

SEVERAL NEW FORMS OF GLOSSOPTERIS FRUCTIFICATIONS FROM THE BEAUFORT DAPTOCEPHALUS-ZONE (UPPER PERMIAN) OF NATAL, SOUTH AFRICA

by

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ABSTRACT

Fertile material, consisting of 27 specimens showing 29 fructifications from Mooi River and 46 specimens showing 98 fructifications from the Loskop site, is described. An emended generic diagnosis of *Dictyopteridium* is given; specimens belonging to *D. sporiferum* Feistmantel and *D. flabellatum* sp. nov. are described, as well as *Fetura* gen. nov. including *F. natalensis* comb. nov. and *Scopus* gen. nov. containing *S. gibbosus*, *S. confertus*, *S. didiscus* and *S. obscurus* spp. nov.

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INTRODUCTION

The history of the fructifications associated with the *Glossopteris* flora is a chequered one, particularly that of the fossils ascribed to *Dictyopteridium sporiferum* Feistmantel. Originally *D. sporiferum* was assigned to the ferns (Feistmantel, 1881), then it was described as a fleshy rhizome with caducous hairs by Zeiller (1902) and now it is generally accepted as being the fructification of one of the species of the form-genus *Glossopteris*. With a change in the grouping of the fructifications the interpretations of their morphological structures have also varied. The round markings were interpreted as sori (Feistmantel, 1881), as marks left by rootlets (Zeiller, 1902), as seed cushions (Harris, in Plumstead, 1952) and as non-specific sacs (Rigby, 1971). At the same time the gross morphology has varied from a flat leaflet (Feistmantel, 1881), a round rootlet (Zeiller, 1902), a flattened reproductive structure (Maheshwari, 1965) and a cone without protection (Surange and Chandra, 1974); the last authors in 1975 consider it as a cone with protec-

tion on one side, the protective body being referred to as a "fertile scale", which is somewhat confusing as it is in fact a sterile scale and usually referred to as a protective scale or half. Similarly, venation reported by Feistmantel (1881) was refuted by Zeiller (1902), re-reported by Maheshwari (1965), again refuted by Surange and Chandra (1973) who in 1974 agreed that they too could detect venation but ascribed it to wrinkling between the seed cushions and not to venation.

From this short history it can be seen that there is great uncertainty about the fructifications ascribed to *Dictyopteridium sporiferum*. If the function of the morphological structures were better understood, more accurate descriptions could be made and the probable morphology of the whole fructification would become evident. From the available evidence it may be taken that *D. sporiferum* is a female fructification, since Surange and Chandra (1973) figure areas on *D. sporiferum* specimens which show seed-like structures. Whether there are any male parts on the structure has not been proven.

The type of preservation probably plays a large part in the current confusion. Information has been taken from casts and moulds, compressions and impressions and possibly replacements. Each of these methods of preservation can give a different picture. Originally this may confuse the issue, but ultimately it should assist in an accurate reconstruction of the whole fructification, each form of preservation supplying additional information.

Rigby (1962a) drew up a schematic line of evolution for the *Glossopteris* fructifications. He does not include *Dictyopteridium*, possibly not recognizing it as a *Glossopteridalean* fructification. At present there is still no irrefutable proof of the association but *Dictyopteridium* is accepted as being one of the *Glossopteris* fructifications (Plumstead, 1958).

Rigby (1961) reported *Glossopteris* fructifications from New South Wales (Illawarra Coal Measures) which he classified as *Scutum thomasi* Plumstead, and some which were left unclassified. The remainder of the flora from that horizon is similar to that of the Raniganj stage of India, and not to the South African *Ecca*. Unfortunately there are no figures provided so to comment is difficult, but it might be possible that some of these fructifications are similar to the new ones described below from the *Daptocephalus* zone.

Two of the fructifications under discussion are referable to *D. sporiferum* and a new species, *D. flabellatum*, is instituted for specimens closely allied to *D. sporiferum*. A monospecific genus, *Fetura*, including *Plumsteadia natalensis* Lacey *et al.* 1975 is instituted for a form mainly represented from Mooi River. The remainder of the specimens are included in the new genus, *Scopus*, in four new species, where the apparent anomaly of four different types of fructification occurring on a single variety of *Glossopteris* leaf arises. This anomaly will only be resolved when the morphology is more perfectly understood. That these four "morphological species" merely show developmental differences of mature and immature forms is not thought likely as no intermediate examples have been found, and simple enlargement of the organs, i.e. growth, could not account for the change in appearance between one form and another. Whether male and female forms are here demonstrated, or possibly even some form of vegetative reproduction, is not now discussed. Only confusion arises from efforts of precisely determining morphological features that do not lend themselves to definition at this stage; the application of precise names implies specific functions for which there is no evidence at present. Thus knobs, sacs and bulges are left rather vague terms that do not imply any function nor do they imply inclusion into any specific group of plants.

DESCRIPTION OF THE FOSSIL SITES

Two of the eighteen localities falling within the Lower Beaufort *Dactylocephalus* zone (Kitching, 1972) from which collections of fossil plants have been made yield

ed fructifications described below, namely the Loskop and the Mooi River National Road sites in Natal.

The Loskop material, coded N-Lk, was collected on the banks of the Little Tugela River, five kilometres beyond the Loskop railway siding on provincial road R35 between Estcourt and Bergville, just above the Courton bridge and the Soolaer monument. A small hill was used as a quarry for road metal, exposing a rich fossil horizon beneath a fairly substantial sandstone layer. The exposed fossil layer measured more than 200 metres long and continued into the hillside, and was approximately one metre thick. It is a diversified flora typical of the *Daptocephalus* zone *Glossopteris* floras, as listed below. Large quantities of fossilized material are so densely packed as to make it difficult to work in places. Many of the specimens described below were obtained from one large block, 80 × 50 × 20 cm. Unfortunately it was a loose block so it is not known which was the upper surface. This may have been relevant as *Dictyopteridium flabellatum* sp. nov. and the specimens belonging to the new genus, *Scopus*, appear to have been in separate layers, and establishing the embedding order might have thrown some light on their possible functions, such as a spring shedding of male (pollen) organs and summer-autumn mature fruit fall. Specimens similar to those from the large block were found scattered throughout the site, too infrequently to establish a geochronological succession.

The Mooi River National Road locality, coded N-MN, is on the N3 freeway on the first road cutting a few hundred metres beyond the bridge over Grantleigh stream after Mooi River towards Estcourt. The large collecting platform exposed during road excavations was destroyed subsequently by further road work, thus the fossiliferous horizon is now inaccessible in the hill side. The collection represents a varied but typical *Daptocephalus* zone *Glossopteris* flora as listed below. The preservation of some specimens is good but many show loss of detail due to *in situ* weathering. The matrix often has fine fissures running diagonally across the specimens. In a few instances these could be mistaken for venation. There is an abundance of fossils at the site but usually the specimens lie singly, hence associations (real or imagined) are difficult to determine.

A list of the genera found at the two sites is as follows:

Loskop

Sphenophyllum
Sphenopteris
Phyllothea
Ribbed stems
Noeggerathiopsis
Scale leaves
Glossopteris
Diverse seeds
Diverse fructifications
Wood
Vertebraria
Insect wing

Mooi River

Sphenophyllum
Sphenopteris
Phyllothea
Noeggerathiopsis
Scale leaves
Glossopteris
Diverse seeds
Diverse fructifications
Wood
Insect wings
Bivalve

The material is now housed at the Bernard Price Institute for Palaeontological Research of the University of the Witwatersrand, Johannesburg.

Note on measurements

Measurements taken of all specimens which are more or less complete, or which illustrate a feature particularly well, have been considered and the range for a particular feature is given. Many of the dimensions are not considered diagnostic *per se*, and hence the figure has been given as approximate, making provision for dimensions outside the present observed range to be included.

Wing width is measured from the point where any surface pattern of the fructification ceases to occur and a structureless tissue follows to the margin.

Stalk length is taken from a point where the natural curve of the base of the fructification would cut across the upper end of the stalk.

The material was investigated under a binocular microscope with the light at a very low angle of incidence.

The numbers given in this paper to holotypes, paratypes and figured specimens are those which are written in ink on the individual specimens. This is because, at present, the fossil-plant collection in the Institute has not yet been systematically catalogued and enumerated. The numbers given in brackets (e.g. PB 005a) are those which are intended to be given in a contemplated catalogue of illustrated specimens.

DESCRIPTION OF MATERIAL

Genus *Dictyopteridium* Feismantel 1881

Dictyopteridium sporiferum Feismantel

Figures 1, 4, 5, 6

Type species: *Dictyopteridium sporiferum* Feismantel 1881. Fossil Floras of the Gondwana System, Vol. III, pt. II, Plate 23A, Figures 4–6, 14. Figures 4 and 5 refigured by Surange and Chandra (1973), Plate 1, Figures 1 and 5.

List of figured specimens

Lectotype: Refigured in Surange and Chandra (1973), Plate 1, Figure 1, specimen No. G.S.I. 5210 which is Feismantel's specimen on Plate 23A, Figure 4 (1881).

Zeiller (1902), Plate 4, Figure 8, refigured by Surange and Chandra (1973), Plate 1, Figure 6.

Arber (1905), Figure 51, refiguring of Zeiller (1902).

Walkom (1922), Plate 9, Figure 48.

Rigby (1962b), Plate XI, Figure 4.

Saksena (1962), Plate 2, Figure 17.

Maheshwari (1965), Plate 1, Figures 3 and 4.

Surange and Chandra (1973), Plate 1, Figures 2 and 3.

Surange and Chandra (1974), Plate 2, Figure 3.

Holmes (1974), Plate 8, Figure 14.

Surange and Chandra (1975), Plate 8, Figure 20 (counterpart of 1974 specimen).

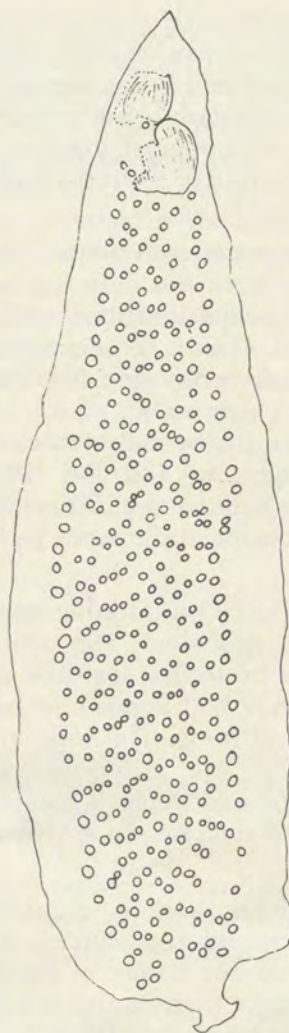


Figure 1. A complete specimen of *Dictyopteridium sporiferum* showing seeds exposed at the tip, the randomly distributed discs (knobs not shown), the wing and the stalk.

Description and comparison

From all the specimens comprising this collection only two are referable to *Dictyopteridium sporiferum* Feismantel: a complete specimen from Mooi River, N-MN 895 (PB 002) (Figures 1, 5 and 6), and a tip on the reverse side of N-Lk 410 (PB 001) from Loskop (Figure 4). The complete specimen is lanceolate tending to oblong-lanceolate tapering from the upper half. Tip acute, base truncate, short stalk present. There is a very narrow wing around the whole of the raised central area. The surface of the central area appears to have been fleshy and smooth except for randomly distributed slightly recessed structures or discs. The discs are small convexly flattened bodies of about 0.5 mm diameter, with slightly pitted surfaces compared with the smooth surface of the surrounding area. Each disc shows centrally a very faint secondary protuberance or knob, approximately 0.15 mm in diameter or a third that of the disc (Figure 4). Figure 2a shows an envisaged surface cross section of *D. sporiferum*. The mode of attachment of the compound disc to the surface of the central area is not known. In view of the fact that no missing or misplaced discs were observed, the at-

tachment is shown as fairly solid, although there is no proof that the discs were not further undercut and thus more tenuously attached to the main surface. The discs are arranged more regularly along the margin of the raised central portion and are very slightly larger than the rest. There does not appear to be any other difference between the central and lateral discs.

At the tip (Figures 5, 6) the covering layer comprising the smooth fleshy area with discs has been torn away and two flattened bodies that show seed-like striations have been exposed. On the remaining area there is no indication of underlying seed-like bodies, further suggesting a fleshy consistency of the covering layers. These seeds appear to be more rounded than those figured by Surange and Chandra (1973). The discs could hardly have been seed cushions as Surange and Chandra (1973) suggest as the seeds lie below the surface of these discs.

There is no evidence of a double nature to the two fructifications here described. The counterpart which may have shown a protective 'leaf-like' structure is not preserved. The fertile half appears to have been a bilaterally symmetrical body. The wing appears to be a uniform structure, not composed of projecting ovuliferous scales or seed wings. It is in organic connection with the raised central area splaying out along its sides.

