Stop A1/4

SOUTHERN SHELF OF THE EUROPEAN PLATE

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Topic:

The erosional unconformity between the Thanetian and Ypresian

Tectonic unit:

South Helvetic nappe complex

Lithostratigraphic units:

Kressenberg formation, Fackelgraben Member, Frauengrube Member

Chronostratigrapic units:

Thanetian and Ypresian

Biostratigraphy:

Calcareous nannoplankton Zones NP9 and NP12

Location:

Frauengrube quarry

Coordinates:

E 013° 00′ 06″, N 47° 56′ 11″

References:

Egger et al., 2009b; Rasser & Piller, 1999 and 2001

Outcrop 1 Frauengrube Section

In the Haunsberg area, the Frauengrube section and the immediately adjoining Kroisbach section are both part of the South-Helvetic Thrust Unit. The base of the succession is a grey mica-bearing marlstone of the Maastrichtian Gerhartsreit Formation, which is overlain by silty claystones and clayey siltstones of the Paleocene Olching Formation. Detailed nannoplankton studies at the Cretaceous/Paleogene-boundary indicate continuous sedimentation across the boundary, since the uppermost Maastrichtian (*Micula prinsii* Zone) and the lowermost Paleocene (*Markalius inversus* Zone) have been discovered (Stradner, pers. comm. 2005). Around the boundary, the amount of terrestrially-derived sediment input strongly increases at the expense of carbonate. This shift in the lithological composition defines the lithostratigraphic boundary between the Gerhartsreit and Olching formations.

The Olching Formation is overlain by the Kroisbach Member of the Kressenberg Formation. This member is characterized by glauconite-bearing quartz-sandstones with abundant brachiopods (*Crania austriaca* Traub) in the lower part and oysters (*Pycnodonte* spp.) in the upper part. The glauconitic matrix of the oyster-beds contains calcareous nannoplankton of the Upper Thanetian *Heliolithus riedelii* Zone (NP8) and very well preserved pollen and spores (Stradner, in Gohrbandt, 1963a; Kedves, 1980; Draxler, 2007).

