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PRELIMINARY REPORT ON EQUISETALEAN PLANTS FROM LIDGETTON, NATAL

by

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ABSTRACT

Fossils of *Equisetum*-like plants from a site near Lidgetton, Natal, South Africa (29°26′S, 30°07′E) are described. These comprise rhizomes bearing roots, stems of varying width showing external and some internal structure (especially nodal markings and vasculature), and ultimate branchlets bearing leaf whorls. No reproductive organs were found. A tentative decision is reached that they are parts of plants of a single genus, perhaps even a single species, and that relationship is closest to *Equisetites* Sternberg.

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INTRODUCTION

Prior to 1929 macroscopic plant remains were taken from accessible parts of a bed of shale exposed in a small stream at Lidgetton about 35 kilometres north-west of Pietermaritzburg at 29°26′S, 30°07′E. According to Thomas (1958), to whom the plant remains were sent, they were of two main types: firstly a series of leaves and leaf-like organs of various sizes, including shorter scale-leaves without a midrib, all referable to the form genus *Glossopteris*, and secondly "... parts of equisetalean plants, stems, pith-casts, branches and leaves." Of these last named fossils this author wrote

> "These may belong to the form called by Du Toit (1927, p. 315) *Neocalamites carreri* Zeiller, but, from the more abundant material present in this collection, it is clear that the plant differed very considerably from the species described by Zeiller."

The equisetalean fossils enumerated by Du Toit (1927) were from Molteno beds near Dordrecht, Cape Province and near Fletcherville, East Griqualand and thus were of Triassic age and younger than the Lower Beaufort specimens from Lidgetton. The first of the Molteno plants (Du Toit no. 833) was a short section of flattened stem showing a node with attached leaf sheath that ended in 18 short free teeth each only 2 mm long. This was tentatively compared with *Equisetites platyodon* Schönlein and Schenck, 1865, from the Middle Keuper of Germany, which had about the same number of free leaf teeth at a node. Two other specimens (Du Toit nos. 8329 and 5806) were referred to *Neocalamites carreri* Zeiller. These showed (no. 8329) a node with external stem surface carrying a leaf whorl consisting of about 60 free leaves, at least 5 cm long in some cases, that broadened and overlapped basally (visible internally were narrow longitudinal ridges and the under surface of a nodal diaphragm), and (no. 5806) the exterior of a portion of stem with the shallow fluted internodal surface traversed by extremely fine striations and with about 18 leaf scars situated immediately beneath each of the two nodal lines present. Other specimens from Duart Castle, Hlatimbe Valley, Natal, were striated moulds with the ridges and grooves continuous in their course from one internode to the next, a feature regarded as characteristic of *Neocalamites*.

Thomas (1958) made no other reference to the "equisetalean plants" from Lidgetton, neither describing them further nor contrasting them with the Triassic plants described by Du Toit (1927). Plumstead (1969, Pl. XVI, 1) referred ribbed and jointed Permian stems superficially similar to many from Lidgetton to *Paracalamites* Zalessky (1927). In so doing she followed Rigby (1966), who proposed that unidentifiable stem fragments from Lower Gondwana deposits frequently referred to as *Phyllotheca* sp. or *Schizoneura* sp. should be described as *Paracalamites*. According to Zalessky, the

stems referable to the form genus *Paracalamites* have ribs of the pith cast opposite at each node. Townrow (1955) in an amended diagnosis of *Phyllotheca* adopted a maximum diameter of "up to 2 cm" for main stems. Many of the stems from Lidgetton exceed this size, Dix (1974) having recorded widths up to 4 cm. Thus, at present, there is no clarity as to the name, or names, if more than one type is represented there, that should be applied to the parts of equisetalean plants at the Lidgetton site.

The purpose of this paper is to record, in the form of a preliminary report, the more important structural features and range of variation of these equisetalean specimens. It may also be possible to come to some conclusion as to whether one, or more, taxa are present and to refer a tentative name, or names, to these.

MATERIAL AND METHODS

The bulk material collected in the field has yielded hand specimens that will be housed in the Natal Museum, Pietermaritzburg. The plants occur as impressions and incrustations or as what have been previously interpreted as pith casts, all of which sometimes show cellular patterns, occasionally with great clarity. In a later paper this cellular detail will be studied more closely and the carbon that remains in many of the incrustations will be treated in an endeavour to make cuticular preparations.

The present paper deals mainly with macroscopic plant parts which have been studied under a binocular microscope with strong low-angle unilateral illumination from a Tiyoda 8,8V 5A focusing bench light.

THE PLANT PARTS

Stems

Portions of stems of varying lengths (from a few mm up to 24 cm) and widths (from 2 mm to 6,8 cm), all comprising short nodes alternating regularly with shorter or longer, ribbed and furrowed internodes, lie side by side or occasionally cross one another in the matrix. Up to seven, usually all of approximately the same size range, may occur on a single hand specimen. Generally only the narrow stems carry whorls of leaves and thus can be immediately orientated in relation to base and apex. The wider stems that appear to lack leaves do not all exhibit similar superficial markings and thus need careful interpretation if external surfaces are to be correctly distinguished from internal casts, and distal and proximal ends accurately recognized. An attempt has been made to sort the equisetalean stem fossils into types and to interpret these. A summary of the more important findings follows.

Stems thought to exhibit external features

(i) *Stems that appear to carry roots.* (Figures 1, 5)

Four stems from 2,0–5,5 cm in width show the presence of a dense cluster of dichotomously branching, non-articulated, smooth surfaced outgrowths laterally from a node or from two successive nodes. The form and position of the outgrowths and the angles at which they lie to the stems suggest that they are roots — richly branched roots as would be in keeping with plants growing in water. A number of other stems, some wider, some narrower, show aggregations of similar outgrowths in close proximity.

If these outgrowths are roots, then the stems bearing them were probably below the surface of the substrate and thus should be interpreted as rhizomes. The markings they carry must be those of the external rhizome surface since, if they were pith casts, root attachment would not be visible. That these stems are rhizomes is supported further by the next stem category.

(ii) *Stems that exceed 4 cm in width.* (Figures 1, 2)

Of 57 stems measured, 14 were 4 cm or more in width (limits 4,0–6,8 cm: mean 5,3 cm). These widest stems comprised internodes (length limits 16,5–42,0 mm: mean 25,8 mm) with the nodes giving the impression of being numerous and closely placed because of the width of the stems. Many of the stems were curved, not straight. This curvature, together with the apparent shortness of the internodes, suggests the stems were not aerial and thus probably were rhizomes. None of these wide stems showed the presence of whorls of leaves. Nodal markings were clearly defined and more or less uniform and will be considered later.

