

NOTES ON SOME GLOSSOPTERIS SPECIES FROM HAMMANSKRAAL (TRANSVAAL)*

by

É. Kovács-Endrödy

Geological Survey, P.Bag X112, Pretoria 0001.

ABSTRACT

The study of *Glossopteris* began with the mistake that two half fronds were glued together as one and that specimen was chosen as the holotype of one of the first *Glossopteris* ever described, *Glossopteris browniana* var. *indica* Bngn. The mistake led to confusion and even to distrust of the possibility of identifying *Glossopteris* species on frond impressions only. As most of the *Glossopteris* remains are such, and the literature from Brongniart onwards is mainly based on them, the frond morphography is bound to be the starting point of the classification. The present paper shows that (a) with the examination of greater numbers of specimens, it is possible to select the specific characters and to learn the individual variations and (b) identifications can only be based on the original descriptions and figures of the taxa.

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INTRODUCTION

“Possibly it (*Glossopteris*) suffered more than any other common plant fossil in classification.” Plumstead (1962), in Fossil Floras of Antarctica.

This sentence expresses a thought of which all palaeobotanists who have ever worked on Gondwanaland material were conscious. Many attempts were made to solve and clear the perplexity in the taxonomy of the *Glossopteridaceae*.

In 1965 Maheshwari summarised the problems and stressed that “the natural thing is to devise a classification based on the morphographic character” as “most of the Lower Gondwana fossils occur more frequently as (leaf) impressions”. He gave directives for more precise circumscriptions of species.

Supporting Maheshwari, I add some particulars to the method and problems in the systematic studies of *Glossopteris* and illustrate them with examples. According to him the main reason for the confusion was “a complete lack of accepted criteria” on which to base the classification.

Another reason is that in the descriptions different authors do not always use the same expressions in the same meaning or the accompanying illustrations are not clear. In the last century the drawings were sometimes incorrect (Feistmantel: “an evil which is not always under the control of the author”, 1881b, Pl. XXXII A). Nowadays on the photographs the fine veins are sometimes blurred and unaccompanied by drawings. “Wenn spätere Autoren an etwa fehlenden Details der Abbildungen der Arbeiten von 1804 und 1820 Anstoss nahmen, so konnten sie nicht ahnen, das 150 Jahre später oft wesentlich weniger Details zeigende Abbildungen gegeben werden.” (Remy, 1966, p. 4). The terms of morphographic characters and the method of description have to be standardized. Both photographs and accurate drawings should accompany the description (see Remy, 1966; Dilcher, 1974).

The main cause of the controversy is, however, that usually the authors did not refer to the original descriptions and figures of the species in their identifications.

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They used second or even later descriptions and in doing so they often added mistakes to those already existing.

If a considerable number of frond impressions are examined, it becomes clear that certain of them consistently display the same characters. These characters can be called specific characters, and the fronds of which they are typical represent a species. In this case the species is not an artificial taxon, although our knowledge is limited to the fronds of the plant assigned to such a species.

The specific characters are determined, preserved and inherited by genes. The morphological characters of any individual are reflections of a specific genetic composition. If constant and distinguishing characters can be found on any organ of plants, including the morphology of fronds, they follow the same genetic rule.

As most of the literature from Brongniart onwards is mainly based on frond impressions, their morphology is bound to be the starting point of the classification. Only knowing a species well as fronds can research proceed for further details of the classification.

When we find cuticles on fronds or fructifications and seeds attached to them, our knowledge of the species concerned improves, and we get closer to the reconstruction of a once-living organism. If taxonomy does not serve this goal, it has missed its essential purpose. It is possible that accumulating knowledge on the genus *Glossopteris* will lead to the separation of several groups of species on generic level. The species, however, will always remain the basis of any classification.

Unfortunately the ICBN is extremely vague when dealing with rules to be applied in palaeobotany. Its Article 3, Note 1, reads: "fossil plants are usually based on fragmentary specimens, and since the connection between these specimens can only rarely be proved, organ-genera and form-genera are distinguished as taxa within which species may be recognised and given names according to this Code." It does not give any directives as to which rules are applicable when "rare" connections are found. Do the newly described parts or organs take the name of the already known part, or should new form-genus names be created for them? When a fructification is attached to a frond, undoubtedly they were parts of the same individual plant. My opinion is that parts with proved connection can bear only one name, following the rule of priority.

Article 59 of ICBN unfortunately lumps fossil plants and fungi in one. The text, however, deals with fungi only with two or more states in their life cycle, and says: "The correct name of all states which are states of any one species is the earliest legitimate name typified by the perfect state." As vascular plants, and Glossopteridaceae with them, have no perfect or imperfect state, Article 59 is not applicable to them. The correct name of all organ names, once the connection between them is proved, is the earliest legitimate name.

Take as an example *Glossopteris taeniopteroides* Feistmantel, which in the Hammanskraal flora is

represented by fronds without fructifications, fructifications without fronds, or many of both attached one to the other. If any of them is found at other localities without great alteration, attached or not, for a clearer view of the evolution and of the correlation they have to be called *G. taeniopteroides*. For this reason all similar fructifications, once attached to fronds, should be assigned to *Glossopteris*.

Maheshwari writes about "the difficulties encountered in determination of transitional forms". "The problem arises that, when a variation is presumed in a character, how are we to know its range?"

In my recent study I have chosen species as examples to show how easily one can be misled following the later literature and neglecting the original author; examining a great number of fronds, I selected the constant specific characters that coincide with the author's species and tried to show individual variations. As in living plants, the size of the fronds and the density of the venation is and was subject to environmental effects. If the great number of fronds indicated autumnal leaf-fall, all are about the same age and the small ones are not younger. They were situated on the trees or shrubs where the lack of humidity or sunshine or both restricted them in their growth.

Attention was paid to possible differences on the upper and lower surfaces of the fronds. It was seen that they differ and not in the same way in all the examined species. This difference in the two surfaces could possibly be the reason why Brongniart (1830, p. 223) wrote of *Glossopteris browniana* (including at that time *Glossopteris indica*) "nervulis basi obliquis reticulatis, apice tantum simplicibus vel furcatis", examining an upper surface, where the anastomoses are fewer and not so well marked.

Finally I would stress that there is not one character which can be used with the same importance in all the species. For example, the pattern of the meshes in *Glossopteris indica* Schimper and *Glossopteris communis* Feistmantel is the main and most constant character, but in *Glossopteris taeniopteroides* Feistm. it changes from specimen to specimen. The characters for each species must be worked out by examining great numbers of fronds. Only at the beginning with the first species was it permissible to describe them from one or a few specimens, but today, having dozens of *Glossopteris* specific names, one could be led to re-describing an already named species.

THE GENUS *GLOSSOPTERIS* AT HAMMANSKRAAL

I selected *G. communis* Feistmantel and *G. taeniopteroides* Feistmantel for my study as they have been misunderstood many times, mixed with other species and often mentioned under wrong names. *G. taeniopteroides* seems to be a very important species, in some floras the dominant one, e.g. in Hammanskraal.

My study is not a revision. I cite from the vast literature only authors with whom it is interesting to compare the original descriptions and who have had a

misleading effect. I cite always the authors of the species, especially as some of their papers are not easily available, and to show how the description of a species changed as, e.g. when *G. taeniopteroides* was later mentioned as *G. indica* Schimper.

As both *G. communis* and *G. taeniopteroides* were synonymised by Arber as *G. indica*, I start with the history of *G. indica*. It is not the first time that the confusion between *G. indica* and *G. communis* has been discussed (e.g. Srivastava, 1956, p. 5; Plumstead, 1962, p. 38; Rigby, 1966, p. 130) but here I investigate matters not previously mentioned.

Brongniart (1830, p. 223) divided *Glossopteris browniana* into two varieties:

Var. *Australasica*: foliis minoribus subspathulatis obtusis.

Var. *Indica*: foliis majoribus lanceolatis acutiusculis.

Fortunately with these short descriptions he gave often criticised but quite useful figures. On them the difference of the two varieties is obvious; the more or less equal meshes of the var. *australasica* and the short, broad meshes near to the midrib on var. *indica*.

The Figure 2 on Pl. 62 of Brongniart (1830) shows that the holotype of *G. browniana* var. *indica* is not one whole frond, but is broken in the middle. Following the outline of the two parts, they would meet properly, but the midribs do not, as it was indicated by the artist with dotted line. By courtesy of Prof. Lehman of the Paris Museum, I received the photograph of the holotype. On that it is clearly visible that the base and top parts are not of the same frond, moreover not of the same species. The artist drew the same type of venation on both parts, which is true only on the lower part (Pl. VI).

When Schimper (1869, Vol. I, p. 645) raised the two varieties to species rank, his description of *G. indica* was in accordance with the drawing and the base of the holotype. Unfortunately he gave no figures.

Lectotype: the basal half of the type specimen of *Glossopteris browniana* var. *indica* Brongniart, No. 506, Museum d'histoire naturelle, Paris.

The lectotype designation seems to be necessary because the specimen is wrongly combined from halves of two different species, the basal half agreeing with Schimper's description (1869, Vol. I, p. 645).

The study of *Glossopteris* started with the mistake that two specimens were glued together as one which was chosen as the holotype of one of the first *Glossopteris* fronds ever described. The mistake led to confusion and even to distrust of the possibility to identify *Glossopteris* species based only on frond impressions.

Zeiller was the one who studied Brongniart's type material and pictured them (1896, p. 367, Figures 11 and 12). He noticed the difference in the venation of the two parts and figured both of them. Figure 11 is from the lowest part of the base and Figure 12 seems to be the lowest part of the upper half. On Figure 11, the two or three shorter meshes near to the midrib are well figured, which is the main character of *G. indica*.

If one puts Figure 12 and Feistmantel's Figure 1a of *G. taeniopteroides* (1878) beside each other, there is no doubt that the venation is the same.

In 1902 Zeiller returned to the question of *G. indica* and discussed it at some length. He gave excellent photographs of fronds which are similar to his drawing of Figure 12 and the upper half of the holotype. On p. 11, with Figure 3, Pl. III, Zeiller wrote that the specimen had so few anastomoses that one would even think one was dealing with a *Taeniopteris*. "Je ne serais pas surpris que le *Gloss. taeniopteroides* Feistmantel, . . . ne fut autre chose qu'une forme de *Gloss. indica* assimilable à celle de la Pl. III, Fig. 3, 3a." The Plate III, Figure 3 really illustrates a *G. taeniopteroides*, as do all his figures except Plate II, Figure 2 — named as *G. indica*. After Zeiller's article for a long time *G. taeniopteroides* was mentioned as *G. indica* (e.g. Halle, 1912; Walton, 1929), which probably would not have happened if the students of the floras had read Schimper.

Bunbury (1861, p. 368) was not sure that the two varieties were distinct. He found the venation "essentially the same", in shape and venation "many shades of variation". Nevertheless his Figure 4, Plate VIII is in accordance with Brongniart's. It is interesting to compare the figure of *G. indica* illustrated by Bunbury (Figure 4) and *G. stricta* Bunbury in Arber's book (1905). Arber was at that time confused by Zeiller and he saw the slabs with Bunbury's types. Moreover he writes (Arber, 1905, p. 77): "This species (i.e. *G. stricta*) is distinguished from *G. indica* . . . by the contrast in the size and shape of the meshes bordering on the midrib with those of the rest of the lamina." The frond on Plate IV, Figure 1, is certainly more similar to *G. indica* than to *G. stricta*.

When Schimper (1869, p. 645) raised the two varieties to species rank, he gave the following descriptions of *G. indica*; "fronde subsequipedali, e basi augusta late stipitata pedentim latiore et in medio 5–6 centim. lata, apicem versus sensim augustiore, lanceolato-acuminata; acuta, raro mutica, rachi lata dorso convexa pluries sulcata, supra late canaliculata, areolis secus rachim positis abbreviatis, latiusculis, caeteris hexagono- en parallelogrammo-elongatis, angustis." In French he states: "Cette espèce se distingue du *Gl. Browniana* par . . . les mailles près du rachis plus larges."

In 1876 Feistmantel found fronds which were similar in shape to *G. indica* but of different venation. He named them *G. communis* and described them as (p. 375): "Fronde simplici, variante, sed plerumque speciosa, integerrima, ovato-oblonga, apice elongata-acuminata, basi attenuata in rachidem decurrente, rachide crassa usque ad apicem currente, nervis omnibus anastomosantibus, retia oblonga, augustissima formantibus." "The frond is simple, oblong-oval, the apex oblongly acuminate (as in *Glossopteris indica*, Schimp., while it is obtuse in *Glossopteris browniana*, Bgt.); at base the frond is attenuate, running down into the rachis; the rachis thick, reaching to the apex; the secondary veins all of pretty equal thickness, all anastomosing; the areoles are all pretty equally oblong and very narrow (while in *Glossopt. indica* they are more polygonal and larger next to the rachis), reaching to the margin." The single figure (Plate XXI, Figure 5), is good enough to

give, together with the description, the main characteristics of the species.

The confusion started when Feistmantel, using for the second time the name *G. communis*, wrote: "It is oblongly, sometimes, however, more obtusely, acuminate at the apex." (1879, p. 16.) On Plate XVII, Figure 2 the "top portion" shows a quite obtuse apex. In the Flora of the Damuda-Panchet Div., p. 98 we find: "the apical portion slightly prolonged, and the apex itself as a rule pointed". Here he gave more figures of the species than ever before or after. This is the paper to which almost all authors turned to compare their specimens to *G. communis* and where Feistmantel under one name figured more species. It is not necessary here to go into more details, as Zeiller (1902) dedicated pages to criticising this work, unfortunately in such a way that he did more harm than good.

The name *G. communis* was out of use for many years; because of a wrong definition *G. indica* was not recognised and instead of it *G. taeniopteroides* Feistmantel was named as such.

In the Flora of Western Bengal (1886), p. 26, Feistmantel had some doubts ". . . the specimen was not quite distinct, so that doubts might have been entertained about its nature, had anybody chosen to do so." But "at present I figure several specimens about which there is no doubt whatever, that they belong to *Glossopteris communis*." The given figures are of fragments. In the "plant-bearing beds of Eastern Australia and Tasmania" (1890) p. 124, we read "the apical portion prolonged and the apex generally pointed".

