

Table S1.

Compiled mangrove pollen records at three thermal maxima (PETM, EECO, MMCO), referring to locations (exposed sections and boreholes) in Figures 2 and 3, with sources on bio- and chronostratigraphy and palaeolatitude estimates.

56 Ma Paleocene–Eocene thermal maximum (PETM): late Thanetian – early Ypresian.

Site No	Location (studied interval for holes)	Present latitude - longitude	Estimated N palaeolatitude	Mangrove pollen identified by	Mangrove taxa	References	
						Bio-chronostratigraphy	Pollen data
1	Site M0004A (382.44 mbsf) ¹	87°51'59.76"N 136°10'38.64"E	>76°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i>	Suc et al. (2020)	
2	Faddeevsky Island Samples GS124-127 ²	76°06'23.30"N 141°49'01.70"E	80°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i>	Suan et al. (2017)	
5	Site 918 hole D (1180.71-1180.49 mbsf)	63° 5'10.82"N 38°39'35.30"W	55°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i> <i>Rhizophoraceae</i> <i>Xylocarpus</i> <i>Brownlowia</i>	Jolley (1998) Larsen et al. (1994) Wei (1998)	This work
7	Noirmoutier Samples 1-3	47° 0'39.99"N 2°13'11.04"W	35°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i> <i>Rhizophoraceae</i> <i>Xylocarpus</i> <i>Nypa</i>	Ters (1978) Olivier-Pierre (1980)	This work
8	Calavanté 1 (3350 m)	43°12'31.00"N 0°10'59.00"E	32°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i> <i>Nypa</i>	Sztrákos et al. (1998)	This work
11	Site 547 hole A (279.53-279.31 mbsf)	33°46'50.40"N 9°20'58.80"W	19°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i> <i>Rhizophoraceae</i> <i>Sonneratia</i> -type <i>Excoecaria</i> <i>Xylocarpus</i>	Hinz et al. (1984)	This work

Site Number (No) refers to Figure 2.

¹ Depth is indicated in mbsf (metres below sea level) for offshore boreholes.

² Samples are listed from base to top.

54–49 Ma Early Eocene climatic optimum (EECO): Ypresian.

Site No	Location (studied interval for holes)	Present latitude - longitude	Estimated N palaeolatitude	Mangrove pollen identified by	Mangrove taxa	References	
						Bio-chronostratigraphy	Pollen data
1	Site M0004A (318.86-282.05 mbsf)	87°51'59.76"N 136°10'38.64"E	>78°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i>	Backman et al. (2006)	Suc et al. (2020)
3	Caribou Hills Samples 12-18	68°45'0.07"N 134°14'0.00"W	73°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i>	Salpin et al. (2019)	
4	Site 343 (214.30-213.99 mbsf)	68°43'13.07"N 5°46'21.54"E	58°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i> <i>Rhizophoraceae</i> <i>Xylocarpus</i> <i>Scyphiphora</i> <i>Excoecaria</i>	Müller (2007) Schrader et al. (2007)	This work
5	Site 918 hole D (1158.21-1156.71 mbsf)	63° 5'10.82"N 38°39'35.30"W	55°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i> <i>Rhizophoraceae</i> <i>Sonneratia</i> -type <i>Brownlowia</i> cf. <i>Heritiera</i>	Larsen et al. (1994) Wei (1998)	This work
6	Kallo 027E148 (286.50-239 m)	51°15'8.25"N 4°17'38.21"E	40°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i> <i>Rhizophoraceae</i> <i>Sonneratia</i> -type <i>Nypa</i>	Roche (1973) Steurbaut (2006)	This work
9	Morlaås 1 (1462-1083 m)	43°19'42.00"N 0°14'17.00"W	32°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i> <i>Rhizophoraceae</i> <i>Sonneratia</i> -type <i>Nypa</i> <i>Pelliciera</i> <i>Xylocarpus</i>	Sztrákos et al. (1998)	This work
10	Gan Samples 1-2	43°13'54.20"N 0°23'45.80"W	33°	S.-M. Popescu J.-P. Suc	<i>Avicennia</i> <i>Rhizophoraceae</i> <i>Sonneratia</i> -type <i>Aegialitis</i> <i>Nypa</i>	Alimen et al. (1963)	This work

Site Number (No) refers to Figure 2.

17–14 Ma Mid-Miocene climatic optimum (MMCO): late Burdigalian – Langhian.

Site No	Location (studied interval for boreholes)	Present latitude - longitude	Estimated N palaeolatitude	Mangrove pollen identified by	Mangrove taxa	References	
						Bio-chronostratigraphy	Pollen data
1	Göllersdorf Samples 1-8	48°30'06.79"N 16°07'32.44"E	45°	G. Jiménez-Moreno	<i>Avicennia</i>	Roetzel et al. (1999)	Jiménez-Moreno et al. (2008)
2	Herend 46 (79-78 m)	47°07'58.43"N 17°45'15.99"E	43°	J.-P. Suc	<i>Avicennia</i>	Nagy & Kokay (1991)	
3	Balgarevo C136A (300-270 m)	43°26'01.78"N 28°24'45.12"E	41°	J.-P. Suc	<i>Avicennia</i>	Ivanov et al. (2007)	Ivanov et al. (2007, 2015)
4	Les Mées 1 (1420-1060 m) Châteauredon	44°01'00.84"N 5°59'14.50"E 44°01'17.12"N 6°13'50.12"E	40.5°	G. Jiménez-Moreno	<i>Avicennia</i>	Dubois & Curnelle (1978) Besson et al. (2005)	Jiménez-Moreno & Suc (2007)
5	Estagel Sampes 4-10 Bayanne Samples 1-3	43°31'06.61"N 4°59'52.09"E 43°31'56.36"N 4°58'48.95"E	40°	G. Jiménez-Moreno	<i>Avicennia</i>	Besson et al. (2005)	Jiménez-Moreno & Suc (2007)
6	Narbonne V. Hugo College (23-11 m) Lespignan II Montady Saint-Génies Montagnac Mèze Loupiac Issanka Poussan Montbazin	from 43°11'34.75"N 3°00'36.88"E to 43°31'24.40"N 3°42'02.90"E	39.5°	M. Bessedik	<i>Avicennia</i>	Aguilar (1981) Cappetta (1970) Magné (1978b) Bessedik (1985)	Bessedik (1984, 1985)
7	La Rierussa Samples 1-16 Sant Pau d'Ordal	41°23'04.77"N 1°48'41.96"E 41°23'04.77"N 1°48'04.42"E	37.5°	G. Jiménez-Moreno M. Bessedik	<i>Avicennia</i>	Magné (1978a) Bessedik (1985)	Bessedik & Cabrera (1985) Jiménez-Moreno & Suc (2007) Jiménez-Moreno et al. (2010)
8	Kultak	37°04'42.27"N 27°56'24.59"E	33°	M.S. Kayseri-Özer	<i>Avicennia</i>	Kayseri-Özer (2014)	
9	Alboran A1 (1193-1163 mbsf)	36°38'00"N 4°13'23"W	33°	G. Jiménez-Moreno	<i>Avicennia</i>	Jiménez-Moreno (2005)	Jiménez-Moreno & Suc (2007) Jiménez-Moreno et al. (2010)
10	Laborde 1D (180-160 m)	43°55'48.825"N 1°04'53.459"W	40°	S.-M. Popescu J.-P. Suc	None	Ortiz et al. (2020)	This work
11	Bignona (149-135 m)	12°46'41.39"N 16°15'26.54"W	8°	J. Médus	<i>Rhizophora</i>	Médus (1975)	
12	Well M1 (2091-2012 m)	ca. 11°N, ca. 2°E	2°	E.U. Durugbo & M.A. Olayiwola	<i>Avicennia</i> <i>Rhizophora</i>	Durugbo & Olayiwola (2017)	
13	Site M0027 (250-200 mbsf)	39°38'02.76"N 73°37'18.06"W	37°		None	Mountain et al. (2010)	Kotthoff et al. (2014)
14	Alum Bluff	30°28'08"N 84°59'10"W	28.5°		None	Bryant et al. (1992)	Corbett (2004) Jarzen et al. (2010)
15	La Herradura	17°20'57.94"N 93°33'18.96"W	15°	R. Palacios Chavez	<i>Rhizophora</i> <i>Pelliciera</i> <i>Nypa</i>	Palacios Chavez & Rzedowski (1993)	
16	Lower Apaporis River	0°19'57.26"S 70°07'04.82"W	-3.5°	C. Hoorn	<i>Rhizophora</i>	Hoorn (2006)	

Site Number (No) refers to Figure 3.

Chronology

As indicated above, a relatively rough age model is provided by biostratigraphy (planktonic foraminifera and/or calcareous nannofossils). A recent oxygen isotope curve is used as reference of global climate variations (Fig. S1; Westerhold et al., 2020). This curve comes from a Cenozoic global dataset based on benthic foraminifera with a sampling interval of 2 to 4.4 kyr. The blue curve is a smoothed curve over 20 kyr and the red curve over 1 Myr. They respectively express different rhythms in temperature variability. The variations observed in pollen records (Figs. 4–6) are mainly interpreted as variation in temperature for the PETM, EECO and Göllersdorf during the MMCO because the pollen diagrams evidence humid conditions (prevailing thermophilous plants, weakness of herbs). For the other MMCO locations, the variations in pollen records are both interpreted as temperature and precipitation variations (forest humid and warmer phases marked by abundant thermophilous

trees opposed to herbaceous drier and less warm phases marked by abundant herbs). According to the time interval represented by each pollen record and according to the number of samples studied within this interval (i.e., the time resolution of each record), we tentatively correlate the pollen variations observed with either the blue curve either the red curve (Fig. S1), following the principles of climatostratigraphy described by Suc (1984), Suc et al. (2018) and Suc et al. (2020).

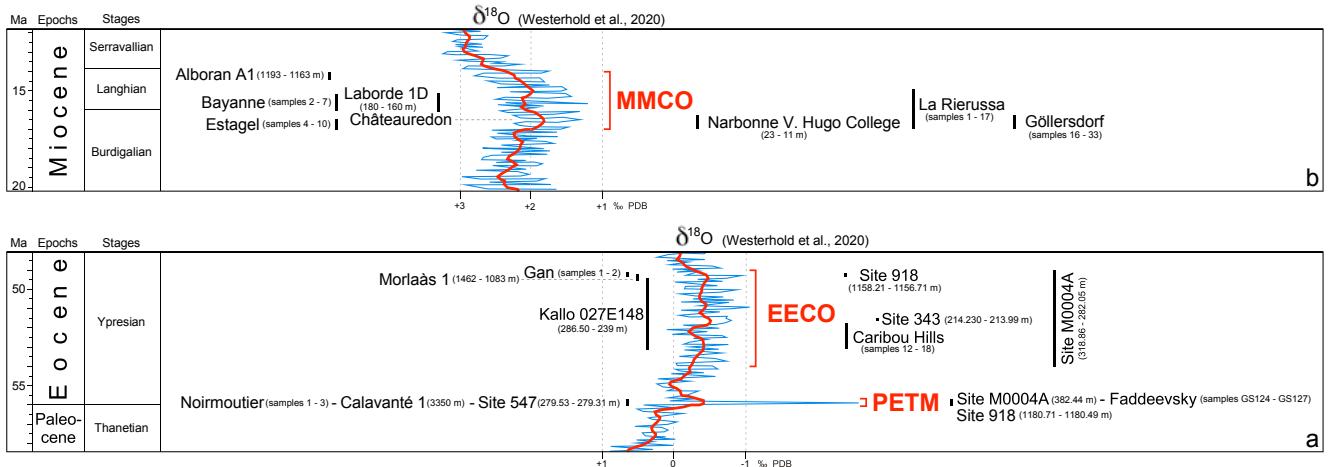


Figure S1. Climatostratigraphic correlations of the studied pollen records with the reference oxygen isotope curve: a, during the PETM and EECO; b, during the MMCO. Explanations are given above.

