STUDIES IN THE GLOSSOPTERIS FLORA OF INDIA — 33. FOSSIL PLANTS AND MIOSPORES FROM THE COAL-BEARING BEDS OF THE UMARIA COALFIELD WITH SOME REMARKS ON THE AGE OF THE BEDS

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ABSTRACT

The age of the coal-bearing beds of the Umaria coalfield is an stratigraphical controversy in Indian Lower Gondwana System. Views have been expressed in the past by several workers to consider them as equivalent to the Barakar stage, however, others opined it to be Karharbari in age. The present investigations of the paleobotanical content of these beds suggest that they are more or less homotaxial to the Karharbari beds of the Giridih coalfield.

INTRODUCTION

FOSSIL plants from the coal-bearing beds of the Umaria coalfield have earlier been described by Feistmantel (1882) and Hughes (1884, 1885). The records of plant fossils are as follows:

Glossopteris indica.

Gangamopteris cyclopteroides var *attenuata.*

Recently Tripathi (1952) has recorded some megaspores from the coals of the coal-bearing beds.

The coal-bearing beds were considered to be more or less equivalent to the Karharbari stage of the Giridih coalfield (PASCOE, 1959; FEISTMANTEL, 1886; HUGHES, 1884). However, some workers like FOX (1931) and others considered the bed to be Barakar in age. Thus, a detailed palaeobotanical investigation of the plant contents of these beds was undertaken to throw some fresh light on the age discrepancy.

The Umaria coalfield is situated in between the latitudes N 23°36′-23°39′ and longitudes E 80°44′-80°47′, on the left bank of Umrar river, a tributary of Mahanadi. The Geology of the area (according to GEE, 1927; PASCOE, 1959; AHMAD, 1957) consists of the following formations:

Supra Barakars

--------Unconformity

Lower Gondwana { ?Karharbari or Barakar Stage; Umaria Marine Beds; Talchirs

--------Unconformity

Archaeans

The Umaria coalfield lies in an angular embayment of the gneissic outcrop caused by a N.E.-S.W. fault and is separated by one tongue of the gneiss by this fault. Talchirs occur to the South-West of the coal-bearing rocks and in this direction lies upon the gneiss. The next beds are marine beds of Lower Permian, found lying conformable upon the Talchirs (AHMAD, 1957, 1961) containing the fauna of *Avicaulopecten* sp., *Eurydesma* and *Pleurotomaria.* These beds are succeeded with the conformable coal-bearing rocks, which according to Pascoe (1959) corresponds more or less to the Karharbari beds. The coal-bearing beds are covered by Supra Barakars which are possibly of Raniganj Stage, and these by the Upper Gondwana deposits.

DESCRIPTION

A. FOSSIL PLANTS

The plant fossils described below were collected from the outlying shale dumps of the New Umaria colliery, Umaria coalfield. The plant remains are preserved on black fine grained carbonaceous shales. The preservation of the plant fossils is not very satisfactory. In some cases the impressions have a carbonized crust but, it does not yield any cuticle.

Gangamopteris cyclopteroides Feistmantel

Pl. 1, Figs. 1, 2

There are about thirty specimens in the collection and all of them are incomplete. In most of the specimens only the middle part of the leaves is preserved. The median region of the leaf is occupied by subparallel veins with interconnections. From them arise arched secondary veins, they coalesce together and form broad elongate meshes towards the median region and narrow elongate meshes towards the margin. The margin is entire.

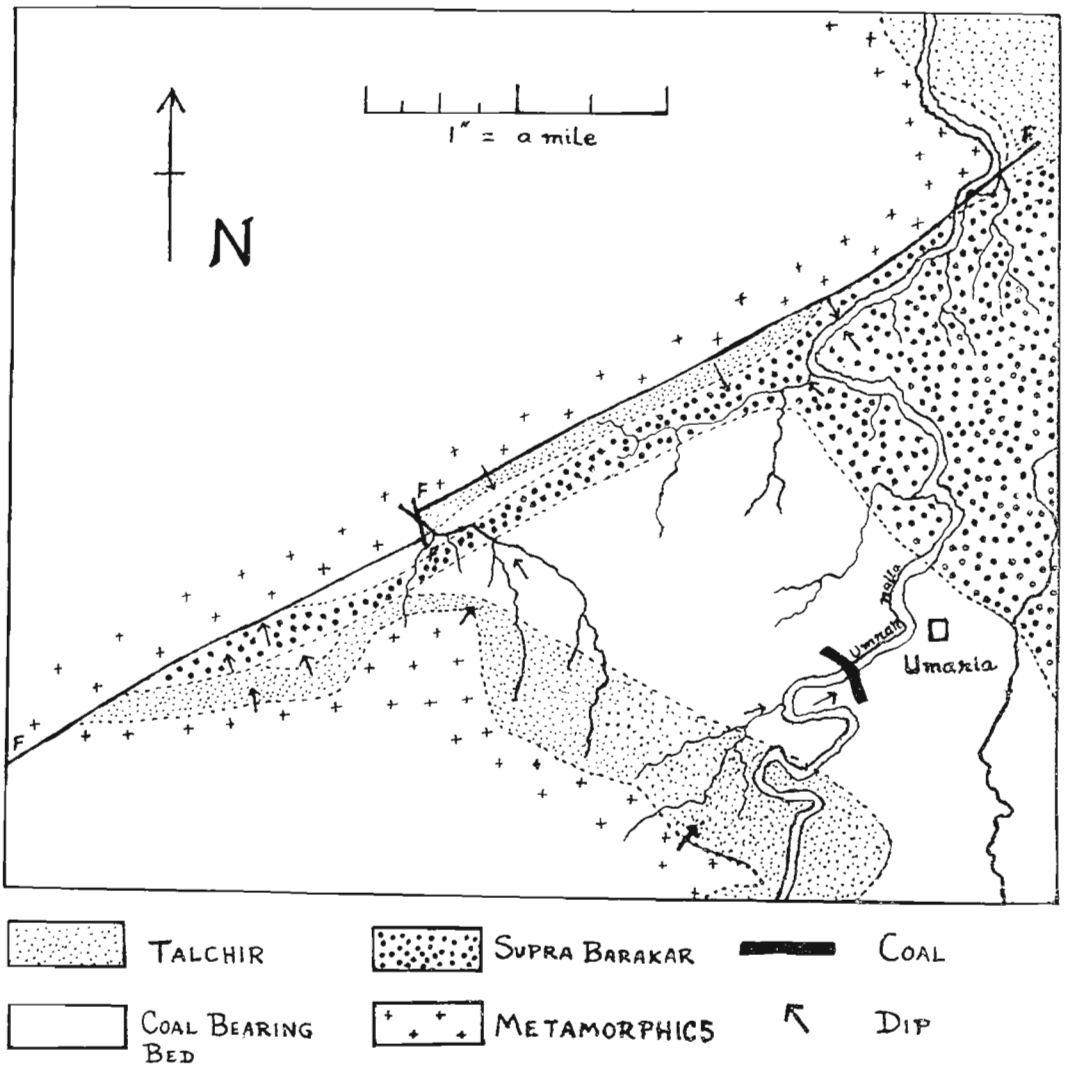
The specimens compare well in their venation characters with *G. cyclopteroides* Feistmantel (1879, PL. 13, FIGS. 1, 5) described from the Karharbari stage of the Giridih coalfield.

