars vary in size and are indefinite in shape. They are found both at the nodes and also in some cases scattered over the internodes (Pl. 23. fig. 8, Pl. 24. figs. 15, 20, Pl. 25. fig. 21).

3. *The Correlation of Specimens exhibiting the external features of certain stems with their pith casts.*

We now come to consider the possibilities of correlating specimens showing the true external features of the stems of *Calamites* with the pith casts.

Although so little attention has been devoted to the former type of incrustation, we know already that this question presents more difficulties than might at first sight be imagined. It is especially in view of these facts that it has been regarded as necessary to erect the genus *Calamophloios*.

It is only quite rarely that the same specimen shows both the external surface of the stem and the pith cast. This is the case in the specimen of *C. undulatus* (Pl. 24. fig. 15), the reverse side of which shows the pith cast, and in the two examples of *C. Suckowi* (figs. 11, 12) figured here.

As a rule, only one type of preservation is seen in a particular specimen. Supposing that type to be the external surface, can one be certain it always belonged to one particular type of pith cast, or *vice versa*? We think there is already evidence to show that this is not a safe assumption, and that the external surfaces of these stems frequently present stereotyped morphological features.

Dr. Jongmans* has stated that when studying *C. paleaceus*, Stur, he had become convinced that this species must represent the external features of *C. ramosus*. It was only when Dr. Kidston pointed out to him that this could not be the case, since the foliage and fructifications of these two *Calamites* are quite unlike, that he realised that the external surfaces of *C. paleaceus* and *C. ramosus* are practically indistinguishable.

Thus the name *Calamophloios rugosus* Arber, is here used as a type of

* Jongmans (1911) p. 122.

external surface which two distinct species of *Calamites* possess in common. Similarly it is regarded as probable that *Calamophloios Goepperti* as here defined is common to at least two types of pith cast, *Calamitina approximata* Brongn. (= *C. Schützeiformis*, Kidst. & Jong. forma *waldenburgensis*, Kidst. & Jong.*) and *Calamitina varians*, Sternb., but that it possibly does not include all the pith casts known under the latter name. Likewise all pith casts of the *Eucalamites cruciatus* type probably did not have the corresponding external features characteristic of *Calamophloios congenius* as here defined.

The problem is thus not so simple as it looks, and some elasticity in the nomenclature is necessary if it is to represent the known facts.

In general we have attempted to avoid adopting new specific names for the types of *Calamophloios* as compared with the pith casts, except where we know or suspect that stereotyping is markedly in evidence—as regards the external features. At the same time we think it possible that eventually a set of specific names entirely distinct from those of pith casts may be found necessary.

It may also be pointed out here, that a small difficulty arises as regards the nomenclature of *species*, if the same specific name is used for both types of preservation. Thus while a pith cast may be correctly designated as *Calamitina undulatus* (Brongn.), to call the corresponding external surface *Calamophloios undulatus* (Brongn.) would hardly be, strictly speaking, accurate, for there is no reason to believe that Brongniart himself knew of the *external surface* but only of the pith cast of this fossil. Strictly speaking it should be *Calamophloios undulatus* (Goode), since that observer first figured and described the external surface of this fossil. As, however, this method or that of supplying an entirely new name for each type (other than a pith cast) would tend to confusion on the one hand or a multiplicity of specific terms on the other, it seems, for the present at any rate, to be advisable where possible to retain the same specific name for both pith cast and its corresponding external surface. If the name of the authority in brackets after the species is taken to imply not merely a displacement of the genus but a definite emendation (which might, but need not, be written *emend.*), the system can perhaps stand.

With regard to the term *Calamophloios* itself it may be necessary to add a few words. A similar genus *Calamodendrofloios* has already been used both by Grand'Eury † and Renault ‡ in much the same sense as *Calamophloios* here, though with a more limited application relating only to the

* Kidston & Jongmans (1915) p. 101.

† Grand'Eury (1877) p. 293.

‡ Renault & Zeiller (1888) p. 462.

external features of a particular type the pith cast of which is known as *Eucalamites cruciatus* (Sternb.). Grand' Eury's term, however, is not only cumbersome, but it can scarcely be retained now in view of the modern use of the word *Calamodendron*, as applied to one special anatomical type occurring among Calamites. The roots of the words *Calamites* and *Calamodendron* have an entirely distinct meaning, and thus *Calamophloios* appears to us to be preferable.

The following table represents a preliminary attempt to correlate the specimens of British Calamites showing the external surfaces, so far as they are described in the present paper, with their corresponding pith casts. We prefer to keep the genus *Calamites* as a natural genus for the whole plant and not to confine it to fragments of pith casts as a form genus. The form genera which we apply to the external surfaces of stems are *Calamophloios* and *Dictyocalamites*, while for the pith casts we prefer Weiss's terms, *Eucalamites*, *Stylocalamites*, and *Calamitina*, as representing three as natural types as can be expected to be distinguished among such fossils.

For further information on the correlation of other British and of foreign specimens the reader is referred to Kidston and Jongmans' Monograph*.

Correlation of the External Surfaces and Pith Casts of Calamites.

TYPES OF EXTERNAL SURFACE.	CORRESPONDING TYPES OF PITH CASTS.
<i>Calamophloios britannicus</i> (Kidston).	(Unknown).
<i>Calamophloios congenius</i> (Renault).	<i>Eucalamites cruciatus</i> (Sternb.) pars.
<i>Calamophloios rugosus</i> (Arber).	{ <i>Eucalamites ramosus</i> (Artis). <i>Eucalamites paleaceus</i> (Stur).
<i>Calamophloios Goepperti</i> (Ett.).	{ ? <i>Calamitina approximata</i> (Brongn.). ? <i>Calamitina varians</i> (Sternb.) pars.
<i>Calamophloios majus</i> (Feistn.).	? <i>Calamitina varians</i> (Sternb.) pars.
<i>Calamophloios discifer</i> (Weiss).	(Unknown).
<i>Calamophloios Sachsei</i> (Stur).	<i>Calamitina Sachsei</i> (Stur).
<i>Calamophloios undulatus</i> (Sternb.).	<i>Calamitina undulata</i> (Sternb.).
<i>Calamophloios verticillatus</i> (L. & H.).	? <i>Calamitina varians</i> (Sternb.) pars.
<i>Calamophloios Suckowi</i> (Brongn.).	<i>Stylocalamites Suckowi</i> (Brongn.).
(Unknown)? cf. Pl. 24. fig. 19.	<i>Stylocalamites Cisti</i> (Brongn.).
<i>Dictyocalamites Burri</i> (Arber).	(Unknown).

* Kidston & Jongmans (1915).

4. *A Systematic Revision of the British Species of CALAMOPHLOIOS
and DICTYOCALAMITES.*

Genus CALAMOPHLOIOS, Arber, 1916.

(Phil. Trans. R. Soc., Ser. B, vol. 208. p. 140.)

DIAGNOSIS. External surfaces of stems and branches of *Calamites*. Internodes smooth or striated. Striæ not reticulate.

Summary of British Species of CALAMOPHLOIOS.

