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Part 10: The Pliocene leaf flora of Auenheim, Northern Alsace (France)

In memoriam

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The Pliocene leaf flora of Auenheim, Northern Alsace (France)

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(dedicated to the late Erwin Knobloch)

Summary: Leaf epidermal and detailed morphological evaluation of selected leaf morphotypes collected by the late Fritz Geissert in the Pliocene of N Alsace is presented. The specimens drive from the "leaf bed" within the main fossiliferous layer of N Alsace once exposed in the sand and gravel quarry at Auenheim. The mummified leaves show excellent venation details and epidermal structures at maceration or by epifluorescence microscopy, which contributes to the understanding of systematic affinities. The leaf assemblage at our disposal consists of 10 gymnosperms and 51 angiosperms. Additions to the previously announced genera are leaf remains of *Tsuga, Pseudotsuga, Cathaya, Sassafras, Dombeyopsis* and *Trichosanthes.* The vegetation type corresponds to a well-diversified temperate mixed coniferous and broad-leaved forest almost without evergreen woody elements (except *Ilex* and *Buxus*). Many exotic deciduous plants have been recovered that are typical of temperate humid climate without much pronounced freezing season known mainly from the present forests of the middle latitude East Asia and Atlantic North America. By its composition the Alsace leaf assemblage is most similar to that from the Pliocene flora excavated from the exposure for the clearing reservoir at Niederrad near Frankfurt u. M.

Key words: leaves, cuticles, fruits, morphology, Pliocene, Europe.

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1. Introduction

The Pliocene deposits within the so-called "Haguenau terrace" and lowlands of the Rhine River in northern Alsace is a classical "Lagerstätte" of fossil plants and animals in Europe (GEISSERT 1962, 1967, 1969, 1972, 1973, 1979, 1987, GEISSERT & MÉNILLET 1979, GEISSERT & NÖTZOLD 1979, GEISSERT et al. 1990). The sites are scattered in the wider surroundings of Haguenau (Soufflenheim, Sessenheim, Auenheim) as sand and gravel pits of a large extent with fossiliferous clay lenses. Plant fossils are represented mostly by carpological material besides wood and much less abundant foliage. During the long collecting activity of Fritz Geissert (*1923-†2005) in this area, thousands of plant fossils have been gathered. The carpological flora has been published in several studies (see GÜNTHER & GREGOR 1993 for review) and consists of several local assemblages both from sandy layers ("Saugbagger flora" – GEISSERT et al. 1990) as welll as clay and marl lenses. However, no comprehensive monograph of the leaf flora has so far been available and only preliminary data have been published, although preservation of the material obtained from “leaf beds” looked very

promising (GEISSERT 1964). The present account is focused on the leaf material which was long in the private property of F. Geissert, Sessenheim, and after his death was transferred to one of us (H.-J. G.). Leaf fossils available are rarely identified so that it is difficult to connect them to the floral lists published in earlier accounts (e.g., GEISSERT 1972, GEISSERT & MÉNILLET 1979). All labeled specimens studied are from the quarry of Auenheim and there is no doubt that also the remaining material originates from there. In order to fill the gap in the knowledge of the Alsace Pliocene flora based on leaf fossils we try to give full descriptions and illustrations of all the material available in particular using the detailed venation and leaf epidermal methodology.

2. Geology

Because the detailed description of the geological setting and previous research activities were given in several publications by Geissert (GEISSERT 1987, GEISSERT et al. 1990), the following text briefly summarises in English the main geological data. The first who described and recognized the Pliocene age of the white sandy-gravel deposits with clay lenses in Northern Alsace in environments of Haguenau was VAN WERVEKE (1892). The unit has been designated the Riedselzer Formation (DUBOIS & DUBOIS 1955). The deposits are divided in two sections by neo-tectonic faults. The higher “Haguenau terrace” extends from Haguenau to Soufflenheim parallel to the Rhine River and includes the “classical” exposures from where the first plant fossils were described (HICKEL 1932, KIRCHHEIMER 1949). According to the current knowledge, they were shifted by some tens of meters higher than the lower section belonging to the bottomland of the river. The latter is opened by large sand pits at Sessenheim, Auenheim, Rountzenheim, and other places (GEISSERT 1962, 1969). According to GEISSERT (1967), GEISSERT et al. (1990) the section of Sessenheim differs from the “Haguenau terrace” by the lowermost levels of the “Saugbagger” flora underlying the main Pliocene fossiliferous horizont and a younger level above it. The latter spreads in the N-S direction and contains a different cold temperate flora (NÖTZOLD 1963). Later executed boreholes on oil and drinking water revealed the thickness of the whole complex at different places. It reaches in the “Haguenau terrace” max. 60 m and in the river valley over 200 m. Geissert, who made most collections and explorations in the sand and gravel pits after the Second World War was able to recognize several palaeontological horizons of different lithology, floral content, and age in main exposures at Soufflenheim, Sessenheim and Auenheim. More detailed data on the geological section at Auenheim were published by GEISSERT (1973), who presented there descriptions of individual layers with palaeontological content. According to the latest evaluation (GEISSERT et al. 1990) the fossiliferous clay deposits underlying the gravel and sands in the Auenheim quarry have been assigned to the Early Pliocene (Brunssumian) on account of palaeofloristic correlations (domination of *Taxodium*, *Fagus* with additional *Ginkgo*, *Viscum miquelii*, *Sassafras*, *Ilex*, *Trichosanthes* and *Vitis teutonica*) – see also below in the chapter on the floristic correlation.

3. Material and Methods

Currently accepted morphological terminology follows DILCHER (1974) and LAWG (1999) for leaves and DILCHER (1974) for fossil cuticles. The leaf material is available as compressions separated from "leaf beds", i.e. coaly layers consisting of accumulated and compressed mummified leaves. The leaf compressions were mechanically separated from each other by preparation in water with the aid of hydrogen superoxid and provisionally preserved spread on bottoms of plastic boxes and moisten in glycerol. The exact position of individual leaf compressions within the area is not indicated on the boxes. According to the previous reports by GEISSERT (1972), GEISSERT et al. (1979), all material studied comes from the "Main Fossiliferous Layer" of Auenheim. The epidermal structures are preserved in many

cases. Unfortunately, glycerol does not contain any disinfection matter so that exposed leaf surfaces after long time since collecting are at present mostly covered with a mouldy film of hyphae. The cuticles have been prepared from fragments of the leaf laminae that have been removed and washed in a drop of diluted HF and mechanically cleaned by micro-scalpels for obtaining clear preparations. After rising in distilled water, the fragment was placed on the microscope slide, shortly macerated in diluted Schulze solution or in commercial bleach (SAVO), rinsed in drops of water, 5% KOH, again water and put in a drop of glycerol. After keeping the sample in glycerol for several hours (overnight), remains of mesophyllous tissue became softer and allowed to get fragments of cuticles separated before placing the cover glass. The preparations were then enclosed by cover glass and sealed with nail varnish.
The compressions have been documented before preparations in transmitted light by a digital camera NIKON COOLPIX 4500. The cuticles were photographed under a biological microscope OLYMPUS in interference and phase contrast light. In some cases, the epidermal structure has been observable only in the epifluorescence microscopy (courtesy L. Hably, Budapest).
The reference cuticle collections are housed at the Charles University, Prague and new samples from various herbaria have been employed for comparisons. Most fossil material studied has been transferred to the collections of the Augsburg Museum (preliminary prefix SS), and duplicates to the National Museum, Department of Palaeontology, Prague (NM K). Besides, some original material from Auenheim studied by F. Geissert has been revised in the collection of the State Museum of Natural History, Stuttgart. The arrangement of taxa of angiosperms applied in the systematic part follows the system suggested by TAKHTAJAN (1987). Only references to the previously published records from the Alsacian Pliocene are included into the synonym lists.

