

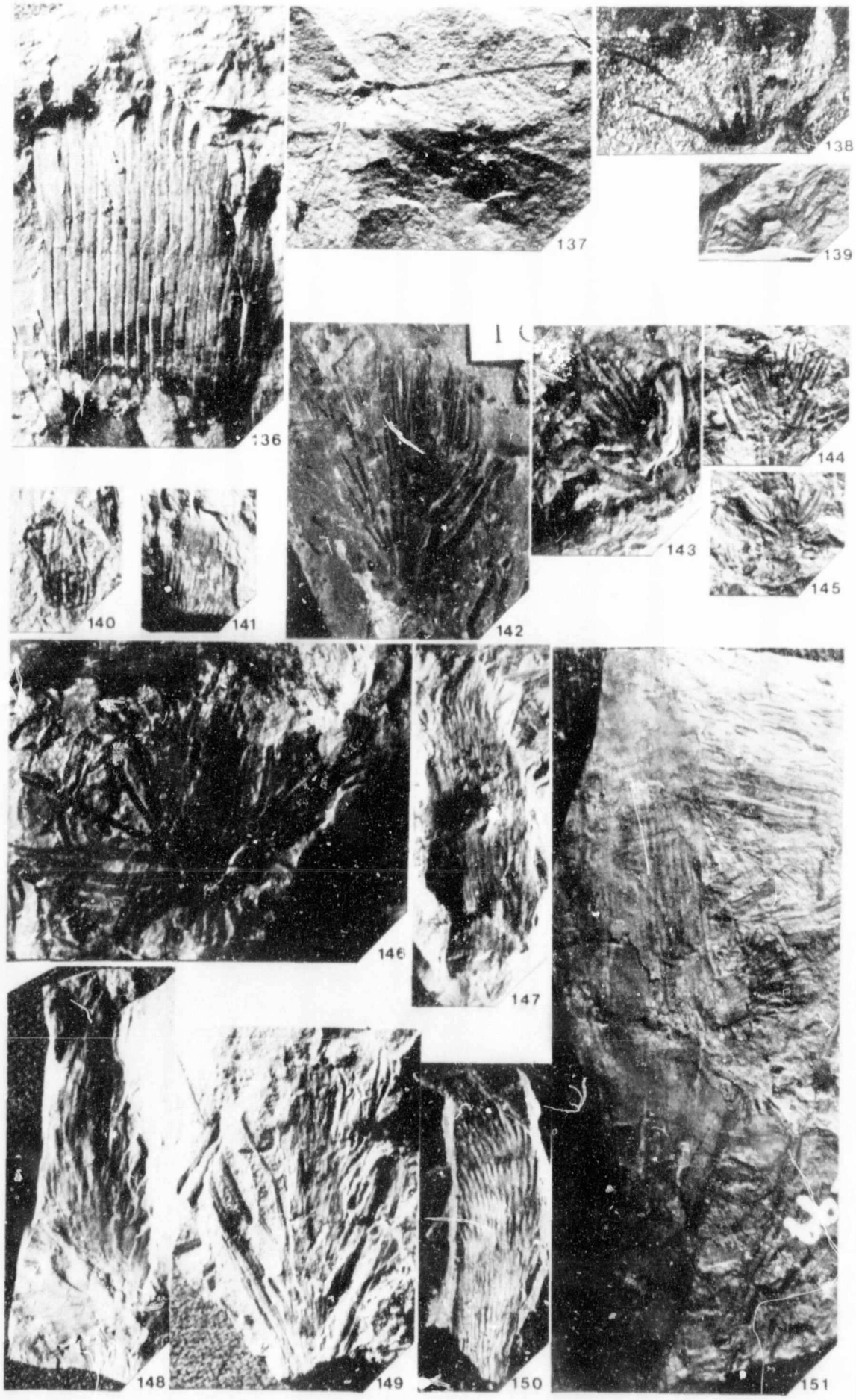
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The sphenopsida of the south african upper permian

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3.2.3.1.9 Phyllotheca from Antarctica. Figs. 137-139.

Two fragmentary pieces of Phyllotheca whorls from Antarctica are preserved. Figure 139 shows a narrow band of the united disc area with strap-like leaves. The leaves shoulder out at the base, commissural lines and midribs are not clearly visible - probably due to to preservation. The lateral longitudinal strand along the leaf margin is clear, with a narrow external flange present. Figure 138 has nine fragmentary leaves preserved, strap-like at the base and tapering to a fine point at the tip, the leaflets hardly spread out at the base to meet the adjacent leaf. Only the longitudinal strand is clearly preserved. Other details are lacking. The specimen in figure 137 has remains on it that are only doubtfully assigned to Phyllotheca. A stem is preserved in cross section, roughly circular, with an average diameter of 9 millimetres. The outside tissue of the stem has been replaced by a fine white siliceous material, a central core of 4,5 millimetres diameter has similarly been replaced. The intervening space is filled with medium grained siltstone of slightly lighter colour than the surrounding matrix. This stem continues through the rock and emerges on the other side, some 15 millimetres distant, with a diameter of 10 millimetres and central core 5 millimetres wide. Three very long, thin (?) leaflets radiate out from the stalk but only the one is seen to join the stem, the other two are on a slightly different cleavage plane. The widest leaflet is 1 millimetre wide, while the longest one preserved has a length of 28 millimetres and 0,8 millimetre width, with no taper over that distance. Some isolated fragments of these leaflets show a circular replacement material of white silica, possibly indicating that the leaflets were in fact tubular. No other detail is preserved. The sparse "leaflets", no united disc and general appearance of the reamins cause it to be hesitatingly mentioned with the Sphenopsids at all, but it is included for the record.

