GEOLOGICA SAXONICA
Journal of Central European Geology

59: 75–87
12 Sept 2013

SENCKENBERG

Taphonomy and vegetational analysis of a late Eocene flora from Schleenhain (Saxony, Germany)

Taphonomie und Vegetationsanalyse einer obereozänen Flora aus Schleenhain (Sachsen, Deutschland)

Denise Hennig and Lutz Kunzmann

[1] Senckenberg Naturhistorische Sammlungen Dresden, Museum für Mineralogie und Geologie, Sektion Paläobotanik, Königsbrücker Landstraße 159, 01109 Dresden, Germany; denise.hennig@senckenberg.de

Revision accepted 21 June 2013.
Published online at www.senckenberg.de/geologica-saxonica on 10 September.

Abstract

A late Eocene megaflora excavated from the interburden between lignite seam 23u and lignite seam 23o of the Bruckdorf Member of the Borna Formation in the open cast mine Vereinigtes Schleenhain in Northwest Saxony (Leipzig district, Germany) is investigated. The fossil plant remains include leaves as compressions with well preserved cuticles, conifer branches, and also fruits and seeds in a good state of preservation. The Schleenhain flora yields key elements of the megafloral complex Zeitz such as *Rhodomyrthophyllum reticulosum* (Myrthaceae) and *Steinhauera subglobosa* (Altingiaceae). The taphocoenosis is dominated by typical evergreen leaf morphospecies of the Zeitz complex including *Rhodomyrthophyllum reticulosum*, *Eotrigonobalanus furcinervis*, *Polyspora saxonica,* and *Toddalia hofmannii*. It is remarkable that Lauraceae which are normally quite common in the Zeitz complex are rare. In contrast, leaves of *Vaccinioides ovosimilis* are unusually frequent. Preliminary palaeosociological analyses have shown that the taphocoenosis combines elements of several plant communities such as *Steinhauera subglobosa-Rhodomyrthophyllum* riparian forest and Myricaceae-Ericaceae swamp forest. Phytotaphonomic data observed from the assemblage characterize the leaf taphocoenosis as being parautochthonous.

Kurzfassung

Untersucht wurde eine obereozäne Makroflora aus dem Zwischenmittel zwischen Flöz 23u und Flöz 23o der Bruckdorf-Schichten der Borna-Formation im Tagebau Vereinigtes Schleenhain in Nordwestsachsen. Fossile Pflanzenreste zeigen sich meist als Blattabdrücke mit oft sehr gut erhalten Kutikeln. Daneben treten Nadelzweige, Früchte und Samen auf. Die Flora aus Schleenhain enthält Schlüsselelemente des Makroflorenkomplexes Zeitz wie z. B. *Rhodomyrthophyllum reticulosum* (Myrthaceae) und *Steinhauera subglobosa* (Altingiaceae). Die Taphozönose wird dominiert von immergrünen Morpho-Typen des Zeitz-Komplexes, einschließlich *Rhodomyrthophyllum reticulosum*, *Eotrigonobalanus furcinervis*, *Polyspora saxonica* und *Toddalia hofmannii*. Die normalerweise im Zeitz-Komplex sehr häufig vertretenen Lauraceae lassen sich im untersuchten Material ungewöhnlich selten nachweisen. Im Gegensatz dazu treten Blätter von *Vaccinioides ovosimilis* erstaunlich häufig auf. Erste paläosoziologische Analysen haben gezeigt, dass die Taphozönosen Elemente aus verschiedenen Pflanzengemeinschaften wie *Steinhauera subglobosa-Rhodomyrthophyllum*-Auwald oder Myricaceae-Ericaceae-Sumpfwald beinhalten. Phytotaphonomische Daten der Pflanzengesellschaft charakterisieren diese Blatt-Taphozönose als parautochthon.

1. Introduction

Floras from the upper Eocene Borna Formation in Central Germany (Northwest Saxony, Southeast Sachsen-Anhalt) are combined in the megafloral assemblage or complex (Florenkomplex) Zeitz (Mai & Walther 1983, 1985, 2000). This megafloral complex Zeitz nicely corresponds to the regional palyno-assemblage named Spore-

ISBN 978-3-910006-37-9 | ISSN 1617-8467

Pollen-Paleogene (SPP) Zone 18 (Krutzsch 1992, 2011) and is characterized by dominant evergreen notophyllous vegetation types growing under warm-temperate to subtropical and humid palaeoclimate (Mai 1995). Deciduous temperate species are still rare in comparison to the floras of the subsequent lower Oligocene Haselbach complex of the same area (e.g. Kvaček & Walther 2001, Kunzmann & Walther 2007). Although the floras of the Zeitz complex have been studied systematically in detail (e. g. Mai & Walther 1985, Kunzmann & Walther 2002, Krause in press), an integrated reconstruction of the regional palaeovegetation has not been given so far. Similar reconstructions have been published for several megafloral complexes of this area (Walther 1990, Kunzmann & Walther 1997, Kunzmann & Walther 2012) based on sedimentological, palaeosociological as well as taphonomical data. However, detailed taphonomical investigations of the Zeitz complex floras are still at the beginning. Preliminary data concerning taxonomy and systematics of the respective floras has been published, e. g. Krause (in press). This article focuses on the taphonomy of a single megaflora, collected from upper Eocene strata at the Vereinigtes Schleenhain open cast mine (Northwest Saxony), and its palaeosociological interpretation. It is therefore the first part of a comprehensive vegetational reconstruction of the Zeitz complex.