(iii) *Stems from 0,5 to 3,9 cm in width.* (Figure 13)

Of the remaining 43 stems, 37 fell within 1,0–3,9: mean 2,1 cm in width, while 6 were between 1,0 and 0,5: mean 0,75 cm in width. These stems of intermediate width had internodes that appeared longer than those of the widest stems (length limits 5–43 mm: mean 19,7 mm) (ratio of node length: node width for stems of intermediate width 10:1; for wide stems 5:1). These stems were mostly straight or only very slightly curved, which is suggestive of aerial growth. Because of their narrower width they gave the fallacious impression that their internodes were longer than were those of the widest stems. They also lacked intact leaf whorls, but there are some specimens in which basal fragments of a sheath might be present, while a very few show evidence of a few free leaf segments lying close to the stem and possibly still attached to the sheath which, in turn, is fused to the stem. The nodes, especially in the case of the incrustations, were mostly clearly defined but any markings were usually less definite and detailed and thus more difficult to interpret than those of the wider stems.

(iv) *Stems less than 0,5 cm in width.* (Figure 18)

Fragments of stems under 0,5 cm in width are frequent in the matrix. Lengths of from under a centimetre to up to about 10 cm occur. These obviously exhibit features of external form, for a leaf whorl is present at every node. This means that no nodal markings are visible. Each leaf whorl is narrowest at the node where it is attached, and gradually widens to the mouth of the leaf sheath from where free leaf segments curve upwards and usually inwards. Thus the fused bases of each leaf whorl form an enveloping cup-like leaf-sheath

round an internode. The sheath, because of its greater width at the mouth, stands away slightly from the internode and thus gives a characteristic form to the stem as a whole. Usually only few leaf segments are present on each sheath, a majority of these probably having been lost before, or during, fossilization.

Twelve of these narrow stem portions were measured. The parameters obtained are summarized as follows:

(a) Overall stem length: limits 2–7,5 cm: mean 4,0 cm.
(b) Leaf sheath length: limits 5–7,5 mm: mean 6,5 mm; (measured from narrowest point of the stem — the node — to the mouth of the sheath).
(c) Leaf sheath width at point of attachment to stem: limits 1,3–3,0 mm: mean 2,4 mm;
(d) Leaf sheath width at mouth: limits 2,7–4,0 mm: mean 3,6 mm.

The maximum number of leaves visible at any single node was seven, which number appeared to span, without any break, the diameter of a flattened narrow stem, thus suggesting the total number of leaves at a node was probably about fourteen.

(v) *Nodal markings.* (Figures 6, 7, 9, 14, 23, 28, 29)

On all the stems considered so far, the nodal markings appear to be of the same general pattern, but the details vary according to the quality of the fossil and whether this is an impression or an incrustation, from stem to stem, node to node on the same stem, and sometimes from one side of a node to the other.

Where the nodal markings are seen from what appears to be the external stem surface they consist of two parallel horizontal lines that extend across the stem and demarcate the depth of the nodal area. Between these lines are a series of evenly placed, more or less oval, or arched, flat or slightly depressed scars. In the best specimens each scar carries at one end a small, often slightly raised, sometimes flat or depressed, mark. Each oval scar is separated from the one to left and right of it by a narrow vertical furrow or depression, the shoulders of which are raised to form two slightly raised ridges that border the furrow. Usually the furrows that separate the oval scars extend from the nodal area on to one of the adjacent internodes more pronouncedly than on to the other. It is on the two raised ridges that border each of these furrows that cellular texture (usually isodiametric or slightly oblong cells) is sometimes visible. The internode that does not show the more pronounced furrows is usually almost smooth, but may sometimes show faint cellular markings also.

It seems that these nodal markings are exposed when the leaf-sheath of fused leaf bases is lost. Each oval scar appears to be the area of attachment of a leaf, and the raised mark within it the position at which a vascular strand entered the leaf. It is difficult to be certain whether these vascular scars were basal or apical on the scar. By consideration of other stem markings it seems reasonable to conclude that the internode with more pronounced furrows and ridges was likely to have been the meristematic base of the internode above the node that, in the living plant, was covered and protected by the fused bases of the leaves. The lower of the two parallel lines demarcating the area of the node is likely thus to represent the lower line of attachment of the leaf whorl, and the more or less smooth appearance of the internode below probably results from the continuity during development of this internode and the leaf sheath. If this interpretation is accepted then the vascular scars are situated at the upper ends of the leaf scars. This then permits orientation of most of the fossil stem fragments and allows more valid comparisons to be made between them. In some cases the impressions appear to show nodal structure from the inner surface. Here the nodal markings are less clear and thus more difficult to interpret.

(vi) *Branch scars.* (Figure 12)

In a few stem fragments, one or two depressed areas elliptic to almost circular in outline occur above or below a node. When more than one is present they lie in the same horizontal line and are suggestive of scars left where branches have emerged. If the interpretation of nodal markings suggested above is followed, these branch scars lie above the node, which is not, however, in keeping with the branching of extant equisetalean stems, where, when the leaf whorl is removed, the branch scars lie on the line of the nodal plate. Nor do they agree with the photograph shown by Lacey and Huard-Moine, 1966 (Pl. 1, 5.) in which a branch stem appears attached directly at a node. So far no branches that clearly show attachment to larger stems have been seen among the fossils from Lidgetton.

(vii) *Stem ridges.* (Figure 13)

The number of ridges on the internodal portions of the stem fragments varies widely, and counts from 6–44 have been made. In counting it is often difficult to interpret ridges with accuracy. As might be anticipated, ridge number appears to relate to stem width, the widest rhizomal (?) portions carrying the most ridges.

The ridges of one stem internode generally appear to alternate with those of the internodes above and below, but it is difficult to interpret their courses accurately. At this stage it is best to state that there is often alternation, but there may be variation.

(viii) *Uncertain features.* (Figures 11, 26, 27)

One specimen, a fragment of stem 3,5 cm in length, 0,6 cm in width, clearly ridged and furrowed and with part of a node evident, carries a number of narrowly elliptic, slightly depressed scars orientated with their longitudinal axes parallel with the ridging of the stem. Immediately above the node these scars lie in a horizontal row, but on the internode they are scattered: 25 scars are present in all. Each has a fine raised line running down the longitudinal axis of symmetry. Some appear to be reversed in relation to others. It may be that these are the marks of attachment of the dichotomously branched, non-articulated, smooth surfaced outgrowths so frequent in the matrix that have been interpreted as roots, but this is

far too uncertain to be suggested except very tentatively. That they represent points of attachment of fertile units is almost as unlikely, since in the equisetalean plants both reproductive branches, and sporangiophores, are usually whorled and at nodes.

Seven stem fragments (length limits 13–30 mm; mean 21 mm; max. width limits 7–15 mm; mean 11 mm) appear to represent the apices of what must have been actively growing stems, for in each case the tip is overarched by a "brush" of fine leaves arising from successive nodes that are closely placed with only short internodes between them. In each of three specimens, 5, 5 and 6 nodes could be detected from the base upwards before the closely packed leaves obliterated the outlines. The clearest of these nodes were measured and were successively 3,5; 2,5; 2,5 mm long and 3,0; 3,5; 3,7 mm wide. The leaves are similar to those of the narrow stems described under (iv) above.

Stems thought to exhibit internal features

(i) *In the longitudinal plane.* (Figures l0, 20, 21, 22, also 2)

Many stem fragments were sorted from the stems that have been considered so far because of differences in the nature of the nodes and the markings present at these nodes. This new group comprises stems all of which fall within the length and width ranges described above. They were not grouped into the same size ranges, however, since this did not seem useful.