3.2.3.2 Discussion and conclusion of Phyllotheca cf.indica

The specimens attributable to this species are fairly robust compared to other members of the genus, the longitudinal strands at the leaflet margin contributing to this impression, particularly by giving relief to the leaflet margin in low incidence light. The relief of commissural lines on the disc similarly enhances this aspect. The strap-like nature

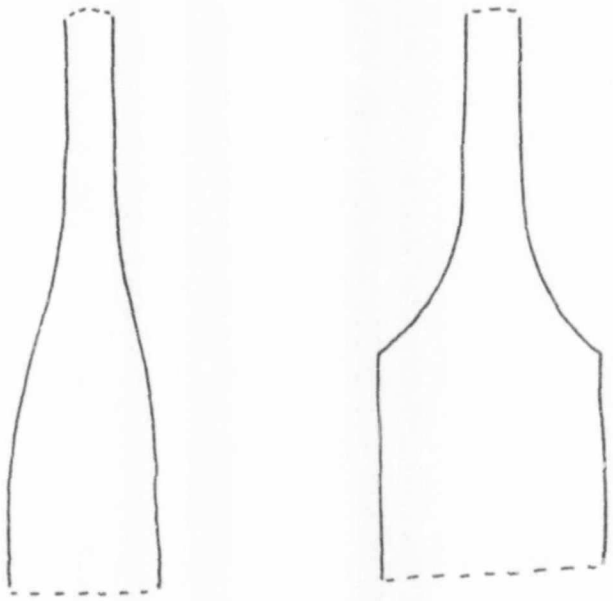


Figure 152 Sketch of the shouldering-out of Phyllotheca leaflets

A. The slight shouldering out of some P.cf.indica leaflets,

B. The marked shouldering out of the P.cf.etheridgei leaflets,

of the leaves is a very clear characteristic, particularly in the larger leaves. In the shorter leaves, the margins are parallel for a lesser distance with the onset of tapering towards the tip commencing almost at once, and thus the strap-like nature is not as evident.

The group as a whole, and sometimes even the individual specimens, shows the range of notches between leaflets at the disc margin from sharp V- to bluntly U-shaped, and the leaflets continuing undistorted into the united disc or shouldering out to meet the adjacent leaflet margin (see figure 62 A-C). The condition with webbing between the leaf bases is not always clearly distinguishable, apparently being more dependent on good preservation. This range in the manner of the leaflet's entry into the disc is thus not a reliable diagnostic character. In the specimens that "shoulder out" it would appear to be more a matter of degree than general outline that distinguishes these specimens from P.cf.etheridgei which as a rule has very well developed shoulders (see figure 152) for P.cf.indica.

The nature of the longitudinal strands is not clear, but they probably contribute towards the rigidity of the leaflets. They are not a continuation of the commissural lines which reach the margin of the disc; the longitudinal line peters out more or less at that point.

The specimens belonging to this group show the well developed leaf sheaths closely adhering to the stem, the united disc leaving the sheath in a definite manner, and not gradually or in a haphazard way; the subsequent angle of the disc in relation to the stem may be dependent on the maturity of the whorl or the whorl position on the stem, as a complete range between slanting upwards to being recurved is present. Part of this variation can no doubt be ascribed to the problem of accommodating a whorl at almost right angles to the stem in the same plane as the stem during fossilization.

The whorls with slightly narrower leaflets and of less robust appearance are included with P.cf.indica. This type of variation is easily included within the species range, and may be due to edaphic conditions or even simply partial shading.

The specimens as a whole fit in relatively well with the range as postulated by Pant and Kidwai (1968) for P.indica, although the length of the free leaflets as recorded by them (up to 32 millimetres long) is not found in the present collection. This is not thought to be due to incomplete leaflets only, but rather to a generally shorter free leaflet length; the width of the leaflets is roughly the same, these

being only slightly narrower (0,8 millimetre wide) than the 1,0 millimetre wide as given by Pant and Kidwai (l.c.). No mature branches with leaf whorls were observed, thus the apparently diagnostic fashion of curved branching (up to 90° or more to become drooping) cannot be ascertained for the present specimens.

No forked free leaflets were preserved, and the single forked specimen found by Pant and Kidwai (1968, p.117) should surely be regarded as an injured leaf initial that divided, rather than a reversion to an ancestral trait.

Neither Pant and Kidwai (1968) nor Townrow (1955) mention the very striking longitudinal strand along the edge of the leaf, with a flange of tissue beyond it to the entire margin (the type specimen is so poorly preserved to be of little use for comparative purposes). This longitudinal strand (fig 10A) is one of the main characteristics of the specimens from Bergville, the other features of which correspond well with P.indica. Thus for the present, the South African specimens are referred to P.cf.indica.

Measurements for the new specimens of P.cf.indica are given in table 7.

3.2.3.2.1 Discussion of Phyllotheca groups probably belonging to P.cf.indica

The whole question of the classification of these Phyllotheca remains not directly referable to P.cf.australis or P.cf.indica is far from clear. The present "splitting" approach is accompanied by strong doubts as to whether a 'lumping' classification would in fact not reflect the true association of these forms more correctly. If, however, the "lumping" of all these variant forms under one specific name was followed, equally strong doubts would be present. As it is far easier to synonymize all the variant forms, should better material prove the necessity of such a step, the splitting of the group into identifiable sub-groups has been preserved, as this type of differentation is far more difficult to accomplish at a later stage.

These sub-divisions are not afforded taxonomic status at this stage as quantitatively they are difficult to define, the various features of each form tending to overlap those morphologically adjacent. The complete removal of subjectivity is impossible to control as the specimens are often imperfectly, although similarly, preserved at one

site, while at different sites the problem of differing preservation on differently coloured matrices can accentuate certain features that are hardly or only imperfectly visible on the specimens from another site. Further collecting from recorded and new sites might resolve this problem to some degree. For the present, the groups are thought of as possibly approaching the various morphological limits of P.cf.indica.

3.2.3.2.2 Phyllotheca with long tapering leaflets

These few whorls have some resemblance to P.cf.australis with the tapering leaves, but they are not starshaped as are those included in that species (figs.45-49) and the presence of a flange of tissue beyond the longitudinal strand differentiates them further from the P.cf.australis group, placing them nearer the "indica" specimens from which the tapering leaves distinguishes them.

3.2.3.2.3 Phyllotheca with long, thin leaflets

The first impression was that these specimens resembled P.griesbachi; the leaflets are however much shorter and notably fewer in number, both characteristics being diagnostic for P.griesbachi.

3.2.3.2.4 "Ragged " Phyllotheca

The bent and disarrayed appearance of the free leaflets in this group is fairly distinctive. The short leaflets expanding basally give a robust impression. These specimens are markedly different from the usual P.cf.indica form.

3.2.3.2.5 Unusually large Phyllotheca remains

These specimens may represent very mature whorls of P.cf.indica, but as in most cases the free leaflets are not preserved, which is diagnostic for the species, and the united disc area is so much larger than usual, they have been separated for convenience.

3.2.3.2.6 Fine Phyllotheca

These specimens seem to be distinctive, both in the small number of leaflets per whorl (14 - 16), and the very narrow width of the leaflets at their base. The resultant impression is of a much lighter plant than the usual P.cf.indica. They would appear to be distinctive and not

merely representing poorly developed specimens of that species.

3.2.3.2.7 Very small whorls of Phyllotheca

These specimens are so much smaller than any of the other groups (excepting above) of Phyllotheca that they cannot be ascribed to those groups although probably representing immature, underdeveloped whorls of the same. They do not have the delicate aspect of fine Phyllotheca.