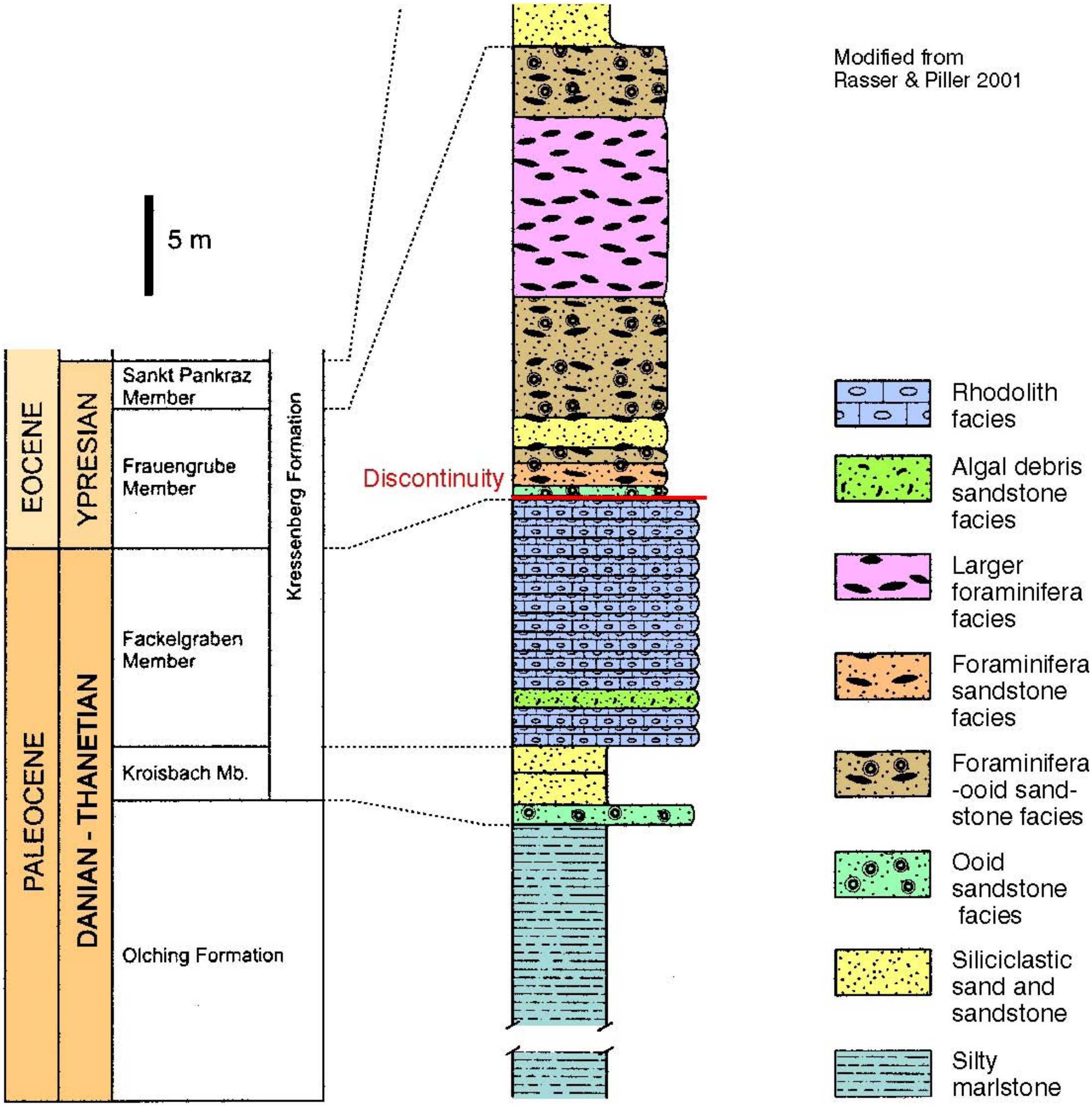


Figure A1.21 ▲
Lithologic log of the south Helvetic succession

Figure A1.22 ►
Glauconitic sandstone of the Kroisbach Member containing abundant oysters

The Kroisbach Member is overlain by the rhodolithic limestone of the Fackelgraben Member. Samples from thin intervening marlstone layers in the upper part of this member contained poorly preserved calcareous nannoplankton of the *Discoaster multiradiatus* Zone (NP9), of latest Paleocene age: *Chiasmolithus* sp., *Coccolithus pelagicus*, *Discoaster falcatus*, *Discoaster mul-*

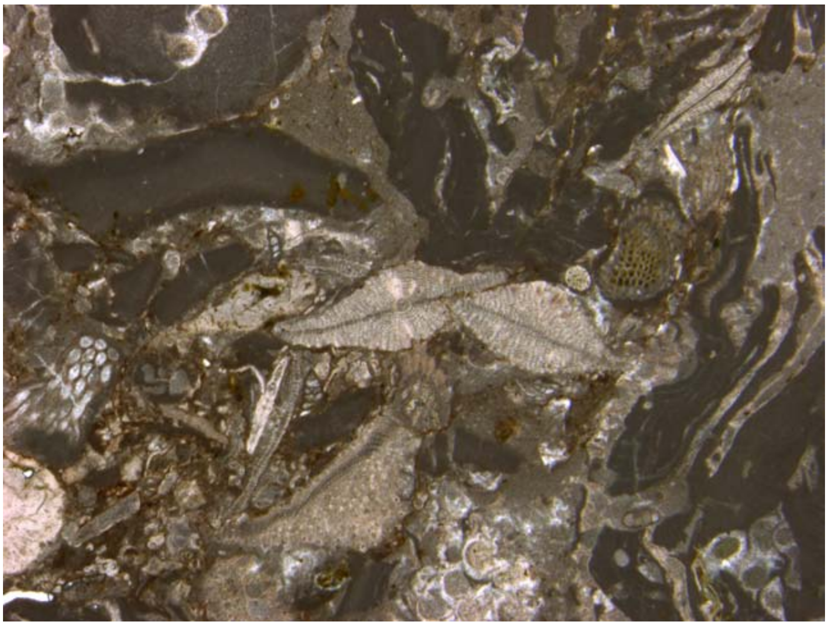


Figure A1.23 ▲
Image of a thin section of rhodolithic limestone with *Discocyclina* sp. (Fackelgraben member)

