PETROGRAPHIC AND SPOROLOGICAL STUDIES OF SOME COALS FROM TALCHER COALFIELD, ORISSA, INDIA

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ABSTRACT

The present paper outlines petrographic and sporological studies of coals from Nandira and South-Balanda mines of Talcher coalfield in the Mahanadi Coal Basin, Orissa, India. No previous knowledge exists about petro-palynological characters of these coals although general microstructural details of Talcher coals have been established.

The coals investigated are dull in appearance and non-banded. They are composed of Durain, Vitrain and Fusain components. Durain forms the main component with narrow short black lenticles of Fusain. The microscopic study of Durain component indicates Vitrinite, Exinite, and Inertinite as main macerals. Exinite constitutes microspores, megaspores and microsporangia. Vitrain and Fusain components under microscope show Vitrinite and Fusinite macerals showing woody structure. Trimacerites form the bulk of the microlithotypes.

Sporological studies of these coals reveal a large variety of miospores. The miospore assemblage in the coals comprises of trilete, monolete, monosaccate and disaccate forms. Genera *Punctatisporites*, *Parasaccites*, *Virkkipollenites*, *Sulcatisporites*, *Lunatisporites*, *Strotersporites*, *Faunipollenites* and *Cuneatisporites* are well represented. Saccate sporomorphs constitute a large group in the miospore assemblage. Among saccate forms the genus *Parasaccites* dominates in miospore distribution.

Petro-palynological characters of the coals investigated indicate that by and large they are of non-banded Durain component composed mostly of saccate forms (predominated by monosaccates), resembling the main seam of Talcher coalfield in palyno-petrographic composition. Presence of mineral matter, high proportion of Inertinite and Exinite constituted by spores, and less amount of vitrain and Clarain indicate high moisture content and low grade quality coals.

INTRODUCTION

INDIA has rich coal deposits of Permian age. There are several coal producing basins wherein extensive exploitation of coal is being carried out. Indian coals confront many problems to coal geologists, mining engineers and technologists such as rank, nature, origin, constitution and identification of coal seams. These aspects are of utmost importance for economic exploitation and judicious utilization of coal for industrial and technological application. The lack of systematic knowledge of the heterogeneous physical components is the basic cause for many problems. Petro-palynological studies contribute to the more efficient use of coal resources as has been demonstrated in several countries (SCHOPF, 1936, 1948; KREMP, 1952; KREMP & FREDERIKSEN, 1960; KREMP, NEAVEL & STARBACK, 1956; SMITH, 1957, 1962; NAVALE 1962, 1963a, 1963b, 1964 and others). It is essential to build up knowledge of systematic palyno-petrographic constitution of Indian coal seams as no attempt has been made so far although some petrographic and considerable sporological studies have been made in many laboratories.

Keeping in view of the above fact, petrographic and sporological investigation has been carried out on newly mined coals from Orissa.

In recent years considerable investigations on Petrology of Indian coals have advanced our knowledge about coal constitution and other properties (BASU, 1964; BASU & BAGCHI, 1959; CHATTERJEE & GHOSH, 1963; GANJU, 1955a-c, 1958, 1960; GHOSH, 1963, LAHIRI & BHATTACHARYA, 1959 & 1961; MARSHALL, 1959; MUKHERJEE & DATTA, 1960; MUKHERJEE & BHATTACHARYA, 1961; PAREEK, 1958a-b, 1963a-b; and others). However a number of sporological investigations particularly on Lower Gondwana sediments (SEN, 1944, 1953; VIRKKI, 1937; GHOSH & SEN, 1948, TRIVEDI, 1954; SURANGE *et al.*, 1953; POTONIÉ & LELE, 1960; DATTA, 1957; BHATTACHARYA *et al.*, 1957 & BHATTACHARYA, 1958; GANGULY, 1958 and others) have been published. But a detailed classified treatment of spore forms from Indian coals and the application of this knowledge in correlation of coal seams was given for the first time by Bharadwaj and his co-workers (BHARADWAJ, 1962; BHARADWAJ & TIWARI, 1964a, b; BHARADWAJ & SALUJHA, 1964).

GEOLOGY OF THE AREA

Talcher coalfield lies in the Brahmani river valley in the province of Orissa and is situated 65 miles away from North West

Cuttack. The area is covered by Karharbari, Barakar and Mahadeva formations. The presence of Karharbari stage is based on palynological evidence (BHARADWAJ, 1965) and also supported by qualitative and other characters (BASU, 1964). This area has been geologically surveyed by Ball (1877), Blanford *et al.* (1861) and Fox (1931, 1934).

