Palynofloral Assemblage from Siwalik Foredeep Neogene Sediments of Darjeeling Foot Hills, Eastern Himalaya

Samik Mitra, Subir Bera* and Manju Banerjee

Department of Botany, University of Calcutta, Calcutta - 700 019

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Fifty seven species under fifty three genera are recorded from the Siwalik foredeep basin of Darjeeling foothills, Eastern Himalaya. Fifteen recycled Permian taxa occur in the assemblage. The assemblage containing dinocyst, *Heliospermopsis* - the isolated salt glands of mangrove plant leaves, *Spinizonocolpites*, *Palaeosantalaceaepites*, *Araliaceoipollenites*, *Psilodiporites* suggests near shore to back swamp environment at a certain phase of deposition. *Cupuliferoidaepollenites*, *Triporopollenites*, *Alnipollenites* and *Pinuspollenites* suggest influence of temperate climate at the time of deposition.

Key-words–Palynoassemblage, Siwalik, Darjeeling Foot Hills, Tropical nearshore, Temperate.

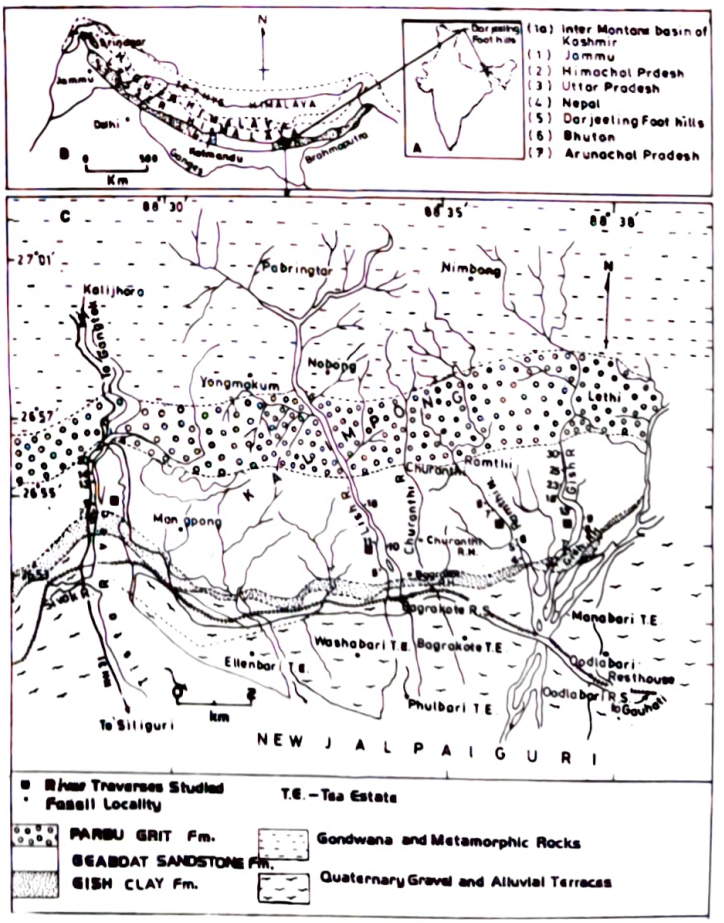
INTRODUCTION

PALYNOASSEMBLAGES have been recorded from almost all the Siwalik foredeep basins (Mathur, 1984; Mathur & Mathur 1991; Singh 1992; Singh & Tripathi 1990; Banerjee & Dasgupta 1995). However, palynological study of Darjeeling foredeep basin has not been attempted so far. Recently, a short report on Darjeeling foot hills palynoassemblage has been communicated (Banerjee & Pathak 1998). In the present paper a detail palynofloristic study of Siwalik sediments from four river traverses of Darjeeling foot hills (Map 1) is recorded for the first time. Megafloral assemblages are, however, known from the Neogene sediments of Darjeeling foot hills since long time (Pathak 1969; Antal & Awasthi 1993; Antal & Prasad 1995; Antal & Prasad 1996a,b,c; Antal *et al.* 1996; Banerjee & Mitra 1997, 1998; Banerjee *et al.* MS).

The sedimentary succesion of Neogene sediments in the Darjeeling foot hills as described by Ganguly and Rao (1970) and Acharyya (1994) are given in Table 1.

MATERIAL AND METHOD

Samples are from Tista, Lish, Gish and Ramthi Nala traverses in the Darjeeling foot hills. Some of the samples are from ONGC collection, some collected during 1980-1985, rest are recent collection during 1997-1999. Samples collected include black shale, sandy shale, sandstones and siltstones mostly from Geabdat Sandstone Formation (Table 1). Total number of samples collected, sample position in the respective traverses and lithology of the samples which have recovered palynomorphs so far are enumerated in Table 2.