These stem fossils consist of a series of vertical parallel ribs that run the length of an internode and which are separated from one another by an equivalent number of long narrow areas occupied by matrix. At each node the ribs link to form a continuous transverse band approximately the same depth as the nodes in the fossils dealt with above, before continuing again as ribs through the next successive internode. There is no alternation of ribs from one internode to the next; instead they follow in the same line. Occasionally, however, two adjacent ribs become confluent in the next internode, thus reducing the overall number. The nodes do not exhibit markings of the kind represented in stems grouped above. Instead the ribs often show fine longitudinal striations some of which, at a node, turn almost horizontally, before turning again to pass out into the adjacent rib of the next internode, while others continue through the node without altering direction. Some specimens, in addition to these fine striations, show imprints of oblong cells on the flanks of the ridges. These are the only markings represented.

These fossils are interpreted as follows. Presumably as burial of the plant fragments takes place, the stems are flattened. During and prior to this process, partial or complete infilling of the central pith cavity must occur. This central cavity, with collapse, if not decay, of the lining cells (presumably parenchymatous tissue), must have an inner ridged and furrowed form similar to that of the outer stem surface. After fossilization and subsequent exposure, shearing of the shale must take place through the tissue of the stem at a point that either exposes the inner stem surface adjacent to the pith cavity or, more likely, that passes through the tissue of the stem itself, thus exposing as fine lines the course of the cells through internode and node.

(ii) *In the transverse plane.* (Figures 16, 17)

In frequent association with the equisetalean stem fragments are circular plates showing a uniform and usually well defined pattern of small isodiametric cells. These plates are either flat, slightly convex, or occasionally just concave. Usually they are complete, sometimes they lack a central area, occasionally only a sector is visible. Thirty complete discs were located and measured: ten more were sufficiently complete for measurement to be possible. The size range of these forty discs was from 5,0–16,0 mm: mean 9,4 mm in diameter. Two specimens were found in which a disc of this kind formed the transverse plate at a stem node (see Figure 15 for one of these). They are interpreted as being the transverse nodal diaphragms that became detached from the stems with partial decay or damage. This interpretation appears to be supported by the finding of three specimens in which two diaphragms occurred at different levels in the matrix, the one partly covering the other. One specimen consists of two diaphragms, separate from one another, lying close together (Figure 16). Another specimen comprises a portion of a stem, partially broken up, with seven diaphragms associated with it: these occur in two groups of two (in each of which the plates partially overlay one another) and three isolated, partially hidden units.

Leaves (Figures 4, 18, 24, 25)

The free leaf segments on both the narrow stems and the stem apices appear to be of the same type. They are from 5–10 mm in length and taper gradually to an acute apex from a base about one millimetre in width. With the exception of one isolated leaf sheath in which the free segments are well spread from one another, each showing clearly what appears to be a central unbranched midvein (not illustrated), all free leaf segments appear to be without defined veins. The margins are entire and unspecialized. The apparent absence of veins from the leaf segments needs explanation in view of the marks on the leaf scars that are interpreted as vascular scars. It is possible the vascular traces terminated soon after entering the leaf sheath and did not continue into the leaf segments.

Roots (Figures 3, 30)

Structures that have been interpreted as roots (see (i) p. 44) were smooth-surfaced and completely lacked nodes and internodes. Fragments are extremely frequent and are scattered throughout much of the matrix. They are least common in those specimens that carry straight lengths of stem interpreted as being aerial in growth. Some portions as much as 6 cm in length and 3 mm in width, narrowing gradually towards the tip, are present. These branch frequently and irregularly along their length, the angle of each branch being usually less than 90° (often ±45°) to the main axis.

These branches re-branch repeatedly, the ultimate or penultimate forkings always being dichotomous. There is no evidence whatever of appendages having been borne upon these structures, nor have wider, more robust branches that could have been major axes of a smooth-stemmed plant been found.

COMPARISON OF STRUCTURAL FEATURES OF EQUISETALEAN PLANT FOSSILS WITH THOSE OF AN EXTANT SPECIES OF *EQUISETUM*

In Southern Africa one species of articulate is extant. This is *Equisetum ramosissimum* Desf., a perennial herb with an underground rhizome dark brown in colour and erect, straight aerial stems that carry, at each node, a whorl of leaves, the bases of which are fused marginally to sheath the stem while the free segments are elongate, filiform, early drying and thus readily broken off. When the elongate apices do break, they leave minute fragments attached to the sheath that are sometimes erroneously interpreted as representing the full leaf length.

By comparison of features of this plant with those of the equisetalean fossils from Lidgetton, it is not intended to imply that relationship exists between them, apart from the fact that all fall within the division Sphenopsida. It seemed possible that by study of a living species of *Equisetum*, some information relevant to the interpretation of structural features of the fossils might be obtained.

The following points have emerged:

(i) Plants of *Equisetum ramosissimum* growing in 30–40 cm of water above a muddy substrate produced many adventitious roots. These roots were smooth and showed no evidence of the ridges and furrows that characterized the stem internodes. Branches to these roots were frequent, and irregularly placed. The ultimate divisions were difficult to trace but did not appear dichotomous. Main roots were developed in a circle from below a stem node, never along the internodes.

(ii) When a leaf whorl was removed from an aerial stem, a narrow zone of markings somewhat similar to those on the fossil stems considered above, but much more faintly marked, was revealed. The leaf whorl did not abscise cleanly and some epidermal tissue from the internode below was removed with it (Figure 34). The vascular traces appeared to enter the leaves high on the nodal scar.

(iii) On older parts of the living rhizome the leaf whorls were almost entirely decayed away leaving an irregular ledge at the node: on younger parts the leaf whorls were intact.

(iv) Internodes of the rhizome were far less obviously ridged and furrowed than were internodes of the aerial stems.

(v) Nodal diaphragms carried isodiametric cellular markings.

DISCUSSION

The parts of equisetalean fossil plants described in this paper have been interpreted as large leafless rhizomes carrying well branched roots; portions of leafless, unbranched, narrower stems that presumably were aerial; apices of these stems that carried simple linear leaves from the nodes, each leaf possibly with a single midvein but usually appearing to lack venation; fragments of narrow stems (presumably ultimate branchlets of larger stems) with a whorl of leaves of the simple type described above at each node, these leaves being fused by their bases into a cup-like sheath that enveloped the stem, but stood away from it at the widened mouth; fragments of stems broken in half, or possibly in tangential section, to reveal the internal anastomoses of the conducting tissues; finally, displaced nodal diaphragms.

Two diaphragms have been found in position (each at the node of an isolated stem fragment), and roots appear to be in direct connection with stem nodes, but apart from these instances, no evidence of direct relationship of plant parts has been obtained. At the same time no discordant evidence exists to suggest that these parts may not, in life, have been united into organisms of one kind, possibly a single species, almost certainly a single genus.

Despite careful searching, no indications whatever of reproductive organs have been detected. Groups of sporangia of the *Arberiella* type are not infrequent in the matrix but these must have been detached from scale-leaves of *Eretmonia*, since scale-leaves bearing sporangia are occasionally present.