tiradiatus, *Discoaster mohleri*, *Fasciculithus tympaniformis*, *Neochiastozygus perfectus*, *Thoracosphaera* sp., *Toweius callosus*, *Toweius pertusus*. Reworking of Cretaceous species has not been observed.

The Fackelgraben Member and the overlying Frauengrube Member are separated by an irregular erosional surface (Rasser and Piller, 1999), that has been described previously from other outcrops in the Salzburg area (Vogeltanz, 1977). Clasts of the Fackelgraben Member are reworked in the basal part of the Frauengrube Member (Rasser and Piller, 2001), which comprises 0.5 m of brownish sandstone with a marly matrix, that contains poorly preserved calcareous nannoplankton. Reworked species from the Campanian and Maastrichtian make up about 5 % of the nannoplankton assemblage (*Arkhangelskiella cymbiformis*, *Broinsonia parca*, *Cribrosphaerella ehrenbergii*, *Cyclagelosphaera reinhardtii*, *Eiffellithus eximius*, *Markalius inversus*, *Micula staurophora*, *Prediscosphaera cretacea*, *Watznaueria barnesae*). The rest of the species observed have their first occurrence during the Paleocene (*Campylosphaera eodela*, *Chiasmolithus bidens*, *Chiasmolithus consuetus*, *Chiasmolithus danicus*, *Coccolithus pelagicus*, *Discoaster barbadiensis*, *Discoaster multiradiatus*, *Thoracosphaera* sp., *Toweius spp.*) or in the lower Eocene (*Neochiastozygus junctus*, *Pontosphaera versa*, *Pontosphaera duocava*, *Rhabdosphaera solus*, *Transversopontis pulcher*, *Zygrhablithus bijugatus*). Unfortunately, no marker species of the lowermost Eocene, in particular of the *Rhomboaster*-*Tribrachiatus* lineage, have been encountered in our samples. However, *Tribrachiatus orthostylus* (Type B = without bifurcated rays) has been described from the base of the Frauengrube Member from another outcrop in the Haunsberg area (Stradner in Gohrbandt, 1963b). This finding indicates that the onset of the transgression did not take place before the *Discoaster binodosus* Zone (NP11).

Beside calcareous nannoplankton, the samples from the base of the Frauengrube Member contain marine and terrestrial palynomorphs. The terrestrial flora indicates a subtropical to tropical climate containing Sapotaceae and Matixiaceae pollen among other floral elements (*Dictyophyllidites* sp., *Pityosporites* sp., *Nudopollis* sp., *Subtriporopollenites* sp., *Cupuliferoidaepollenites liblarensis).* Palmpollen have not been found (Draxler, pers. comm. 2006).

The marine flora contains very similar, relatively well preserved dinoflagellate assemblages dominated by *Homotryblium tenuispinosum* ("*tasmaniense*-type"), *Polysphaeridium zoharyi* and *Apectodiniu*m spp. (excluding *A. augustum*). The three taxa are equally common, and together are estimated to constitute 60 – 90 % of the dinoflagellate assemblages. Of relevance for age-determination is the occurrence of the *Areoligera undulata – A. sentosa* group (present in each sample), *Glaphyrocysta* cf. *semitecta* (samples 1 and 3), *Deflandrea oebisfeldensis* (2 specimens in sample 1) and *Phthanoperidinium* cf. *echinatum* (1 or 2 specimens in sample 1). In addition to these taxa, the samples also include low abundances of several long ranging taxa without stratigraphic value. *Spiniferites* spp. and peridinioids, apart from *Apectodinium*, are rare.