The new coal mines lie in the south west part of the coalfield. The geological sequence of the area is as follows:

Recent	Soil and subsoil, 2″-11″
Barakar	Sandstone, 20′-250′
	Upper coal seams, 30′-200′
	Pebbly sandstone, 190′-250′ and pebbles
Karharbari	Lower coalseam, 2′-45′
	Sand stone, 450′
Talchir	Talchir shales and sandstones
Archaeans	Archaeans metamorphic rocks.

Archaeans are exposed 4 miles away from the coal mine area. The typical Talchir shales and sandstones have been exposed in the village Tentullai. The Talchir Series was named after the state of Talcher where they were first studied. The Talchirs are overlain by Karharbari and Barakar formations. They are either flat or have very low northernly dip usually not exceeding 4°. There is no evidence of distinct unconformity between Talchirs and the overlying series. The total thickness of Karharbari and Barakar beds is about 700′. There is only one coal seam (Lower coal seam) having a thickness ranging from 2′-45′ in Karharbari stage. The lower coal seam has soft medium grained sandstone, highly kaolinized and gritty with clay matrix at places. The sandstones overlying the lower seam are decomposed. The 450′ thick sandstone underlying the seam is devoid of any coal seam.

Above the lower seam there is a thick pebbly zone having, small to large sized pebbles. They form ridges in the coalfield. The thickness of the zone is about 106′-200′. Above the pebbly zone is the upper seam of Barakar stage. The upper seam is constituted by interbanded coal and carbonaceous coal having a thickness of about 30′-200′. In none of the bore holes both upper and lower seams have been encountered by N.C.D.C. borings since the pebbly zone has not been punctured.

The main seam or lower coal seam in South Balanda occurs at a shallow depth of 80 feet or so. The decomposition has taken place due to the action of the subsurface water, making the superincumbent strata soft and friable. This occurrence of the seam at shallow depth with flat gradient and good thickness with fair quality of coal, coupled with friable nature of overburden to a depth of 80′ or so from surface indicated mining by open cut method. The other working mines are Dera and Dealbera collieries. The thickness of the coal seam varies from 6′ to 18′. The main seam (Lower seam) indicates split character towards the basin end. The main seam is fairly good in quality compared to the upper seam which is poor in quality without much of mining prospects.

MATERIAL AND METHODS

The material investigated was collected from Nandira and South-Balanda mines newly opened by National Coal Development Corporation of India. Samples were collected from exposed coal surfaces of the seams. A systematic sampling was carried out as described in my earlier paper (NAVALE, 1964). However, for the present studies representative coal blocks from each coal mine were investigated to resolve the general microstructure of coals. Several techniques for preparation of Indian coal microscopic study have been developed (PAREEK, 1954). But the present investigation has been made by polished surfaces of coal for determining macerals and microlithotypes. The block of coal after being cut to size was impregnated with palatal mixture in a metallic disc. The embedding mixture (Palatal) was prepared by mixing 100 grams of resin with 3 grams of catalyser and few drops of activiser. Grinding was done with carborundum powders of 155, F220, FF500 grades on separate glass sheets. After obtaining uniform smooth surface, free from scratches, finer grinding was done. Before finer grinding, the block was thoroughly washed and air dried. Finer polishing was done on a revolving disc covered with coarse felt using chromide polishing medium. Further polishing was done on a revolving disc covered with thick felt using Aloxide grade No. 1 and then No. 2. Time spent in polishing varies with different coals. The block was examined now and then with hand lens to make sure a scratch free surface of the coal. A final polish was given by polishing with finer grade Aloxide No. 3 for few minutes after which the block was ready for examination by reflected light microscope using oil immersion lenses. The various constituents were distinguished by the power of their reflactence.

To separate the microfossils from coal matrix 40 gm. of 2-5 mm. sized representative homogeneous coal samples were taken for maceration. After washing, the coal samples were placed in jars and covered with nitric acid. From day to day small amount of acid was added. After complete maceration which took about a week, the acid was decanted and the material was washed well in water and seived through muller gauze (0·06). From this macerate, 2-4 gm. of material was taken and covered with 10% KOH solution and kept in water bath till the material got slightly warmed. After cooling, the macerate was washed free of alkali. The residue was collected in jars for miospores. A good concentration of clear miospores was obtained after a series of centrifuging and causing separation of the spores floating on surface from heavier particles of sand, etc. remaining in bottom, by shaking gently in watch glasses. The glycerine jelly mounts were made in the usual way using formalin to harden jelly along the edges and sealing it with Gold seal. Four preparations were prepared for high power microscopic study through transmitted light.

STUDY OF PETROGRAPHIC COMPONENTS

Nandira and South-Balanda coals are dull in appearance. They lack bandings into dull and bright layers unlike coals from Raniganj coalfield. Durain forms the predominant component with Vitrain and Fusain as secondary components.