Glossopteris indica Schimper

Pl. 1, Fig. 3

Only few specimens are in the collection and all of them are incomplete. The one figured here in Pl. 1, Fig. 3, is 6·2 cm. long and 2·5 cm. broad. The leaf has a tapering base. The median region is occupied by a midrib, which is deeply striated. From the midrib arise arched secondary veins. They coalesce together and form short-narrow meshes towards the median region and elongate-narrow meshes towards the margin of the leaf. The margin is entire.

The specimens from the Umaria coal-bearing beds compare well with the figures of Feistmantel (1881, PL. 25A, FIGS. 1, 2) from the Raniganj stage.



TEXT-FIG. 1 — Map showing the geological sequence in the Umaria coalfield, South Rewa Gondwana basin.

Noeggerathiopsis sp.

Pl. 1, Fig. 4

Only a solitary specimen is in the collection. The specimen is incomplete and only the basal part is preserved. The specimen is 6·2 cm. long and 2·4 cm. broad. The leaf base is tapering. A number of prominent veins arise from the base and go straight up in slightly diverging manner. They are seen dichotomizing during their upwards course. The density of veins is 18 per cm.

In past a large number of incomplete specimens of *Noeggerathiopsis* have been assigned by various workers to *N. hislopii* (Bunb.) Feistm. But the recent cuticular studies of *Noeggerathiopsis* by Lele & Maithy (1964) and Pant & Verma (1964) have shown that the species is heterogenous, and the assignment of incomplete forms to any definite species is not free from doubt. Therefore, the present form is referred under *Noeggerathiopsis* sp.

Cordaicarpus zeilleri Maithy

Pl. 1, Fig. 5

There are a large number of seeds in the collection. The seeds are 1·5 × 1·2 cm. in size; ovate in shape with a cordate base and obtuse apex. Sarcotesta has several faint longitudinal striations. A narrow border (?sclerotesta) encircles the sarcotesta.

The seeds from the Umaria coal-bearing beds compare well with the type specimen of *Cordaicarpus zeilleri* Maithy described from the Karharbari beds, Giridih coalfield (1965a, PL. 1, FIGS. 1, 3).

cf. *Gondwanidium* sp.

Pl. 1, Fig. 6

Only a solitary pinnule, 1·5×1·5 cm., ovate shape with contracted base, obtuse apex and entire margin with several dichotomizing, curved and spreading veins. This specimen agrees in its shape with *Gondwanidium*, however, in view of its solitary pinnule a detailed comparison is not possible.

Equisetalean stems

Pl. 1, Fig. 7

The collection includes a large number of leafless equisetaceous stems with continuous ridges and grooves. The absence of leaves make the generic assignment difficult, however, the record in the collection is quite important, because it signifies the presence of equisetalean remains.

B. SPORES AND POLLEN

Shales were macerated to isolate the miospores by the method followed by Bharadwaj (1962). The taxonomic treatment of spores have been done according to the system proposed by Potonié (1956, 1958) and Bharadwaj (*l.c.*).

TAXONOMIC DESCRIPTION

Anteturma — *Sporites H.* Potonié
Turma — *Triletes* (Rein) Pot. & Kr.
Subturma — *Azonotriletes* Luber
Infraturma — *Laevigati* (Benn. & Kidst.) Pot.

***Punctatisporites* (Ibr.) Pot. & Kr.**

Punctatisporites sp.

Pl. 1, Fig. 8

Size 100-130 μ, spore $\pm$ circular-triangular in outline, exine intrapunctate, Y-mark distinct, rays attaining nearly to equator. Only few grains are represented in the assemblage.

Infraturma — *Apiculati* (Benn. & Kidst.) Pot.

***Cyclogranisporites* Pot. & Kr.**

Cyclogranisporites sp.

Pl. 1, Fig. 9

Only few grains are in the assemblage, size 40-60 μ, spore $\pm$ circular in outline, exine surface covered with grana, Y-mark distinct, rays extending $\pm$ to equator, rays are $\pm$ equal in size.

Anteturma — *Pollenites* R. Pot.
Turma — *Saccites* Erdt.
Subturma — *Monosaccites* (Chita.) Pot. & Kr.
Infraturma — *Apertacorpiti* Lele

***Plicatipollenites* Lele**

Plicatipollenites indicus Lele

Pl. 2, Fig. 11

These grains are rare in the assemblage. Size range 130-150 μ, outline $\pm$ circular, body outline $\pm$ circular, weakly defined, structure finely intramicroreticulate; Y-mark $\pm$ clear, rays $\pm$ equal, extending $\pm$ 1/2 body radius; saccus $\pm$ circular, fairly

wide, usually more than 1/2 body radius; body infold system ± circular, subdued, situated touching the body margin, sac structure finely reticulate.