Feistmantel was an excellent taxonomist and his mistake is understandable. He worked with floras of a great number of fossils. He was the one who laid the fundamentals for all the palaeobotanists working on Gondwanaland material. His task was enormous.

In 1908 (Permo-Carboniferous . . . p. 115), Seward and Leslie submitted a drawing and a description of specimens collected from Vereeniging to Zeiller who designated them as *G. angustifolia* var. *taeniopteroides*. Seward noticed the similarity between those and *G. indica* sensu Zeiller. It is indeed the same species.

Halle (1912) figures more specimens as *G. indica*. One of them "in general, forms with dense venation and parallel, comparatively rarely anastomosing secondary veins, seem to be predominant among the Falkland-material of this species." (Page 169.) In Plate 7, Figures 4 and 4a, he shows a "specimen which may be best referred to as *G. indica* . . . The venation presents some peculiarities, however, which make its attribution to that species a somewhat doubtful step. . . . Close to the midrib the areoles are fairly large and open; at a greater distance from it, they rapidly become narrower, and the marginal part of the lamina is characterised by very dense sub-parallel secondary veins, forming only few anastomoses". The predominant species is *G. taeniopteroides* and the one with the peculiar venation is *G. indica*.

Seward and Walton on fossil plants from the Falkland

Islands (1923, p. 322): "The enlarged piece of lamina reproduced in Fig. 13, Pl. XXI, differs from most of the specimens in the very small number of lateral anastomoses between the lateral veins, a feature shared by some of the leaves of *G. indica* from Antarctica named *G. indica* var. *Wilsoni* and by specimens described by Zeiller (1902, Pl. III, Fig. 3, 3a) from the Lower Gondwana rocks of India." It is *G. taeniopteroides*.

Walton (1929, p. 70) reports *G. indica* from Southern Rhodesia. "This common species is probably the dominant fossil in the flora represented in the collection." Figure 19 shows a *G. taeniopteroides*.

Glossopteris occidentalis White (1908) from South Brazil and *Rhabdotaenia waginae* Rigby (1966) from Western Australia belong also to *G. taeniopteroides* Feistmantel.

Seward (1897, p. 321) wrote about a specimen from Vereeniging: "possibly a fragment of *Gangamopteris*. This form of leaf bears a close resemblance to those named by Feistmantel *Glossopteris damudica*, which is difficult to distinguish from his *G. communis* (*Browniana* var. *indica*). Compare also *G. ampla* Dana." The Plate XXII, Figure 1, is an apex of *ampla* Dana. Seward here touched on a problem which was mentioned many times: whether *Gangamopteris* as a genus exists at all? Later he discussed the question (1905, p. 2) more profoundly and came to the conclusion that the absence of the midrib has no great taxonomic importance. The mentioned *Glossopteris* species are represented at Hamanskraal and they are well distinguished. *G. ampla* Dana (1849, p. 717): "Frond very large and broad ovate, entire, undulate, apex obtuse. Midrib very stout and broad, $\frac{3}{4}$ to 1 inch at base, and slender towards apex. Venation close, narrow, reticulate. Near the margin for nearly an inch, veins very much subdivided; more closely crowded, and scarcely reticulate." Rigby (1966) on Plate 34, Figure 41, figured the type specimen. *G. damudica* Feistmantel (1881b, p. 105): "Fronde latissima, obovata, apice obtuse an emarginate; rhachide crassa, nervus secundariis angulo subrecto ex rhachide egregientibus, retia rhachidem versus breviora, trigonalia an polygonalis, latiuscula, marginem versus oblonge-polygonalia, augusta formantibus."

McCoy at first neither noticed nor figured the anastomoses in the median part. Moreover (1847), he wrote "all the nerves dichotomise at irregular intervals, and those of the sides occasionally anastomose and are connected by a few transverse bars". When he described the genus *Gangamopteris* (1874) he marked anastomoses in the middle part near the base (Figure 3a).

McCoy (1874, p. 11): "Gen. Char. . . . no midrib; veins coarsely reticulate, many arising from the base, branching as they diverge towards the margin, and frequently anastomosing to form an irregular polygonal network. The gigantic ferns constituting the genus *Gangamopteris* were originally described by me in a paper in the Annals of Natural History for 1847, from a single terminal leaflet having the form and netted venation of the narrow varieties of *Glossopteris Brown-*

niana, but which I pointed out as generically distinct from wanting the midrib." This description is adaptable to *Glossopteris browniana*, the first described *Glossopteris* species, as was noticed by Zeiller (1896, p. 364). This is true of *G. ampla* Dana, if one looks at the upper surface of a frond. Often it is difficult to decide whether in the middle the parallel veins or a bundle of veins can be called a midrib, and thus whether it is a *Glossopteris* or a *Gangamopteris*.

With careful and close examination one can follow the secondary veins into the "midrib" in many *Glossopteris* fronds, in which case the midrib is nothing else but a bundle of veins, actually the same vein being first in the middle and then turning towards the margin.

Plumstead (1958, p. 65): "an *Ottokaria* type of fructification being characteristic of two leaf genera, *Gangamopteris* and *Glossopteris*". Does this not show that we deal with one genus only?

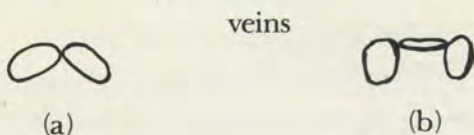
The genus *Gangamopteris* is more typical in the Lower Gondwana formations. It seems that the evolutionary tendency progressed in one taxon from the equally spread venation through the always more dense parallel veins in the middle to the real midrib. A revision of the species from this respect could shed more light on the correlation. A decision of the generic status of *Gangamopteris* needs further research.

Fructifications were reported as borne not only on the petiole but on the midrib of the fronds. The seeds of *G. communis* Fstm. were attached to the median vein bundle. On one frond of *G. pseudocommunis* Kovács more seeds and at least two big protecting leaves were found in connection with the median vein bundle.

Before dealing with the detailed descriptions of the species, I wish to explain my observations connected with the venation.

It depends on the preservation whether the median parallel veins are clearly seen or are only a groove or the impression of a strong vein in the middle.

Splitting the slabs it was possible to examine the counterparts. The pattern of the venation in various species differed often on the two counterparts and not in the same way. In some specimens, on one surface the number of anastomoses was less than on the other. I discussed the matter with Mr. R. Ellis of the Botanical Research Institute. We agreed on the possibility that the veins do not actually join by the anastomoses. There are two ways of forming anastomoses — both can be seen, e.g. on a well-preserved *G. browniana* Bngn. impression. One is when the veins touch one another, and the other is when there is a connecting vein as a bridge between them. If the cross section of a frond was as it is shown on Figures a and b, then there would be more anastomoses on one surface and less on the other.



As the plant remains from Hammanskraal were impressions or badly preserved carbonaceous crusts, it was impossible to prove the cause of the difference in the two surfaces.

Another way in which the two surfaces differ is shown in *G. pseudocommunis* Kovács. Here on one surface the venation is well seen with anastomoses, the other displaying only the cuticle with fine lines. That surface was described as genus *Rubidgea* by Tate (1867) (Kovács, 1977 in press). Some impressions are not merely on one surface. Depending on how preservation was effected, some specimens display the characters of both surfaces. On *G. pseudocommunis* Kovács, e.g. on the "*Glossopteris*" surface there are sometimes "*Rubidgea*" patches, or the other way round, or between the veins there are fine lines running independently of the venation.

In describing the shapes, I have followed Dilcher (1974, pp. 18–20). In the descriptions I give the maximum width of the fronds.

Glossopteris browniana Bngn. 1828

Plate IVe; Figures 1a and 1b

G. Browniana Brongniart, 1828, Prodr. Hist. Veget. foss., p. 54.

G. Browniana var. *australasica* Brongniart, 1830, Hist. Veget. foss., p. 223, Plate 62, figs. 1 and 1a.

G. Browniana Brongniart, in Schimper, 1869, Traité Paléont. veg., 1, pp. 645–46.

Brongniart's description: "G. foliis lanceolatis vel subspathulatis obtuses (1–2 pollicibus latis); nervo medio valido superne canaliculato; nervulis basi obliquis reticulatis, apice tantum simplicibus vel furcatis, marginique subperpendicularibus, vix. obliquis. var. *Australasia* foliis minoribus subspathulatis obtusis." Schimper's description: "fronde minore, rarissime pedali, plerumque longitudine inter centim. 6 et 10 ludente, apicem versus repente angustata, nunquam acute lanceolata, mutica, saepe rotundata, areolis rachi proximis longioribus, plantae junioris elongato-, an-sioris spathulato-lingulata." Brongniart's figure, see Figure 1a. Frond oblanceolate, narrow elliptic. Length 3.5–12 cm, width 1–4 cm. Apex suddenly contracted, varying, often obtuse; base attenuate.

Parallel veins occupy the whole width of the base; as the blade begins to broaden, in the first mm, the outer veins bifurcate, the inner branch runs parallel with the median veins, the outer branch turns aside; they bifurcate repeatedly. The bifurcating veins approaching each other give the impression of anastomoses, or nearby veins are connected by a short one, forming polygonal meshes. The meshes are better seen on the lower surface (on impression where the veins are incised); on the upper surface (on impression where the veins are raised), the veins run less frequently near to each other to meet, and thereby the number of anastomoses is fewer.

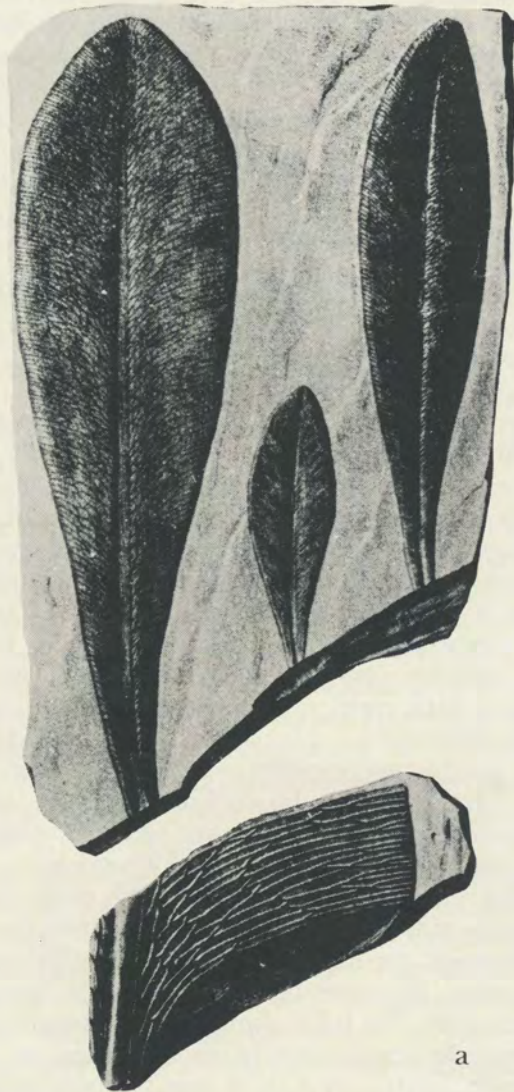
The parallel median veins are not always apparent, due to the preservation; sometimes they look like a

striated midrib, or there is only a groove in the middle. Some middle veins reach the apex without turning aside.

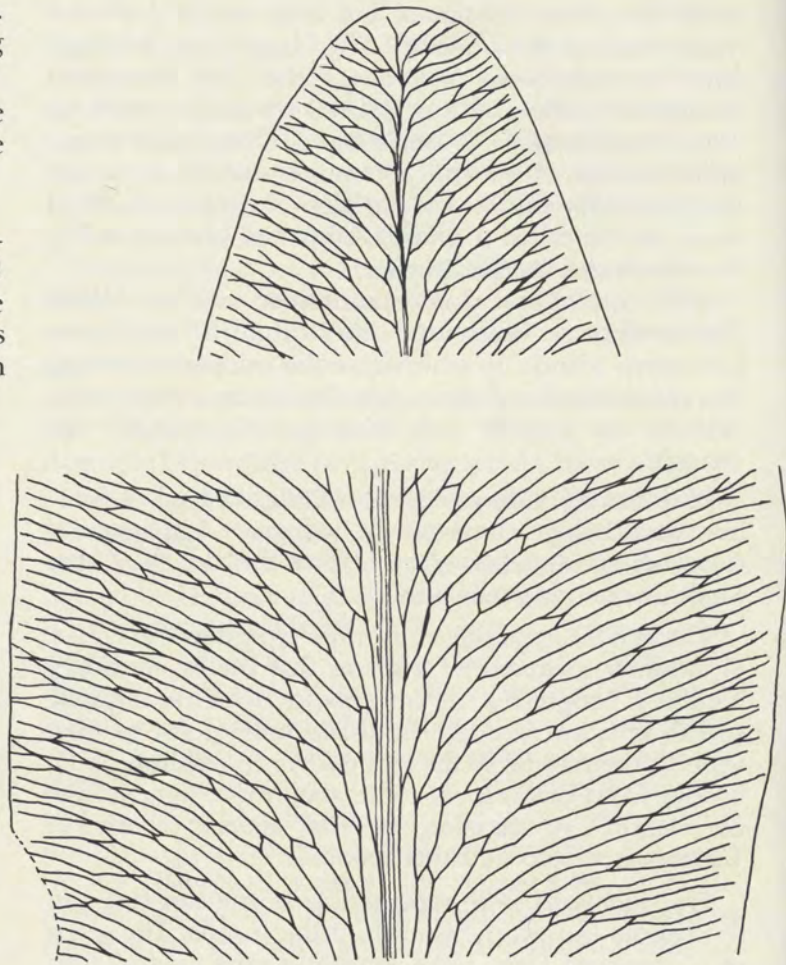
The first meshes form with the median veins a more acute angle than those following. The meshes are polygonal; all are about the same size.

Number of examined specimens: 33.