3.2.3.2.8 Detached sheath of main stem

See comments under the description.

3.2.3.2.9 Phyllotheca shoot tips from Bergville

The shoot tips do not indicate whether these Phyllotheca plants had a determinate type of growth or not. In all instances the shoot tip is recognized by the tuft of closely overlapping leaves. How many nodes are hidden under the longest set of leaves that forms the outside whorl of the tuft is not indicated. As noticed by Townrow (1955) the leaf tissues are differentiated early on, as the midrib is visible in leaflets of the tuft. Whether a matured shoot tip would be recognizable with a determinate type of growth is debatable as the topmost whorl of leaflets would expand and differentiate in a manner similar to those below, and in fossil form it would probably look like a shoot that had been broken off, and not like a tip.

The broader-stemmed tips are interpreted as belonging to the main stem as there are clear indications of nodes and ribbed sheaths with short, spiky upright leaflets, closely adhering to the stem and no indication of an apical tuft or whorls with long free leaflets and an expanded disc, which forms the leafy shoot apex. If this interpretation is correct, it would appear that the main stem and foliar shoot have a different development from the start, and that the main stem does not have leaf whorls of the foliar shoot kind which are later shed as the side branches develop. The main stem develops with a larger diameter than the shoots, as the tips are already far more robust; the remaining growth in the diameter of the stem is probably more through cell enlargement rather than cell division. The nature of the leaves does not permit the determination of these specimens, but they are probably referrable to P.cf.indica as the main species from Bergville.

3.2.3.2.10 Phyllotheca from Antarctica

The two fragmentary whorls cannot be closely compared to any group. The third specimen, with its long "tubular" leaflets has a most superficial resemblance to the figured P.zeilleri (Etheridge 1902, p.13, fig.6) which however has many more leaflets per whorl than have been preserved in the Antarctic specimen, which in any case is only doubtfully included in the Sphenopsids.

3.2.4 Phyllotheca etheridgei Arber 1905

Type specimen:No.F 5470 Australian Museum Sydney

Diagnosis (Arber 1905, p.26)

"Leaf-bearing, stems articulate, faintly ribbed longitudinally. Leaf-sheath large narrow and clasping for about three millimetres at the base, but expanding above into an open peltate disc with a diameter of 2,5 - 3 centimetres. The free segments are reduced to very short teeth, 3 millimetres in length, and are twenty-three or more in number. A nerve traverses the sheath to each tooth, between the nerves there is a "faint groove or depression", and also "the finest possible transverse striae, arranged in a festoon-like manner"."

In 1905 Arber (p.26, fig.9) instituted the species to accommodate some specimens described by Etheridge jun. (1895) as Phyllotheca sp. from Australia. The whorls with longer free leaflets were described by Etheridge (l.c.,p.150) as having short leaf sheaths with uninervate leaflets that curve obliquely outwards and are sharp pointed distally. The whorls with a greatly expanded horizontal disc he described as "peltate infundibuliform leaves", with the periphery being extended into a series of tooth like projections or spikes. The midribs, commissural lines and transverse striae are very clear. Etheridge (1895, pl.18 and 19) figured several specimens, mostly the peltate form with very short free teeth. He (pl.18, fig.3), however, showed rather longer free leaflets, fairly narrow, while pl.18, figs.4 and 5 show the long-leaved type of whorl. Several specimens (pl.19, figs.1, 3,4) show a very obvious, tightly fitting sheath round the relatively broad stems. Arber (1905, p.27) pointed out that the chief characters of this species are "the short free teeth, and the sheath, clasping at the base, but expanding distally into an open and spreading disc-like structure ...". Arber (l.c.,p.28) stated that he agrees with Zeiller

(1902, p.31) that the specimens with free leaves (Etheridge 1895, pl.18, figs.4,5) are not identical with P.etheridgei (this suggestion cannot be found in Zeiller, 1902, certainly not on p.30-31).

Saksena (1952, p.412-414) redescribed and refigured some of the original material of P.etheridgei comparing it to his new species P.sahnii which is remarkably similar, but from a (?) lower geological horizon (the age of this horizon is given as Barakar Stage of the Damuda series in India, but Saksena (l.c.) questions it as being correct). Saksena had one hand specimen with four fragments referable to the new species to work from, thus the table of differences for the two species probably does not reflect a true character range. The nature of the free leaflets on the peltate form of P.sahnii is unknown, although also thought to be recurving as in P.etheridgei. The possibility of the two species being identical is further enhanced by the reconstruction of both as Saksena (1955, p.52-53) himself admited that the two were very similar in general habit and form and differed only in minor details. P.sahnii is shown with strap-like free leaflets while P.etheridgei has small tooth-like projections. The more robust appearance of P.sahnii resulting from this is misleading, as none of the leaflets are preserved. Both species are shown with peltate whorls lower down on a stem and narrower disc and longer reflexed leaves near the apex.

Townrow (1955, p.50-53) described some specimens from Australia which he attributed to P.sahnii, giving that the important points of division of P.etheridgei and P.sahnii are the short free teeth of P.etheridgei (1,0 millimetre long) while P.sahnii is said to have leaves 15 millimetres long, Townrow (l.c.) does not qualify whether these long P.sahnii leaves are/or typically peltate discs or on the "younger" whorls with less developed discs. Both Saksena (1952) and Townrow (1955) took the smaller stomata of P.etheridgei (9x12 µm) and larger stomata of P.sahnii (16x32 µm) as diagnostic, although the cuticular studies were on two small fragments only. Pant and Nautiyal (1967, p.60-61) proposed that neither P.etheridgei nor P.sahnii should be considered as Phyllotheca as both have the sheath (disc?) united for more than half the length of the free leaflets. P.sahnii they consider synonymous with Raniganjia bengalensis while P.etheridgei they renamed R.etheridgei. This suggestion is found unacceptable as neither species of Phyllotheca has the typically narrow stem of Raniganjia, nor do the free leaflets, short as they might be, qualify

as "mucronate tips" which is apparently typical of Raniganjia. Thus, without redefining the genus Raniganjia to include thick stems, definite, tight-fitting sheaths and recurved free leaflets that are appreciably narrower at their base than at the edge of the expanded disc, (which is certainly not flat but concave abaxially,) the inclusion of P.sahnii and P.etheridgei into Raniganjia is not possible. The enlargement of the sense of the genus Raniganjia to include P.etheridgei and P.sahnii does not appear desirable, as both species can be better accommodated within Phyllotheca. The two species of Phyllotheca are so similar that they are here questionably synonymized as P.etheridgei until better material should prove them to be separate.