The specimen from Loskop (Figure 4) shows the same surface structuring and patterning as that from Mooi River. The double nature of the disc and knob arrangement is clearer than on the first specimen. The wing area is poorly preserved. There is no evidence of underlying seeds. The fructification lies at a slight angle to the mid-rib of an underlying *Glossopteris* leaf with open reticulate venation, that opens out to nearly right angles at the margin. Whether there ever was any connection between this leaf and the fructification can only be surmised, but the alignment of the fructification with the mid-rib is suggestive of such an association.

The two specimens described above are comparable with those given in the list of figured specimens. These, under the present system of classification, are all referable to *Dictyopteridium sporiferum* Feistmantel, which appears to be a rather rare form of fructification.

Surange (1966) reports *D. sporiferum* from the Talchir Coalfield, Barakar stage, Damuda series, and the Karanpura coalfield, Raniganj coalfield and South Rewa Basin from the Raniganj stage, Damuda series, India. The Australian specimens come from the Illawarra Coal Measures (Holmes, 1974) and the Baralaba Coal Measures (Walkom, 1922).

White (1962) reported fertile material which was interpreted as a gradation of normal *Glossopteris angustifolia* leaves through a male stage which would correspond to *Dictyopteridium sporiferum*, and finally to a female stage. The progressive modification of the leaves to increased fertility is supported with schematic line drawings. In the text it is mentioned that all stages are observed in the fossil form. White (1963) figured the

stages (Plate 22, Figures 1–5) including all in the new species *Lidgettonia australis* with no further mention of a similarity of the male stage to *Dictyopteridium sporiferum* Feistmantel. This appears a more satisfactory interpretation as the figure (Plate 22, Figure 5, White, 1963) does not show the discs associated with *Dictyopteridium*. On Plate 24, Figure 12, White (1963) figures a fragment of *D. sporiferum* which if correctly determined shows a very large wing.

Plumstead (1972) reports the occurrence of *D. sporiferum* from a borehole sunk at Somkele. The figures (Plate 5, Figures 1, 2) show leaf-like structures with protuberances that do not fall within the present limits of the genus *Dictyopteridium* but possibly resemble more White's (1962) material discussed above.

Total length: 43 mm; Stalk length: 2 mm; Diameter discs: 0.5 mm; breadth: 12 mm; Stalk breadth: 1 mm; Diameter knobs: 0.15 mm; Wing width: 2 mm.

Disc density approximately 150–172 discs/10 mm².

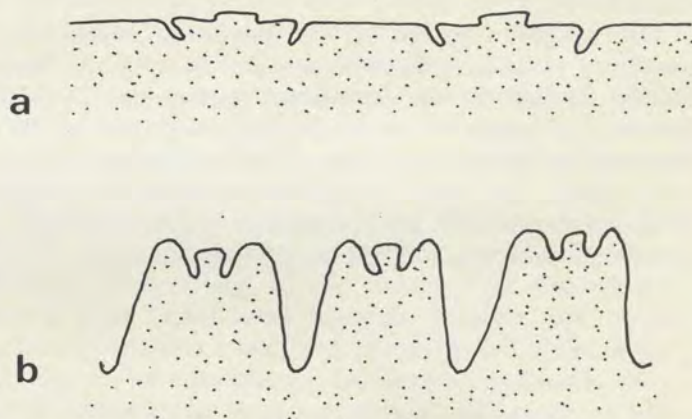


Figure 2. Envisaged cross section of (a) the compound, slightly recessed discs of *Dictyopteridium*; (b) the sacs indented to accommodate the simple discs of *Fetura*.

Thanks must be expressed to Surange and Chandra (1973) for publishing photographs of Feistmantel's 1881 original specimens and also of Zeiller's 1902 specimen. It is hoped that this example will be followed by others who have access to type specimens that have been inadequately figured in the past.

Dictyopteridium flabellatum sp. nov.

Figures 7–24 and 88

Holotype N-Lk 424 (PM 005a), counterpart N-Lk 360 (PB 005b), Figures 9, 10.

Paratypes N-Lk 406 (2) and counterpart (PB 011a, b), Figures 19, 20, 21, N-Lk (PB 008) Figures 13, 14.

Specific diagnoses

Fructification double, bi-laterally symmetrical, oblong-lanceolate; tip acute, base truncate gathering into stalk area; from several entry points at base an acute dichotomous vein-like pattern in high relief of grooves with swollen areas between them curving out-

wards at approximately 15°, swelling further to form an ordered array of elongated sac-like swellings along the margin, which form an escarpment ending in a wing; over the entire central raised portion on swollen areas between grooves are randomly scattered discs with knobs, not recessed into depressions. Protective half has reverse relief of fertile half, wing area tends to be broader.

Name derivation

Flabellatum (L) = fan shaped. Dichotomizing grooves show fan-shaped pattern.

Total length: 34–35 mm; breadth 5–14 mm: Stalk when present: length 1.5–3 mm; breadth 2 mm: Wing width: 0–2 mm.

Disc diameter approximately 0.4–0.5 mm.

Knob diameter approximately 0.15–0.2 mm.

Swollen marginal bulges approximately 8–10/10 mm.

Disc density approximately 80–175/10 mm².

Type locality

Five kilometres past Loskop railway siding, above the Soosilaer Monument on the Little Tugela River, Natal. *Daptocephalus* zone, Upper Permian.

Description and comparison

There is no direct evidence that the dichotomizing grooves are veins as no vein structure is visible. The vein was possibly embedded in a fleshy surface with the tissue above the vein being less fleshy and hence forming a groove. The randomly scattered discs with knobs are clearly visible on the swollen ridges in Figure 14. Figures 19 and 20 show the wing area which tends to be broader on the protective half than on the fertile half. Figures 22–24 show two fructifications lying close together. By projecting their bases it appears that the two specimens joined basally. It is proposed that the specimen closest to the scale in Figure 24 (and enlarged in Figure 22) is the fertile head while the other specimen in Figure 24 (and enlarged in Figure 23) is the protective half of what was originally one reproductive body. Maheshwari (1965) figured a specimen (Plate 1, Figure 2) of *D. sporiferum* which shows the same arrangements for the two halves.

Figure 12 is a slightly laterally compressed specimen that shows the lateral sacs from an “escarpment” view. In well-preserved specimens the marginal swellings show no particular surface patterning (Figures 15, 18, 20). In Figure 8 the margin is poorly preserved (partial rotting before preservation?). On the upper side of the illustration are a series of five solid round bodies in the place of the marginal swellings. These round bodies show no particular structure that could assign to them a special function, but their order and position appears significant. Figure 9 has a portion of the high relief surface missing on the left-hand side revealing a row of about eight flat oblong areas lying side on (enlarged in Figure 88) their long axis at right angles to the margin, thus not corresponding with the orientation of swollen sacs on the upper surface. These flat areas are clearly

striated. They do not show any particular thickness, nor do they appear to be seeds. The stalk-like structure to the inside of these striated bodies is on a lower level and is probably not part of the fructification. At the very tip a small area is also missing (still attached to top of Figure 10), revealing a similarly faintly striated area below it. How to reconcile the round structure from Figure 8 with that of the striated areas in Figure 9 is not clear.

The tip of the specimen shown in Figure 9 broke off (arrowed), showing a cross sectional view of the specimen. From this it appeared that on the left-hand side the main surface folded over, continuing as the lower striated surface. The details on the right-hand side were obscure. It is thus not clear whether the cross section is as shown in Figure 3a or 3b.

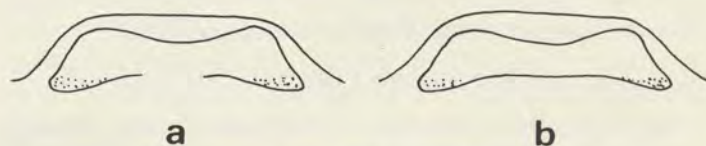


Figure 3. Possible cross section of *D. flabellatum* with an overlying protective cover; (a) an open, folded over structure, and (b) a closed structure.

With the tenuous evidence on hand 3a is favoured.

These fructifications are not found closely associated with any leaves. All the specimens to date come from Loskop.

It is suggested that the Maheshwari (1965, Plate 1, Figure 5) specimen may be included in this group due to the vein-like relief shown on the Canada balsam transfer. Without being shown what the specimen looked like before a transfer preparation was made, it is difficult to assess whether the vein-like relief was in fact not visible on the upper surface, so the interpretation, that it represents the “other” (i.e. lower? reverse?) surface only, is not clear. The observation by Maheshwari (loc. cit.) that the “scars” (discs) are not present on the ridged and grooved surface is not in accordance with the evidence as noted in *D. flabellatum* where the discs with knobs are found randomly distributed on the ridges. Thus the inclusion of Maheshwari’s (1965, Figure 5) specimen into this group is tentative.

In the present collection there are enough specimens showing consistent distinguishing features to warrant the institution of a new species. The general shape of the fructification, and more particularly the details of the discs with knobs bring together the two species under *Dictyopteridium*. *D. sporiferum* is recognized as a female fructification; thus the possibility exists that *D. flabellatum* is its male counterpart, although there is no direct evidence to support this.

The position of the genus *Isodictyopteridium* Rigby 1972 is unclear. Without seeing Walkom’s 1922 specimen the opinion of Surange and Chandra (1974) is accepted that *Isodictyopteridium* should be merged with *Dictyopteridium* again. The specimens figured by Holmes (1974) and included in *Isodictyopteridium* are strange in

showing a thick central strand; however, Maheshwari, (1965, Plate 1, Figures 1–2) shows a similar strand. Figures 11 and 12 (Holmes, op. cit.) do not show a clear surface, but Figure 13 (Holmes, op. cit.) could possibly belong to *D. sporiferum*.

Some confusion appears to have arisen about the surface structure of *Dictyopteridium*. The actual fructification or fertile half has discs with knobs while the counterpart shows a pitted surface — the negative image of the fertile half. The pitted surface is clearer on a reverse mirror image of the fertile half and less clear though still discernible on the inner surface of the protective half.

Following on the discussions of both *D. sporiferum* and *D. flabellatum* it is felt that the most recent diagnosis for the genus as given by Surange and Chandra (1973) needs revision.

Genus *Dictyopteridium* Feistmantel 1881

Diagnosis Surange and Chandra, 1973, p. 128

A pedicellate female fructification of linear-lanceolate shape about 3.5 cm long and 1 cm broad; the cone axis or receptacle covered over with round to oval seed cushions or seeds, seed cushions or seeds crowded on the cone axis in close spirals, seeds arranged on two margins in regular rows, one below the other; seed small, oval with obtusely pointed neck and round or concave chalazal end.

Emended diagnosis: *Dictyopteridium* Feistmantel 1881

Fructification bi-partite, bi-laterally symmetrical, lanceolate to oblong-lanceolate, tip acute, base truncate, short stalk present; very narrow wing surrounds raised central portion; randomly scattered discs with knobs attached to outer surface over central area of fertile half, protective half usually shows reverse relief of fertile half on inner side, with a broader wing area around the outside.

Genus *Fetura* gen. nov.

Type species *Fetura natalensis* comb. nov.

Generic diagnosis

Bi-partite, stalked fructifications consisting of leaf-like protective part and fertile head composed of sacs with depressions to accommodate simple discs. Sacs ordered along the margin; very narrow wing surrounds fertile head. Fructification attached to a *Glossopteris* leaf.

Derivation of name: *Fetura* (L) = breeding, bringing forth of young.

Fetura natalensis comb. nov.

Figures 25–41

Synonymy: *Plumsteadia natalensis* Lacey et al., 1975. Figures on p. 397.

Specific diagnosis

Fructifications bi-partite, lanceolate oblong, tip obtuse to acute, base truncate ending in a squat stalk; cen-

tral head of fertile half covered with randomly distributed sub-circular sacs, touching at their bases, free higher up, sac top depressed to accommodate disc shaped structure; sacs radiating out from upper end of stalk poorly defined, elongated, lacking the depressions with discs in most cases; sacs along margin regimented, tending to be elongated with the long axis of the sac at approximate right angles to the main axis of the fructification, depression on the inner end to accommodate disc; disc size more or less constant on both central and lateral sacs; narrow wing sometimes visible; protective half of fructification leaf-like, has little relief over entire surface, only slight depressions to accommodate sacs from fertile half, venation-like striations sometimes visible; fructification attached to mid-rib of a *Glossopteris* leaf, towards base of lamina.

Total length: 13–25 (29)* mm. Wing width: 0–3 mm; breadth: 4–10 mm. Stalk length: 1.5–2 mm; breadth: 1–2.5 mm.

Disc diameter approximately 0.2–0.4 mm.

Central sac diameter approximately 0.6–0.8 mm.

Lateral sac length approximately 1.0–2.5 mm.

Lateral sac width approximately 0.8–1.5 mm.

Central sac density approximately 104–175 sacs/10 mm².

Lateral sacs 10–14 sacs/10 mm.

Many of these dimensions are not considered diagnostic and hence the figure has been given as approximate, making provision for dimensions outside the present observed range to be included.

Type locality

Mooi River National Road, road cutting a few hundred metres after Grantleigh Spruit Bridge on the N3, shortly after Mooi River on the way to Estcourt. *Daptocephalus* zone. Upper Permian.