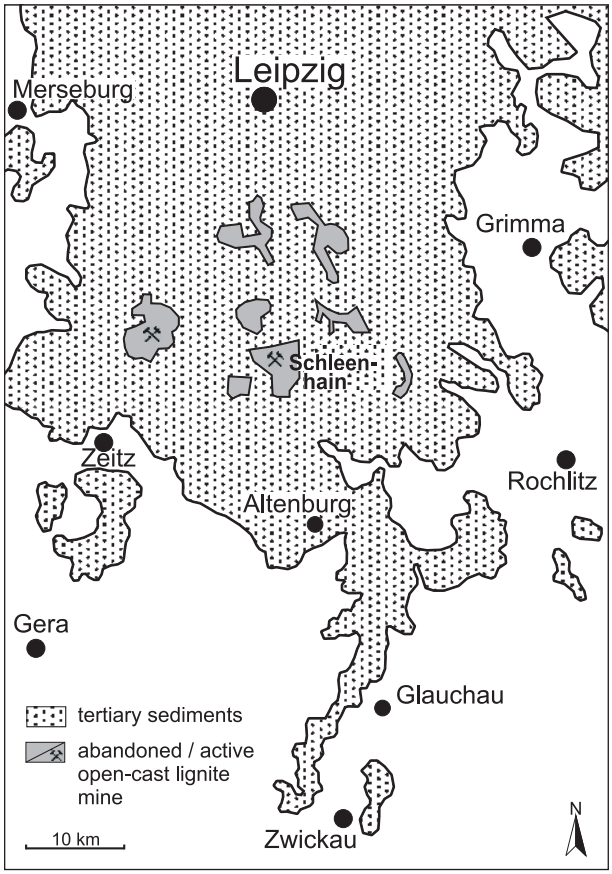


Fig. 1. Distribution of Tertiary sediments and location of the open cast mine Vereinigtes Schleenhain in the region south of Leipzig; modified from Standke (2008: 366, fig. 4.5-5).

Abb. 1. Verbreitung tertiärer Sedimente und Lage des Tagebaus Vereinigtes Schleenhain südlich von Leipzig; verändert nach Standke (2008: 366, fig. 4.5-5).

2. Material and Methods

The material investigated was collected between 2008 and 2009 in the open cast lignite mine Vereinigtes Schleenhain of Mibrag mbH company (Zeitz, Sachsen-Anhalt). Schleenhain is located in Northwest Saxony (Leipzig district, Germany), about 20 km south of Leipzig (Fig. 1). It belongs to the Weißelsterbecken (Weißelster Basin). This traditional term was originally established by Meyer (1950) for the lignite mining area south of the city of Leipzig. However, this lagerstaette does not represent a distinct sedimentary basin and sedimentation unit. It is the southernmost part of the Leipzig embayment and thus the southern margin of the North German depression (Standke et al. 2010). Nevertheless, the term is still used for the palaeontological lagerstaette that becames famous for its rich and well preserved megafloras (Walther & Kunzmann 2008).

The Weißelster Basin contains middle Eocene to early Miocene sedimentary sequences with an interlocking of marine, estuarine, paralic and fluvial strata. Several lignite seams, mostly developed from bog swamps in the coastal plains, are of economic importance since more than 150 years. The described material comes from the interburden between the lignite seam banks 23u and 23o (classically termed seam II and seam III; see Standke et al. 2010). In particular, the fossil bearing beds belong to the Bruckdorf Member of the middle Borna Formation that is considered to be upper Eocene (middle Priabonian) in age (Standke et al. 2010). The regional biostratigraphical age is defined by Krutzsch (2008) as SPP Zone 18 m, based on distinct palynological sub-assemblages.

The material used in this study came from isolated sediment blocks which were falling down from the highwall during the excavation process. At that time access to the highwall was impossible due to landslide slopes. However, the geologists of the mining company identify the fossil bearing horizon genetically as roof of the lignite seam 23u. The material is a light grey to brown coloured, laminated, clay- and silt-dominated sediment that was putatively deposited in an abandoned channel of a large meandering river system (Krause in press). After splitting off the sediment blocks approximately 130 hand specimens with more than 600 fossil plant remains were received (see Figs. 2–5 and Pl. I). In addition to leaves, the material also includes nicely preserved fruits and seeds (Pl. I, Figs. E, H) as well as conifer branches (Pl. I, Fig. D), cone scales, and wood fragments (Fig. 2). Occasionally, pressure solution phenomena are observed on bedding surfaces. Furthermore, concretions developed as hard round pellets could be found in the sediment.

Table 1. Results of leaf surface orientation analysis.

Tabelle 1. Analysenergebnisse der Blattoberflächenorientierung.

Specimen no. PB MMG Schle OE	**711 : 1** (Fig. 3)	**720** (Fig. 4)	**785 : 1** (Fig. 5)
Quantity of useable leaf fragments	23	22	34
Adaxial side up	11	10	13
Abaxial side up	9	7	14
Not distinguishable	3	5	7
Adaxial : abaxial ratio	1.22 : 1	1.43 : 1	1 : 1.08

For leaf determination using micromorphological characters of cuticles, small fragments of the coalified organic matter were removed and macerated for some minutes in Schultze solution. Afterwards, the fragments were neutralized with NH_4OH and washed with distilled water. Then the cuticles were stained with Safranin and embedded in glycerol jelly to prepare slides for light microscopic studies. The fruits and seeds found in the material were not specified yet except the aggregate fruit of *Steinhauera subglobosa* and seeds from *Trigonobalanopsis andreanszkyi*.