Summary

The species is typified by the peltate discs which have fairly short free, recurving tooth-like projections. There are usually transverse striae and clear commissural lines. Arber (1905) instituted P.etheridgei for these specimens. Saksena (1952) erected a new species, P.sahnii for very similar remains, both species being reconstructed with a fair degree of heterophylly; the younger whorls having a smaller disc with longer free leaflets, while the more mature whorls have the typical peltate disc. Pant and Nautiyal (1967) proposed the removal of these two species from Phyllotheca into Raniganjia, which suggestion is not accepted here. As both P.etheridgei and P.sahnii are so similar and incompletely known, they are tentatively synonymized as P.etheridgei.

3.2.4.1 Description of New Material of Phyllotheca cf.etheridgei. Figs 153-206.

These specimens are all from Loskop (N-Lk), and a wide range is represented both in size of sheath/disc, and in length of free leaflets.

Some of the smallest specimens are represented by lateral views of the whorls. For example in figure 153 (1) the free leaflets are sharply pointed, almost triangular, about 2 millimetre long with the sheath and disc not easily divisible into its component parts, but more like an inverted cone, the leaflets continuing in a line with the cone. Figure 153 (2) is attached to a short length of stem on which three more nodes are visible at regular intervals. Figure 155 shows a small whorl dorsiventrally preserved, of similar dimensions as above, while figure 156 has portion of a whorl where the free leaflets are less symmetrically arranged, more typical of the larger whorls. Figure 157 represents two small adjacent whorls. The length of the free leaflets

Figures 153 - 181 Phyllotheca cf.etheridgei x 2

Figure 153 1) (Lower) A very small whorl with almost triangular leaflets
2) (Upper) Small successive whorls N-Lk 333.

Figure 154 - 157 Further examples of small whorls.
154 - N-Lk 333 155 - N-Lk 191 156 - N-Lk 196
157 - N-Lk 211a

Figure 158 Three successive whorls (left) with long internodes and strongly reflexed leaflets, lying next to a larger, more robust whorl (right). N-Lk 385.

Figures 159 - 162 and 179 - 181 All show whorls with reflexed leaflets.
159 - N-Lk 386 160 - N-Lk 273
161 - N-Lk 122 162 - N-Lk 367a(3)
179 - N-Lk 205 180 - N-Lk 341a PTO.
181 - N-Lk 341a PTO.

Figures 163 - 164 Counterparts. Two whorls were probably compressed in such a way as to appear as one whorl of leaflets from above. 163 - N-Lk 337b 164 - N-Lk 337a.

Figure 165 A whorl with narrow leaflets on a poorly developed disc, giving a more delicate appearance than usual. N-Lk 277.

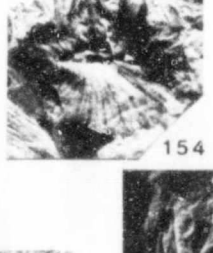
Figures 166 - 168 Whorls with the discs and leaflets of similar length.
166 - N-Lk 195 167 - N-Lk 387 168 - N-Lk 347
(Figure 166 see also figure 203).

Figure 169 A whorl with similar overall dimensions as the three above, but the disc is more developed than the leaflets. N-Lk 193.

Figures 170 - 178 Whorls which show a range in disc size and length of leaflets. 170 - N-Lk 353 171 - N-Lk 377
172 - N-Lk 423 173 - N-Lk 399 174 - N-Lk 468
175 - N-Lk 276 176 - N-Lk 350 177 - N-Lk 200
178 - N-Lk 274.

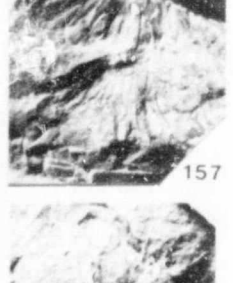
Figures 179 - 181 see above under figs. 159 - 162

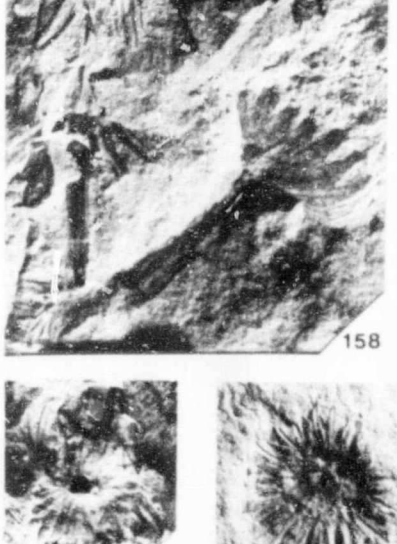

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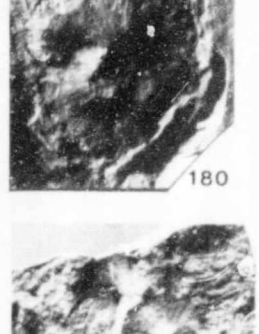

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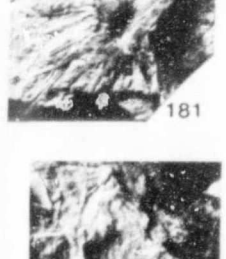

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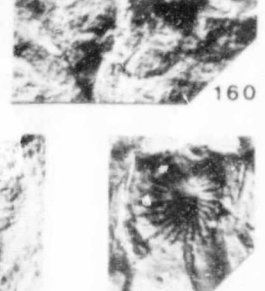

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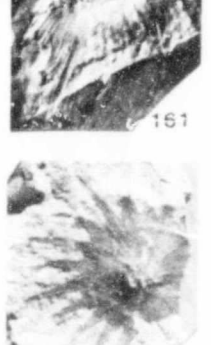

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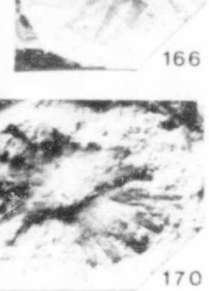

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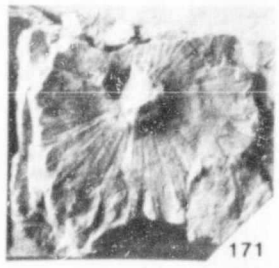

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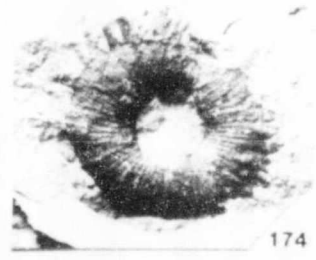
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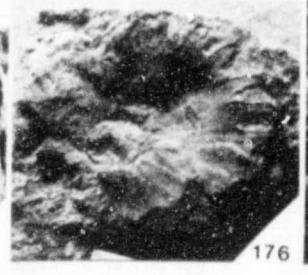