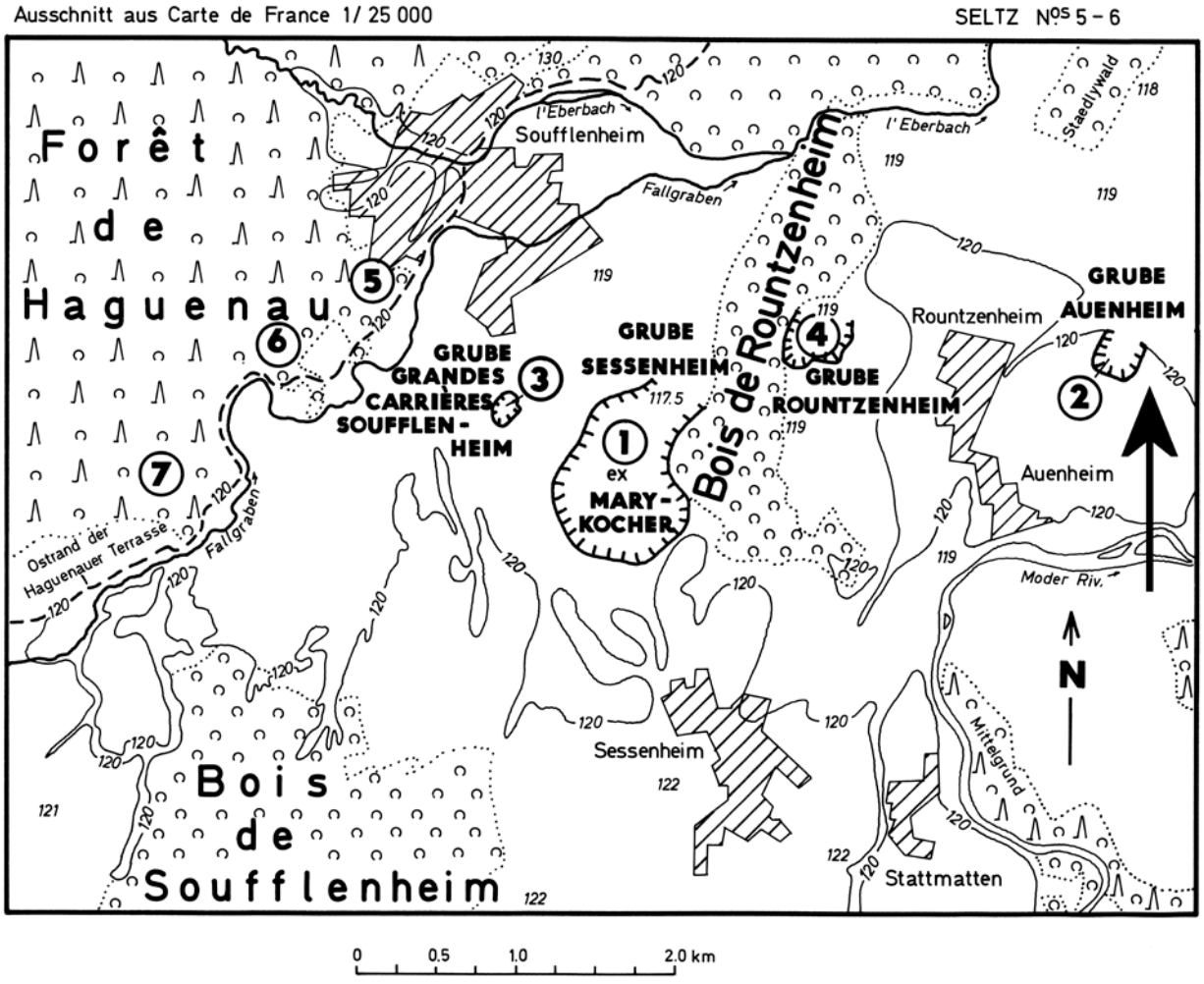
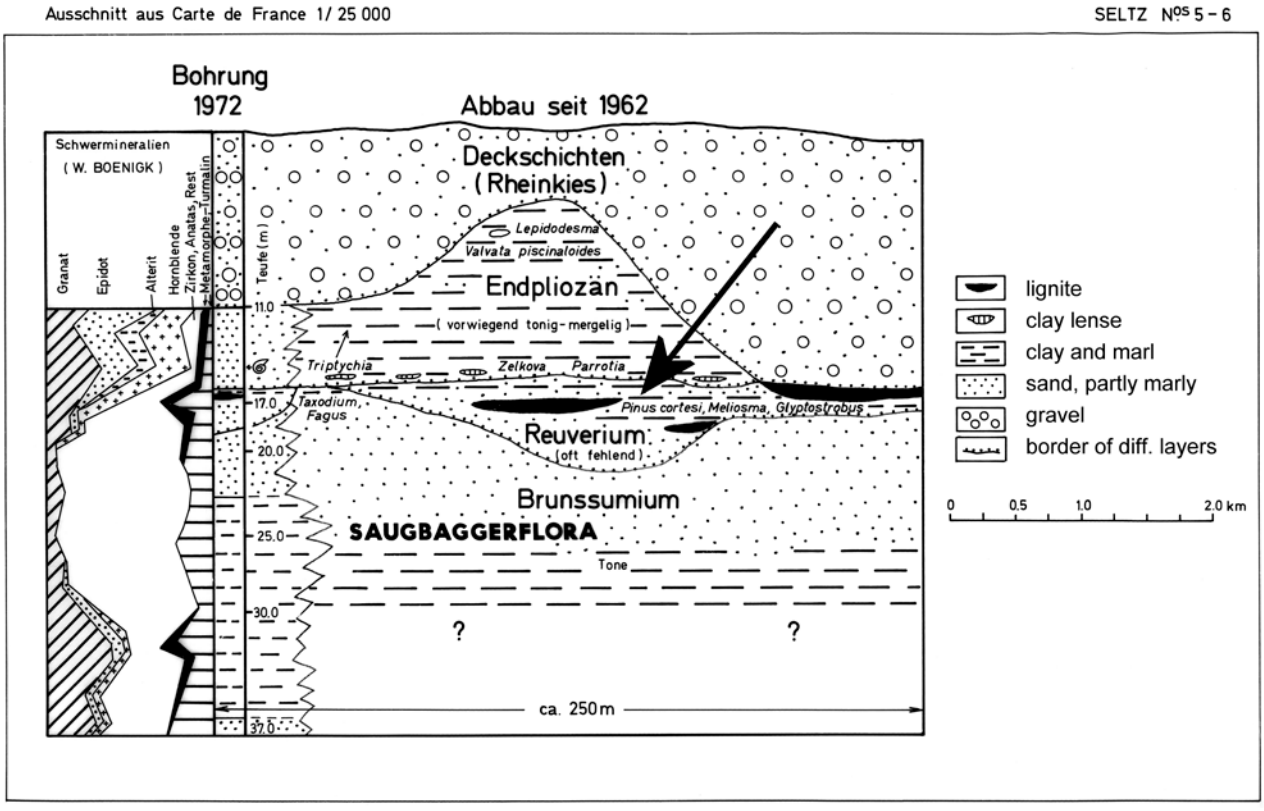