The *Areoligera undulata – A. sentosa* group, *Glaphyrocysta* cf. *semitecta* and *Phthanoperidinium* cf. *echinatum* were not recorded in the Anthering Formation at Anthering, from where dinoflagellates were previously studied (Egger et al., 2000; 2003). This suggests a younger age for the Frauengrube Member. The *Areoligera undulata – A. sentosa* group is probably of inner neritic-lagoonal origin and has previously been recorded in the Lutetian in southern England (Eaton 1976; Bujak et al. 1980). Little is

Figure A1.24 ▲
Photograph of the type locality of the Frauengrube Member (Note the erosional unconformity between the Fackelgraben Member (left) and the Frauengrube Member (right))

known about its stratigraphical distribution elsewhere. The several specimens of *Glaphyrocysta* (cf.) *semitecta* are very close to, but perhaps not identical with *Glaphyrocysta semitecta*, a taxon previously recorded from NP15 to near the Eocene/Oligocene boundary in NW Europe (e.g. Bujak et al. 1980; Heilmann-Clausen and Van Simaeys 2005). Nothing else in the samples suggests such a young age. The abundance of *Apectodinium* points to an age no younger than the Ypresian-Lutetian transition, most likely early Ypresian or older. The two specimens of *Deflandrea oebisfeldensis* also point to an early Ypresian or older age, as this form becomes extinct in the lower Ypresian in NW Europe (probably in or near top of NP11, e.g. Heilmann-Clausen and Costa 1989; Luterbacher et al. 2004).

In summary, the calcareous nannoplankton and dinoflagellate assemblages of the Frauengrube section indicate an erosional gap across the P/E-boundary, spanning the upper part of zone NP9, the entire zone NP10, and at least a large part of zone NP11.

Outcrop 2: St. Pankraz Section

Topics:
Palynology at the Paleocene-Eocene transition

Tectonic unit:
South-Helvetic nappe complex

Lithostratigraphic unit:
Claystone and marly claystone (not formalized)

Chronostratigraphy:
Upper Paleocene to lower Eocene

Location:
Hiking trail and creek south of St. Pankraz

Directly to the south of the St. Pankraz carpark, 8 m thick succession of grey claystone and marly claystone is exposed along a hiking trail. No macrofossils or indicators of bioturbation were observed in the claystone that consists of kaolinite (47 wt%), smectite (39 wt%) and illite (14 wt%). The claystone-rich succession is the tectonically truncated base of a small tectonic thrust unit of the south-Helvetic nappe complex. A higher part of this south-dipping succession outcrops ca. 20 m southward, in the course of a small creek. There, thick poorly sorted coarse-grained sandstone beds are alternating with the claystone. Most of the white to yellowish coloured sandstone beds show poor grain sorting. Occasionally parallel lamination occurs. The sandstone beds have sharp contacts to the pelitic rocks and often display rip-up clasts (up to 20 cm in diameter) indicating high energy erosive events. The claystone-sandstone-succession is overlain by a few meters of very pure quartz sandstone overlain by calcareous arenites

Figure A1.25 ▲
Sharp contact between claystone and sand at the St. Pankraz section

rich in larger foraminifers. The St. Pankraz outcrop is interpreted to expose a general transgressive succession.

Composition of the microflora

The claystone at St. Pankraz yields high percentages of the dinoflagellate genus *Apectodinium* including the species *Apectodinium augustum*. The range of this species is almost exclusively restricted to the negative carbon isotope excursion (CIE) at the base of the Eocene.