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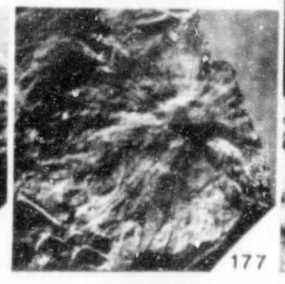

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is roughly 3 millimetre which equalls the width of the disc; both the leaflets and the disc are reflexed. One specimen (fig.158) shows three successive whorls with reflexed leaflets that are 4,5 millimetres long while the disc is only 1 millimetre wide. Lying next to the three whorls is portion of a mature whorl as a comparison. Figures 159-162 and 179 - 181 all show the narrow gently reflexed leaves. Figures 163-164 gives the effect of a whorl with more numerous leaves than usual. It would appear that two whorls have been compressed in such a way as to give the impression of one whorl. The leaves are narrow and the disc not well developed. Figure 165 similarly has the leaves narrow on a poorly developed disc, giving a delicate appearance to the whorl.

Figures 166-168 all show whorls with discs and free leaflets of similar length, in figure 168 the leaflets and the edge of the disc are curved in a manner typical of the more mature whorls.

Figure 169 shows a whorl with similar overall diameter as the above specimens, but the disc is much wider than the leaflets are long, the leaflets also appear to be more robust than in the other smaller whorls.

Figures 170 to 178 show a range in the disc size and length of leaflets. The smaller discs such as in figures 170-173 tend to have rather narrower and longer leaves than the larger whorls. These narrower leaves are often less recurved than the larger leaves although figure 174 has a convex disc with the leaves continuing in a downward direction.

Many of the larger discs have only a short length of the free leaflet remaining on the periphery. The leaflet is relatively wide at the base and cut off straight across the width. This break occurs at a fairly regular distance from the edge of the disc, particularly if the disc is preserved with the abaxial, concave side up; for example figures 175-177 have the adaxial, convex surface up and the free teeth preserved for their whole length on one side of the disc. The leaflets taper regularly the whole of their length, ending in a pointed, recurved apex. Figures 178 and 182 show further examples of discs with short incomplete leaflets preserved.

Figures 183 and 186 show large discs in which there is only the suggestion of leaflets at the margin, very like some of the poorly preserved specimens attributed to P.sahnii and P.etheridgei. The veins and commissural lines are clearly seen radiating from round the stem gap.

Several specimens have a few successive whorls preserved. The

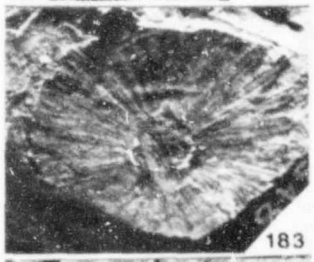
Figures 182 - 190 Phyllotheca cf. etheridgei x 2

Figure 182 A whorl with the leaflets broken off near to margin of the discs. N-Lk 329.

Figures 183, 186 Large discs that have only very short lengths of leaflets preserved along the margin. Specimens such as these have a superficial resemblance to Raniganjia specimens. 183 - N-Lk 348 186 - N-Lk 311

Figures 184, 185, 187 - 190 Specimens that have several successive whorls preserved. In most the closely adpressed sheath is clearly visible, expanding rapidly into the united disc-like area. Figure 187 has the free portion of some leaflets preserved over their entire length, demonstrating the tapering leaflet, ending in a very acute apex.
184 - N-Lk 21 185 - N-Lk 343 187 - N-Lk 332
188 - N-Lk 197 189 - N-Lk 351
190 - N-Lk 361

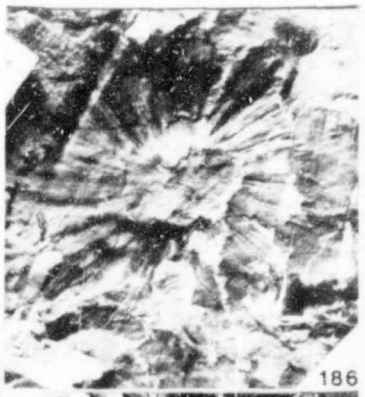

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clearest specimen is figure 187 with three whorls. The expanded discs show the arching upwards and then curving downwards very well. The free leaflets can be traced to a very narrow pointed apex. The leaflets form a fringe along the periphery of the disc, claw-like in appearance.

Figure 184 shows a foliar shoot with three nodes. The one whorl is preserved [with the adaxial surface up, the lower whorl is laterally compressed, clearly showing the tight fitting sheath which expands into a conical portion in this particular whorl. Figures 185, 188 and 189 similarly show leaf whorls at various angles of preservation. In figure 190 the closely adpressed sheaths are clearly visible. Figures 191-193 show free whorls with the sheath intact, and the disc area fanning out above.

Along the margin of most leaflets can be seen a strand of thickening. It does not appear to represent an inrolled margin as there is a narrow flange of material between the thickening and the margin. This feature has not shown up well photographically but N-Lk 332 [(fig. 187) and N-Lk 200 (fig. 177) show it particularly well in the larger whorls on the specimen itself. The thickening peters out at the base of the leaflet where it joins the disc. Similarly most whorls have faint transverse striae on the leaflets and the united disc, which are not evident on the plates. Figure 194 shows a succession of five whorls that have only the expanded disc preserved except for a few leaflets on the lowest whorl. The manner of cleavage has given the specimen a fern-like appearance.

The average large specimen with a peltate disc has a sheath of about 5,4 millimetres long, fitting relatively tightly around a stem of roughly 3 millimetres diameter. The width of the peltate disc is about 4,4 millimetres and the length of the free recurved leaflets between 4 and 5 millimetres. In laterally preserved specimens the angle of the disc to the stem is between 60-80°.

A small long-leaved specimen may have leaflets longer than 4,5 millimetres and the disc 2 millimetres wide, with the sheath as long or longer than the width of the disc.

There is an endless possibility of combinations for the dimensions of this species. The measurements of the new specimens are given in table 8.

3.2.4.1.1 Phyllotheca species. Possibly referable to P.cf.etheridgei (figs. 195-201)

Amongst the specimens from Loskop are a few samples that do not fit into the typical range of P.cf.etheridgei as described above, such as that in figure 195 which is close to the above specimens but the leaflets give

Figures 191 - 194 Phyllotheca cf. etheridgei x 2

Figures 191 - 193 Three specimens showing very clearly the sheath and expanded disc area. 191 - N-Lk 417a 192 - N-Lk 343 193 - N-Lk 367a.

Figure 194 Five successive whorls that have been broken in such a way as to give the specimen an almost fern-like appearance. N-Lk 204.