Comparison: Between *G. browniana* Bngn. and *G. indica* Sch. (Figure 2). In extreme cases the shape and size can be similar, but usually *G. indica* is larger. The apex of *G. indica* is always acute, but *G. browniana* has usually an obtuse apex but sometimes acute. The main



a



b

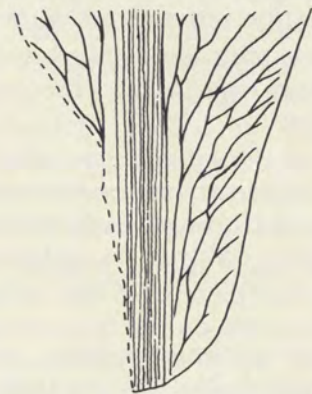


Figure 1. (a) Brongniart's original drawing of *Glossopteris Browniana* var. *australasia* from *Hist. Végét. foss.*, Plate 62, Figures 1 and 1a. 1830.

(b) *Glossopteris browniana* Bngn. Portions of the frond (Catalogue no. H.I. 15) showing the obtuse apex, the parallel veins in the middle and the polygonal meshes, the attenuate base. x2 approx.

specific difference is in the venation. The meshes of *G. browniana* Bngn. are polygonal all over, usually the longest near the middle. Because of the polygonal shape of the meshes, the veins nowhere run parallel. In *G. indica* Sch. the middle meshes are usually broader and shorter than the rest, but always shorter. They are oblong nearer to the margin, where the veins are parallel.

Glossopteris ampla Dana 1849

Plate Ia; Figures 3a, 3b, 3c, 13 and 20.

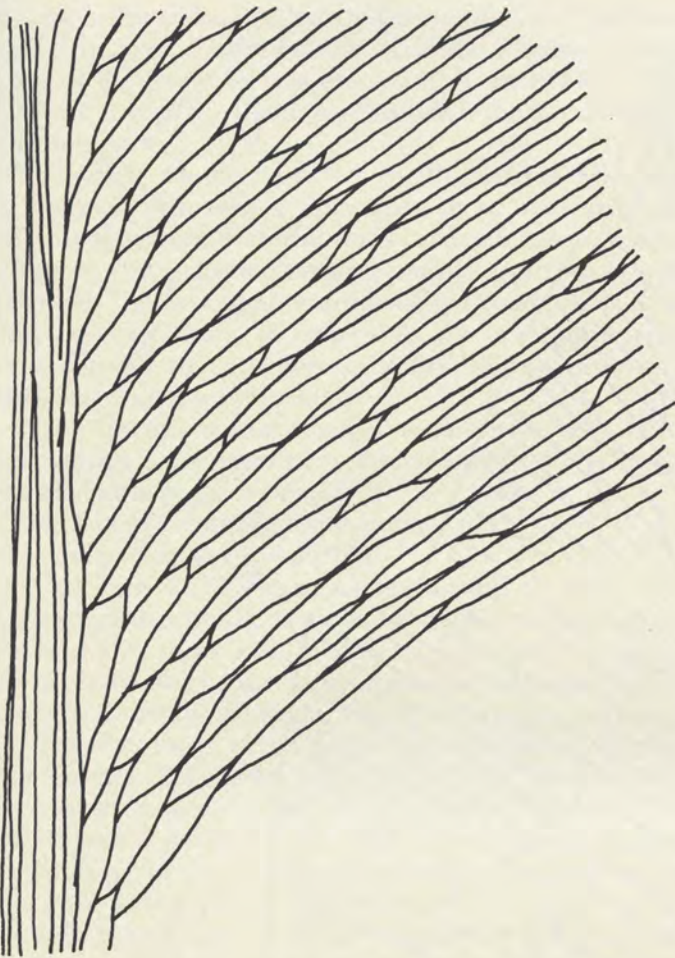


Figure 2. *Glossopteris indica* Schimper. Portion of the frond (Catalogue no. H.I. 74). The side veins are parallel except near to the middle, where the meshes are broader and shorter. x3.

G. ampla Dana, 1849, in Wilkes' U.S. Exped., Vol. 10, p. 717, Figures 1a and 1b.

There is nothing to add to the original description of Dana, which is quoted on page 70. The specimens examined agree in all details with the original description. Under the name *G. ampla* Dana Arber (1905, p. 78, Figure 20) gave a description and figure of *G. damudica* Fstm. and synonymised *G. damudica*. The two species were re-established (Archangelsky, 1957; Plumstead, 1962). The difference in the venation of these two species is impressive. The veins of *G. ampla* Dana pass from the middle with a long curve, forming very long and narrow meshes, which are more or less the same all over the blade. The first meshes of *G. damudica* Fstm. next to the median veins are triangular; then the veins turn at almost a right angle to the margin, and are parallel; the meshes are never so long as in *G. ampla* Dana.

Number of examined specimens: 99.

Glossopteris indica Sch. 1869

Plate Ia; Figures 2, 4, 5 and 21.

G. Browniana var. *indica* Brongniart, 1830. Hist. Veget. foss., p. 223, Plate 62, Figure 2.

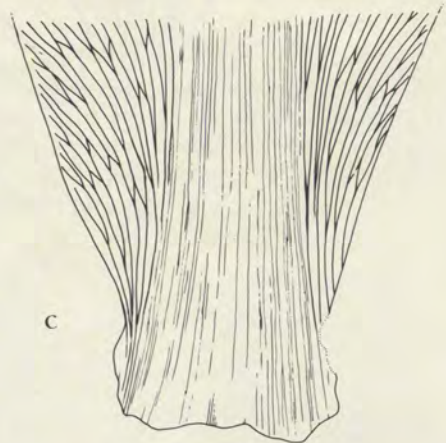
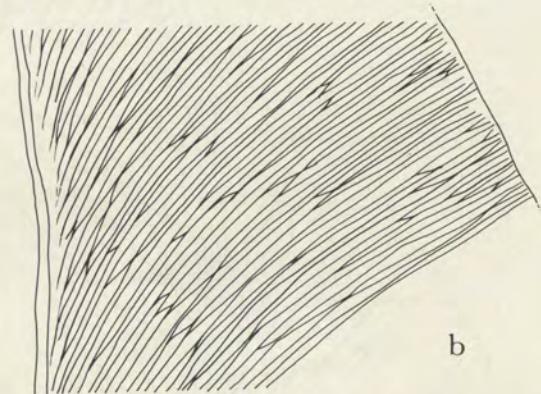
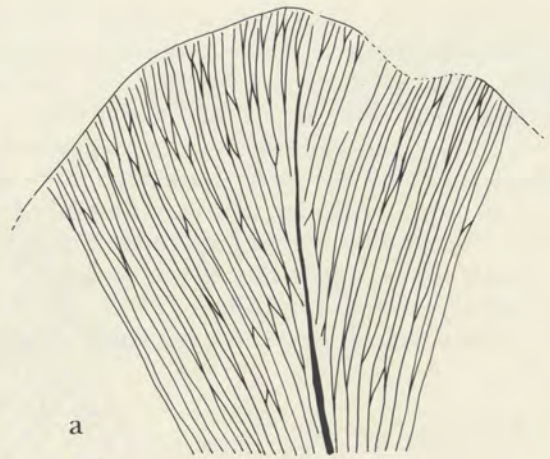


Figure 3. *Glossopteris ampla* Dana. (a) The obtuse apex of the specimen H.I. 134; (b) The portion of the frond no. H.I. 25 showing the long, narrow, equal sized meshes; (c) The base of the specimen no. H.I. 245 with the broad middle part. x1,5 approx.

G. indica Schimper, 1869, Traité Paléont. veg. 1, p. 645.

Brongniart's and Schimper's descriptions are given on page 69. Brongniart's figure Plate VI.

Frond narrow elliptic, tapering to the base and apex, apex always acute.

Length usually more than 20 cm; according to some fragments it can exceed 30 cm. Width 3–7 cm.

In the middle the veins are parallel, but due to the preservation this is not always obvious. Sometimes they are overlain by a layer, which in connection with *G.*

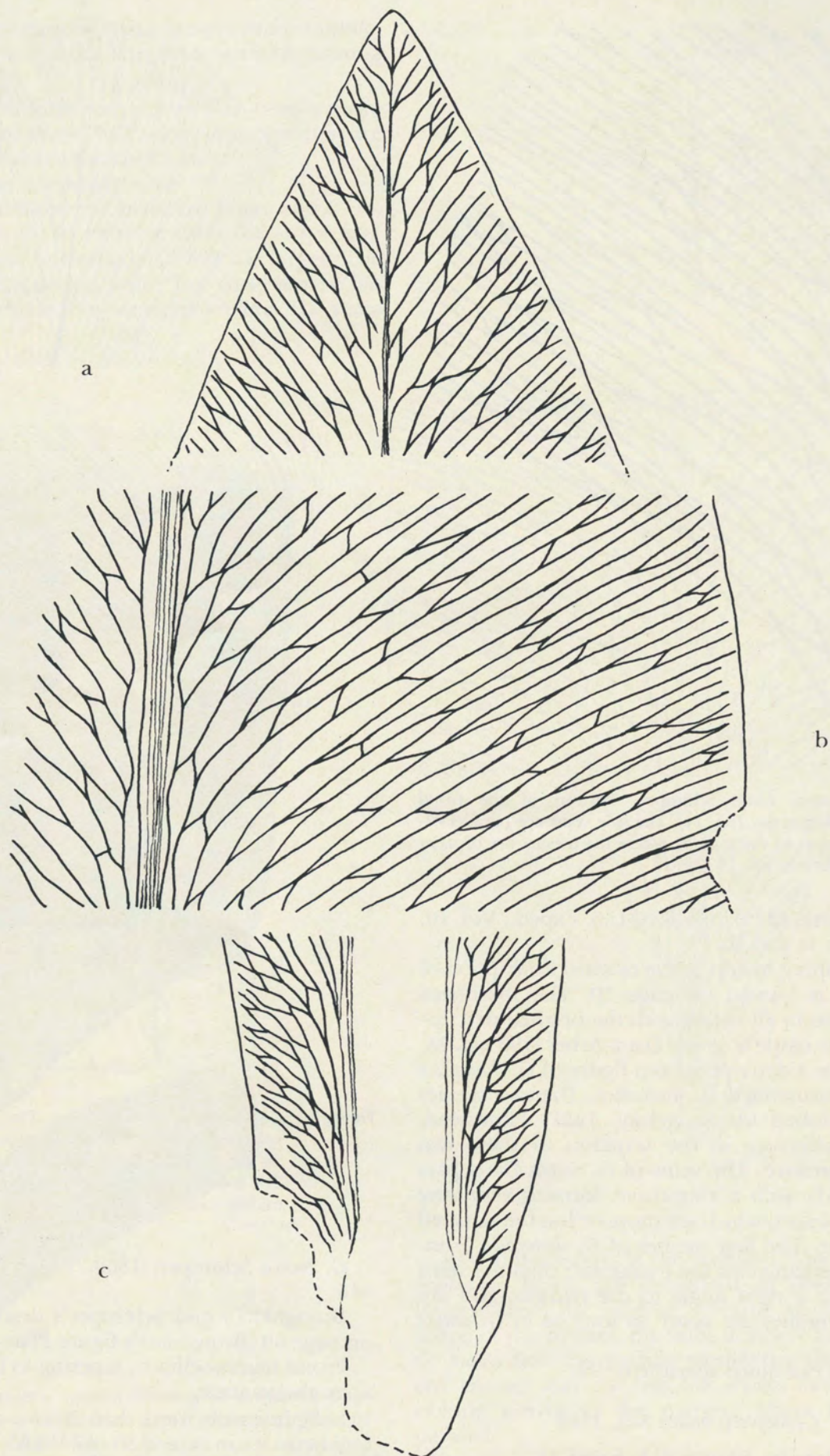


Figure 4. *Glossopteris indica* Schimper. (a and b) The acute apex and the middle portion of the specimen no. H.I. 38 a; (c) The base of the specimen no. H.I. 28 a. x3.

communis Fstm. was called by Feistmantel the "peculiar cell structure". I am not able to decide whether it was a part of the frond or was the result of the preservation. One or two of the median veins reach the apex without turning aside.

The first meshes formed by the lateral veins are polygonal, with two or three rows at an acute angle to the median line; then the veins turn at a more oblique angle to the margin, forming parallel, narrow oblong meshes. The first meshes are usually broader and in all cases shorter than the others. At the apex and at the base the difference between the first and the following meshes is not always striking.

On the upper surface the venation is very faint; anastomoses are seen near the middle and few in the parallel-running side veins.

Number of examined specimens: 103.

Comparison (Figures 5, 6 and 7).

The veins of *G. browniana* Bngn. and *G. indica* Sch. start from the middle at an acute angle, then turn to the margin at a more oblique angle; those of *G. communis* Fstm. have about the same direction, but are slightly curved. *G. browniana* Bngn. has relatively big polygonal, *G. communis* Fstm. very narrow oblong meshes. The inner meshes of *G. indica* Bngn. border the median veins in two or three rows, and differ from the meshes of the more lateral parallel veins. The first meshes of *G. communis* Fstm. in shape, size and direction are more or less the same as the rest.

The shape of *G. indica* Sch. is elliptic, of *G. taeniopteroides* Fstm. oblanceolate. The apex of *G. indica* is always acute, that of *G. taeniopteroides* always obtuse or rounded. The veins of *G. indica* change their course after the first meshes, in which the anastomoses are always well marked. The secondary veins of *G. taeniopteroides* (Figure 8) after bifurcation follow the same direction, anastomoses are few and irregular. When there are meshes, they are all oblong and narrow, with no difference between the median and marginal meshes.

To differentiate *G. indica* Sch. from *G. damudica* Dana (Figure 9) can be difficult when the apex is missing, as in both species the venation with two kinds of meshes is typical; moreover the veins, except near the median line, are parallel. The meshes bordering the median bundle of veins, however, differ; in *G. indica* they are in two or three rows, oblong-polygonal and form an acute angle with the median veins; in *G. damudica* the meshes of the first row are long and parallel with the middle, and the meshes of the second row are triangular, trapezoid.

Glossopteris communis Fstm. 1876

Plate Ib; Figures 7, 10a, b, c and 11.