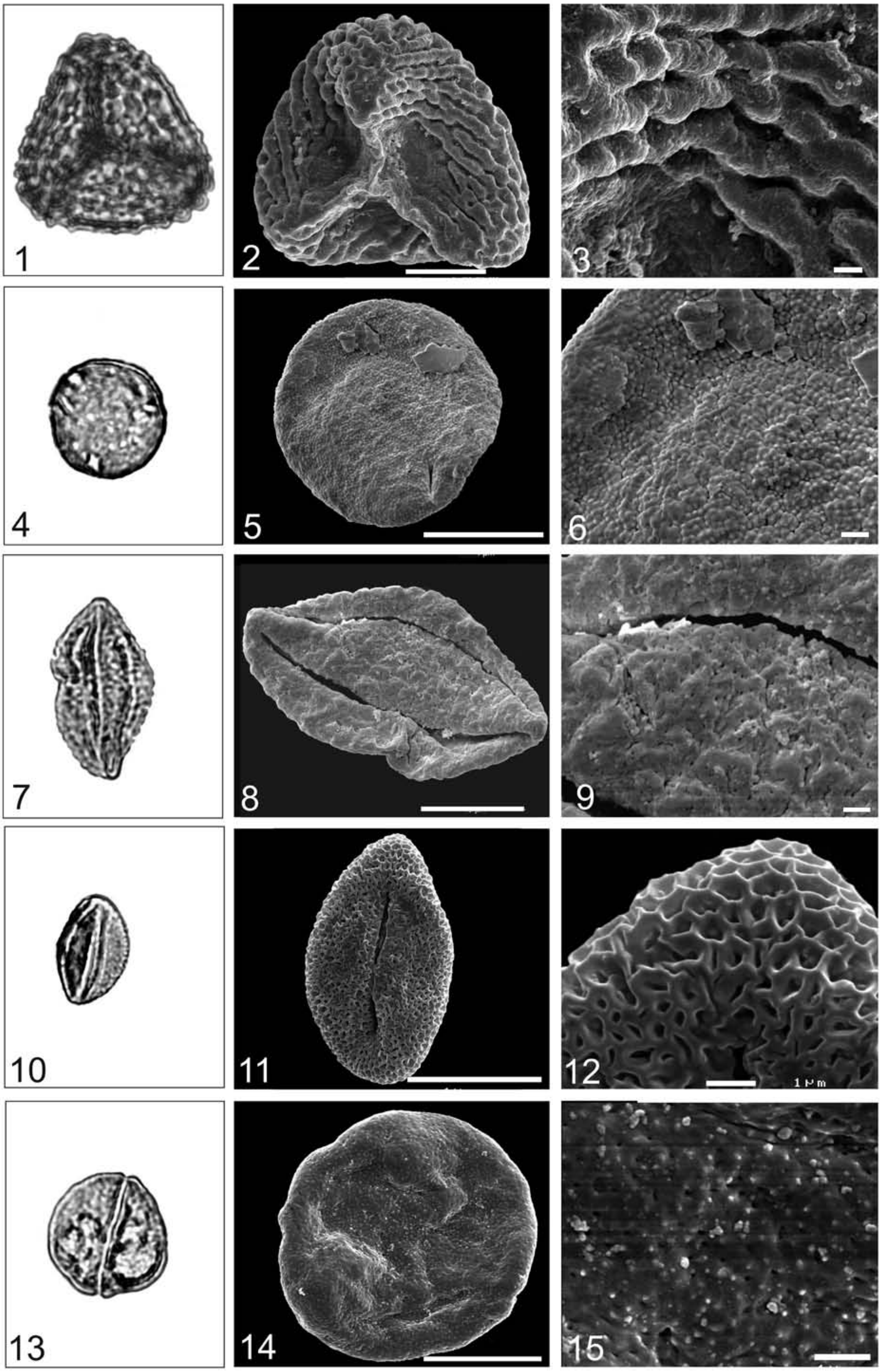
Gymnosperms are extremely rare, comprising only a few grains of Taxodiaceae/Cupressaceae s.l., Pinaceae (*Pinus, Abies, Cathaya,* and a *Tsuga*-type) and *Ephedra* (*Ephedrites*), whereas spores are relatively diverse but not common.