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Table S2. Listing of taxa constituting the ecological groups of plants used for the synthetic pollen diagrams, distributed by locations with respect to PETM, EECO and MMCO, respectively.

The suffix ‘-type’ is used to indicate that the concerned pollen morphology exists in several taxa (species or genera). The prefix ‘cf.’ means that the selected taxon has the nearest morphology with the fossil pollen after comparison with pollen of modern species or genera.

Ecological groups of plants	Taxa	PETM locations					EECO locations					MMCO locations										
		1	2	5	7	8	11	1	3	4	5	6	9	10	1	4	5	6	7	9	10	
Other mangrove trees and shrubs	<i>Avicennia</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	cf. <i>Aegialitis</i>													x								
	<i>Brownlowia</i>		x							x			x									
	<i>Excoecaria</i>					x			x													
	cf. <i>Heritiera</i>									x												
	<i>Nypa</i>		x	x							x	x	x									
	<i>Pelliciera</i>											x			x							
	<i>Rhizophoraceae</i>	x	x		x			x	x	x	x	x	x									
	<i>Scyphiphora</i>								x													
	<i>Sonneratia</i> type					x			x	x	x	x	x									
Other megathermal plants	<i>Xylocarpus</i>	x	x	x				x			x		x									
	<i>Acanthaceae</i>	x								x					x		x	x		x	x	
	<i>Alchornea</i>											x			x		x	x		x	x	
	<i>Amanoa</i>							x				x	x									
	<i>Bombax</i> type	x			x				x				x		x			x	x			
	cf. <i>Bridelia</i>									x												
	<i>Buxus bahamensis</i> type	x	x					x	x	x	x	x	x		x	x	x	x	x	x	x	
	<i>Canthium</i> type									x		x	x		x	x						
	cf. <i>Corypha</i>											x				x						
	<i>Croton</i>							x									x	x	x	x	x	
	<i>Dodonaea</i>				x				x	x	x	x	x		x		x	x	x	x	x	
	cf. <i>Drypetes</i>			x									x			x						
	<i>Euphorbiaceae</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	<i>Fothergilla</i>							x		x							x	x				
	cf. <i>Gordonia</i>								x													
	<i>Grewia-Corchorus</i>									x			x						x			
	<i>Icacinaeae</i>	x							x			x										
	cf. <i>Lasianthus</i>										x				x							
	<i>Leguminosae Caesalpinoideae</i>	x	x							x	x	x	x	x	x	x	x	x	x	x	x	
	<i>Leguminosae Mimosoideae</i>	x													x		x	x	x	x	x	
	<i>Malpighiaceae</i>																x					
	<i>Mappianthus</i>										x			x		x	x	x	x	x	x	
	<i>Melastomataceae</i>										x			x			x	x	x	x	x	
	<i>Meliaceae</i>	x									x			x	x	x	x	x	x	x	x	
	<i>Morinda-Randia</i> type										x			x								
	cf. <i>Parsonia</i>										x			x								
	<i>Passifloraceae</i>	x	x													x		x	x	x	x	
	<i>Phyllostylon</i>		x						x	x												
	<i>Prosopis</i>																	x				
	<i>Sapindaceae</i>				x				x				x	x	x	x	x	x	x	x	x	
	cf. <i>Sapium</i>												x									
	<i>Simaroubaceae</i>	x																				
	<i>Sindora</i>		x	x																		
	<i>Theaceae</i>	x																x				
	<i>Tiliaceae</i>																		x			
Mega-mesothermal plants	cf. <i>Acanthopanax</i>												x									
	<i>Agavaceae</i>																			x		
	<i>Alangium</i>													x								
	cf. <i>Alfaroa</i>	x	x	x	x	x	x	x		x	x	x	x	x	x							
	<i>Arecaceae</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	cf. <i>Beaumontia</i>			x																		

Ecological groups of plants	Taxa	PETM locations					EECO locations					MMCO locations										
		1	2	5	7	8	11	1	3	4	5	6	9	10	1	4	5	6	7	9	10	
	<i>Castanopsis-Lithocarpus</i>	x	x	x	x			x	x	x	x	x	x		x	x	x	x	x	x	x	
	<i>Casuarina</i>			x	x	x	x	x	x	x	x	x	x									
	<i>Celastraceae</i>	x			x												x	x	x			
	<i>Ceratonia</i>																x					
	<i>Chloranthaceae</i>																x					
	<i>Cissus</i>		x						x	x		x	x			x	x		x			
	<i>Cordyline</i>																	x				
	<i>Cornaceae</i>																	x				
	<i>cf. Corylopsis</i>																x					
	<i>Craigia</i>			x	x					x	x	x	x									
	<i>Cupressaceae (former Taxodiaceae type)</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Cyrillaceae-Clethraceae</i>			x				x	x		x		x			x	x	x	x	x	x	x
	<i>Dacrydium</i>							x														
	<i>Decodon</i>	x			x							x	x									
	<i>Dicoryphe</i>			x					x													
	<i>Diplodiscus</i>		x																			
	<i>Distylium</i>	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Embolanthera</i>		x	x			x			x								x				
	<i>Engelhardia</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Eustigma</i>	x		x													x					
	<i>Hamamelidaceae</i>																x	x	x	x	x	x
	<i>Hamamelis</i>																x	x	x	x	x	x
	<i>Ilex floribunda</i> type	x					x		x		x		x		x		x		x		x	
	<i>Ipomoea</i>									x												
	<i>Itea</i>										x											
	<i>Lauraceae</i>															x						
	<i>Leea</i>	x	x						x	x	x		x		x		x		x		x	
	<i>Liriodendron</i>		x																			
	<i>Loranthaceae</i>															x		x				
	<i>Loropetalum</i>	x								x	x				x	x	x		x			
	<i>Ligustrum</i>														x		x	x	x			
	<i>cf. Lysidice</i>	x																				
	<i>Magnolia</i>	x																				
	<i>Matudaea</i>								x	x												
	<i>Menispermaceae</i>	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Microtropis fallax</i>		x														x	x	x	x	x	x
	<i>Mussaenda</i> type											x	x	x	x	x	x	x	x	x	x	x
	<i>Myrica</i>	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Nolina</i>													x								
	<i>Nyssa</i>	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Nyssa cf. sinensis</i>	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Olea</i>		x						x			x			x		x	x	x	x	x	x
	<i>Phillyrea</i>																x	x	x	x	x	x
	<i>Pistacia</i>															x						
	<i>Platycarya</i>	x	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Rhamnus</i>																x					
	<i>Rhodoleia</i>	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Rhoiptelea</i>		x												x		x		x			
	<i>Rhus cf. cotinus</i>																x	x				
	<i>cf. Ricinus</i>	x	x					x		x		x		x			x	x	x			
	<i>Rubiaceae</i>								x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Sapotaceae</i>	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Sciadopitys</i>				x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Sequoia</i> type															x	x	x				
	<i>Styracaceae</i>													x								
	<i>Symplocos</i>	x							x		x		x		x		x	x	x	x	x	x
	<i>Taxodium</i> type	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>cf. Trichocladus</i>																	x				
	<i>Uncaria</i> type	x						x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Ecological groups of plants	Taxa	PETM locations					EECO locations					MMCO locations									
		1	2	5	7	8	11	1	3	4	5	6	9	10	1	4	5	6	7	9	10
Mesothermal plants	<i>Acer</i>	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Aesculus</i>		x																		
	<i>Alnus</i>	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Anacardiaceae							x		x								x	x		
	Araliaceae								x											x	x
	<i>Betula</i>							x	x		x	x				x	x	x	x	x	x
	<i>Buxus sempervirens</i> type	x													x	x	x	x	x	x	x
	Caprifoliaceae																			x	
	<i>Carpinus</i>	x	x	x				x	x	x				x	x	x	x	x	x	x	x
	<i>Carya</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Celtis</i>		x	x		x		x	x	x	x			x	x	x	x	x	x	x	x
	<i>Corylus</i>																	x			
	Ericaceae	x	x				x	x	x	x	x				x	x	x	x	x	x	x
	<i>Erica cf. terminalis</i>																			x	
	<i>Eucommia</i>	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Fraxinus</i>						x		x		x										
	<i>Hedera</i>	x							x				x			x		x	x	x	x
	<i>Ilex</i>												x		x	x	x	x	x	x	x
	<i>Juglans</i>	x					x		x				x		x	x	x	x	x	x	x
	<i>Liquidambar</i>	x				x	x	x	x	x	x			x	x	x	x	x	x	x	x
	<i>Lonicera</i>																		x		
	<i>Nothapodytes</i>	x																			
	Oleaceae														x	x	x	x	x	x	x
	<i>Ostrya</i>		x			x	x		x			x								x	
	<i>Parrotia cf. persica</i>	x	x		x	x			x			x		x	x	x	x	x	x	x	x
	<i>Parrotiopsis cf. jacquemontiana</i>					x			x			x							x		
	<i>Parthenocissus</i>					x			x	x		x	x	x	x	x	x	x	x	x	x
	<i>Parthenocissus cf. henryana</i>	x				x	x		x	x		x		x		x	x	x	x	x	x
	<i>Phelline</i>			x																	
	<i>Platanus</i>	x												x							
	<i>Populus</i>	x	x	x			x	x						x		x	x	x	x	x	x
	<i>Pterocarya</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Quercus</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Quercus ilex</i> type													x	x	x	x	x	x	x	x
	Rhamnaceae	x				x	x	x	x	x	x	x	x				x	x	x	x	x
	<i>Rhus</i>		x		x				x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Salix</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Sambucus</i>				x																
	<i>Tamarix</i>		x														x	x	x	x	x
	<i>Tilia</i>	x	x	x				x	x	x					x	x	x	x	x	x	x
	<i>Ulmus</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Ulmus-Zelkova</i>																	x			
	Viburnum																x	x	x		
	<i>Vitis</i>	x														x	x				
	<i>Zelkova</i>	x	x					x	x		x	x	x	x	x	x	x	x	x	x	x
Pinus + indeterminable Pinaceae	diplostellate type	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	haplostellate type	x				x												x			
	haploxyton type								x												
Meso-microthermal plants	<i>Cathaya</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	<i>Cedrus</i>	x	x			x		x	x	x							x		x		x
	<i>Fagus</i>					x	x	x							x	x	x	x	x	x	x
	<i>Podocarpus</i>	x		x	x	x	x	x	x	x	x	x	x	x							
	<i>Tsuga</i>	x				x	x		x		x		x				x	x			
Microthermal plants	<i>Abies</i>							x	x	x		x			x	x				x	
	<i>Picea</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Ecological groups of plants	Taxa	PETM locations					EECO locations					MMCO locations									
		1	2	5	7	8	11	1	3	4	5	6	9	10	1	4	5	6	7	9	10
Elements without significance	<i>Aglaoreidia</i>											x									
	cf. <i>Alyxia</i>				x	x					x	x	x								
	Apocynaceae											x	x								
	Convolvulaceae																		x		
	cf. Cucurbitaceae												x								
	<i>Dolichandrone</i>			x																	
	Normapolles			x				x	x		x	x	x								
	Ranunculaceae	x	x	x				x	x	x	x	x	x	x		x		x	x	x	
	Rosaceae	x						x	x		x		x	x	x	x	x	x	x	x	
	Rutaceae	x	x									x	x	x	x	x	x	x	x	x	
	<i>Sanguisorba</i> type										x										
	Solanaceae																x				
	<i>Tricolporopollenites sibiricum</i>														x	x	x				
	Unidentified pollen grains	x	x	x	x	x		x	x	x	x	x	x	x		x	x	x	x	x	
	Vitaceae															x					
Cupressaceae p.p.	<i>Cupressus-Juniperus</i> type	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Herbaceous plants	<i>Alisma</i>							x	x	x	x	x									
	Amaranthaceae		x										x	x	x	x	x	x	x	x	x
	Apiaceae													x			x	x	x		
	<i>Aquilegia</i> type	x																			
	<i>Artemisia</i>	x	x					x						x	x	x	x	x	x	x	x
	<i>Asphodelus</i>				x																
	Boraginaceae															x					
	Brassicaceae															x		x	x		
	<i>Bupleurum</i>																x				
	<i>Calligonum</i>						x														
	Campanulaceae	x	x		x	x		x				x	x					x			
	Caryophyllaceae														x	x	x	x	x	x	
	<i>Cephalanthus</i>									x									x		
	Cistaceae														x	x	x	x	x	x	
	<i>Cistus</i>															x					
	Compositae Asteroideae	x	x		x				x	x	x	x	x	x	x	x	x	x	x	x	
	Compositae Cichorioideae							x				x	x	x	x	x	x	x	x	x	
	<i>Convolvulus</i>	x		x				x			x					x	x	x	x	x	
	Crassulaceae						x														
	<i>Cuphea</i>	x																			
	Cyperaceae	x	x		x	x		x	x		x	x	x	x	x	x	x	x	x	x	
	<i>Diodia</i> type							x													
	<i>Ephedra</i>															x	x	x	x	x	
	<i>Erodium</i>															x	x	x	x	x	
	<i>Euphorbia</i>	x				x										x					
	<i>Filipendula</i>															x					
	<i>Galium</i>															x					
	Gentianaceae							x		x											
	Geraniaceae														x		x				
	<i>Geranium</i>	x																			
	<i>Gunnera</i>												x								
	<i>Helianthemum</i>								x					x			x	x	x	x	
	<i>Hyoscyamus</i>														x						
	Leguminosae Papilionideae						x			x		x	x	x	x	x	x	x	x	x	
	Liliaceae												x	x	x	x	x	x	x	x	
	<i>Linum</i>																x	x	x	x	
	cf. <i>Lobelia</i>									x											
	<i>Lygeum</i>																	x			
	Lythraceae													x							
	Malvaceae																x	x	x	x	
	<i>Melilotus</i> type								x												
	Menyanthaceae	x	x		x	x	x	x	x	x	x	x									
	<i>Mercurialis</i>		x		x				x								x	x	x	x	
	Aquatic monocotyledon		x							x			x			x					