Description and comparison

The central head of the fertile half of the fructifications referable to *F. natalensis* is covered with more or less randomly distributed roundish sacs (Figure 36) which are touching at the base, sometimes crowding one another and are free higher up. The sac tops are depressed to accommodate a simple disc-shaped structure (Figure 35). On the sac top a rim is formed, surrounding the depression, which can give the impression of a circular structure (the rim) round a central body (the disc). Many of the descriptions of this phenomenon give the impression of “compound discs” as in *Dictyopteridium*, where the disc with knob has a similar concentric appearance, of a totally different origin.

The sacs radiating out from the upper end of a short stalk are poorly defined; they are elongated and lacking a depression with disc in most cases. The sacs along the margin are regimented and tend to be elongated with the long axis of the sac at approximate right angles to the main axis of the fructification (Figure 27). The

* refers to specimens figured 30 and 31, see below.

lateral sacs have a depression on the inner end to accommodate the discs. The disc size is more or less constant on the central and lateral sacs. A narrow wing is sometimes visible, apparently the undifferentiated continuation of the lateral sacs (Figure 32). In size it is just larger than the thickness of the central head. Figure 37 shows an abnormally large wing at the tip but has a few ill-defined sacs with discs, and is thus placed in this group. The protective half of the fructification has little relief over its entire surface, showing only slight depressions to accommodate the sacs from the fertile half (Figures 25 and 30). It appears to have venation which on closer inspection shows no vein detail either dichotomising or anastomosing. It may be fine venation or an accident of preservation. Figure 26, being the fertile half does not show this venation-like pattern. Figures 28 and 29 are interpreted as showing the fructifications covered by the protective half, the general sac lay-out corresponding with the other specimens of the species, but all disc detail obscured. Figure 29 shows one of the few specimens from Loskop placed in this group which is predominantly represented by samples from Mooi River.

The specimen shown in Figure 38 has been retained in *F. natalensis* as the poorly defined sacs show discs, although it superficially resembles *Scopus gibbosus* forms.

F. natalensis has simple discs unlike the *Dictyopteridium* species which have compound discs. Figure 2b shows an envisaged cross section of a *Fetura* sac with disc, the actual mode of attachment is not known and the internal configuration of the sac is not known, although it may have been a hollow sac with inclusions. The sac appears to have been a soft structure judging from the radiating tension gathers round the recessed disc (an upholstery button effect) visible on Figure 26 on the seventh sac from the bottom right hand side (arrowed). Most sacs do show this effect under a microscope. On the same specimen the ninth sac down, top right (arrowed), shows the only observed sac with a missing disc. The sac appears hollow and deflated. The shedding of discs does not seem to be the normal occurrence, as all the other sacs show the discs firmly in place.

The specimens figured in Figures 30 and 31 are counterparts showing two different surfaces of protective and fertile halves respectively. Figure 31 shows very poorly defined sacs and discs but a few are visible on the right hand side thus placing it under *Fetura*. At 29 mm length it is 4 mm larger than the largest Mooi River specimen. It is thus provisionally placed in this group. Figures 33 and 41 (counterparts) are poorly preserved but the sacs along the margin make them referable to *Fetura*. They show a possible triple structure with two protective halves and a central fleshy, fertile portion. The triple structure may be an illusion caused by the tearing of the fleshy portion. These specimens may be immature examples.

Figure 34 shows a fragment of a typical *F. natalensis* lying in alignment with the mid-rib of a *Glossopteris* leaf. Where the fructification is missing there is a clear

convex impression on the lamina, with lateral sacs well defined. The lamina is not altered beneath the fructification, the veins clearly following their natural course from the well-defined mid-rib. The manner in which the lamina has been moulded suggests that the fructification must be a rigid structure. It is puzzling that the mould is convex, suggesting a concave back surface for these fructifications. A more substantial fructification could have been imagined which would have left a straight or even slightly concave impression on the lamina. The supporting tissue might be in this case merely a thin rigid leaf-like or bract-like structure forming a base for the sacs which are borne only on the upper surface, the thickness of the fructification being the thickness of the sacs. This interpretation could also hold for the type specimen of *Plumsteadia microsacca* Rigby, 1962b, Plate XI, Figure 5. However, the original interpretation given was that there is an adnate organ (the convex mould area) "developed from expansion and rupture of the mid-rib" (op. cit., p. 344). The mid-rib in Figure 34 is so clear that it cannot be described as expanded or ruptured. The mid-rib is not so clear in Rigby's (1962b) figured Australian specimen.

The *Fetura* specimens are most similar to the *Cistella*, *Plumsteadia* and *Scutum* groups. The type specimens for *Cistella* Plumstead and *Scutum* Plumstead were re-examined. The sac details are difficult to observe in the material preserved from Vereeniging, which includes these type specimens, as the grain size of the matrix begins to obscure the fine detail. The sacs on the *Scutum* species show depressions, with some mass in the depressions; whether these are comparable to the discs on *Fetura* is difficult to assess. However, the very large fluted wing of the *Scutum* group excludes *Fetura* from *Scutum*, *Fetura* only having a very narrow wing or 'wing-like' area. *Cistella* and *Plumsteadia* have no wing. The sac details of *Fetura* are different from those described by Rigby (1971, Figures 2a-c) for *Plumsteadia*, where they are described as being unexploded and exploded sacs in the course of developmental ripening. There is no reference to discs on these sacs nor do the figures show any such structures. Amongst all the sacs on the *Fetura* specimens only one showed a missing disc (Figure 26) and the resultant structure could hardly be referred to as an exploded sac as the edge of the depression is smooth.

Plumsteadia Rigby 1962b has been redefined (Rigby 1969, paper not available). The Rigby 1971 definition is very different from the first one and is meant to absorb *Cistella*. The limits of the genus *Plumsteadia* have become confused and at this stage it would appear that *Cistella* is not synonymous with *Plumsteadia*. *Cistella* Plumstead 1958 is a genus instituted for fructifications from the Lower Gondwana horizons (Ecca series in South Africa). *Cistella stricta* does not show indented sacs with discs but *C. waltonii* has an arrangement of sacs similar to the *Fetura* arrangement of regimented sacs along the margin and random sacs in the centre. The *C. waltonii* sacs have a central cavity, somewhat larger and deeper than the depression on a *Fetura* sac; there does not appear to be a disc in the cavity.

The *Daptocephalus* zone plants are very much younger than the *Ecce* plants and, although they are still referred to as a "*Glossopteris* flora", they differ from the lower flora and thus if specimens show slight differences a new genus should be instituted rather than stretching the generic bounds over such long time intervals.

Lacey *et al.* (1975) placed identical specimens, collected from the same locality (Mooi River) in the genus *Plumsteadia* which for differences in sac and disc arrangement is unacceptable (see above). In their diagnosis of *Fetura natalensis* (= *Plumsteadia natalensis*) sp. nov. there is no mention of a protective half to the fructification, nor of a short stalk. The presence of a wing is problematical; there is definitely a lateral area below the escarpment, formed by the lateral sacs, that is undifferentiated and very wing-like. It is not seen on all specimens, nor often on both sides of the fructification, and is very narrow. Whether it is referred to as 'wing-like' or as a 'wing' does not alter the fact that some such structure is visible on many, though not all, specimens. Lacey *et al.* (1975) separate *Dictyopteridium sporiferum* and *F. natalensis* on the basis of *D. sporiferum* being a cone (radially symmetrical) and *F. natalensis* "a flattened bifacial organ" (p. 399). The two genera are separable on the disc detail and the compound nature of *F. natalensis* — many sacs forming the fertile head. The specific name of *multiplex* was to have been used for these specimens. The comparison of *F. natalensis* with *Hirsutum dutoitides* Plumstead by Lacey *et al.* (1975) is not as close as they would suggest as the sacs on *H. dutoitides* do not have a regimentation as they do in *Fetura*.

The sac and disc differences between *Fetura* and both *Cistella* and *Plumsteadia* are considered diagnostic. None of the existing genera of fructifications can comfortably accommodate *Fetura natalensis*, thus a new genus is proposed.

Scopus gen. nov.

Type species *Scopus gibbosus* nov.

Generic diagnosis

Fructification usually bi-partite, consisting of a protective leaf-like organ and a bi-laterally to radially symmetrical compound reproductive structure; stalked, attached to the petiole of a particular species of *Glossopteris* leaf.

Derivation of name

Scopus (L) = a mark set up to shoot at; referring to several different types of fructification occurring on a single leaf type, and the comment this is likely to elicit.

Scopus gibbosus sp. nov.

Figures 42–45, 55–81, 85, 94

Holotype N-Lk 316 a and b, Figures 42 and 43 (PB 026) a and b.

Paratypes N-Lk 318, Figure 73 (PB 051).

N-Lk 370 a and b, Figures 72 and 71 (PN 050) a and b.

N-Lk 315a, PTO Figure 56 (PB 035).

Specific Diagnosis

Fructification bi-partite, rather narrowly deltoid ovate to lanceolate and oblong; tip acute to rounded obtuse, base sub-cordate or truncate, stalk present; fertile head winged, with centrally random, rounded or flattened bulges under a thin covering layer; protective half has same shape range as fertile half, winged, shows various degrees of being keeled along central axis.

Total length: 20–38 mm; breadth: 5–14 mm. Stalk length: 0–7.5 mm; breadth: 1.5–4 mm. Wing width: 0–3.5 mm.

Bulge size approximately 1–1.5 mm.

Distance between bulges approximately 2 mm.

Bulge density approximately 36–44 bulges/10 mm².

Type locality

Five kilometres past Loskop railway siding, above the Sooi laer Monument on the Little Tugela River, Natal. *Daptocephalus* zone, Upper Permian.

Derivation of name

Gibbosus (L) = bulgy, referring to the central head showing bulges covered by a thin integument.

Description and comparison

The fructification consists of two separable portions ranging in shape from rather narrowly deltoid ovate to lanceolate and oblong. The tip is acute to rounded obtuse, the base sub-cordate to truncate with a thick stalk more or less centrally attached to the base. With the protective half removed the winged (Figures 71, 72) or unwinged (Figure 66) fleshy head shows random rounded (Figure 59) or flattened bulges (Figures 75–77) under a thin covering layer over the central portion. The protective half has the same shape range as the main body. It is preserved as either a convex (outer surface) or concave (inner surface) structure, winged especially towards the tip (Figure 57): it may be keeled along the whole length of the main axis (Figure 63), only towards the tip (Figure 56) or not at all (Figure 57). The protective half appears to have been a fairly rigid structure and when both halves are preserved the stalk tends to be continuous with the protective half (Figures 57, 65 and 72), while the fertile half shows a break (Figure 71) or a tenuous attachment to the petiole of a *Glossopteris* leaf (Figure 55). The fructification attachment to the petiole appears to be almost immediately below the end of the lamina; this point is obscured by the overlying fructification, thus the exact mode of attachment is not clear. The fructification is free of the lamina as it lies at various angles to the mid-rib. With the protective cover lying over the fertile half all relief of bulges is obscured (Figure 63). Both halves range from more or less bi-lateral symmetry to definite asymmetry. In some instances the fructification is preserved in such a way as to suggest a leaf folded over along the mid-rib, enclosing the bulges within the folded area (Figures 74, 78, 79). The specimens showing this tendency are provisionally grouped under *S. gibbosus* as

there is insufficient evidence to separate them; they are not found associated with any *Glossopteris* leaf, and the stalk in Figure 74 is longer and thinner than usual, but the bulges appear to correspond to the general design of the species.

The *S. gibbosus* in Figure 64 is more laterally compressed than the other specimens. It shows that the structure tends to be bi-laterally symmetrical rather than cylindrical as was proposed by Surange and Chandra (1973) where *Dictyopteridium sporiferum* is described as "cone-like". The same authors in 1975 proposed that *Scutum* and allied fructifications have a lenticular shape.

The fertile half of *S. gibbosus* is nearly always preserved as a convex structure, though it may lie flat. If a wing is present it forms an escarpment off the sides of the raised portion. The cell pattern suggests that the surface of the covering layer and the wing are continuous. The wing is composed of large cells. The covering layer over the raised central head appears to be a fairly thin structureless layer (Figures 44, 59) which nevertheless obscures the detail of the bulges beneath, only showing them as bulgy rounded or overlapping flattened areas (possibly a developmental feature?). In two instances the layer has been torn away or damaged, exposing the bulges (Figures 73, 76, 77). In both the bulges are round flattened structures (tightly overlapping in Figures 76 and 77) suggestive of seeds, though not showing any of the characteristic striations frequently found on seeds. No evidence of a micropylar end or any other structure can be distinguished. In some examples there appears to be evidence of a third structure, a second protective part lying beneath the fleshy head (Figures 44, 45). Towards the tip (Figure 44) a fleshy portion has broken away, exposing a further layer. Similarly Figure 71 shows a portion missing from the base and another structure below it. These areas may be impressions of the reverse side of the head but they seem too definite for impressions and might thus be structures in their own right.

The wing in some examples (Figures 58, 67) tends to fold under the head on one side while being exposed on the other; in other examples it is visible at the tip and folds under the head just over halfway towards the base.