Figures 195 - 201 ? Phyllotheca cf. etheridgei x 2

Figure 195 The leaflets appear less rigid than usual. N-Lk 305

Figure 196 Leaflets longer and less tapering than usual. N-Lk 207

Figure 197 This single specimen probably belongs to a new species. The long, linear, widely spaced leaflets radiate from the flattened disc. N-Lk 378.

Figures 198 - 200 Specimens with well developed flattened discs and rather short, narrow free teeth. 198 - N-Lk 376 199 - N-Lk 382 200 - N-Lk 380a (Figure 200 see also figure 204).

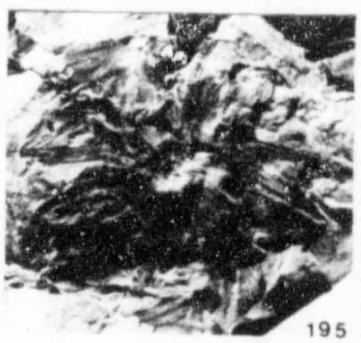
Figure 201 A laterally preserved whorl with a short sheath and funnel-like disc area, subtending long thin leaflets. N-Lk 470.

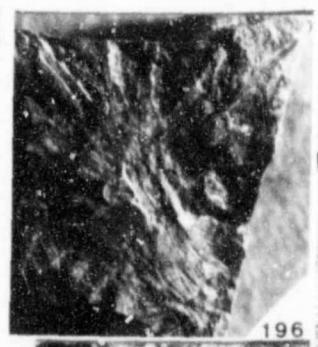

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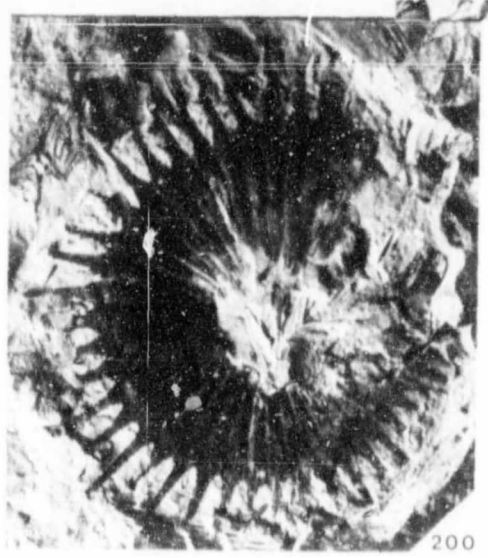

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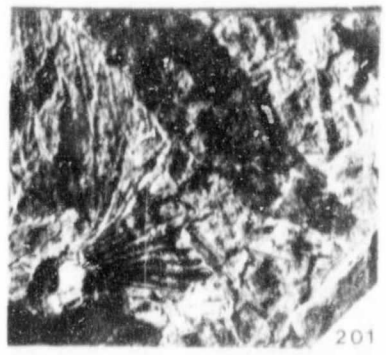

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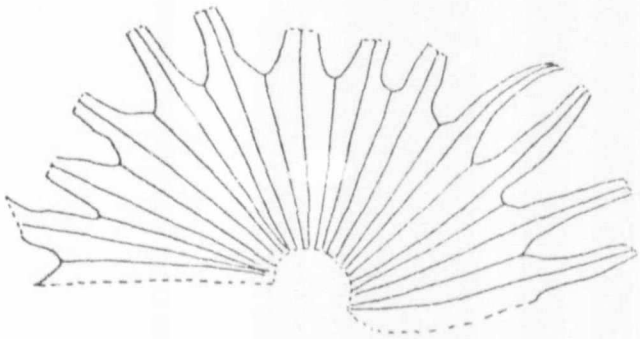
Figures 202 - 204

Figure 202 Portion of a typical whorl of P.cf.etheridgei with the united disc showing the well developed midribs and commissural lines. The free leaflets shoulder out markedly at the margin of the discs. The leaflets are strongly recurved and have an acute apex (not preserved in this specimen). Scale is 1 cm. N-Lk 199b.

Figure 202 A Portion of the above enlarged to show the substantial midrib in relation to the commissural lines. Scale is 5 mm.

Figure 203 A "younger" whorl of P.cf.etheridgei. The strongly retlexed nature of the free leaflets is not clearly seen on the flat paper. The midribs and commissural lines are very faint. Scale 1 cm N-Lk 195 (see also fig.166).

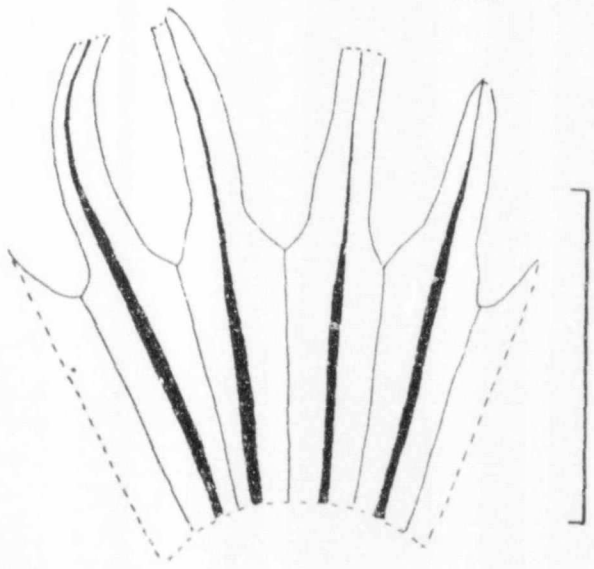
Figure 204 A specimen probably referable to P.cf.etheridgei but having short, narrow leaflets in comparison to the width of the united disc. The commissural lines are prominent while the midribs are most indistinct. Scale 1 cm N-Lk 380. (see also fig.200).