Ecological groups of plants	Taxa	PETM locations					EECO locations					MMCO locations									
		1	2	5	7	8	11	1	3	4	5	6	9	10	1	4	5	6	7	9	10
Herbaceous plants	<i>Myriophyllum</i>			x			x				x										
	<i>Nitraria</i>									x										x	
	Nymphaeaceae																			x	
	Oenotheraceae		x					x		x		x									
	Papaveraceae	x			x	x	x	x	x	x	x	x									
	<i>Plantago</i>							x							x	x	x	x	x	x	x
	Plumbaginaceae															x		x	x		x
	Poaceae		x	x	x						x	x			x	x	x	x	x	x	x
	Polygonaceae												x			x		x	x	x	x
	<i>Polygonum</i>							x													
	<i>Polygonum aviculare</i> type							x			x										
	<i>Potamogeton</i>		x	x						x	x			x		x	x		x	x	
	Primulaceae					x															
	Resedaceae	x					x	x	x	x	x	x									x
	Restionaceae	x	x	x			x	x	x	x	x	x	x	x					x		
	<i>Restio</i>	x	x						x	x		x			x						
	<i>Rumex</i>		x	x	x	x					x			x			x	x	x		
	Saxifragaceae								x												
	<i>Sparganium</i>		x							x	x				x	x		x	x	x	x
	<i>Thalictrum</i>						x										x	x			
	<i>Typha</i>										x				x	x	x	x	x	x	
	Urticaceae	x			x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	Valerianaceae		x			x													x		

The pollen data used for the PETM and EECO result from recent analyses because of a noteworthy evolution in Paleogene palynology. The pollen records used for MMCO are relatively recent and homogenous enough in terms of botanical identifications.

Botanical identification of pollen grains

The rarely used technique of mounting the residue in glycerol allows some mobility of the pollen grains so their different sides can be examined, thus facilitating their botanical identification. Analyses were made using a light microscope at 200x magnification, and each pollen grain was identified at 1,000x magnification.

Aiming to optimize reliability of pollen analysis, we perform appropriate techniques (see the chapter 'Material and methods' of the main text and we follow an accurate nomenclature in pollen morphology (Punt et al., 2007) for understanding shape, structure, aperture(s) and ornamentation, according to the LO-analysis (*Lux* = light vs. *Obscuritas* = darkness) technique of observation at the transmitted light microscope (TLM) (Erhardt, 1952). Scanning electronic microscope (SEM) has also been used to check some of the pollen characters, particularly those perceptible in surface, such as shape and ornamentation. Information on the present-day accepted botanical taxa and synonymies comes from The Plant List (2013). Most of the pollen photographs come from specimens from the ISEM collection (website: data.oreme.org), some others come from the GeoBioStratData private collection.

Below, we provide an accurate description, illustrated by photographs, of some critical pollen grains benefiting from a botanical identification, which belong to plants of the mangrove ecosystem. This approach challenges for elevating pollen floras at the same step of botanical relevance than macrofloras, at least at the genus level. In this context, the genus appears to be the most relevant taxonomic entity because (1) most of genera existed from the earliest Paleogene, and (2) its bioclimatic significance is generally well delimited (Harris et al., 2017). The limited identification at the genus level replaces the so-called species, we believe imagined, in most of the previous Paleogene studies.

Avicennia (Acanthaceae)

Because the Early Eocene and Mid-Miocene recorded pollen grains ascribed to *Avicennia* show some morphological variety, we present hereafter three figures with photographs from pollen grains of six modern species (among the eight accepted species by The Plant List, 2013), four from the Western province (*A. bicolor*, *A. germinans*, *A. schaueriana*, *A. tonduzii*; Figures S2–S3), two from the Eastern province (*A. marina*, *A. officinalis*; Fig. S4). Comparisons can be done with ten photographs of *Avicennia* pollen from PETM (Figure S7), thirty-one photographs of *Avicennia* pollen from EECO (Figures S8–S10), sixteen photographs of *Avicennia* pollen from MMCO (Figure S11).

Avicennia shows prolate to spheroidal tricolporate or tricolporate pollen grains characterised by long and largely opened colpi (with or without costae) that makes the polar area (apocolpium) very small and the pollen close to be syncolp(or)ate. Tricolporate pollen grains show a slightly elongated endoaperture along the polar axis, which does not pass the edges of colpus at the pollen equator. A homobrochate semitectate reticulum constitutes the exine sculpture with dense muri, larger than luminae, which are characterised by a polygonal and slightly elongated outline. Thickness of muri somewhat increases toward the poles that reduces the size of luminae. Colpi are bordered by a thin margo where reticulum is smaller. The structure of the semi-tectate ectexine shows dense columellae with large head constituting the tectum overlying a thinner endexine. At SEM, general shape and exine sculpture can be observed in finer detail showing, in particular, the smooth surface of the tectum somewhat prominent above the columellae. These characters, whatever the pollen is colporate or colporate, are those of the modern *Avicennia* pollen (also supported by an almost similar size), which unique morphology has been extensively described and documented by many photographs at TLM and SEM (Thanikaimoni, 1987; Mao et al., 2012).

Three modern *Avicennia* species display pollen morphologies (with a colporate or colporate apertural system) very close to the *Avicennia* pollen grains of the Early Eocene Arctic–Atlantic: *A. germinans* (L.) L., *A. marina* (Forssl.) Vierh., and *A. officinalis* L. Two of these species (*A. marina* and *A. officinalis*) have pollen grains very close to those recorded in the Mid-Miocene sediments from the Mediterranean region.

Figure S2. Photographs at TLM and SEM of pollen grains of the modern species *Avicennia bicolor* Standl. (slide n° 10887 from the ISEM collection, plant specimen collected in Panama), *A. africana* P.Beauv. = *A. germinans* (L.)L. (slide 875 of the GeoBioStratData collection, plant specimen 14273 from the Herbarium of the University C. Bernard Lyon, France, plant specimen collected in Africa), and *A. tomentosa* Jacq. = *A. germinans* (L.)L. (slide 874 of the GeoBioStratData collection, plant specimen 5 from the Herbarium of the University C. Bernard Lyon, France, plant specimen collected in India) (shots by J.-P. Suc & S.-M. Popescu).

Scale bar = 5 µm.

A. *Avicennia bicolor*.

A1–A4, LO-analysis of equatorial view (aperture facing): A1, reticulate ornamentation; A2, focus at base of columellae; A3, ecto- and endo-apertures; A4, optical section.

A5–A8, LO-analysis of polar view: A5, reticulate ornamentation; A6, focus at base of columellae; A7, apocolpium; A8, optical section.

B, *Avicennia africana* = *A. germinans*.

B1–B4, LO-analysis of equatorial view (intercolpium): B1, reticulate ornamentation; B2, focus at base of columellae; B3, colpi; B4, optical section.

B5–B6, LO-analysis of polar view: B5, reticulate ornamentation; B6, optical section.

B7, Equatorial overview (aperture facing).

B8, Polar overview.

C, *Avicennia tomentosa* = *A. germinans*.

C1–C4, LO-analysis of equatorial view (aperture facing): C1, reticulate ornamentation; C2, focus at base of heads of columellae, ectoaperture; C3, focus at base of columellae; C4, optical section.

C5–C6, LO-analysis of polar view: C5, reticulate ornamentation and focus at base of columellae; C6, optical section.

C7, equatorial overview (intercolpium).

C8, polar overview.