The fossils were studied using a Leica stereomicroscope (M-series) equipped with a camera lucida for line-drawings. The macro photographs were taken with a Canon EOS 450 D, some with intermediate rings, and were edited with Adobe Photoshop CS2. The microscopic slides were studied using a Leica DM 5500 B microscope with a DFC 420 camera. All material investigated is stored in the collection of the Sektion Paläobotanik at the Senckenberg Naturhistorische Sammlungen Dresden, Museum für Mineralogie und Geologie (specimens MMG PB Schle OE 709 – 802; preparation slides Schle OE 1/11 – 198/11).

3. Results

3.1. Preservation of plant remains

The material does not split off that good effecting the unevenness of the fossil-bearing surfaces of the beds (Fig. 2). Therefore leaf individuals with complete outlines are rare. Most leaves are fragments with missing apices and/or missing bases and/or discontinuous leaf margins (see Figs. 2 – 5). However, by observing these remains it became clear that the majority of leaves are originally completely preserved. There is no damage by transport detectable. It is remarkable that some of the leaves are lying shifted in the sediment but being neither crumbled and folded nor teared to pieces.

The fossil leaves are preserved as impressions and/or coalifications with cuticles. After splitting off the sediment, the fossil matter usually lies on a single bedding surface whereas the opposite surface bears an impression. The colour of the preserved substance is mostly dark grey to black, sometimes brown to light brown (Fig. 2). In some cases the colour is indicative for distinct taxa in the investigated material. Those individuals who are brown coloured are an indication either for leaves of the family Hamamelidaceae gen. et spec. indet. (Pl. I, Fig. J) or for leaves of the Ericaceae *Vaccinioides ovosimilis* (Pl. I, Fig. I). The cuticles of the fossil leaves are also mostly well preserved (Pl. II, Figs. A – G), only some are damaged by fungal decay (Pl. II, Fig. H). However, not only the robust cuticles of the laurophyllous leaves are excellently preserved (e.g. Pl. II, Fig. A), even the very thin and delicate cuticles can be obtained by usual maceration procedure (Pl. II, Fig. B). The cuticles exhibit all micromorphological characters that are needed for the identification of the fossil species. In particular, some cuticles show not only the basal parts of trichomes ("bases") they bear the complete cuticle cover of simple trichomes, peltate trichomes (Pl. II, Fig. B) or even stellate trichomes.

3.2. Taphonomic characters

Leaf remains in fluvial and costal settings are often derived from parautochthonous assemblages. Behrensmeyer & Hook (1992) consider a fossil plant assemblage as parautochthonous if the phytoclasts have been transported away from the original death or discard site but have remained within the original habit. Based on the preservation of leaves and the sedimentological setting, an allochthonous origin of the herein studied assemblage is mainly not taken into consideration. Only the carpological component of the taphocoenosis could be possibly derived from a nearby hinterland vegetation by water transport.

To verify a leaf assemblage as parautochthonous, different criteria can be used. After Gastaldo et al. (1996, 1998) these criteria include: (1) planar orientation of leaves, (2) leaf-surface orientation (adaxial/abaxial side up), and (3) a log-normal distribution of leaf sizes (ratio length/width). Only the first two criteria were used to evaluate the leaf assemblage of the investigated material as parautochthonous. The third criterion could not be recorded as the majority of leaves are incompletely pre-

Fig. 2. Complete specimen showing an uneven surface with leaves and leaf fragments preserved as coalified matter; arrow indicates a leaf as an example for brownish coalified substance that is indicative in the taphocoenosis for representatives of family Hamamelidaceae gen. et spec. indet. (a detailed photograph is given in Pl. I, Fig. J); note the big wood fragment on the upper left side; specimen MMG PB Schle OE 759 : 1. Scale: 3 cm.

Abb. 2. Sedimentplatte mit unebener Oberfläche zeigt inkohlt erhaltene Blätter und Blattfragmente; der Pfeil verweist auf ein Blatt mit bräunlich erhaltener Substanz, welche in dieser Taphozönose charakteristisch ist für das Taxon Hamamelidaceae gen. et. spec. indet. (für Details siehe Taf. I, Abb. J); im oberen linken Bereich ist ein größeres Holzfragment zu erkennen; Stück MMG PB Schle OE 759 : 1. Maßstab: 3 cm.