G. communis Feistmantel, 1876. Jl. asiat. Soc. Beng. 45, 2, 4, p. 375, Plate 21, Figure 5.

For Feistmantel's description see p. 69 and figure see Text fig. 11d.

Frond is narrow or very narrow elliptic, apex always acute, gradually tapering towards the apex and base.

Length 10–20 cm; width 2,5–7 cm. The veins are parallel in the middle, which is not always well visible, as they are often covered by the "peculiar cell structure" (Feistmantel, 1881b, p. 98). The vein bundle reaches the apex, gradually thinning.

The veins emanating from the median bundle arch moderately and reach the margin almost in the same course. The meshes are oblong, very narrow and more or less of the same size and shape on the whole blade. The venation is very dense, and crowded to such an extent that the veins are not clearly distinguished.

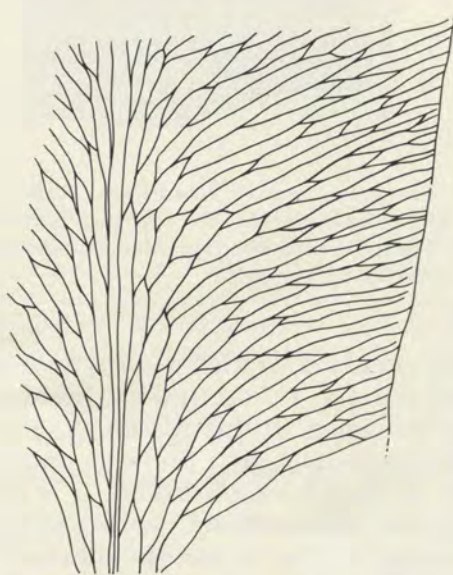


Figure 5. *Glossopteris browniana* Bngn. Portion of the frond (Catalogue no. H.I. 15) to show the veins starting from the middle at an acute angle, then turning to the margin at a more oblique angle. The meshes are all polygonal. $\times 1,5$ approx.

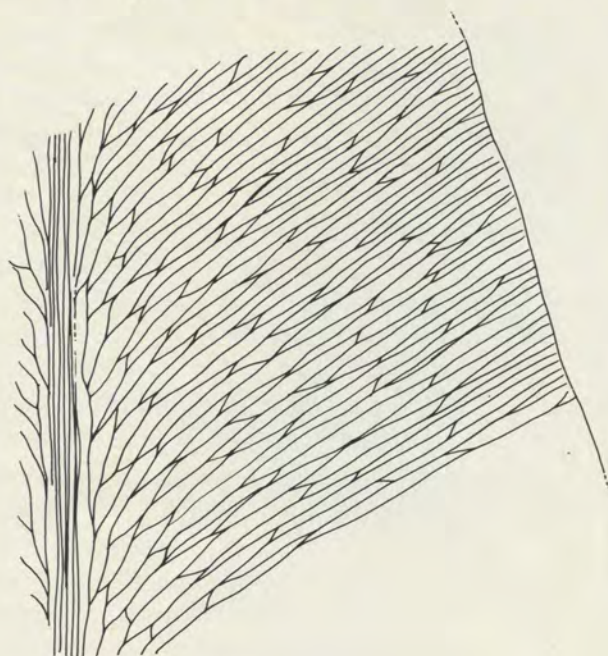


Figure 6. *Glossopteris indica* Schimper. Portion of the frond (Catalogue no. H.I. 174). Two or three inner meshes border the median veins and differ from the long meshes of the lateral parallel veins. $\times 3$ approx.

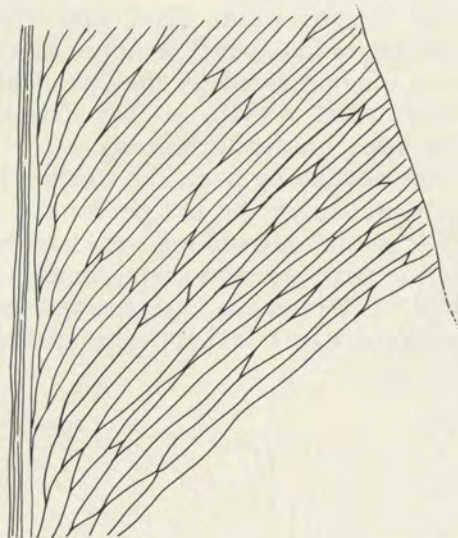


Figure 7. *Glossopteris communis* Feistmantel. Portion of the frond (Catalogue no. H.I. 67). The slightly curved veins have about the same direction. All the meshes are narrow and oblong. x1,5 approx.

A seed attached to the median vein bundle was described (Kovács, 1974a), and the frond is now identified as belonging to this species. Re-examining the same specimen (H.I. 74), knowing more about the venation of the *Glossopteris* fronds, it is certain that a number of the middle veins supported the megasporophyll. The remainder followed their course in the middle of the leaf. That is why the bundle of veins suddenly becomes narrower above the seed.

Number of examined specimens: 199.

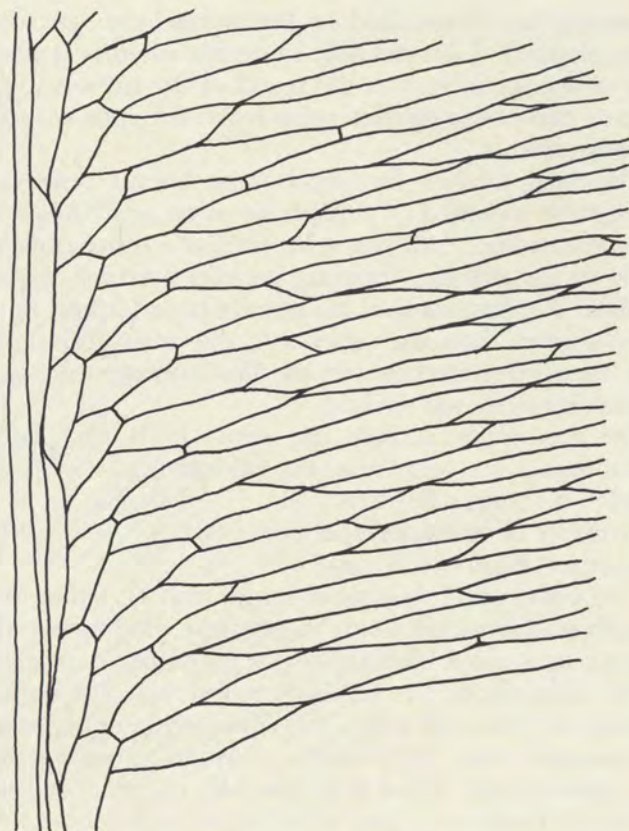


Figure 9. *Glossopteris damudica* Fstm. Portion of the frond (Catalogue no. H.I. 126). The first long meshes are parallel with the middle, the next meshes are more or less triangular, trapezoid, then the veins form polygonal, and finally oblong, parallel meshes, running to the margin almost at right angle. x2,5 approx.

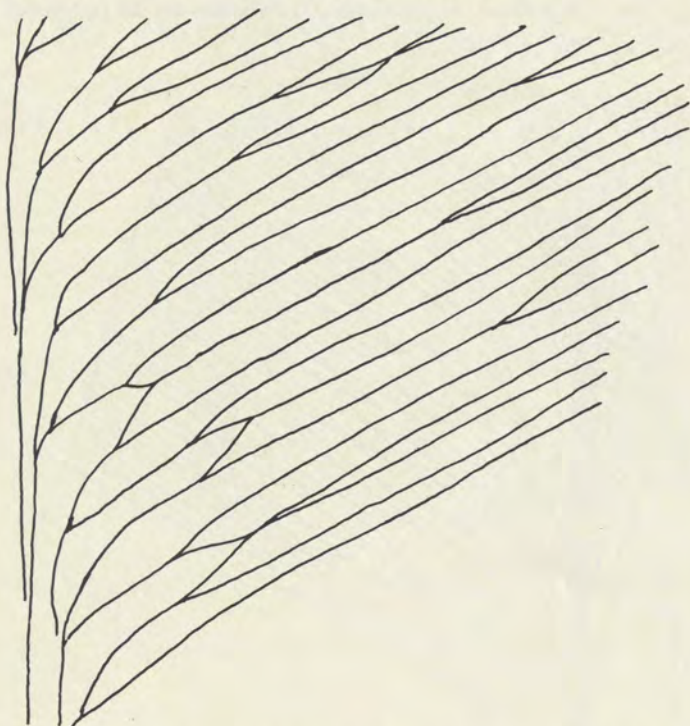
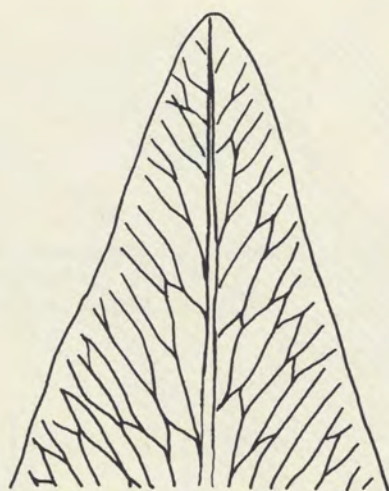


Figure 8. *Glossopteris taeniopteroides* Fstm. Portion of the frond (Catalogue no. H.I. 27a). The veins after bifurcation follow the same direction, anastomoses are few and irregular. 2,5 approx.

Comparison

Feistmantel, describing *G. communis*, figured fronds with obtuse apices (1879, Plate 17, fig. 2; 1881, Plate 37A, fig. 4, Plate 38A, fig. 1). At Hammanskraal both *G. communis* Fstm. and the species with obtuse apex have been found. *G. communis* differs from the species, which I named as *G. pseudocommunis*, not only in the shape of the apex, but in venation. The veins of *G. communis* Fstm. curve a little, forming very narrow crowded meshes. The veins are more or less straight (Figure 11). The veins of *G. pseudocommunis* Kovács arch forming prominently arcuate venation with bending meshes (Figure 12). A few of the median parallel veins always reach the apex in *G. communis*. The median veins near the apex sometimes spread out fan-like in *G. pseudocommunis*. On the upper surface *G. pseudocommunis* has the "Rubidgea" feature, but the two surfaces of *G. communis* do not differ significantly.

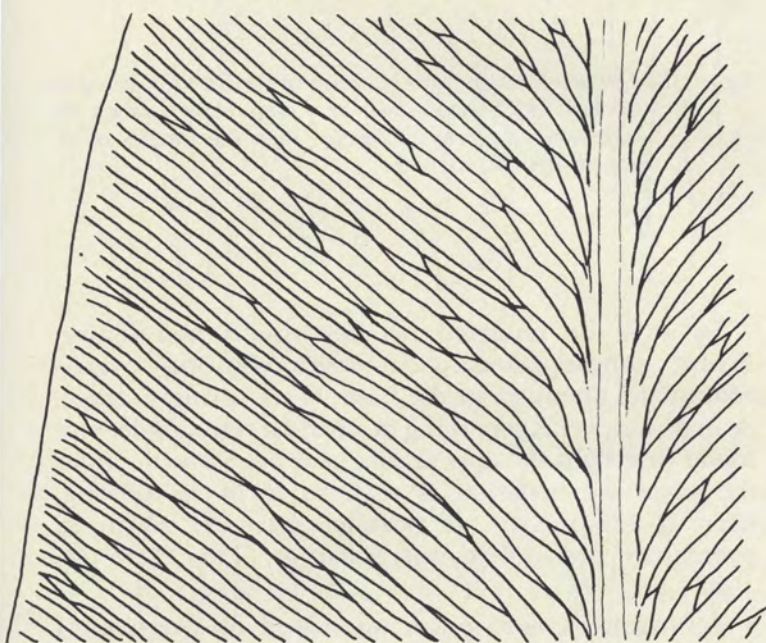
G. communis differs from *G. ampla* in shape and venation. *G. communis* has an acute apex, *G. ampla* obtuse, rounded or emarginated. The base of *G. communis* tapers gradually, that of *G. ampla* abruptly. The veins of *G. ampla* form very long bending meshes (Figure 13). The meshes of *G. communis* are shorter and straighter.



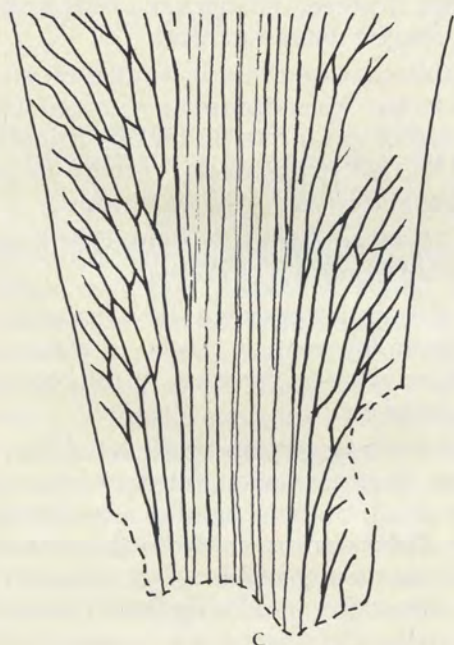
a



d



b



c

Figure 10. *Glossopteris communis* Fstm. (a) The acute apex of the specimen no. H. I. 28 (a); (b) Portion of the frond (Catalogue no. H.I. 137). The meshes are oblong, narrow and more or less of the same size and shape; (c) The gradually tapering base of the specimen H.I. 39. x3 (d) Feistmantel's original drawing (1876).

Glossopteris taeniopteroides Fstm. 1878

Plate IIe; Plate IIIa, b and c; Plate IVa; Figures 14, 15, 16 and 17

G. taeniopteroides Feistmantel, 1878, *Palaeontographica*, Nachtr. 3,3, p. 92, Plate 9, Figures 1 and 1a.

G. indica Schimper, in Zeiller, 1902, *Mem. Geol. Surv. India*, N.S. 2, 1, pp. 8-13, Plate 1, Figures 1-5, Plate 2, Figures 1, 3 and 4 Plate 3, Figures 1, 3.

