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BIOSTRATIGRAPHY OF THE SEDIMENTARY FORMATION ABOVE THE BASEMENT COMPLEX AT BARAIPARA, NW BANGLADESH

La biostratigraphie de la formation sédimentaire au-dessus du Basement Complex à Baraipara, Bangladesh nord-occidental

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RESUME

Les couches sédimentaires étudiées présentent ceratines similitudes avec différentes formations: Tura/Chera Sandstone Formation (Paléocène), DupiTila Formation (Moi-Pliocène), Dihing Formation (Plio-Pléistocène). Afin de faire le départ entre ces trois formations, on a procédé à l'analyse palynologique de quatre échantillons prélevés dans la partie inférieure de la formation lors d'un sondage. 766 palynomorphes ont été identifiés parmi lesquels prédominent les Tricolpopollenites. *Ces fossiles indiquent un âge plio-pleistocène. De cette analyse ainsi que celle de la composition lithologique, il apparaît que la formation étudiée doit être rapportée à la DupiTila Formation.*

ABSTRACT

The Sedimentary Formation overlying the Pre-Cambrian Basement Complex at Baraipara, Dinajpur District, the NW Bangladesh was some what controversial because of its apparent similarity with the Tura/Chera Sandstone Formation of Paleo-Eocene, the DupiTila Formation of Mio-Pliocene and the Dihing Formation of Plio-Pleistocene. As an effort to solve this problem, palynological investigation of four core samples from the lower horizon of the formation was carried out.

The Formation contains well preserved spore-pollen and in total 766 palynomorphs have been identified from these four samples. Tricolpopollenites is the most dominating form associated with Triporopollenites, Tricolporopollenites, Dicolpopollis/Disulcites, Diporopollenites, Polypodiisporites, Gramanidites, Palmae-pollenites, Polyporina, Inaperturopollenites, Laevigatosporites, Cyathidites *and so on,*

The palynological study of the samples illustrated in this paper shows the assemblage of Tricolpopollenites. *This* Tricolpopollenites *along with* Tricolporo-pollenites, Triporopollenites, Graminidites, Polypodiisporites *indicates that the Formation is of Plio-Pleistocene age and appear to be equivalent to the Debagram Formation of West Bengal.*

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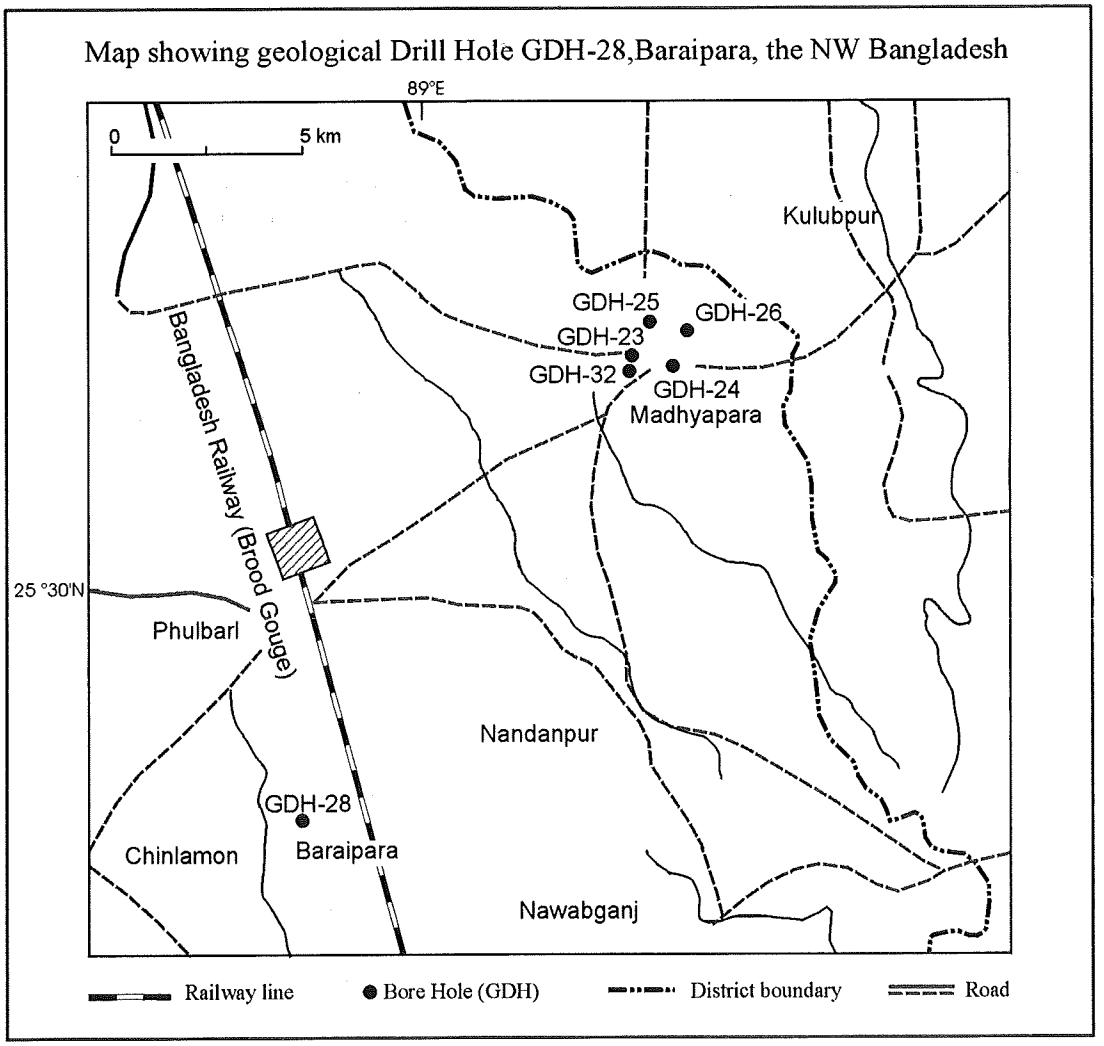

Fig.1:

Considering the palynological evidence and the lithological characteristics, the sedimentary formation above the Basement Complex at Baraipara appears to be more similar to the Dihing Formation than the DupiTila.