The equisetalean vegetative fragments alone are, however, sufficiently characteristic to attempt identification. The large size of some of the rhizomes suggests a reasonable duration of growth for these. Presumably the plants of which they formed part were perennial. This is further supported by anatomical evidence obtained from acetate "pulls", one of which (Figure 19) shows what is almost certainly secondary conducting tissue in a fragment of stem that was sectioned transversely.

Broad comparison of the fossils with plants of an extant species of *Equisetum* suggests that the Lidgetton fragments probably came from plants constructed on the same general pattern as is *Equisetum*, but which were very much larger and which underwent secondary thickening. Many of the widest stems were probably rhizomes developed under water. This might afford explanation of why leaf whorls are completely lacking from the wider stems (rhizomes), whereas they are present on the slender branchlets. The wide stems must have attained their size over a reasonably long period of growth. Thus, firstly, the internodes must have become fixed in length, the meristematic zone at the internodal base, by this time, having probably lost the capacity for cell division. Secondly, after so long a period in water, and with increase in rhizome width, the leaf whorl probably fragmented and decayed away, leaving the nodal markings clearly defined.

The Lidgetton stems relate closely to leafless sphenopsid stems of Middle to Upper Ecca age from Wankie, Rhodesia that were described, but not assigned to any particular genus, by Lacey and Huard-Moine (1966). These authors commented that in their stems the longitudinal striations appeared to alternate at the nodes. They ascribed this to possible twisting of the specimen before compression. Some evidence for alternation of striations (ridges) from one internode to the next has been obtained from the Lidgetton fossils, so possibly this is characteristic of these plants and not the result of twisting. If so, it is another point of relationship with *Equisetum*.

Paracalamites is a form genus to which the isolated stem fragments from Lidgetton could be referred. However, there seems little to be gained by this, for there appears to be confusion as to the path of the ridges through the nodes in stems referred to it, for Rigby (1966) states:

> "Zalessky erected this genus [*Paracalamites*] in 1932 [*sic*] to include Permian articulate stems and rhizomes having the ribs of the pith cast opposite at each node, as in *Asterocalamites*, not alternating."

Later Rigby continues:

> "From *Paracalamites* sp. described below it is thought that ribs dichotomise and recombine with adjacent ribs at nodes rather than dichotomise and recombine with themselves as in *Asterocalamites* . . ."

He then goes on to describe the specimen as follows:

> "Ribbing is distinct in only a few places. It is opposite at nodes on both the inner and outer surfaces."

There is some slight resemblance to *Stellotheca robusta* (Feistmantel) Surange and Prakash in the cup-like base to the leaf whorl (Rigby, 1966, p. 48), but there the relationship ends.

Perhaps one of the most valuable contributions that will be derived from study of the Lidgetton sphenopsids will prove to be the better understanding of nodal markings and nodal and internodal structures that these fossils provide. With such information available, re-study of Du Toit's (1927) Triassic sphenopsids should be undertaken. Comparisons should also be made against the types of already established genera and species. In this way definite conclusions may be possible as to whether the Lidgetton fossils are distinctive and worthy of description as new, as appears to be the case at present, or whether they should be referred to a genus and species, or perhaps to genera and species, already established. There seems little doubt that the affinities of these Lidgetton specimens lie with Equisetales rather than with Sphenophyllales, and with Equisetaceae rather than with Calamitaceae. It is tempting to take this further and to suggest the relationship lies with *Equisetites*, for Andrews, (1961, pp. 274–5) makes the following statements that suggest this possibility:

> "Stem impressions of *Equisetites* are distinguished from the calamitean plants partly by the fusion of the leaves into a sheath, and if the assumption that they are closely allied to *Equisetum* is correct, they attained an appreciably greater size than the living species." [of *Equisetum*].
>
> "There are a few intriguing suggestions that plants closely akin to *Equisetum* did live in the late Paleozoic."

Equisetum ramosissimum comes in late summer to autumn. The strobili do not persist on the plants into spring. It may be that disruption of the Lidgetton plants prior to fossilization took place at a season when cones were not present. Nevertheless the matrix must be carefully studied for evidence of spores that could relate to the distinctive elater-bearing spores of living *Equisetum* species.