The spores are organizationally similar with those of *P. indicus* Lele (1964, PL. 1, FIGS. 7-9) described from the Talchirs of the South Rewa Gondwana basin.

Plicatipollenites gondwanensis Lele

Pl. 1, Fig. 10

The spores are rare in the assemblage. Size range 130-150 μ, outline ± circular, body outline ± circular, thin, exine finely intramicroreticulate; Y-mark weakly developed or invisible, rays ± equal, extending ± 1/2 body radius; saccus ± circular, usually more than 1/2 body radius, distal saccus overlap is ± 1/3 body radius; body infold system well developed, typically polygonal; saccus intrareticulate; muri tend to be radially elongated, outline of saccus ± undulated.

The spores compare well with the forms of *P. gondwanensis* Lele (1964, PL. 2, FIG. 11) from the Talchirs of the South Rewa Gondwana basin and by Maithy (1965e) from the Karharbari beds, Giridih coalfield.

***Virkkipollenites* Lele**

Virkkipollenites mehtae Lele

Pl. 2, Fig. 12

This grain is frequently recorded in the assemblage. Size range 80-120 μ; outline ± circular; body circular, outline of the body distinct, exine intramicroreticulate; Y-mark distinct or indistinct, rays ± equal, extending ± 1/2 body radius. Saccus ± circular, distal zone of saccus attachment distinct, saccus width ± 1/2 body radius, surface frilled, outline undulated, muri of the sac intrareticulum tending to be radially arranged.

The present spores recorded from the coal-bearing beds of Umaria compare well with *V. mehtae* Lele (*l.c.* PL. 2, FIG. 16) described from the Talchirs of the South Rewa Gondwana basin and by Maithy (1965e) from the Karharbari beds, Giridih.

Virkkipollenites obscurus Lele

Pl. 2, Figs. 13-15

The spores are fairly common in the assemblage. Size range 110-140 μ, outline of spore ± circular or circular oval; body thin, outline diffused, saccus ornamentation intramicroreticulate; Y-mark obscure to invisible, rays ± unequal, extending 1/2 body radius, saccus narrow, usually ± 1/2 body radius, structure fine intrareticulate, distal saccus overlap narrow, zone of attachment ± indistinct, frills uncommon.

The present spores compare well with *V. obscurus* Lele (1964) from the Talchirs of South Rewa Gondwana basin and Maithy (1965e) from the Karharbari beds, Giridih coalfield. *Virkkipollenites* was proposed by Lele for the grains having the saccus attachment equatorial on the proximal side and subequatorial on the distal side. In the same year Bharadwaj & Tiwari (1964b) proposed another generic name *Parasaccites* for spores looking superficially similar, but with a different saccus attachment, i.e.; the saccus attached on both the sides of the body subequatorially. In badly preserved grains it becomes extremely difficult to identify the generic entity of these grains. However, in well preserved grains it is possible to mark the zones of saccus attachment. In the present assemblage, grains with both the types of organization are present and on a careful examination one can distinguish them easily. In *Virkkipollenites* one can mark under different focus the saccus attachments. On the proximal surface of the spore the saccus attachment is on the equator of the body (PL. 2, FIG. 15) and on the distal side the saccus is attached subequatorially (PL. 2, FIG. 14) on the body. But, in *Parasaccites* under different focus one marks that the saccus is attached subequatorially on both the sides of the body.

Infraturma — *Amphisacciti* Lele

***Parasaccites* Bharadwaj & Tiwari**

Parasaccites karharbarensis Maithy

Pl. 3, Figs. 18 & 19

Spores are fairly common in the assemblage. Size range 110-140 μ, outline of spore ± circular or circular-oval, body, thin, outline distinct, exine finely intramicroreticulate; Y-mark obscure to indistinct; rays ± equal, extending ± 1/2 body radius; saccus narrow, ± 1/2 body radius, saccus attachment subequatorial both on the proximal and distal side of the body, leaving a ± circular saccus free body area, zone of

saccus overlap ± 1/3 of the body diameter, saccus exine intrareticulate, surface frilled, outline undulated.

The spores from the coal-bearing beds of Umaria are organizationally similar to *P. karharbarensis* Maithy (1965e) recorded from the Karharbari stage of the Giridih coalfield.

Crucisaccites Lele & Maithy

Crucisaccites monoletus Maithy

Pl. 3, Fig. 22

Spores are frequently recorded in the assemblage. Size range 100-150 μ, outline ± oval, body thin, outline obscure. Saccus exine finely intrareticulate, mark indistinct, saccus narrow more or less uniformly wide, ± 1/4 body diameter, saccus attachment subequatorial on both the sides of body, leaving a ± oval saccus free body area, zones of attachment are crossed at right angles to each other; saccus exine intrareticulate, surface smooth, outline entire.

The spores are organizationally similar to *Crucisaccites monoletus* Maithy (1965e, Pl. 3, Figs. 17, 18) described from the Karharbari stage of the Giridih coalfield.

Stellapollenites Lele

Stellapollenites talchirensis Lele

Pl. 2, Figs. 16, 17

Spores are frequently recorded in the assemblage. Size range 110-160 μ, outline ± circular or circular-triangular, body thin, distinct, outline well marked, ± circular, exine intramicroreticulate, no mark is perceptible, saccus narrow, ± 1/4 body radius, zones of saccus attachment amphilateral, radially symmetrical, triangular leaving a correspondingly broad triangular saccus-free area around the poles; amphilateral attachment zones mutually reversed in position; saccus structure intrareticulate, surface smooth, margin entire.

The grains from the coal-bearing beds of Umaria are organizationally similar to *S. talchirensis* Lele (1965, Pl. 1, Figs. 1, 2) described from the Talchirs of the South Rewa Gondwana basin. So far this genus was known only from the Talchir stage of India. It is the first record from beds younger than the Talchirs.

Vesicaspora (Schm.) Wilson & Venkatachala

Vesicaspora sp.