INTRODUCTION

Geological Survey of Bangladesh drilled a bore hole GDH-28 to determine the depth of Pre-Cambrian Basement Complex in the course of exploration for hard rocks. The drill hole having latitude 25°26'15" and longitude 88°58' is located at Baraipara village of the Phulbari Police Station (Fig.1) in Dinajpur district of the Rangpur Platform, the NW Bangladesh (Fig.2)

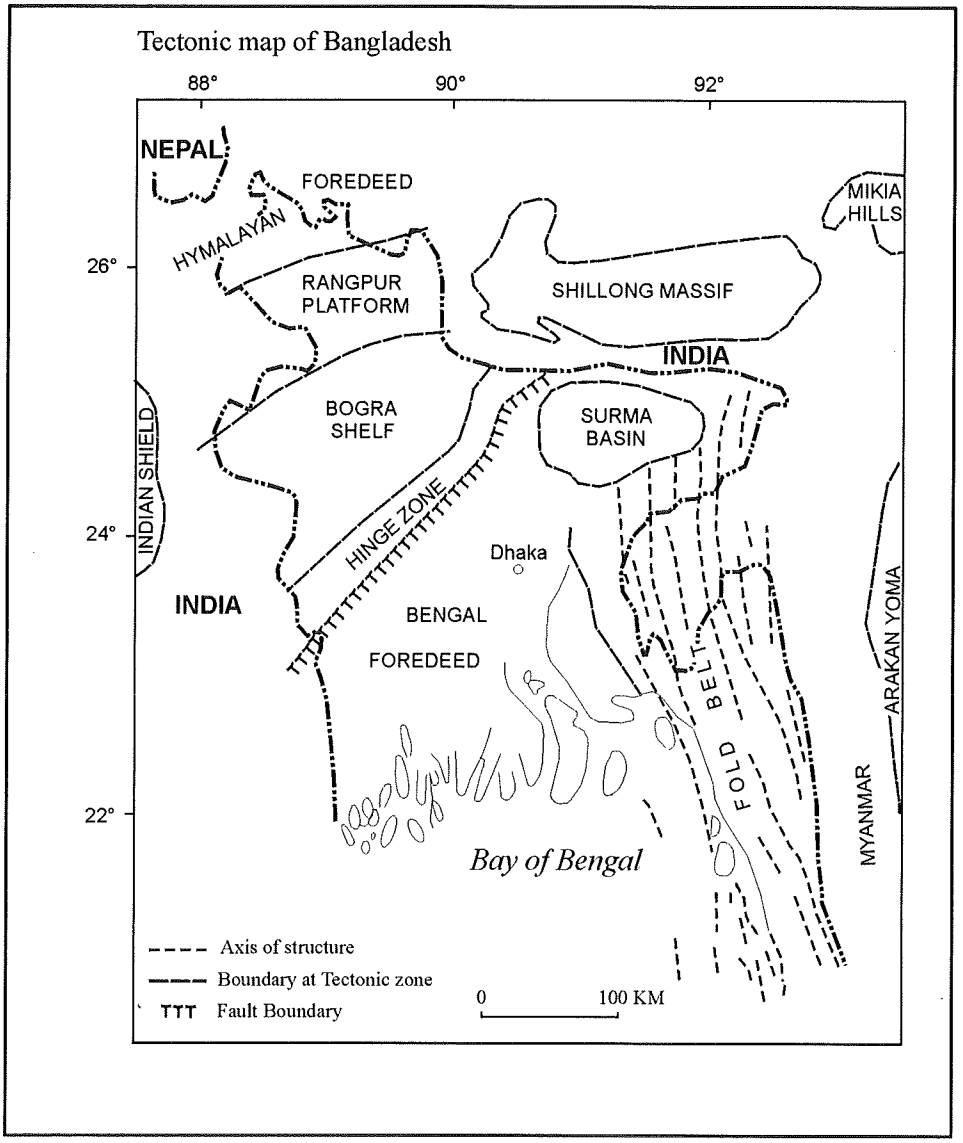

Fig.2:

Tab. I. Stratigraphic succession based on GDH-28, Baraipara, Dinajpur, the NW Bangladesh

Probable age	Formation	Lithology	Thickness
Recent	Alluvium	Light grey sandy clay, silty clay with fine sand	3.05m
Pleistocene	Madhupur Clay	Clay:reddish brown, yellowish brown, grey sticky ferruginous nodules	3.35m
Plio-Pleistocene	DupiTila (?)	Sandstone, Claystone with pebble beds -Sandstone: light grey to yellowish brown , fine to course -Claystone:grey to light grey, bluish grey with occasional pebbly sandstone and carbonaceous bands -Pebble: grey, greenish grey, pink, course to fine grained	173m
Pre-Cambrian	Basement Complex	Granodiorite, Quartz Diorite gneiss, pegmatite with occasional quartz veins	94.82m +

The surface of the Baraipara area is covered with Recent Alluvium and the rock sequence along with lithological description encountered in this drill hole is illustrated in Tab.I (RAHMAN, 1977). In the Baraipara area, the DupiTila (?) Formation of Plio-Pleistocene age directly rests on the Basement Complex of Pre-Cambrian age.

There was certain confusion about the rock unit just above the Basement Complex at Baraipara because of its apparent similarity with the Tura or Chera Sandstone of Paleo-Eocene, the DupiTila Formation of Mio-Pliocene and the dihing Formation of Plio-Pleistocene. To solve this problem, palynological investigation was carried out on four core samples taken from the lower horizon of the formation in order to – i) identify spore-pollen (palynomorphs), ii) compare these palynomorphs with the palynomorphs of Tertiary and Quaternary stratigraphy of Indian sub-continent as well as with the spore-pollen of similar age of other parts of the world, and iii) to determine/confirm the stratigraphic position and the probable age of the formation.

MATERIALS AND METHODS

Four samples of claystone were collected from the core of GDH-28 at depths of 135.98m to 136.07m, 140.43m to 140.52m, 150.61m to 150.70m and 150.79m to 150.88m for palynological investigation. The samples increments removed for maceration were assigned to letter symbols A through D which is depicted in Tab.II.

