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LOWER TERTIARY DINOFLAGELLATES, SPORES AND POLLEN GRAINS FROM SIANG DISTRICT, ARUNACHAL PRADESH

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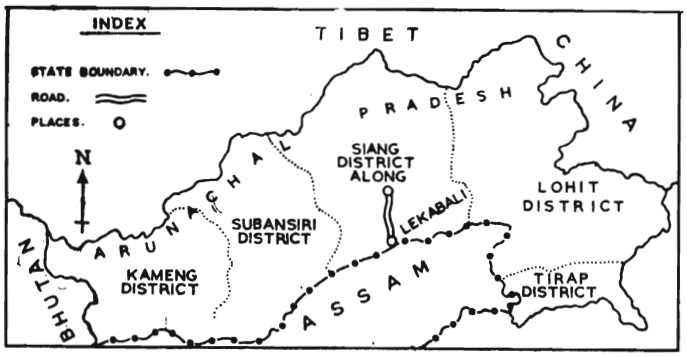
ABSTRACT

The present communication records a palynological assemblage from a limestone sample, collected near the contact of Lower Gondwana and Upper Tertiary, in the Siang District of Arunachal Pradesh. It is characterised by the predominance of dinoflagellates and subdominance of Palmae pollen grains. A Lower Tertiary, probably Eocene, age for the sample has been suggested. The palaeoenvironmental derivations led to conclude a near shore sedimentation having decreased salinity and depth.

INTRODUCTION

The area under investigation occupies the sub-Himalayan zone of the Siang district in the central part of the Arunachal Pradesh (Map-1). It is densely covered with thick forest and alluvium and hence, it is extremely difficult to get a continuous sedimentary sequence. The small road-cutting exposures provide the best available outcrops to develop the stratigraphy.

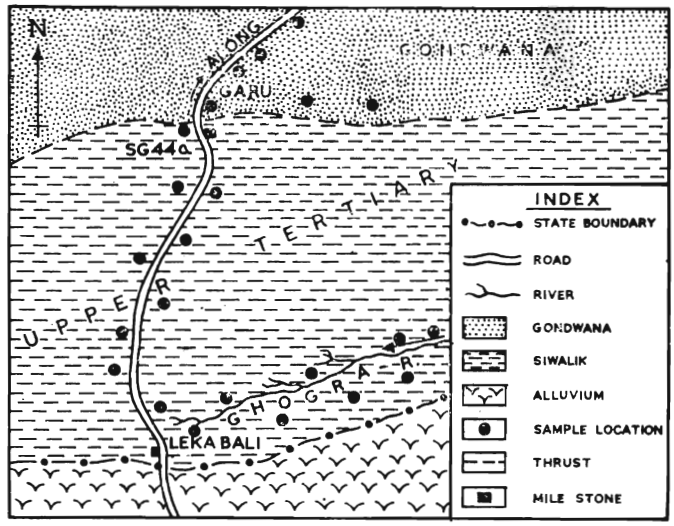


Map 1

The general sedimentary sequence encountered represents the Upper Tertiary (Siwalik) and the Lower Gondwana rocks. The Upper Tertiary rocks throughout the Arunachal Himalayas are generally underlain by the Lower Gondwana sediments where the volcanic traps of Mesozoic Era (?) are not present. The main boundary fault is prominent in this area. The Siwalik in general forms the high relief topography while Gondwana shows more or less low relief. This criterian makes it possible to differentiate the two groups of rocks.

The presence of Lower Tertiary rocks in Arunachal Himalaya has been indicated by Bhandari *et al.* (1974, p. 646), in the Subansiri district, and by the Director General, Geological Survey of India (1974, p. 11), in the Kameng, Subansiri and Siang districts, on the basis of scismic data and stratigraphy respectively.

One of us (S. K. D.) while taking a traverse along the Lekabali-Along road, observed a number of limestone patches near the Gondwana-Upper Tertiary contact. It is for the present difficult to conclude on field observations alone whether these limestone patches are boulders, relics of original beds or drifted ones. The limestone sample (S. G. 44a), which forms the basis of the present investigation, was collected near the Gondwana-Tertiary contact close to 38 km milestone (Map-2). The distribu-



Map 2

tion of the limestone at this particular topography, in the opinion of the authors, is important and must not be ignored particularlarly when it is indicating an evidence of marine early Tertiary rocks in eastern Himalayas.

The chemical analysis of the sample was done by the conventional acid/alkali method but better results could be obtained by avoiding alkali treatment.