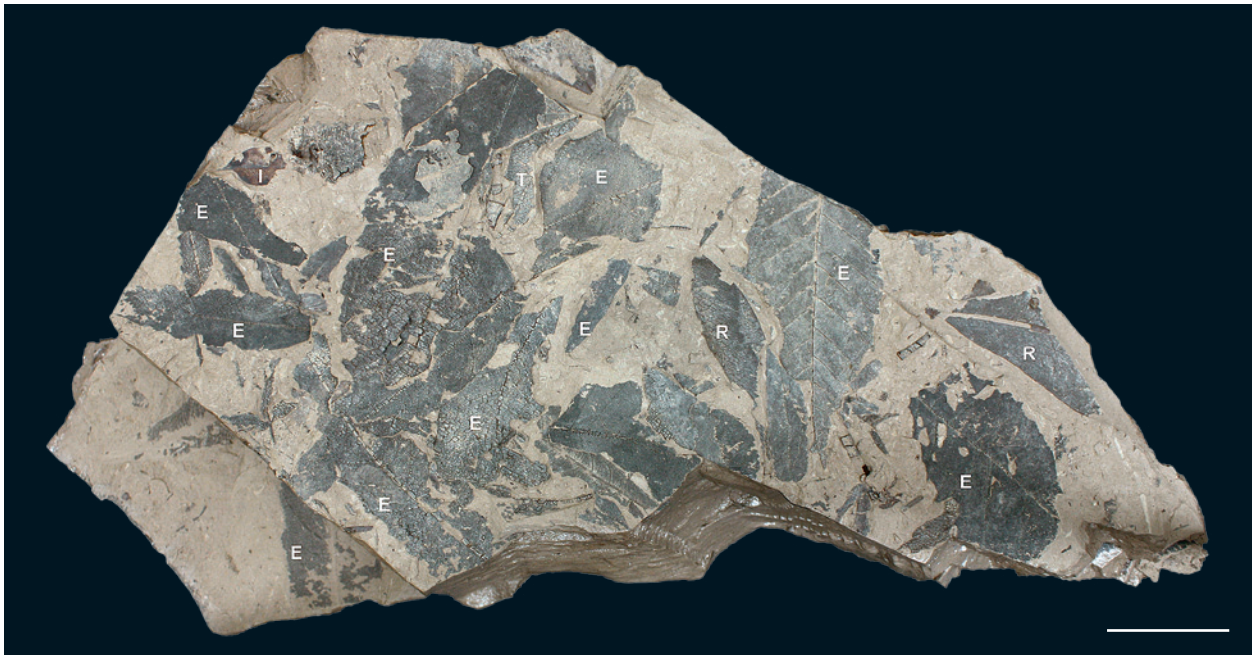


Fig. 3. Complete specimen used for leaf surface orientation analysis; selected taxa: **E**, *Eotrigonobalanus furcinervis*; **I**, dicot indet.; **R**, *Rhodomyrthophyllum reticulosum*; **T**, *Toddalia hofmannii*; specimen MMG PB Schle OE 711 : 1. Scale: 3 cm.

Abb. 3. Sedimentplatte, welche für die Analyse von Blattoberflächenorientierungen verwendet wurde; ausgewählte Arten: **E**, *Eotrigonobalanus furcinervis*; **I**, dicot indet.; **R**, *Rhodomyrthophyllum reticulosum*; **T**, *Toddalia hofmannii*; Stück MMG PB Schle OE 711 : 1. Maßstab: 3 cm.

Table 2. Determined species listed after its frequency: > 10% = dominant species, 1 – 10% = frequently occurring species, < 1% = accessory species; **L**, leaves; **D**, diaspores; *after Mai & Walther 1985, 2000 and Kunzmann & Walther 2002.

Tabelle 2. Identifizierte Arten aufgelistet nach ihrer Häufigkeit: > 10% = dominante Arten, 1 – 10% = häufig vorkommende Arten, < 1% = seltene Arten; **L**, Blätter; **D**, Früchte und Samen; *nach Mai & Walther 1985, 2000 und Kunzmann & Walther 2002.

Species		Frequency [%]	Habitus*	Typical forest type*	Zonal (Z) vs. azonal (A) vegetation*
Eotrigonobalanus furcinervis	L	43.3	Tree	Swamp forest Riparian forest Mesophytic forest	A, Z
Rhodomyrthophyllum reticulosum	L	25.8	Tree	Riparian forest	A
Quasisequoia couttsiae	L	7.1	Tree	Swamp forest Riparian forest Mesophytic forest	A, Z
Toddalia hofmannii	L	4	Woody climber	Mesophytic forest Riparian forest	A, Z
Vaccinioides ovosimilis	L	2.2	Small shrub	Bog swamp forest	A
Hamamelidaceae gen. et spec. indet.	L	1.6	Shrub?	?	–
Polyspora saxonica	L	1.5	Shrub	Mesophytic forest Bog swamp forest	A, Z
Sloanea nimrodi	L	1.1	Shrub? (occ. climber)	Riparian forest?	A
Osmunda lignitum	L	0.7	Herbaceous fern	Swamp forest	A
Steinhauera subglobosa	D	0.5	Small tree?	Riparian forest	A
Daphnogene	L	0.4	Shrub or small tree	Bog swamp forest Riparian forest Mesophytic forest	A, Z
Dicotylophyllum altenburgense	L	0.4	Shrub?	Riparian forest? Swamp forest?	A
Actinodaphne pseudogermari	L	0.2	Shrub or small tree	Mesophytic forest (EBF)	Z
Laurophyllum hypolanatum	L	0.2	Shrub or small tree	Mesophytic forest	Z
Trigonobalanopsis andreanszkyi	D	0,2	Tree	Mesophytic forest	Z
Zingiberoideophyllum sp.	L	0.2	Subshrub	Riparian forest Swamp forest	A
Dicots indet.	L	7.1	–	–	–
Monocots indet. aff. Arecaceae	L	3.7	Trees?	–	–

served. The original orientation of the sediment blocks could not be reconstructed. However, from observations of selected specimens it can be stated that the planar orientation of fossil leaves and conifer branches relatively to arbitrary north appears random. In Tab. 1 the results of the leaf surface orientation analysis (adaxial/abaxial) are given. The majority of sediment block surfaces show a small quantity of leaf fragments in general. For that reason only three specimens (Figs. 3 – 5) were used to observe the phytotaphonomic characters. While the surfaces of the first two specimens show more leaves with orientation of adaxial side up, the third specimen shows more of abaxial side up. Additionally, the number of leaves which could not be distinguished in surface orientation is relatively high. In conclusion, the orientation of leaves surfaces seems to be random, neither adaxial side up nor abaxial side up is preferred. Based on the leaf surface orientation and the planar leaf orientation the assemblage is considered as being parautochthonous.