Fig. 1 (left): Geographical map with quarries in the environment of Haguenau, the sand-pit Auenheim is marked with an arrow (altered after GEISSERT et al. 1990, Fig. 3)
The numbers are different pits and outcrops, all belonging to the Pliocene sediment complex of the River Rhine.
1 sand pit “Graviere du Rhin de Sessenheim”
2 sand pit Auenheim
3 sand pit “Grandes Carrieres”
4 open pit Runtzenheim
5 water station Sufflenheim
6 clay pit in the forest section No. 45
7 fossil site in forest section No. 7

Fig. 2 (below): Schematic profile with lithology, sedimentology, fossil finds and stratigraphical age through the Pliocene in the Alsace area (altered after GEISSERT et al. 1990, Fig. 4) with the possible situation of the Auenheim Flora (arrow).
The “Saugbagger-Flora” (suction pipe excavator-flora) from Sessenheim is of Uppermost Miocene – Lowermost Pliocene (Susterium) age, the overlying sediments belong to the Brunssumian (without floras, lower Pliocene). Than the sandy Reuverian (Upper Pliocene) sediments are following (erosional layers of the river Rhine), mixed up with clay and marl lenses. In one of these clay lenses the leaves were found, in the more sandy layers a rich fruit- and seed-flora was found.



4. Systematic descriptions
4.1 Gymnospermae
4.1.1 Ginkgoaceae ENGL.
***Ginkgo* L.**
***Ginkgo adiantoides* (UNGER) HEER**
Pl. 1, figs 1-4; Pl. 16, figs 1-2

1972 *Ginkgo adiantoides* (UNGER) HEER; GEISSERT, pp. 199 (Soufflenheim), 213, fig. 7 (Auenheim)
1987 *Ginkgo adiantoides* (UNGER) HEER; GEISSERT, p. 7, pl. 1, fig. 1, pl. 2, fig. 3 (Soufflenheim)

Material: Complete and incomplete leaves (SS 165-167, 339-341, NM K 703).

Description: Leaves long petiolate, petiole up to 52 mm long, lamina deltoid to broadly fan-shaped, 28-(34)-40 mm long and 33-(45)-54 mm wide, simple to deeply bilobate, apex truncate to emarginate, base widely cuneate, decurrent into petiole, margin entire to coarsely undulate in the apical part, venation flabellate, primary veins subparallel, often forked, two outermost lateral veins thicker, distinctly bordering the leaf margin, midrib lacking. Mesophyllous narrow, spindle-shaped oil cells parallel to the veins scattered within the lamina, not always visible. Cuticles thick; adaxially composed of non-modified cells quadrangular to polygonal in outline, weakly differentiated in costal and intercostal areas, longitudinally arranged in the former case, otherwise random, anticlines generally straight to curved, finely undulate; abaxial cuticle weakly papillate, composed of distinctly differentiated non-modified cells, in narrow costal areas quadrangular, very narrow and elongate, longitudinally oriented, with smooth and straight anticlinal walls, cross walls oblique, in intercostal areas with monocyclic stomata, subsidiary and other adjacent cells isodiametric, anticlinal walls almost straight, outer periclinal walls mostly with thin papillae, stomata with deeply sunken guard cells 42-62 μm long (mean of 10 mesurements 54 μm) showing thick stomatal ledges and mostly preserved polar T-pieces, surrounded by 4-6 subsidiary cells. Trichomes not observed.

Remarks: The described population of *Ginkgo* from Alsace matches in leaf morphology and epidermal anatomy other late Neogene records in Europe mostly referred to as *Ginkgo adiantoides* (TRALAU 1967, 1968; HABLY & KVAČEK 1997; DENK & VELITZELOS 2002). In particular it is not distinguishable from the Pliocene *Ginkgo* from Niederrath at Frankfurt u. M. (FLORIN 1936; MÄDLER 1939), which was separated as an independent species and named *G. florinii* by SAMYLINA (1967). The intensity (depth) of the anticline undulation on the adaxial cuticle and the density of pubescence used by SAMYLINA (1967) as diagnostic traits differentiating the Pliocene species of *Ginkgo* from other Neogene records vary in our opinion due to ecological influence. They cannot be employed for such purposes.

4.1.2 Cupressaceae GRAY. sensu lato
***Taxodium* RICH.**
***Taxodium* cf. *dubium* (STERNB.) HEER**
Pl. 1, figs 7-9, 21; Pl. 16, figs 3-4

1987 *Taxodium* cf. *distichum* RICH.; GEISSERT, p. 8, pl. 1, fig. 5

Material: Incomplete sterile leafy short shoots, partly attached to twigs, but mostly fragments (SS 170, 172-182, 275, NM K705-709).

Description: Long shoots (macroblasts) narrowly oblong to broadly oblong or obovate in outline, flattened, 39-(48)-58 mm long to 15-(14)-20 mm wide, cryptomerioid type (SS 170) with short needles up to 4 mm long, originating at an angel of 40° to 60°, helically arranged; taxodioid type (most specimens) with distichous needles, linear to narrow lanceolate, 8-(11)-14 mm long and 1-(1.6)-2 mm wide, base obtuse with a minute petiole, alternate at unequal distances, midrib strong, distinct. Leaves amphistomatic, cuticles extremely thin. Non-modified cells elongated, isodiametric to short quadrangular, ca. 18-70 µm long, 15-37 µm wide (narrower at the margins), anticlines straight or slightly wavy, stomata in 2-3 (-4) rows on both leaf surfaces, usually perpendicular or oblique to the leaf length, deeply sunken, in submacerated samples with polar T-pieces and thick ledges, 37-42 µm long, incompletely amphicyclic, polar subsidiary cells of the inner circle often lacking, stomatal apparatus 30-50 µm long, stomatal pit elongated quadrangular.

Remarks: The studied Pliocene records of *Taxodium* differ from typical *T. dubium* (KVAČEK 1976, KUNZMANN et al. submitt.) by amphistomatic leaves like the Polish Pliocene record from Ruszów (HUMMEL 1983, as *Taxodium dubium*). They and corresponds in this respect with the living *T. distichum* (L.) RICH. from the Atlantic part of North America. Some specimens recall *Sequoia abietina* (BRONGN.) KNOBLOCH by broader needles (Pl. 1, fig. 21) but according to the epidermal anatomy they belong to *Taxodium.* A more detailed study of other Pliocene records of *Taxodium* including all associated organs is needed to assess accurately the taxonomic status and evolution of the European Pliocene ancestors of bald cypress.

4.1.3 Pinaceae LINDL.
***Abies* MILL.**
***Abies* cf. *albula* (LUDWIG) MÜLLER-STOLL**
Pl. 1, figs 5, 6; Pl. 16, fig. 5

Material: Incomplete needle (SS 281).

Description: Needle leaf acicular, uni-veined, 15 mm long and 3 mm wide, apex not preserved, base narrowed into a petiole, broadly disc-shaped at the base (2 mm wide), margin entire, midrib strong, straight, distinct, 0.5 mm wide. Leaves hypostomatic, cuticles very thin, poorly preserved, adaxial cuticle composed of quadrangular, elongated non-modified cells with fine undulate or pearl-string thickened anticlines, underlain by a straight-walled hypodermis, abaxial cuticle with two lateral and one medial non-stomatal areas and two stomatal bands, non-stomatal areas composed of quadrangular elongated cells with fine undulate anticlines, stomatal bands poorly cutinized, showing 7 (?) rows of stomata preserved only as guard cell pairs with T-pieces, stomatal pits not recognizable.