G. angustifolia Bngn. var. *taeniopteroides* Seward and Leslie, 1908, *Quart. J. Geol. Soc. London*. 64, p. 113, Text Figures 2 and 3, Plate 9, Figure 2.

G. occidentalis White, 1908, *Co. Est. Minas Carvas Pedra Brazil*. Rio de J. Pt. 1. p. 511-3-5-7. Plate VII, Figures 1-4 and 4a.

G. indica Schimper, in Halle, 1912, *Bull. Geol. Instn. Univ. Uppsala*, 11, p. 169.

G. indica Schimper cf. var. *Wilsoni* Seward, in Seward-Walton, 1923, *Quart. J. Geol. Soc. Lond.* 79, p. 322, Plate 21, Figure 13.

G. indica Schimper in Walton, 1929, *Bull. geol. Surv. S. Rhod.* 15, 2, p. 70, Plate C, Figure 19.

Rhabdotaenia waginae Rigby, 1966, *Palaeontographica* 118, B. p. 135, Plate 34, Figure 43; Plate 35, Figure 56; Plate 36, Figure 57.

Feistmantel's description: Fronde simplici speciosa, oblonge-ovate-spathulata, ad basem attenuata; rhachide valida, lineata, nervis secundariis sub angula subrecto egredientibus, primo aspectu nervationi Taeniopteridis simulantibus, sub lente retia oblonga, angusta, oblique-acute-parallelo gamma aut indistincte polygonalia exhibentibus.

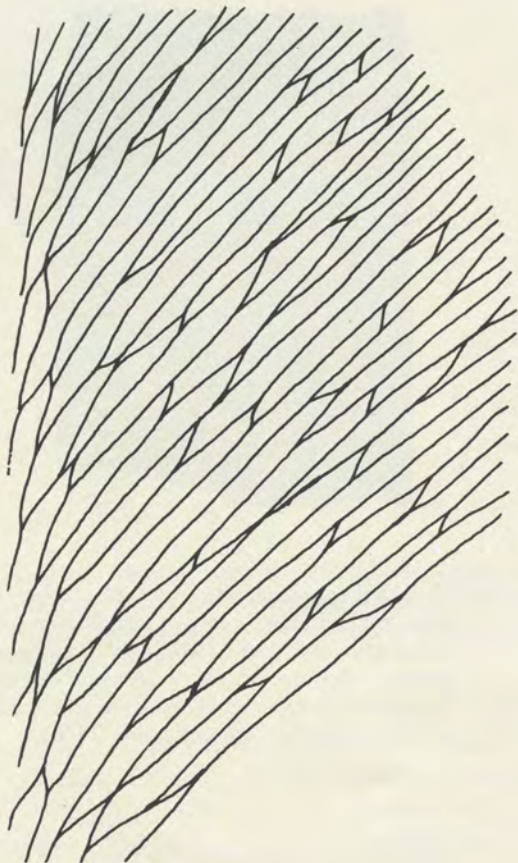


Figure 11. *Glossopteris communis* Fstm. Portion of the frond (Catalogue no. H.I. 67). The veins are more or less straight. x3.

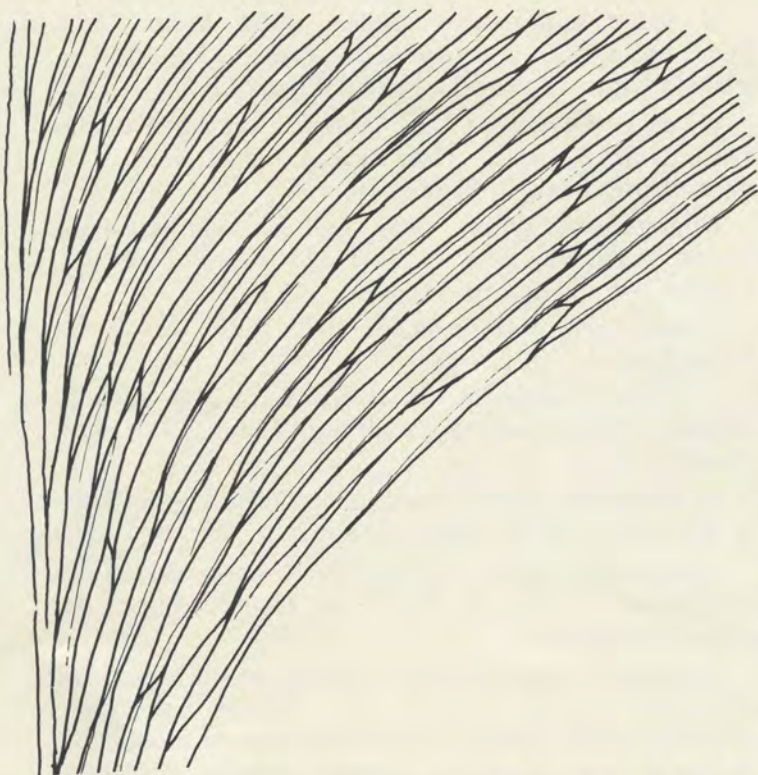


Figure 12. *Glossopteris pseudocommunis* Kovács. Portion of the frond (Catalogue no. H.I. 171). Arcuate venation with bending meshes, with fine lines between the veins. x3.

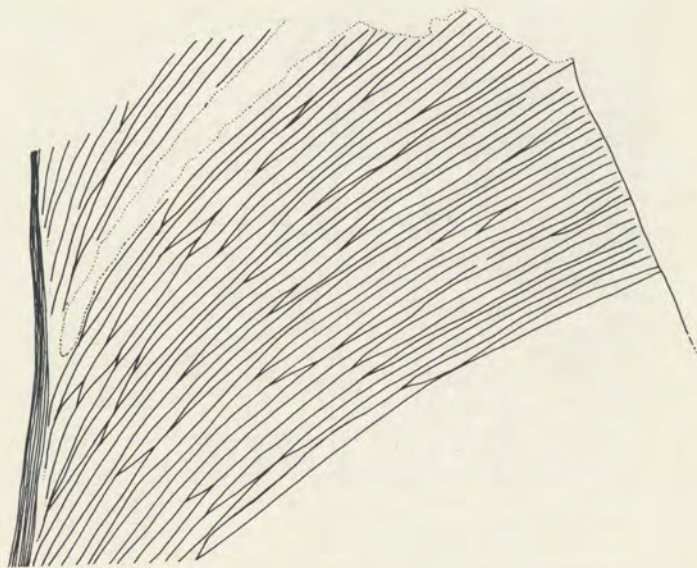


Figure 13. *Glossopteris ampla* Dana. Portion of the frond (Catalogue no H.I. 25). Venation with very long meshes, which are narrower relatively to the size than the meshes of *G. pseudocommunis*. x3.

In 1890 he repeated his description and figure: Frond simple, elegant in form, oblong ovato-spathulate, attenuate at the base; costa strongly striate, or grooved; veins emerging at nearly a right angle, giving at first sight the appearance of a *Taeniopteris*. Under the glass the venation is seen to form an oblong, narrow, obliquely-acute parallel network, which in sometimes indistinctly polygonal (p. 128, Plate 18, figs. 1 and 1a).

Feistmantel's description was based on one typical fragment. The venation, as it was determined, is characteristic in the one specimen. The number of anastomoses, however, changes not only from frond to frond, but also on the same frond.

Frond oblanceolate or narrow oblanceolate, the fertile fronds lyrate. Apex obtuse or rounded. (Figure 14.) Base cuneate or on the fertile fronds roundly hastate. (Figure 15.) All transitional forms between the oblanceolate and lyrate form can be found.

Length 15–30 cm, width 3–7 cm. One fragment was of a very small frond, 1,5 cm broad.

Midrib strong. It appears to be a real unit, i.e. not a bundle of parallel veins. It can be as wide as 7 mm at the base, narrowing to the apex. At the base it occupies a third of the blade.

In respect of anastomosis of the secondary venation, some veins anastomose regularly, some once and others not at all, but run parallel towards the margin. The angle of the veins varies from almost a right angle to 35°. The constant character of the venation is that the secondary veins after branching from the midrib bifurcate and run parallel towards the margin.

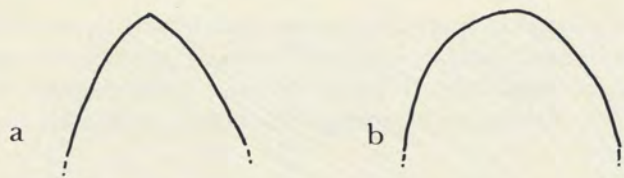


Figure 14. *Glossopteris taeniopteroides* Fstm. (a) The obtuse apex of the specimen no. H.I. 76; (b) The rounded apex of the specimen no. H.I. 298. x1.

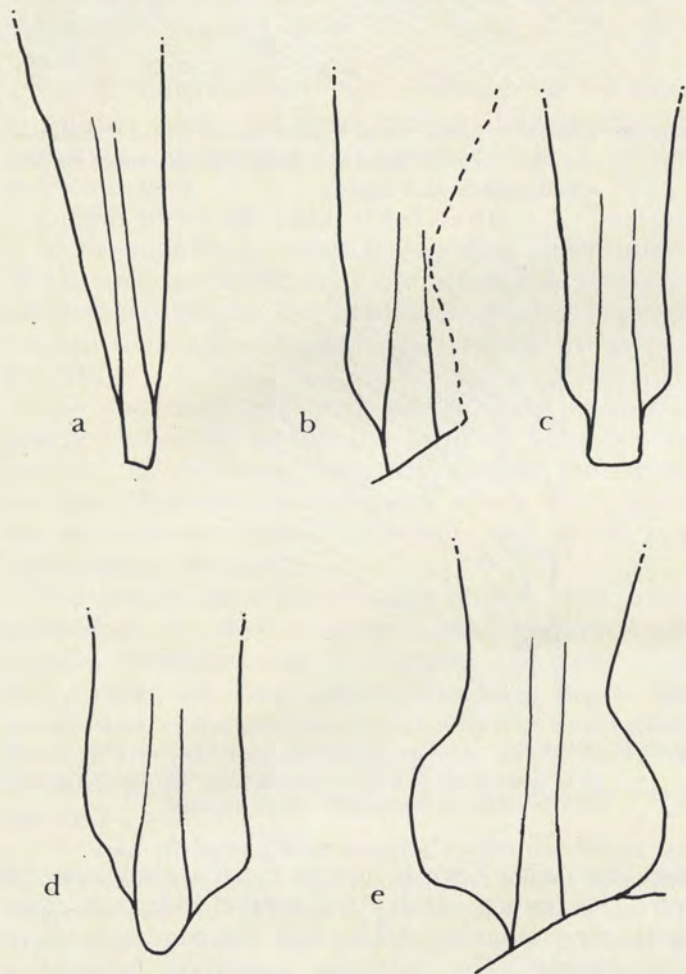


Figure 15. *Glossopteris taeniopteroides* Fstm. The variation of the base from cuneate to roundly hastate. Catalogue nos: (a) H.I. 150; (b) H.I. 17; (c) H.I. 17; (d) H.I. 21; (e) H.I. 76. x1.

The reproductive organ is attached to the petiole. It is a strobilus with two protective leaves. Bannerjee (1969) reported the female fructification from Bihar, India. The seeds were prepared out of an attached fertile body. According to his description ("arranged in linear rows . . .") "sessile seeds are attached to the median axis . . .") and his photographs it seems not impossible that the seeds were on the midrib, and covered by a strong veil.

The fructifications from Hammanskraal, mentioned here, are probably pollen-bearing organs, though Dr. Stapleton of the Geological Survey, Pretoria, found no pollen in them.

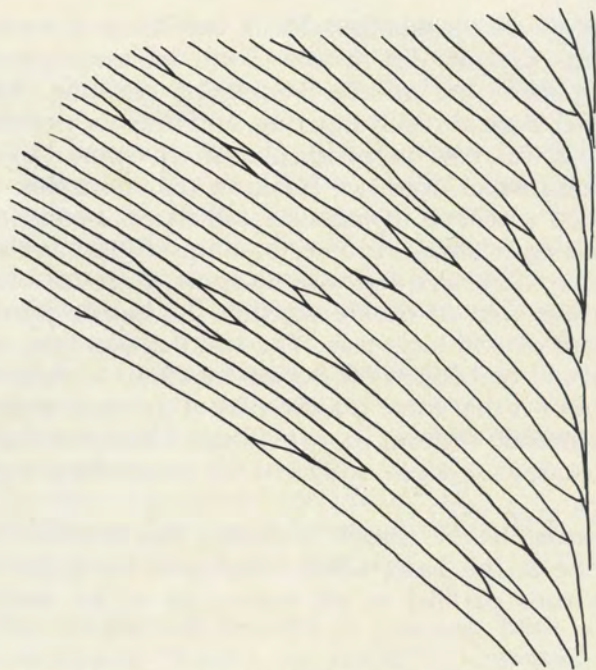


Figure 16. *Glossopteris taeniopteroides* Fstm. Portion of the frond (Catalogue no. H.I. 21). x2 approx.

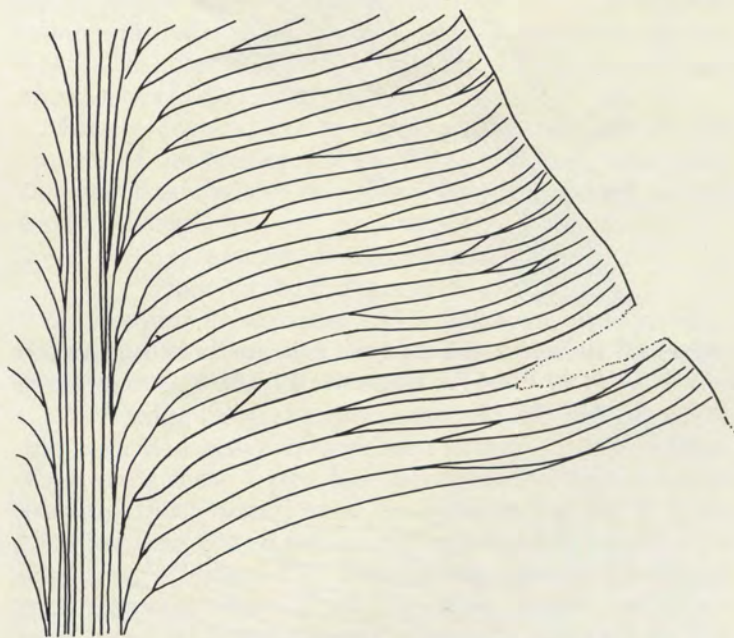


Figure 17. *Glossopteris taeniopteroides* Fstm. Portion of the frond (Catalogue no. H.I. 160) showing venation. x2 approx.