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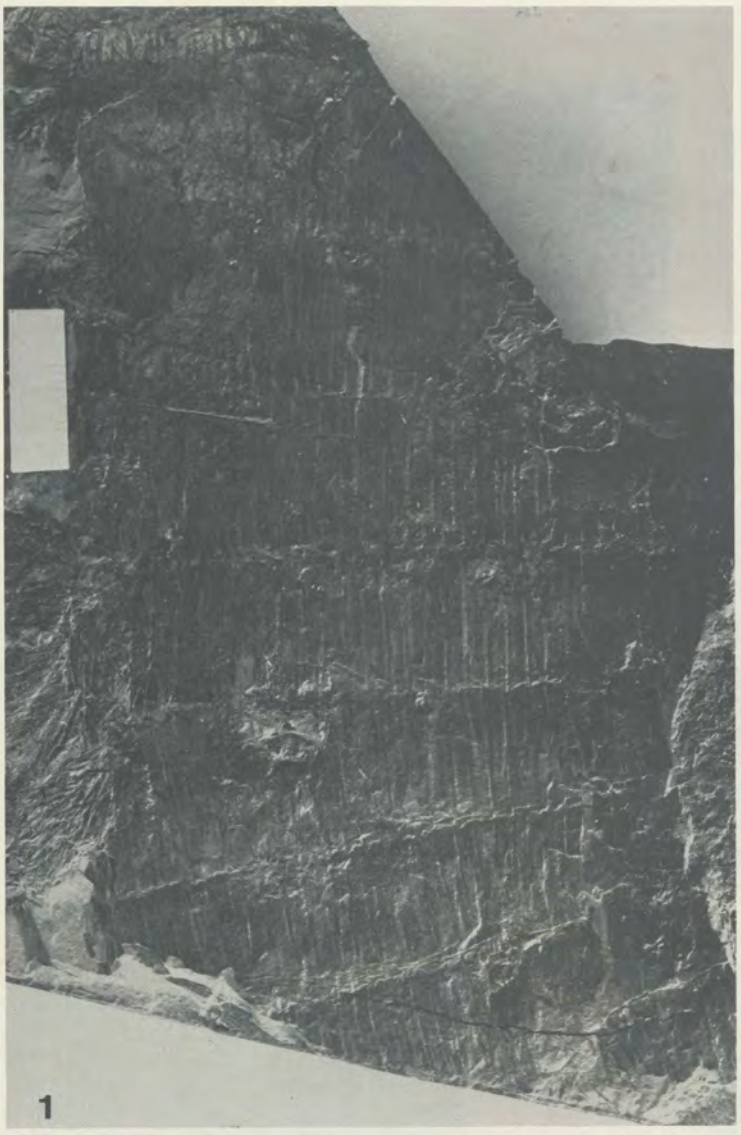
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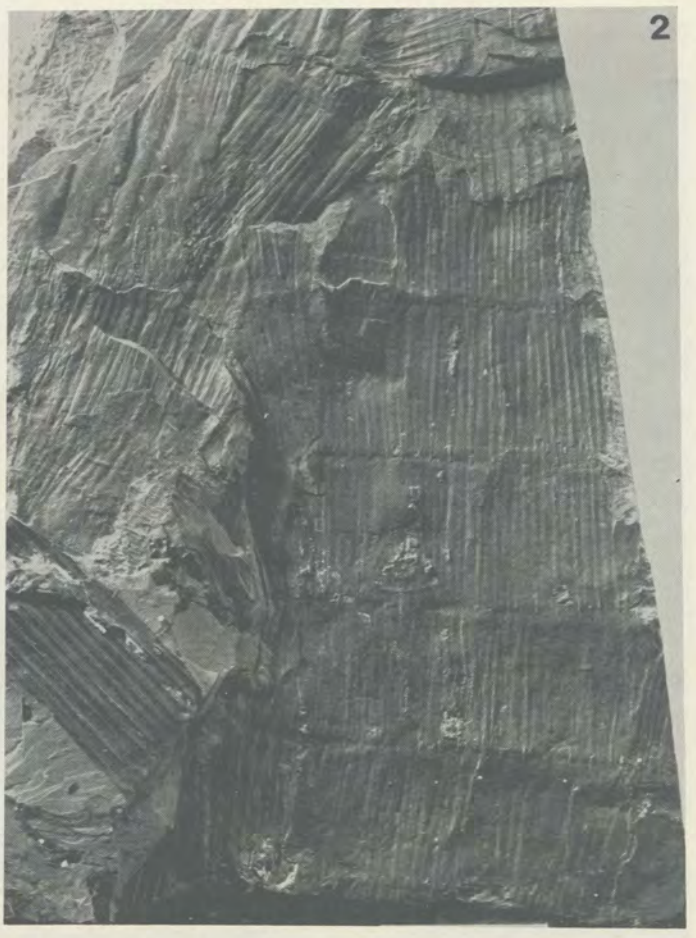
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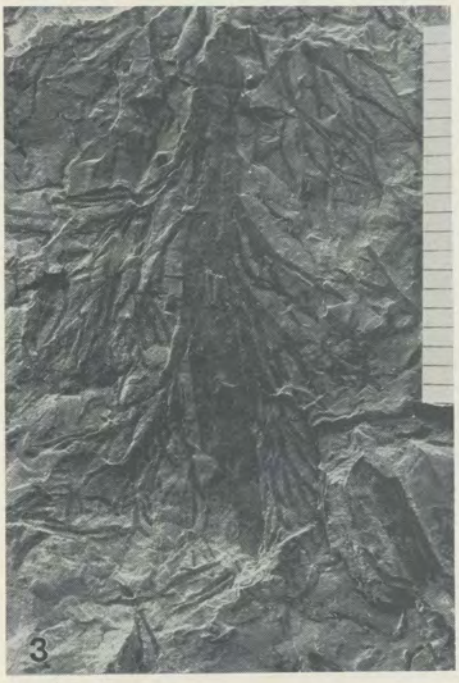
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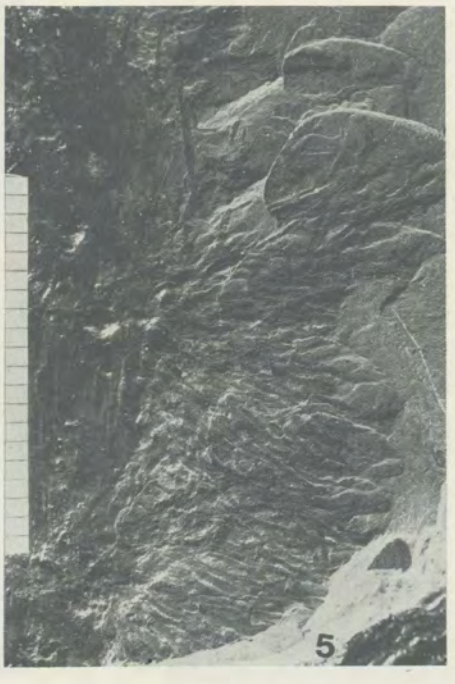


PLATE I

Equisetalean plant fossils from Lidgetton (thought to be orientated as in life: except where otherwise stated stems are interpreted as being in external view).

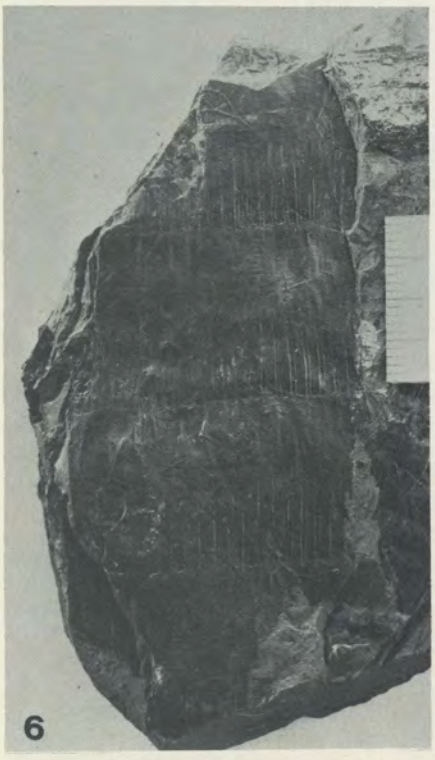
Figure 1. Portion of rhizome (?) showing, at left, apparent attachment of well branched, smooth, adventitious rootlets.

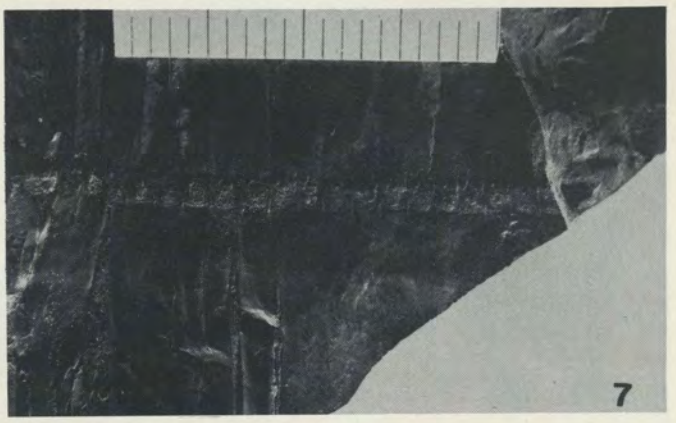
Figure 2. Impression of another portion of rhizome, showing nodal markings seen from the internal surface. (Note that towards the top of the photograph the impression is overlain by sediment carrying vascular tissue — carbon present as a thin layer in which fine longitudinal markings that alternate with adjacent ribs at the node, may be discerned.)

Figure 3. Portion of a root with lateral roots (note frequency of dichotomous branchings).

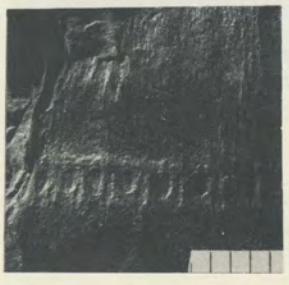
Figure 4. Stem apex (note overarching leaves and below a series of nodes and internodes).