Remarks: This single fragment belongs obviously to *Abies* in view of the escutcheon-like leaf base. Poorly preserved epidermal features prevent us to make a more detailed comparison at the species level. Similar fossil needle leaves are known from the Pliocene of Dernbach (MÜLLER-STOLL 1938, as *Abies albula* (LUDWIG) MÜLLER-STOLL) and Niederrad (MÄDLER 1939, as *Abies pectinata* DC. *fossilis*), in both cases similar in very thin cuticles and fine undulating anticlines of non-modified cells.

***Cathaya* CHUNG & KUANG**
***Cathaya* sp.**
Pl. 1, fig. 10; Pl. 16, fig. 6

Material: Incomplete needle (SS 171).

Description: Needle linear, univeined, 92 mm long, 2 mm wide, slightly curved, apex acute, margin entire, midrib distinct, 0.6 mm wide. Leaves hypostomatic, adaxial epidermis composed of narrow elongate, straight-walled cells over 300-500 µm long and 15-25 µm wide, either with pointed endings or with more or less oblique cross walls, abaxial epidermis with three non-stomatal areas, two lateral and a medial one consisting of non-modified cells similar to those of the adaxial epidermis, and with two stomatal bands showing up to 9 tightly set rows of stomata. Stomata monocyclic, strictly longitudinally arranged, guard cells well preserved, with T-pieces, 50 µm long, uniform in size, two polar subsidiary cells quadrangular, almost isodiametric, ca. 20-25 µm long and 25 µm wide, often shared by adjacent stomata, two lateral subsidiary cells narrow elongated, quadrangular, very long, shared often with adjacent stomata, stomata underlain by transverse thin-walled strands of transfusion tissue, which may occasionally fuse or fork.

Remarks: The needle leaves of *Cathaya* are recognizable first of all according to their leaf anatomy, recently described in detail from the Miocene record of Wiesa (KUNZMANN & MAI 2005, as *Cathaya roseltii* SCHNEIDER). Two kinds of needle leaves seam to co-occur in the latter locality, a shorter morphotype matching the Middle Miocene *Cathaya roseltii* (~ *Cathaya multiserialis* (WEYLAND) KVAČEK & WILDE 2006) and a long-leaved morphotype originally described from the Pliocene of Niederrad as *Podocarpus kinkelinii* MÄDLER (1939) and announced also from Wiesa (LITKE 1965). The leaf fragment described above belongs to the latter. Indeed, the morphology of seed cones points also to two species of *Cathaya* in Europe (see LIU & BASINGER 2000), viz. *C. bergeri* (KIRCHHEIMER) SCHNEIDER typified by the material from the Miocene of Wiesa and *C. vanderburghii* GOSSMANN, nom. inval. from the Miocene of Adendorf (GOSSMANN 1991) and Pliocene of Germany and Italy (MAI 1994, MARTINETTO 1995, 1996).

***Picea* A. DIETR.**
***Picea echinata* MÜLLER-STOLL**
Pl. 1, figs 11-13; Pl. 16, fig. 7

Material: Fragment of a leafy twig and isolated needles (SS 168, 279, 300, NM K 711).

Description: Twig 32 mm long and 9 mm wide (preserved only needles on the left side of the twig) with 5 alternately attached incomplete needles, complete needle linear, laterally flattened, 15-26 mm long and 2 mm wide, apex spinose, base truncate, margin entire, midrib strong, straight, distinct (0.3 mm wide). Leaves amphistomatic, adaxial and abaxial epidermis similar in distribution of stomata, non-stomatal areas and intercalated rows of non-modified cells composed of long quadrangular cells with pitted / finely undulate anticlines, underlain by a straight-walled hypodermis or hypodermal strands, 4 stomatal bands composed of up to 7 rows of stomata, partly wide apart due to simple or double rows of intercalated non-modified cells, stomata amphicyclic, longitudinally oriented, guard cell pairs with I - pieces, 52-62 µm long, stomatal pits quadrangular, mostly concealed by guard cells, subsidiary cells 2 polar, rounded or trapezoidal, ca. 25 µm in diameter, 2 lateral half-moon in shape, usually a complete

ring of encircling cells present, sometimes polar encircling cells shared by adjacent stomata or lacking.

Remarks: These needle leaves belong undoubtedly to spruce on account of leaf morphology (spiny apex, truncate base). They perfectly match both in morphology and epidermal anatomy *Picea echinata* MÜLLER-STOLL (1938) previously described as *Pinus abies rotunde-squamosa* LUDWIG (1861), nom. illegir. and re-combined to *Picea rotunde-squamosa* (LUDWIG) MAI & WALTHER (1988) from the Pliocene of Dernbach. Similar Pliocene records are known e.g. from Krościenko (SZAFER 1947, as *Picea polita foss.*). The nearest living relative appears *Picea torano* (SIEBOLD ex K. KOCH) KOEHNE (syn. *P. polita* (SIEBOLD & ZUCC.) CARR. from Japan.

***Pseudotsuga* CARRIÈRE**
***Pseudotsuga* sp.**
Pl. 1, figs 14, 15; Pl. 16, fig. 8

Material: Incomplete needle (SS 277).

Description: Needle linear, 19 mm long (preserved length), 1.3 mm wide, straight, apex not preserved, base decurrent into thin petiole, 1.3 mm long, margin entire, midrib distinct 0.3 mm wide; leaves hypostomatic, mesophyll containing branched thick-walled sclereids 70-120 μm long, sometimes only forked, sometimes with twice branched slender processes, cuticles extremely thin, adaxial epidermis composed of very narrow elongated cells, 4-6 μm wide, with straight to wavy lateral walls, cross walls usually oblique, abaxial side showing non-stomatal areas composed of the same kind of non-modified cells and two stomatal bands each with about 6 rows of longitudinally arranged stomata, guard cells pairs preserved, with T-pieces, broadly elliptical, the type of stomatal apparatus not well recognizable due to the very thin cutinisation.

Remarks: Idioblasts are not very common in conifer needles. A most popular example is *Sciadopitys* (MÄDLER 1939). STERLING (1947) lists *Pseudotsuga* but also *Cephalotaxus*, *Torreya*, *Cunninghamia*, some Podocarpaceae, and Araucariaceae. Needle leaves of *Pseudotsuga* are most similar to the fragment described above and also to the previously described material from the Frankfurt Pliocene (MÄDLER 1939, as *Abies sclereidea*) both in leaf morphology and anatomy. Living *P. menziesii* (MIRB.) FRANCO (Douglas fire) seems to be a best living equivalent. Only in old trees sclereids develop. They have not been noticed in cultivated comparative material so far. The original interpretation as *Abies* by MÄDLER (1939) is excluded both in view of very different epidermal anatomy (different pattern in amphicyclic stomata in *Abies*) and the attachment of the needles.

***Tsuga* (ENDL.) CARRIÈRE**
***Tsuga* (sect. *Tsuga*) sp.**
Pl. 1, figs 16, 17; Pl. 16, fig. 11

Material: Complete isolated needle (SS 278).