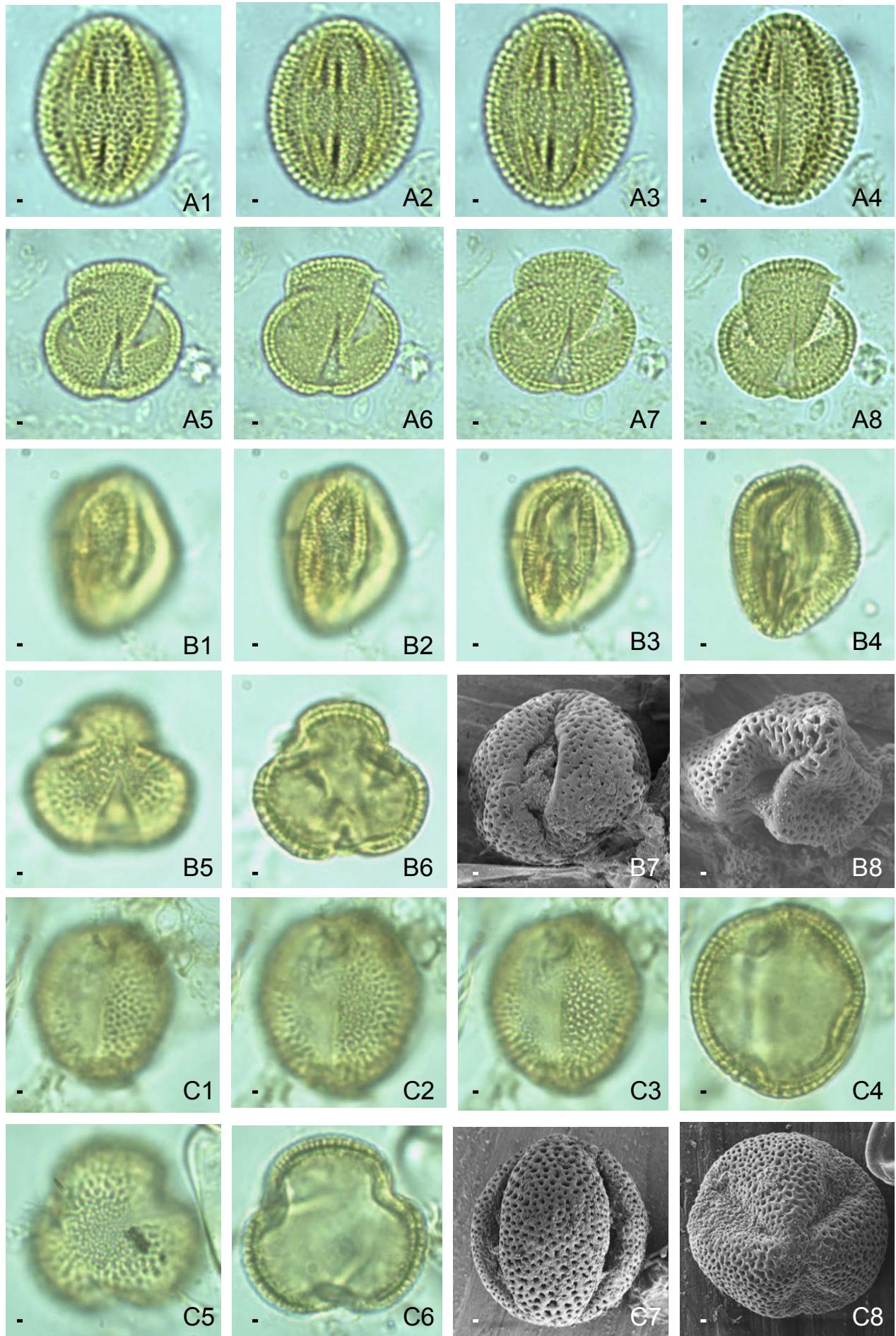


Figure S3. Photographs at TLM of pollen grains of the modern species *Avicennia schaueriana* Stapf & Leechm. ex Moldenke (slide 10886 from the ISEM collection, plant specimen collected in the West Indies) and *A. tonduzii* Moldenke (slide 10885 from the ISEM collection, plant specimen collected at Costa Rica) (shots by J.-P. Suc & S.-M. Popescu). Scale bar = 5 µm.

A. *Avicennia schaueriana*.

A1–A3, LO-analysis of equatorial view (aperture facing): A1, reticulate ornamentation; A2, focus at base of columellae; A3, optical section.

A4–A6, LO-analysis of polar view: A4, reticulate ornamentation; A5, focus at base of columellae; A6, optical section.

B. *Avicennia tonduzii*.

B1–B3, LO-analysis of equatorial view (aperture facing): B1, reticulate ornamentation; B2, focus at base of columellae; B3, optical section.

B4–B6, LO-analysis of polar view: B4, reticulate ornamentation; B5, focus at base of columellae; B6, optical section.

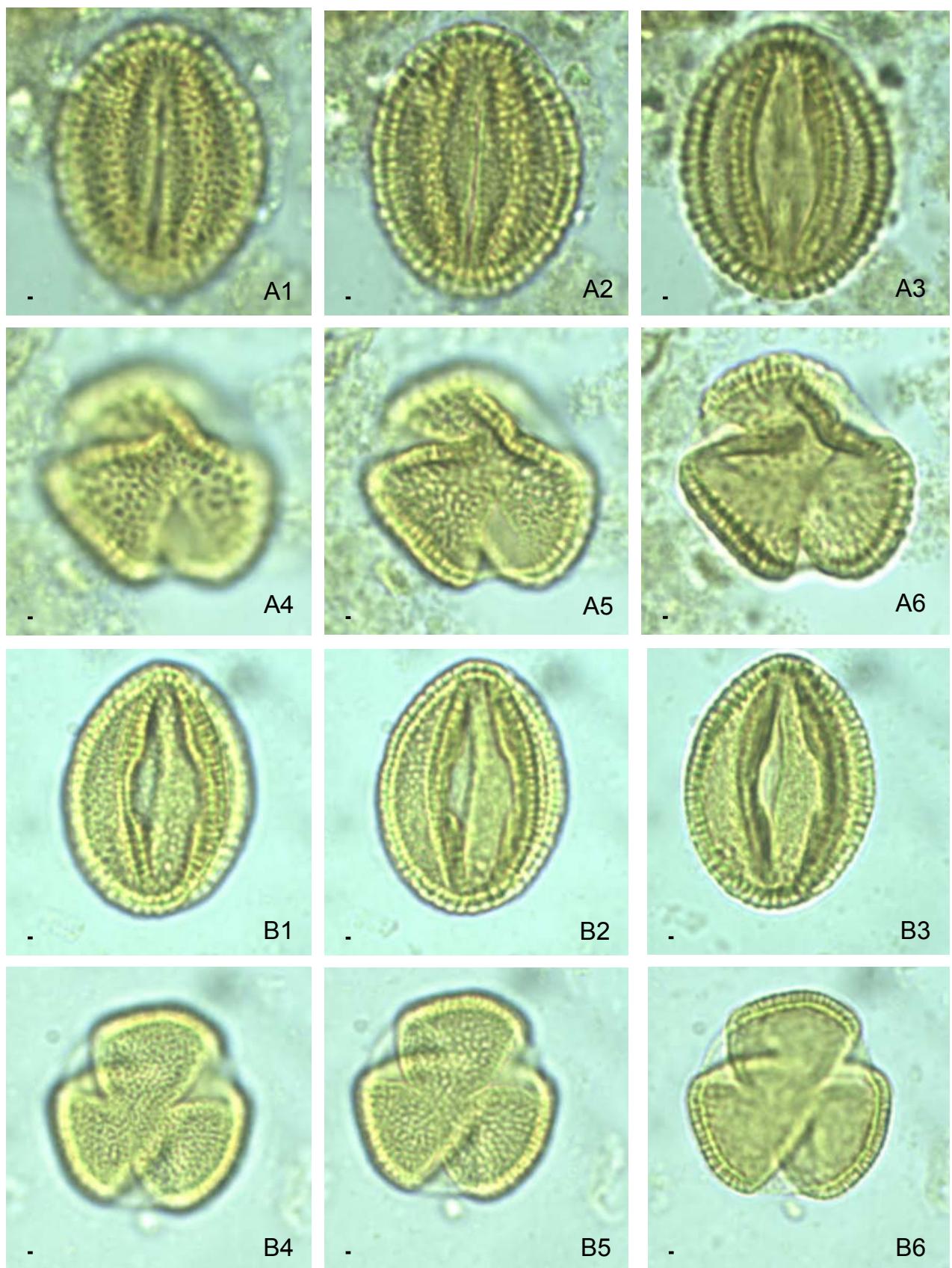


Figure S4. Photographs at TLM and SEM of pollen grains of the modern species *Avicennia alba* Blume = *A. marina* (Forssk.) Vierh. and *A. officinalis* L. (shots by J.-P. Suc & S.-M. Popescu).

Scale bar = 5 µm.

A, *Avicennia alba* = *A. marina*.

A1–A4, LO-analysis of equatorial view (intercolpium): A1, reticulate ornamentation; A2, focus at base of columellae; A3, colpori; A3, optical section.

A5–A6, LO-analysis of polar view: A5, reticulate ornamentation and focus at base of columellae; A6, optical section.

A7, Equatorial overview (aperture facing).

A8, Polar overview.

B, *Avicennia officinalis*.

B1–B4, LO-analysis of equatorial view (intercolpium): B1, reticulate ornamentation; B2, focus at base of columellae; B3, colpi; B4, optical section.

B5–B7, LO-analysis of equatorial view (aperture facing): B5, reticulate ornamentation; B6, focus at base of columellae; B7, optical section.

B8–B11, LO-analysis of polar view: B8, reticulate ornamentation; B9, focus at base of columellae; B10, apocolpium; B11, optical section.

B12, Equatorial overview (intercolpium).