1. <i>C. britannicus</i> , Weiss	p. 516.
2. <i>C. congenius</i> , Arber	p. 517.
3. <i>C. rugosus</i> , Arber	p. 518.
4. <i>C. Goeperti</i> , Arber	p. 518.
5. <i>C. majus</i> , Arber	p. 520.
6. <i>C. discifer</i> , Arber	p. 521.
7. <i>C. Sachsei</i> , Arber	p. 521.
8. <i>C. undulatus</i> , Arber	p. 522.
9. <i>C. verticillatus</i> , Arber	p. 523.
10. <i>C. Suckowi</i> , Arber	p. 524.
11. Miscellaneous specimens	p. 525.

CALAMOPHLOIOS BRITANNICUS, Weiss MS. (Plate 23. fig. 1.)

1888. *Eucalamites (Calamites) britannicus*, Kidston, Ann. & Mag. Nat. Hist. ser. 6, vol. ii. p. 131, pl. 7.

1909. *Calamites britannicus*, Arber, Foss. Plants, p. 73, fig. on p. 50.

1911. *Calumites britannicus*, Jongmans, Anleit. Bestimm. Karbonpfl. West-Europas, vol. i. p. 123, fig. 118 on p. 123.

1915. *Calamites britannicus*, Kidston & Jongmans, Mededeel. Rijksopspor. Delfstoff. No. 7, p. 160, pl. 119. fig. 1; pl. 122. fig. 2.

DIAGNOSIS.—*Internodes* usually broader than long or of about equal length and breadth.

Bark with smooth surface, with shrinkage cracks or wrinkles. Cracks mostly transverse, short, deep; but in the region of the node the cracks are vertical, well marked, and short. Sub-epidermal surface striated longitudinally.

Leaf scars small, lenticular, approximated or slightly separated.

Branch scars elliptical or oval, several on every node, irregularly distributed, distant.

DESCRIPTION OF SPECIMEN.—The specimen figured on Pl. 23. fig. 1, slightly reduced, shows two nodes, and a complete internode exceeding 10 cms. in length and about 6.5 cms. in height. The surface has the leathery transverse wrinkles which occur also in the case of other species, e. g., *C. undulatus*. There is also a series of short vertical grooves or bark cracks immediately underneath the node. One root scar is seen on the higher, and a branch scar on the lower node. The surface is quite smooth, and there is no sign of

sub-epidermal striation. Possibly where the epidermis is removed and the sub-epidermal structure revealed, the surface might be striated as appears to be the case in Kidston's type. The leaf scars are very indistinct in this specimen.

Small scars occur on the nodes which are probably root scars.

Distribution.

Middle Coal Measures—rare.

South Staffordshire ; Yorkshire.

CALAMOPHLOIOS CONGENIUS, Arber. (Plate 23. fig. 2.)

1890. *Calamodendrophloios congenius*, Renault, Flore foss. Terr. houill. Commentry, part 2, p. 464, pl. 56. fig. 3.

1893. *Calamites (cruciatus) septenarius* var. *fasciatus*, Sterzel, Abhandl. K. Sächs. Gesell. Wissen. (math.-phys. Classe) vol. xix. pp. 58, 75, pl. 8. figs. 4 & 5.

DIAGNOSIS.—*Internodes* very short, regular, 14–15 mm. long, much broader than long. Surface smooth, except on the borders of a node, where there is a small area, both above and especially below the node, in which the surface is strongly striated with very short striæ. Owing to the occurrence of branch scars the margins of these striated areas are sinuate.

Branch scars rounded or elliptical, small, many on each node, somewhat distant, alternating.

Leaf scars unknown.

DESCRIPTION OF SPECIMEN.—The specimen figured on Pl. 23. fig. 2, slightly reduced, is, so far as we are aware, unique from Britain. It was collected by one of us in 1905 from the Upper Coal Measures of the Somerset coal-field. Only part of the specimen—which exceeds 20 cms. in length—is shown in the photograph. It consists of a flattened stem with internodes about 6·5 cms. in width. The internodes are about 15–18 mm. in length and exceedingly regular. Each node bears many small oval branch scars, somewhat distant from one another. For an interval of about 5 mm., both above and below the node, the internode is slightly raised and is strongly striated. Between these striated regions the internode is smooth. The smooth area usually exceeds 1 cm. in length. Leaf scars invisible.

Remarks.—Kidston and Jongmans* include this type under *C. multiramis*, but in our opinion the British specimen figured here and the examples figured by Renault and Sterzel, as indicated in the above synonymy, are entirely distinct from the pith cast named *C. multiramis* by Weiss. It is clear that the characters attributed to the outer surface of this species by Kidston and Jongmans† are quite distinct from those of the present species.

* Kidston & Jongmans (1915) p. 171.

† *Ibid.* p. 172.

Sterzel * says that in his specimen leaf scars exist (Blattspuren vorhanden) and again that the leaf scars are indicated (angedeutet). We are, however, unable to see any trace of these organs in the British specimen.

Distribution.

Upper Coal Measures—very rare.

Radstock coalfield (Somerset).

CALAMOPHLOIOS RUGOSUS, Arber. (Plate 23. figs. 3 & 6.)

1913. *Calamites ramosus* var. *rugosus*, Jongmans & Kukuk, Mededeel. R. Herbarium, Leiden, No. 20, p. 38, pl. 13. figs. 1-3.

1915. *Calamites carinatus* var. *rugosus*, Kidston & Jongmans, Mededeel. Rijksopspor. Delfstoff. No. 7, pl. 41. figs. 1-3.

1916. *Calamophloios rugosus*, Arber, Phil. Trans. Roy. Soc. series B, vol. 208. p. 141, pl. 3. fig. 9.

DIAGNOSIS.—*Internodes* long, usually longer than broad, rugose, with crowded, irregular, shallow pittings. Also very faintly or (?) strongly striated longitudinally.

Branch scars, two on each node, very large with a very large central cavity, alternating in position.

Leaf scars unknown.

DESCRIPTION OF SPECIMENS.—The specimen figured on Pl. 24. fig. 3 shows a node with a fragment of a branch scar, and part of a long internode below. The surface of the internode is rugose, with numerous, crowded, irregular, shallow pittings. The rugose character is less marked here than in some other specimens. The sub-cortical surface is clearly striated longitudinally, as is seen immediately below the node. This ribbing is of the type met with in the pith cast of ?*Calamites Cisti* (see p. 525). A fragment of an internode of another specimen, showing the rugose surface more distinctly, is shown on Pl. 23. fig. 6.

Distribution.

Transition Coal Measures—very rare.

South Staffordshire.

Middle Coal Measures—rare.

Derbyshire; Yorkshire; Kent.

CALAMOPHLOIOS GOEPPERTI, Arber. (Plate 24. fig. 13.)

1854. *Calamites Goepperti*, Ettingshausen, Abhandl. k.-k. Geol. Reichsanst. Wien, vol. ii. part 3, No. 3, p. 27, pl. 1. figs. 3, 4.

1874. *Calamites verticillatus*, Williamson, Phil. Trans. Roy. Soc. vol. 164, pp. 66 & 80, pl. 7. fig. 45.