Pl. 3, Fig. 23

The grains are frequently recorded in the assemblage. Size range 90-110 μ; outline ± circular; body ± oval faintly discernible, exine finely intramicroreticulate; saccus attachment amphilateral (Sensu Lele 1965), subequatorial, leaving a ± vertical saccus free area on both the sides of the body, zones of attachment are at the same plane on both sides of the body; saccus exine intramicroreticulate in structure.

Infraturma — *Vesiculomonoraditi* Bharadwaj

Vestigisporites Balme & Hennelly

Vestigisporites diffusus Maithy

Pl. 3, Fig. 20

Spores are fairly common in the assemblage, size range 110-130 μ; outline ± oval; body ± circular or vertically oval, thin walled, outline distinct, exine finely intramicroreticulate; monolete mark obscure to indistinct, a faint transverse slit, extending ± 1/2 body radius. Saccus longer along the horizontal axis and narrower along the the vertical axis, attachment subequatorial distally, exine intramicroreticulate, surface smooth, outline entire.

The spores compare well with *V. diffusus* Maithy (1965e) recorded from the Karharbari beds of the Giridih coalfield.

Potonieisporites Bharadwaj

Potonieisporites neglectus Potonié & Lele

Pl. 3, Fig. 21

Spores are rare in the assemblage; size range 170-190 μ; monosaccate ± oval in outline; body distinct ± circular-oval in outline, exine intramicroreticulate; sometimes a monolete mark is perceptible. Saccus encircles the body, attachment equatorial on the proximal and subequatorial on the distal side. Saccus narrow along the vertical axis and broad along the horizontal axis. Body infold well developed ± tetragonal in shape. Saccus ornamentation intrareticulate, muri and lumina are of equal thickness.

The spores are organizationally similar to *Potonieisporites neglectus* Potonié & Lele

(1960) described from the Talchirs of South Rewa Gondwana basin and by Maithy (1965e) from the Karharbari stage of the Giridih coalfield.

Subturma —*Disaccites* Cookson
Infraturma—*Striatiti* (Pant) emend. Bharadwaj

***Striatites* Pant emend. Bharadwaj**

Striatites sp.

Pl. 4, Fig. 24

Spores are rare in the assemblage. Size range 160-180 μ, diploxylonoid grain, body $\pm$ oval, thin, distinct, exine microverrucose with several transverse striations connected by interconnections. Sacci hemispherical, distal zone of saccus attachment sub-equatorial, full length, leaving a narrow saccus free area. Zones of attachment are associated with body folds. Saccus exine intrareticulate.

***Faunipollenites* Bharadwaj**

Faunipollenites varius Bharadwaj

Pl. 4, Fig. 25

Spores are fairly common in the assemblage. Size range 140-170 μ; outline $\pm$ oval, haploxylonoid, body thin, outline diffused, faintly discernible, vertically oval, exine intramicroreticulate with 10-12 transverse striations. Saccus hemispherical, zones of attachment subequatorial, saccus free area narrow, saccus exine intrareticulate.

These grains are comparable with *F. varius* Bharadwaj (1960, PL. 18, FIG. 230) recorded from the Raniganj stage and Maithy (1965e, PL. 6, FIG. 39) from the Karharbari stage, Giridih.

Faunipollenites goraiensis (Pot. & Lele) Maithy

Pl. 4, Fig. 25

The spores are fairly common in the assemblage. Size range 130-150 μ, outline $\pm$ circular, haploxylonoid, body outline indistinct and only marked by the ends of striations. Body exine intramicroreticulate with 8-11 horizontal striations with few vertical connections. Saccus attachment obscure. Distal saccus free body area $\pm$ straight. Saccus exine intrareticulate, muri and lumina are of equal width.

The spores are organizationally similar to *Faunipollenites goraiensis* (POTONIÉ & LELE) Maithy (1965e) described from the Karharbari stage, Giridih coalfield.

***Stoterosporites* Wilson**

Stoterosporites sp.

Pl. 4, Fig. 27

Only few grains are in the assemblage, size range 110-130 μ, diploxylonoid, body $\pm$ circular, thin, exine finely intramicroreticulate, body has several transverse striations with interconnections. Saccus attachment subequatorial, distal saccus free body area is narrow, exine intrareticulate.

***Rhizomaspora* Wilson**

Rhizomaspora sp.

Pl. 4, Fig. 28

Only few grains are in the spore assemblage. Size range 120-150 μ; body thin, outline $\pm$ circular, exine intrareticulate; body has reticuloid striations; saccus attachment zone diffused, subequatorial, laterally the saccus are closely placed, saccus exine intrareticulate.

Turma — *Polyplicates* Erdtman
***Welwitschiapites* Bolchowitina**

Welwitschiapites magnus Maithy

Pl. 4, Fig. 29

Size range 110-130 μ, outline $\pm$ oval, exine externally smooth, internally microverrucose, several longitudinal striations run parallel to long axis all round the body with several interconnections, exine 2 μ thick, outline of spore smooth. The spores compare with the grains described by Maithy (1965e) from the Karharbari beds, Giridih.

DISCUSSION

The age of the coal-bearing beds of the Umaria coalfield has remained a stratigraphical controversy in the Indian Lower Gondwana succession. Fox (1931), Gee (1927) and Ahmad (1957) considered it to be equivalent to the Barakars. In contrary to this Feistmantel (1882) and Pascoe (1959) regarded it to be corresponding to the Karharbari stage.

A critical analysis of the plant assemblage of the Umaria coal-bearing beds show

that the representation of number of plant fossil genera is poor. The fossil plants show a dominance of *Gangamopteris* and *Cordaicarpus*. Besides, the record of cf. *Gondwanidium* is quite interesting and further search for this fossil plant is needed in these beds.

The miospore flora is represented by 15 genera and 18 species. The miospore assemblage shows the characteristic dominance of monosaccate grains. Disaccate and alete grains are comparatively rare. Trilete genera are very scarce, and zonate and monolete ones are absent. Among the miospore *Virkkipollenites, Parasaccites, Stellapollenites, Crucisaccites, Vestigisporites* and *Faunipollenites* are most dominant genera. *Plicatipollenites, Potonieisporites, Striatites, Rhizomaspora, Vesicaspora* and *Welwitschiapites* are next in order. *Punctatisporites, Cyclogranisporites* and *Stotersporites* are rare.