All stage coordinates for plates I-II refer to Carl Ziess No. 297054. The slides containing the figured specimens are deposited at the museum, Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATIC PALYNOLOGY

(A) ALGAE—Fossil dinoflagellates

Genus Hystrichokolpoma Klumpp emend. Williams & Downie, 1966

Remarks : Hystrichokolpoma is known to occur from Late Cretaceous to Middle Miocene sediments. But only a single species viz., *H. sequanaportus* Deflandre & Deflandre-Rigaud (1958) is recorded from the Upper Cretaceous rocks. The Early Tertiary marks the period of quantitative and qualitative development of the genus.

Hystrichokolpoma rigaudae Deflandre & Cookson, 1955
(Pl. I—1-3)

Geologic and geographic distribution : H. rigaudae was originally described from Eocene-Miocene sediments of Australia by Deflandre and Cookson (1955, p. 279-281). They mentioned its common occurrence in the Birregurra deposite (Miocene or older). Cookson and Eisenack (1965, p. 129) corrected the range of this species in Victorian sediments to be Upper Palaeocene to Upper Eocene. Other occurrences of this species are : Palaeocene, Victoria (Cookson & Eisenack, 1967), Grand Banks, Atlantic coast—(Williams & Brideaux, 1975) ; Eocene, England (Williams & Downie, 1966), Belgium (De Coninck, 1965, 1967, 1972 ; Morgenroth, 1966), England and France (Gruas Cavagnetto, 1970), England (Eaton, 1976), Australia (Cookson & Eisenack, 1965) ; Oligocene, Germany (Brosius, 1963 ; Gerlach, 1961 ; Benedek, 1972) ; Miocene, Germany (Maier, 1959 ; Gerlach, 1961), Italy (Habib, 1971) ; Grand Bank, Atlantic Coast (Williams & Brideaux, 1975), West of Tasmania (Kennett, *et al.*, 1975) ; Pliocene, Italy (Habib, 1971) ; Pleistocene, Israel (Rossignol, 1962, 1964).

Genus Homotryblium Davey & Williams, 1966

Homotryblium has been recorded from the Lower Tertiary sediments.

Homotryblium tenuispinosum Davey & Williams, 1966
(Pl. I—8-10)

Remarks : The specimens are badly preserved and therefore, the ornamentations are not clearly seen.

Geologic and geographic distribution : Eocene, north Spain (Caro, 1973), South England (Davey & Williams, 1966 ; Downie Husain & Williams, 1971 ; Eaton 1976), Grand Banks Atlantic Coast (Williams & Brideaux, 1975).

Homotryblium pallidum Davey & Williams, 1966
(Pl. I—12-13)

Geologic and geographic distribution : Eocene, South England (Davey & Williams, 1966) and Belgium (De Coninck, 1968), Grand Banks, Atlantic Coast (Williams & Brideaux, 1975).

Homotryblium plectilum Drugg & Loeblich, 1967
(Pl. I—11)

Remarks : Only a single badly preserved specimen has been recovered.

Geologic and geographic distribution : Eocene, Grand Bank, Atlantic Coast (Williams & Brideaux, 1975) ; Oligocene, Gulf Coast, U.S.A. (Drugg & Loeblich, 1967), Grand Banks, Atlantic Coast (Williams & Brideaux, 1975).

Genus Cyclonephelium Deflandre & Cookson, 1955

Cyclonephelium pastielsii Deflandre & Cookson, 1955
(Pl. I—5)

Geologic and geographic distribution : Eocene, Australia (Deflandre & Cookson, 1955), Belgium (Pastiels, 1948 ; De Coninck, 1969), London Clay, England (Williams & Downie, 1968).

Cyclonephelium intricatum Eaton, 1971
(Pl. I—4)

Geologic and geographic distribution: M. Eocene, South England (Eaton, 1971, 1976).

Genus Polysphaeridium Davey & Williams, 1966

Polysphaeridium sp. cf. *giganteum* Caro, 1973
(Pl. I—6)

Description : Cyst distorted, ovoidal, surface reticulate, processes more than 50, distally open, recurved, proximally merged with surface reticulations. Archaeopyle not seen.

Dimensions :

Overall size	..	110×140 μm
Cyst body	..	90× 70 μm
Length of processes up to		30 μm

Remarks—Polysphaeridium giganteum Caro (1973) has been described from the Eocene sediments of Spain.

Genus Impletosphaeridium Morgenroth, 1966

Impletosphaeridium multispinosum Benedek, 1972
(Pl. I—14)

Geologic and geographic distribution : Middle Oligocene, Germany (Benedek, 1972).

Genus Spiniferites Mantell emend. Sarjeant, 1970

Spiniferites ramosus subsp. *gracilis* (Davey & Williams) Lentin & Williams, 1973
(Pl. I—7)

Geologic and geographic distribution : Cenomanian to Miocene (see Davey & Williams, 1966).