1875. *Calamitina Göpperti*, Weiss, Abhandl. Geol. Specialk. Preuss. vol. ii. part 1, p. 127, pl. 17. figs. 1 & 2.

* Sterzel (1893) p. 75.

1884. *Calamites (Calamitina) varians inconstans*, Weiss, Abhandl. Geol. Specialk. Preuss vol. v. part 2, pp. 62 & 69, pl. 16 A. figs. 7 & 8; pl. 25. fig. 2.
1884. *Calamites (Calamitina) varians abbreviatus*, Weiss, *ibid.* vol. v. part 2, pp. 62 & 73 pl. 16A. fig. 10.
1886. *Calamophyllites Goepperti*, Zeiller, Flore foss. Bassin houil. Valenciennes, p. 363, pl. 57. fig. 1.
1899. *Calamites varians*, Hofmann & Ryba, Leitpfl. p. 23, pl. 1. fig. 1.
1901. *Calamitina Goepperti*, Kidston, Proc. York. Geol. and Polytech. Soc. vol. xiv. part 2, p. 223, pl. 34. fig. 1.
1901. *Calamitina varians* var. *inconstans*, Kidston, *ibid.* p. 201.
1911. *Calamites Goepperti*, Jongmans, Anleit. Bestimm. Karbonpfl. West-Europas, vol. i. p. 82. figs. 81, 82.
1912. *Calamites (Calamitina) Goepperti*, Vernon, Quart. Journ. Geol. Soc. vol. lxxiii. p. 622, pl. 57. fig. 10.
1913. *Calamites Goepperti*, Jongmans & Kukuk, Mededeel. R. Herbarium, Leiden, No. 20, p. 26, pl. 11. figs. 1-3; pl. 12. figs. 1-3.
1915. *Calamites Goepperti*, Kidston & Jongmans, Mededeel. Rijksopspor. Delfstoff. No. 7, p. 51, pl. 51. figs. 3 & 4; pl. 53. figs. 1-3; pl. 54. figs. 1-3; ? pl. 55. fig. 2; ? pl. 56. fig. 3; ? pl. 61. fig. 3; pl. 65. fig. 1; pl. 66. figs. 1-3.

DIAGNOSIS.—*Length of internodes* very variable, 2-35 mm. Both very short and very long internodes occur. Internodes smooth or only very faintly striated longitudinally, but with distant vertical continuous or discontinuous deep cracks or furrows in the bark unequally spaced.

Leaf scars usually clear, prominent, oval, catenulate or even quadrate, 2-2.5 mm. broad, of medium size or even large, exactly approximated, with a punctate scar in the centre.

Branch scars of medium size or large, usually quadrate or circular or oval, often of unequal size and diameter, approximated, with a central umbilicus, 10 to 12 in a whorl. Internode bearing branch scars usually short. Periods very variable.

? *Root scars* occurring singly on nodes which do not bear branch scars.

DESCRIPTION OF SPECIMEN.—The specimen figured on Pl. 24. fig. 13, natural size, shows part of two periods, in which the internodes are very variable in length. The irregular longitudinal furrows or cracks in the bark are here clearly seen as they are still filled with the coaly matrix, but the surface of the internodes is perfectly smooth. The leaf scars are large, particularly prominent and regular.

Remarks.—Kidston and Jongmans include under this species a number of examples which we here regard as belonging to a separate species—*C. majus*. In *C. Goepperti*, according to our definition, the surface of the internodes is quite smooth, with the exception of the longitudinal cracks or clefts. In *C. majus* the internodes are clearly striated, often markedly so (see p. 520).

Distribution. Frequent.

Transition Coal Measures—rare.

Kent; ? South Wales; South Lancashire.

Middle Coal Measures—infrequent.

Kent; Wyre Forest (North); Warwickshire; Yorkshire.

Lower Coal Measures—very rare.

Yorkshire; Ayrshire.

CALAMOPHLOIOS MAJUS, Arber. (Plate 23. figs. 5, 7 & 9; Plate 26. fig. 22.)

1874. *Cyclocladia major*, Feistmantel, Palæontogr. vol. xxiii. part 1, p. 96, pl. 1. fig. 8.

1884. *Calamites (Calamitina) extensus*, Weiss, Abhandl. Geol. Specialk. Preuss. vol. v. part 2, p. 87, pl. 4. fig. 2.

1889. *Calamitina (Calamites) varians* var. *inconstans*, Kidston, Trans. R. Soc. Edinburgh, vol. xxxv. part 2, p. 398, pl. 1. figs. 1 & 1a.

1911. *Calamites extensus*, Jongmans, Anleit. Bestimm. Karbonpfl. West-Europas, vol. i. p. 91, fig. 89 on p. 91.

1915. *Calamites Goepperti*, Kidston & Jongmans, Mededeel. Rijksopspor. Delfstoff. No. 7, p. 51, pl. 55. figs. 1, 3, 4; pl. 56. figs. 1, 2, 4; pl. 81. fig. 4; pl. 135. figs. 1 & 2; pl. 136. fig. 1.

DIAGNOSIS.—*Internodes* strongly and coarsely striated longitudinally, very variable in length, often a little or distinctly shorter than broad. Periods 6–14, the shortest internode being above the branch-bearing node.

Branch scars of medium size, usually crowded, approximated, more or less quadrate, the angles sometimes rounded.

Leaf scars small, chain-like, oval, circular, or semi-circular, approximated.

DESCRIPTION OF SPECIMENS.—A large specimen, $7\frac{2}{3}$ cms. across, is seen half the natural size on Pl. 23. fig. 5. Here there are more than five internodes in the period which is, however, incomplete. The internodes are broader than long and are distinctly striated longitudinally, the striae being broad and flat. The leaf scars are only faintly preserved. The branch scars are rather small, crowded, and the branch-bearing internode is very short.

One or two internodes from a smaller specimen, 2 cms. across, are shown on Pl. 23. fig. 7, enlarged $1\frac{1}{2}$, to show the nature of the ribbing. The leaf scars are also indistinct here.

Part of a large stem, 11 cms. broad, is represented half natural size on Pl. 23. fig. 9. It shows a node and three complete internodes. The latter are clearly striated longitudinally, as is seen from a part of one of the internodes shown natural size on Pl. 25. fig. 22. The leaf scars are again indistinct.

Remarks.—Kidston and Jongmans* unite the specimens here termed *C. majus* with *C. Goepperti*. We, however, are inclined to maintain both species, for we have seen no conclusive evidence that the type here called *C. majus* is a partly decorticated example of *C. Goepperti*, which it must be if the two species are really identical.

* Kidston & Jongmans (1915) p. 56.

Distribution.

Middle Coal Measures—rare.

South Lancashire; Yorkshire; Derbyshire; Kent.

CALAMOPHLOIOS DISCIFER, Arber. (Plate 25. fig. 23.)

1884. *Calamites (Calamitina) discifer*, Weiss, Abhandl. Geol. Specialk. Preuss. vol. v. part 2, p. 91, pl. 7. fig. 3.

1884. *Calamites (Calamitina) pauciramis*, Weiss, *ibid.* vol. v. part 2, p. 93, pl. 11. fig. 1.