To prepare slides, samples were subjected to chemical treatment. Five grams were taken from each sample and crushed into 2 mm size and put them into the respective beaker. First samples were tested with 10% HCL to know whether the samples contain $CaCO_3$ and then treated with 36% HCL to remove $CaCO_3$ and with 40% HF for about 48 hours to dissolve silicates (Sio_4) and again with 10% HCL to dissolve flour silicates. In each step samples were washed and

Tab. II. Samples with depth and lithology from GDH-28, Baraipara, NW Bangladesh

Samples assigned to symbols	Samples depth in meter	Lithology	Slides prepared	Remarks
A	135.98m - 136.07m	Claystone	3 slides prepared and examined	Yielded rich and well preserved palynomorphs
B	140.43m - 140.52m	Claystone	3 slides prepared and examined	Yielded rich and well preserved palynomorphs
C	150.61m - 150.70m	Claystone	3 slides prepared and examined	Yielded rich and well preserved palynomorphs
D	150.79m - 150.88m	Claystone	3 slides prepared and examined	Yielded rich and well preserved palynomorphs

centrifuged several times until the samples were free from acid. To oxidize organic materials, samples were treated with Schulezes solution for 20 minutes and then washed and centrifuged to make the samples free from solution. Next, the samples were treated with 10% KOH to release palynomorphs and sieved through 200 mesh sieve. The residue below 200 mesh sieve were collected and centrifuged to take out water to put the sample in glycerine. Finally, the processed samples were put into the glycerine jelly and three slides from each sample were prepared for microscopic studies.

RESULT OF THE STUDY

All twelve slides prepared from four core samples taken from GDH-28 were studied carefully and all samples contain enough palynomorphs. The palynomorphs are well preserved and in total 766 palynomorphs have been identified. Almost all palynomorphs belong to the class angiospermae except a few corroded grains which seems to be gymnospermae. The percentage of *Retitricolpopollenites* in all samples is much higher than that of other spore-pollen. The sample-wise frequency of spore-pollen has been shown in the following Tab. III.

Tab. III. Sample-wise frequency of spore-pollen in GDH-28, Baraipara, the NW Bangladesh

Palynomorphs	S738 D:135.98-135.07m	S739 D:140.43-140.52m	S740 D:150.61-150.70m	S741 D:150.79-150.88m
Diporopollenites	-	-	R	-
Disulcites	-	R	-	-
Ephedrapites	R	-	-	-
Fungus	F	F	F	F
Graminidites	F	R	R	R
Inaperturopollenites	R	R	-	R
Monoletti	F	F	F	F
Palmaepollenites	F	F	F	F
Polycolpites	R	R	R	R
Polypodiisporites	R	R	R	R
Polyporina	F	R	R	R
Taxodiaceapollenites	F	-	-	-
Tricolpopollenites	A	A	A	A
Tricolporopollenites	C	C	C	C
Triletti	F	F	R	F
Triporopollenites	F	F	F	F

The sample A, at a depth of 135.98m-136.10m contains abundant *Tricolpopollenites* in which *Retitricolpopollenites* is predominant followed by *Tricolporopollenites*, *Triporopollenites*, *Palmaepollenites*, *Laevigatosporites*, *Polyporina*, *Graminidites*, *Triletti*. Other spore-pollen like *Inaperturopollenites*, *Tetracolpites*, *Polycolpites*, *Polypodiisporites*, *Taxodiaceapollenites* are also present but as rare grains.

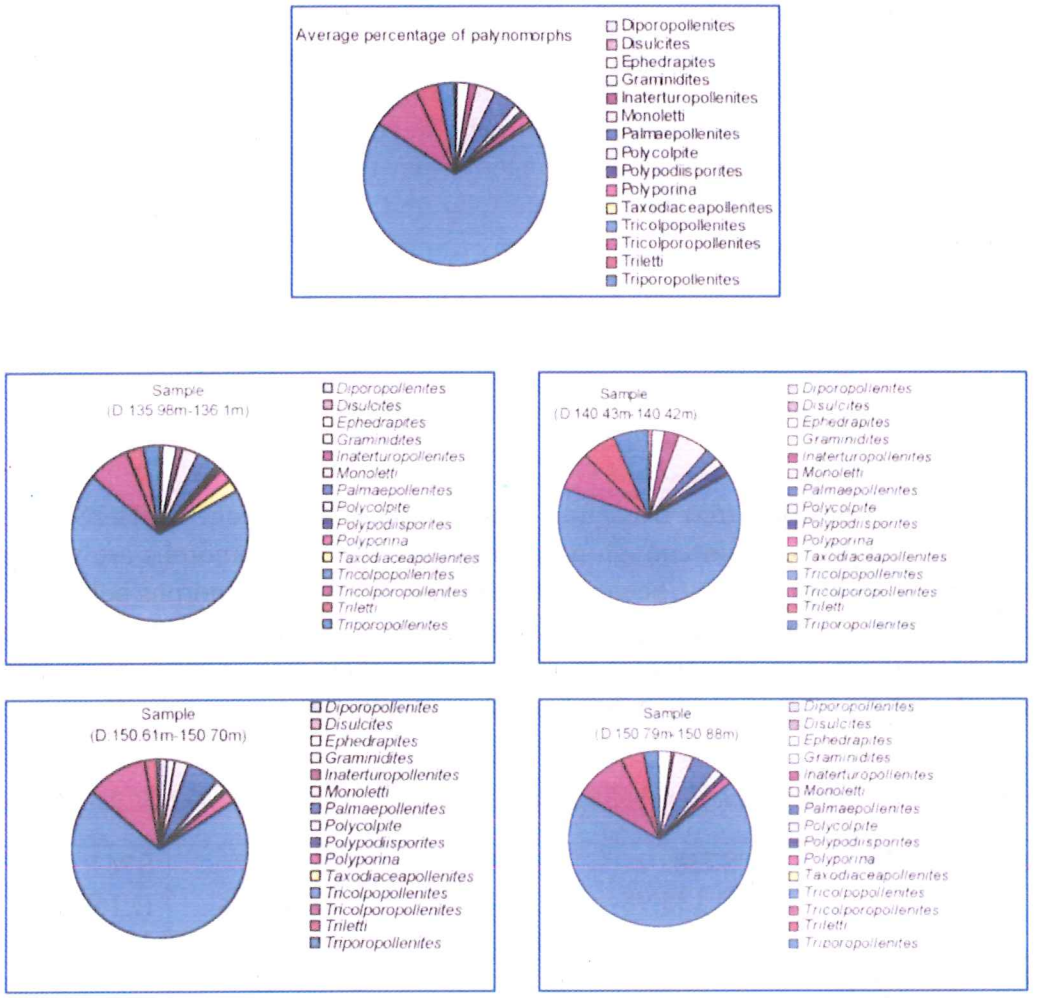

Figure 3.: *Average and sample - wise percentage of palynomorph in GDH - 28, Bariapara Dinajpur, the NW Bangladesch*