Durain (Pl. 1, Figs. 1-7)

The term Durain was introduced by Stopes (1919) to designate macroscopically recognizable dull bands in coals. The conspicuous Durain of this mine is composed of thin bands of Vitrain and short numerous fragments of Fusain appearing as charred strips which soil the fingers when touched (PL. 1, FIG. 1). It gives fibrous appearance to Durain. Microscopic examination of this Durain reveals Vitrinite, Exinite, Inertinite, Micrinite and Mineral matter as the maceral components.

Vitrinite which constitutes Collinite and Telinite macerals appear as moderately thick or thin parallel sheets. Mostly Collinite without any botanical structures constitute Vitrinite (PL. 1, FIG. 5).

Exinite which is composed of Sporinite, Resinite, and Cutinite is a very common microconstituent. Sporinite includes microspores, megaspores, and microsporangia. Spore material is rather very abundant in this type of Durain. Microspores occur as yellow strips or as flattened discs along the bedding plane (PL. 1, FIG. 2). Innumerable variety of spore exines have been recognized. However it is difficult to identify or classify them as they are very small and thin. But Maceration analysis brings out different types of spore exines. Megaspores appear as elongated brownish bodies. They show different exine patterns which could be easily identified under the microscope. Although megaspore exines are not abundant as microspore exines yet few characteristic types could be recognized by their ornamentation either by smooth, spiny or tubercled surface patterns (PL. 1, FIGS. 2 & 3). Sporangium-like bodies occur in these coals which probably contained miospores (PL. 1, FIG. 4). Outer wall of the sporangium-like bodies is thick and is filled by small bodies which are oval in shape and lighter in colour than the wall of the sporangium. Resinite (PL. 1, FIG. 5) is a common microconstituent occurring as discrete, small, yellowish, brownish or reddish bodies of various shapes which in cross section are round, oval, or rod-like. Cutinite (PL. 1, FIG. 7) which constitutes cuticles is rare to absent. When present the cuticles appear in the form of more or less narrow bands of which one margin is serrated.

Inertinite is composed of Fusinite, Semifusinite, fusinized resins and Micrinite as macerals. Semifusinite and Fusinite which dominate Inertinite component occur as lenticles or sometimes as fragments in coal. They are woody in origin. Woody cells are round to oval showing distortion or compression of cells (PL. 1, FIGS. 9, 10). Fusinized resin bodies occur commonly within the Durain complex (PL. 1, FIGS. 6 & 7). They are opaque bodies, with irregular shape. These bodies show high reflectivity. The size of the bodies varies from 20 to 1000 microns. Resin bodies are hard and robust. Often they are seen as colonies forming dominant microconstituent. Fusinized resin bodies seem to be conspicuous entity of Durain and a variety of forms of these bodies are found in the coals.

Micrinite (PL. 1, FIGS. 2 & 3) occurs as finely or granular opaque matter showing no cellular structure. Wide differences in size and form have lead to distinction between fine Micrinite of 1 or more microns in size and massive Micrinite having well defined outline of 10-100 microns in size. Fine Micrinite is often associated with microspores.

Mineral matter (PL. 1, FIGS. 2-7) occurs as small grains mixed with organic microconstituents. It is formed from detrital matter contributing largely towards high ash content in Durain coals.

Fusain (Pl. 1, Figs. 9-11)

The term Fusain was introduced by Grand'Eury in 1882 (see Glossary of terms) to designate black silky lustrous bands recognized macroscopically in coals. The main maceral Fusinite shows woody structure. The cell cavities vary in size and appear as small rounded closely compacted bodies. Transverse section of fusinized tissue shows rounded to oval cells that are arranged serially in two or three rows (PL. 1, FIG. 9). This tissue is surrounded by thinner-walled tissue of lower reflectivity. Tissues show distortion of cells (PL. 1, FIG. 10) or are compressed showing bogen structure. Semifusain which occurs frequently as the Semifusinite maceral is a transitional component intermediate between Fusian and Vitrain (PL. 1, FIG. 11). The boundary between Fusain and Semifusain is less definite than that between Vitrain and Semifusain. The woody cells are thick-walled and their cavities are empty, standing out prominently among opaque mass. Generally the cells do not appear to be greatly crushed. Only in few cases the cells have been crushed forming bogen structure.