Description: Needle acicular, 10.95 mm long, 1.62 mm wide, flat in cross-section, apex rounded, base broadly cuneate with short, obliquely attached, thin petiole of 1 mm length, margin entire, midrib straight, strong, distinct, 0.23 mm wide; leaf hypostomatic, adaxially slightly grooved along the midrib, abaxially with slightly revolute margins. Adaxial epidermis

composed of straight-walled narrow cells, 12-25 µm wide, very elongated, up to 250 µm long, abaxial epidermis showing midrib and two lateral non-stomatal areas composed of cells similar to those of the adaxial side, and two stomatal bands reaching from the very base up to the leaf tip, each including max. 6 rows of stomata closely spaced, without intercalated rows of non-modified cells. Stomata longitudinally arranged, tightly set, incompletely amphicyclic, guard cells sunken, with a quadrangular outer pit surrounded by two short polar and 2 (-3) half-moon shaped lateral subsidiary cells, outer encircling cells occasionally present. Polar cells 12 µm in diameter, slightly doomed, often shared with the adjacent stomata.

Remarks: Morphologically identical needles were described from the Pliocene of Niederrad, Frankfurt u. M. as *Tsuga europaea* MENZEL (MÄDLER 1939, pl. 1, figs. 21-19) and from Kroscienko (SZAFER 1947, pl. 4, figs. 5-15, partly as *T. caroliniana*) without known epidermal anatomy. The detailed comparison of needle leaves of most living species (KUNZMANN & MAI 2005) allows assigning the above described solitary specimen to *Tsuga* sect. *Tsuga* (hypostomatic leaves). However, not a single living species matches in all respect of leaf morphology and anatomy. *T. caroliniana* is most similar (margin entire, 6-8 stomatal rows) but differs in rows of non-modified cells intercalated between the stomata. A Pliocene record described as *Tsuga* Section *Tsuga* ENGELMANN *fossilis* (MAI & WALTHER 1988) is similar in respect of the topography of stomata and differs only in broader stomatal bands with up to 12 rows. Similar records are known also from the Upper Miocene (MAI 2000). The Early-Middle Miocene needle leaves of *T. schneideriana* KUNZMANN & MAI (2005) are much more robust and have rows of non-modified cells intercalated between more widely spaced stomata.

***Tsuga* (sect. *Hesperopeuce* ENGELM.) sp.**
Pl. 1, fig 18; Pl. 16, figs 9-10

Material: Incomplete needle (SS 280).

Description: Needle acicular, 21 mm long, 2 mm wide, slightly curved, flat, half-moon in cross section, apex not preserved, base cuneate with short fragmentary petiole 0.5 mm long, margin entire, midrib distinct, 0.7 mm wide; leaf amphistomatic, with four stomatal bands and four non-stomatal areas; non-modified cells outside and partly intercalated between stomata long quadrangular with pointed ends, straight-walled, well over 100 µm long and mostly 25 µm wide, stomata adaxially in 2 incomplete rows, abaxially in 3-4 rows per band, longitudinally arranged, widely spaced, incompletely amphicyclic, guard cells preserved with T-pieces, up to 65 µm long, stomatal pit narrow quadrangular, polar subsidiary cells quadrangular to trapezoidal, not shared with adjacent stomata, encircling polar cells partly present, lateral subsidiary cells 2-4, half-moon or quadrangular, usually touching the intercalated rows of ordinary cells.

Remarks: This petiolate needle fragment belongs to *Tsuga* sect. *Hesperopeuce* ENGELM. because of amphistomatic needles and the stomatal type. The living *Tsuga longibracteata* W.C. CHENG is usually separated into a monotypic genus *Nothotsuga* H.H. HU ex C.N. PAGE (PAGE 1989). Its fossil representative, *Nothotsuga protogaea* KUNZMANN & MAI (2005), has recently been announced from the Miocene of Wiesa, Germany. Both differ from the fossil fragment described above by fully flattened leaves and much wider, up to 12 rows wide stomatal bands. Fossil needle fragments from the Middle- and Upper Miocene of

Germany (MAI 1999, 2000, as *Tsuga* sect. *Hesperopeuce* ENGELMANN) are incompletely amphistomatic and differ also in the stomatal pattern.

Pinaceae gen. et sp. indet.
Pl. 1, fig. 19

Material: Fragmentary needles (SS 276).

Description: Isolated needles oblong in outline, 18 mm and 21 mm long, 1.9 mm and 2.1 mm wide, apex not preserved, base broadly cuneate, petiole not preserved, margin entire, midrib straight, strong, distinct (0.3 mm wide).

Remarks: Due to the fragmentary preservation and the lack of epidermal structures, the identification of this fossil must remain open.

4.1.4 Taxaceae GRAY
***Torreya* ARN.**
***Torreya* sp.**
Pl. 1, fig. 20; Pl. 16, fig. 12

Material: Incomplete isolated needle fragments (SS 169, 274).

Description: Needles acicular, 15 mm and 16 mm long, 3.5 mm and 2.6 mm wide, apex mucronate spinose, base truncate and rounded, margin entire, midrib strong, straight, 0.6 mm wide; leaves hypostomatic, adaxial epidermis heavily cutinized, cuticle with surface, minutely pitted, composed of prosenchymatous, narrow elongate cells, 50-100 and more µm long and 15-20 µm wide, with oblique or perpendicular cross walls; abaxial epidermis showing three non-stomatal areas, two lateral and one medial, composed of the same kind of cells as in the adaxial epidermis, stomatal bands heavily papillate, composed of max. 6 irregular rows of stomata, fairly concealed under the papillae, papillate zone adjacent to the stomata narrow, usually one cell wide or lacking. Stomata monocyclic, elliptic, 40-50 µm long and 30 µm wide, longitudinally arranged, scattered over the band, subsidiary cells hardly visible, quadrangular-polygonal, more or less isodiametric, each bearing high papillae, usually up to 6 surrounding the guard cells.

Remarks: Fossil leaves of *Torreya* occur commonly in the Pliocene of Europe (MÄDLER 1939, SITÁR et al. 1989). According to the epidermal anatomy, our fragments match best the record from Niederrad (MÄDLER 1939, as *Torreya nucifera* S. & Z. *fossilis* KINKELIN). Besides leaves, also seed remains were described from the Pliocene of Europe, more recently as *Torreya schulzii* GREGOR et al. (2000), but not from the studied area. The nearest living relatives of these records are equivocal, either from Japan and China, or from the Atlantic or Pacific North America (for review see GREGOR et al. 2000).

4.2 Angiospermae
4.2.1 Lauraceae JUSS.
***Sassafras* TREW.**
***Sassafras* cf. *ferretianum* MASSALONGO & SCARABELLI**
Pl. 2, figs 1-3; Pl. 17, figs 1-2

Material: Fragmentary leaf (SS 120).

Description: Leaf incomplete, long petiolate, preserved petiole 15 mm long, lamina 3- lobed, obovate, 114 mm long, 49 mm wide, apex and lateral lobes not preserved, leaf base cuneate, margin entire; venation suprabasal actinodromous, primary veins straight, distinct, strong, secondary veins looping near the margin, opposite in the basal part to alternate, tertiary veins thinner, straight to convex, alternate percurrent, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Mesophyllous oil cells lens-shaped, ca. 50 µm in diameter, strongly reflecting in the epifluorescent light. Cuticles extremely thin. Adaxial cuticle smooth, non-modified cells polygonal, straight-walled, 15-20 µm in diameter. Abaxial cuticle reflecting in the epifluorescent light, non-modified cells slightly doomed, up to 25 µm long, with straight or slightly wavy anticlines, stomata paracytic, broadly elliptic with sunken guard cells ca. 12-18 µm long (average 14 µm), outer stomatal ledges reaching the stomatal poles, trichome bases not observed.