The sample B, at a depth of 140.43m-140.52m is characterized by the presence of *Disulcites* which is absent in other three samples. Here, *Tricolpopollenites* is also the dominating palynomorphs followed by *Tricolporopollenites, Triporopollenites, Monoletti* (both *Verrucatosporites* and *Laevigatosporites*). The palynomorphs *Graminidites*, *Inaperturopollenites, Palmaepollenites Polycolpites Polypodiisporites, Polyporina and Triletti,* are present as rare elements.

The sample C, at a depth of 150.61m-150.70m is recognized by the appearance of *Diporopollenites* which is absent in other three samples. But here also the dominating palynomorph is *Tricolpopollenites* followed by *Tricolporopollenites* and *Palmaepollenites*. Other associated palynomorphs are *Graminidites, Monoletti, Triletti, Polycolpites*, *Polypodiisporites, and Polyporina.*

The sample D, the lowermost, taken from a depth of 150.79m-150.88m also reveals abundant *Tricolpopollenites* followed by *Tricolporopollenites* accompanied with *Triporopollenites Palmaepollenites, Monoletti, Triletti, Graminidites, Polyporina* (?), *Disaccites* (?), *Laevigatosporites.*

All four samples contain some fungal spores. There are also some degraded palynomorphs, which could not be identified because of obscure structural features. The palynomorphs recovered from the present studies could not be identified as specific names because of limited access to the literatures.

The number of dominating *Tricolpopollenites* and also the number of *Tricolporopollenites* in samples at a depth of 135.98m-136.10m and 150.61m-150.70m are higher than that of samples at a depth of 140.43m-140.52m and 150.79m-150.88m. The overall palynomorphs and consequently the content of *Tricolpopollenites* in uppermost samples i.e., at a depth of 135.98m-136.10m is comparatively higher than that of other samples though the number of *Tricolporopollenites* in sample at a depth of 150.61m-150.70m is slightly higher.

The average percentage of some of the important palynomorphs encountered from the sedimentary formation just above the Basement Complex are 55.88% *Tricolpopollenites,* 7.4% *Tricolporopollenites,* 2.62% *Triporo-pollenites*, 3.47% *Palmaepollenites*, 3.1% *Monoletti*, 2.99% *Triletti*, 1.73% *Graminidites*, 1.4% Polyporina, 0.7% *Polypodiisporites*. The average and sample-wise percentages of palynomorphs have been shown by pie diagrams in Fig. 3, and the sketch of some of the palynomorphs in four plates with explanations.

PALEOENVIRONMENT IN BENGAL BASIN

Pre-Cretaceous geology of Bengal Basin is not well known except the continental Gondwana sedimentary deposits of Permo-Carboniferous age. In Mid-Cretaceous period marine transgression took place and covered the almost entire Bengal Basin (RAHMAN,. 1963). This continued upto Tertiary period with the deposition of Tura Sandstone/Chera Sandstone of Paleocene to Eocene and foraminiferal Sylhet Limestone and Kopili Formation of Middle to Upper Eocene age. With Oligocene upliftment, sea regressed (KRISHNAN, 1960) from many areas while sediments of Barail Formation were deposited in Assam and Sylhet areas. During Miocene to Pleistocene some more transgression and regression were recorded with the deposition of Surma, Tipam, DupiTila, Dihing and Madhupur Clay in shallow water, coastal to estuarine environment.

PALEOENVIRONMENT OF BARAIPARA AREA

At Baraipara, the Plio-Pleistocene Formation is present above the Basement Complex of Pre-Cambrian age. The absence of the vast deposition in between the Pre-Cambrian to Plio-Pleistocene may be explained either by erosion or by non-deposition. The unconformities between the different formations in most of the areas of Bengal Basin represent very limited time period. It is very difficult to explain such a big depositional gap at Baraipara area with the help of erosional phenomenon prior to the deposition of the next formation.

	Age		Surma Basin (and Bengal foredeep)		Lithology
	Group	Formation	Group	Formation	
Holocene		Alluvium		Alluvium	Silt, sand, gravel, and clay
	Madhupur	Dihing	Dihing Madhupur	Madhupur Clay	Pebbly sandstone sticky clay
		DupiTila	DupiTila Madhupur)	Upper DupiTila Lower DupiTila	Sandstone, coarse quartz pebbles, petrified wood
	Bhagirathi	Debagram	Tipam	Girujan Claystone	Claystone with siltstone, sandstone
Pleistocene-Miocene				Tipam Sandstone	Sandstone, coarse-grained, cross-bedded; pebbles of granite, quartzite, shale and lignite, clay
		Pandua	Surma Bhaghirati	Bokabil	Marine shale, pyritic gray, marine fossils
				Bhuban	Sandy shale, sandstone, breccia interbeds
Early Miocene-Oligocene	Barail	Bogra/ Burdwan	Barail	Renji Jenam Laisang	Siltstone, Fine-grained Sandstone, Calc. Shale
Late Eocène Middle Eocene Early Eocene Paleocene	Jaintia	Kopili Sylhet Limestone Tura Sandstone	Disang	Undiff.	Sandstone, locally glauconitic, fossiliferous shale, calc. Beds nummulitic limestone, sandstone, coal and shale
Late-Middle Cretaceous Early Cretaceous-Jurassic	Upper Gondwana	Sibganj	?	?	Course yellow-brown sandstone, clay, volcanic ash
			?	?	Basalt, andesite, shale, agglomerate
	Lower Gondwana	Late-Early Permian	?	?	Sandstone, feldspathic graywacke, coal, shale
		Kuchma			
Pre-Cambrian		Basement Complex			Gneiss and schist

(After KHAN 1980, ZAHER & RAHMAN1980 and BANERJI 1984)

So, it seems that prior to Pliocene age, the Rangpur Platform was a high land between the Bengal Foredeep (Bengal Basin) to the south and the Himalayan Foredeep to the north. Sedimentation during the Pilo-Pleistocene period covered the basement complex, with sediments eroded from the Himalayas.