Fossil plants from the Barakar stage of India have been described by Feistmantel (1881, 1886), Surange & Prem Singh (1953), Dutta (1957), Bhattacharya, D. (1958), Bhattacharya, B. (1958), Ganguly (1958a, b) and Surange & Maithy (1962, 1963). The Barakar flora is represented by the genera *Schizoneura, Phyllotheca Sphenophyllum, Sphenopteris, Gangamopteris, Glossopteris, Noeggerathiopsis, Rhabdotaenia, Walkomiella, Rhipidopsis, Barakaria, Samaropsis, Indoxylon, Barakaroxylon* and *Dadoxylon*. The Barakar flora shows the dominance of *Glossopteris* and *Rhabdotaenia*. *Sphenophyllum* and *Sphenopteris* are also fairly common. In contrast to this the flora of the coal-bearing beds of Umaria is comparatively much poorer in representation of the *Glossopteris*. Besides, the dominant and characteristic genera *Walkomiella, Sphenophyllum, Barakaria* and *Sphenopteris* of the Barakars are absent. The genus *Cordaicarpus* a dominant element in the Umaria coal-bearing beds is also not known so far from the Barakars.

The miospore flora of the Barakars has recently been described in detail by Bharadwaj & Tiwari (1964a, b) and Tiwari (1964). The miospores of the coal-bearing beds compare with Barakars by the common occurrence of *Punctatisporites, Cyclogranisporites, Plicatipollenites, Virkkipollenites, Parasaccites, Potonieisporites, Vestigisporites, Striatites, Rhizomaspora, Stotersporites, Faunipollenites* and *Welwitschiapites*. However, in contrast to this the miospore assemblage of the Barakars is comparatively more divergent and much richer in number of species and genera. The flora in addition to the monosaccate grains are dominated by trilete, zonate and disaccate grains. The zonate grains are unknown from the Umaria coal-bearing beds and trilete and disaccate grains are scarce. Furthermore, the typical genera *Crucisaccites* and *Stellapollenites* of the coal-bearing beds are absent in the Barakar assemblage.

In recent years the plant fossils and miospores from the Karharbari stage, Giridih coalfield have been described by Maithy (1965a-f). This study indicates that the Karharbari flora occupies an intermediate position in between the underlying Talchir flora and the overlying Barakar flora, however, more closely related to the former one. The plant fossils from the coal-bearing beds of the Umaria are, though, poorer in content still show a close resemblance to the Karharbari flora of the Giridih by the common occurrence of *Gangamopteris cyclopteroides, Glossopteris indica, Noeggerathiopsis* sp., *Cordaicarpus zeilleri* and cf. *Gondwanidium*. Both the flora shows a close comparison by the dominance of *Gangamopteris* leaves and gymnospermic seeds. Thus, the plant fossils of the coal-bearing beds of Umaria show a closer floral affinity with the Karharbari stage flora of the Giridih coalfield.

The miospores of the coal-bearing bed show a close resemblance with that of Karharbari by the common occurrence of *Punctatisporites, Cyclogranisporites, Plicatipollenites, Virkkipollenites, Parasaccites, Crucisaccites, Vesicaspora, Potonieisporites, Vestigisporites, Rhizomaspora, Striatites, Faunipollenites* and *Welwitschiapites*. Both the floras show a dominance of monosaccate and imperfectly disaccate grains, rareity of trilete grains and absence of zonate grains. In both the assemblages the spores with amphilateral saccus attachment are common. However, the Karharbari flora is comparatively much diversified and is richer in number of species and genera. The Karharbari flora shows a dominance of *Plicatipollenites, Potonieisporites* and *Lunatisporites* in addition to the genera mentioned dominant in the coal-bearing beds of the Umaria coalfield. The genus *Stellapollenites* is so far known only from the Talchir stage and its presence suggests

that the coal-bearing beds of Umaria are comparatively older than the Karharbari beds of the Giridih coalfield.

Thus, the above comparison suggests that the flora of coal-bearing beds of the Umaria coalfield are, though, poorer in plant fossil contents, still it compares more to the Karharbari flora of the Giridih coalfield, and its assignment to the Karharbari stage for the present seems to be much justifiable. The poorer content of the plant fossils and miospores in this flora may be due to the ecological condition which prevailed during this period. It is well known in the Umaria coalfield after the Talchir period an marine transgression took place and after this coal-beds have been deposited. This marine intrusion may have effected a severe condition for the development and growth of the plants. Further detailed palaeobotanical investigations and a better understanding of the geology of the various formations in this area may throw more light on this aspect.

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EXPLANATION OF PLATES

(*All the specimens and slides are preserved at the Museum of the Birbal Sahni Institute of Palaeobotany*)

PLATE 1

1. *Gangamopteris cyclopteroides* Feistmantel, Specimen No. 33091/563. × 1.
2. *Gangamopteris cyclopteroides* Feistmantel, Specimen No. 33093/563. × 1.
3. *Glossopteris indica* Schimper, Specimen No. 33092/563. × 1
4. *Noeggerathiopsis* sp., Specimen No. 33094/563. × 1
5. *Cordaicarpus zeilleri* Maithy, Specimen No. 33096/563. × 1.
6. Cf. *Gondwanidium* sp., Specimen No. 33095/563. × 1.
7. Equisetalean stem, Specimen No. 33090/563. × 1
8. *Punctatisporites* sp., Slide No. 2370. × 500.
9. *Cyclogranisporites* sp., Slide No. 2366. × 500.
10. *Plicatipollenites gondwanensis* Lele, Slide No. 2366. × 500.