Most of the leaves on single bedding planes are observed as isolated individuals. Mass accumulations with overlapping each other are seldom (e.g. Fig. 3). Leaves that are still attached to branches were not observed. All leaf litter probably originates from normal abscission processes. Detachments by strong wind or storm events have not to be taken into consideration to explain the plant taphocoenosis. This is also supported by the preservation of palm leaves i.e. only small fragments of leaflet segments occur.

The leaves of *Eotrigonobalanus furcinervis* show a wide spectrum of morphological types including slender dentate types, broad dentate types, and also entire types (Pl. I, Figs. A – C; for comparison see Kriegel 2001). The longest leaf observed is about 22 cm long and of the slender dentate morphotype. The evidence of several distinct morphotypes within an assemblage indicates that the mother plants must have been grown nearby the burial place, and any selection or sorting processes by fluvial transport can be excluded.

In short, all features observed support the interpretation of parautochthony. This result is important for a palaeosociological interpretation of the leaf assemblage.

Fig. 4. Complete specimen used for leaf surface orientation analysis; arrow indicates a complete leaf of *Eotrigonobalanus furcinervis* (a detailed photograph is given in Pl. I, Fig. A); specimen MMG PB Schle OE 720. Scale: 5 cm.

Abb. 4. Sedimentplatte, welche für die Analyse von Blattoberflächenorientierungen verwendet wurde; der Pfeil verweist auf ein vollständiges Blatt von *Eotrigonobalanus furcinervis* (für Details siehe Taf. I, Abb. A); Stück MMG PB Schle OE 720. Maßstab: 5 cm.

3.3. Vegetational analysis

In Tab. 2 the species preliminarily identified are listed after their frequency. Additionally the common habitus of each species and the usual occurrence in distinct forest types is annotated for the vegetational analysis.

Regarding these facts the following statements and conclusions could be made. *Eotrigonobalanus furcinervis* is the most frequent species with almost every second leaf fragment found in the investigated material (43.3%). Every fourth leaf fragment (25.8%) was determined as *Rhodomyrthophyllum reticulosum*. Both leaves of *Eotrigonobalanus furcinervis* and *Rhodomyrthophyllum reticulosum* make up approximately 70% of the whole material and were distinguished as the dominant taxa in the floral assemblage. *Rhodomyrthophyllum reticulosum* (Pl. I, Fig. F) is an index fossil for identifying late Eocene assemblages in the Atlantic-boreal bioprovince of Central Europe (Mai 1995, Mai & Walther 2000, Kunzmann & Walther 2002) and could thus be used as a key fossil of the Zeitz complex. In association with *Steinhauera subglobosa* (Pl. I, Fig. E) it is the dominant component of the *Rhodomyrthophyllum-Steinhauera* riparian forest (Mai & Walther 2000).

While the two dominant species are considered as being leaves of large trees, other species show a higher variety of habits including trees, shrubs and climbers. Those species occuring with 10 to 1% in the taphocoenosis are concidered as frequently occuring components. The extinct evergreen conifer *Quasisequoia couttsiae* (Pl. I, Fig. D) belongs to these frequent components of the flora with 7.1%. It has often been called a giant subtropical conifer of riverine and swampy environments (Kunzmann 1999). *Vaccinioides ovosimilis* (Pl. I, Fig. I) is another example within this group. In comparison to other assemblages from the same geological setting (Kunzmann & Walther 2002), this Ericaceae species is unusually frequent in the investigated material (2.2%). *Vaccinioides ovosimilis* indicates swamp conditions and thus could be an indicator for the occurrence of a Myricaceae-Ericaceae swamp forest (Mai & Walther 2000). Most of the fragments listed as monocots indet. probably may have been derived from palm leaves, and thus palms in gen-

Fig. 5. Complete specimen used for leaf surface orientation analysis; selected taxa: **E**, *Eotrigonobalanus furcinervis*; **P**, *Polyspora saxonica*; **R**, *Rhodomyrthophyllum reticulosum*; specimen MMG PB Schle OE 785 : 1. Scale: 3 cm.

Abb. 5. Sedimentplatte, welche für die Analyse von Blattoberflächenorientierungen verwendet wurde; ausgewählte Arten: **E**, *Eotrigonobalanus furcinervis*; **P**, *Polyspora saxonica*; **R**, *Rhodomyrthophyllum reticulosum*; Stück MMG PB Schle OE 785:1. Maßstab: 3 cm.

eral can be placed in the category of frequently occurring species with 3.7% of all plant remains. The occurrence of palms in these coastal environments is usually tied on habitats with sandy soils such as river banks or dunes. It is also regarded as pioneer plant.