The palynological investigation of this rock unit reveals the sole dominancy of angiospermous pollen grains and scarcity of gymnospermae and presence of a number of fungal spores.

In genereral, the abundance of angiospermous palynomorphs and scarcity of gymnospermous palynomorphs and also the presence of some fungal spores suggest a tropical warm, humid climate and the sediments were mos probably deposited in the deltaic condition under shallow water environment.

CONCLUSIONS

The palynomorphs like *Tricolpopollenites, Tricolporopollenites, Triporo-pollenites, Palmaepollenites, Laevigatosporites, Polyporina and Graminidites* encountered in the sedimentary formation just above the basement complex at Baraipara are also reported to be found in Assam, Tripura and Kutch Basin of Tertiary age in India by different authors. SAH & DATTA (1967) recorded the presence of *Palmaepollenites, Polyporina Graminidites, Monoletti, Tricolpo-pollenites, Triporopollenites* and *Triporopollenites* from Tertiary succession of Assam Basin.

BISWAS (1961) and BAKSI (1972) reported *Palmaepollenites, Tricolpites* together with others Angiospermae and a few Gymnospermal pollen grains from Bengal Basin of Tertiary age. Palynological analysis of Assam Basin by VENKATACHALA (1978) revealed the presence of *Tricolpites* and *Triporopollenites* together with pollen grains of Mio-Pliocene age in the Bhuban and Bokabil Formation; Graminae of the same age in the Tipam Sandstone and *Polyporina* in the Dihing formation of Pliocene age.

VENKATACHALA (1972) assigned Siwalik formation as Miocene by the presence of *Palmae* and *Graminae* along with other pollen grains. He also reported *Chenopodiacae* from Murree formation of Tertiary age in the Jammu area. BANERJEE (1968) and other Indian authors documented a large number of angiosperm and a few number of gymnospermal pollen grains. Palynological analysis of Cuavery Basin of Tertiary age of Peninsular India by Venkatachala and Rawat reveals the presence of *Tricolpopollenites, Monoporopollenites* and *Polyporina* together with other pollen grains.

TRAVERSE (1988) mentioned that a *Monoporopollenites* (*Gramineae*) – a grass pollen, and a number of *Tricolpopollenites* such as *Quercus, Acer, Ilex*, etc are the pollens of common Pleistocene trees and shrubs and also some *Polyporina* (*Chenopodiceae*)like *Alnus, Ulmus, Pterocarya* are the characteristic pollen grains of Plio-Pleistocene age. And these types of pollen grains are also more or less common in GDH-28. In NW Europe, some species of *Tricolpopollenites* and *Tricolporopollenites* are very abundant in Pliocene and in older age which declines in sediments to wards the boundary of Plio-Pleistocene (TSCHUDY & SCOTT, 1969).

ALDERSON (1991) documented the presence of *Cyathidites Graminidites, Laevigato-sporites, Polypodiisporites, Triporopollenites, Retitriporites, Tricol-porites, Foveotriletti* etc in rock units – Bhuban to DupiTila Formation of Miocene to Pleistocene age, and *Cyathidites, Dicolpopollis, Inaperturopollenites, Striatricolpites, Retitricolpites* in DupiTila Formation of Plio-Pleistocene from Surma Basin, the northeast Bangladesh.

AKHTAR (1992) reported the presence of *Graminidites, Monoletti Palmaepollenites, Polyporina, Tricolpopollenites, Tricolporopollenites, Triletti, Triporopollenites,* etc. from Girujan Clay of Tipam Group of St. Martin's Island, Cox's Bazar, Bangladesh. She concluded on the basis of the type of palynomorphs that the rock unit may be of Neogene in age but considering immaturity of overall pollen grains she also mentioned that the rock units is comparatively younger in age, probably closer to the Pliocene. REIMANN (1993) mentioned a number of such palynomorphs in Tertiary rock sequence of Bangladesh.

The present study in view of above discussions suggests that the palynomporphs documented from rocks of Tertiary sequence in Indian sub-continent are more or less similar type. The present findings show that almost all palynomorphs are greenish yellow or very light yellow in colour which means immaturity of colour and it indicates comparatively younger age, and it may be Pilo-Pleistocene and the rock unit may belong to DupiTila or Dihing Formation.

Considering the palynological evidences, specially the immaturity of pollen grains along with lithological point of view, it may be said that the rock formation just above the basement complex at Baraipara is much younger than DupiTila Formation. That is, it appears to be more similar to the Dihing Formation than the DupiTila, or it may be closely comparable with the sediments of both formation of Pilo-Pleistocene age.