(B) FUNGI :

The fungal remains in the assemblage are very few. Only two badly preserved specimens belonging to microhyriaceous fungi (Pl. II—22) are recovered.

(C) PTERIDOPHYTIC SPORES AND GYMNOSPERMOUS POLLEN GRAINS :

The representation of pteridophytic spores and gymnospermous pollen grains is very poor. Only a single bisaccate pollen grain (Pl. II—25), and a few trilete spores are recorded (Pl. II—23).

(D) ANGIOSPERMOUS POLLEN GRAINS :

Genus *Couperipollis* Venkatachala & Kar, 1969

Couperipollis wodehousei (Biswas) Venkatachala & Kar, 1969
(Pl. II—28)

Remarks : The present pollen grains fall within the specific dimension range recorded so far. Sah and Dutta (1966, p. 76) restated the diagnosis of this species to possess long spines with bulbous base and rounded tip and sexine showing pitted-reticulate ornamentation. Singh (1977, p. 195) described his specimen with laevigate to slightly granulose interspinal space. In the original specimen the spine tips are pointed. We for the present place our specimens having acutely pointed spines in *C. wodehousei.*

Geologic and geographic distribution : Eocene, Assam (Biswas, 1962 ; Sah & Dutta, 1966 and Singh, 1977).

Couperipollis grandis sp. nov.
(Pl. II—16-17)

Holotype : Pl. II—16 ; Size 110×80 μm.

Type locality : Near 38 km milestone along Lekabali —Along Road, Arunachal Pradesh.

Horizon : Lower Tertiary (Probably Eocene).

Diagnosis: Pollen grains elliptical, monosulcate, sulcus well developed, extending from one pole to another, broad. Exine up to 2.5 μm thick, sexine much thicker than nexine, spinose ; spines variable in size, irregularly placed, deep-rooted, tips obtuse ; interspinal space granulate.

Dimensions : Overall size .. 110×80 μm
Length of spines .. 6—10 μm

Comparison : *Couperipollis grandis* sp. nov. is characterised by its large size and finger like spines with round tip. It compares best with *Monosulcites prominatus* McIntyre (1965) described from Palaeocene-Middle Eocene sediments of New Zealand, in having long spines and thick exine but differs in its nonbaculate, reticulate endexine and larger size.

Affinity : Probably *Lepidocaryum gracile* Mart. (cf. Erdtman, 1952, p. 304, fig. 177B and Thanikaimoni, 1966, p. 57, pl. 14, figs. 85-87).

Genus *Lakiapollis* Venkatachala & Kar, 1969

Remarks : The genus *Lakiapollis* Venkatachala & Kar (1969) has so far been recorded only from the Eocene sediments (Venkatachala & Kar, 1969 ; Sah & Kar, 1974 ; Singh, 1977).

Lakiapollis sp. A
(Pl. I—18)

Description : Pollen grains ± circular, 85-90 μm in diameter, tricolporate, colpi inconspicuous. Pores well developed, oval-elliptical, outer margin slightly thickened. Exine 2 μm thick, psilate.

Remarks : Present species compares well with *Lakiapollis ovatus* Venkatachala & Kar (1969) in having psilate exine and ± circular shape. But differs mainly in its larger size.

Genus *Malvacearumpollis* Nagy, 1962

Malvacearumpollis sp. A.
(Pl. II—19)

Description : Pollen ellipsoidal, polyforate, 110× 74 μm in size, nexine thicker than sexine. Spines irregularly distributed distantly placed, base bulbous, apex pointed.

Remarks : Only a single well preserved specimen has been recovered. Singh (1977, p. 200) recorded this genus from Tura (Eocene) sediments of Assam. Previously it was known to occur only from the Miocene sediments (Sah, 1967, p. 152).

Affinity : Malvaceae.

Genus *Polycolpites* Couper, 1953

Polycolpites sp. A.
(Pl. II—24)

Description : Polycolpate (16), semicircular, 70 μm in diameter, colpi extend upto centre of main body when seen in polar view.

Remarks : The polycolpate pollen grains are common in Lower Tertiary sediments of Assam (Sah & Dutta, 1966).

Affinity : *Utricularia* (Lentibulariaceae), Fresh water, aquatic.

Genus *Triorites* (Erdtman) Couper, 1953

Triorites sp. A.
(Pl. II—21)

Description : Pollen grains 30-35 μm in size, triangular;

triorate, sides between ora convex in polar view. Diameter of ora 5 μm, usually surrounded by a collar like thickening. Sexine coarsely reticulate.

Remarks : *Triorites harrisii* Couper (1953) differs in having psilate exine.

Affinity : Onagraceae.