In contrast to the gymnosperms, angiosperms are far more abundant and dominate the assemblages: Prevailing are the *Triporopollenites* formgenus, the "*Normapolles*" s.l. group (*Nudopollis, Interpollis*, etc.), *Plicapollis* (Rhoipteleaceae), *Subtriporopollenites*- (Fig. A1.26, 4 – 6)*, Triatriporopollenites*-species, *Platycaryapollenites,* and *Engelhardiapollenites* (all Juglandaceae). Fagaceae (*Trigonobalanopsis*, Fig. A1.26, 7 – 9), *Alnus* (Betulaceae), *Salix* (Salicaceae) and *Platanus* (Platanaceae. Fig. A1.26, 10 – 12) are much less common. The remaining eudicot taxa are all accessory elements (< 1 %) and include, for example, *Ilex*, *Parthenocissus, Vitis*, *Symplocus*, *Zanthoxylon* (Fig. A1.27, 7 – 9), *Euphorbia*- pollen and other rare elements. Most of the rare pollen taxa and some spore taxa (Schizaeales such as*, Ruffordia, Schizaea*, Fig. A1.26, 1 – 3) from the St. Pankraz claystone represent genera and families nowadays preferring warm temperate to (sub)tropical climates This is particularly the case for genera that are affiliated with extant families that grow under present day megathermal conditions, such as Anacardiaceae (*Lannea*, Fig. A1.27, 4 – 6), Arecaceae (*Sabal* and *Aiphanes* type, Fig. A1.27, 10 – 15), Malvaceae (*Durio*-type and *Kostermansia*-type, *Craigia*, and a probable sterculoid gen. indet., Fig. A1.27, 1 – 3), Chloranthaceae (*Ascarina*), Icacinaceae (*Iodes*), Hamamelidaceae (cf. *Neostrearia*), Picodendraceae (*Aristogeitonia*), Sapotaceae (*Palaquium* and gen. indet.) and are interpreted to originate mostly from East Asia (Manchester, 1999; Manchester et al., 2009) and to certain extent coming via Africa (*Aristogeitonia*, Picrodendraceae, Zetter and Hofmann, 2008). A few other rarer taxa, such as *Eotrigonobalanus*, *Euphorbia* type, *Ilex, Parthenocissus, Quercus, Symplocus, Vitis* etc. can also grow under more mesothermal conditions. Taxa such as *Alnus, Salix* and *Platanus* are not useful as palaeoclimate indicators. The helophytes such as *Sparganium, Lysichiton,* Restionaceae (a characteristic family of swamp inhabitants in the southern hemisphere) and a newly discovered Hydatellaceae (*Monosulcites rivularis*, Fig. A1.26, 13 – 15) are assumed to prefer humid, temperate to warm temperate conditions.

From the climatic point of view, the terrestrial palynomorphs of St. Pankraz are similar to palynofloras from the Thanetian Kroisbach Member of the same sedimentary succession (Draxler, 2007). The palynoflora indicates a climate warmer than the Cfa climate witnessed by Miocene microfloras from Austria and falls into the "warm temperate evergreen deciduous forest", which is effectively a "subtropical flora with temperate elements".

Figure A1.26 ►
all LM images x 1000, SEM overview bar = 10 µm, SEM detail bar = 1µm
1 – 3. *Cicatricosisporites pseudodorogensis* (*Schizales*)
4 – 6. *Subtriporopollenites* sp. ? (Juglandaceae)
7 – 9. *Trigonobalnopsis* sp. (Fagaceae)
10 – 12. *Platanus* (Platanaceae)
13 – 15. *Monosulcites rivularis* (Hydatellaceae)