Vitrain (Pl. 1, Figs. 11-13)

The term Vitrain was introduced by Stopes in 1919 (see Glossary of terms) to designate the macroscopically recognizable very bright bands of coals. The megascopic appearance of Vitrain in polished surfaces of the coal varies but little from coal to coal of the same general rank except in the width of the band. The microscopic appearance of Vitrain designated as Vitrinite varies considerably as some of them exhibit cell structure. Vitrain showing the cell structure has been called Telinite of Vitrinite. Telinite forms the main maceral component of Vitrinite in this coal. It shows woody structure (PL. 1, FIG. 13) and bark tissues (PL. 1, FIG. 12). In transverse plane of the block, thick-walled, serially arranged cells are seen. Tangential plane of the vitrinized woody tissue indicates tracheidal cells. Bark tissues appear as thin-walled and thick-walled cells appearing dark brown in transmitted light. The cell cavities are filled with resinous substance. The intermediate stage of transition from Vitrinite to Fusinite is commonly seen. Often the cell walls of wood have yielded to compression by folding without any visible sign of fracture suggesting that the cell walls are plastic. Cell walls also get contorted and closely packed appearing as cell dots. Various gradations have been seen in the transition stage.

STUDY OF MIOSPORE COMPONENTS

The coals investigated are rich in miospores. Different types of Trilete, Monolete, Monosaccate and Bisaccate forms have been recognized in Durain component. Following genera constitute miospore assemblage of the coals. Also some diagnostic characters have been given for those unfamiliar with Sporae dispersae.

Punctatisporites (Ibr.) Pot. & Kr., 1954
(Pl. 2, Figs. 17 & 18)

Trilete, circular to subcircular forms, Y-mark distinct, rays more than 2/3 radius long, labra being thick and vertex generally slightly raised. This genus includes spores with laevigate but structured exine (BHARADWAJ, 1962). This form is fairly well represented in the assemblage.

Cyclogranisporites Pot. & Kr., 1954
(Pl. 2, Fig. 19)

Trilete, circular to subcircular spores, Y-mark subdued by closely set grana, rays ranging from 2/3 to 3/4 length of the radius, exine covered with grana. Not common in the assemblage.

Lophotriletes **(Naum.) Pot. & Kr., 1954**

(Pl. 2, Fig. 14)

Trilete triangular spores, Y-mark distinct, rays reaching the corners, labra thin, vertex low, exine ornamentation with cones longer than broad.

Cyclobaculisporites **Bharadwaj, 1955**

(Pl. 2, Fig. 15)

Trilete circular spores, Y-mark distinct, exine covered with uniform sized regular baculate processes. Rarely distributed in the coals.

Apiculatisporis **(Ibr.) Pot. & Kr., 1956**

(Pl. 2, Fig. 16)

Trilete subcircular to roundly triangular spores, Y-mark not very distinct, exine covered with cones, coni high and equally broad at base. Not common in the dispersed miospores of coals.

Latosporites **Pot. & Kr., 1954**

(Pl. 2, Fig. 20)

Monolete miospore, shape longish oval, monolate mark distinct, labra thin, exine laevigate.

Densipollenites **Bharadwai, 1962**

(Pl. 2, Fig. 21)

Monosaccate, circular, subcircular or elliptical spores; central body dark brown and dense to light; exine densely granular to smooth; saccus finely intrareticulate on one side or coarsely intrareticulate on the other. Rarely distributed in the assemblage.

Parasaccites **Bharadwaj & Tiwari, 1963**

(Pl. 2, Figs. 22-25)

Monosaccate, circular to bilaterally oval miospores with para-condition of saccus attachment, saccus attached subequatorially both on proximal as well as on distal face of the central body leaving almost circular, equal bladder free areas on both faces. Exine intramicroreticulate. This miospore is dominantly distributed forming a characteristic genus of the coals.

Plicatipollenites **Lele, 1963**

(Pl. 2, Fig. 26)

Monosaccate, circular to roundly triangular or oval miospore, trilete mark inconsistently developed, clear to obscure, rays never reach body margin; saccus proximally attached at body equator, distal attachment along subequatorial zone, zone of attachment associated with at regular body infold system. This form closely resembles *Parasaccites* but for attachment of saccus and in having a typical body infold system. Not as common as *Parasaccites* in distribution.

Virkkipollenites **Lele, 1963**

(Pl. 3, Fig. 29)

Monosaccate, circular to subcircular or triangular miospore, body outline variable trilete mark weakly developed, rays not reaching body margin, saccus attached proximally at equator, distally along narrow subequatorial zone; body infold system absent. Also resemble the above two genera but for the characters mentioned above. However this genus is rarely distributed.

Potonieisporites **Bharad., 1954**

(Pl. 3, Fig. 31)

Monosaccate miospore, monolete mark borne on the proximal face of the central body; saccus is equatorially attached proximally and or subequatorially attached on distal side leaving an uncovered wide area. Zone of saccus attachment is accompanied by thin folds. Common in miospore assemblage.

Strotersporites **Wilson, 1962**

(Pl. 3, Fig. 33)

Bisaccate pollengrains, bilateral, bladders bigger in height than breadth of central body; central body circular to oval, exine bearing number of horizontal striations on proximal face, often dentate, finely pitted; sulcus obscure. Sacci distally tilted slightly flattened, length $\pm$ 60 μ, width $\pm$ 80 μ, intrareticulate. This form is fairly well represented in the assemblage.