Map 1. Location Map

The usual techniques for recovery of palynomorphs using HCl, HF, HNO_3 and KOH have been adopted including specific gravity floatation method. Slides prepared in glycerine jelly are kept in the repository, Palaeobotany and Palaeopalynology Laboratory, Department of Botany, University of Calcutta.

OBSERVATION

The taxa identified are enlisted in the check list (Table 3; Plate 1, figs 1-36; Plate 2, figs 1-10).

DISCUSSION AND CONCLUSION

The miofloral assemblage recovered from the Neogene sediments of Darjeeling foot hills include fifty seven species under fifty three genera of which fifteen are Permian recycled taxa (Plate 1, figs 1-36; Plate 2, figs 1-10). Palynomorphs recovered from different stratigraphic levels of Geabdat Sandstone Formation of Siwalik sequence (Map-1) have affinities to plants growing in tropical, subtropical, temperate, cosmopolitan, humid, fresh water, mangrove swamp and shallow marine environmental conditions (Table 3).

A good number of megaplant remains of similar environmental conditions have been recorded from the same sediments (Awasthi 1993; Antal & Prasad, 1995, 1996a-c, 1997, 1998; Banerjee *et al.* 1996, 1997; Banerjee & Mitra, 1998). The mega-plant remains include members of Anacardiaceae, Apocynaceae, Arecaceae, Anonaceae, Asteraceae, Burseraceae, Combretaceae, Clusiaceae, Dilleniaceae, Dipterocarpaceae, Ebenaceae, Euphorbiaceae, Flacourtiaceae, Fabaceae, Lauraceae, Lythraceae, Marantaceae, Poaceae, Rubiaceae, Sapindaceae, Sterculiaceae, Tiliaceae, Urticaceae and Verbenaceae. The assemblage suggests occurrence of a tropical, wet evergreen to moist deciduous forest in the Neogene Siwaliks of Darjeeling foot hills.

Table 1: Stratigraphic succession in the frontal zone of eastern Himalaya.

Darjeeling Foot hills	Age	
Damuda Formation	Permian	
——— MBT———		
Chunabati Formation (Contain horses of Damuda & slivers of earliest Miocene limestone)	Early Miocene	
——Thrust———		
Murti Boulder Bed Formation		
Parbu Grit Formation	Upper Siwalik	Neogene
Geabdat Sandstone Formation	Middle Siwalik	Neogene
Gish Clay Formation	Lower Siwalik	Neogene
—— Foot hill Thrust ——		
Alluvial topped sediments of Ganga-Brahmaputra Basin		

Palynomorphs belonging to tropical wet evergreen to moist deciduous plant families viz., Sterculiaceae (*Bombacacipites nacimientos*), Anacardiaceae (*Rhoipites nitidus*), Apocynaceae (*Psilodiporites hammenii*) and Tilliaceae (*Retitricolporites guianensis*) have been recorded from the same sediments. *Graminidites* pollen grains of Poaceae are associated with megascopic graminaceous spikelets *Sharmatheca siwalikensis* (Banerjee & Mitra, 1998).

Occurrence of *Spinizonocolpites brevispinosus*, *Heliospermopsis* spp. (Nagy) Banerjee, 1985, the isolated salt glands of mangrove plant leaves, dinocysts,

PLATE 1 ⟶

(All figures magnified x 700)

Fig. 1 - *Notothyrites setiferus*, Fig. 2 - *Meliolinites* sp., Fig. 3 - *Alternaria* type, Fig. 4 - *Polyadosporites* sp., Fig. 5 - *Dicellaesporites minutus*, Fig. 6 - ? Dinocyst type - 1, Fig. 7 - ? Dinocyst type - 2, Fig. 8 - Microthyriaceous germling, Fig. 9 - *Polypodiisporites speciosus*, Fig. 10 - *Dictyophyllidites trilobiformis*, Fig. 11 - *Alsophilidites* sp., Fig. 12 - *Laevigatosporites gracilis*, Fig. 13 - *Ephedripites* sp., Fig. 14- *Graminidites media*, Fig. 15 - *Palmaepollenites kutchensis*, Fig. 16 - *P. plicatus*, Fig. 17 - *P. keralensis*, Fig. 18 - *P. ovatus*, Fig. 19 - *P. communis*, Fig. 20 - *Spinizonocolpites brevispinosus*, Fig. 21 - *Liliacidites crassireticulatus*, Fig. 22 - *Bombacacipites nacimientos*, Fig. 23 - *Cupuliferoidaepollenites quisqualis*, Fig. 24 - *Polybrevicolporites cephalus*, Fig. 25 - *Retitricolporites guianensis*, Fig. 26 - *Araliaceoipollenites reticulatus*, Fig. 27 - *Favitricolporites microreticulatus*, Fig. 28 - *Tetracolporites onagraceoides*, Fig. 29 - *Sapotaceoidaepollenites communis*, Fig. 30 - *Palaeosantalaceaepites primitiva*, Fig. 31 - *Alnipollenites verus*, Fig. 32 - *Tricolpites reticulatus*, Fig. 33 - *Rhoipites nitidus*, Fig. 34 - *Cupuliferoipollenites ornatus*, Fig. 35 - *Triporopollenites triangularis*, Fig. 36 - *Chenopodipollis miocenica*.