PLATE 2

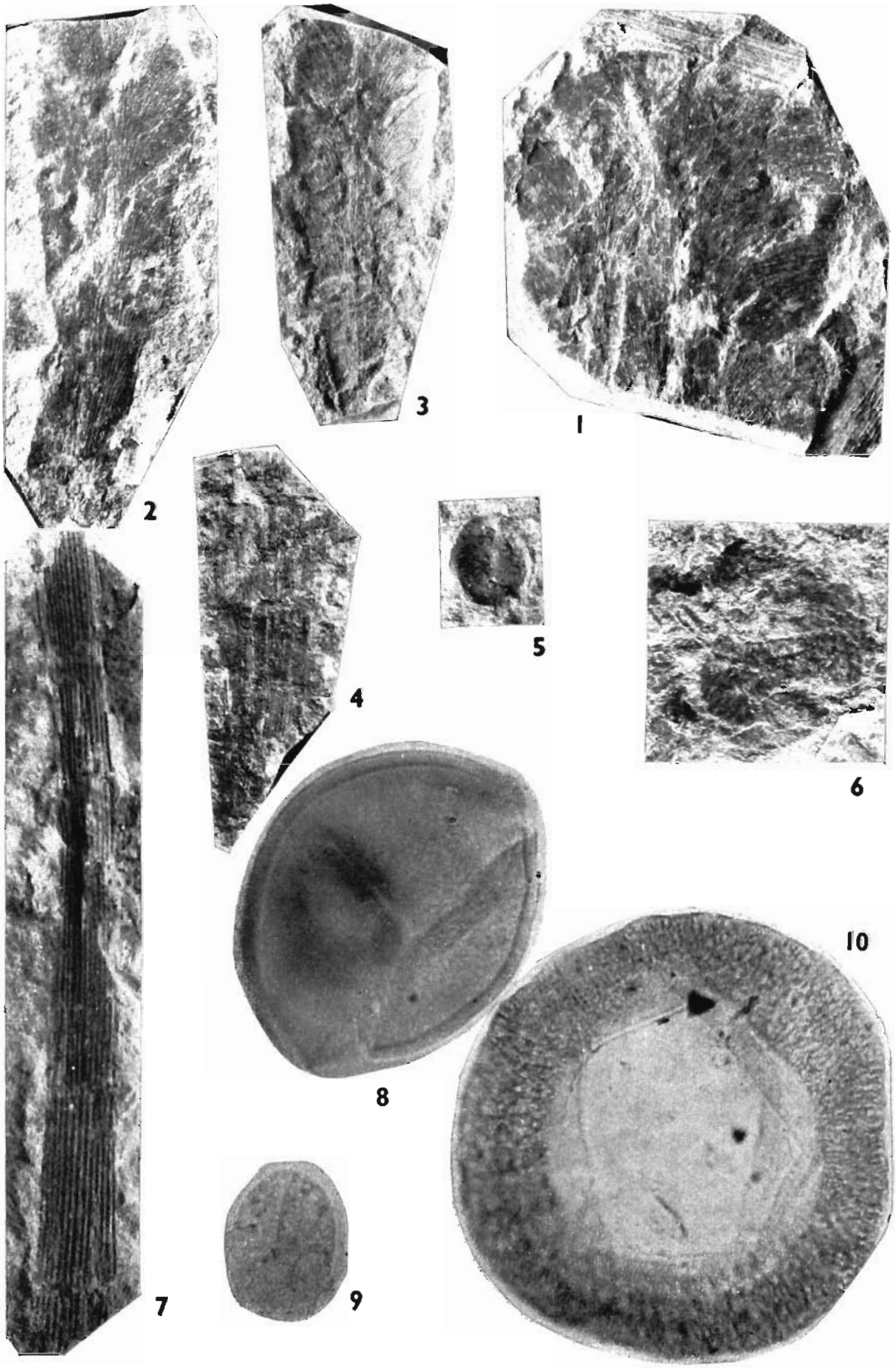
11. *Plicatipollenites indicus* Lele, Slide No. 2370. × 500.
12. *Virkkipollenites mehtae* Lele, Slide No. 2370. × 500.
13. *Virkkipollenites obscurus* Lele, Slide No. 2367. × 500.
14. *Virkkipollenites obscurus* Lele, A part of the spore enlarged showing subequatorial attachment of saccus on the body × 1000.
15. *Virkkipollenites obscurus* Lele, A part of the spore showing proximal side under focus the body and equatorial attachment of the saccus. × 1000.
16, 17 *Stellapollenites talchirensis* Lele, Slide No. 2366. × 500.

PLATE 3

18, 19. *Parasaccites karharbarensis* Lele, Slide No. 2366. × 500.
20. *Vestigisporites diffusus* Maithy, Slide No. 2366. × 500.
21 *Potonieisporites neglectus* Potonié & Lele, Slide No. 2370. × 500.
22. *Crucisaccites monoletus* Maithy, Slide No. 2366. × 500.
23. *Vesicaspora* sp., Slide No. 2369. × 500.

PLATE 4

24. *Striatites* sp., Slide No. 2366. × 500.
25. *Faunipollenites varius* Bharadwaj, Slide No. 2369. × 500.
26. *Faunipollenites goraiensis* (Pot. & Lele) Maithy, Slide No. 2369. × 500.
27 *Stoterosporites* sp., Slide No. 2366. × 500.
28. *Rhizomaspora* sp. Slide No. 2369 × 500.
29. *Welwitschiapites magnus* Maithy, Slide No. 2369. × 500.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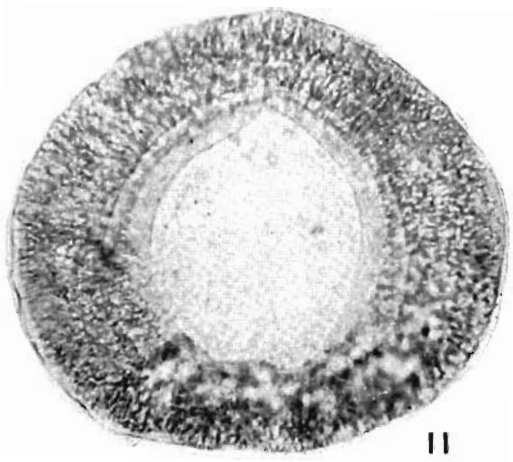