Faunipollenites **Bharadwaj, 1962**

(Pl. 2, Fig. 28)

Bisaccate bilateral, heploxy'onoid pollen grains; central body ill-defined, proximally exine intramicroreticulate and bearing a number of horizontal, simple or forked striations, distally an uniformly wide biconvex area, free from saccus where exine is thin and granulose. Commonly distributed in the dispersed spores of the present coals.

Lunatisporites Leschik, 1955

(Pl. 3, Fig. 34)

Bisaccate, bilateral, pollen grains; central body subcircular to oval, proximal exine thick to thin, intramicroreticulate, horizontally striated, body wall frequently folded forming semilunar or arcuate folds. Sacci distally inclined forming a biconvex sulcus. Zone of saccus attachment convex. Fairly well distributed in the miospore association of the coals.

Vesicaspora Schemel, 1951c

(Pl. 3, Fig. 32)

Bisaccate, bilateral miospore; central body fusoid, dense, microreticulate, sacci forming convex sulcus, bladders unfolded.

Rhizomaspora Wilson, 1962

(Pl. 3, Fig. 35)

Bisaccate miospore, oblate, circular, or slightly oval, proximally ornamented with radiating or diverging ribs which are smooth or minutely fitted. Distal wall thinner, sulcus narrow, often obscure, sacci reniform, proximal attachment on equator, distal attachment deeply inserted on central body unattached parts often adjacent or overlapping on free edges. Rarely distributed assemblage.

Sulcatisporites (Lesch.) Bharad., 1962

(Pl. 3, Fig. 36)

Bisaccate, oval to circular miospore; central body faintly discernible, outline not defined distally showing frequent folds, sacci distally inclined mostly unfolded in a characteristic way. Not a principal miospore in the assemblage.

Cuneatisporites Leschik, 1955

(Pl. 3, Fig. 37)

Bisaccate, central body vertically oval, body exine intramicroreticulate, sacci distally attached, frequent folds within the body wall. An uncommon miospore in the distribution.

Vittatina Luber, 1938

(Pl. 2, Fig. 27)

Oval to subcircular miospore, folds at right angles to the plane of striations, exine transversely striated without any vertical connecting striations. Few forms of the genus have been recognized in the coals.

DISCUSSION

Nandira and South-Balanda coals are typically dull, lacking banding into bright and dull layers as revealed in Raniganj and Jharia coalfields. The lithotype Durain occurs in two types, fibrous Durain and fine grained Durain. The former forms the major part, constituted by structureless Vitrinite, lenticles and fragments of Fusain, and abundance of Exinite constituted by microspores, megaspores, microsporangium like bodies. The fine grained Durain on the other hand is rich in opaque constituents, Fusinite and Micrinite while Inertinite and miospores are present in subordinate amounts. Fusinized resins occur in a variety of forms and are characteristic of these coals, and such bodies have been reported in other Indian and European coal seams (KOSANKE & HARRISON, 1957; GHOSH 1962; PAREEK, 1963b). The microsporangium like bodies recognized in the coals have also been reported in other Indian Gondwana coal seams (GANJU, 1955a, GHOSH, 1962, PAREEK, 1963b). Trimacerites form the bulk of microlithotypes constituted by Duroclarite, Clarodurite microlithotypes with clay and mineral particles.

Sporologically these coals are mainly composed of *Punctatisporites Parasaccites*, *Faunipollenites*, *Strotersporites*, *Sulcatisporites* and *Vesicaspora* as principal genera. Among these, the saccate forms constitute the bulk of the miospore assemblage. The genus *Parasaccites* is very conspicuous, characteristic and dominantly distributed. However, *Lunatisporites*, *Strotersporites* and *Faunipollenites* are distributed in subordinate frequency. Triletes and monoletes are not abundant. However, *Punctatisporites* though not a major associate in the assemblage yet, is a conspicuous and characteristic genus of the dispersed miospores.

CONCLUSION

Nandira and South-Balanda coals are microfragmental in nature. The main component Durain which is mostly of fibrous type is largely formed by monosaccate (*Parasaccites*) miospores associated with bisaccate forms. Presence of Fusinized resins, vitrain and Fusain indicate woody elements in the coal. Coal forming peat seems to have been derived from woody vegetation (Gymnospermous as shown by cells of Fusain and Vitrain) of saccate miospore producing plants, mostly of *Parasaccites* type, in subordinate association with bisaccate miospore producing plants.

Meagre presence of Vitrain and Clarain components, abundance of fragments of Fusain, mineral matter and Exinite constituted largely by miospores suggest low grade and impure coal with high moisture content.

Innumerable lenticles, fragments of fusain characterizing Talcher coals suggest extensive " Forest Fire " during the formation of the coals.