The specimen in Figure 43 shows a finely striated area on the torn part of the fructification (not visible on the photograph). Figure 94 shows a similarly striated "scale leaf" which is the only free-lying one observed. Whether this is merely a coincidence of similar striations on different structures or whether such small scale leaves are associated with the fructifications cannot be assessed, as these are the only two examples found.

The specimen in Figure 62 shows relatively little surface detail, but enough to suggest that it is not a protective half obscuring the fertile part, but rather the covering layer being fleshier than usual, or the bulges not well developed.

Figure 63 shows the only fructification associated with a cordate based leaf in this collection. From the keeled appearance of the specimen it is interpreted as

being the protective cover over the fleshy portion. The fact that it is on a slightly different leaf does not warrant separation from the group at this stage.

From Mooi River the specimen (Figure 80) does not show the features of the other groups but displays random bulges which places the specimen within the *S. gibbosus* group, although it is not quite typical. With this as the only Mooi River example there is not strong evidence for *S. gibbosus* occurring at that site.

The positioning of these fructifications is so consistently in alignment with the mid-rib of the leaf on the petiole that they must be in the original position, although actual organic connections cannot be demonstrated (Figures 42, 43, 58, 61, 62, 63, 69, 70, 73).

There are no examples of the fleshy, fertile and protective parts lying adjacent to one another. The specimens shown in Figures 55 and 56 are the closest to this, although certainly not touching, being a few centimetres apart on the same rock surface.

Surange and Chandra (1973, Plate 1, Figure 7) show a specimen that could be a protective half belonging to this category rather than to *Dictyopteridium sporiferum*, although no fertile halves of anything resembling *S. gibbosus* have been reported from India.

Description of the *Glossopteris* leaf variety to which the *Scopus* fructifications are attached

They are medium sized ob-lanceolate leaves with an acute tip, the lamina gradually merging into the petiole. There is a strong mid-rib, the lateral veins leave the mid-rib at a very acute angle and open near the centre of the leaf half to an angle of approximately 45°, the vein islands are distinct, elongated, the veins dichotomizing and anastomosing from three to five times between the mid-rib and margin, there are approximately eleven vein endings per 10 mm at the margin. Before a general revision of the Lower Beaufort (*Daptocephalus* zone) *Glossopteris* leaves is available, this leaf will remain as *Glossopteris* species. Figure 70 shows a fairly small but almost complete leaf specimen with the tip of a *S. gibbosus* on the bottom left.

Scopus confertus sp. nov.

Figures 46–54

Holotype N-Lk 315 a and b, Figures 46 and 47 (PB 028) a and b.

Specific diagnosis

Fructification bi-partite, narrowly oblong, apex subtruncate, base truncate; in some cases stout projections randomly radiate off the central body; short stalk present attaching fructification to petiole of a *Glossopteris* leaf; central head covered with tightly packed, randomly placed, oblong swollen bodies; protective half leaf-like.

Total length: 6–14 plus mm; breadth: 3–4 mm. Stalk length: 1.5 mm; breadth: 1 mm. Stout projection length: 1.5–2 mm.

Type locality

Five kilometres past Loskop railway siding, above the Soolaer Monument on the Little Tugela River, Natal. *Daptocephalus* zone, Upper Permian.

Derivation of name

Confertus (L) = crowded; referring to the oblong swollen bodies tightly packed over the fertile head.

Description and comparison

These narrowly oblong fructifications probably had a radially symmetrical fertile half; as in various specimens belonging to this group the preservation shows a three dimensional remain (Figures 46, 50, 52, 54). A short stalk attaches the fructification to the petiole of a *Glossopteris* leaf a small distance below the ending of the lamina (organic connection visible in Figures 46 and 47). The function of the stout projections radiating off parts of the central body is not known. The fact that only one specimen (Figures 46, 47) shows these projections suggests that they may have been of a transient nature, being shed at a later developmental stage. The mode of attachment of the projections to the central axis is not visible; they appear to have come out between the tightly packed swollen bodies that cover the central head. The nature and function of the oblong swollen bodies is not clear. They appear to be individually attached to the central axis, and do not have any encasing tissue. The sacs are distorted due to overcrowding, and they do not give the impression of being very resistant bodies, as in most cases there appears to have been some form of tissue disintegration before preservation; thus only the specimen figured in 46 and 47 show the complete sacs.

The protective half is visible in two instances (Figures 51, 54). Figure 51 shows a flattish leaf-like structure in possible organic connection with the continuation of the leaf mid-rib (probably on the petiole). Whether this connection is real or apparent is not clear as the stalk may only be closely appressed or adnate to the petiole. In Figure 54 the fleshy portion is lying on the protective half in a depression with a wing-like area spreading out on a level with the fleshy head (upper left of figure).

The specimen figured 48 and 49 is slightly different from the others, the oblong bodies appearing more swollen and overlapping but it appears to fit best into the *S. confertus* group and is thus included.

Figure 50 shows a fructification on the right hand side of a good specimen of the *Glossopteris* leaf variety to which the *Scopus* fructifications are attached. The leaves appear to be the same and yet *S. gibbosus* and *S. confertus* are two morphologically distinctive units with no intermediate specimens having been found; thus two morphological species or form-species are proposed. Whether they represent male and female reproductive units of the same plant or whether the differences are developmental with the intermediary forms not yet discovered is unclear. There is no evidence particularly to recommend either theory.

Scopus didiscus sp. nov.

Figures 69, 81–84, 93, 94

Holotype N-Lk 317 a, Figure 81 (PB 056).

Paratype N-Lk 369 a (5), Figure 83 (PB 062).

Specific Diagnosis

Fructifications double, quadrato-orbicate, base slightly contracted, central area strongly obtuse-cuneate convex to almost flat; fluted wing-like area may surround central area, showing radially divergent from the central area dichotomizing vein-like striations.

Total length: 11–15 mm; breadth: 9–13 mm: Wing width: 0–3 mm.

Vein-like endings along margin approximately 14/10 mm.

Type locality

Five kilometres past Loskop railway siding, above the Soolaer Monument on the Little Tugela River, Natal. *Daptocephalus* zone, Upper Permian.

Derivation of name

Didiscus (L) = two plates, referring to the two apparently rigid concavo-convex disc-shaped bodies facing one another, forming a central cavity.

Description and comparison

The double disc-like fructification usually presents a convex view. The raised central area is strongly obtuse-cuneate convex (Figure 81) to almost flat (Figure 82(9)). There may be a fluted wing-like area surrounding the convex portion (Figure 81) or it may be absent (Figure 82(7)). Coming off the central area, more or less radially, are dichotomizing striations superficially vein-like but not showing any definite vein structure. The two halves of the fructification appear to be fairly firmly attached, as in three specimens they have remained together in spite of a gap allowing considerable sediment infill (Figures 81, 83, 84). No other structure appears to be preserved between these two halves.

Superficially Figure 82(9) appears to have a relatively long stalk. This is probably the petiole continuation from the leaf with which it is aligned, although it might be an adnate stalk. This specimen connects *S. didiscus* with the same type of *Glossopteris* leaf as the other *Scopus* fructifications, the positioning and alignment being the same; the other specimens do not show a stalk, merely a contracting of the base.

The specimens give the impression of being thin but rigid structures. The specimens are in close association with *S. gibbosus* and *S. obscurus*. The structure was possibly protective in function; whether it contained any of the other *Scopus* species cannot be deduced from the material on hand. The only fructifications to fall within the size range of the central cavity are the *S. confertus* forms; they, however, have their own protective halves, which do not resemble *S. didiscus* at all, and thus it seems unlikely that they should be connected.

There appeared to be a mass fall of *S. didiscus* as seen in Figures 93 and 94, whether this was seasonal or a freak of nature is not known.

Scopus obscurus sp. nov.

Figures 86, 87, 89–94

Holotype N-Lk 222 a and b, Figures 89, 91, 92 (PB 072) a and b.

Paratypes N-Lk 315 a and c, Figure 87 (PB 071). N-Lk 369 b (2), Figures 86 and 90 (PB 059).

Specific diagnosis

Fructifications thin, appearing fleshy, quadrato-oblong, tip obtuse to apiculate, base truncate with short stalk; slightly swollen “sacs” sometimes developed at approximately right angles to margin, giving a gently fluted appearance; if “sacs” absent structureless appearance results.

Total length: 15–22 mm; breadth: 11–13 mm. Stalk length: 4 mm; width: 1 mm.

Sacs at margin if present approximately 9/10 mm.

Sac width: 0,8–1,1 mm; length approximately: 1,5 mm.

Type locality

Five kilometres past Loskop railway siding, above the Sooiiaer Monument on the Little Tugela River, Natal. *Daptocephalus* zone, Upper Permian.

Derivation of name

Obscurus (L) = showing little detail, obscure.

Description and comparison

These fructifications do not appear to have a closely associated protective cover as do the other *Scopus* forms. Whether there ever was such a cover remains to be discovered. The fructifications appear to have been thinly fleshy, particularly the specimens that show little structuring (Figure 86); whether that is a developmental feature, tending to a more structured, rigid, mature form is not known. Figure 90 is an enlargement of Figure 86 and shows large surface cells, forming faint radiating striations.

Figure 86 shows the structureless form while Figure 89 shows a specimen with very well developed and perfectly aligned sacs. Figure 87 shows an intermediate stage with sacs developed towards the top only. Whether these sacs were ever hollow structures is difficult to determine, as in the preserved form they appear to be fairly flat.

The specimen in Figures 91 and 92 shows the organic connection between the stalk and leaf petiole, the cell patterning can be followed through. It is interesting to note that in Figure 91 the leaf petiole bearing the fructification continues and joins a small stalk that appears to fork off a thin branch.

The specimen figured in 87 has the actual organic connection of the fructification and the petiole broken, but the positioning of the fructification on the leaf petiole implies the original position.

These fructifications occur in close proximity to *S. didiscus* but it is doubtful whether they form a unit together; the overall dimensions of the two are different, *S. obscurus* being larger than *S. didiscus*.

The *Glossopteris* leaf to which these fructifications are attached is the same as for the other *Scopus* species.

This *S. obscurus* is a small group. Originally it was thought that the difference in appearance from *S. didiscus* could have been due to an accident of preservation, but with even the cell pattern surviving fossilisation the preservation was probably good and hence these have been separated from *S. didiscus*. What were thought to have been intermediary forms are specimens of *S. didiscus* which tend to have the more flaccid appearance of *S. obscurus* but they have the radiating, dichotomising vein-like striations typical of the *S. didiscus*.

These specimens all came from Loskop.

SUMMARY AND CONCLUSION

“There are no clear indications of the original nature of any of these structures save the stalk nor of their morphological category. There can be little doubt of the vegetable origin of the fossil, and it seems highly probable that it was connected with the reproduction of the plant on which it grew” (Thomas, 1921, p. 287).

After more than fifty years one cannot with much certainty say more than this!

If the specific designation of fossil plants is to have any meaning it must represent a definable unit, hence four names have been given to separate the four morphological forms of the *Scopus* group, although they appear to belong to the same form of *Glossopteris* leaf. Thus in this case “species” does not imply a breeding unit but merely a recognisable morphological form, i.e. a form species. A future amalgamation of these four form species into a “real” species (a breeding unit) can only take place once the roles of each form in the reproductive cycle of the plant have been understood.

The interpretation of the simple discs of *Fetura* and the compound discs, discs with knobs, of *Dictyopteridium* is difficult. That they are seed cushions (Surange and Chandra, 1974) is not acceptable as the seeds are below the surface bearing the compound discs; thus the knob cannot be the area of vascular bundles as was suggested by Surange and Chandra (1975), nor is it in this case likely to be the place of the attachment of the stigma or the base of the style (Plumstead, 1956 and Varama, 1963), although the slight pitting on the surface of the discs as compared with the smooth surface which covers the rest of the fructification is reminiscent of a stigma. The relevance of the pitting is not clear. In *Fetura natalensis* the discs top a definite sac, thus occurring in a predetermined position, which is not the case in *Dictyopteridium sporiferum* or *D. flabellatum*. That these discs are only a surface embellishment does not seem a very satisfactory explanation either, as they show some consistency in positioning, either along the margin of *Dictyopteridium* (although the central area has

a random distribution of discs) or on the sacs in *Fetura*.

Walton (in Plumstead, 1952, p. 332) puts forward the idea of a cone or strobilus with appendages that would form the wing for the fossil form of *Scutum*, with the same principle applying to similar types of fructifications. Surange and Maheshwari (1970) accept this organisation, putting forward the idea that the scales which overlap on the central head area break off when the specimen is split showing a "protective" counterpart that is not the same as the main fructification. This idea is neither acceptable for wing formation nor as an explanation of the origin of the protective half. The wing area could not have such a uniform appearance if it were composed of closely appressed scales, nor could there always be such a clean break as to leave no trace of the scale on the fertile half. The counterpart would have to show some sign, even if only in the cell pattern, that it had a composite nature, which is not the case. Likewise the margin of this counterpart could not be entire, which it is, if it consisted of a torn-off agglomeration of scales. This theory could also not explain how there is sometimes a reverse mirror image on the counterparts when the protective cover is not preserved, as this would imply that the scale leaves would fall off completely in some instances and not at all in others, with no intermediate stages possible.