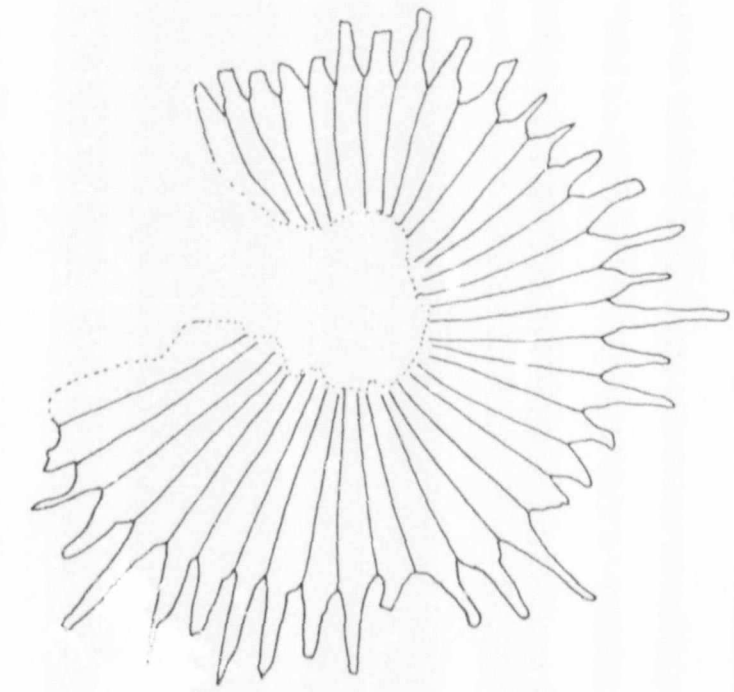
202



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202 A



204

the appearance of being less rigid, and lie on one plane. The apparent curve of the leaflets is not due to reflexed leaflets. With these specimens the mode of preservation may have influenced the preserved appearance, and they are considered as probably belonging to P.cf.etheridgei.

specimen in Figure 196 has longer leaflets than usual radiating out from the disc, with no sign of being recurved and only faintly tapering probably likewise a slightly atypical form of P.cf.etheridgei. Figure 197 is quite atypical with widely spaced leaflets that are linear, radiating from a flattened disc. There are indications of transverse striae on the fused portion of the leaflets, and there is a lateral groove almost along the margin of the leaflets. Both the midribs and commissural lines are clearly visible. This specimen is so different it probably represents a separate species, but as the only representative found to date, it is merely being recorded and figured at this stage.

Figures 198-200 represent a series of whorls small to large, where the flattened disc is very well developed and the free teeth are rather short and narrow in comparison to the more typical squat P.cf.etheridgei leaflets. The median veins are not clearly preserved only faintly visible on some leaflets, while the commissural lines are very clear. The diameter of the specimen in figures 200 and 204 is taken as exaggerated due to a break and subsequent opening up in the disc.

Figure 201 shows a laterally preserved whorl, with a short sheath and funnel-like disc area. The free leaflets are very long and narrow. In the disc the midribs are clear, taking up almost half of the leaflet width at the disc periphery. The specimen is not well preserved and in its poor state of preservation does not compare well with the typical P.cf.etheridgei of Loskop.

None of these specimens have any support in numbers of specimens, and are probably all (except figure 197) referable to P.cf.etheridgei, but as they are not typical of the taxon they have been separated from it.

3.2.4.1.2 P.cf.etheridgei from Estcourt-Wagondrift dam

Two specimens of P.cf.etheridgei were found at Estcourt, Wagondrift dam. The one (figure 205) shows the typical recurved claw-like leaflets of the lower whorl, with the united disc also typically curved. There is an upper whorl laterally preserved showing the tight fitting sheath

joining the rapidly expanding disc. The recurved leaflets are not seen on the upper whorl. The median vein is visible, though faintly, while commissural lines and longitudinal strands are not discernable.

The second specimen (figure 206) shows a horizontally preserved whorl which is typically saucer shaped. The leaflets are only indicated at their bases. Commissural lines and midribs not clearly visible.

Although these two specimens are apparently isolated examples of the species they are so typical as to be referred to it without doubt.

3.2.4.1.3 Phyllotheca shoot tips referable to P.cf.etheridgei. Figs. 207-215.

These shoot tips from Loskop are probably referable to P.cf.etheridgei as they are in close association with remains attributable to that species. Measurements are given in table 5. Figure 207 shows fairly clearly up to six whorls preserved over a distance of 10,3 millimetres. The leaflets are somewhat overlapping making observation difficult. Some of the measurable free leaflets are 4 millimetres long by 0,2 millimetre wide, with an acute apex. The expanded disc is 2 millimetres wide on the fourth whorl from the tip. Figure 208 similarly shows a shoot tip with four successive nodes. The free leaflets appear sparser than in other shoot tips which tend to have a bunch of leaflets, an apical tuft, terminating the shoot. The sparse leaflets give this specimen a moss-like appearance.

Figure 209 has only the very tip of a shoot preserved, the apical tuft showing a substantial aggregation of leaflets. The outermost whorl obscuring any inner detail. A tight fitting sheath of 3,7 millimetres is visible. Figure 210 has a similar tuft arising out of an expanded whorl. Figure 211 shows the tip of a small shoot with four whorls over 9,3 millimetres, the apical tuft accounting for 5,2 millimetres.

Figure 212 has three successive nodes possibly from near a tip, as the whorls are closely overlapping. The apical tuft is not clear. Figures 213-215 show fairly broad shoot tips, figure 213 has only the tuft preserved while figure 214 shows a fair length of stem, with several nodes close together. The longest leaflets are more than 11,7 millimetres long, recurved for the last 3,5 millimetres. The stem is approximately 3,5 millimetres wide, being completely obscured by the leaflets. Portion of an expanded disc with claw-like leaflets is preserved at the lower end of the shoot, whether this whorl is in the original position or is a chance association cannot be ascertained.

None of these apical shoots is particularly well preserved. Whether

Table 5 Dimensions of shoot tips of [illegible]etheridgei

Specimen Number	Length of shoot mm	Width stem mm	No. of nodes	Length Free leaf-let mm	Width Free leaf-let mm	Width Expanded disc mm	Length apical tuft mm	Angle of disc (and leaflets) to stem
N-Lk 201a	10,3	-	6	4	0,2	2	6	30°
N-Lk 208	-	2,5		3,5	0,4	4,3	8,5	40°
N-Lk 271	-	3,5		11,7	-	-	-	60-80°
N-Lk 321	6,0	2,2	3	4,9	-	3	-	40°
N-Lk 333 PTO2				6,0	0,5		8,3	
N-Lk 343 PTO length internode	0,3	1,5	4	4,0			3,9	20°
N-Lk 466		1	3	6,9			5,2	40-50°
a+b length internode	0,2							

Figures 205, 206 P.cf.etheridgei Two isolated but typical examples of the species. Figure 205 has two consecutive whorls. The lower whorl shows the claw-like leaflets, while the upper whorls shows the closely adhering sheath expanding into a saucer shaped united disc.
Figure 206 is a normal, horizontally preserved whorl.
205 - N-Ew 8 206 - N-Ew 7.

Figures 207 - 215 Shoot tips referable to P.cf.etheridgei.

Figures 207 - 208 Two small tips, with several nodes. The leaflets of both but particularly of Figure 208, are sparse giving an almost moss-like appearance.
207 - N-Lk 201a 208 - N-Lk 343.