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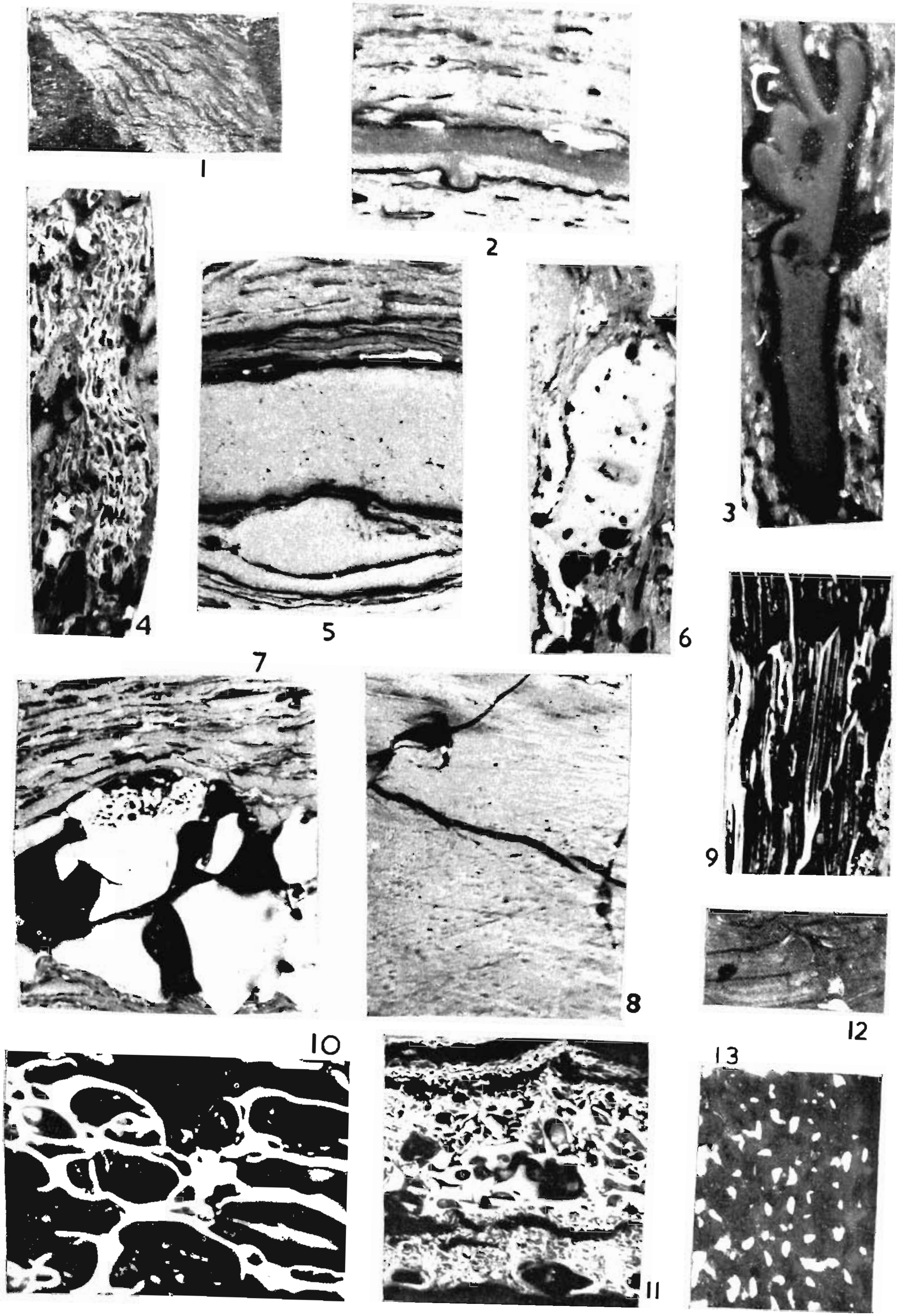
Addendum — Two papers on Petrology and Geology of Talcher Coalfield have come to writer's attention since the present paper was submitted for publication (Pareek, H.S. 1965 — *Econ. Geol.* **58** (7): 1089-1109 & *Min. Met. Inst.