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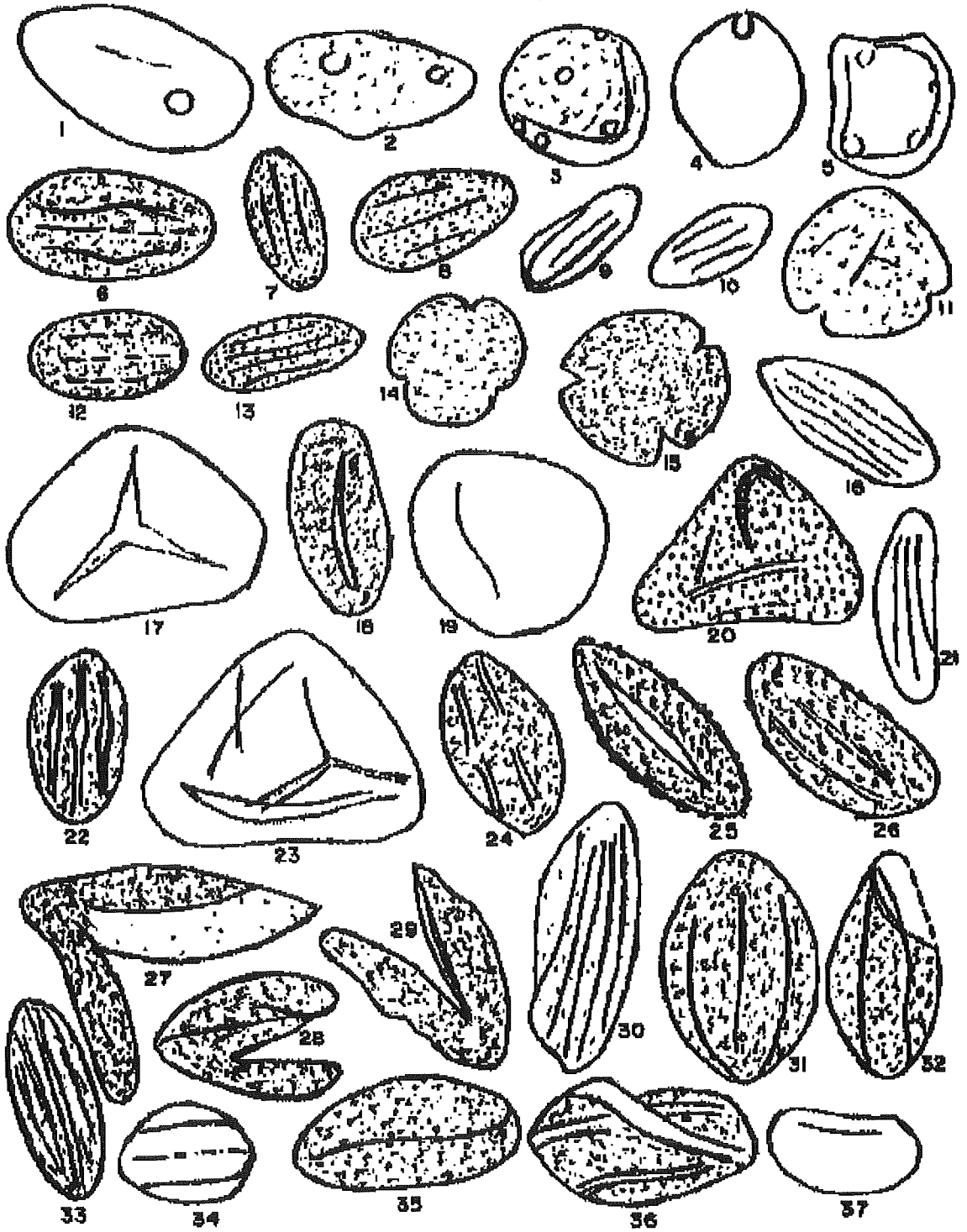

Plate 1: 1.Graminidites, 2. Triporopollenites, 3. Polyporina , 4. Graminidites, 5. Tetraporities (Planera hebridica? – Simpson 1961 , 6. Tricolporopollenites, 7 & 8. Retitricolpopollenites, 9 & 10. Tricolpopollenites (psilate), 11. Triporopollenites, 12. Retitricolpites ovalis-Van der Hammen et Wymstra 1964, 13. Tetracolpopollnites, 14. Retitriporopollenites, 15. Retitricolpopollenites, 16. Polycolpites, 17. Triletti/Cyathidites, 18 & 19. Palmaepollenites, 20. Granotriletti, 21. Tricolpollenites, 22. Retitricolporites ellipticus-Van Hoeken-klinkenberg (1966), 23. Triletti, 24. Retitricolporopollenites, 25. Monosulcites, 26. Verrutricolpopollenites, 27, 28 & 29. Taxodiaceapollenites/ Taxodium , 30. Polycolpites, 31 & 32. Retitricolpopollenites, 33. Ephedrapites, 34. Tricolpopollenites, 35. Monosulcites, 36. Retitricolpopollenites, 37. Laevigatosporites.