1903. *Calamites (Calamitina) pauciramis*, Kidston, Trans. R. Soc. Edin. vol. xl. part 4, p. 789, pl. 4. fig. 36; pl. 5. fig. 44.

1911. *Calamites discifer*, Jongmans, Anleit. Bestimm. Karbonpfl. West-Europas, p. 106, figs. 102, 103.

1911. *Calamites pauciramis*, Jongmans, *ibid.* p. 105, fig. 101.

1911. *Calamites discifer*, Kidston, Mém. Mus. Roy. Hist. Nat. Belgique, vol. iv. p. 105, pl. 10. fig. 6.

1913. *Calamites discifer*, Jongmans & Kukuk, Mededeel. R. Herbarium, Leiden, No. 20, p. 33, pl. 14. figs. 2, 3.

1915. *Calamites discifer*, Kidston & Jongmans, Mededeel. Rijksopspor. Delfstoff. No. 7, p. 75, pl. 58. fig. 4; pl. 61. fig. 4; pl. 62. fig. 3; pl. 65. fig. 2; pl. 67. figs. 2, 3; pl. 68. fig. 3; pl. 78. fig. 2; and text-figs. 41-44.

DIAGNOSIS.—Internodes of variable length, usually broader than long. Surface smooth, with very fine close longitudinal striations. Branch periods irregular. Branch scars of large or medium size, isolated, oval. Leaf scars circular, rather large, approximated.

DESCRIPTION OF SPECIMEN.—Part of a stem showing several internodes is figured natural size on Pl. 25. fig. 23. This shows the surface of the internode and also a large branch scar. We are indebted to Dr. Kidston for this negative, which is taken from a specimen in his collection.

Distribution.

Middle Coal Measures—very rare.

Canonbie; Yorkshire.

CALAMOPHLOIOS SACHSEI, Arber. (Plate 24. fig. 16.)

1884. *Calamites (Calamitina) varians Sachsei*, Weiss, Abhandl. Geol. Specialk. Preuss. vol. v. part 2, p. 77.

1887. *Calamites Sachsei*, Stur, Abhandl. k.-k. Geol. Reichsanst. Wien, vol. xi. part 2, p. 180, pl. 2. figs. 1, 3, 4 & 5; pl. 2 B. fig. 2; pl. 5. fig. 1; pl. 11. fig. 1.

1887. *Calamites schatzlarensis*, Stur, *ibid.* p. 164, pl. 13. figs. 10, 11.

1911. *Calamites Sachsei*, Jongmans, Anleit. Bestimm. Karbonpfl. West-Europas, vol. i. p. 89, figs. 87 & 88.

1913. *Calamites Sachsei*, Jongmans & Kukuk, Mededeel. R. Herbarium, Leiden, No. 20, p. 29, ? pl. 12. fig. 4.

1915. *Calamites Sachsei*, Kidston & Jongmans, Mededeel. Rijksopspor. Delfstoff. No. 7, p. 60, ? pl. 56. figs. 5 & 6; ? pl. 57. figs. 1-3 & 7; pl. 58. figs. 1, 3; pl. 60. figs. 2, 3; pl. 62. fig. 1; ? pl. 63. figs. 4-6; ? pl. 66. fig. 4.

DIAGNOSIS.—Internodes smooth, with a faint and very fine longitudinal sub-epidermal striation. Internodes usually broader than long. Periods

usually short. Branch-bearing internodes short. Branch scars prominent, rather small or of medium size, quadrate, crowded. Leaf scars approximated, chain-like, small.

DESCRIPTION OF SPECIMEN.—A fragment of a cast showing a very prominent branch-bearing node is seen on Pl. 25. fig. 16, natural size. It also exhibits the smooth surface of the internodes.

Remarks.—This species is not very clearly marked off from *C. Goepperti*. According to Kidston and Jongmans* *C. Goepperti* is distinguished from *C. Sachsei* by its more circular and irregular branch scars and by the usually much shorter internodes.

Distribution.

Middle Coal Measures—very rare.

Wyre Forest (North); Derbyshire; Yorkshire; Durham.

Lower Coal Measures.

Lancashire; Fifeshire; Clackmannanshire.

CALAMOPHLOIOS UNDULATUS, Arber. (Plate 23. fig. 4; Plate 24. figs. 15, 17, ? 14.)

1884. *Calamites* sp., Weiss, Abhandl. Geol. Specialk. Preuss. vol. v. part 2, pp. 22, 27, pl. 17. fig. 2.

1913. *Calamites undulatus*, Goode, Quart. Journ. Geol. Soc. vol. lxi. p. 262, text-fig. 2.

1913. *Calamites cf. undulatus*, Jongmans & Kukuk, Mededeel. R. Herbarium, Leiden, No. 20, p. 10, pl. 7. fig. 4.

1915. *Calamites undulatus*, Kidston & Jongmans, Mededeel. Rijksopspor. Delfstoff. No. 7, p. 5, pl. 1. fig. 1; pl. 2. figs. 1 & 2; pl. 3. fig. 2; pl. 8. ? fig. 1; pl. 9. figs. 1-3; pl. 15. fig. 2; pl. 30. ? figs. 4 & 5.

DIAGNOSIS.—Internodes with smooth surface with numerous transverse, discontinuous grooves or wrinkles. Sub-epidermal longitudinal striations, faint, very fine, ? discontinuous, sinuate. Branch scars rather small, elliptical or circular, approximated. Leaf scars markedly elliptical, approximated. Root scars of varying size, elliptical or circular, abundant both on nodes and ? the internodes.

DESCRIPTION OF SPECIMENS.—Fragments of the external surface of two internodes are seen natural size on Pl. 24. fig. 15. This specimen, which was originally described by Mr. Goode in 1913, is remarkable for the fact that it shows both the external surface and the pith cast of *C. undulatus*. The internodes are quite smooth with close, very fine, wrinkles. Several ? root scars are also seen on the internodes.

Another specimen is shown natural size on Pl. 24. fig. 17. Here two nodes are seen, one of which bears a number of branch scars. The surface is again smooth, but there are numerous short, discontinuous, transverse grooves. The internodes also appear to be very finely striated longitudinally,

* Kidston & Jongmans (1915) p. 57.

the striæ being perhaps discontinuous irregular and wavy. This feature is here possibly better seen than in the former specimen.

Another fragmentary specimen, possibly also belonging to this species, is shown natural size on Pl. **23**. fig. 4. This again exhibits part of a branch-bearing node and two internodes. The transverse wrinkling of the latter is here more prominent than in the other specimens illustrated above. In this case the longitudinal striations are extremely faint.

The transversely elongated form of the leaf scars is here particularly prominent. The specific determination of this specimen is, however, somewhat doubtful.

Another specimen, also of somewhat doubtful determination but possibly *C. undulatus*, is shown natural size on Pl. **24** fig. 14. Two internodes are here seen, the surfaces of which have the same characters as in the specimens above described.