*, Wadia Comm. Vol,.).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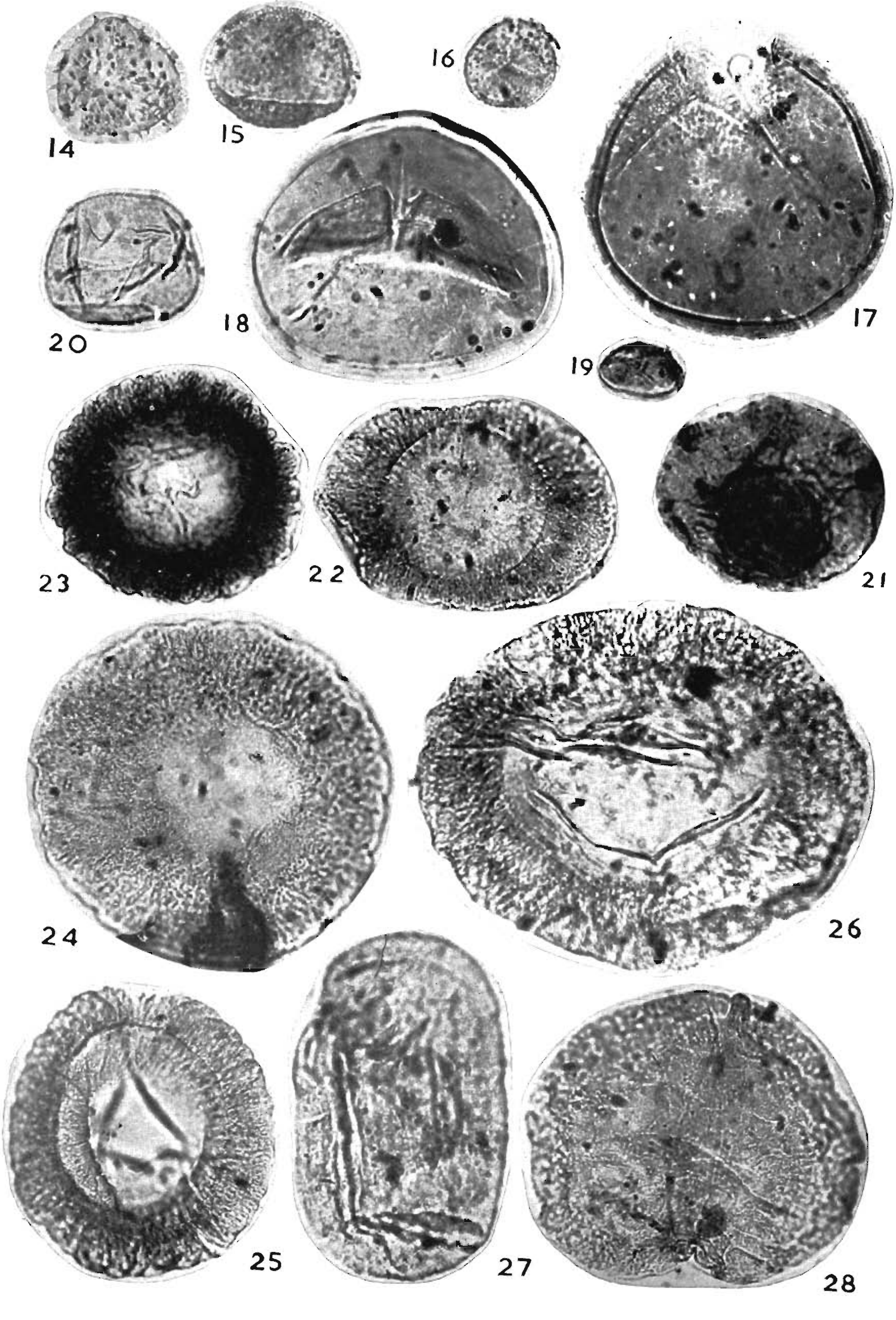
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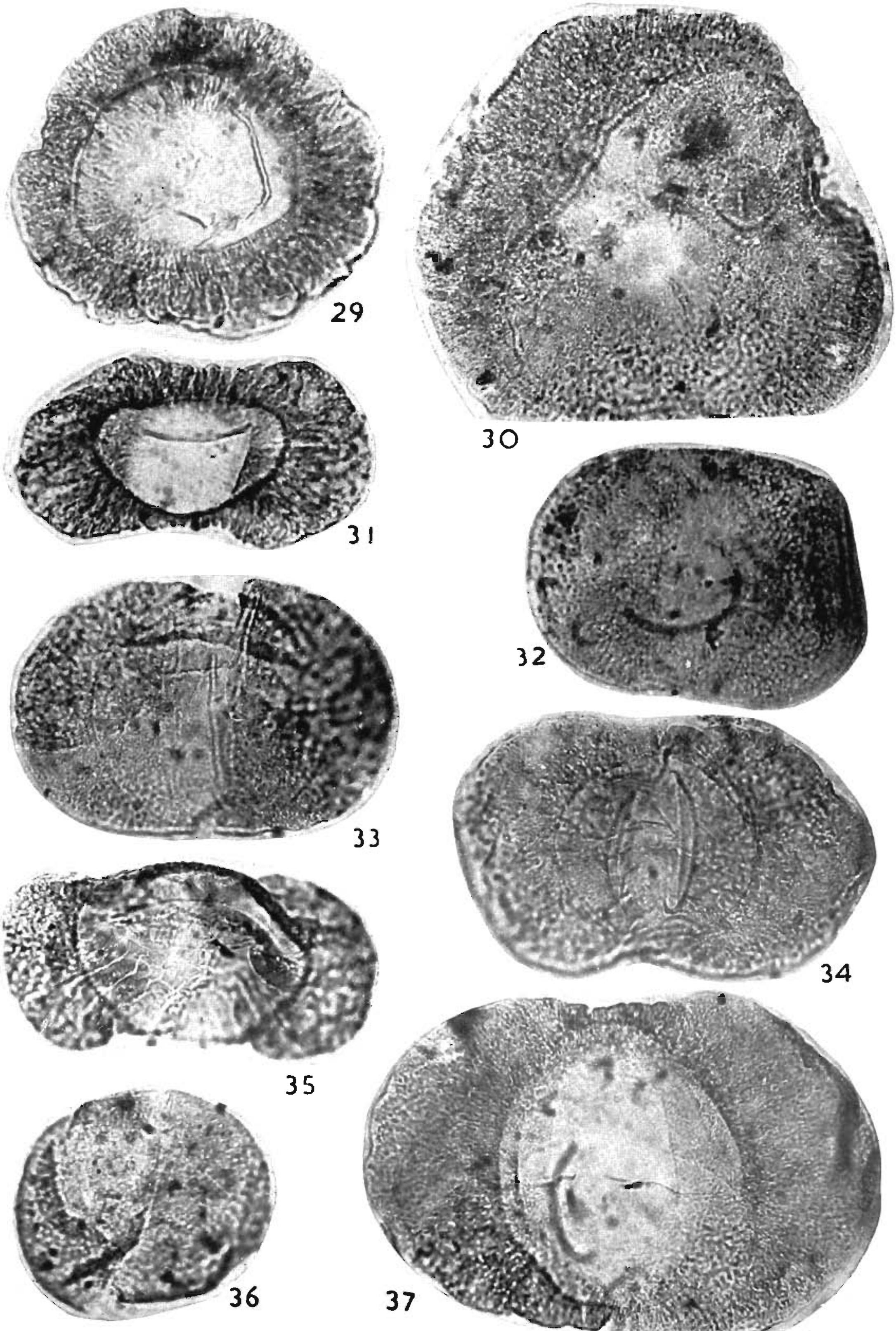
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EXPLANATION OF PLATES