Figure A1.27 (Page 46)
all LM images x 1000, SEM overview bar = 10 µm, SEM detail bar = 1µm
1 – 3. *Intratriporopollenites* sp. (? sterculoid Malvaceae)
4 – 6. *Tricolporopollenites* cf *solé de portai* (Anacardiaceae, *Lannea*-type)
7 – 9. *Tricolporopollenites* sp. ??? (Rutaceae, *Zanthoxylum* type)
10 – 12. *Arecipites* sp. (?Arecaceae)
13 – 15. *Monoporopollenites* sp. (Arecaceae, Bactridinae)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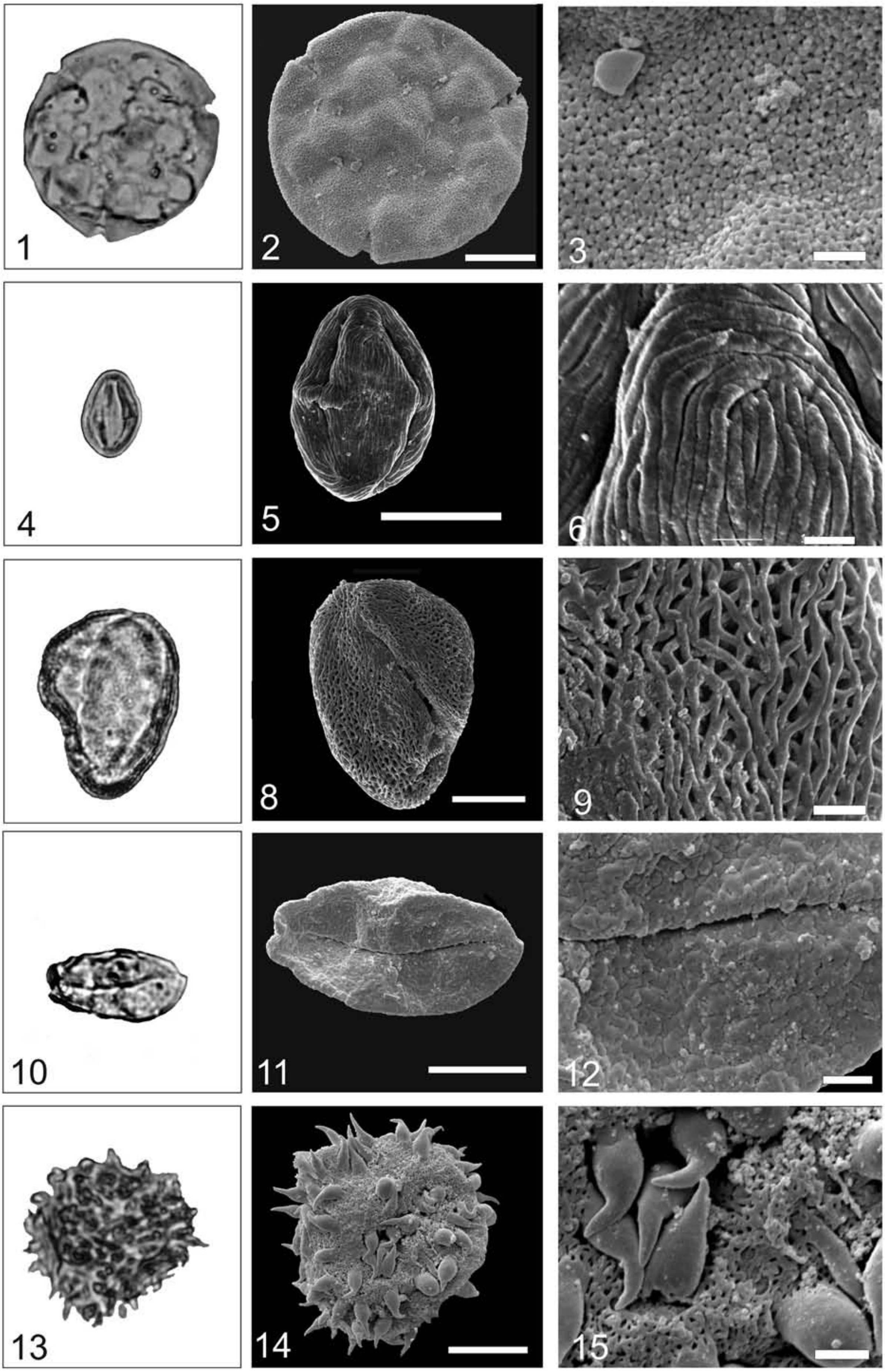
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