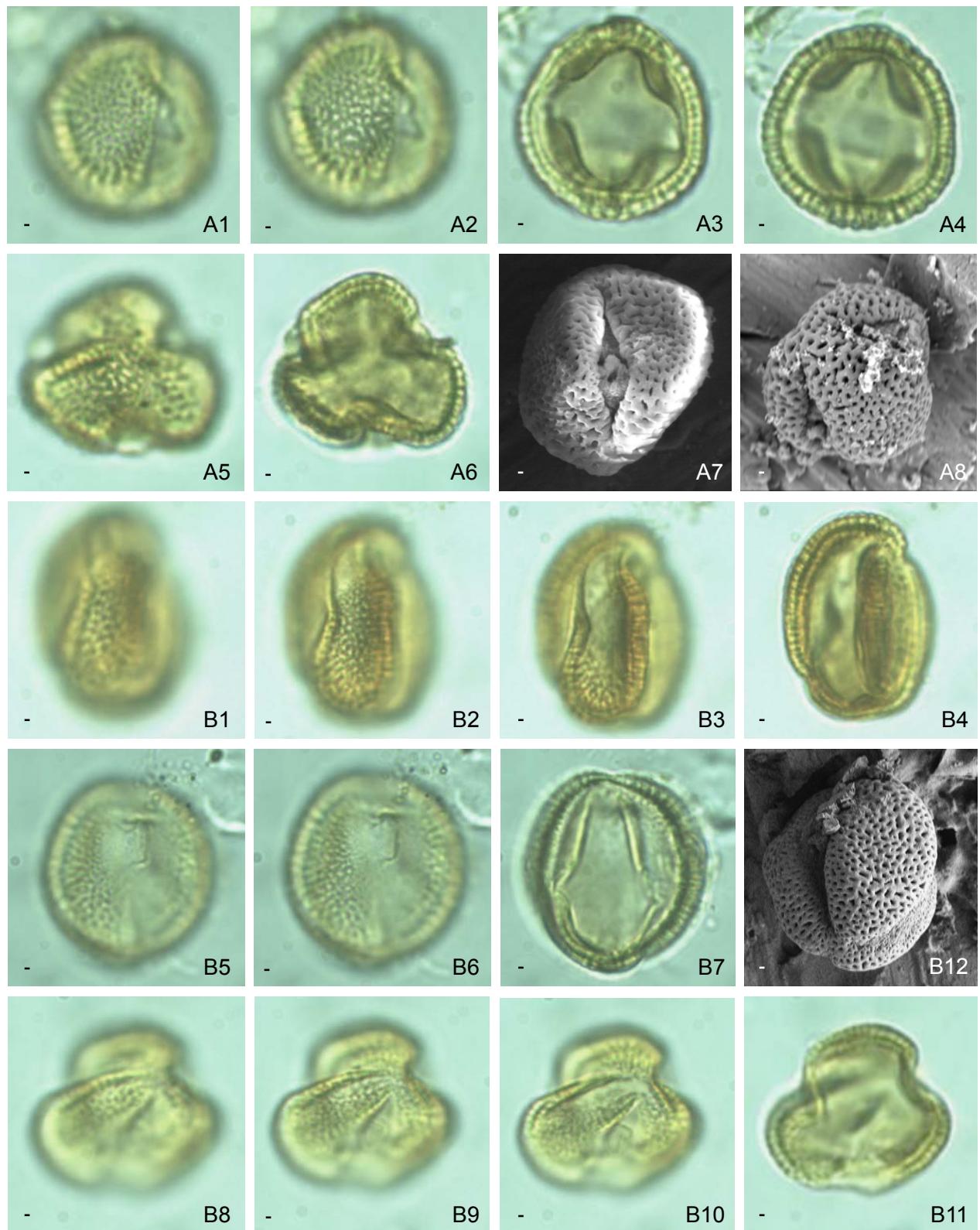


Figure S5. Photographs at TLM of pollen grains of the modern species *Pelliciera rhizophorae* Planch. & Triana

(Tetrameristaceae) (slide 38826 from the ISEM collection) and Rhizophoraceae: *Rhizophora candelaria* DC. = *R. apiculata* Blume (slide 34256 from the ISEM collection, plant specimen collected in India), *R. mucronata* Lam. (slide 10833 from the ISEM collection), *Bruguiera parviflora* (Roxb.) Wright & Arn. ex Griff. (slide 40409 from the ISEM collection), *Ceriops roxburghiana* Arn. = *C. decandra* (Griff.) W.Theob. (slide 15072 from the ISEM collection, plant specimen collected in India) (shots by J.-P. Suc & S.-M. Popescu).

Scale bar = 5 µm.

A, *Pelliciera rhizophorae*.

A1, Equatorial view (aperture facing), optical section.

A2, Polar view, optical section.

B, *Rhizophora candelaria* = *R. apiculata*.

B1–B2, LO-analysis of equatorial view (aperture facing): B1, microreticulate ornamentation; B2, optical section.

B3–B4, LO-analysis of equatorial view (intercolpium): B3, microreticulate ornamentation; B4, optical section.

B5–B6, LO-analysis of polar view: B5, microreticulate ornamentation; B6, optical section.

C, *Rhizophora mucronata*.

C1–C2, LO-analysis of equatorial view (aperture facing): C1, scabrate ornamentation; C2, optical section.

C3–C4, LO-analysis of polar view: C3, scabrate ornamentation; C4, optical section.

D, *Bruguiera parviflora*.

D1–D2, LO-analysis of equatorial view (aperture facing): D1, scabrate ornamentation; D2, optical section.

D3–D4, LO-analysis of polar view: D3, scabrate ornamentation; D4, optical section.

E, *Ceriops roxburghiana* = *C. decandra*.

E1–E2, LO-analysis of equatorial view (aperture facing): E1, scabrate ornamentation; E2, optical section.

E3, Polar view, optical section.

***Pelliciera rhizophorae* Planch. & Triana (Tetrameristaceae) (Figure S5, A1–A2).**

The great-sized spheroidal pollen of this species is tricolporate with thin and relatively short colpi as ectoapertures that confers a large apocolpial field in polar view. The endoapertures are perpendicular to the ectoapertures delimited by slightly marked costae discontinuous at the equator. The pollen is tectate with relatively thick endexine and ectexine, which shows a foveolate-fossulate to verrucate-rugulate ornamentation. This pollen morphology is described and illustrated by Thanikaimoni (1887).

Rhizophoraceae (Figure S5, B1–E2).

The mangrove genera of Rhizophoraceae show an almost similar pollen morphology.

Slightly prolate to spheroidal, the pollen is tricolporate, sometimes tetracolporate, with long ectoapertures and perpendicular long endoapertures bordered by prominent costae. Rounded triangular polar view shows vestibula. Ectexine, thicker than endexine, shows a variable ornamentation, scabrate to microreticulate or foveolate. In addition to variability in pollen size, such a homogenous morphology makes very difficult the identification of genera according to pollen.

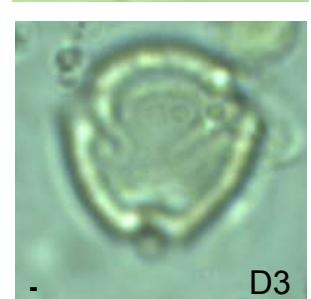
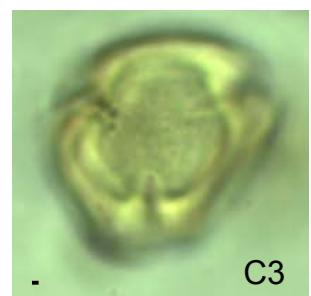
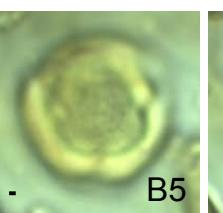
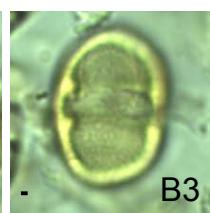
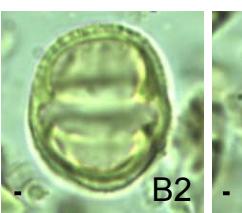
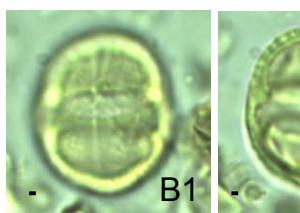
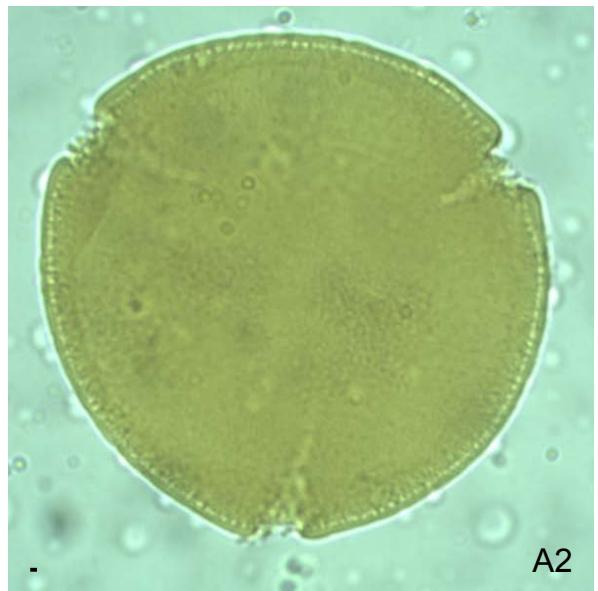


Figure S6. Photographs at TLM of pollen grains of the modern species *Nypa fruticans* Wurmb (Arecaceae) (slide 34258 from the ISEM collection, plant specimen collected in India), *Tarrietia perakensis* King = *Heritiera sumatrana* (Miq.) Kosterm. (Malvaceae) (slide 17929 from the ISEM collection, plant specimen collected in Malaysia), *Scyphiphora hydrophylacea* C.F.Gaertn. (Rubiaceae) (slide 21266 from the ISEM collection, plant specimen collected at Singapore), *Brownlowia argentata* Kurz (Malvaceae) (slide 20764 from the ISEM collection, plant specimen collected in Indonesia), *Brownlowia elata* Roxb. (Malvaceae) (slide 19839 from the ISEM collection, plant specimen collected in Burma), *Xylocarpus mekongensis* Pierre (Meliaceae) (slide 11310 from the ISEM collection, plant specimen collected in India), *Sonneratia caseolaris* (L.) Engl. (Lythraceae) (slide 653 of the GeoBioStratData collection), *Excoecaria agallocha* L. (Euphorbiaceae) (slide 11306 from the ISEM collection, plant specimen collected in Vietnam) (shots by J.-P. Suc & S.-M. Popescu). Scale bar = 5 µm.

A, *Nypa fruticans*.

A1, Equatorial view (aperture facing), optical section.

B, *Tarrietia perakensis* = *Heritiera sumatrana*.

B1–B2, LO-analysis of equatorial view (aperture facing): B1, reticulate ornamentation; B2, optical section.

C, *Scyphiphora hydrophylacea*.

C1–C2, LO-analysis of equatorial view (aperture facing): C1, reticulate ornamentation; C2, focus at base of columellae and colporus.

C3–C4, LO-analysis of polar view: C3, reticulate ornamentation; C4, optical section.

D, *Brownlowia*.

D1–D2, *Brownlowia argentata*, LO-analysis of polar view: D1, reticulate ornamentation; D2, optical section.

D3–D4, *Brownlowia elata*, LO-analysis of polar view: D3, reticulate ornamentation; D4, optical section.

E, *Xylocarpus mekongensis*.

E1, Polar view of a tetracolporate pollen, optical section.

E2, Polar view of a tricolporate pollen, optical section.

F, *Sonneratia caseolaris*.

F1–F2, LO-analysis of equatorial view (aperture facing): F1, verrucate ornamentation; F2, optical section.

G, *Excoecaria agallocha*.

G1–G4, LO-analysis of equatorial view (aperture facing): G1, finely reticulate ornamentation; G2, focus at base of columellae; G3, colporus; G4, optical section.

G5, polar view, optical section.

Nypa fruticans Wurmb (Aceraceae) (Figure S6, A1).

Large spheroidal to elliptical pollen, monocolporate, with long spines, finely reticulate in between spines.

Tarrietia perakensis King = *Heritiera sumatrana* (Miq.) Kosterm. (Malvaceae) (Figure S6, B1–B2).