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PLATE 1

Palaeosantalaceaepites (Rhizophoraceae), *Araliaceoipollenites* (Araliaceae), *Psilodiporites* (Apocynaceae) suggest nearshore to back mangrove swamp environment indicating marine influence at certain phase of deposition. Record of *Ramanujamipalmaephyllum siwalikensis*, a pinnately compound palm leaf from Ramthi Nala Section having close affinity to modern day nypoid palm, supports the near shore environment of the deposits. In addition, occurrence of diverse types of palm pollen also signifies prevalence of coastal environment. Acharyya *et al.* (1987), Sinha and Srivastava (1992), Acharyya (1994) have described Early Miocene planktonic microforaminifera from Chunbati Formation of Darjeeling foot hills. Shallow marine and mangrove swamp environment have been recorded in the Lower and early Middle Siwalik of Bhutan (Banerjee, 1985, 1995, 1996a,b; Banerjee & Dasgupta, 1995).

Presence of *Cupuliferoidaepollenites* (Fagaceae), *Triporopollenites* (Betulaceae/ Myricaceae), *Alnipollenites* (Betulaceae) and *Pinuspollenites* (Pinaceae) suggests influence of temperate climate at the time of deposition. The occurrence of the temperate climate loving plant pollen grains in the assemblage further suggests that uprising of the Himalayas has already initiated at the time of deposition of the Geabdat Sandstone Formation. The palynomorphs produced by the plants of temperate climate forest growing in the high slopes in near vicinity were carried to the site of deposition.

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Table 2 : Total number and details of samples yielding palynomorphs from Siwalik sediments of four traverses from Darjeeling foot hills.

Formation	Sample nos.	Lithology
TISTA RIVER	(Total 20 samples collected)	
TRAVERSE	S/TR-20	Brown fine grained sandstone.
	S/TR-14	Brown fine grained sandstone with paper salt
Geabdat Sandstone	S/TR-13	Brown coloured sandstone
	S/TR-9	Paper salt, sandstone with leaf impression
	S/TR-7	Grey coloured fine grained sandstone
	S/TR-4	Dark coloured sand stone
LISH RIVER	(Total 23 samples collected)	
TRAVERSE	S/LR-18	Dark coloured shale
	S/LR-11	Brownish-grey fine grained sandstone
Geabdat Sandstone	S/LR-10	Fine grained greyish-brown sandstone
	S/LR-5	Fine grained brownish grey sandstone.
GISH RIVER	(Total 33 samples collected)	
TRAVERSE	S/GR-30	Brownish grey fine grained sandstone.
	S/GR-25	Grey clay
	S/GR-23	Brownish grey fine grained sandstone
Geabdat Sandstone	S/GR-18	Bluish grey clay
	S/GR-13	Fine grained sandstone with leaf impression
	S/GR-9	Fine grained brown sandstone
	S/GR-8	Fine grained sandstone
	S/GR-7	Fine grained sandstone
RAMTHI NALA	(Total 26 samples collected)	
TRAVERSE	S/RN-8	Fine grained sandstone with leaf impressions
	S/RN-7	.....
Geabdat Sandstone	S/RN-6	Fine grained sandstone with leaf impressions
	S/RN-5	Blackish claystone
	S/RN-4	Dark coloured fine grained sandstone

PLATE 2 →

(All figures magnified x 700)

Fig. 1 - *Polyadopollenites* sp., Fig. 2 - *Heliospermopsis* sp., Fig. 3 - *Marsupipollenites* sp., Fig. 4 - *Pinuspollenites tenuicorpus*, Fig. 5 - *Alisporites* sp., Fig. 6 - *Rhizomaspora* sp., Fig. 7 - *Psilodiporites hammeni*, Fig. 8 - *Primuspollenites* sp., Fig. 9 - *Scheuringipollenites* sp., Fig. 10 - *Microbaculispora* sp.