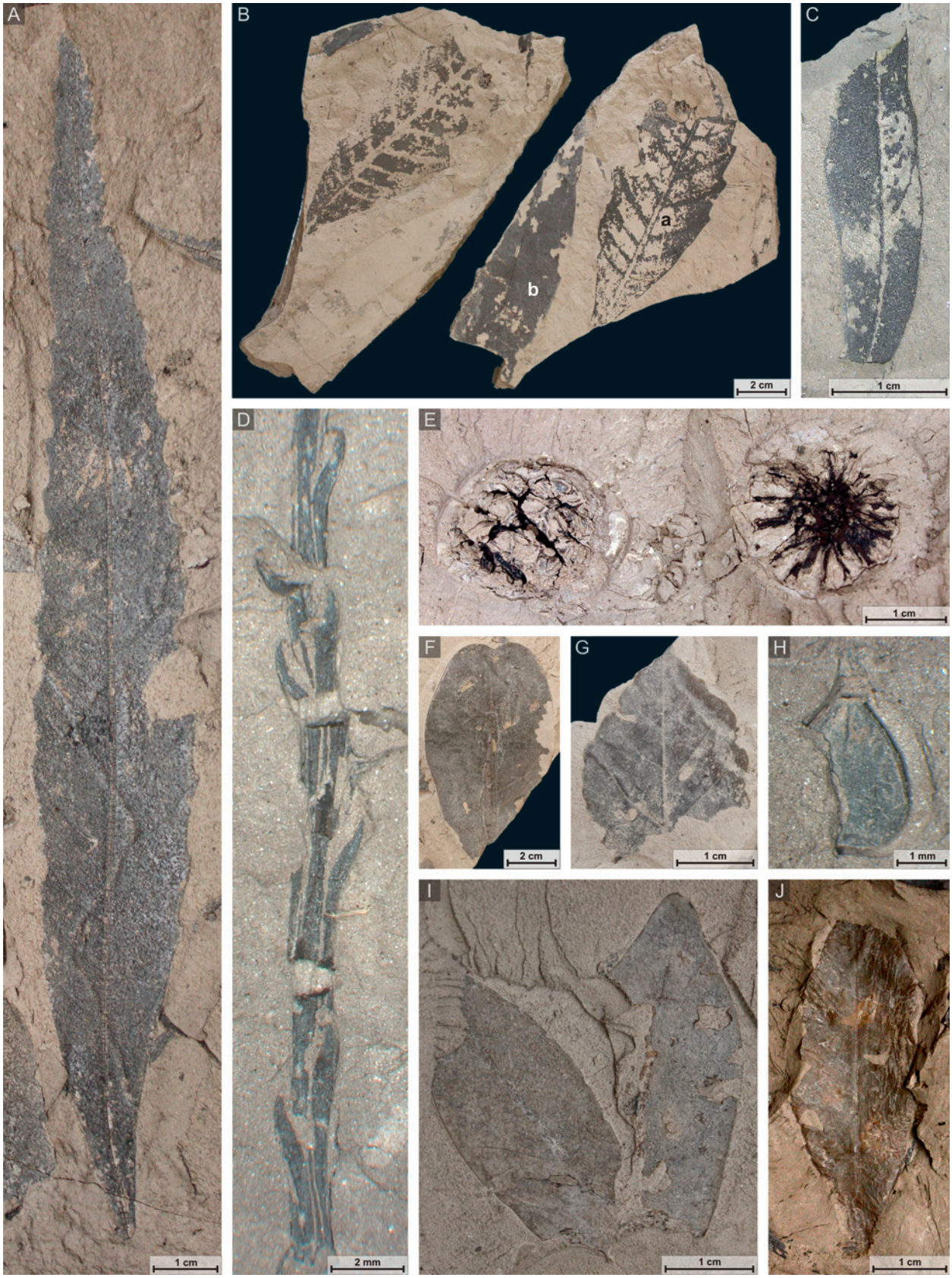
Species that share less than 1% of the identified plant remains are treated herein as accessory elements. Ferns and Lauraceae fall in this category. It is remarkable that Lauraceae which are normally quite common in late Eocene megafloras (Mai & Walther 2000) in the Weißelster Basin are absolutely rare. Only two remains of *Daphnogene* sp., one remain of *Actinodaphne pseudogermari* and one remain of *Laurophyllum hypolanatum* (Pl. I, Fig. B) could be observed in the material.

Mai (1995) describes the zonal evergreen Fagaceae-Lauraceae forest as an important and widespread vegetational unit in the late Eocene and *Eotrigonobalanus furcinervis* as the dominant species in the canopy level of these forests. This vegetational unit is clearly represented in the fossil taphocoenosis although Lauraceae are not quite common in the assemblage. *Actinodaphne pseudogermari*, *Daphnogene* sp., and *Polyspora saxonic*a are considered to be shrubby elements within the forest. The climbers *Toddalia hofmannii* and *Sloanea nimrodi* (Pl. I, Fig. G) are also typical species in this vegetation type.

The occurrence of swamp vegetation is not only indicated by the remarkable frequency of *Vaccinioides ovosimilis* but although by the record of *Osmunda lignitum* and *Zingiberoideophyllum* sp. that could have been grown in clearings of a *Quasisequoia couttsiae* dominated swamp forest (Kunzmann & Walther 2007, Kunzmann 2012).

4. Summary

In this article a late Eocene flora from Schleenhain was investigated taxonomically as well as phytotaphonomically. The leaf component of the assemblage has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1 cm
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1 cm

Plate I

Macrophotographs of selected fossil remains.