PLATE 1

1. Portion of a coal block showing Durain with thin fragments of Fusain (Megascopic — natural size).
2. Portion of a polished block of Durain showing thin-walled miospores and a megaspore. × 280.
3. A megaspore — characteristic type. × 280.
4. Microsporangium like structure. × 280.
5. Portion of a polished block showing Collinite, Resinite and Cutinite. × 280.
6. Portion of a polished block showing Fusinized resin and Micrinite. × 280.
7. Portion of a polished block showing Cutinite, Fusinized resin and Micrinite. × 280.
8. Vitrain (Collinite) showing fissures. × 280.
9. Fusain (Fusinite) showing woody cell walls. × 250.
10. Fusain (Fusinite) decomposed cells. × 280.
11. Fusain (Semifusinite) transition. × 250.
12. Vitrain (Telinite) showing bark cells. × 300.
13. Vitrain (Telinite) showing woody cells. × 300.

PLATE 2

(*All Figures* 500 ×)

14. *Lophotriletes*. Ph. No. 254/5.
15. *Cyclobaculisporites*. Ph. No. 253/23.
16. *Apiculatisporites*. Ph. No. 252/13.
17, 18. *Punctatisporites*. Ph. No. 251/2 & 3.
19. *Cyclogranisporites*. Ph. No. 251.
20. *Latosporites*. Ph. No. 251/4.
21 *Densipollenites* Ph. No. 255/26.
22-25. *Parasaccites* Ph. Nos. 252/17, 254/11, 252/8 & 254/9.
26. *Plicatipollenites* Ph. No. 255/17.
27. *Vittatina* Ph. No. 254/12.
28. *Faunipollenites* Ph. No. 257/19.

PLATE 3

(*All figures* 500 ×)

29. *Virkkipollenites* Ph. No. 254/17.
30. cf. *Crucisaccites* Ph. No. 250/2.
31. *Potonieisporites* Ph. No. 250/18.
32. *Vesicaspora* Ph. No. 253/31.
33. *Strotersporites* Ph. No. 253/3.
34. *Lunatisporites* Ph. No. 253/4.
35. *Rhizomaspora* Ph. No. 252/29.
36. *Sulcatisporites* Ph. No. 251/8.
37. *Cuneatisporites* Ph. No. 255/31.