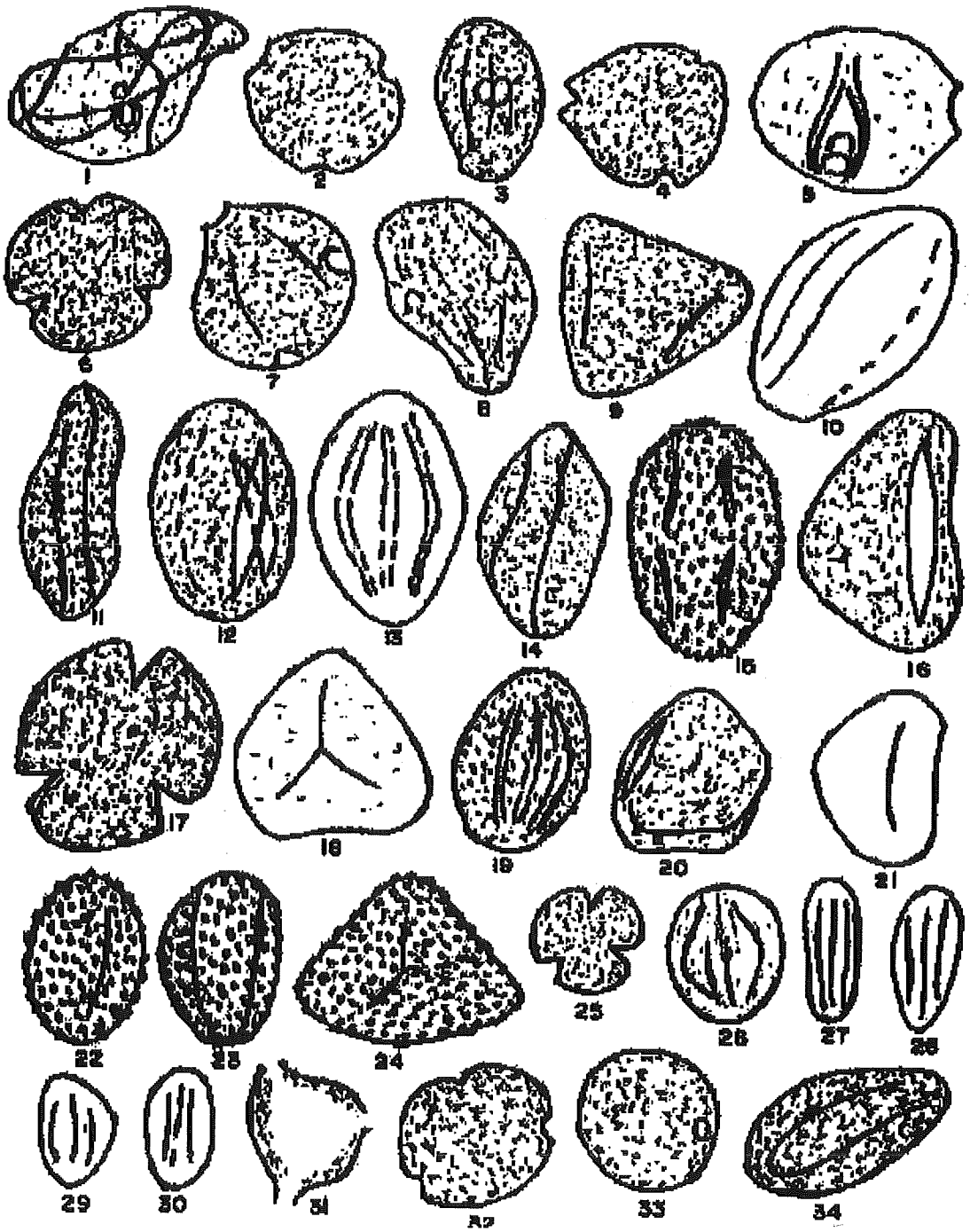

Plate 2: 1.Graminidites, 2. Retitriporopollenites, 3. Foveotricolporities floreschutzi-Van der Hammen et Wymstra (1964), 4 & 7.. Retitriporopollenites/Corylus mullensis-Simpson(1961), 5. Tricolporopollenites, 6. Retitricolporopollenites, 8. Retitricolporopollenites, 9. Disulcites, 10. Tricolpopollenites–psilate, 11 & 12. Retitricolpopollenites, 13. Tricolporopollenites, 14. Retitricolpopollenites, 15. Foveotricolporopollenites, 16. Monoletti, 17. Retitricolpopollenites, 18. Triletti, 19. Granotricolpopollenites, 20. Monoletti, 21. Laevigatosporites, 22. Verrucososporites, 23. Verrutricolpopollenites/Menisperum scoticum? (Simpson,1961) 24. Foveotriletti, 25. Retitricolpopollenites, 26. Striatotricolporopollenites, 27, 28, 29 & 30. Tricolpopollenites- laevigate, 31. Mereuriales type/ Momipites / Corylus (Betulaceae)-Van Hoeken-klinkenberg(1966)?, 32. Retitriporopollenites, 33. Graminidites, 34. Retitricolpopollenites.