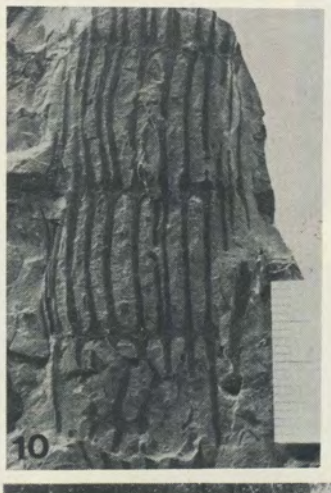
Figure 5. Portion of rhizome (?) showing two successive nodes with adventitious rootlets developed from these.

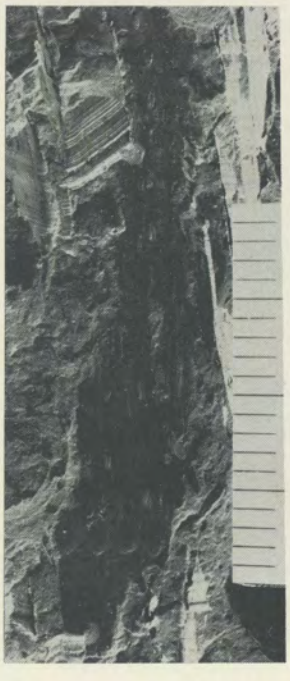

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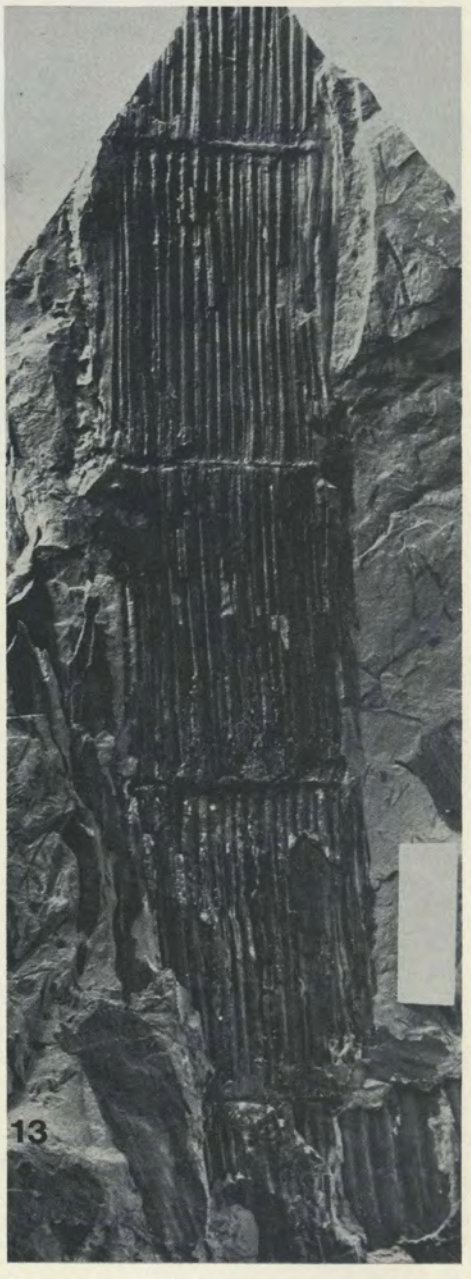

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PLATE II

Equisetalean plant fossils from Lidgetton (thought to be orientated as in life: except where otherwise stated, stems are interpreted as being in external view).

Figure 6. Stem fragment showing nodal markings at three successive nodes.

Figure 7. Stem fragment showing detail of nodal markings (note what are thought to be leaf scars, each with a vascular bundle scar (?) towards the top).

Figure 8. This fossil is tentatively interpreted as ribs of two successive internodes with the furrows between the ribs somewhat infilled. (But the node is narrow and without characteristic markings.) Such fossils have previously sometimes been interpreted as a stem node with an attached whorl of leaves which are free from one another, but this is thought to be incorrect.

Figure 9. Another stem fragment showing nodal markings.

Figure 10. This fossil is thought to represent an internal cast or tangential section of a stem fragment. Ribs of successive internodes are linked by nodes which show a horizontal extension of tissue, and the occasional confluence of ribs. Markings associated with nodes as seen in external view are lacking.

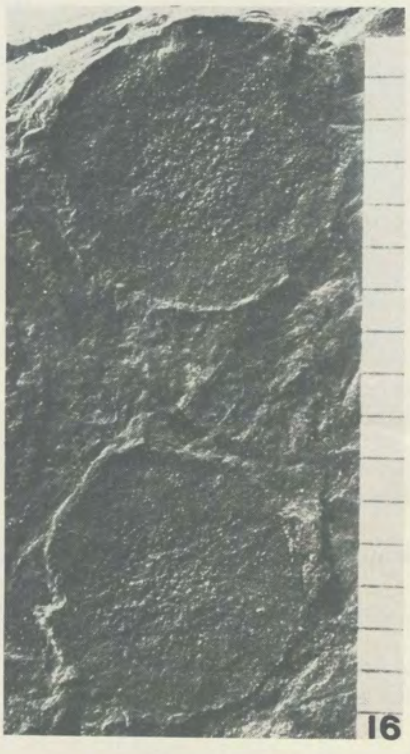
Figure 11. Fragment of stem showing, at the base, four leaf scars of a node, and above, a series of scattered narrow-elliptic scars, some of which appear reversed in relation to the others.

Figure 12. Stem fragment showing a node with (above in the photograph) three (or four ?) elliptical or rounded depressions that are tentatively interpreted as branch scars.

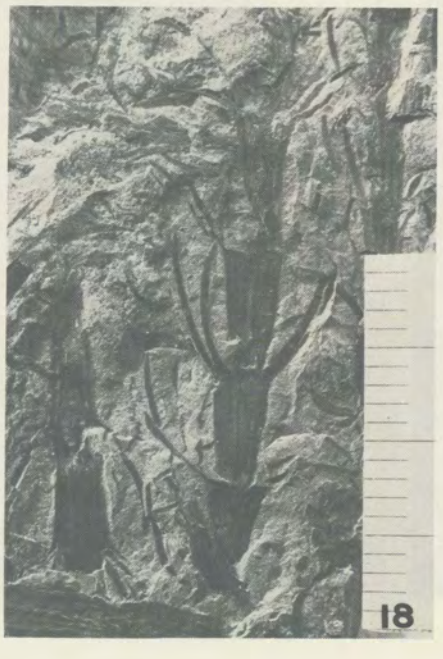
Figure 13. A length of stem showing three whole and two parts of ridged and furrowed internodes that are separated by nodes, the markings of which are poorly defined: leaf whorls appear to be entirely lacking (carbon is present over some internodes).