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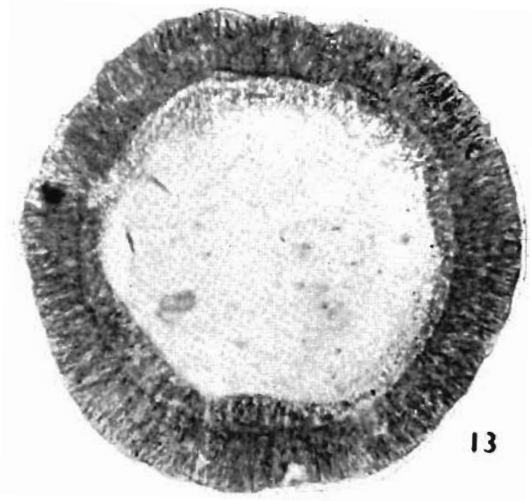

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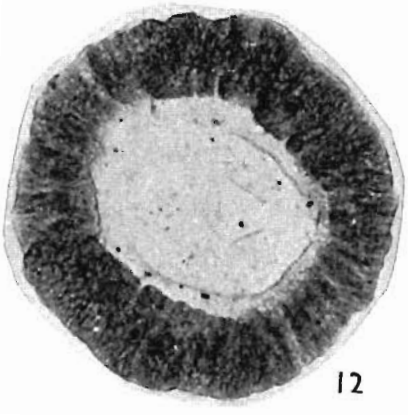

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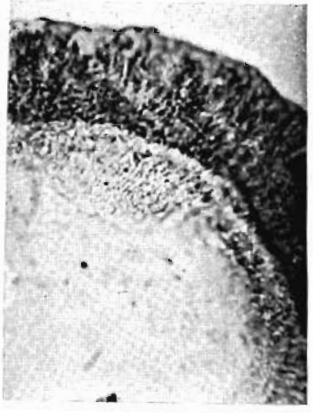

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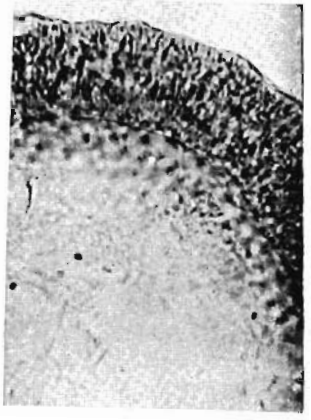

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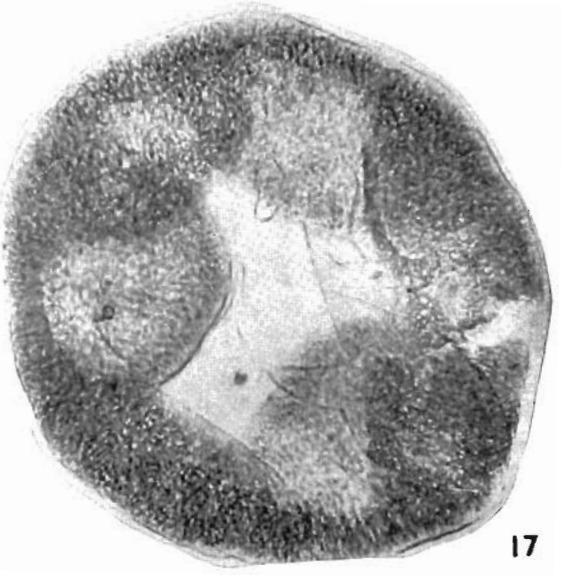

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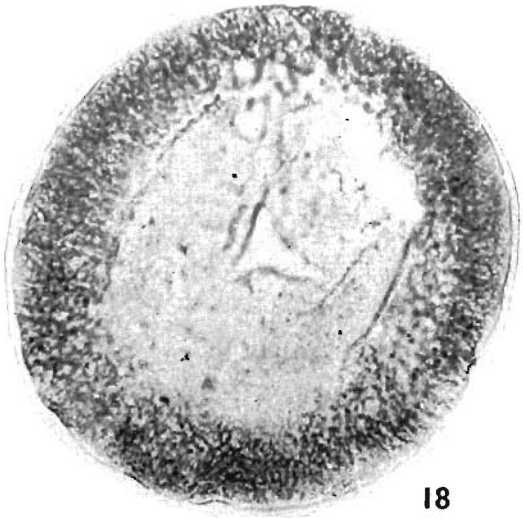

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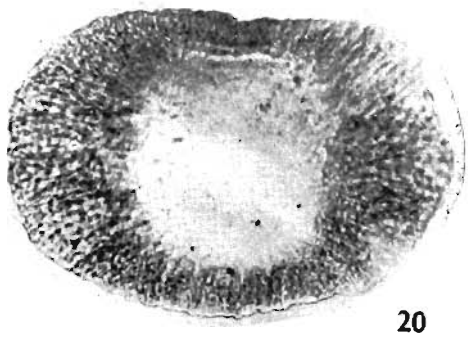

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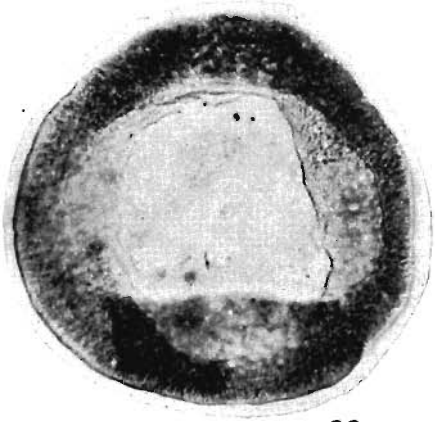