Remarks.—The question whether root scars can occur on the *internodes* of Calamite stems is a disputed one. In the specimen figured on Pl. **24**. fig. 15, as originally pointed out by Goode, there are scars on the *internodes*, which may possibly be interpreted as root scars. Similar specimens have been figured by other authors on several occasions, and these scars occur in the case of several species and also in *Dictyocalamites*. Kidston and Jongmans* regard these scars as due to some damage to the bark during the life of the plant. They add that “the position of these markings precludes the possibility of their being root scars.” From this remark we infer that these authors only recognise as root scars those which are confined to the nodes. We are inclined, however, to regard these internodal scars as marking the position of adventitious roots, at any rate in some cases. Their occurrence is too common† for them to be explained as mere local imperfections of the bark. Until, however, roots are actually found attached, proof of this contention must remain lacking.

Distribution.

Middle Coal Measures—very rare.

Pembrokeshire ; Notts, and Derby.

CALAMOPHLOIOS VERTICILLATUS, Arber. (Plate **24**. fig. 18.)

1835. *Calamites verticillatus*, Lindley & Hutton, Foss. Flora, vol. ii. pl. 139.

1886–1888. ? *Calamophylites verticillatus*, Zeiller, Flore Foss. Bass. houill. Valenciennes p. 360, pl. 57. fig. 2.

1893. *Calamitina verticillata*, Kidston, Trans. Roy. Soc. Edin. vol. xxxvii. part 2, p. 311, pl. 4. fig. 18.

1908. *Calamitina varians*, Renier, Rev. Univ. Mines, etc., series 4, vol. xxi. p. 42, text-fig. 17 on p. 42.

* Kidston & Jongmans (1915) p. 13.

† Kidston & Jongmans (1915) pl. 55. fig. 2.

1910. *Calamites varians*, Renier, Doc. Étude Pal. Terr. houil. p. 17, pl. 45.
 1911. *Calumites verticillatus*, Jongmans, Auleit. Bestimm. Karbonpfl. West-Europas, vol. i. p. 61, fig. 67.
 1912. ? *Calamites* (*Calamitina*) *variens* var. *insignis*, Johnstone, Mem. and Proc. Manchester Lit. and Phil. Soc. vol. lvi. No. 17, pl.
 1915. *Calamites verticillatus*, Kidston & Jongmans, Mededeel. Rijksopspor. Delfstoff. No. 7, p. 71, pl. 51. ? fig. 2 ; pl. 52. ? figs. 3-5, 6 & 7 ; pl. 156. fig. 7.

DIAGNOSIS.—*Internodes* of variable length, strongly striated longitudinally. Striations more or less salient. Branch scars medium to large, circular, elliptic or quadrate, approximated, with a small umbilicus slightly eccentric. Leaf scars small rounded, quadrate, chain-like, approximated.

DESCRIPTION OF SPECIMEN.—The example figured on Pl. 24. fig. 18, natural size, shows a number of internodes and a branch-bearing node. The nodes are distinctly tumid and the internodes are strongly ridged longitudinally ; between the ridges are finer parallel striæ.

Distribution.

Middle Coal Measures—rare.

Yorkshire ; Notts, and Derby.

Lower Coal Measures.

Ayrshire.

CALAMOPHLOIOS SUCKOWI, Arber. (Plate 24. figs. 11-12 ; Plate 25. fig. 21.)

1915. *Calamites Suckowi*, Kidston & Jongmans, Mededeel. Rijksopspor. Delfstoff. No. p. 111, pl. 86. fig. 2.

DIAGNOSIS.—*Internodes* usually broader than long. Surface smooth, with sub-cortical striations. Branch scars absent or very rare. Leaf scars small, distant, obscure.

DESCRIPTION OF SPECIMENS.—The specimen figured on Pl. 24. fig. 11, natural size, appears to be the termination of a branch or rhizome. In the upper part the characteristic pith cast of *C. Suckowi* is seen, while below two internodes, showing external surface, are visible. The surface of these internodes is quite smooth, but there are longitudinal wrinkles and a very faint longitudinal and probably sub-cortical striation can be observed. Leaf scars are small, distant and indistinct.

Another specimen probably belonging to this species is figured on Pl. 25. fig. 21, natural size. This shows four nodes, separated by smooth internodes which are, however, very faintly striated longitudinally. The leaf scars are again indistinct.

Another fragment, similar to that first described, is seen on Pl. 24. fig. 12, somewhat enlarged. On the left-hand side the external features of the internodes are seen, while on the right the pith cast is exposed,

Distribution.

Middle Coal Measures—infrequent.

South Staffordshire ; Notts, and Derby ; Kent.

MISCELLANEOUS SPECIMENS. (Pl. 23. fig. 10 ; Pl. 24. fig. 19 ; Pl. 25. fig. 24.)

In addition, we have seen several specimens, some of which are figured here to show the external features of the internodes, but which, for one reason or another, we have not been able to identify specifically. One of these is shown somewhat enlarged on Pl. 23. fig. 10. It is merely a fragment showing two nodes, one bearing branch scars. The internodes are smooth, with exceedingly fine, discontinuous and close longitudinal striations.

Another specimen is figured on Pl. 24. fig. 19, natural size. The internodes are here fairly long, and the surface is smooth though also finely striated longitudinally. The leaf scars are chain-like and small, and not very distinct individually. We are inclined to regard this example as possibly the external surface of *Stylocalamites Cisti* (Brongn.), but the specific determination is uncertain. Another, somewhat exceptional specimen is shown natural size on Pl. 25. fig. 24, which exhibits part of four internodes. One node shows two somewhat large branch scars, ill-defined as to their limits. The surface of the internodes is smooth, longitudinally wrinkled, especially near the node, and very finely striated longitudinally. The leaf scars are somewhat indistinct. This specimen has been doubtfully referred by Kidston and Jongmans* to their new species *C. pseudogermarianus*.

Kidston and Jongmans† have also recorded from Britain the following species showing external features of *Calamites*, of which we have seen no examples from this country :—

- C. Wedekindi*, Weiss.
- C. semicircularis*, Weiss.
- C. dictyoderma*, Kidst. & Jong.
- C. ohlsbachensis*, Sterzel.
- C. Germarianus*, Goepp.
- C. Schützei*, Stur.
- C. jubatus*, Kidst. & Jong.
- C. paleaceus*, Stur.

Genus DICTYOCALAMITES, Arber, 1912.

(Geol. Mag. dec. 5, vol. ix. p. 97.)

DIAGNOSIS. Stems or rhizomes, with internodes possessing reticulate striations. Roots or root scars numerous, nodal or internodal.

Remarks. When this fossil was first described from Britain, in 1912, no other similar example was known to us. We have since discovered that

* Kidston & Jongmans (1915) p. 85, pl. 59. fig. 4 etc.

† *Ibid.* (1915).

Stur * had figured, in 1887, a more complete specimen from the Schatzlarer Schichten in Silesia. This specimen will be further discussed below. It confirms the provisional conclusion arrived at from the Kentish species, namely that the fossil represents the external surface of a Calamite.

DICTYOCALAMITES BURRI, Arber. (Plate 23. fig. 8; Plate 24. fig. 20.)