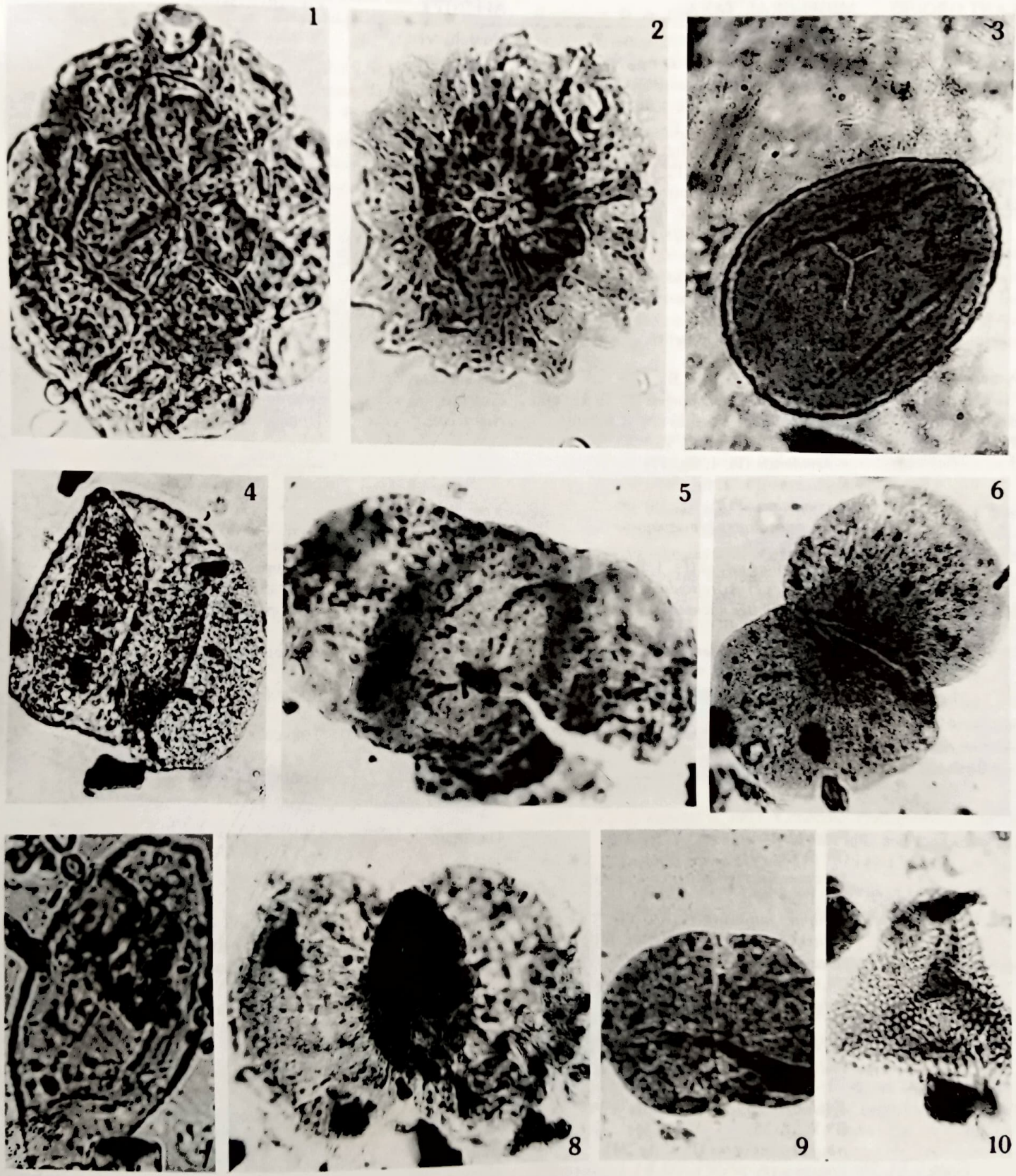

PLATE 2

Table 3: Affinity and environmental consideration of mioflora recovered

PLANT GROUPS	MIOFLORAL TAXA	AFFINITY	ENVIRONMENT
Algae	? Dinocyst type-1 (Pl. 1, fig.6)	Dinophyceae	Shallow marine
	? Dinocyst type-2 (Pl. 1, fig. 7)	Dinophyceae	Shallow marine
Fungi	*Dicellaesporites minutus* (Pl. 1,fig. 5)	Uncertain	Tropical humid
	Polyadosporites sp. (Pl. 1,fig. 4)	Uncertain	.....".....
	Alternaria type (Pl. 1, fig. 3)	*Alternaria* sp.	.....".....
	Meliolinites sp. (Pl. 1 fig. 2)	Meliolinaceae	.....".....
	Notothyrites setiferus (Pl. 1, fig.1)	Microthyriaceae	.....".....
	Microthyriaceous germlings (Pl. 1, fig. 8)	Microthyriaceae	.....".....
Pteriodophytes	*Alsophilidites* sp. (Pl. 1, fig. 11)	Cyatheaceae	Tropical and subtropical
	Dictyophyllidites trilobiformis (Pl. 1, fig. 10)	*Coniopteris* sp. (Dicksoniaceae)	Cosmopolitan
	Gleicheniidites senonicus	Gleicheniaceae	Tropical and subtropical
	Polypodiisporites speciosus (Pl. 1, fig. 9)	Polypodiaceae	Cosmopolitan
	Laevigatosporites gracilis (Pl. 1, fig. 12)	Polypodiaceae	.....".....
Gymnosperms	*Ephedripites* sp. (Pl. 1,fig. 13)	Ephedraceae	Tropical and subtropical
	Pinuspollenites tenuicorpus (Pl. 2, fig. 4)	Pinaceae	Subtropical - Temperate
Angiosperms	*Palmaepollenites ovatus* (Pl. 1, fig. 18)	Arecaceae	Tropical and subtropical
Monocotyledons	*P. kutchensis* (Pl.1, fig. 15)	.....".....	.....".....
	P. keralensis (Pl. 1, fig. 17)	.....".....	.....".....
	P. plicatus (Pl.. 1, fig. 16)	.....".....	.....".....
	P. communis (Pl. 1, fig. 19)	.....".....	.....".....
	Spinizonocolpites brevispinosus (Pl. 1, fig. 20)	*Nypa* sp. (Arecaceae)	Tropical - subtropical, Swampy mangrove.