Small prolate spheroidal pollen, tricolporate, finely reticulate. Ectoapertures (colpi) are long with thin costae, endoapertures (pori) are small and weakly annulate.

Scyphiphora hydrophylacea C.F.Gaertn. (Rubiaceae) (Figure S6, C1–C4).

Large spheroidal pollen, tricolporate, with reticulate ornamentation. Endoapertures (pori) are bordered by a thick annulus.

Brownlowia argentata Kurz and *Brownlowia elata* Roxb. (Malvaceae) (Figure S6, D1–D4).

Oblate pollen, tricolporate, interaperturate with marked costae along the short ectoapertures, reticulate ornamentation of the thick ectexine.

Xylocarpus mekongensis Pierre (Meliaceae) (Figure S6, E1–E2).

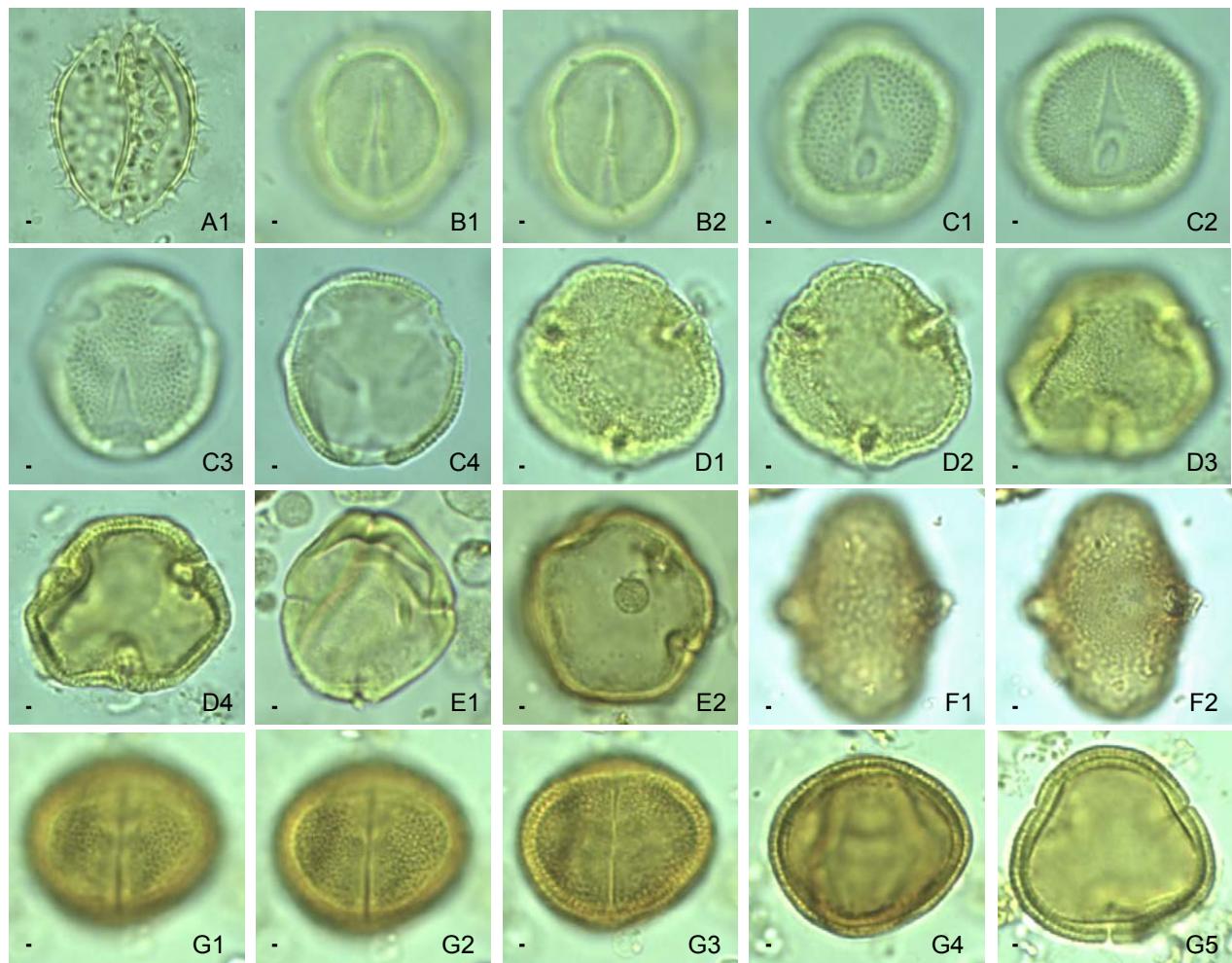
Oblate pollen, tricolporate to tetracolporate, scabrate. Ectoapertures (colpi) are very short, endoapertures (pori) are bordered by a thick discontinuous annulus.

***Sonneratia caseolaris* (L.)Engl. (Lythraceae)** (Figure S6, F1–F2).

Large prolate pollen, triporate, granulate to verrucate ornamentation. Apertures (pori) are circular, prominently protruding and bordered by a thin annulus.

***Excoecaria agallocha* L.** (Euphorbiaceae) (Figure S6, G1–G5).

Prolate to oblate pollen, tricolporate, finely reticulate ornamentation. Ectoapertures are long, endoapertures narrowly elliptic.



Fossil pollen flora

Figures S6–S10 display photographs of fossil pollen grains ascribed to mangrove taxa from PETM, EECO and MMCO samples.

To complete our iconography of *Avicennia* fossil pollen grains, it is to be specified that the pollen grains published as *Gunnera* by Palacios Chavez & Rzedowski (1993: Plate XXIV, Fig. 479) and as *Retitricolpites* sp. by Médus (1975: Plate XIV, Figs. 27–28) probably belong to *Avicennia*.

Comment about the *Sonneratia*-type pollen. Only seven pollen grains (from Gan, Kallo, Morlaàs 1, Site 547 and Site 918) have been recorded showing a morphology evoking that of *Sonneratia*. The best preserved pollen of this group is shown in Figure S9 (C1–C2). These pollen grains, similar to that published by Gruas-Cavagnetto et al. (1988) from Thanetian of Southern France, are characterised by mesocolpal ridges, a verrucate equatorial belt, and no distinctive polar caps: according to Mao and Foong (2013), they are possibly assignable to the fossil genus *Florschuetzia*, a potential precursor of the extant *Sonneratia* genus. Waiting for more records of such pollen grains, we chose to group them within the term *Sonneratia*-type.

Figure S7. Photographs at TLM of fossil pollen grains from PETM sediments – location number refer to Figure 2 (shots by J.-P. Suc & S.-M. Popescu).

Scale bar = 5 µm.

A, *Avicennia*.

A1–A2, Site M0004A (location 1), 382.44 mbsf: A1, cluster of pollen grains; A2, polar view.

A3, Faddeevsky Island (location 2), sample GS127, polar view.

A4–A6, Site 918 (location 5), 1180.49 mbsf: A4–A5, equatorial view (aperture facing); A6, polar view.

A7, Site 918 (location 5), 1180.71 m, equatorial view (aperture facing).

A8–A10, Site 547 (location 11), equatorial views (aperture facing): A8, 279.31 mbsf; A9–A10, 279.53 mbsf.

B, *Brownlowia*.

B1–B2, Site 918 (location 5), 1180.49 mbsf, LO-analysis polar view: B1, reticulate ornamentation; B2, optical section.

C, Rhizophoraceae.

C1, Site 918 (location 5), 1180.49 mbsf, equatorial view (aperture facing).

C2, Site 547 (location 11), 279.31 mbsf, equatorial view (aperture facing).

C3–C4, Site 547 (location 11), 279.53 mbsf, equatorial view (aperture facing).

D, *Xylocarpus*.

D1, Noirmoutier (location 7), sample 2, equatorial view (intercolpium).

D2, Site 547 (location 11), 279.31 mbsf, polar view.

E, *Nypa*.

E1, Noirmoutier (location 7), sample 2, optical section.

E2, Calavanté 1 (location 8), 3402 m, optical section.

F, *Excoecaria*.

F1–F2, Site 547 (location 11), 279.53 mbsf, LO-analysis of equatorial view (intercolpium):

F1, reticulate ornamentation; F2, optical section.

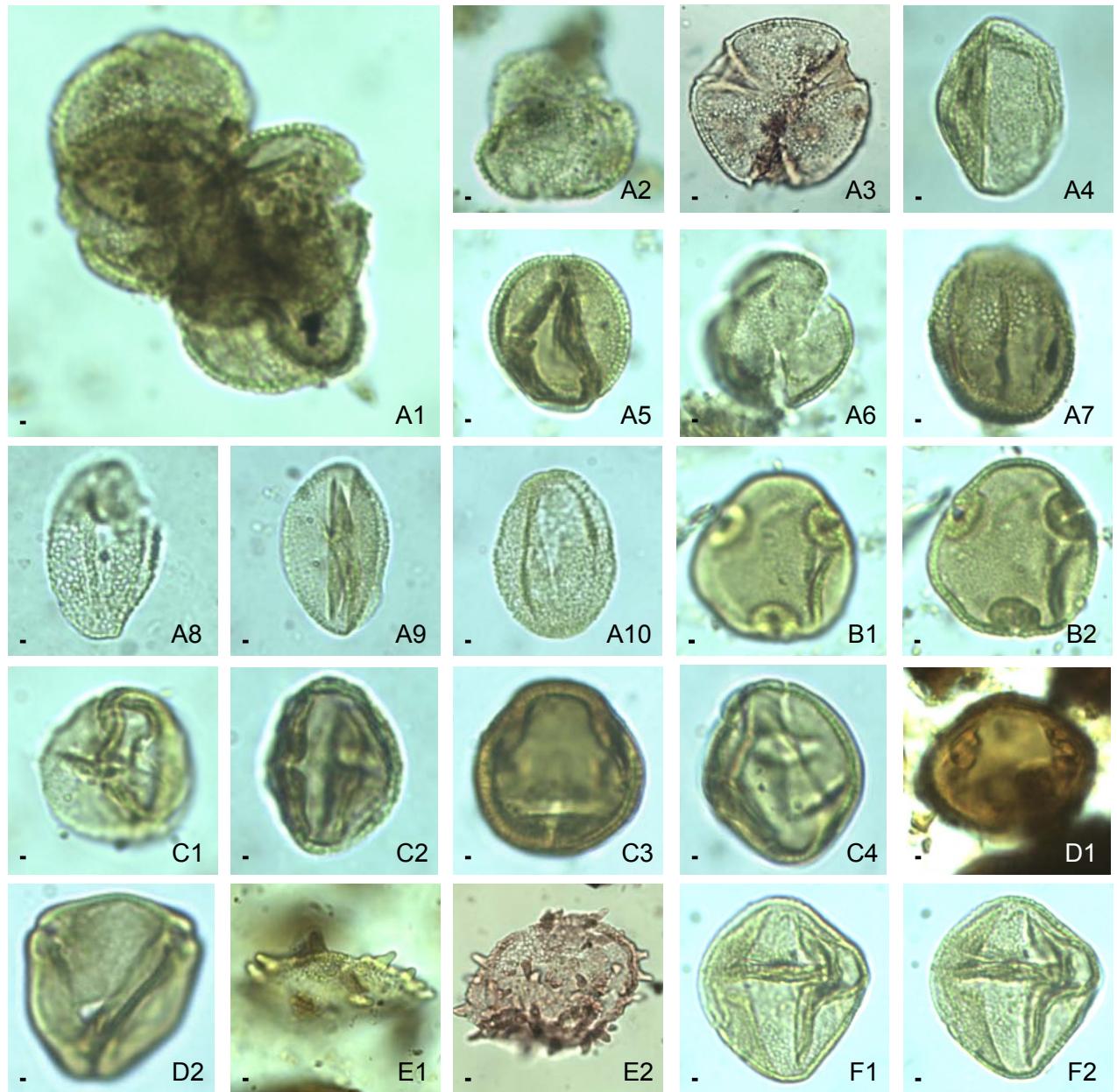


Figure S8. Photographs at TLM and SEM of fossil pollen grains from EECO sediments – location numbers refer to Figure 2 (shots by J.-P. Suc & S.-M. Popescu).
Scale bar = 5 µm.