Number of examined specimens: 558.

The bifurcating parallel veins with few irregular anastomoses is such a typical character that the species is easily recognisable even on fragments.

Glossopteris damudica Fstm. 1881

Plate IVb, c and d; Figures 9, 18 and 19.

G. damudica Feistmantel, 1879. Palaeont. indica, ser. 12, 3, 1, p. 17.

G. damudica Feistmantel, 1881, Palaeont. indica, Ser. 12, 3, 3, p. 105, Plates 30A, 1-2; 31A, 1-3; 32A, 1; 40A, 6.

A whole frond was found with excellently preserved venation. Length with petiole 15 cm, maximum width 3,5 cm above the middle. Petiole 1,5 cm long. Apex rounded. Base abruptly tapering, and near the petiole it ends with narrow perpendicular sharp spurs (Figure 18). Feistmantel does not mention the spurs, but the discussed specimen in venation and shape is consistent with his description. Another base was also found with the same characters, but without spurs. I was unable to detect any sign to decide whether the base originally was with or without spurs. The spurs are so fine, that they could be broken off during fossilisation. Another possibility is that there is a diversity at the base, as in *G. taeniopteroides*. Without more evidence I have not found the hastate base alone sufficient for establishing a new species.

Venation: In the middle the veins run parallel. The first one at the base, which bifurcates, has a branch which runs parallel as the outermost of the median

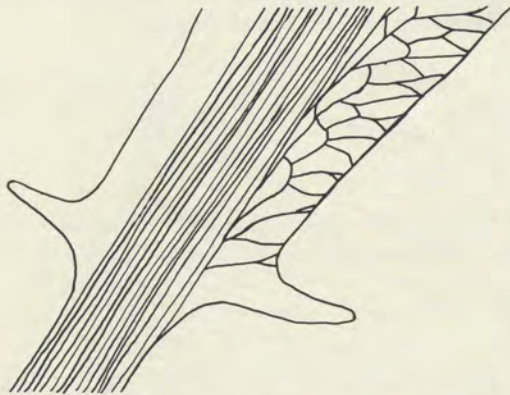


Figure 18. *Glossopteris damudica* Fstm. Enlargement of basal portion of the frond (Catalogue no. H.I. 126) to show the spurs. $\times 1,6$ approx.

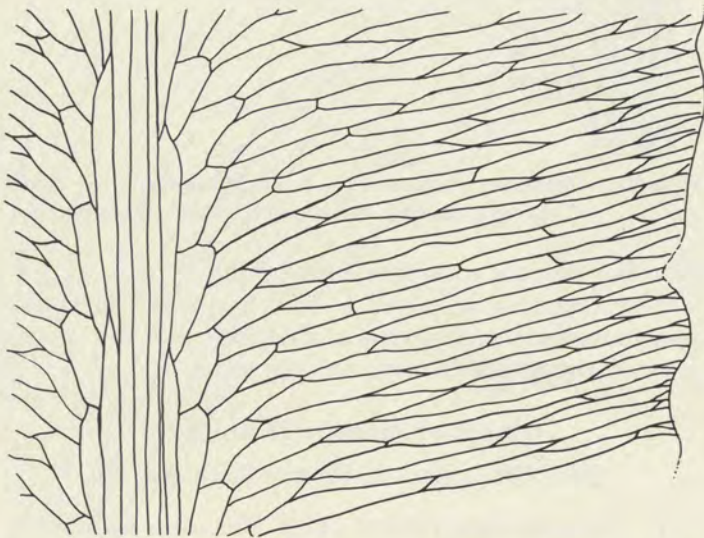


Figure 19. *Glossopteris damudica* Fstm. Portion of the frond (Catalogue no. H.I. 126) to show venation. The meshes near to the median veins are triangular, then polygonal, finally oblong. $\times 2$ approx.

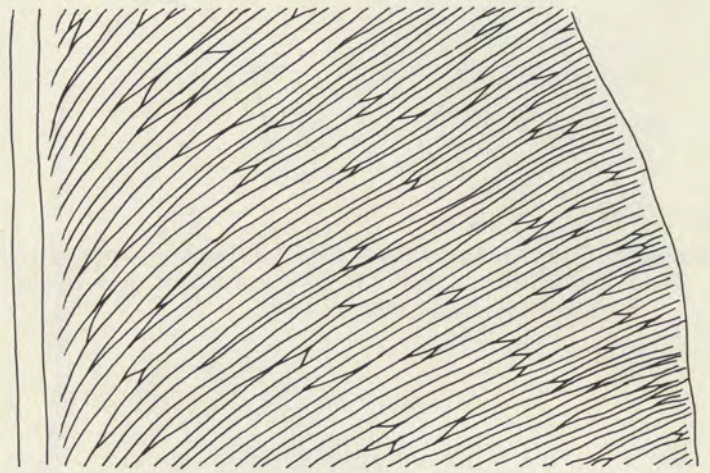


Figure 20. *Glossopteris ampla* Dana. Portion of the frond (Catalogue no. H.I. 170) to show the long, narrow, more or less equal meshes. $\times 2,5$ approx.

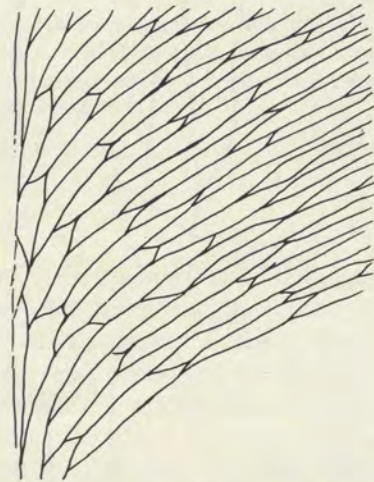


Figure 21. *Glossopteris indica* Schimper. Portion of the frond (Catalogue no. H.I. 27a) showing the oblong-polygonal meshes near to the middle. $\times 2,25$ approx.

veins. The other branch runs to the margin above the spur. The branch which runs parallel bifurcates twice again; the branching veins reach the margin without anastomosing. The following outermost bifurcating veins form a network in which the first long meshes are parallel with the middle, the next meshes are more or less triangular, trapezoid, then the veins form polygonal, and finally longer oblong parallel meshes, running to the margin almost at right angles. The direction of the venation is more or less the same from the base to the apex. (Figure 19.)

Number of examined specimens: 11.

For comparisons see *G. ampla* Dana and *G. indica* Sch. (Figures 20 and 21). It is not difficult to distinguish *G. damudica* from *G. communis*. *G. communis* has equal meshes.

Another frond was found with hastate base. The apex was missing. The venation showed the typical *Glossopteris* feature, but the fragment was not sufficient for identification. The base is similar to that described by Lacey, Van Dijk and Gordon-Gray (1974) as *Belemnopteris elongata*. Feistmantel established the genus

Belemnopteris for broad arrowhead shaped fossils with three chief veins. I am of the opinion that these fronds with hastate base have a closer resemblance to the genus *Glossopteris* than to the genus *Belemnopteris*.

Glossopteris pseudocommunis n. sp.

Plate IIa, b, c and d; Figures 12, 22, 23, 24, 25 and 26.

G. communis Feistmantel (pars) 1879, 1881 Palaeont. indica Ser. 12, 3, 1 (Suppl.) Plate 31, Figure 4. Palaeont. indica, Ser. 12, 3, 1, Plate 17, Figure 2; 1881, Palaeont. indica, Ser. 12, 3, 3, Plate 17A, Figure 4, Plate 38A, Figure 1.

Frond oblanceolate. Apex obtuse or rounded, sometimes acute, but never pointed (Figure 22). The base long and tapering into a petiole about 4 cm long and 7 mm wide.

Length 10–28 cm, width 1, 4–5, 5 cm.

In the middle the veins are parallel. Unfortunately on the only specimen where the petiole was preserved, the base is overlapped by another frond, but where the median veins are seen again, they appear the same as the petiole.

The outermost veins arch steeply from the median bundle, bifurcate repeatedly, forming long bending meshes. As the veins leave the median bundle this becomes thinner. Near the apex it is only a thin line or the veins spread fan-like. The veins arch evenly from the middle to the margin.

The size of the meshes varies on the same frond. Sometimes the bifurcating veins anastomose near the middle, sometimes near the margin; thus some of the first meshes are short, others very long. Some veins anastomose at the margin, but usually they end without joining. The number of anastomoses on the half blade is two or three, sometimes only one. (Figures 23, 24, 25 and 26.)

The two surfaces differ intensely. On the lower surface (where the veins are incised) the above described venation is seen. On the upper surface there are fine lines arching from the middle (Figures 25 and 26) without anastomosing. That surface was described by Tate as genus *Rubidgea*. On an impression either one surface of a frond or both can be seen. There are impressions of *Glossopteris* venation covered at some places with "*Rubidgea*" patches. On other impressions the "*Rubidgea*" surface is interrupted irregularly by typical anastomosing and stronger *Glossopteris* veins. Often the

two surfaces are seen on the same impression, when the lines of the "*Rubidgea*" surface run between the actual veins. These lines were named by Pant (1956, p. 130, Figure 1A) as fibres.

On specimen No. H. II.57b, there are more *G. pseudocommunis* fronds. On one of them there are three seeds in a row beside the median bundle. Two more seeds are on the other side of the median bundle but they seem to be dislocated, and one seed fell out when splitting the slab. There are carbonaceous fragments of two protecting fronds and the impression of one of them. As the preservation is rather poor and only one specimen was found further discussion about the female reproductive organ of *G. pseudocommunis* would be premature.

Number of examined specimens: 138.

Holotype: Geological Survey, Pretoria, H.I. 103a.

Paratypes: H.I. 29, H.I. 150, H.I. 172, H.I. 195, H.I. 216.

For comparison between *G. communis* Fstm. and *G. pseudocommunis* Kovács see under *G. communis*, page 76.

In extreme cases big *G. pseudocommunis* fronds can have the same size as smaller *G. ampla* fronds. The base of *G. ampla* tapers abruptly, the base of *G. pseudocommunis* gradually. The meshes of *G. pseudocommunis* are always broader relatively to the size of the frond than the meshes of *G. ampla*.

Finally, I would like to report a rare species from the quarry of the Marico Mineral Co. (Pty) Ltd., which lies 3,5 km from where the previously mentioned fossils were collected.

Glossopteris divergens Fstm. 1881

Plate Va, b, c; Figures 27 and 28.

G. divergens Feistmantel 1881. Palaeont. indica, Ser. 12., 3,3, p. 104, Plate 28A, Figures 3 and 4; Plate Va, b, c. Text Figures 27 and 28.

"To judge from the specimens the leaf was obovate; the midrib appears to have been strong; . . . The secondary veins show a peculiar arrangement; in the lower portion their direction is downwards; in the middle they are horizontal; and in the upper portion they pass upwards" (Figure 27) "exhibiting thus a diverging arrangement, while in all the other species the veins pass more or less obliquely upwards, especially in the basal portion of the leaf. The veins form anastomoses, the meshes being short close to the midrib, and becoming oblong towards the margin, but being pretty broad throughout." (Figure 28) (Feistmantel, 1881, p. 104.)

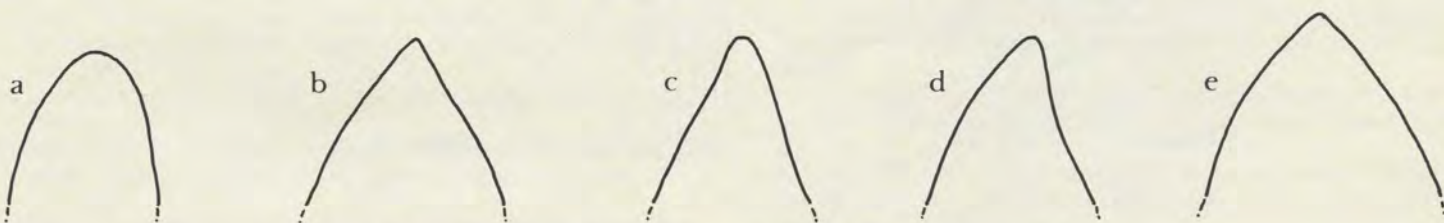


Figure 22. *Glossopteris pseudocommunis* Kovács. The variation of the apex. Catalogue nos. (a) H.I. 192; (b) H.I. 151; (c) H.I. 216; (d) H.I. 74; (e) H.I. 50. x1.