Genus *Polygonacidites* Sah & Dutta, 1966

Remarks : This genus represents the fossil Polygonaceae. So far it is known from the Neogene sediments of Assam (Sah & Dutta, 1966).

Polygonacidites sp. A.
(Pl. II—20)

Description : Amb globular, 50-55 μm in size, polyforate, exine thick, ornamentation reticulate, tegillate, reticulum ridges broad, lumen penta to hexagonal.

Remarks : Only a few specimens of *Polygonacidites* have been recovered.

DISCUSSION

The palynological assemblage recovered from the limestone sample consists of excessive amount of organic detritus including large and small pieces of terrestrial cuticles and wood tracheids ; algal cysts (dinoflagellates), fungal bodies ; pteridophytic spores ; pollen grains of gymnosperms and angiosperms ; and some recycled Permian monosaccate trilete pollen grains referable to *Plicatipollenites* (Pl. II—27).

The quantitative and qualitative analyses of the palynological assemblage revealed the following results in 200 counts :

Dinoflagellates	..	..	68%
Angiospermic pollen	..	..	28%
Pteridophytic spores	..	..	2%
Fungal bodies	..	..	1%
Gymnospermic pollen	..	..	0.5%
Reworked pollen	..	..	0.5%

The dinocysts constitute the dominant component of the total palynological assemblage. The majority (92%) of dinocyst flora is represented by a single species : *Hystrichokolpoma rigaudae*. The associated species include, *Homotryblium pallidum*, *H. tenuispinosum*, *H. plectilum*, *Cyclonephelium intricatum*, *C. pastielsii*, *Cordosphaeridium microtriaina*, *Impletosphaeridium multispinosum*, *Polysphaeridium* sp. cf. *giganteum* and *Spiniferites ramosus* subsp. *gracilis*.

The geologic distribution of *Hystrichokolpoma rigaudae* extends from Palaeocene to Middle Miocene (Eaton, 1976 ; p. 270), but its maximum development is observed in the Lower Tertiary rocks. Most of the associated taxa mentioned above have been recorded from the Eocene sediments.

Dinocysts in this assemblage can be given most reliance since they have also been found elsewhere particularly in European Eocene. Recently we recovered good representation of *Homotryblium plectilum*, *H. pallidum*, *H. tenuispinosum* in the Kopili Formation (Upper Eocene) sediments of Assam. These have also been reported from Middle Eocene rocks of S. W. Kutch (Personal communication, K. P. J.).

The angiospermic pollen forms the subdominant palyno-unit of the assemblage and the pollen grains belonging to *Couperipollis* Venkatachala & Kar (1969) predominate. Most of them show affinity with the extant genus *Lepidocaryum* (Erdtman, 1952 ; Thanikaimoni, 1966).

The occurrence of 25% *Couperipollis* pollen grains in the present angiosperm pollen assemblage compares well with the results of Sah & Dutta (1968, p. 180) who reported 30% *Monosulcites* (*Couperipollis*), from the Sylhet Limestone Stage (Lower-Middle Eocene). The available records of the genus *Couperipollis* also show its maximum development during Eocene times.

The available palynological evidences suggest a Lower Tertiary, probably Eocene, age for the sample. Our conclusions support the seismic and stratigraphic indications, of the presence of Lower Tertiary rocks in Kameng, Subansiri and Siang districts of Arunachal Pradesh, made by Bhandari *et al.*, (1974) and the Director General, Geological Survey of India (1974).

Recently Dutta and Singh (MS) have discussed and described the palynology of the Siwalik rocks of the Lesser Himalayas of Kameng District, Arunachal Pradesh. They suggested the presence of three different types of microfloral assemblages, relating them to the rock units D, B+C and A. The assemblage D comes from the rock Unit D collected at the contact of Lower Gondwana and Upper Tertiary (Dutta & Singh, MS) and is characterised by the dominance of Permian palynomorphs and only a few dinoflagellates viz., *Thalassiphora* and *Hystrichosphaeridium*. It is further mentioned (MS.) that it contains smaller foraminifera. The presence of dinoflagellates and foraminifera in the assemblage definitely indicates marine influence during the time of deposition of rock unit D.

We are, therefore, of the opinion that the rock unit D might represent the marine Lower Tertiary part of the Tertiary sequence in Kameng district, probably equivalent to the present one. A detailed microplankton study of the rock unit D will be helpful to support the above contention.

The presence of marine Lower Tertiary (Eocene) sediments in Arunachal Himalayas thus, suggests every possibility of eastern extension of the Eocene Sea. More data in future shall confirm this hypothesis.