Remarks: The Neogene European records of *Sassafras* are heterogenous in regard of leaf epidermal anatomy. Some Pliocene leaves are hairy and without any trace of doomed cells on the abaxial side (e.g., STRAUS 1930 – Willershausen, HABLY & KVAČEK 1997 – Gérce) and correspond in this respect to the Late Miocene records (e.g., KVAČEK et al. 2002- Vegora). The present record with doomed cells abaxially is more similar to the Early Miocene morphotaxon described as cf. *Sassafras* sp. by BŮŽEK et al. (1996) from the Cypris Shale in Western Bohemia. In comparison with the living representatives it is close to the living East Asiatic *S. tzumu* (HEMSL.) HEMSL. (E and SE China) in respect of adaxial straight-walled cells and the abaxial pattern (doomed cells, small size of stomata). The other East Asiatic species *S. randaiense* (HAYATA) REHDER (Taiwan) as well as the North American *S. albidum* (NUTT.) NEES lack doomed cells on the abaxial epidermis and have much larger cells and stomata (IMKHANITSKAYA 1966).

4.2.2 Eucommiaceae ENGL.
***Eucommia* OLIV.**
***Eucommia* sp.**
Pl. 14, figs 9, 10; Pl. 15, figs 1, 3; Pl. 23, figs 11-13; Pl. 24, figs 3-4

1967 *Eucommia* aff. *europaea* MÄDLER; GEISSERT, p. 98, pl. 1, figs 4-6 (Sessenheim)
1972 *Eucommia* sp. 1, 2; GEISSERT, p. 200, fig. 10 (Sessenheim, Auenheim).
1973 *Eucommia* sp.; GEISSERT, figs 12, 13 (Auenheim).
1987 *Eucommia* sp.; GEISSERT, p. 8, pl. 1, figs 6 (Sessenheim)

Material: Almost complete leaf (SS 17) and a fragment (SS 16), complete fruits (SS 463, 464).

Description: Leaves simple, petiolate, petiole preserved in length of 14 mm, lamina elliptic to obovate, 53 mm and 63 mm long, 64 and 22 mm wide, apex acute, base broadly cuneate to rounded, margin regularly simple serrate, teeth acute to obtuse, fine, sinuses angular, venation semicraspedodromous, midrib strong, straight, slightly moderately narrowed, secondaries alternate, thinner, originating at an angle of ca. 50° and wider, slightly wavy and curved, looping well within the lamina several times, abmedial veinlets ending in teeth, tertiary venation reticulate, sinuous to curved, venation of the higher orders regularly polygonal reticulate, areolation well developed, 3 to 4 sided, veinlets lacking. Adaxial cuticle striate near veins or smooth, showing straight-walled cells, 30-50 µm in diameter, abaxial cuticle smooth, non-modified cells polygonal, ca. 15-35 µm in diameter, with anticlines wavy, stomata nomocytic, oval, 18-25 (-45) µm long, outer cavity short, spindle-shaped, open, bordered by

double stomatal ledges, two kinds of trichomes observed, serial simple trichomes up to 120 µm long and 12 µm wide attached to simple bases and simple unicellular trichomes up to 150 µm long, 25 µm in diameter on surface, strands of guttapercha within vascular bundles of venation.
Remarks: The leaves of *Eucommia* were mentioned and illustrated previously from the impression/compression material from the Alsace Pliocene (GEISSERT 1967, 1972, 1973, 1987). The leaves described above are more variable in form, partly wider than described before. The shreds of gutta-percha along the leaf venation (GEISSERT 1987, p. 9; MARTINETTO personal communication 2007) corroborate the generic affinity. Our collection contains fruits of *Eucommia europaea* MÄDLER (Pl. 15, fig. 10), which were reported already from the Alsace Pliocene by GEISSERT (1987, pl. 3, fig. 11). They are similar to the records from Niederrad at Frankfurt u. M. (MÄDLER 1939) and bigger than in the living *E. ulmoides* OLIV. Contrary to the only living species from central China, the above noted co-occurring fossil leaves (see also GEISSERT 1967, pl. 1, figs. 4-6) are partly sub-entire, like in other occurrences of this genus, e.g., at Mizerna (SZAFER 1952), Gérce (HABLY et al. 1997, p. 37, pl. 16, figs 84-86) and Willershausen (TRALAU 1963; KNOBLOCH 1998, pl. 46, figs 1a-c, 5 – as cf. *Eucommia* sp.).

4.2.3 Hamamelidaceae R. BR.
***Parrotia* C. A. MEY. sensu lato**
(incl. *Shaniodendron* DENG, WEI & WANG)
***Parrotia pristina* (ETTINGSH.) STUR**
Pl. 2, figs 4-7; Pl. 17, figs 3-4

1967 *Parrotia* cf. *persica* A. MEYER; GEISSERT, p. 98, pl. 1, fig. 2 (Sessenheim).
1973 Hamamelidacée, cf. *Parrotia*; GEISSERT, fig. 19 (Auenheim).
1979 Hamamelidaceae, cf. *Parrotia*; GEISSERT and MÉNILLET, pl. 4. fig. 4 (Auenheim).
1987 *Parrotia* cf. *persica* A. MEYER; GEISSERT, p. 8, pl. 2, figs. 8, 12 (Sessenheim).

Material: Complete leaves and leaf fragments (SS 20, 81-86, 87, 88, NM K 608)

Description: Leaves shortly petiolate, complete petiole 3-(5.5)-9 mm long, lamina broadly elliptic to ovate, 30-(47)-76 mm long, 19-(32)-43 mm wide, apex widely acute to obtuse, base often asymmetric, rounded to subcordate, the ratio between length of lamina and petiole 7-(10)-15 mm, margin in the lower part entire to slightly undulate, in the upper part distinctly undulate; venation simple craspedodromous, midrib strong, moderately narrowed, straight to slightly curved, secondary veins mostly straight, alternate, originating at acute angles, basal pair distinct, opposite to slightly alternate, tertiary veins percurrent straight to sinuous, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided; pocket-like domatia in axils of the lower secondary veins occasionally preserved. Adaxial cuticle very thin, smooth, anticlines hardly observable, wavy, non-modified cells polygonal, probably 25-35 µm in diameter, star-like trichome bases thickly cutinized on the outer edge, ca. 18-30 µm in diameter, scattered on margin and veins, abaxial cuticle still thinner, usually not macerable, anticlines usually not reflected, probably wavy, stomata brachyparacytic, subsidiary cells large and isodiametric, guard cell pairs elliptic, variable in length of 10-20 µm, outer front cavity elliptic, not reaching to the poles, stomatal ledges thin, scattered trichome bases of the same kind as adaxially, 30 to 35 µm in diameter, occasionally larger. Trichomes not preserved in macerated samples.