A, *Avicennia*.

A1–A2, Site M0004A (location 1), 318.86 mbsf, LO-analysis of equatorial view (aperture facing): A1, reticulate ornamentation; A2, aperture.

A3, Site M0004A (location 1), 313.41 mbsf, equatorial view (aperture facing).

A4–A5, Site M0004A (location 1), 297.72 mbsf, equatorial view: A4, intercolpium; A5, aperture facing.

A6, M0004A (location 1, 301.53 mbsf, equatorial view (intercolpium).

A7, M0004A (location 1), 318.86 mbsf, equatorial view (intercolpium).

A8–A9, M0004A (location 1), 287.395 mbsf, equatorial view (intercolpium), reticulate ornamentation.

A10–A12, Caribou Hills (location 3), sample 18, polar view: A10, optical section; A11, reticulate ornamentation; A12, reticulate ornamentation.

A13, Caribou Hills (location 3), sample 12, polar view, reticulate ornamentation.

A14, Caribou Hills (location 3), sample 18, equatorial view (aperture facing), optical section.

A15–A16, Caribou Hills (location 3), sample 18, equatorial overview (intercolpium).

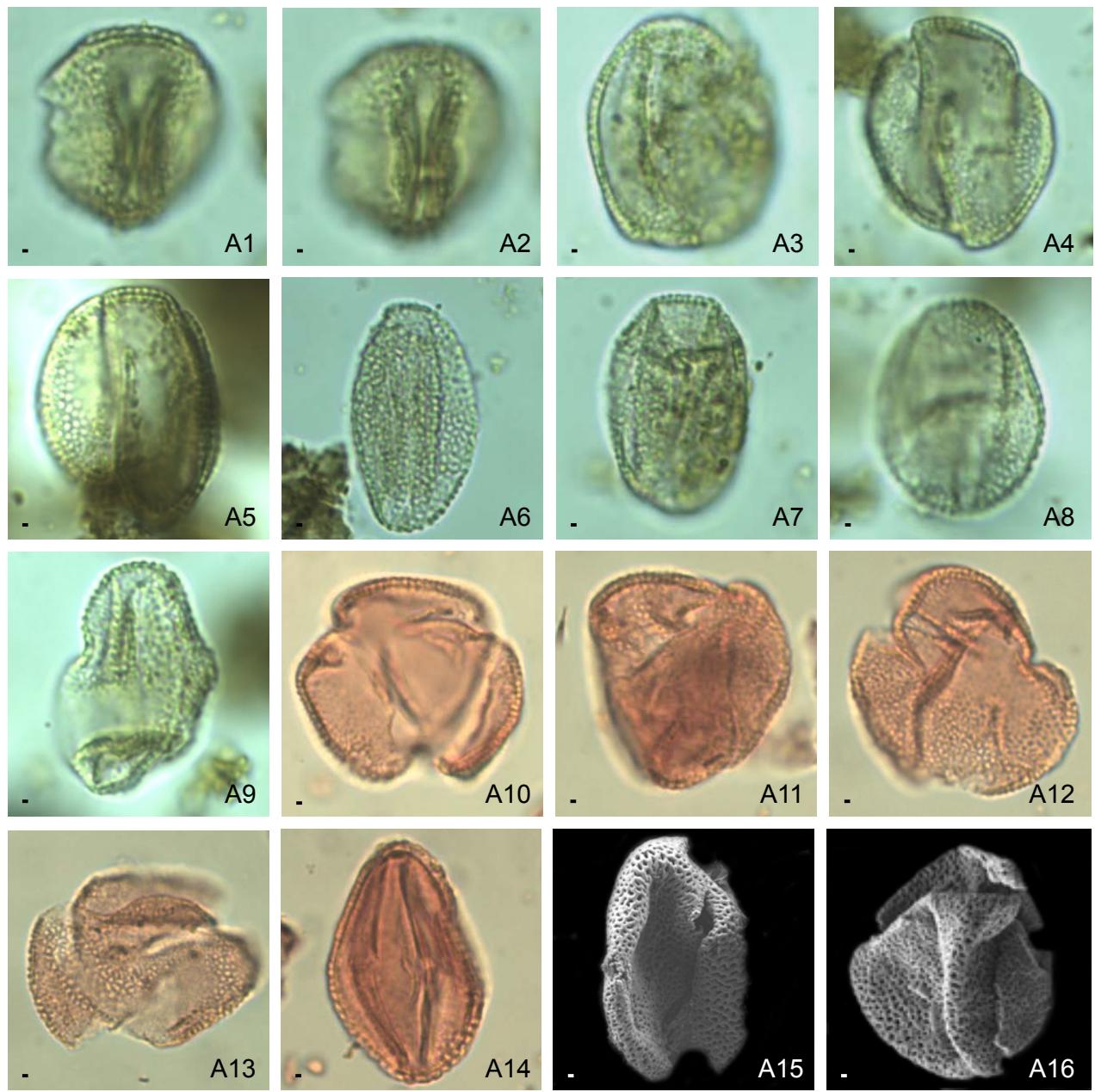


Figure S9. Photographs at TLM of fossil pollen grains from EECO sediments – location numbers refer to Figure 2 (shots by J.-P. Suc & S.-M. Popescu).
Scale bar = 5 µm.

A, *Avicennia*.

A1–A6, Site 343 (location 4).

A1–A3, 213.995 mbsf, equatorial view: A1, intercolpium, reticulate ornamentation; A2–A3, aperture facing, reticulate ornamentation.

A4–A6, 214.30 mbsf, equatorial view (intercolpium): A4–A5, reticulate ornamentation; A6, optical section.

A7–A12, Site 918 (location 5).

A7, 1157.21 mbsf: polar view, reticulate ornamentation.

A8–A9, 1156.71 mbsf, LO-analysis of polar view: A8, reticulate ornamentation; A9, optical section.

A10, 1157.71 mbsf: polar view, optical section.

A11–A12, 1158.21 mbsf: A11, polar view, optical section; A12, equatorial view (aperture facing), reticulate ornamentation.

B, *Excoecaria*.

B1–B3, Site 343 (location 4), 213.995 mbsf, LO-analysis of equatorial view (intercolpium): B1, microreticulate ornamentation; B2, optical section; B3, aperture.

C, *Rhizophoraceae*.

C1–C2, Site 343 (location 4), 214.3 mbsf, equatorial view (aperture facing): C1, ornamentation; C2, aperture.

C3–C5, Site 343 (location 4), 213.995 mbsf, LO-analysis of equatorial view (aperture facing): C3, ornamentation, aperture; C4, aperture; C5, optical section.

C6–C7, Site 918, 1158.21 mbsf, LO-analysis of equatorial view (aperture facing): C6, ornamentation and aperture; C7, optical section.

D, *Xylocarpus*.

D1–D3, Site 343 (location 4), 214.3 mbsf, LO-analysis of polar view: D1, finely reticulate ornamentation; D2, aperture; D3, optical section.

E, *Scyphiphora*.

E1–E2, Site 343 (location 4), 213.995 mbsf, LO-analysis of polar view: E1, ornamentation and apertures; E2, optical section.

F, *Brownlowia*.

F1–F2, Site 918 (location 5), 1158.21 mbsf, polar view: F1, ornamentation; F2, optical section.

G, *Heritiera*.

G1, Site 918 (location 5), 1158.21 mbsf, polar view.

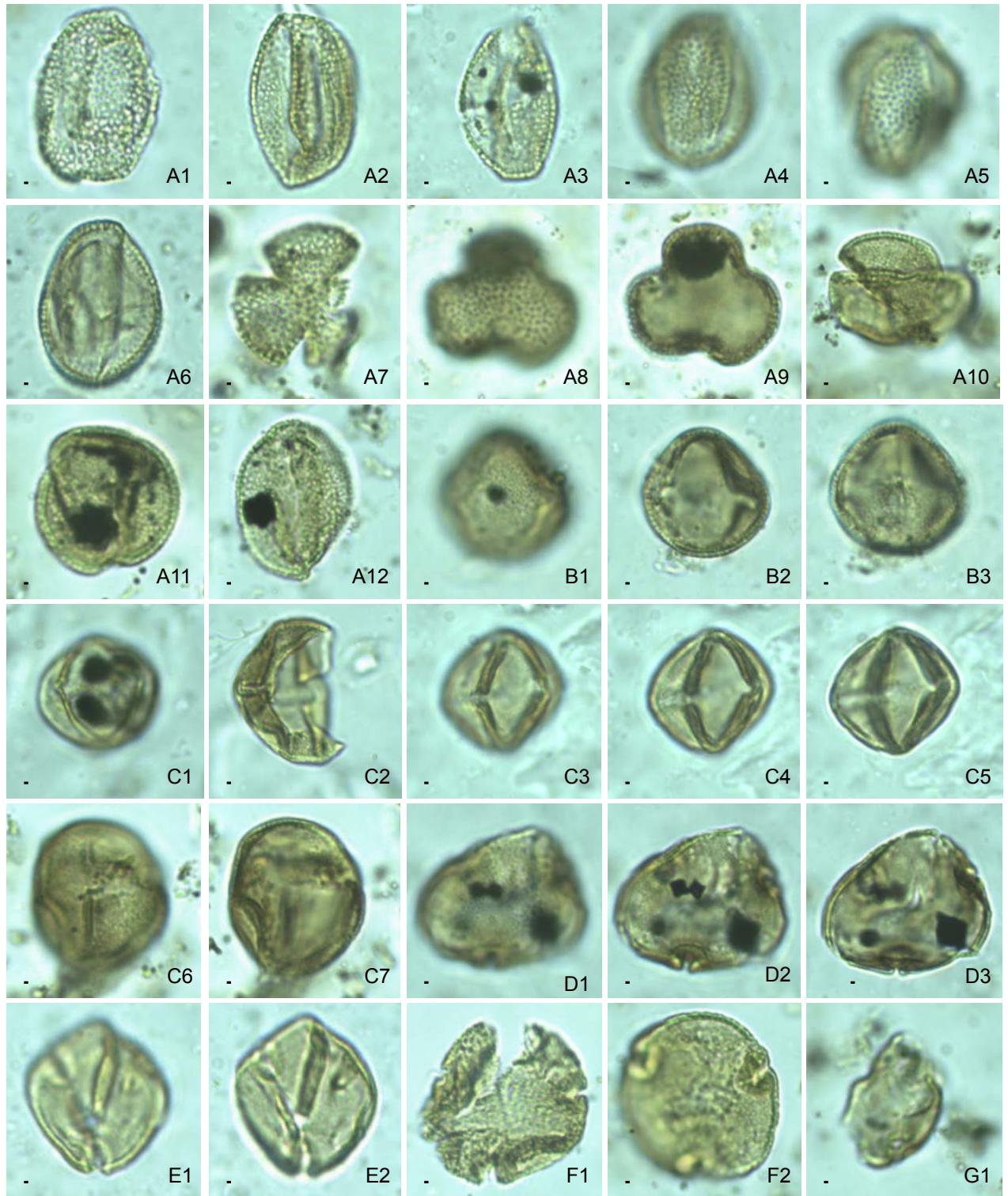


Figure S10. Photographs at TLM and SEM of fossil pollen grains from EECO sediments – location numbers refer to Figure 2 (shots by J.-P. Suc & S.-M. Popescu).
Scale bar = 5 µm.