Surange and Maheshwari (1970) also put forward that the "false, irregular venation-like design which is generally seen on the counterpart could result from seepage of sediment in the small crevices between the overlapping scales". The faint venation-like pattern seen on the protective half can certainly not be described as "normal" type *Glossopteris* venation (Surange and Chandra, 1975) if its origins were due to overlapping scales. From evidence of the specimens on hand and

due to the difficulty of explaining the double nature of the fructification with compound cover, the wing appears to be a uniform structure, continuous with the central head.

Sen (1955) and Surange and Chandra (1974) suggest that the protective half falls away to expose the fertile half for fertilisation, which would account for the large number of unattached "scale leaves" found in this type of deposit. However, the large number of "scale leaves" found in the deposits under discussion are not of the same shape or size as the "fertile halves" and are thus probably totally independent of the fructification, rather representing the protection of growing points. This suggested deciduous habit of the protective half would be a most inconsistent feature as fructifications with the protective half attached are also found, in which the seeds have been totally shed according to Surange and Chandra's (1973) interpretation of discs being seed cushions. The protective half of these fructifications would appear to be more persistent than suggested by the above authors. It probably protected the whole fructification rather than the seeds directly as the seeds are protected by the covering layer.

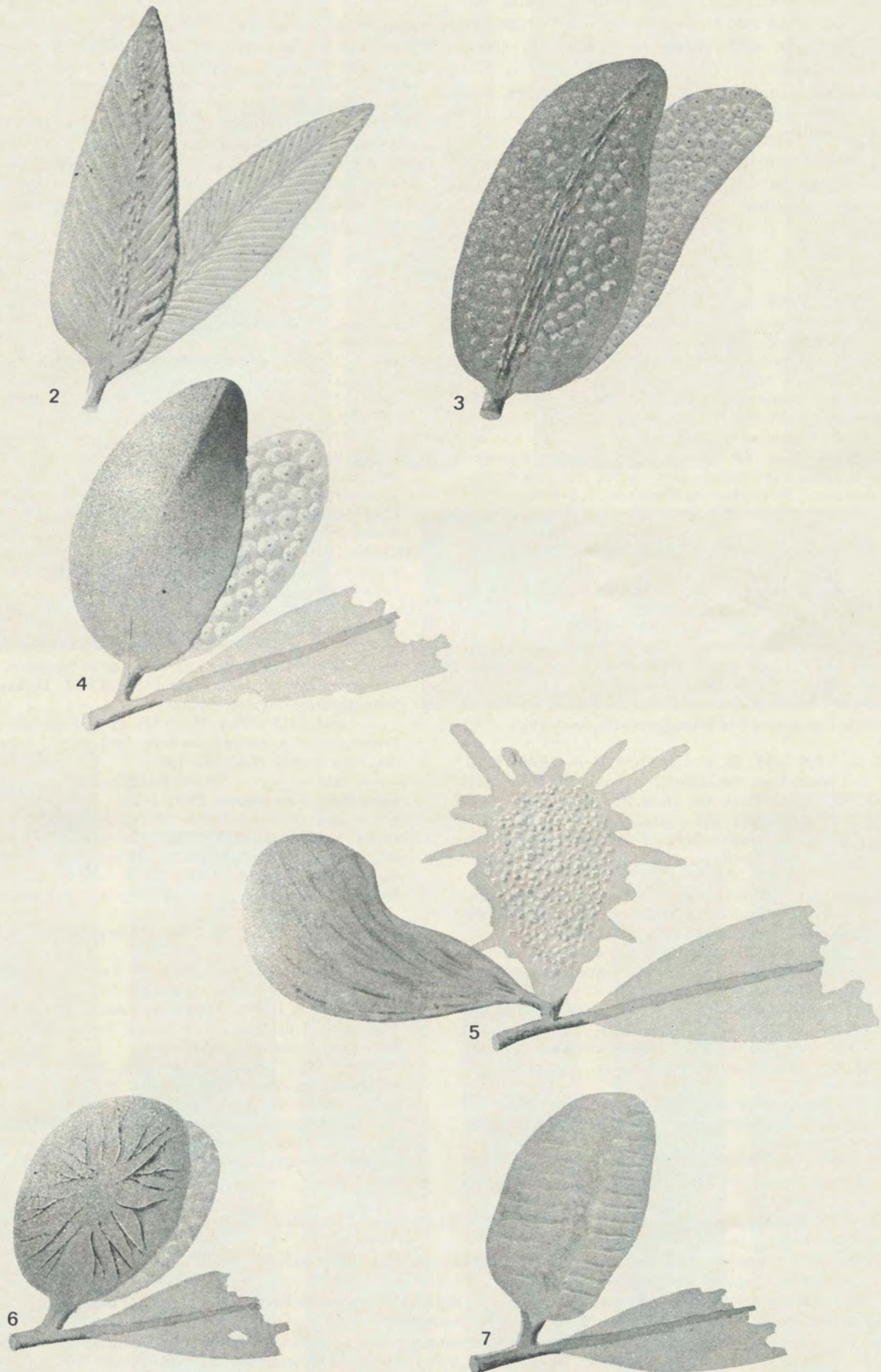
Archangelsky and Bonetti (1963) and Arrondo (1972) show different types of *Glossopteris* fructifications from South America which throw no further light on the local specimens. The fructification reported by Lambrecht, Lacey and Smith (1973) from the Law Glacier area, Central Antarctica is so poorly preserved as to make comparison difficult, but it does not appear to have any resemblance to the South African specimens.

Taking into account the difficulty of adequately describing these fructifications without using terminology which implies inclusion in a definite plant group, resultant impressions are necessarily vague,

TABLE I
Tabular classification of the Fructifications

Species	Overall shape	Tip	Base	Wing	Surface relief	Disc detail
1. <i>Dictopteridium sporiferum</i>	lanceolate oblong-lanceolate	acute	truncate	2 mm	Smooth, fleshy surface with depressions accommodating discs	Discs with knobs, larger along margin
2. <i>D. flabellatum</i>	narrowly oblong lanceolate	acute	truncate	0-2 mm	High relief of grooves and ridges. Discs on ridge not in depressions	Random discs with knobs
3. <i>Fetura natalensis</i>	lanceolate oblong	obtuse to acute	truncate	0-1 mm	Sacs touching at base, depressed tips accommodating discs. Lateral sacs elongated	Discs simple, same size over whole fructification
4. <i>Scopus gibbosus</i>	narrowly deltoid ovate to lanceolate and oblong	acute rarely obtuse	sub-cordate to truncate	0-3,5 mm	Thin undifferentiated layer overlying bulges	—
5. <i>S. confertus</i>	narrowly oblong	sub-truncate	truncate	—	Random oblong swollen bodies tightly packed	—
6. <i>S. didiscus</i>	quadrato-orbiculate	—	obtusely cuneate	0-3 mm	Dichotomising vein-like pattern radiating off central area	—
7. <i>S. obscurus</i>	quadrato-oblong	obtuse to apiculate	truncate	—	Sac-like areas at right angles to central axis along margin, some show no detail at all	—

For reconstructions of Nos 2-7 see opposite page.



Note. The pits on the bulges in 4 above are an error in reconstruction and should not have been inserted.

which expose the fructifications to much theorising. No certain function being ascribed to most of the structures makes comparisons with other fructifications mentioned in literature all the more difficult as the specimens are very often not very clear themselves, and the figures even less clear.

An attempt has been made here merely to describe the structure of these fructifications as they appear in this collection; the actual interpretations will be left to persons more specialised in the field of comparative morphology.

ACKNOWLEDGEMENTS

Many thanks to Dr. Plumstead for stimulating guidance throughout the years and for making available so many reprints of papers that would normally have been difficult to obtain; to Brian Schaller who was responsible for introducing me to both sites; to the CSIR for a grant during the years in which the Loskop material was collected and prepared; to Drs. Ann Anderson and J. T. Brown for helpful suggestions and discussions; and to S. J. Smithies for tracing some obscure literature; to G. F. Smith for reconstructions; to an understanding and helpful husband and finally to my mother and mother-in-law for looking after domestic affairs in order to let this paper see daylight.

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Figure 4. *Dictyopteridium sporiferum* showing the randomly distributed compound discs with knobs, in possible association with the *Glossopteris* leaf behind it. x 5 N-Lk 410 PTO (PB 001).

Figure 5. *D. sporiferum* with seeds visible at the tip under the disc bearing surface. x 2 N-MN 895 (PB 002).

Figure 6. Enlargement of Figure 5 to show seed details. x5.

Figure 7. The broadest specimen of *D. flabellatum* showing typical ridges and marginal swellings. x 2 N-Lk 478a (PB 003).

Figure 8. *D. flabellatum*, the poorly preserved margin discloses five round bodies in place of the marginal swellings. x 5 N-Lk 398 (PB 004).

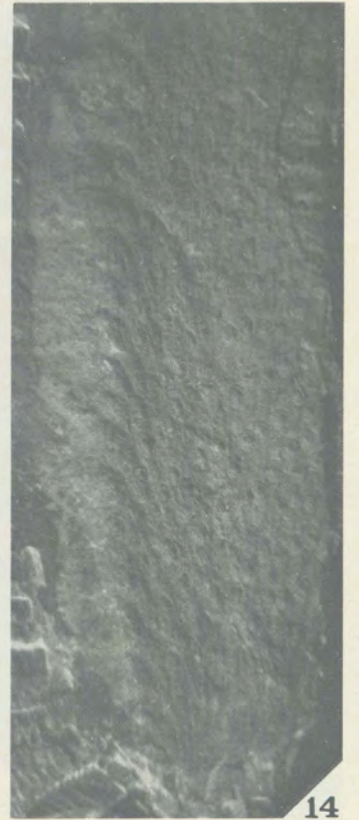
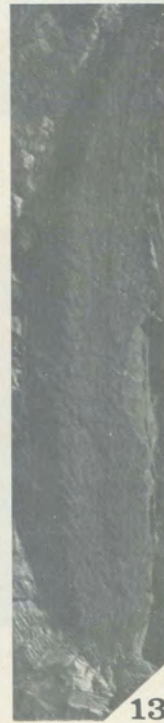
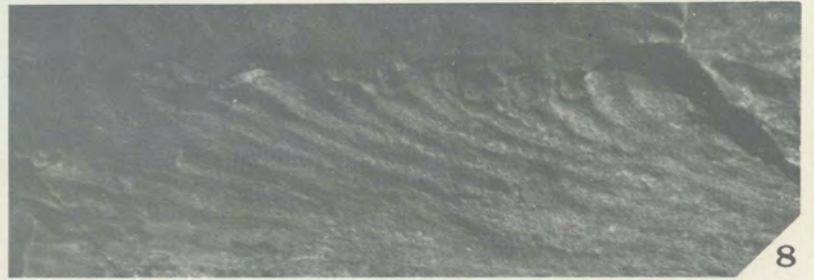
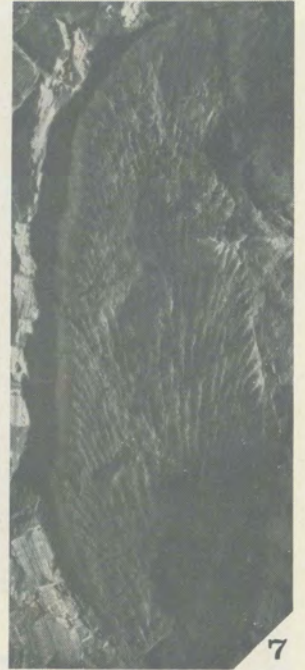
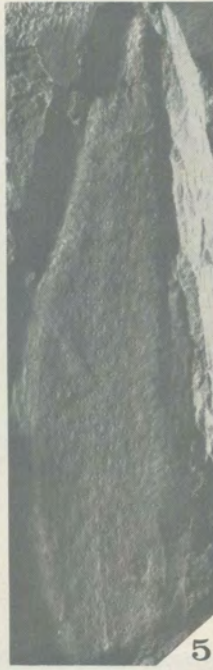
Figures 9 and 10. Holotype *Dictyopteridium flabellatum* sp. nov. showing the random discs and knobs on the swollen areas between grooves and the ordered array of swollen sac-like endings. Figure 9 on left shows the striated bodies under the torn-away surface. The arrow indicates the breaking point. x 2 N-Lk 424 and N-Lk 360 (PB 005 a, b).

Figure 11. *D. flabellatum* showing dichotomising grooves. N-Lk 31b x 2 (PB 006).

Figure 12. Lateral compression shows sac-like swelling on *D. flabellatum* forming an escarpment ending in a small wing. x 2 N-Lk 322a (PB 007).

Figure 13. Paratype. An almost complete specimen of *D. flabellatum* showing a short stalk and tip. x 2 N-Lk 410 (PB 008).

Figure 14. Enlargement of above. Detail of discs with knobs. x 5 N-Lk 410 (PB 008).