1887. Cf. *Calamites Schultzi*, Stur, Abhandl. k.-k. Geol. Reichs. Wien, vol. ii. part 2, p. 73, pl. 6. fig. 2.

1912. *Dictyocalamites Burri*, Arber, Geol. Mag. dec. 5, vol. ix. p. 97, pl. 5. figs. 1, 3 & 5.

DIAGNOSIS.—*Internodes* somewhat variable in length, usually longer than broad. Surface smooth, with prominent, distant, reticulated grooved striæ, forming an elongate network with acute angles, the nodes usually longer than the internodes, reticulations bearing no relation in position to the node, or origin of the roots.

Root scars fairly large, irregularly oval on the nodes and internodes. Roots fairly stout, with fine and close transverse striations.

DESCRIPTION OF SPECIMENS.—The type specimen figured on Pl. 23. fig. 8, nearly twice enlarged, shows the reticulate ridges of an internode and also root scars. Another fragment of the type figured on Pl. 24. fig. 20, likewise nearly twice enlarged, shows a node and part of an internode, the latter having reticulate ridges and root scars.

Remarks.—We are not convinced that the Kentish specimens, which are fragmentary examples obtained from the cores of a boring, are specifically identical with Stur's plant. In the British examples the striations are somewhat closer and more prominent and grooved, the node is better defined, and the root scars are larger and more irregular.

In any case Stur's specific name can hardly stand, since under the name *Calamites Schultzi* he has also figured several pith casts, and there is no evidence that the particular specimen with which we are here concerned belonged to the same plant as the pith casts.

Stur states that the anastomosing striæ on his specimen are artificial and due to the fissuring of the coaly surface of the specimen. However this may be in the case of the Austrian example—and it appears to us to be very unlikely that Stur's explanation is correct—it is certainly not the case in the British fossil.

From Stur's figure one would imagine that this fossil may be a rhizome and not an aerial stem. This again must remain doubtful until further specimens of this rare fossil are available.

It may be also mentioned that according to Sterzel the sub-cortical surface of *Calamites ohlsbachensis* Sterzel † is reticulate.

Distribution.

Transition Coal Measures—Kent coalfields.

* Stur (1887) p. 73, pl. 6. fig. 2.

† Sterzel (1907) p. 437, pl. 67. fig. 1b. *

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- ZEILLER, R. See RENAULT & ZEILLER.

EXPLANATION OF THE PLATES.

(Some of the photographs require examination by means of a hand-lens. All the negatives were taken by Mr. W. Tams of Cambridge except Pl. 23. figs. 1 & 2, which are by Dr. Arber, and Pl. 25. fig. 23 by Dr. Kidston. All the specimens figured except Pl. 25. fig. 23 are in the Carboniferous Plant collections, Sedgwick Museum, Cambridge, to which the numbers refer.)

PLATE 23.

- Fig. 1. *Calamophloios britannicus*, Weiss. Showing the horizontal and vertical series of cracks or furrows in the smooth bark, and also root scars.
From the Middle Coal Measures of Barnsley, Yorks. No. 410. Slightly reduced. ($\times \frac{5}{7}$.)
- Fig. 2. *Calamophloios congenius*, Arber. Showing the ridged regions of the internodes subtending the nodes and separated by areas with smooth bark. Many branch scars are also seen.
From the Upper Coal Measures, Lower Conygre Pit, Tinsbury, Somerset. No. 1363. Slightly reduced. ($\times \frac{5}{8}$.)
- Fig. 3. *Calamophloios rugosus*, Arber. Showing the ornamentation of an internode and an indistinct branch scar.
Transition Coal Measures, Red Clay Series, Granville Clay Pit, Old Hill, South Staffordshire. No. 3322. (*Natural size*.)
- Fig. 4. *Calamophloios undulatus*?, Arber. Showing the transverse wrinkling of the internodes, the leaf scars and two branch scars.
Middle Coal Measures, Bonds Main Colliery, Temple Normanton, Derbyshire. No. 4011. (*Natural size*.)
- Fig. 5. *Calamophloios majus*, Arber. A reduced photograph of a large specimen with several internodes, which are longitudinally ridged. A number of branch scars are seen on the second node above the base of the specimen.
Middle Coal Measures, Mattice Hill Boring, at 1680 ft., Kent. No. 2338. ($\times \frac{1}{2}$.)
- Fig. 6. *Calamophloios rugosus*, Arber. Part of an internode showing the rugose ornamentation.
Middle Coal Measures, Clay Cross, Derbyshire. No. 3398. (*Natural size*.)
- Fig. 7. *Calamophloios majus*, Arber. Enlarged view of internodes to show the ribbing. Branch scars are faintly seen at the summit of the specimen.
Middle Coal Measures, Ripple Boring, at 2666 ft., Kent. No. 2290. ($\times \frac{3}{2}$.)

- Fig. 8. *Dictyocalamites Burri*, Arber. Enlarged photograph of type specimen showing the reticulate ridges of an internode and root scars.

Transition Coal Measures, Barfreston Boring, at 2559 ft., Kent. No. 2225.
($\times \frac{2}{3}$.)

- Fig. 9. *Calamophloios majus*, Arber. Reduced photograph showing the ridged internodes and a whorl of branch scars.

Middle Coal Measures, Bonds Main Colliery, Temple Normanton, Derbyshire No. 3996. ($\times \frac{1}{2}$.)

- Fig. 10. *Calamophloios* sp. Enlarged photograph showing the smooth internodes and a whorl of prominent branch scars.

Lower Coal Measures, Trowel Colliery, Notts. No. 3967. ($\times \frac{4}{3}$.)

PLATE 24.

- Fig. 11. *Calamophloios Suckowi*, Arber. The surface of the lower internodes is smooth, with a faint sub-cortical striation. Towards the upper end of the branch the characteristic pith cast of this species is exposed.

Middle Coal Measures, Newthorpe Clay Pit, Notts. No. 3994. (*Natural size.*)

- Fig. 12. *Calamophloios Suckowi*, Arber. Enlarged photograph showing the external features of the internodes on the left-hand side and the pith cast on the right.

Middle Coal Measures, Newthorpe Clay Pit, Notts. No. 4005. ($\times \frac{2}{3}$.)

- Fig. 13. *Calamophloios Goeperti*, Arber. Showing the smooth internodes with irregular vertical grooves, the leaf scars and a whorl of branch scars.

Middle Coal Measures, Summit Colliery, Derbyshire. No. 3992. (*Natural size.*)

- Fig. 14. *Calamophloios undulatus*?, Arber. Finely ornamented bark of two internodes.

Middle Coal Measures, Digby Clay Pit, Kimberley, Notts. No. 3993.
(*Natural size.*)

- Fig. 15. *Calamophloios undulatus*, Arber. Showing the ornamentation of two internodes and root scars.

Middle Coal Measures, Falling Cliff, Little Haven, Pembrokeshire. No. 2863.
(*Natural size.*)

- Fig. 16. *Calamophloios Sachsei*, Arber. Showing the apparently smooth internodes and a prominent whorl of branch scars.