Remarks: The fossil occurences of *Parrotia*, which are widely spread in the European Neogene do not differ much from each other in gross morphology. The present data confirm also little variation in epidermal anatomy (slightly smaller stomata in the present material than indicated by KNOBLOCH & KVAČEK (1976) for *Parrotia* from Wackersdorf). BŮŽEK (1971) did not accept the generic affinity of Miocene morpho-types because of difference in ratio of petiole vs. lamina length different from living *P. persica* C.A. MEY. (Near East). A similar argument led POP (1936) to assign such leaves from the Pliocene of Borsec to *Fothergilla*. KNOBLOCH & KVAČEK (1976) argued for the affinity to *Parrotia*, because they found in fossils from Wackersdorf marsupial domatia in axils of the lower secondary veins, which are diagnostic of *Parrotia persica* and are lacking in living *Fothergilla* (North America). MEYER & MANCHESTER (1997) distinguished *Fothergilla* (as *F. praeovata* (CHANEY) MEYER & MANCHESTER) and *Parrotia* (as *P. brevipetiolata* MEYER & MANCHESTER) in the Oligocene of the western USA based on the detailed venation. They described both morphotypes differ from the European fossil *Parrotia* morphologically. We are inclined to follow HAO & WEI (1998) in a broader concept of *Parrotia* including a newly described genus *Shaniodendron* (China), which may help to elucidate the palaeogeographic differentiation of this group of Hamamelidaceae within the Northern Hemisphere during the Cenozoic time interval. The Chinese living populations of *Parrotia subaequalis* (CCHANG) HAO & WEI ~ *Shaniodendron subaequale* (CCHANG) DENG, WEI & WANG seem not to possess pocket domatia mentioned above (own observation Z. K.). Hence the Near East *Parrotia persica* and fossil *Parrotia pristina* appear closer to each other than to any other member of the Hamamelidaceae. There are also no differences in epidermal anatomy except for little longer stomata in the living species. The associated seeds and fruit remains have been assigned to *Corylopsis urselensis* MÄDLER (e.g., TRALAU 1963) but their affinities need re-consideration (ENDRESS, personal communication 2006) because none of the foliage morphotypes at hand matches the very characteristic leaves of living *Corylopsis* SIEBOLD & ZUCC.

4.2.4 Juglandaceae A. RICH. ex KUNTH

***Carya* NUTT.**

***Carya* sp.**

Pl. 2, figs 8-16; Pl. 17, figs 5-6

? 1972 *Carya* sp.; GEISSERT, p. 200 (Auenheim)

Material: Incomplete leaflets and leaflet fragments (SS 71, 93, 149, 326, 355, NM K 692, K 698).

Description: Leaflets partly petiolulate, with petiolule 11.6 mm long or subsessile (SS 71), lamina elliptic to ovate, 50-(63)-97 mm long and 15-(26)-39 mm wide, apex acute to attenuate, base asymmetric rounded to cuneate margin rarely entire in the basal part, irregularly finely serrate, teeth acute to mucronate; venation semicraspedodromous, midrib strong, straight to curved, moderate, secondary veins thinner, opposite at base to alternate, looping, tertiary veins alternate to opposite, percurrent, straight to sinuous, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle fragmentary, reflecting non-modified cells ca. 25-35 µm in diameter close to the margin getting smaller, aniclines wavy, straight near the margin, trichome bases on veins of two kinds, rounded, 15 µm in diameter with a rounded rest of a basal cell (? of a glandular trichome), and thick-walled, polygonal bases of unicellular trichomes ca. 15 µm in diameter, partly in pairs. Abaxial cuticle extremely thin, often curling in shreads at maceration, non-modified cells

hardly visible, ca. 17-25 µm in diameter, with straight to fine wavy anticlines, stomata anomocytic, narrow oval, exceptionally almost circular, variable in size, (13-) 15-25 (-30) µm long, outer front cavities spindle-shaped and narrow, ledges thin, trichomes of three kinds, peltate trichomes partly preserved, with head ca. 75-120 µm in diameter, marginally slightly wavy, consisting of numerous radially disposed, narrow segments, and broadly elliptic to circular basis 15-30 µm in diameter, sometimes divided by a cross wall, widely scattered on veins and intercostal areas, and two other kinds of trichome bases described as above on veins.

Remarks: The epidermal anatomy (glandular and peltate trichomes of variable size) as well as pollen of *Carya* occasionally adhering to the foliage corroborates the correct generic identification of the leaflets, but it is certainly difficult to assign them to a particular fossil morphospecies. The leaflets of *Carya* do not express well the specific differences (or even generic affinities – MANCHESTER 1987, p. 67) and therefore the above fossils are identified using open nomenclature. In view of co-occurring fruits differentiated in several species (MAI 1981, MANCHESTER 1987), several morphotypes of foliage can be expected in the European Tertiary but available leaf entities need re-descriptions. The fruits from the Alsace Pliocene have been assigned to *C. angulata* C. & E.M. REID, *C. askenasyi* (KINKELIN) MAI (syn. *C. moenana* KIRCHHEIMER) and *C. globosa* (LUDWIG) MÄDLER, the former, obviously is associated with the above described foliage (GEISSERT et al. 1990).

***Pterocarya* KUNTH**
***Pterocarya paradisiaca* (UNGER) ILJINSKAYA**
Pl. 3, figs 1-5; Pl. 17, figs 7-8

Material: Incomplete leaflets and leaflet fragments (SS 92, 289, 290).

Description: Leaflets subsessile, lamina oblong, 39 mm, 42 mm and 64 mm long; 21 mm, 25 mm and 29 mm wide, apex not preserved, probably acute, base slightly asymmetric, rounded, margin finely simple serrate, venation semicraspedodromous, midrib distinct, moderately narrowed, secondary veins distinctly thinner, alternate, originating almost at right angles, then distinctly curved and looping, tertiary veins alternate, percurrent, straight to sinuous, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle medium thick, smooth, reflecting quadrangular – polygonal cells 20-30 µm in diameter, anticlinal walls almost straight to coarsely wavy, abaxial cuticle much thinner, at places slightly striated, non-modified cells ca. 30 µm in diameter, stomata anomocytic, oval, of variable size, 15-35 µm long, outer front cavity oval, opened, pore slit-like, ledges thin, bases of peltate trichomes well thickened, circular (to elliptical on veins), uniform in size, mostly 15 µm in diameter, rarely larger, heads occasionally preserved circular in outline, max. 100 µm in diameter, with entire margin, consisting of numerous radially disposed segment cells.

Remarks: The overall gross morphology (asymmetrical leaflets) and epidermal anatomy (uniform peltate trichomes, variable stomata with open outer cavity) corroborate the affinity of the present material to *Pterocarya*. Fossil leaflets assigned to this genus have been variously determined in Europe (e.g., *P. castaneifolia* (GÖPP.) KRÄUSEL, *P. denticulata* (O. WEBER) HEER) and nomenclature has only been partly accepted so far particularly for more ancient representatives in Asia (ILJINSKAYA in BUDANTSEV 1994). The foliage from the Middle Miocene to Pliocene called *Pterocarya paradisiaca* (type locality Swoszowice, Middle Miocene) matches best the above described leaflets in gross morphology and epidermal anatomy (KNOBLOCH & KVAČEK 1976, WOROBIEC 2003). Certain variation in size of non-modified cells the adaxial epidermis (15-25 µm at Wackersdorf, 30-40 µm at Belchatow,

20-35 µm in the present material) may be due to ecological influence but may also express specific differentiation. More morphospecies have been recognized in the European Neogene (GREGOR 1980; NEGRU in BUDANTSEV 1994), of which only fruits of *P. limburgensis* C. & E.M. REID occur in the Pliocene of Alsace. They may belong to the same plant as the above foliage.