PALAEOENVIRONMENT

The palynological assemblage described and dis-

cussed in the present article is characterised by the following four significant features ; (i) The dominance of dinoflagellate cysts, (ii) low specific diversity and predominance of a single dinocyst species ; (iii) abundance of terrestrial plant cuticles and wood tracheids, of larger size and (iv) subdominance of palmae pollen grains. These features respectively indicate marine influence at the time of deposition, low salinity, nearshore sedimentation bordering the land mass with influx of fresh water, and nearly *in situ* deposit (Davey, 1971, p. 205).

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REFERENCES

Benedek, P. N. 1972. Phytoplanktonten aus dem mittel-und Oberoligozän von Tönisberg (Niederrheingebiet). *Palaeontographica.* B, **137** (1-3) : 1-71.

Bhandari, L. L., Furoria, R. C. & Sastri, V. V. 1973. Stratigraphy of Assam Valley, India. *Bull. Amer. Assoc. Petrol. Geol.* **57** (4) : 642-654.

Biswas, B. 1962. Stratigraphy of the Mahadeo, Langpar, Cherra and Tura Formation, Assam, India. *Bull. Geol. Min. metall. Soc. India.* **25** : 1-48.

Brosius, M. 1963. Plankton aus dem nordhessischen Kasseler Meeressand. (Oberoligozän). *Z. deutsch. geol. Fes.* **114** : 32-54.

Caro, Y. 1973. Contribution à la connaissance des dinoflagellés du Paléocène-Eocène inférieur des Pyrenées Espagnoles. *Rev. Espan Micropaleontol.* **5** : 329-372.

Cookson, I. C. & Eisenack, A. 1965. Microplankton from the Brown Creek Clays, S. W. Victoria. *Proc. R. Soc. Vict.* **79** (1) : 119-131.

Cookson, I. C. & Eisenack, A. 1967. Some microplankton from the Palaeocene Rivernook bed, Victoria. *Proc. R. Soc. Vict. Melbourne.* **80** : 247-258.

Davey, R. J. 1971. Palynology and palaeoenvironmental studies, with special reference to the continental shelf sediments of South Africa. *Proc. IInd Planktonic Conf. Rome* **1** : 331-347.

Davey, R. J. & Williams, G. L. 1966. The genus *Hystrichosphaeridium* and its allies. *Bull. Br. Mus. nat. Hist. (Geol.) Suppl.* **3** : 53-106.

De Coninck, J. 1965. Microfossiles planctoniques du sable Ypresien a Merelbeke. Dinophyceae et Acritarcha. *Acad. Roy. Belg. Cl. Sci. Mem., Coll.* 8; **26** (2) : 1-56.

De Coninck, J. 1968. Dinophyceae et Acritarcha de l'Ypresien du Sondage de Kallo. *Inst. Roy. Sci. Nat. Belg. Mem.* **161** : 1-67.

De Coninck, J. 1972. Application stratigraphique des microfossiles organiques dan l'ypresien due bassin Belge. *Bull. Soc. Belg. Geol. Paleont. Hydrol. Brussels.* **81** (2) : 1-11.

Deflandre, G. & Cookson, I. C. 1955. Fossil microplankton from Australian Late Mesozoic and Tertiary sediments; *Austral. J. Mar. Freshw. Res.* **6** : 242-313.

Director General, Geological Survey of India 1974. Geology and mineral resources of the states of India. Part-IV Arunacha Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. *Geol. Surv. India. Misc. Pub.* **30** : 1-124.

Downie, C., Hussain, M. A. & Williams, G. L. 1971. Dinoflagelate cyst and acritarch associations in the Palaeogene of southeast England. *Geoscience Man.* **3** : 27-35.

Drugg, W. S. & Loeblich, A. R. (Jr.) 1967. Some Eocene and Oligocene Phytoplankton from the Gulf Coast, U.S.A. *Tulane Stud. Geol.* **5** (4) : 181-194.

Dutta, S. K. & Singh, H. P. (MS). Palynostratigraphy of the sedimentary formations of the Arunachal Pradesh : 1. Palynology of the Siwalik rocks of the Lesser Himalayas, Kemeng, District.

Eaton, G. L. 1976. Dinoflagellate cysts from the Bracklesham beds (Eocene) of the Isle of Wight southern England. *Bull. Br. Mus. nat. Hist. (Geol.).* **36** (6) : 227-332.

Erdtman, G. 1952. *Pollen morphology and plant taxonomy. Angiosperms,* U.S.A.

Gerlach, E. 1961. Mikrofossilen aus dem Oligozän und Miozän Nordwestdeutschlands Unter besonderer Berücksichtigung der Hystrichosphären und Dinoflagellaten : *Neues Jahrb. Geol. Paläontol. Abh.* **112** : 143-228.