A *Eotrigonobalanus furcinervis*, slender dentate leaf type; detail from specimen in Fig. 4; MMG PB Schle OE 720e.

B Specimen MMG PB Schle OE 726:1,2 with compression on right side and corresponding counterpression; **a**, *Eotrigonobalanus furcinervis,* broad dentate leaf type; **b**, *Laurophyllum hypolanatum*, leaf.

C *Eotrigonobalanus furcinervis*, entire leaf type; MMG PB Schle OE 716.

D *Quasisequoia couttsiae*, branch; MMG PB Schle OE 764a.

E *Steinhauera subglobosa*, two aggregate fruits; left hand side: outer surface visible, right hand side: cross-section; MMG PB Schle OE 709:1a,b.

F *Rhodomyrthophyllum reticulosum*, leaf; MMG PB Schle OE 755.

G *Sloanea nimrodi*, leaf; MMG PB Schle OE 746.

H *Trigonobalanopsis andreanszkyi*, seed; MMG PB Schle OE 764c.

I *Vaccinioides ovosimilis*, two leaves; MMG PB Schle OE 801:1b,c.

J Hamamelidaceae gen. et spec. indet., leaf; detail from specimen in Fig. 2; MMG PB Schle OE 759:1a.

Tafel I

Makrofotografien ausgewählter Fossilreste.

A *Eotrigonobalanus furcinervis*, schmaler gezähnter Blatttyp; Detail von Stück in Fig. 4; MMG PB Schle OE 720e.

B Stück MMG PB Schle OE 726:1,2 Druck rechts, Gegendruck links; **a**, *Eotrigonobalanus furcinervis,* breiter gezähnter Blatttyp; **b**, *Laurophyllum hypolanatum*, Blatt.

C *Eotrigonobalanus furcinervis*, ganzrandiger Blatttyp; MMG PB Schle OE 716.

D *Quasisequoia couttsiae*, Zweig; MMG PB Schle OE 764a.

E *Steinhauera subglobosa*, zwei Sammelfrüchte; links mit sichtbarer Oberfläche, rechts im Querschnitt; MMG PB Schle OE 709:1a,b.

F *Rhodomyrthophyllum reticulosum*, Blatt; MMG PB Schle OE 755.

G *Sloanea nimrodi*, Blatt; MMG PB Schle OE 746.

H *Trigonobalanopsis andreanszkyi*, Samen; MMG PB Schle OE 764c.

I *Vaccinioides ovosimilis*, zwei Blätter; MMG PB Schle OE 801:1b,c.

J Hamamelidaceae gen. et spec. indet., Blatt; Detail von Stück in Fig. 2; MMG PB Schle OE 759:1a.

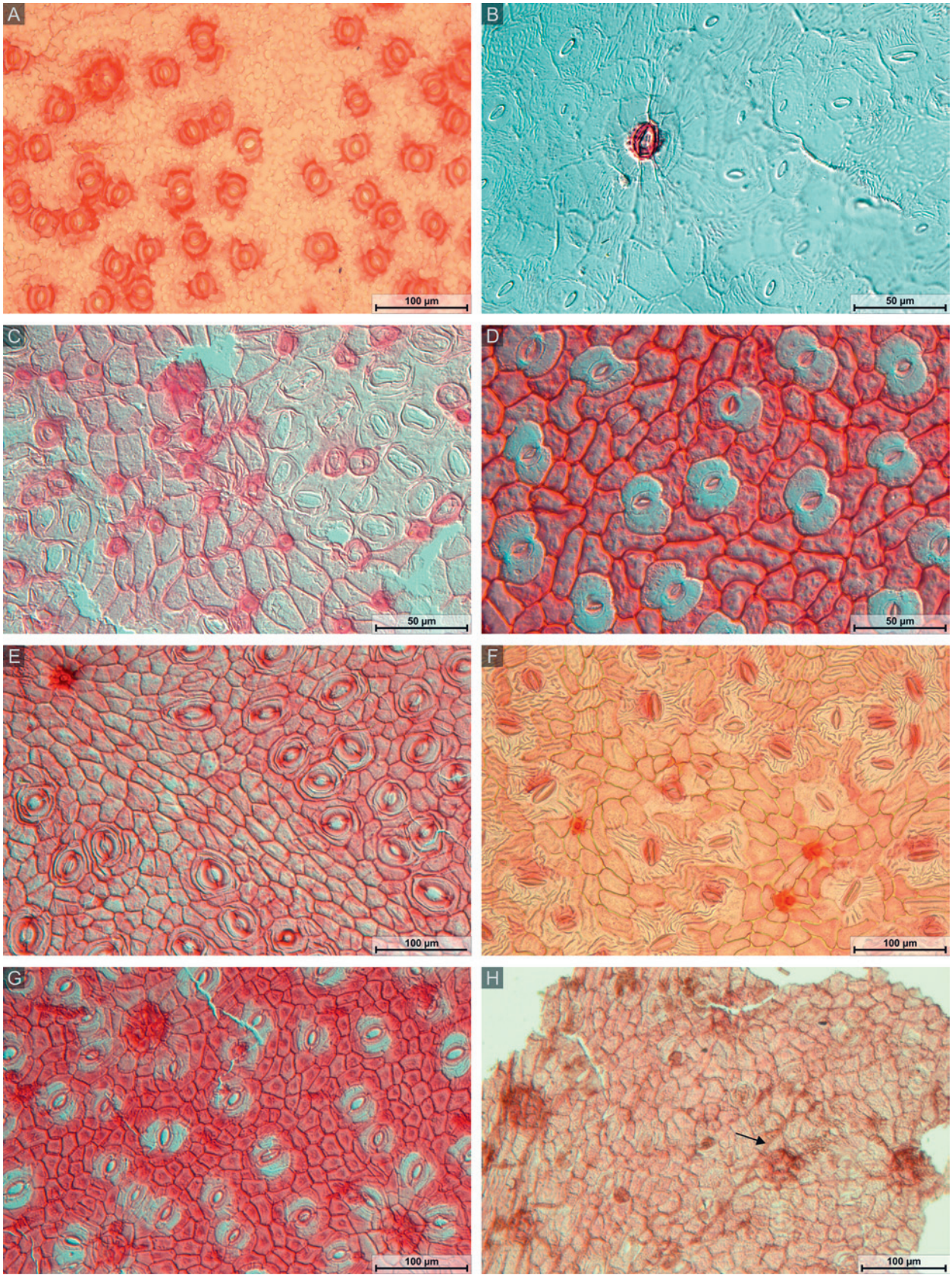
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Plate II