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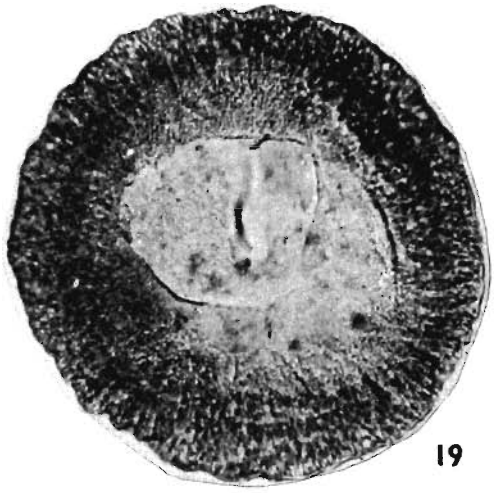

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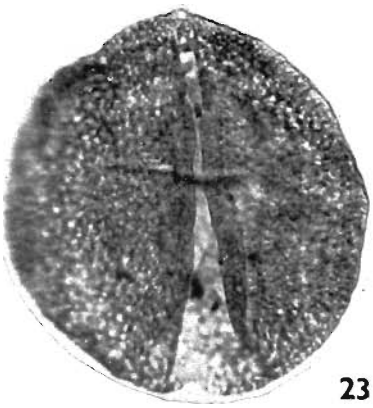

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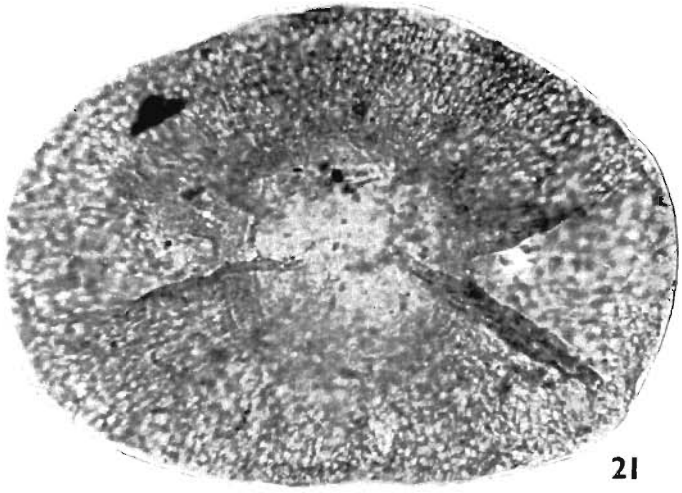

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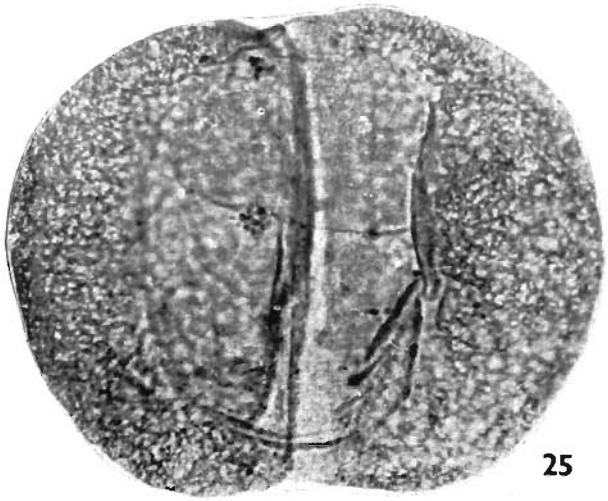

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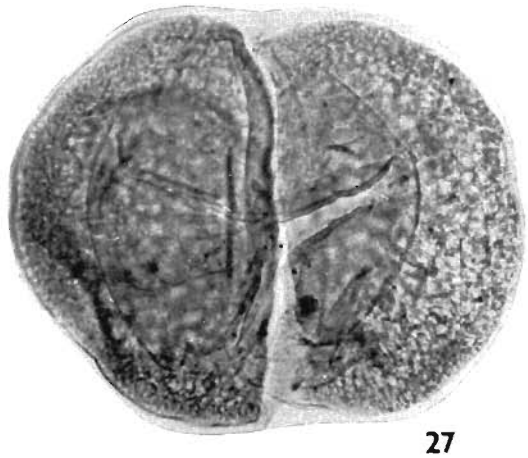

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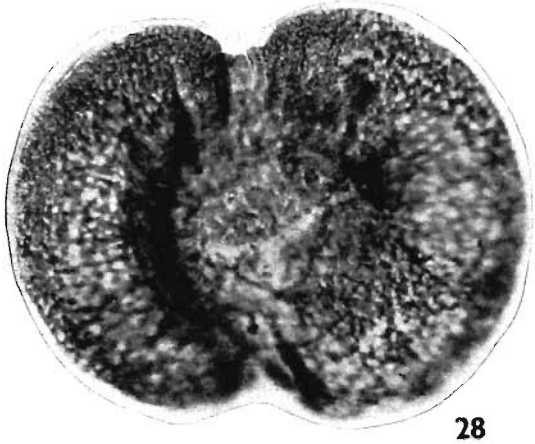

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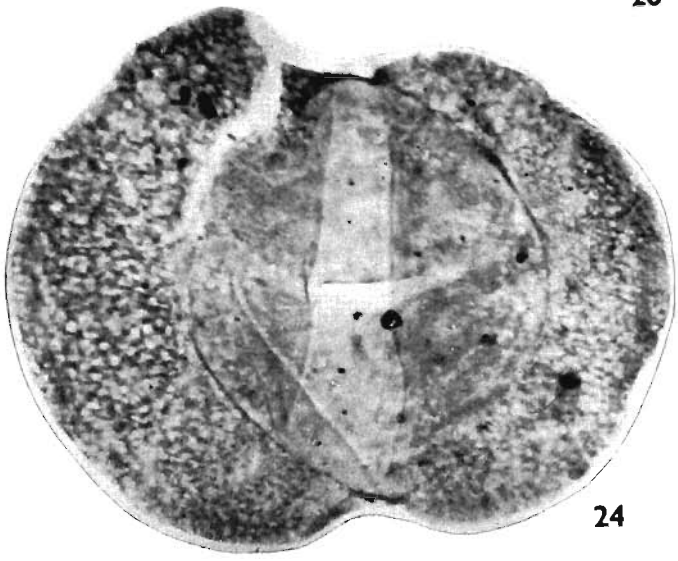

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