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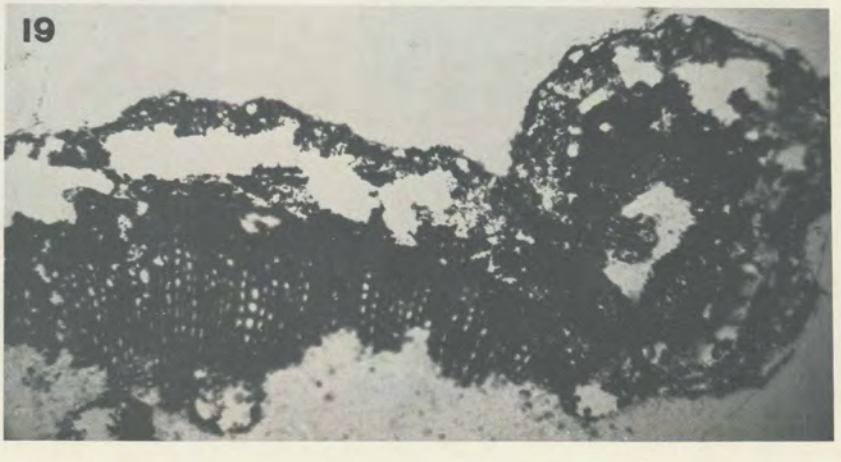

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PLATE III

Equisetalean plant fossils from Lidgetton.

Figure 14. Fragment of stem broken above node and infilled with matrix. The nodal markings are clear and depressions in the front face are represented as projections in the internal surface behind (seen above in the photograph).

Figure 15. Fragmented stem or rhizome showing portion of a nodal diaphragm and ribs of two successive internodes with intervening node splayed out as though compressed from above (compare Du Toit no. 8329, 1927, where a similar structure is differently interpreted).

Figure 16. Two nodal diaphragms.

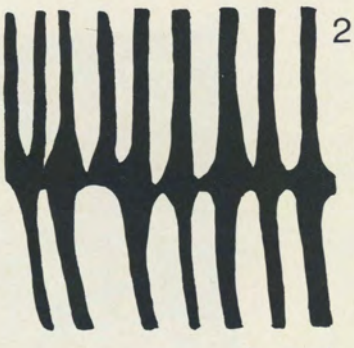
Figure 17. Nodal diaphragm showing cellular markings.

Figure 18. Fragment of aerial branchlet showing three (possibly four) leaf whorls that are each wider at the mouth than the base. From the mouths free, linear, leaf segments arise.

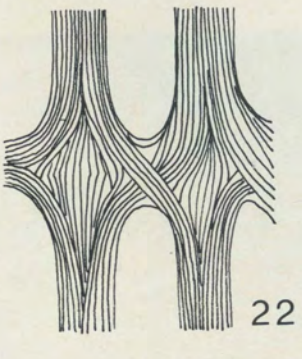
Figure 19. Acetate "pull" of etched transverse section of portion of stem (note cells in radial rows, presumably tracheids of secondary xylem).



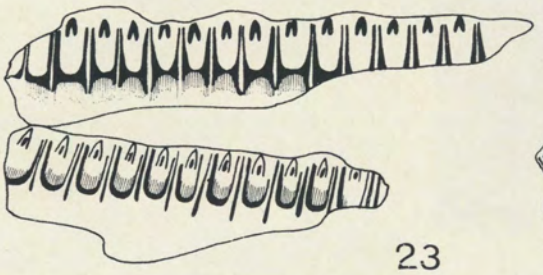
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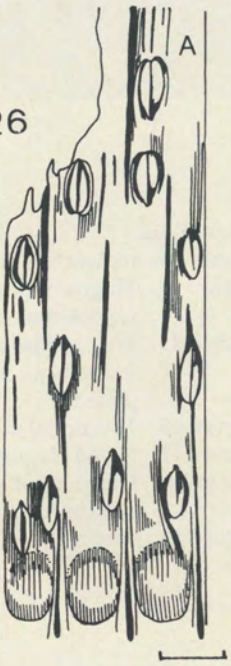
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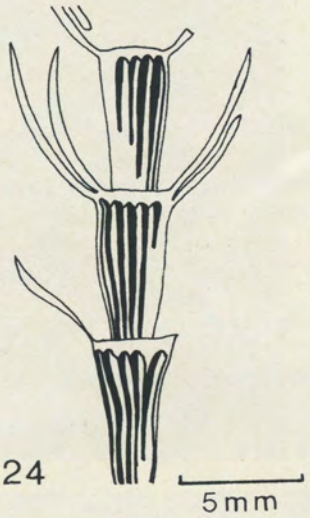


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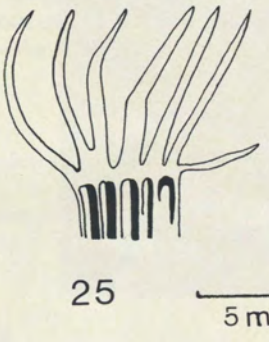


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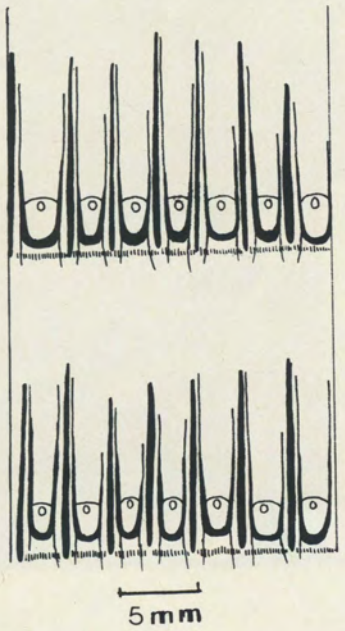
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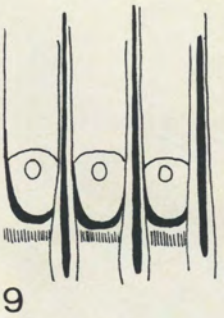
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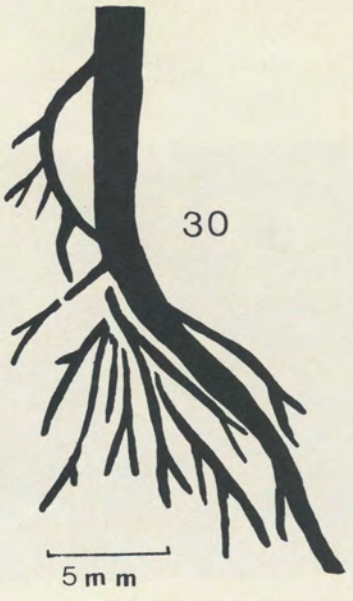
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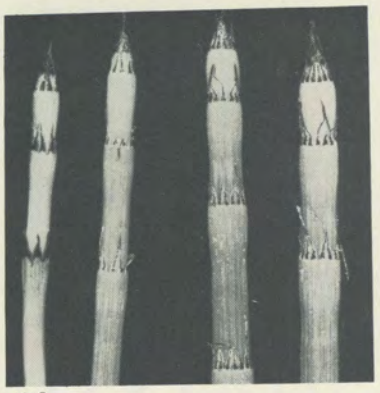
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PLATE IV.