Gruas-Cavagnetto, C. 1970. Dinophyceae, acritarcha et pollen de la formation de Varengeville (Cuisien, Seine-Martime) *Rev. Micropaléont.* **13** (2) : 69-78.

Habib, D. 1971. Dinoflagellate stratigraphy across the Miocene-Pliocene Boundary, Tabiano stratotype Section. *Proc. IInd Planktonic Conference,* Rome. **1** : 591-598.

Kennett, J. P. *et al.* & Wilson, G. J. 1975. Site 282. *Initial Reports of DSDP.* **29** : 317-363.

Maier, D. 1959. Planktonuntersuchungen in tertiären und quartaren marinen sedimentent. *N.Jb. Geol. Palaont. Abh.* **107:** 278-340.

Morgenroth, P. 1966. Mikrofossilen und konkretionen des nordwesteuropäischen Untereozäns. *Palaeontographica.* (B), **119** (1-3) : 1-53.

Pastiels, A. 1948. Contribution à l'étude des microfossiles de l'Éocène belge. *Mém. Mus. r. Hist. nat. Belg.* **109** : 1-77.

Rissignol, M. 1962. Analyse pollinique de sédiments marins Quaternaires en Israël. II. Sédiment Pleistocènes. *Pollen Spore.* **4** : 121-148.

Rossignol, M. 1964. Hystrichosphères du Quaternaire en Méditerranée orientale, dans les sédimens pléistocènes et les boues marines actuelles. *Rev. Micropaléont.* **7** (2) : 83-99.

Sah, S. C. D. 1967. Palynology of an Upper Neogene profile from Rusizi Valley. (Burundi). *Mus. Roy. Afr. Cenr. Ann.* **8** (57) : 1-173.

Sah, S. C. D. & Dutta, S. K. 1966. Palynostratigraphy of the Tertiary sedimentary formations of Assam—1 Stratigraphical position of Cherra Formation. *Palaeobotanist.* **15** (1-2) : 72-86.

Sah, S. C. D. & Kar, R. K. 1974. Palynology of the Tertiary sediments of Palana, Rajasthan. *Palaeobotanist.* **21** (2) : 163-188.

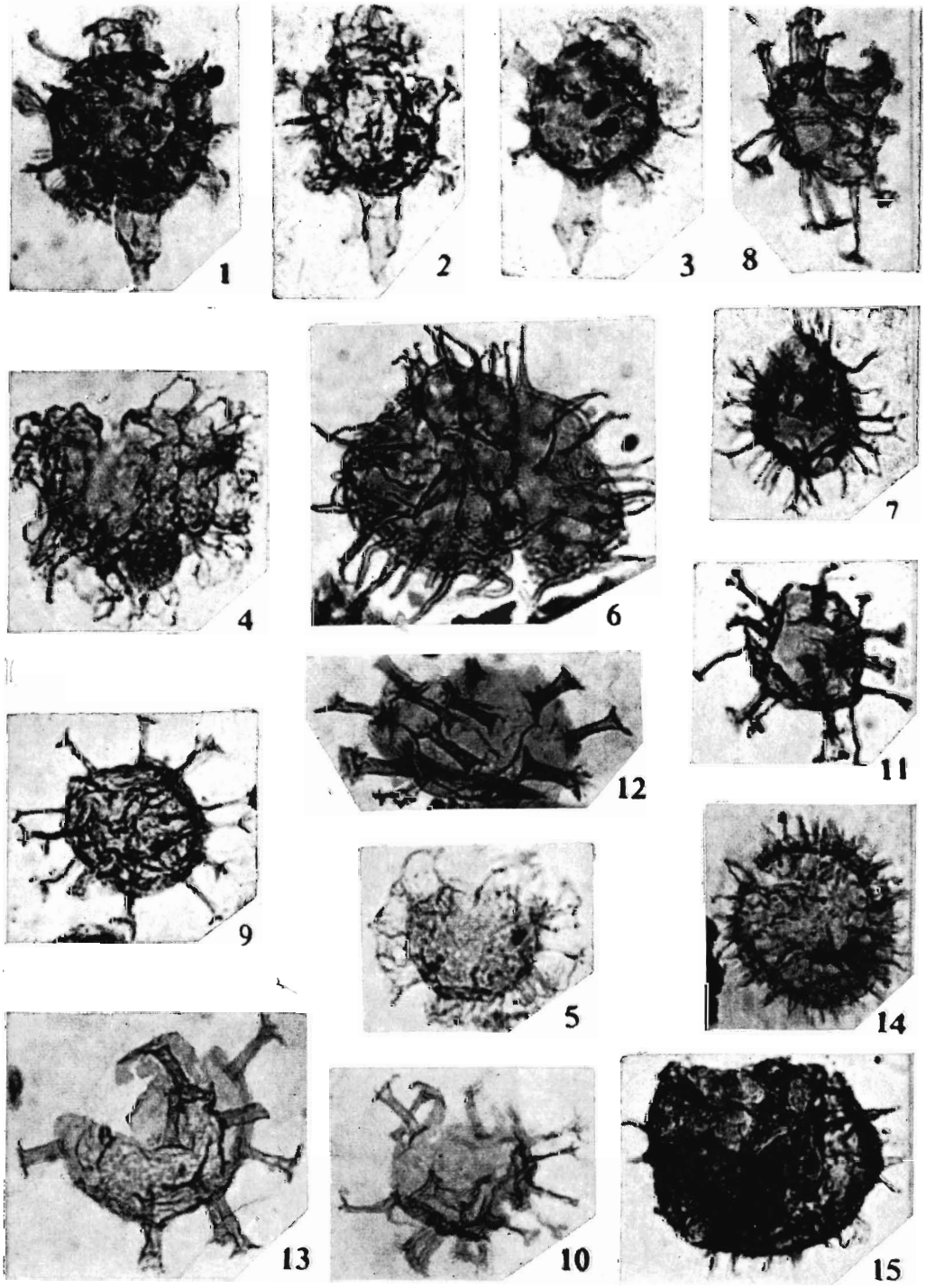
Singh, R. Y. 1977. Stratigraphy and palynology of the Tura Formation in the Type area Part-II (Descriptive Palynology). *Palaeobotanist.* **23** (3) : 189-205.