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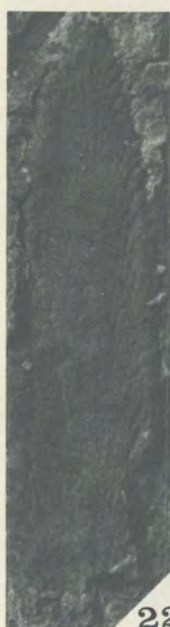
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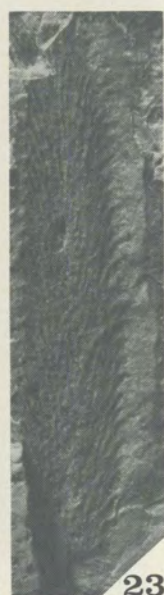
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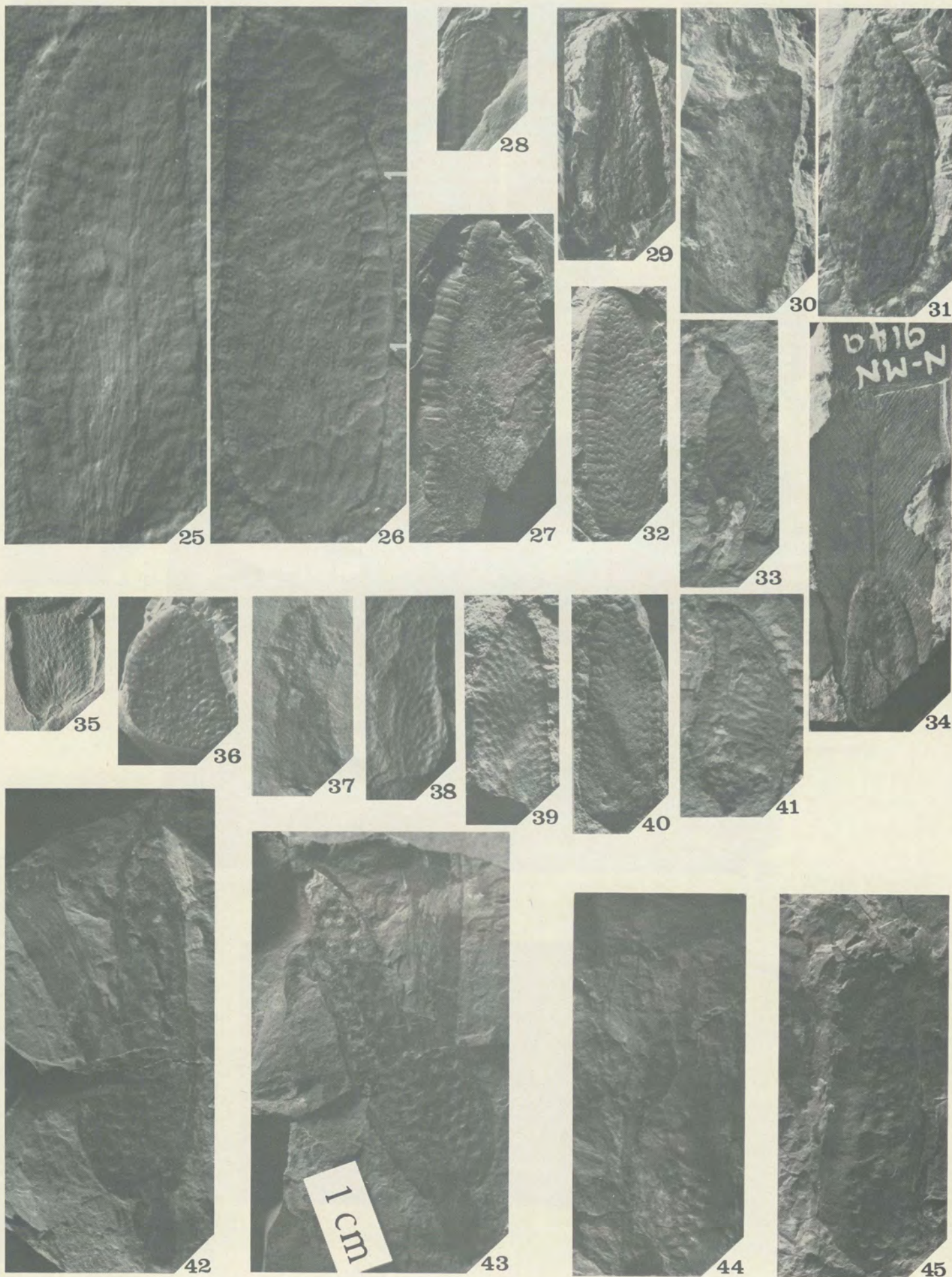


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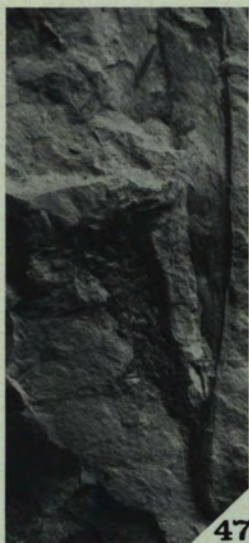
- Figures 15 and 16. Fertile and protective halves of *D. flabellatum*. One of the largest specimens. Enlargement of Figure 21 (1). x 2 N-Lk 406a and c (PB 009 a, and c).
- Figures 17 and 18. Protective and fertile halves of *D. flabellatum*. Figure 17 shows the slight depressions over its surface to accommodate the discs of the fertile half. Figure 18 shows particularly well developed lateral swollen ends. x 2 N-Lk 407 and N-Lk 406 (4) (PB 010 a, b).
- Figures 19 and 20. *D. Flabellatum* paratype. Protective and fertile halves, both showing a clear wing, the protective half shows a clear reverse image of the grooves and ridges. x 2 N-Lk 406b and N-Lk 406a (2) (PB 011 b and a).
- Figure 21. The parent block of Figures 15–20, to show the relative position of the fructifications to each other. Parallel with and to the left of the centimetre measure is a very poorly preserved specimen (3). x 1 N-Lk 406a (PB 009–011).
- Figures 22 and 23. Fertile protective half of *D. flabellatum* possibly of one fructification. The fertile half does not show a wing while the protective half has a clear wing. x 2 N-Lk 411a (PB 012).
- Figure 24. The parent block of Figures 22 and 23 to show the spatial relationship between the two halves of what may have been one fructification. x 1 N-Lk 411a (PB 012).



- Figure 25. Holotype *Fetura natalensis* comb. nov., the protective half showing the venation-like striations and only faint reverse relief of the counterpart. x 5 N-MN 909a (PB 013a).
- Figure 26. Holotype *Fetura natalensis*, the fertile half showing sacs with simple knobs; the sacs are ordered along the margins and arranged at random centrally; a short stalk is visible. The seventh sac from bottom right (arrowed) shows the upholstery button effect, and on the same side the ninth sac down (arrowed) is missing the disc, giving a deflated impression. x 5 N-MN 909b (PB 013b).
- Figure 27. Tip of *F. natalensis* with particularly well developed lateral sacs and poorly developed central sacs. x 2 N-MN 901 (PB 014).
- Figure 28. From the arrangement of the lateral and central sacs the specimen is interpreted as *F. natalensis* seen with the protective cover over the fertile half, thus the disc details are obscured. x 2 N-MN 913a (PB 015).
- Figure 29. Same interpretation as for Figure 28. This specimen is from Loskop (as is that from Figures 30 and 31) and is provisionally placed in the *F. natalensis* group. x 2 N-Lk 39b (PB 016).
- Figures 30 and 31. *F. natalensis*, protective and fertile halves. Discs and sacs poorly defined but recognisable. x 2 N-Lk 416 N-Lk 329 (PB 017a, b).
- Figure 32. *F. natalensis*; the wing appears to be undifferentiated continuation of the lateral sacs. There is no evidence of a compound nature to this wing as no sediment infill is visible between sac endings. x 2 N-MN 906 (PB 018).
- Figures 33 and 41. *F. natalensis* possibly showing a triple structure, (41) being the fertile half with what could be another protective part lying beneath it, (33) is the clear protective part. x 2 N-MN 890 and N-MN 904 (PB 019a, b).
- Figure 34. Fragment of *F. natalensis* in alignment with a *Glossopteris* leaf showing convex impression moulded on the lamina by the reverse side of the fructification. x 2 N-MN 914a (PB 020).
- Figure 35. Very clear discs depressed into sacs can give a double ring effect to *F. natalensis* which is quite different from the compound discs of *Dictyopteridium*. Here the outer ring is formed by the curved edge of the sac round the depression containing the disc which forms the inner ring. x 2 N-MN 915a (PB 021).
- Figure 36. A broad tip of *F. natalensis*. x 2 N-MN 897 (PB 022).
- Figure 37. Specimen with abnormally large wing on left tip and ill defined sacs. Provisionally placed in *F. natalensis*. x 2 N-MN 899 (PB 023).
- Figure 38. *F. natalensis* that could be mistaken for *S. gibbosus*, but has poorly defined sacs and discs. x 2 N-MN 892 (PB 024).
- Figures 39 and 40. Protective and fertile halves of *F. natalensis*. x 2 N-MN 960 a and b (PB 025a, b).
- Figure 41. See Figure 33.
- Figures 42 and 43. Holotype *Scopus gibbosus* torn in such a way as to reveal the protective half behind the fleshy fructification (42). The attachment to the petiole of a *Glossopteris* leaf is not clear, the two structures apparently merging. x 2 N-Lk 316a and b (PB 026a, b).
- Figures 44 and 45. A specimen of *S. gibbosus* which shows a possible second protective half lying beneath the fertile head, visible at the tip of (44) where the bulgy mass has broken away. x 2 N-Lk 384a and b (PB 027a, b).



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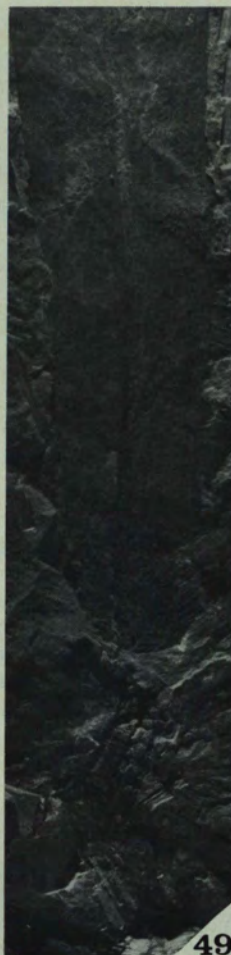
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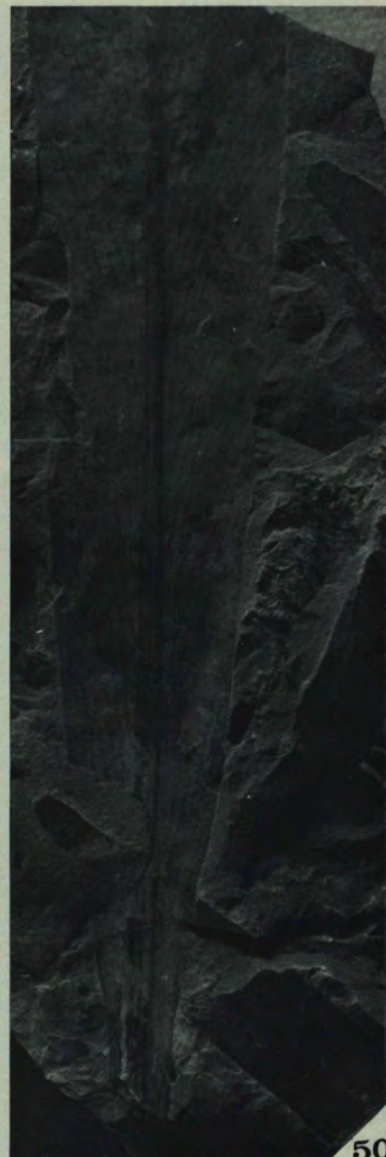
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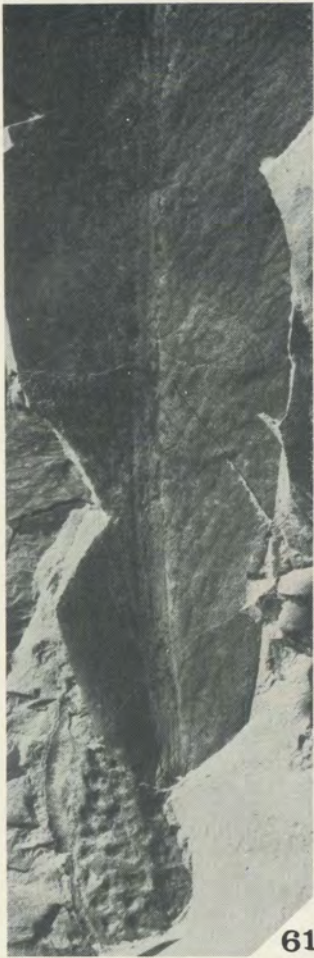