A, *Avicennia*.

A1–A3, Kallo 027E148 (location 6).

A1–A2, 239 m, LO-analysis of equatorial view (aperture facing): A1, reticulate ornamentation; A2, optical section.

A3, 265 m, equatorial view (intercolpium), reticulate ornamentation.

A4, Morlaàs 1 (location 9), 1282 m, equatorial view (intercolpium), reticulate ornamentation.

B, *Nypa*.

B1, Kallo 027E148 (location 6), 286.5 m, reticulate ornamentation and optical section.

B2–B3, Gan (location 10), sample 1: B2, overview; B3, optical section.

C, *Sonneratia*-type.

C1–C2, Kallo 027E148 (location 6) 286.5 m, LO-analysis of equatorial view (intercolpium): C1, verrucate ornamentation; C2, aperture and optical section.

D, *Xylocarpus*.

D1, Morlaàs 1 (location 9), 1462 m, polar view, optical section.

E, *Pelliciera*.

E1, Morlaàs 1 (location 9), 1462 m, polar view, apertures and optical section.

F, Rhizophoraceae.

F1, Morlaàs 1 (location 9), 1462 m, equatorial view (aperture facing), ornamentation.

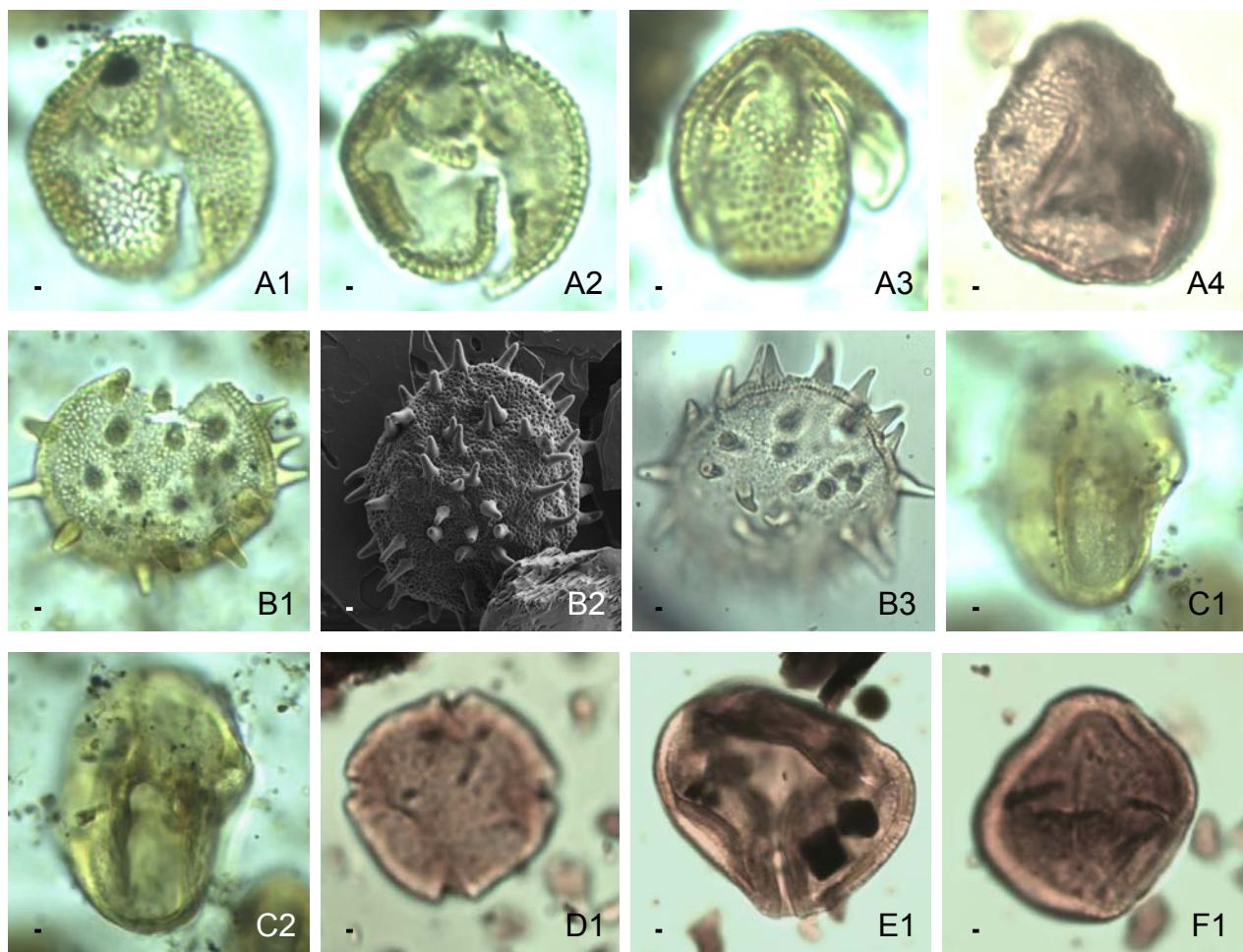


Figure S11. Photographs at TLM and SEM of fossil pollen grains from MMCO sediments – location numbers refer to Figure 3 (shots by J.-P. Suc & S.-M. Popescu).
Scale bar = 5 µm.

A, *Avicennia*.

A1–A2, La Rierussa (location 7), sample 1, equatorial view (aperture facing): A1, reticulate ornamentation; A2, optical section.

A3, Saint-Geniès (location 6), equatorial view (intercolpium), overview.

A4–A13, Estagel (location 5), sample 8.

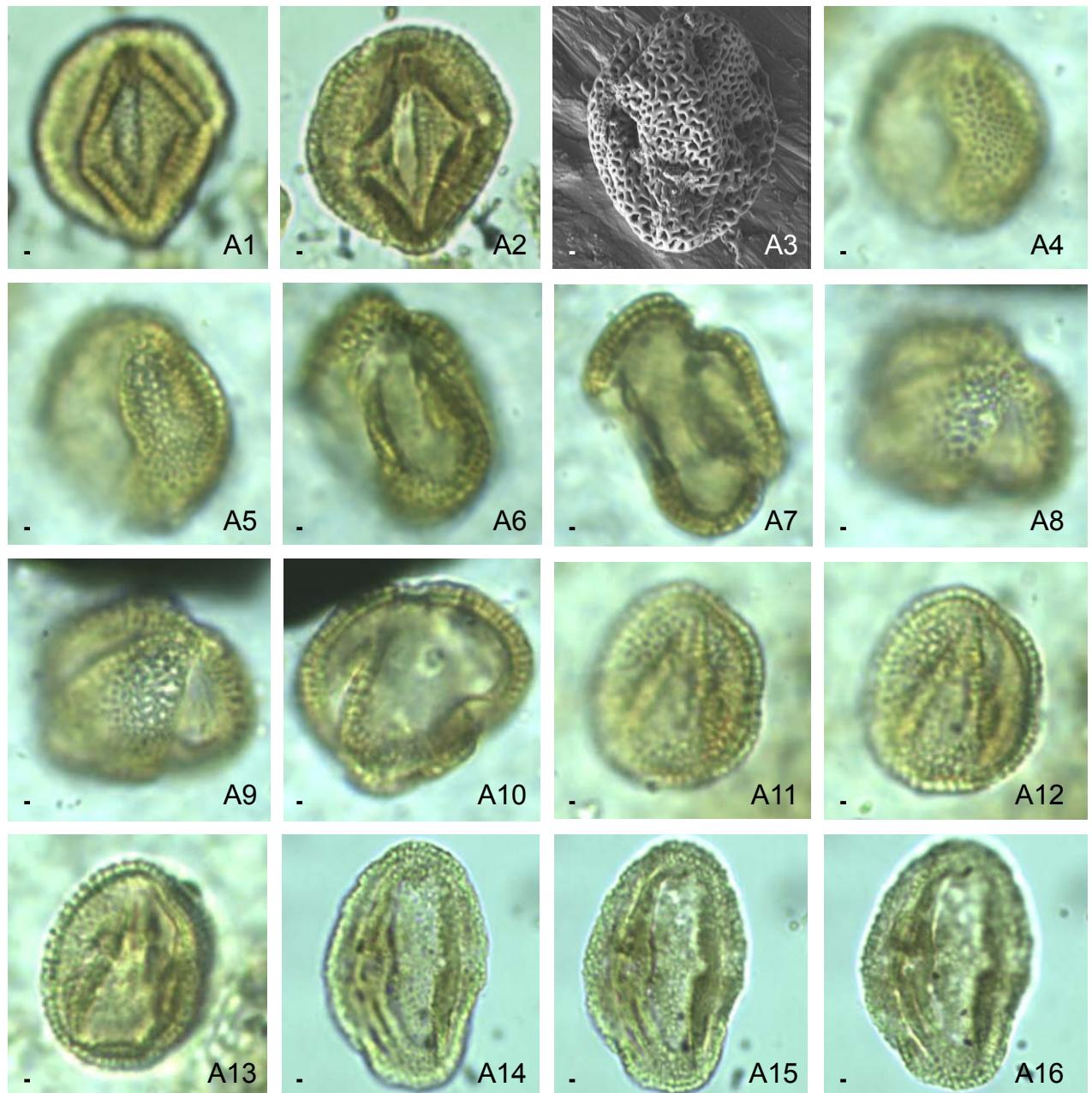
A4–A5, equatorial view (intercolpium): A4, reticulate ornamentation; A5, focus at base of columellae and optical section.

A6–A7, polar view: A6, reticulate ornamentation; A7, optical section.

A8–A10, polar view: A8, reticulate ornamentation; A9, focus at base of columellae; A10, optical section.

A11–A13, equatorial view (aperture facing): A11, reticulate ornamentation; A12, focus at base of columellae; A13, optical section.

A14–A16, Göllersdorf (location 1), sample 22, equatorial view (intercolpium): A14, reticulate ornamentation; A15, optical section; A16, apertures.



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