Figure 20. Representation of course of ribs in fossil illustrated in Plate II, Figure 10. (Note occasional confluence of ribs at node.)
Figure 21. Enlargement of node seen in Figure 20.
Figure 22. Further enlargement of node showing the course of the fine striations visible in the carbon present.
Figure 23. Representation of node illustrated in Plate III, Figure 14.
Figure. 24. Representation of portion of narrow branchlet illustrated in Plate III, Figure 18.
Figure 25. Representation of a portion of a leaf whorl, showing fused leaf sheath and free leaf segments.
Figure 26. Representation of the portion of stem illustrated in Plate II, Figure 11. (Note reversal of scars at A.)
Figure 27. Enlargement of a single scar illustrated in Figure 26.
Figure 28. Representation of nodal markings (external view).
Figure 29. Enlargement of nodal markings shown in Figure 28. (The dark vertical lines represent depressions, the white areas adjacent to them raised shoulders: between each depression is a leaf scar with a vascular scar asymmetrically placed.)
Figure 30. Representation of a portion of a root. (Note the numerous dichotomous branchings.)

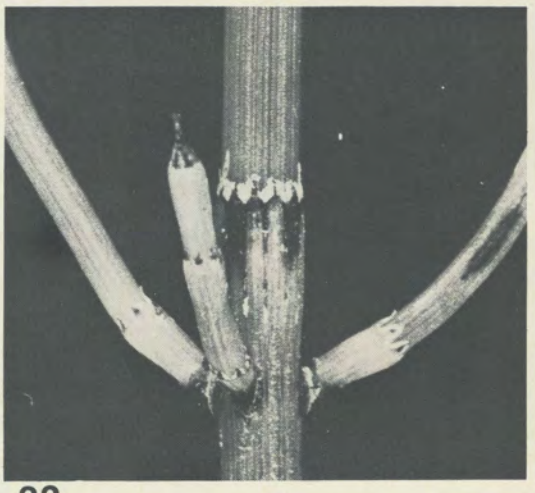


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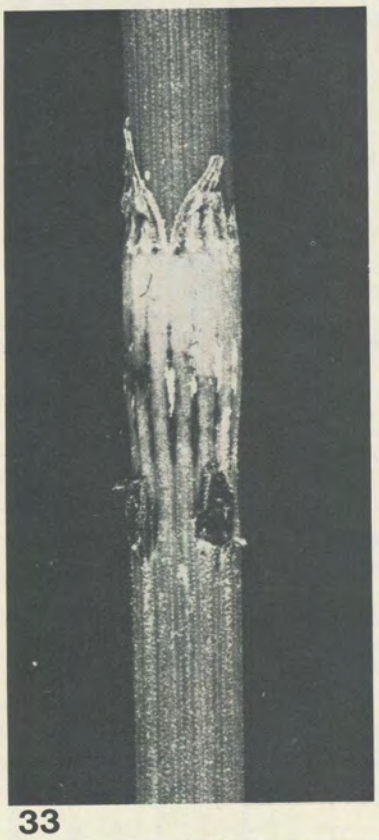
31, 36 — 5 mm

37 — 3 mm

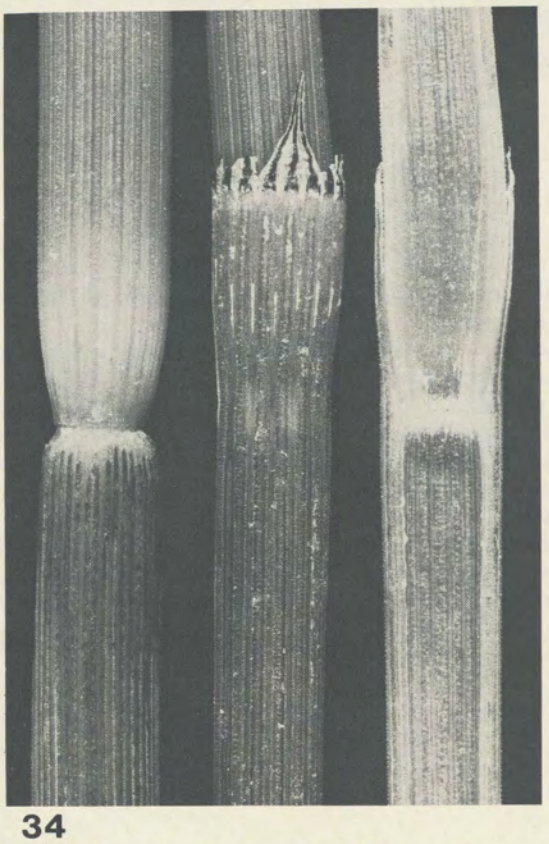
32-35 — 2 mm



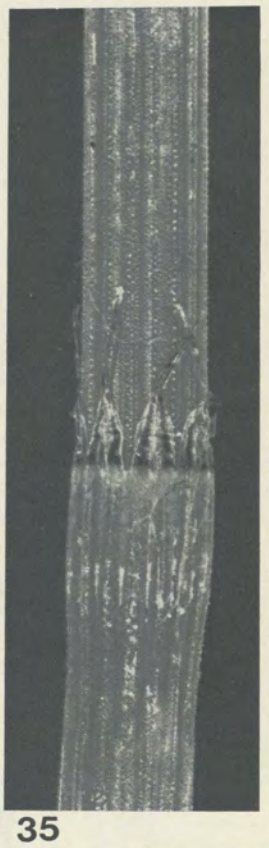
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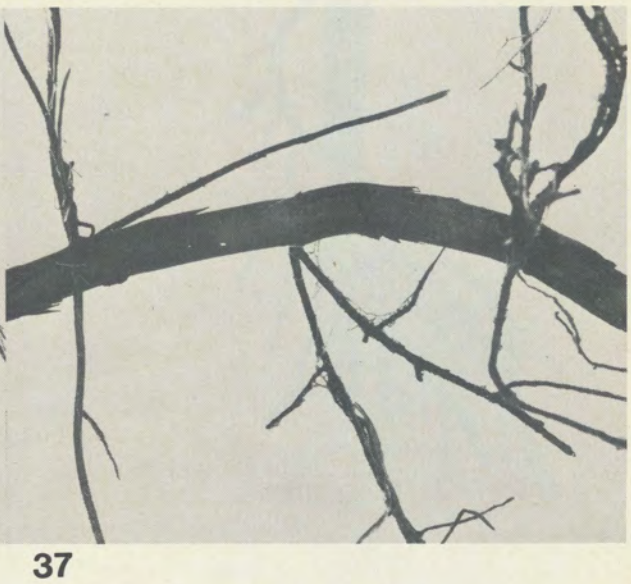
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PLATE V

Equisetum ramosissimum Desf.

Figure 31. Stem apices.

Figure 32. Portion of stem showing node with whorled lateral branches.

Figure 33. Portion of stem showing node with branch scars.

Figure 34. Stem nodes: left, with leaf whorl removed (note that fragments of internodal epidermis have come away with the leaf whorl); centre, with leaf whorl intact; right, in longitudinal section showing relative positions of nodal diaphragm and leaf whorl.

Figure 35. Stem node with leaf whorl showing long, dry attenuate apices to leaves.

Figure 36. Portion of rhizome showing leaf whorls and adventitious roots developed from the nodes (note the absence of clearly defined ridges and furrows).

Figure 37. Enlargement of portion of rhizome shown in Figure 6 (note branching of adventitious roots as they leave the rhizome).