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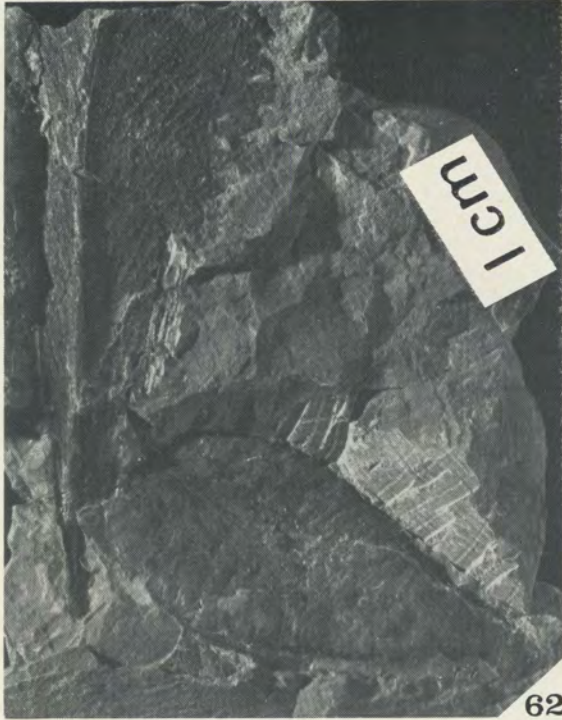


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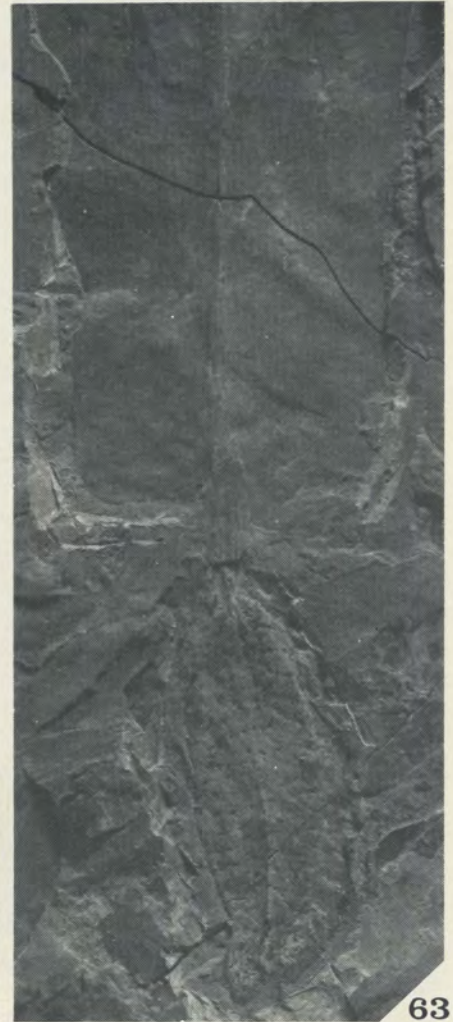
- Figures 46 and 47. Holotype *Scopus confertus*. The organic connection of the fructification onto the petiole of a *Glossopteris* leaf is clearly visible. Stout projections of unknown function radiate out at irregular intervals from what was probably a radially symmetrical body, the surface of which is covered with tightly packed, swollen, oblong bodies. x 2 N-Lk 315b and a (PB 028b, a).
- Figures 48 and 49. The swollen, overlapping, oblong bodies are larger and of slightly fleshier appearance than those of the Holotype, but the overall size, position on the petiole and shape of the fructification places it within *S. confertus*. x 5 and x 2 N-Lk 315 PTO (PB 029).
- Figure 50. A *S. confertus* next to right hand side of a good *Glossopteris* leaf specimen of the *Scopus* type. x 2 N-Lk 217 (PB 030).
- Figure 51. Leaf-like protective half of *S. confertus* attached (?) to the petiole of a *Glossopteris* leaf. x 2 N-Lk 359 PTO (PB 031).
- Figures 52 and 53. *S. confertus* counterparts showing a sub-truncate tip of a cylindrical body, closely associated with a *Glossopteris* leaf though dislodged from the petiole. x 2 N-Lk 306a and b (PB 032a, b).
- Figure 54. The cylindrical fertile half lies in a depression in the protective half, which forms a wing visible on the upper left. x 2 N-Lk 316a (PB 033) *S. confertus*.
- Figure 55. The fertile part of a *S. gibbosus* in alignment with the mid-rib of a *Glossopteris* leaf. The protective half figured in 56 is lying close by on the same rock surface. x 2 N-Lk 315a PTO (PB 034).
- Figure 56. A Paratype of *S. gibbosus*, a protective half, stalked and keeled at the tip. x 2 N-Lk 315a PTO (PB 035).
- Figure 57. Stalked, concave inner surface of a protective half of *S. gibbosus*. Not keeled, winged at the tip. At attachment of stalk with protective half a ridge is seen, probably to accommodate the fertile half. Mode of attachment of the fertile half to protective half not known, possibly a gradual fusion of cells as no abscission lay is visible. x 2 N-Lk 293b (PB 036).
- Figure 58. *S. gibbosus* in alignment with mid-rib of *Glossopteris* leaf. Wing is clear on the right hand side and folded under the fructification on the left (see Figure 67). x 2 N-Lk 314 (PB 037).
- Figure 59. *S. gibbosus* with well-rounded bulges. x 2 N-Lk 373a (PB 038).
- Figure 60. *S. gibbosus* showing a large wing round the central head. x 2 N-Lk 244 PTO (PB 039).



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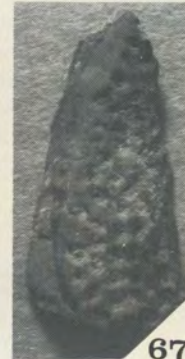
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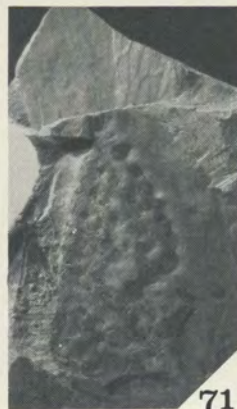
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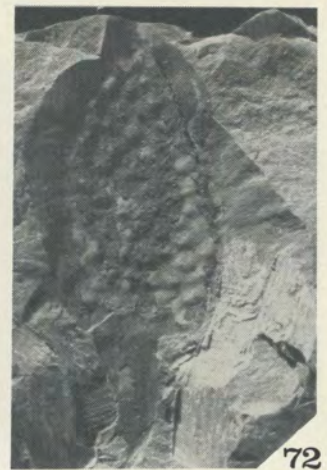
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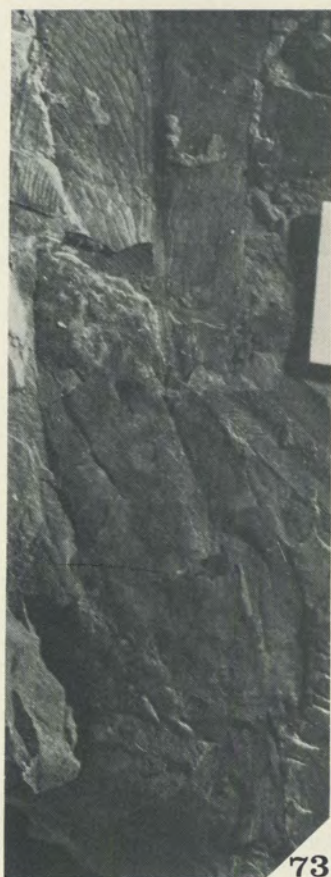


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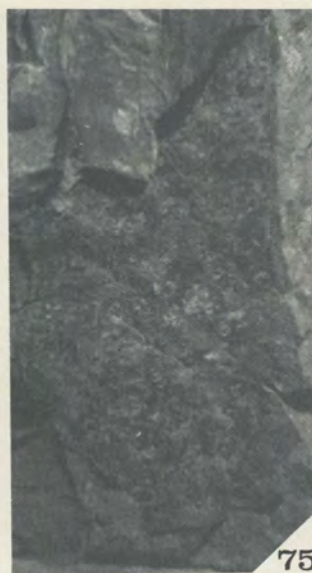
- Figure 61. *S. gibbosus* in alignment with mid-rib of *Glossopteris* leaf. x 2 N-Lk 294 (PB 040).
- Figure 62. The fleshier than usual appearance of this *G. gibbosus* obscures the bulges, it does not appear to be covered by the protective half. Probably attached to the *Glossopteris* leaf. x 2 N-Lk 313 (PB 041).
- Figure 63. *S. gibbosus* which is covered by a protective half which is keeled along the whole length, obscuring the bulges of the fertile half. This is the only fructification associated with a cordate based *Glossopteris* leaf. x 2 N-Lk 232 (PB 042).
- Figure 64. A slightly laterally compressed *S. gibbosus* showing that the structure could not have been radially symmetrical. x 2 N-Lk 300a (PB 043).
- Figure 65. Protective half of *S. gibbosus* with clear stalk. x 2 N-Lk 298b (PB 044).
- Figure 66. An unwinged fertile head of *S. gibbosus*. x 2 N-Lk 295b (PB 045).
- Figure 67. *S. gibbosus* with wing clear on left hand side and folded under head on the right. x 2 N-Lk 309 (PB 046).
- Figure 68. A broad fertile head of *S. gibbosus*. x 2 N-Lk 315a (PB 047a) (see Figure 85 for enlargement).
- Figure 69. A *S. gibbosus* with large wing at the right base of a *Glossopteris* leaf; in lower left corner is a *S. didiscus*. x 2 N-Lk 427 (PB 048).
- Figure 70. Tip of a *S. gibbosus* visible at the left base of a small almost complete *Glossopteris* leaf. x 2 N-Lk 310a (PB 049).
- Figures 71 and 72. A paratype of *S. gibbosus*, fertile and protective half, strongly winged. Figure 72 shows a slight break at the top of the stalk which may have been the point of attachment of the fertile half. Figure 71 is the fertile half, it has a small portion missing at the base revealing a possible second protective part beneath it; it is aligned with a fragment of *Glossopteris* leaf. x 2 N-Lk 370b and a (PB 050b, a).



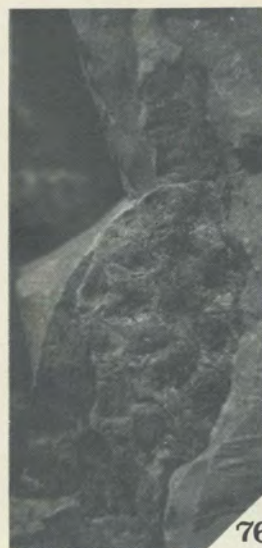
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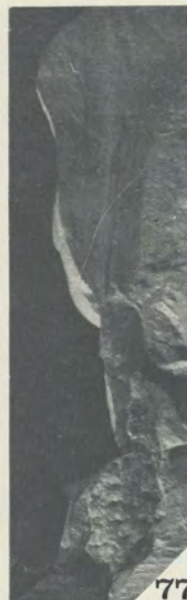
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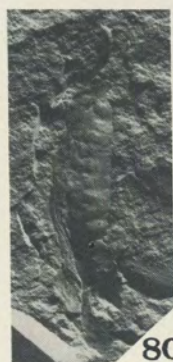
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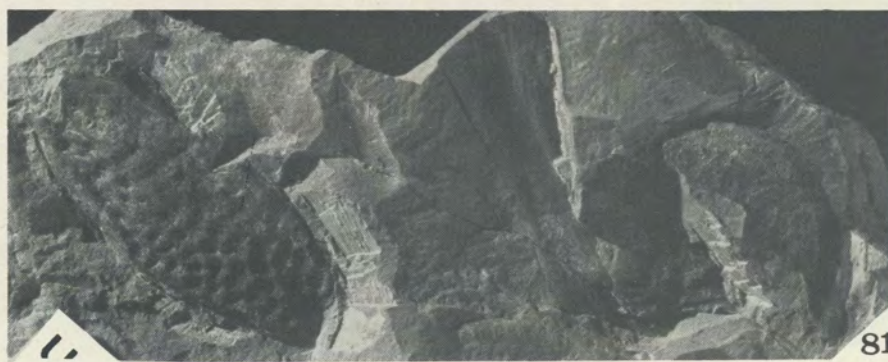
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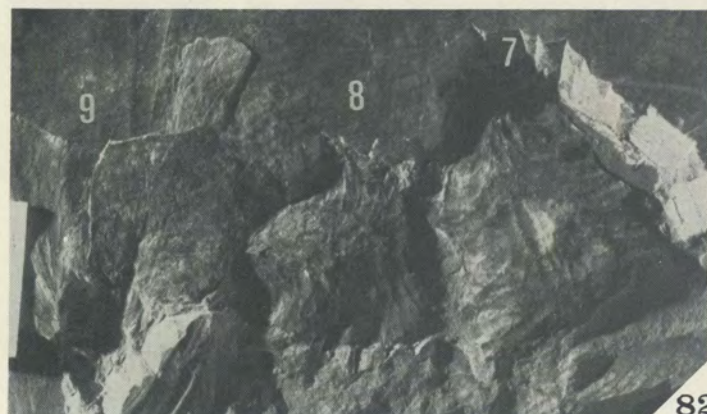
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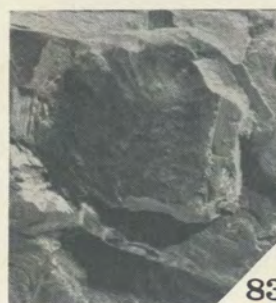
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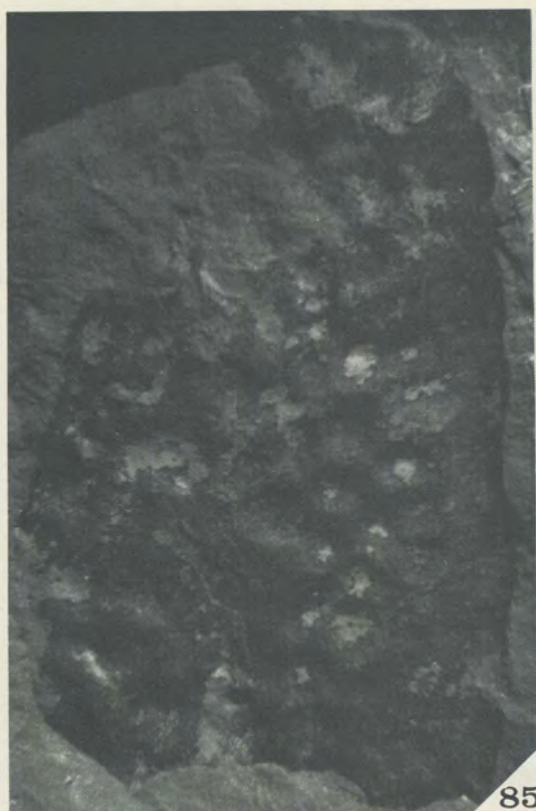