Thanikaimoni, G. 1966. Contribution à l'étude palynologique des Palmiers. Pt. 2. *Inst. Fr. Pondy. Trav. Ser. Sci. Tech.* **5** : 1-91.

Venkatachala, B. S. & Kar, R. K. 1969. Palynology of the Tertiary sediments of Kutch-1, Spores and pollen from Bore-hole no. 14. *Palaeobotanist.* **17** (2) : 157-178.

Williams, G. L. & Brideaux, W. W. 1975. Palynologic analysis of Upper Mesozoic and Cenozoic rocks of the Grand Banks Atlantic continental margin. *Bull. Geol. Surv. Canada.* **236** : 1-160.

Williams, G. L. & Downie, C. 1966. The genus *Hystrichokolpoma. Bull. Br. Mus. nat. Hist. (Geol.), London.* **3** : 176-181.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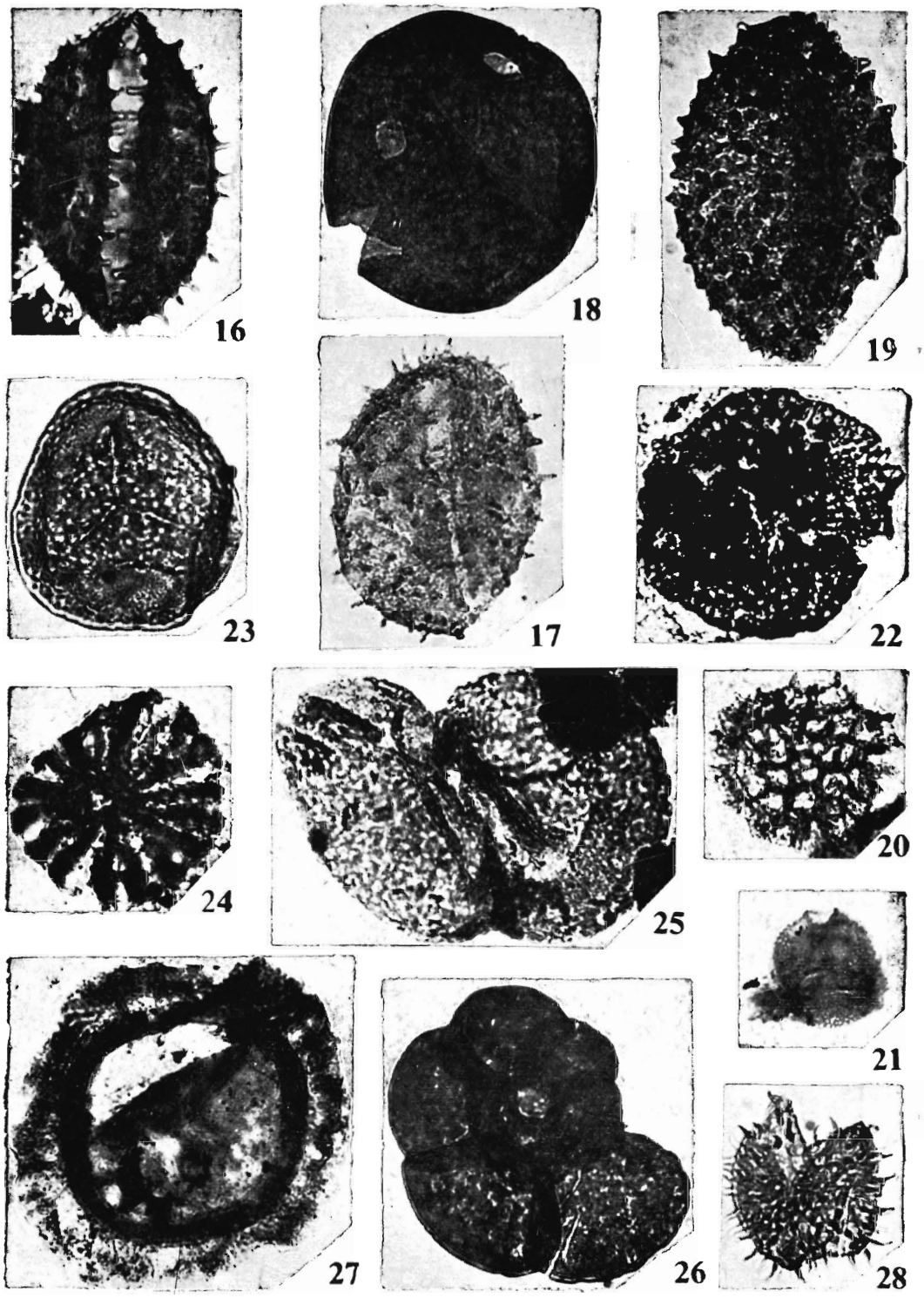
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EXPLANATION OF PLATES