	Graminidites media (Pl. 1, fig. 14)	Poaceae	Cosmopolitan
	Liliacidites crassireticulatus (Pl. 1, fig. 21)	Liliaceae	.....".....
Dicotyledons	*Bombacacipites nacimientos* (Pl. 1, fig. 22)	*Freemontodendron* sp. (Sterculiaceae)	Pantropical and subtropical
	Cupuliferoidaepollenites quisqualis (Pl. 1, fig. 23)	Uncertain	Temperate
	Tricolpites reticulatus (Pl. 1, fig. 32)	*Gunnera* sp. (Haloragaceae)	Cosmopolitan
	Araliaceoipollenites reticulatus (Pl. 1, fig. 26)	Araliaceae	Tropical
	Cupuliferoipollenites ornatus (Pl. 1, fig. 34)	*Castanea* sp. (Fagaceae)	Temperate
	Favitricolporites microreticulatus (Pl. 1, fig. 27)	Uncertain	—
	Sapotaceoidaepollenites communis (Pl. 1 fig. 29)	Sapotaceae	Tropical
	Rhoipites nitidus (Pl. 1, fig. 33)	Anacardiaceae	Tropical and temperate
	Retitricolporites guianesis (Pl. 1, fig. 25)	*Grewia* sp. (Tiliaceae)	Tropical, marshy
	Tetracolporites onagraceoides (Pl.1. fig. 28)	Onagraceae	Cosmopolitan
	Palaeosantalaceaepites primitiva (Pl. 1, fig. 30)	Rhizophoraceae	Tropical, mangrove
	Polybrevicolporites cephalus (Pl. 1, fig. 24)	Uncertain	—
	Psilodiporites hammenii (Pl. 2, fig. 7)	Apocynaceae/ Proteaceae	Cosmopolitan
	Triporopollenites triangularis (Pl.1, fig. 35)	Betulaceae/ Myricaceae	Temperate
	Alnipllenites verus (Pl.1, fig. 31)	*Alnus* sp. (Betulaceae)	.....".....
	Chenopodipollis miocenica (Pl. 1, fig. 36)	Chenopodiaceae	Halophyte
	Polyadopollenites sp. (Pl. 2, fig. 1)	Uncertain	—
Incertae sedis	*Heliospermopsis* sp. 1 (Pl. 2, fig. 2)	Salt gland of ?	Tropical, mangrove
	Heliospermopsis sp. 2	*Aegiceras* sp.	

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