Cuticle preparations of selected species, abaxial side.

A *Rhodomyrthophyllum reticulosum*, stomata and typical undulated anticlinal walls of ordinary epidermis cells; example for robust cuticle; bright field, preparation slide MMG PB Schle OE 156/11.

B Indet. type, stomata and peltate trichome; example for well preserved delicate cuticle; differential interferation contrast, preparation slide MMG PB Schle OE 39/11.

C *Eotrigonobalanus furcinervis*, stomata and simple trichome bases; differential interferation contrast, preparation slide MMG PB Schle OE 96/11.

D *Vaccinioides ovosimilis*, stomata with typical aliform subsidiary cells; differential interferation contrast, preparation slide MMG PB Schle OE 146/11.

E *Polyspora saxonica*, stomata and one simple trichome base in the left upper corner; differential interferation contrast, preparation slide MMG PB Schle OE 121/11.

F Hamamelidaceae gen. et spec. indet., typical crumpled cuticle and stomata; bright field, preparation slide MMG PB Schle OE 52/11.

G, H *Toddalia hofmannii*, stomata and apertures of glands, differential interferation contrast.
- **G** Preparation slide MMG PB Schle OE 56/11.
- **H** Example for poorly preserved cuticle with fungial attack, arrow: fungal hyphae; preparation slide MMG PB Schle OE 46/11.

Tafel II

Kutikula-Präparate ausgewählter Arten, abaxiale Seite.

A *Rhodomyrthophyllum reticulosum*, Spaltöffnungen und typisch undulierte Antiklinen der gewöhnlichen Epidermiszellen; Beispiel einer robusten Kutikula; Hellfeld, Schliff MMG PB Schle OE 156/11.

B Indet. type, Spaltöffnungen und Schirmhaar; Beispiel einer außergewöhnlich gut erhaltenen dünnen Kutikula; Differentieller Interferenzkontrast, Schliff MMG PB Schle OE 39/11.

C *Eotrigonobalanus furcinervis*, Spaltöffnungen und einfache Haarbasen; Differentieller Interferenzkontrast, Schliff MMG PB Schle OE 96/11.

D *Vaccinioides ovosimilis*, Spaltöffnungen mit typisch flügelförmigen Nebenzellen; Differentieller Interferenzkontrast, Schliff MMG PB Schle OE 146/11.

E *Polyspora saxonica*, Spaltöffnungen und Haarbase im linken oberen Bildausschnitt; Differentieller Interferenzkontrast, Schliff MMG PB Schle OE 121/11.

F Hamamelidaceae gen. et spec. indet., typisch faltige Kutikula mit Spaltöffnungen; Hellfeld, Schliff MMG PB Schle OE 52/11.

G, H *Toddalia hofmannii*, Spaltöffnungen und Drüsenöffnungen, Differentieller Interferenzkontrast.
- **G** Schliff MMG PB Schle OE 56/11.
- **H** Beispiel einer schlecht erhaltenen Kutikula mit Pilzbefall, Pfeil verweist auf Pilzhyphe; Schliff MMG PB Schle OE 46/11.

been identified as being mostly parautochthonous. The flora contains species of different habits including tall trees, smaller trees, shrubs and climbing plants. A palaeosociological analysis refers to the evidence of several azonal and zonal vegetational units near the burial place. Azonal types are represented by a *Rhodomyrthophyllum-Steinhauera* riparian forest and swampy vegetation that is putatively represented by a Myricaceae-Ericaceae swamp forest and by a *Quasisequoia* swamp. Zonal vegetation is proofed by typical species of the Fagaceae-Lauraceae forest including *Eotrigonobalanus furcinervis*, *Polysopra saxonica*, *Toddalia hofmannii* and others. Remarkably, Lauraceae in general are rare in the taphocoenosis.

5. Acknowledgements

The authors would like to thank the co-workers from Mibrag mbH (Zeitz) for enabling access to the open cast mine at Schleenhain, in particular Thomas Fischkandl for fieldwork and helpful discussions. Carola Kunzmann (Senckenberg Naturhistorische Sammlungen Dresden) is acknowledged for assistence of preparations in cuticular micro slides and collection management. Mareike Eberlein and Franziska Krause supported our fieldwork and sampling.

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