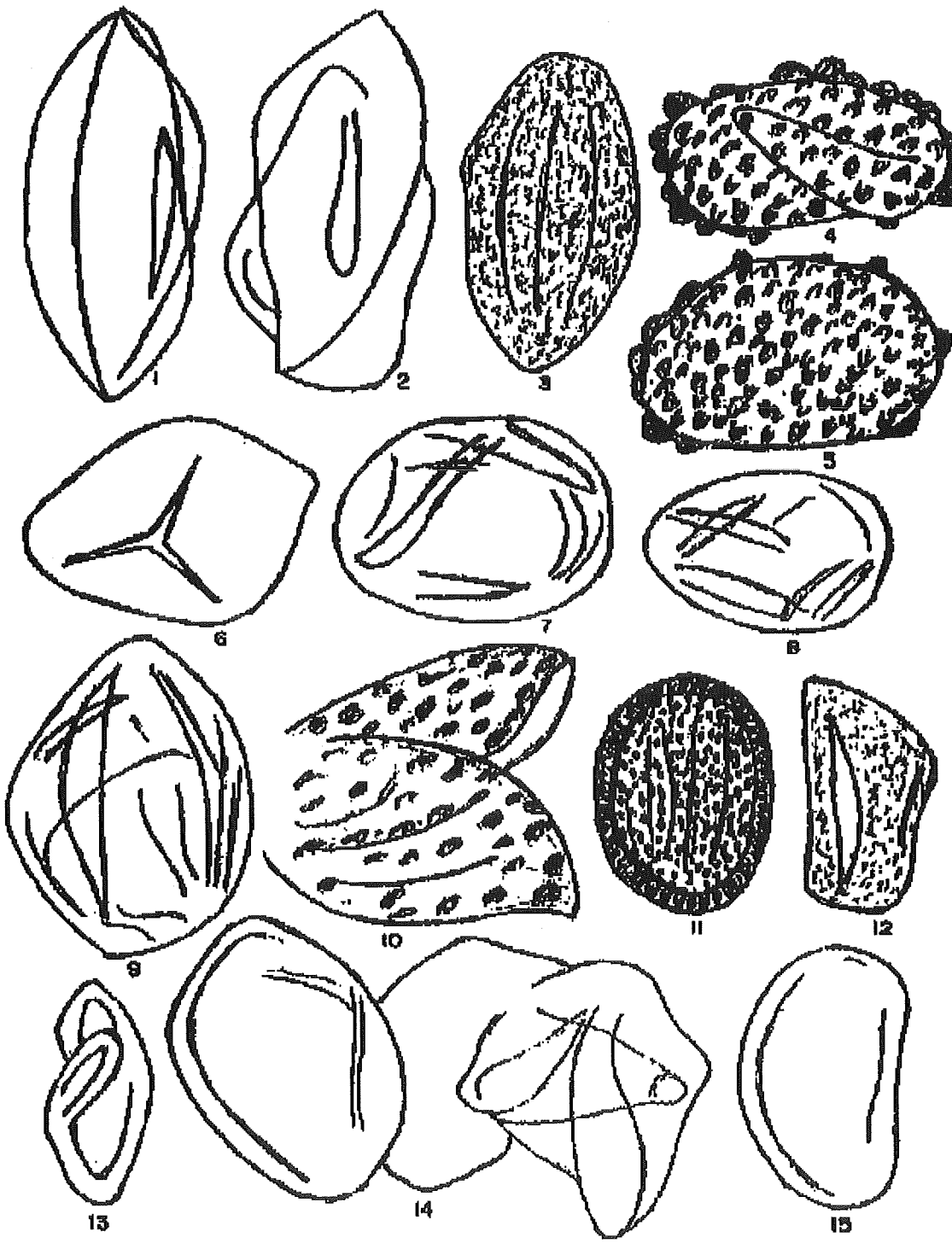

Plate 3: 1. Laevigatosporites, 2. Palmaepollenites (may be Magnolia scotica - Simpson,1961), 3. Retitricolpopollenites, 4 & 5. Polypodiisporites, 6. Triletti, 7 & 8. Inaperturopollenites, 9. Inaperturopollenites ?, 10. Indeterminate, 11. Foveotricolpopollenites, 12. Monoletti, 13. Tricolpopollenites ?, 14. Graminidites, 15. Laevigatosporites.

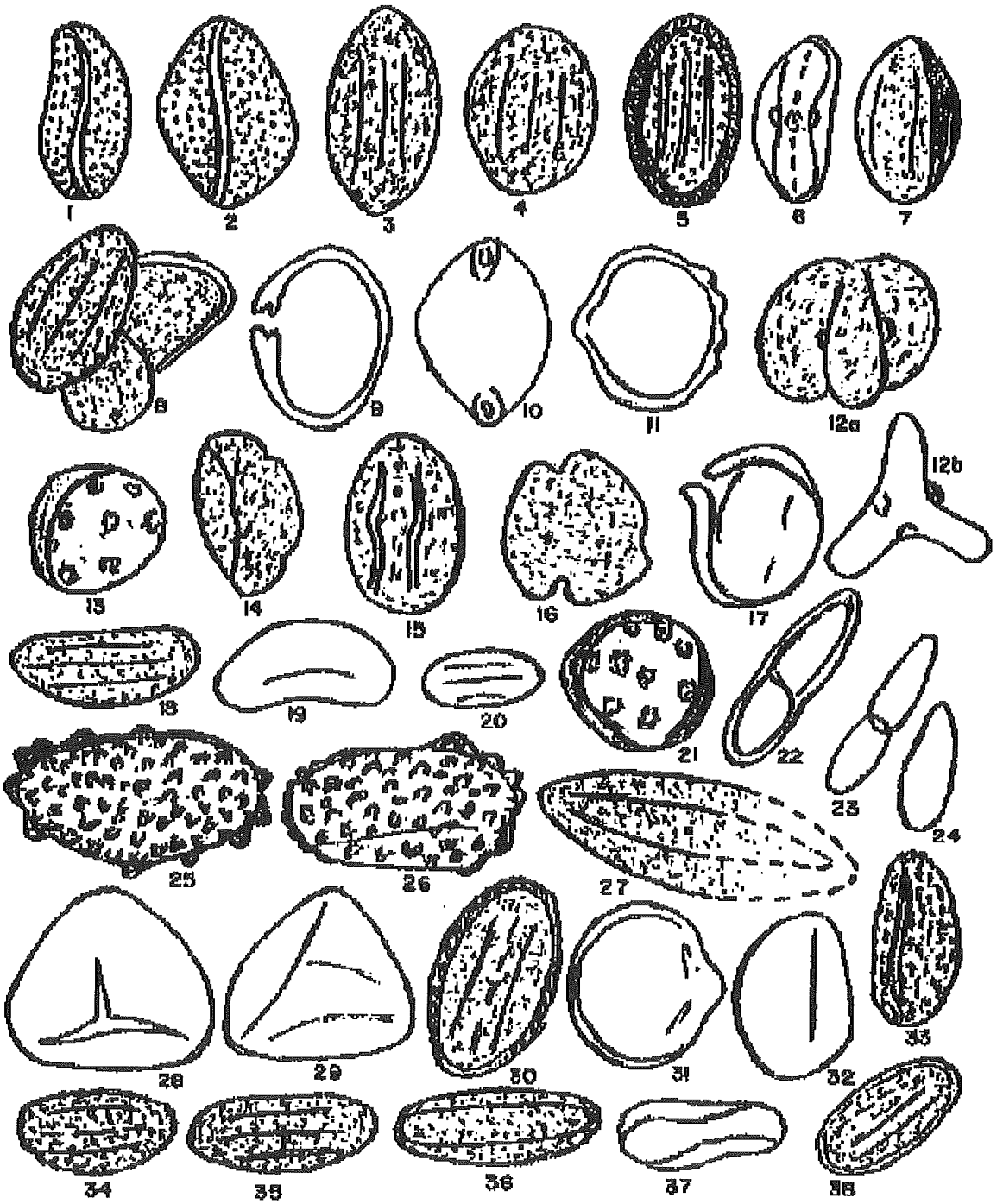

Plate 4: 1 & 2. Monosulcites/Monocolpites (Gemmanocolpites gemmatus?-Van der Hammen, 1954) , 3 & 4. Retitricolpopollenites, 5. Tricolpopollenites-verrucate/clavate (may be Ilex) , 6. Psilatricolporopollenites[Pasania (Quercus) densiflora-Simpson,1961, 7 & 8. Retitricolpopollenites, 9. Triporopollenites, 10. Diporopollenites, 11. Polyporina (?), 12a/12b. Retitricolporopollenites, 13. Polyporina, 14. Retitriporopollenites, 15. Retitricolporopollenites, 16. Retitriporopollenites, 17. Tricolpopollenites/Triporopollenites (?),18. Tricolpopollenites 19. Laevigatosporites, 20. Tricolpopollenites, 21. Polyporina, 22, 23 & 24. Fungus spores, 25 &26. Polypodiisporites, 27. Retitricolpopollenites, 28 & 29. Triletti, 30. Tricolpopollenites, 31. Tricolpopollenites/Artemisia ? may be pollen grain of Compositae, 32. Palmaepollenites, 33. Monosulcites, 34. Verrutricolpopollenites 35.Retitricolpopollenites, 36. Retitricolpopollenites, 37. Ginkgo shiabensis-Simpson (1961), 38. Retitricolpopollenites.