? Middle Coal Measures, ? locality, Derbyshire. No. 1996. (*Natural size.*)

- Fig. 17. *Calamophloios undulatus*, Arber. Showing the transverse furrows of an internode and a whorl of branch scars.

Middle Coal Measures, Brethby Clay Pit, Derbyshire. No. 3991. (*Natural size.*)

- Fig. 18. *Calamophloios verticillatus*, Arber. Showing the longitudinally ridged internodes and a whorl of branch scars.

Middle Coal Measures, Newthorpe Clay Pit, Notts. No. 2736. (*Natural size.*)

- Fig. 19. *Calamophloios Cisti*?, Arber. Showing smooth internodes, with sub-cortical ridging. (Unfortunately turned upside down in reproduction.)

Middle Coal Measures, Mattice Hill Boring, at 1276 ft., Sandwich, Kent. No. 2339. (*Natural size.*)

- Fig. 20. *Dictyocalamites Burri*, Arber. Enlarged photograph of the type specimen, showing a node and part of an internode with reticulate ridges and root scars.

Transition Coal Measures, Barfreston Boring, at 2559 ft., Kent. No. 2225.
($\times \frac{2}{3}$.)

PLATE 25.

Fig. 21. *Calamophloios Suckowi*?, Arber. Three internodes with smooth surfaces, but showing faint sub-cortical striations.

From the Middle Coal Measures, Ten-foot Ironstone, Claycroft Openwork, Cosely, South Staffordshire. No. 3709. (*Natural size.*)

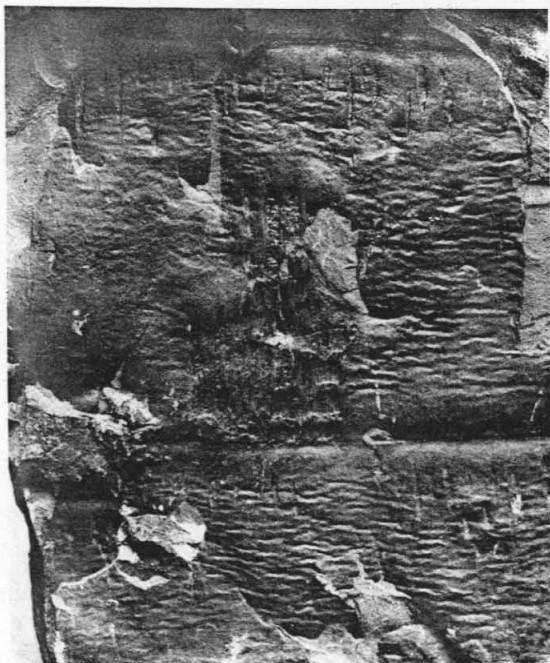
Fig. 22. *Calamophloios majus*, Arber. Part of one of the internodes shown on Pl. 23. fig. 9, natural size, to exhibit the ribbing. Some branch scars are also partly seen at the top of the photograph.

Fig. 23. *Calamophloios discifer*, Arber. A specimen showing several internodes and one large branch scar. Several leaves are still attached at the nodes. The surface of the internodes is smooth with a fine longitudinal sub-cortical striation.

From the Middle Coal Measures of Canonbie, Dumfries. No. K/3144 in Dr. Kidston's collection. (*Natural size.*)

Fig. 24. *Calamophloios pseudogermanicus*?, Arber. A specimen with smooth internodes, showing two large branch scars.

From the Upper Coal Measures of New Fancy Colliery, Forest of Dean, Gloucestershire. No. 1723. (*Natural size.*)



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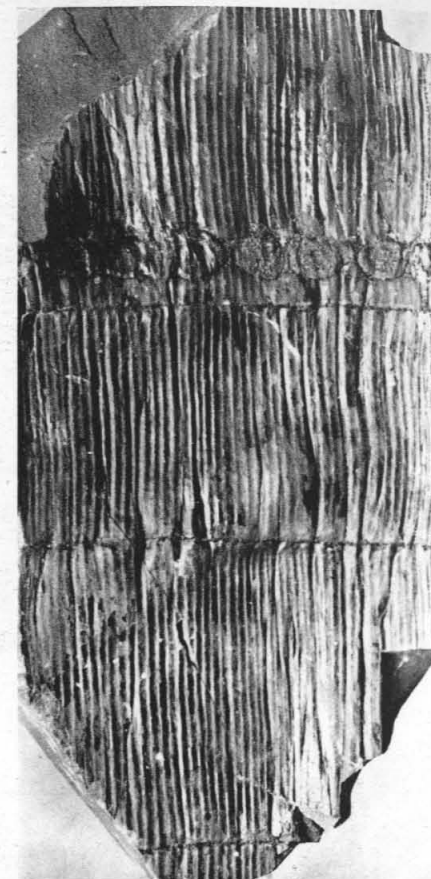
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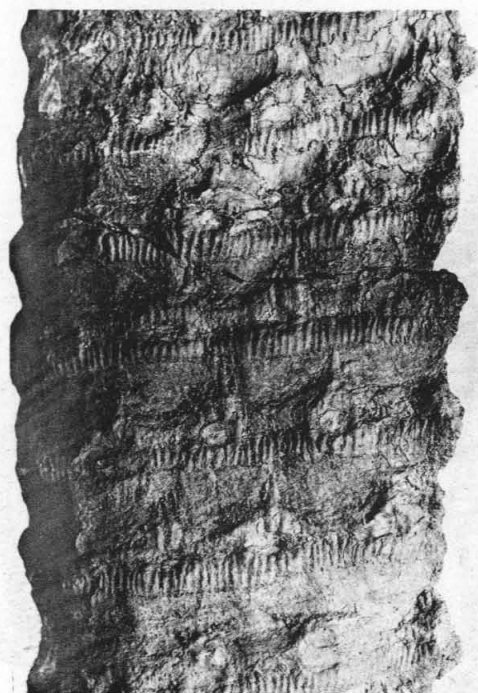
5 x $\frac{1}{2}$.



7 x $\frac{1}{2}$.



9 x $\frac{1}{2}$.



2 x $\frac{5}{6}$.



4.



6.



8 x $\frac{4}{5}$.

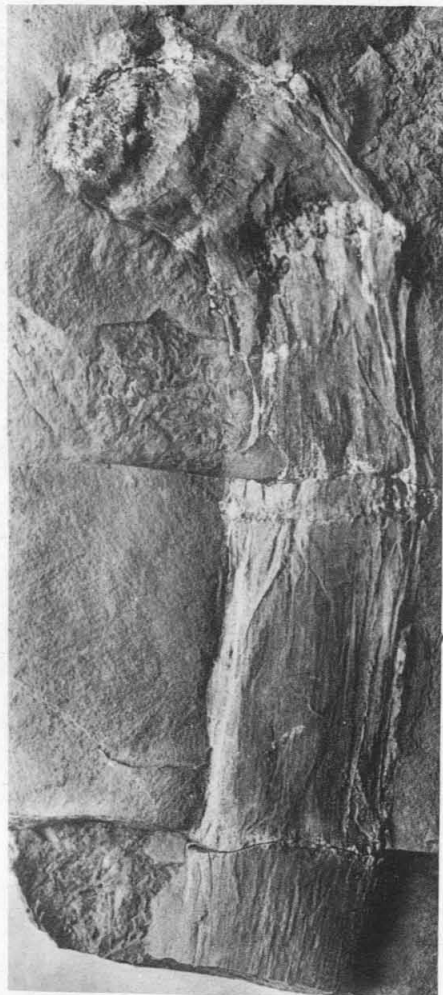


10 x $\frac{4}{3}$.