Figures 209 - 211 Specimens with tightly closed apical tufts.
209 - N-Lk 336 210 - N-Lk 333(2) PTO.
211 - N-Lk 466b.

Figure 212 A section possibly coming from near a tip. The internodes are not yet fully expanded, but neither is the apical tuft present. N-Lk 321.

Figure 213 - 215 Broad shoot tips with apical tufts and closely overlapping leaflets covering lower internodes.
213 - N-Lk 271a 214 - N-Lk 271 a PTO 215 - N-Lk 341a

Figures 216 - 221 Possible Sphenopsid fructifications.

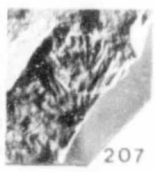
Figures 216, 217 Possible sporangial clusters of Phyllotheca.
216 - N-Bgv 211 217 - N-Bgv 210.

Figures 218, 219 Counterparts of a shoot with twelve recurring swollen areas. 218 - N-In 364b 219 - N-In 364a.

Figures 220, 221 Counterparts showing mass of reproductive bodies. At the upper end is a fragment of a ? Raniganjia partially overlying a fragment with dichotomous veins (? Sphenophyllum) (not visible on photograph).
A stalk-like structure is seen to emerge from the lower end of the mass.
220 - N-In 369b 221 - N-In 369a.

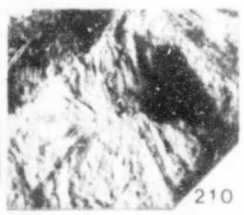

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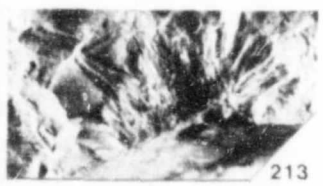

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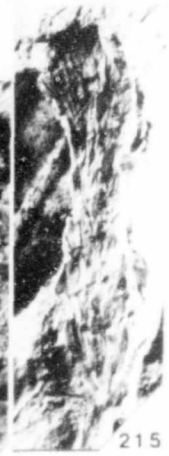

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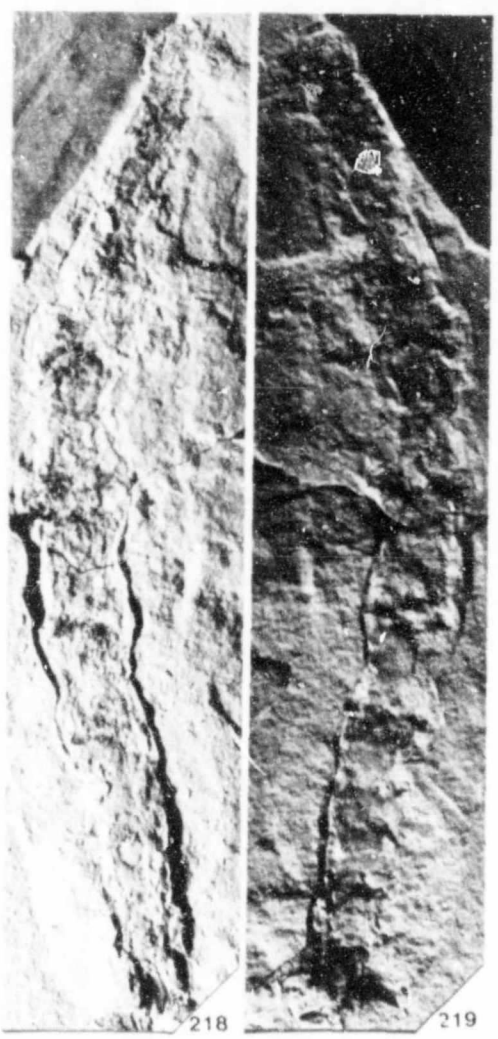

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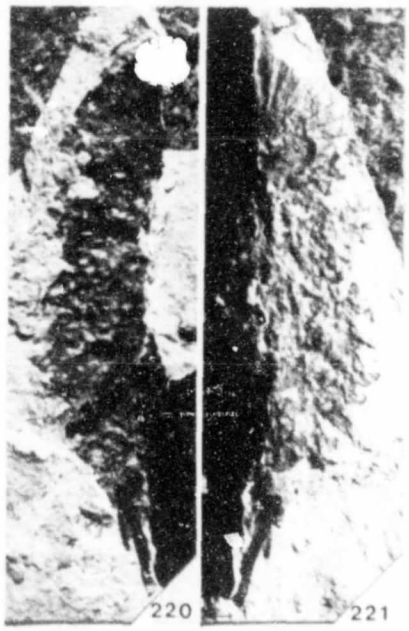

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218 219


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220 221

or not the midrib is already differentiated in the top-most leaflets is not quite clear. On some leaflets it would appear to be present (see left hand leaflets on figure 213).

There is no indication of the reflexed leaflets or discs commonly found on more mature specimens, except in figure 214 where the leaflets are reflexed, thus these tips do not look like miniature whorls of the older plant, but by association they are thought to represent the growing points of P.cf.etheridgei.

3.2.4.2 Discussion and Conclusion of Phyllotheca cf.etheridgei

These specimens from Loskop are designated as Phyllotheca cf.etheridgei as in broad outline they correspond to the species, which is distinctive from other Phyllotheca species by the greater development of the peltate disc that gently recurves in such a manner as to cause the free leaflets to hang down from the margin of the disc or to be partly folded under the disc; this would explain the frequent encounter, especially on larger discs, of no part of the free leaflets being preserved, as they lie on a different bedding-plane, and thus tend to be split off and discarded on opening up the rock. The preservation of the free teeth is thus most often found on medium sized discs, particularly if preservation fixed them in a slightly lateral position. The longer free teeth of the smaller whorls tend to be preserved in the same plane as the sheath and narrow disc, and are thus present in their entirety.

In the present collection there are several shoots showing successive whorls. In each case the whorls are of a single type, not showing any tendency towards the heterophylly as postulated in the reconstruction by Saksena (1955), however, the fact that in the Australian, Indian and now the South African material, the two types of whorls are always in close association points to their probably belonging to one and the same species, contrary to Arber's (1905) thoughts of a chance association. Neither the disc-like nor the longer leaved type of whorl have been found independently at a site except at Estcourt-Wagondrift dam where an insignificant number of specimens have been found due to exceptionally sparse material.

The manner in which this heterophylly manifested itself in the living plant is not obvious. In all the specimens on hand there is no indication of branching, although most Phyllotheca species are thought to have had at least a main stem and one order of branch: with the present information it is not possible to state whether or not different orders of branching may account for the heterophylly.

Author Benecke Anna Katherina
Name of thesis The Sphenopsida of the South African Upper Permian. 1977

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