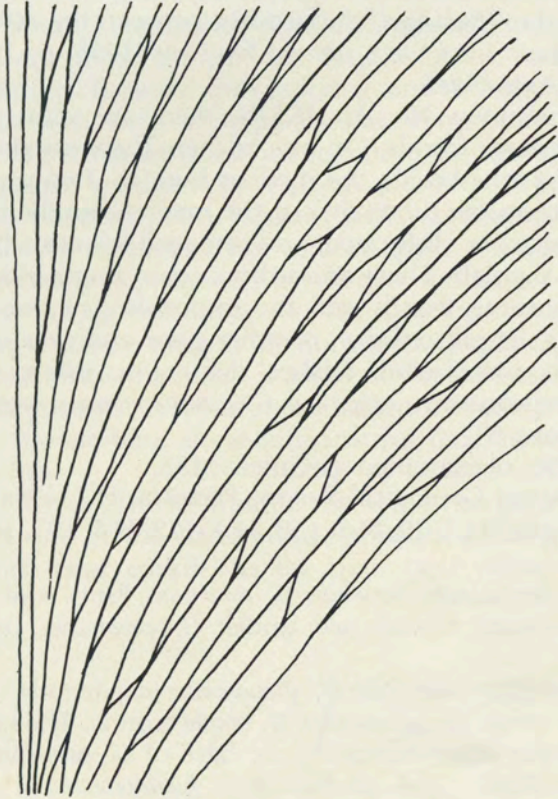


Figure 23

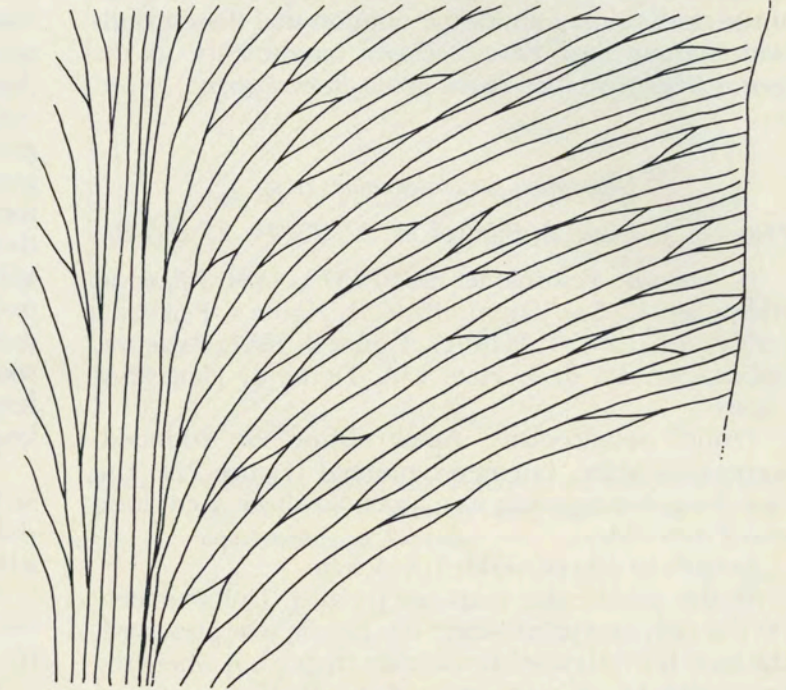


Figure 24

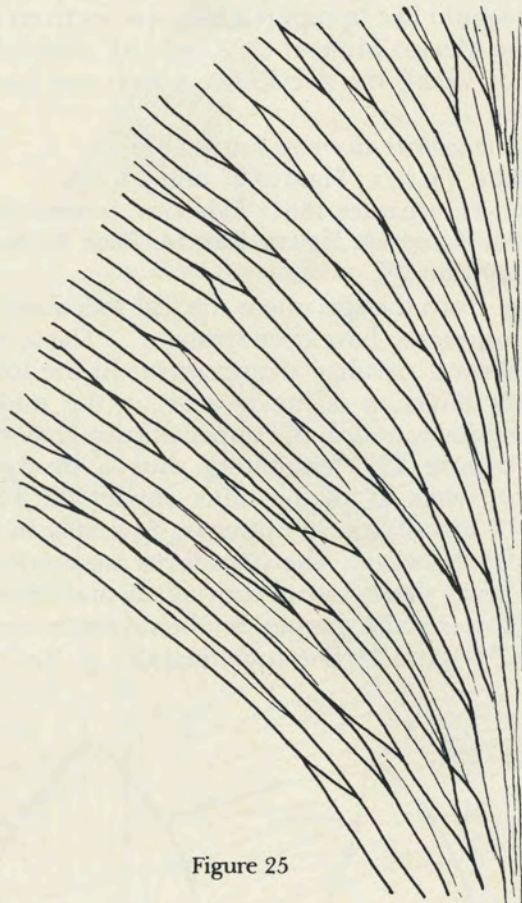


Figure 25

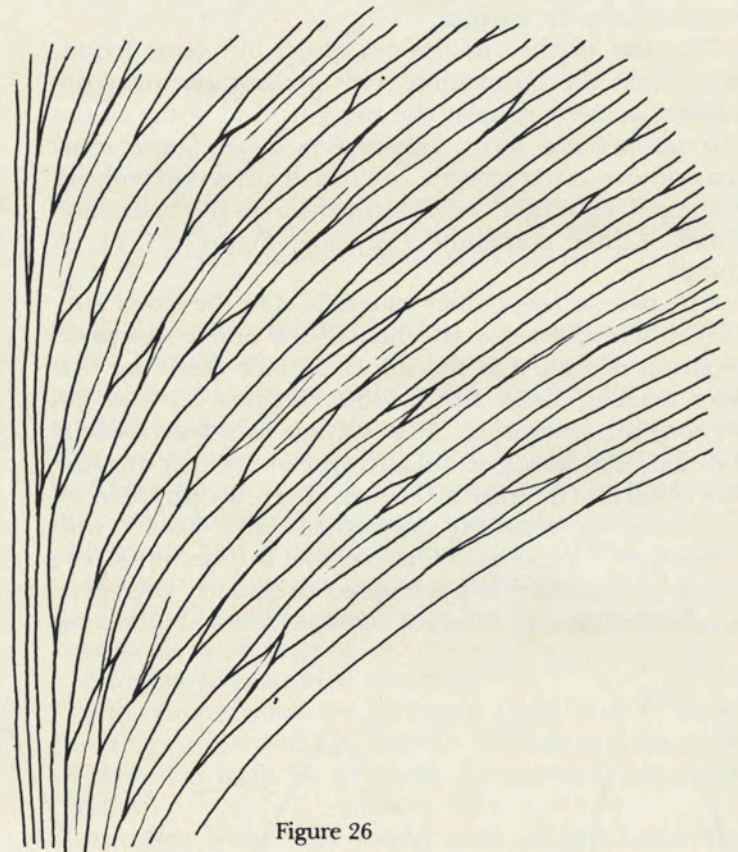


Figure 26

Figures 23–26. *Glossopteris pseudocommunis* Kovács Figure 23. Catalogue no. H.I. 76; Figure 24. Catalogue no. H.I. 175; Figure 25. Catalogue no. H.I. 27a; Figure 26. Catalogue no. H.I. 27a. Showing venation. $\times 2,5$ approx.

Fifteen fragments were found. One base and three apices were preserved. They were large fronds, some of them 10 cm broad. No one fragment was sufficient to judge the length and shape. Two apices were obtuse and one rounded, emarginated. The base was truncate.

The fronds have no midrib, but parallel veins in the middle. Otherwise the venation is as described by Feistmantel (1881).

Srivastava (1956, p. 4) described the cuticle of an incomplete specimen, which he identified as *G. cf. divergens* Fstm. His photographs do not exhibit the

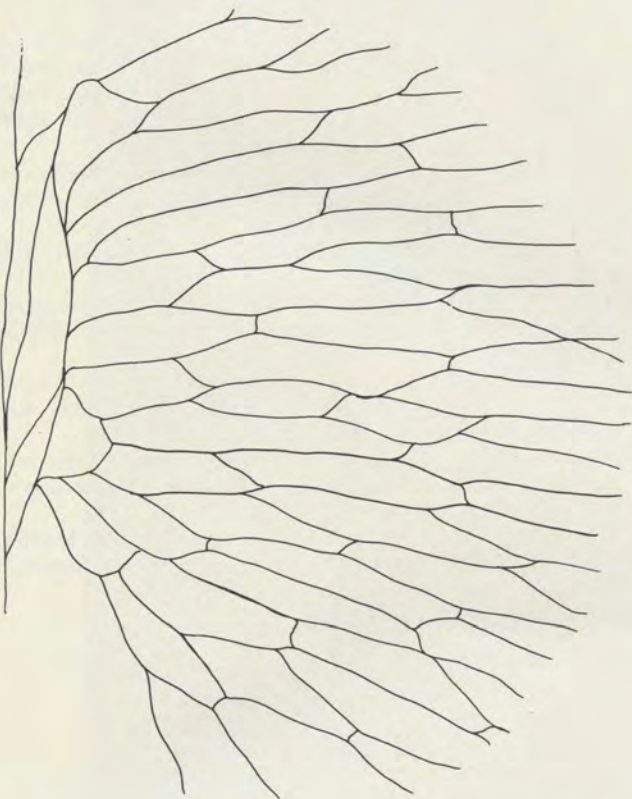


Figure 27. *Glossopteris divergens* Fstm. Portion of the frond (M.II. 65) showing the divergent course of the veins. x2 approx.

characters mentioned by Feistmantel, i.e. the divergent course of the veins and the short meshes close to the middle line.

ACKNOWLEDGEMENTS

Thanks are due to Dr. J. F. Enslin, the Director of the Geological Survey, Pretoria, and to Dr. A. W. Keyser, the chief geologist of the Palaeontological Department for permission to publish this paper. I am grateful to Dr. S. H. Haughton for critical examination of the manuscript, to Dr. B. de Winter and to Mr. R. Ellis for many discussions of botanical questions. To talk over the taxonomical problems with Dr. S. Endrödy-Younga was a great help. The figures were drawn by Mrs. R. Fregona, who with her critical observations helped to improve the descriptions. I am thankful to Dr. C. R. Hill, British Museum, for checking Pant's holotypes of *G. fibrosa* and *G. hispida*, to Prof. Dr. J. P. Lehman, Museum, Paris, for sending the photograph of the holotype of *G. indica*, to Dr. S. Endrödy-Younga for making the photographs, to Mr. J. J. Brits for allowing me to collect on his farm, to Prof. Dr. W. Remy, to the Plant-systematic Institute of E. L. University, Budapest, and others for sending the copies of the original literature.

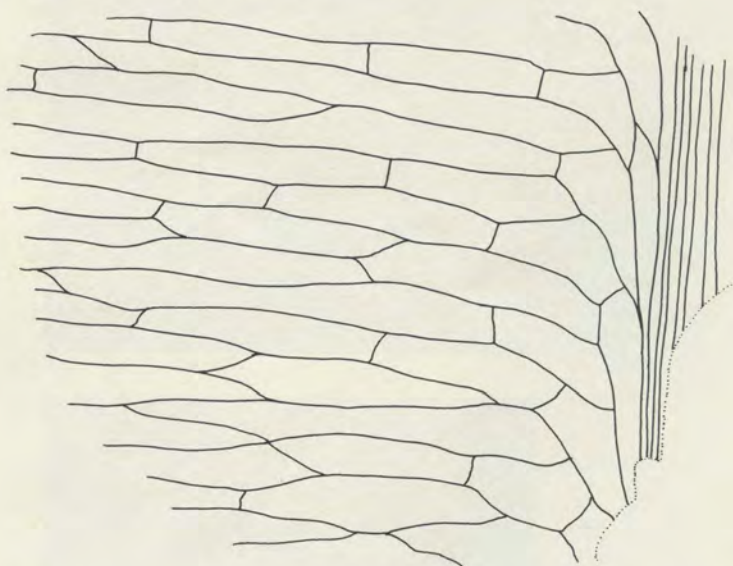


Figure 28. *Glossopteris divergens* Fstm. Portion of the frond (M.II.68) showing the short meshes near to the parallel middle veins. x2 approx.

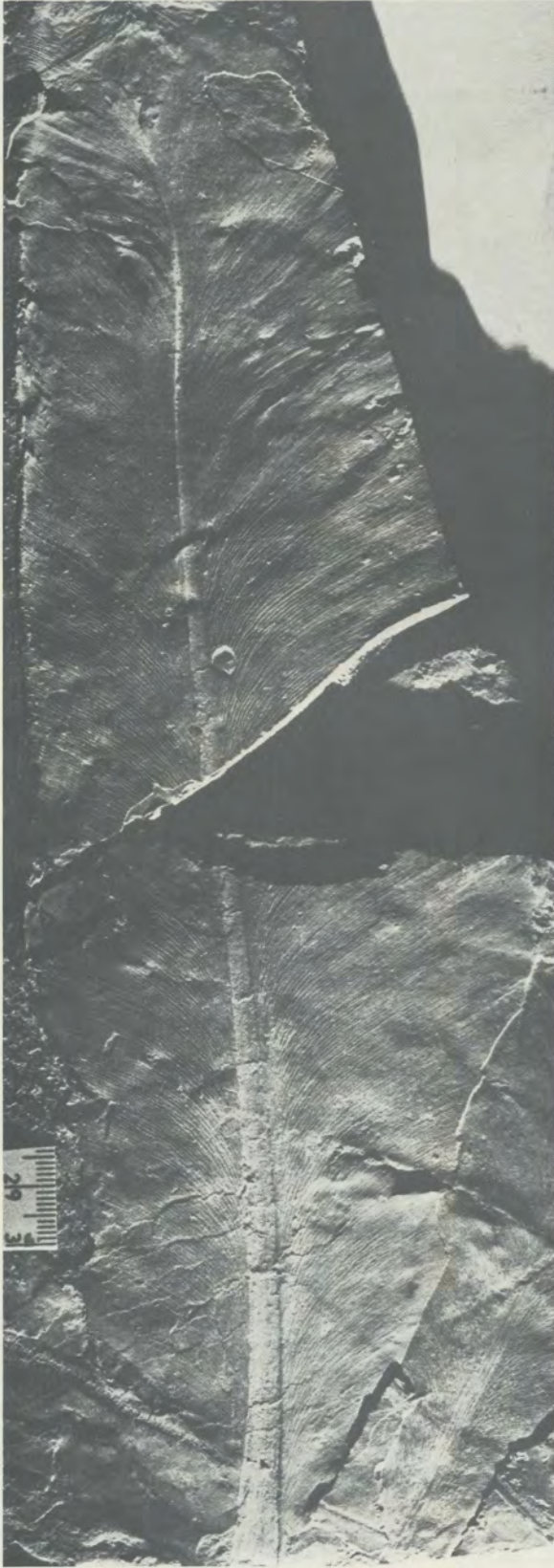
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PLATE I

Ia



Ib

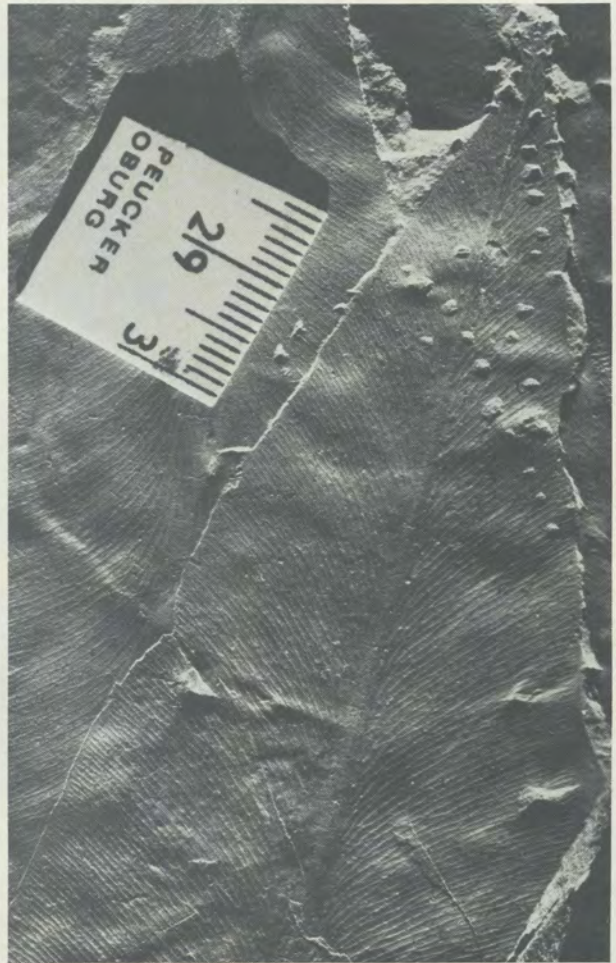


PLATE I

- (a) *Glossopteris ampla* Dana. Catalogue no. H.I. 171.
 (b) *Glossopteris communis* Feistmantel, apex. Catalogue no. H.I. 67.
 (c) *Glossopteris indica* Schimper, apex. Catalogue no. H.I. 102.