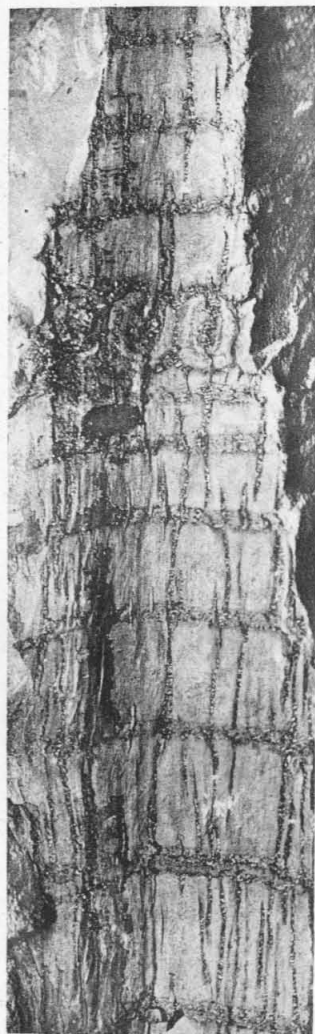
E.A.N.A. et W. Tams photo.

CALAMOPHLOIOS DICTYOCALAMITES.

Huth coll.



11.



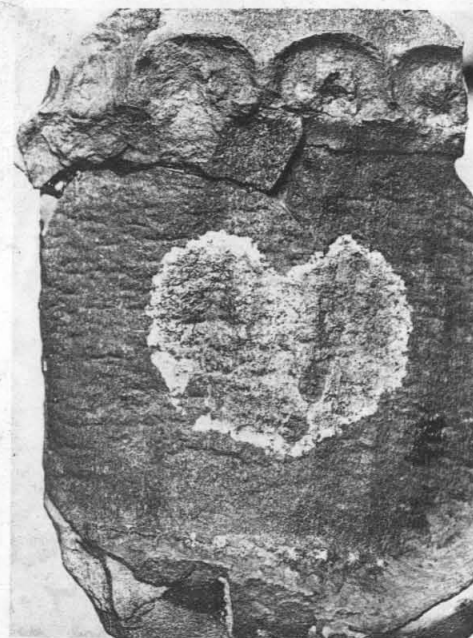
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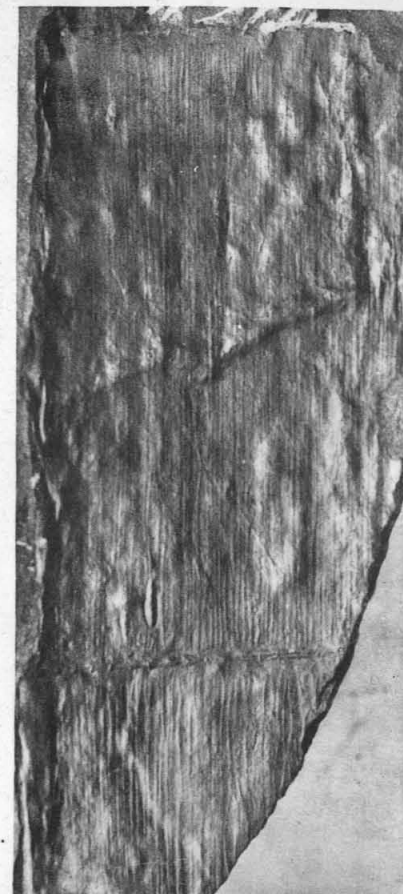
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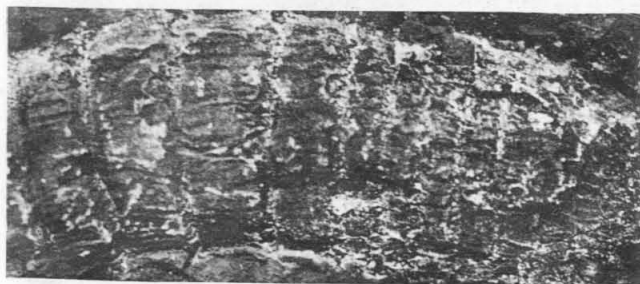
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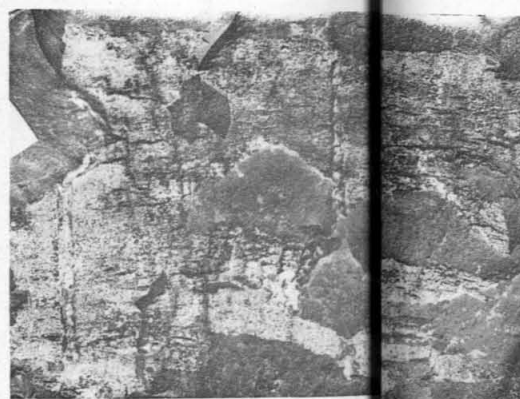
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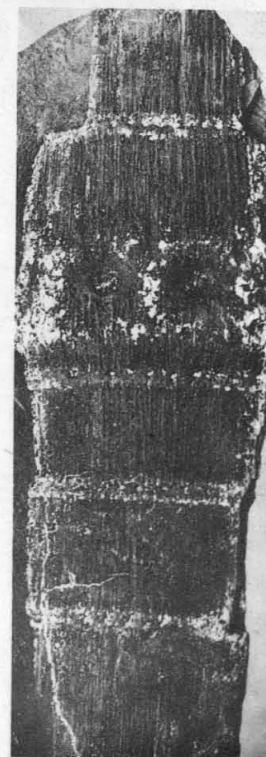
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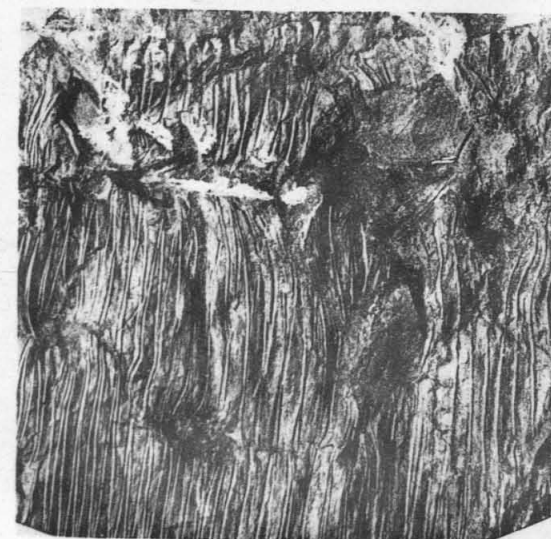
12 x 3/2.



14.



18.



20 x 9/5.



21.



23.



22.

E.A.N.A. & W. Tame photo.



24.

Huth coll.

CALAMOPHLOIOS.