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- Figure 73. *S. gibbosus* attached to the petiole of a *Glossopteris* leaf. Structureless covering layer obscuring the bulges on the main head, damaged at the base showing round, flattened structure. x 2 N-Lk 318 (PB 051).
- Figure 74. *S. gibbosus* appears to be folded along central axis to enclose the fertile body, long stalk present. x 2 N-Lk 293a (PB 052).
- Figures 75 and 76. Protective and fertile halves of *S. gibbosus* with the covering layer removed in Figure 76 showing overlapping flattened bulges suggestive of seeds but not showing seed-like markings or structures. Fructification associated with a *Glossopteris* leaf. x5 N-Lk 293 a and b (PB 053 a, b).
- Figure 77. A x 2 of Figure 76.
- Figures 78 and 79. *S. gibbosus*, the central fructifications in the plates appear to be folded along the central axis, the two outer ones are more usual specimens. x 2 N-Lk 296a, b (PB 054a, b).
- Figure 80. The fertile part of *S. gibbosus* appears to be lying on the protective part, the bulges do not show any details hence inclusion into this group. x 2 N-MN 908 (PB 055).
- Figure 81. Holotype *Scopus didiscus* showing double nature of fructification associated with base of a *Glossopteris* leaf. Strongly convex upper surface, and fluted wing-like area clearly visible on right. Sediment infill between two halves visible where top part has broken away, exposing other half of fructification, lying near to a typical *S. gibbosus*. x 2 N-Lk 317a (PB 056).
- Figure 82. Three specimens of *S. didiscus*, left to right: (9) an almost flat specimen that appears stalked probably due to alignment with a *Glossopteris* petiole; (8) the central one shows typical convex aspect and a good wing area; (7) while the one on the right is convex with no wing area showing. x 2 N-Lk 369a (9), (8) and (7) (PB 066, 065, 064).
- Figure 83. *S. didiscus* paratype; the double nature is not clearly illustrated in the figure, but the sediment along the right hand side of the shown disc is the infill between the two halves. x 2 N-Lk 369a (5) (PB 062).
- Figure 84. *S. didiscus* showing double nature of fructification with sediment infill. x 2 N-Lk 244 (PB 057).



- Figure 85. Enlargement of counterpart of *S. gibbosus* as figured in 68, showing cell pattern. x 5 N-Lk 315c (PB 047c).
- Figures 86 and 90. Paratype *S. obscurus* in its structureless form. It has a relatively fleshy appearance. Figure 90 shows the cell pattern. x 2, x 5 369b (2) (PB 059).
- Figure 87. Paratype *S. obscurus*, the organic attachment between fructification and petiole broken, but obviously in original position on leaf petiole. On the upper half of the specimen faint indications of the "sacs" are visible, as well as clear cell pattern. x 5 N-Lk 315c (PB 071).
- Figure 88. Enlargement of a portion of *Dictyopteridium flabellatum* from Figure 9, showing the detail of the striated sac-like bodies which are exposed where the covering layer has torn away. x 5 N-Lk 424 (PB 005a).
- Figure 89. Enlargement of Figure 92 showing stalk and petiole junction, clear "sacs" and a good cell pattern.
- Figure 90. See Figure 86.
- Figures 91 and 92. Holotype of *Scopus* showing sac-like marginal areas at right angles to central axis. Organic attachment of fructification to leaf petiole, which in turn joins a small twig, is seen in Figure 92. This is the structured form of the species. x2 N-Lk 222a and b (PB 072a, b).

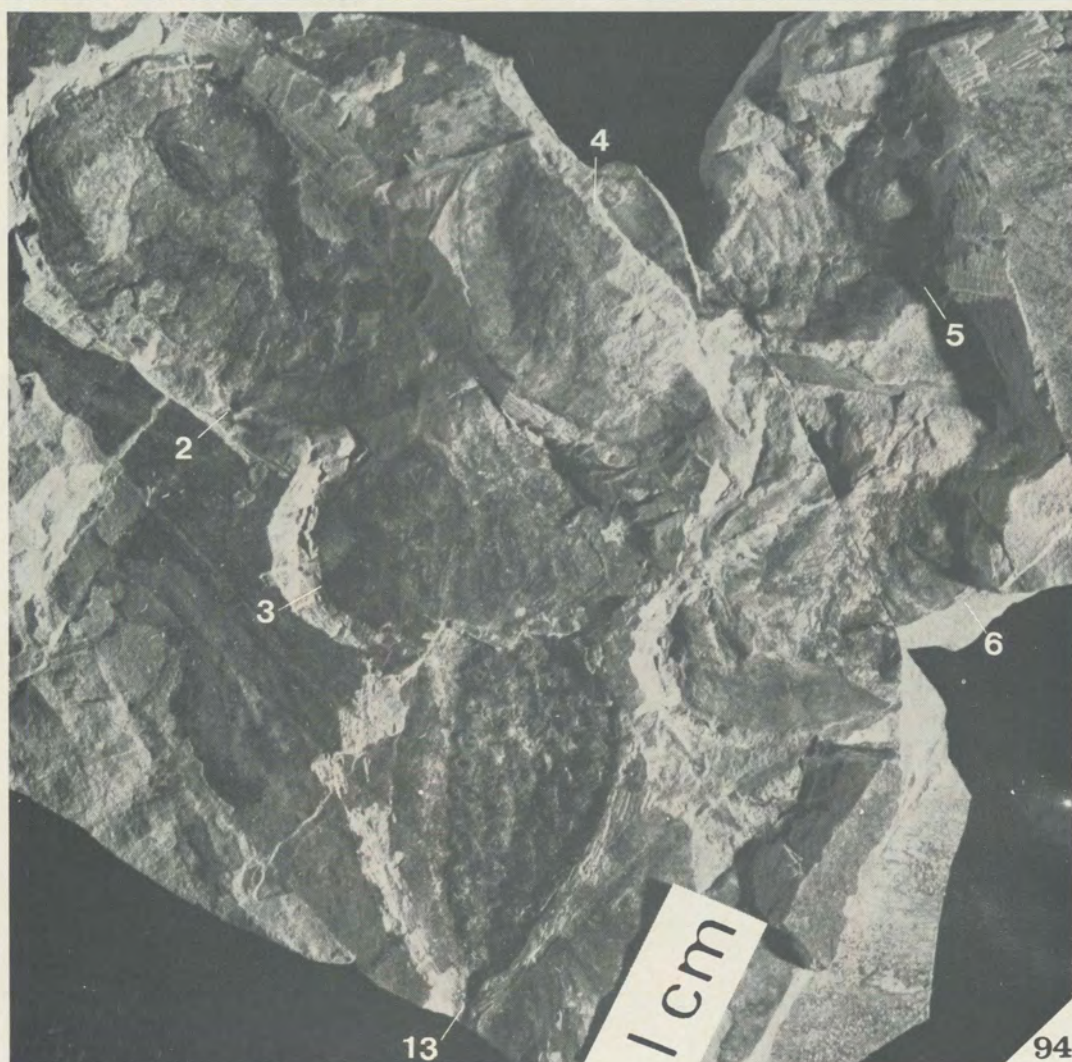
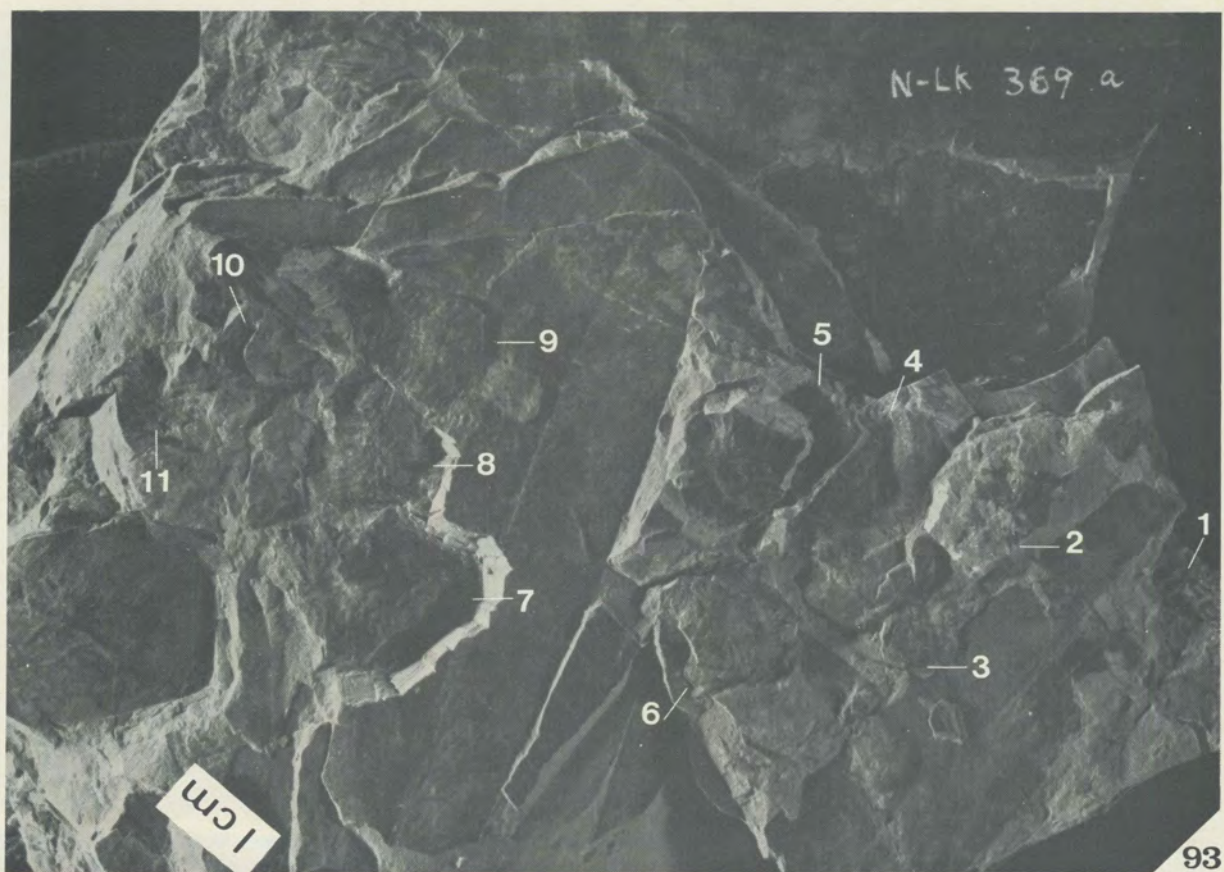


Figure 93. The parent block of many of the specimens to show the spatial arrangement of the fructifications, one to the other.

c. x 1 N-Lk 369a

- (1) *S. gibbosus* (PB 058)
- (2) *S. obscurus* paratype (PB 059)
- (3) *S. didiscus* (PB 060)
- (4) *S. obscurus* (PB 061)
- (5) *S. didiscus* paratype (PB 062)
- (6) *S. didiscus* (PB 063)
- (7) *S. didiscus* (PB 064)
- (8) *S. didiscus* (PB 065)
- (9) *S. didiscus* (PB 066)
- (10) *S. didiscus* (PB 067)
- (11) *S. didiscus* (PB 068)

Figure 94. The counterpart of the lower right portion of Figure 93. The white figures refer to the same fructification as on Figure 93. x $2\frac{1}{2}$ N-Lk 369b.

- (13) *S. gibbosus* (PB 070).

Just below (6) lies a scale leaf showing faint venation patterns and a finely striated surface.