Ic



II a

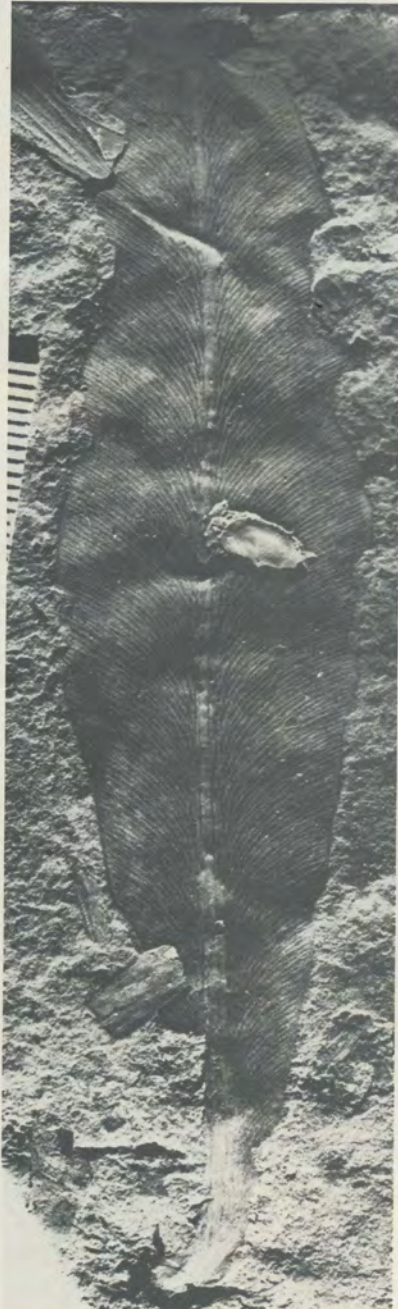


II c

PLATE II



II b



II c



II d

PLATE II

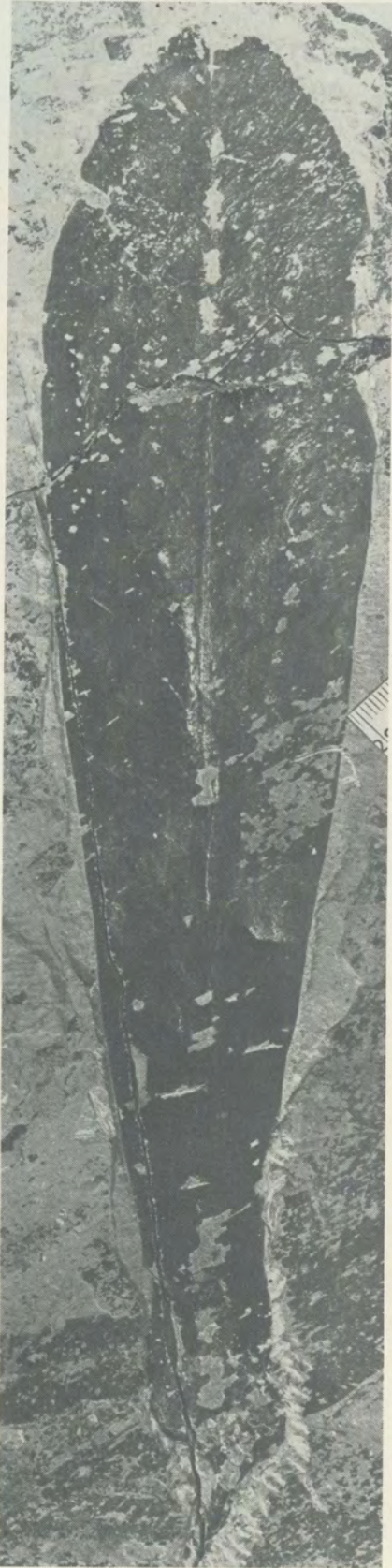
- (a) *Glossopteris pseudocommunis* Kovács paratypes, one apex, one base with petiole, an almost whole leaf, x1. Catalogue no. H.I. 29.
- (b) *Glossopteris pseudocommunis* Kovács, Holotype with the "Rubidgea" surface, Catalogue no. H.I. 103a.
- (c) *Glossopteris pseudocommunis* Kovács, Holotype, counterpart of H.I. 103a. Catalogue no. H.I. 103b.
- (d) *Glossopteris pseudocommunis* Kovács paratype with "fibres". Catalogue no. H.I. 172.
- (e) *Glossopteris taeniopteroides* Feistmantel, apex. Catalogue no. H.I. 150.

PLATE III

III b



III a



III c

PLATE III

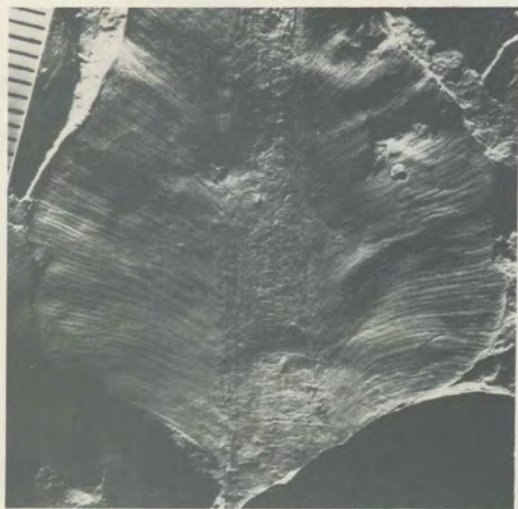
- (a) *Glossopteris taeniopteroides* Feistmantel. Catalogue no. H.II. 57a.
(b) *Glossopteris taeniopteroides* Feistmantel, apex, x2. Catalogue no. H.II. 160.
(c) *Glossopteris taeniopteroides* Feistmantel, two bases, one with fructification. Catalogue no. H.I. 4a.



IV b



IV c



IV a



IV d



IV e

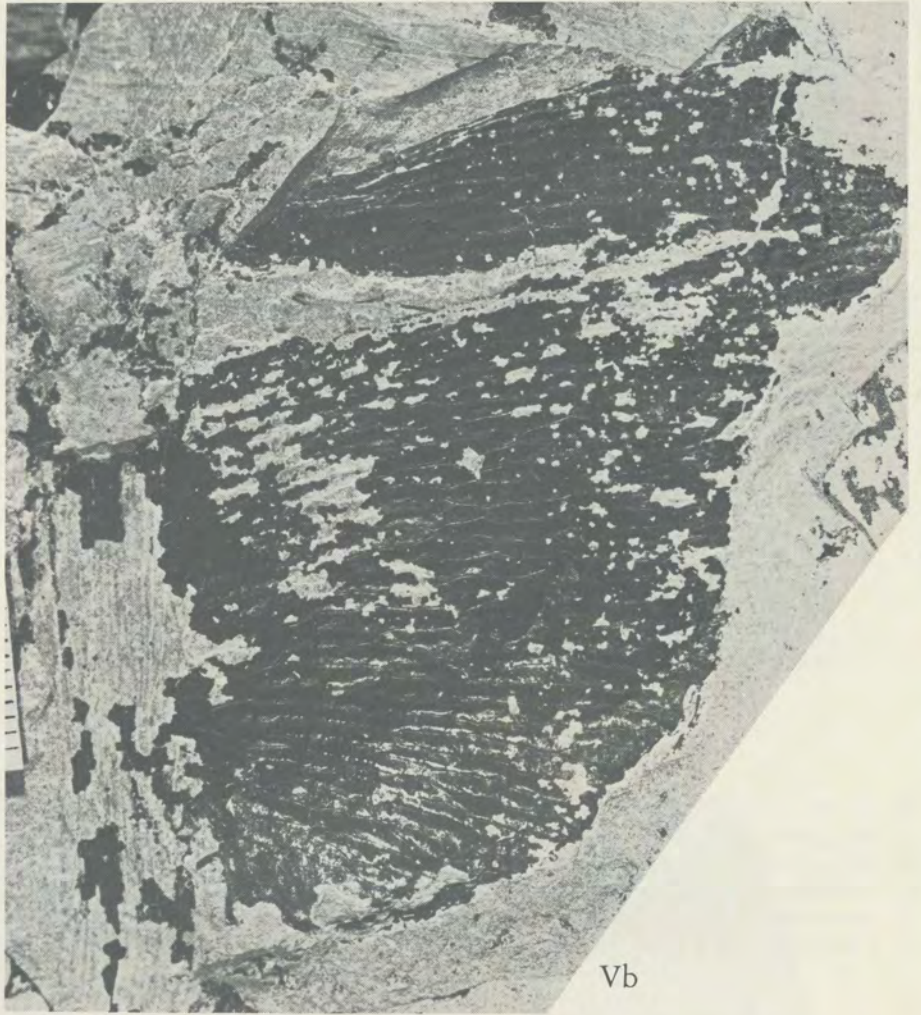
PLATE IV

PLATE IV

- (a) *Glossopteris taeniopteroides* Feistmantel, lyrate base. Catalogue no. H.I. 16.
- (b) *Glossopteris damudica* Feistmantel. Catalogue no. H.I. 126.
- (c) *Glossopteris damudica* Feistmantel, enlargement, showing "spurs". Catalogue no. H.I. 126.
- (d) *Glossopteris damudica* Feistmantel. Catalogue no. H.II. 174.
- (e) *Glossopteris browniana* Brongniart, x2. Catalogue no. H.I. 15.

PLATE V

Va



Vb



Vc

PLATE V

- (a) *Glossopteris divergens* Feistmantel, fragment with base. Catalogue no. M.II. 66.
- (b) *Glossopteris divergens* Feistmantel, base. Catalogue no. MII. 65.
- (c) *Glossopteris divergens* Feistmantel. Catalogue no. M.II. 67.

PLATE VI

VIa

VIb

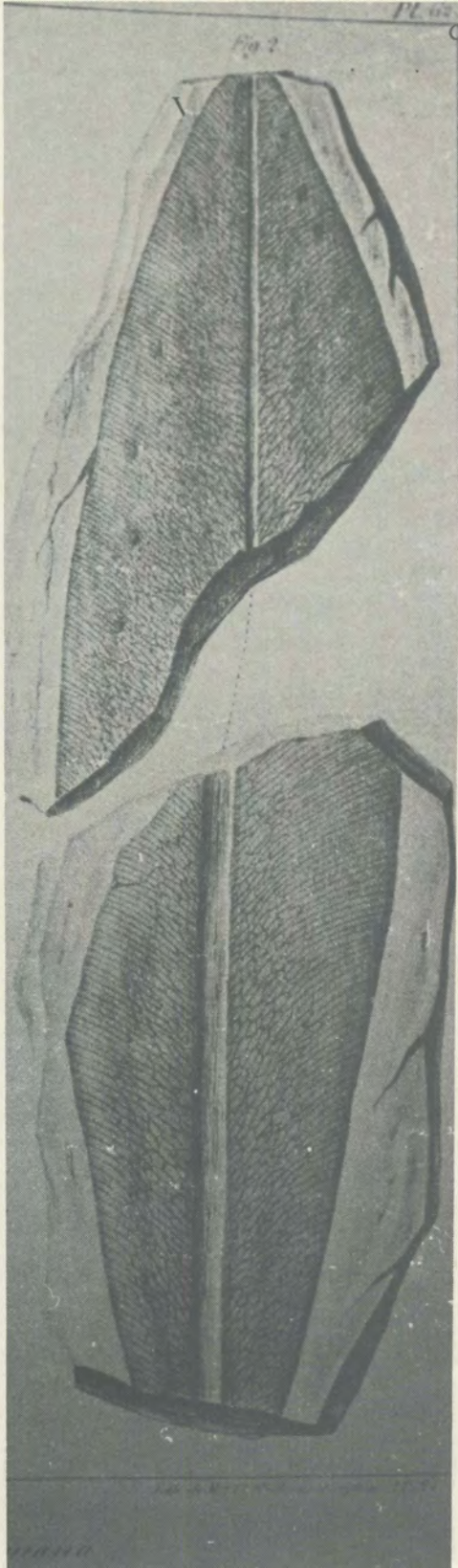


PLATE VI

(a) Holotype of *Glossopteris browniana* var. *indica* Brongniart, xl. No. 506, Muséum d'histoire naturelle, Paris, and (b) its drawing from: Brongniart, Hist. Végét. foss. 1830, Plate 67, Figure 2.