(All microphotographs magnified 500 × until otherwise stated)

Plate I

1-3. *Hystrichokolpoma rigaudae* Deflandre & Cookson; Slide nos. 5938, 5937 & 5944; coordinates 123.6 × 9.8; 139.5 × 15.2 & 102.4 × 23.8.
4. *Cyclonephelium intricatum* Eaton; Slide no. 5944, coordinates 104.7 × 9.3.
5. *Cyclonephelium pastielsii* Deflandre & Cookson; Slide no. 5938, coordinates 116.8 × 18.0.
6. *Polysphaeridium* sp. cf. *giganteum* Caro; Slide no. 5941, coordinates 136.8 × 13.5.
7. *Spiniferites ramosus* subsp. *gracilis* (Davey & Williams) Lentin & Williams; Slide no. 5943; coordinates 95.4 × 22.3.
8-10. *Homotryblium tenuispinosum* Davey & Williams; Slide nos. 5941 & 5937; coordinates 126.2 × 18.0; 127 × 7 & 112 × 23.
11. *Homotryblium plectilum* Drugg & Loeblich; Slide no. 5937; coordinates 117.6 × 11.0.
12-13. *Homotryblium pallidum* Davey & Williams; Slide no. 5938; coordinates 104.0 × 8.0 & 108.0 × 22.6.
14. *Impletosphaeridium multispinosum* Benedek; Slide no. 5940; coordinates 100.2 × 20.5.
15. *Cordosphaeridium microtriaina* Eisenack emend. Davey; Slide no. 5940; coordinates 123.1 × 15.5.

Plate II

16-17. *Coupsripollis grandis* sp. nov.; Slide nos. 5942, 5938; coordinates 125.4 × 9.6; 103.0 × 6.4.
18. *Lakiapollis* sp. A.; Slide no. 5939, coordinates 124.7 × 16.8.
19. *Malvacearumpollis* sp. A.; Slide no. 5939, coordinates 125.2 × 20.7.
20. *Polygonacidites* sp. A.; Slide no. 5938, coordinates 113.3 × 10.5.
21. *Triorites* sp. A.; Slide no. 5937, coordinates 136.4 × 22.3; (1000 ×).
22. Microthyriaceous ascomata; Slide no. 5938, coordinates 122.0 × 5.5.
23. Pteridophytic spore; Slide no. 5940; coordinates 108.2 × 8.0.
24. *Polycolpites* sp. A.; Slide no. 5945; coordinates 106.6 × 9.8.
25. Bisaccate pollen grain; Slide no. 5939; coordinates 123.0 × 15.0.
26. "Microforaminifera"; Slide no. 5940; coordinates 112.5 × 19.0.
27. *Plicatipollenites* sp. (reworked); Slide No. 5944; coordinates 128.7 × 10.2.
28. *Couperipollis wodehousei* (Biswas) Venkatachala & Kar; Slide no. 5937, coordinates 98.3 × 7.5.