4.2.5 Fagaceae DUMORT.
***Fagus* L.**
***Fagus kraeuselii* KVAČEK & WALTHER**
Pl. 3, figs 6-13; Pl. 17, figs 9-10

Material: Complete leaves and leaf fragments (SS 32, 60, 232-246, 337, 351, NM K 633-637, K 639, K 643-644, K 647-648, K 651, K 687).

Description: Leaves with fragmentary petiole up to 12 mm long, lamina elliptic to ovate, 35-(69)-98 mm long, 19-(36)-53 mm wide, base often asymmetric, rounded to broadly cuneate, apex acute to attenuate; margin simply widely serrate, teeth regularly spaced, distinct, acute; venation simple craspedodromous, midrib straight, moderately narrowed, secondary veins straight, alternate, regularly spaced, tertiary veins straight to sinuous, alternate percurrent, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle extremely delicate, in epifluorescent light reflecting polygonal-lobate non-modified cells, ca. 30-35 µm in diameter with fine undulate anticlines, abaxial cuticle delicate, smooth, showing in epifluorescent light polygonal non-modified cells ca. 15-20 and more µm in diameter with slightly wavy anticlines and rounded, incompletely cyclocytic stomata, guard cell pairs rounded, 18-26 µm long (mean of 17 measurements 21.8 µm), with polar I-pieces, subsidiary cells mostly 4 or more, partly narrow, partly isodiametric, smaller than non-modified cells, rounded bases of glandular (serial) trichomes ca. 12 µm in diameter, slightly larger than the trichome itself, partly paired, more cutinized, solitary unicellular trichomes about 8 µm thick, incompletely preserved.

Remarks: This morpho-type does not differ from that occurring in the Pliocene of Niederrad at Frankfurt u. M. in gross morphology and leaf anatomy. Both occurrences are noteworthy by larger stomatal length (18-26 µm and 18-32 µm respectively) in contrats to the late Miocene *F. silesica* WALTHER & ZASTAWNIAK (1991) with the range of 15-22 µm, otherwise similar in the stomatal type. Contrary to DENK (2004), who fused late Neogene populations into a single morphospecies *F. haidingeri* KOVÁTS without known epidermal structure (type locality Erdöbény, Middle Miocene), we maintain the Pliocene and late Miocene "microspecies" with known epidermal feautures apart. We follow in this respect the taxonomy of European fossil beech suggested by KVAČEK & WALTHER (1991) and WALTHER & ZASTAWNIAK (1991), which may better express evolution of fossil beach than by using infraspecific taxa (see also KNOBLOCH 1998).

***Quercus* L.**
***Quercus pseudocastanea* GÖPP. emend. WALTHER & ZASTAWNIAK**
Pl. 4, figs 1-5; Pl. 17, figs 11-12

Material: Incomplete leaves and leaf fragments (SS 121, 193, 195, 197, 198, 215, NM K 655-657).

Description: Leaves petiolate, with relatively short petiole 6.6 mm long, lamina obovate, pinnately lobed in basal and medial parts, 47-(69)-100 mm long, 29-(37)-46 mm wide, base broadly cuneate to decurrent, apex slightly attenuate to obtuse, margin coarsely simply dentate - lobate, teeth acute to rarely rounded (mostly in basal leaf part), tips acute, often hooked, sinuses rounded, slightly to broadly opened; venation simple craspedodromous, midrib strong, moderate, secondary veins thinner, alternate, rarely opposite, straight to curved, tertiary veins alternate percurrent, sinuous to straight, looping by the margin, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle extremely delicate, seen in submacerated preparations, straight-walled, abaxial cuticle slightly shagreen, non-modified cells straight-walled, ca. 25-30 μm in diameter, stomata anomocytic, broadly quadrangular -oval to rounded, (15-) 18-20 μm long, with thin polar T-pieces, outer cavity broadly oval, bordered by stomatal ledges, pore short oval, trichomes of two kinds, stellate – fasciculate, dense, very dense on veins, with 2-6 rays ca. 50 μm and more long on thin bases, and uniseriate glandular trichomes on rounded thin bases about 8-10 μm in diameter, dispersed all over the abaxial leaf surface.

Remarks: The morphotypes of oak foliage, which are included into the above species, are characterized by the leaf anatomy matching in general the type population from the Late Miocene floras of Poland (WALTHER & ZASTAWNIAK 1991) and additional records from Greece (KVAČEK et al. 2002), particularly in higher number of rays per trichome (4-8). The morphospecies *Q. pseudorobur* KOVÁTS from the Middle Miocene of Hungary indistinguishable in respect of gross-morphology may appear a younger synonym but its epidermal anatomy is not available as the type locality Erdöbény yielded only leaf impression material.

***Quercus gigas* GÖPP. emend. WALTHER & ZASTAWNIAK**
Pl. 4, figs 6-10; Pl. 18, figs 1-2

Material: Incomplete leaves and leaf fragments (SS 225-228, 353).

Description: Leaves fragmentary, lamina oblong, 42-(57)-75 mm long and 18-(47)-61 mm wide, apex attenuate to acute, base rounded, margin coarsely simple dentate, teeth often asymmetrical, sharp, acute to mucronate, sinuses rounded, opened to broadly opened in basal and medial part; venation simple craspedodromous, midrib strong, moderately narrowed, secondary veins thinner, alternate, straight to curved, tertiary veins alternate percurrent, straight, convex to sinuous, looping by the margin, venation of the higher orders regular polygonal reticulate, areolation well developed, 4 sided. Adaxial cuticle reflecting straight-walled polygonal cells 25-40 μm in diameter, abaxial cuticle thicker, non-modified cells variable in size, straight-walled, stomata anomocytic to incompletely cyclocytic, oval, 15-25 μm long, with polar T-pieces and thick stomatal ledges, outer cavity short oval, subsidiary cells partly isodiametric, up to 5 in number, trichomes of two kinds, stellate trichomes with large rounded well thickened bases 20-25 μm and more in diameter bearing numerous (8 and more) rays, glandular trichome bases asymmetrical rounded, thin-walled, 13-15 μm in diameter, with an asymmetrically attached thin rest of serial trichome.

Remarks: The identification of the leaves included into *Quercus gigas* requires epidermal anatomical data, because they are not distinguishable from the following morphotype assigned to *Quercus* cf. *kubinyii* (KOVÁTS ex ETTINGSH.) CZECZOTT, when gross morphology is only available. Dense indumentum of stellate trichomes with large disk-shaped polycellular bases is a diagnostic trait of this *Q. gigas* (WALTHER & ZASTAWNIAK 1991). It has also

been treated as *Castanea* MILL. (ILJINSKAYA in TAKHTAJAN 1982), but undoubtedly belongs to *Quercus* sect. *Cerris* SPACH (see also HUMMEL 1983, as *Q. czeczottiae* HUMMEL).

***Quercus* cf. *kubinyii* (KOVÁTS ex ETTINGSH.) CZECZOTT**
Pl. 4, figs 11-16; Pl. 18, figs 3-5

Material: Incomplete leaves and leaf fragments (SS 18, 37, 38, 212, 213, 218, 224, 229, 230-231)

Description: Leaves petiolate, with petiole up to 14 mm long, lamina elliptic, 48-(52)-67 mm long and 35-(53)-60 mm wide, apex acute to attenuate, base cuneate to decurrent, margin simple dentate, teeth sharp, mucronate, triangular to reduced to undulate margin in the basal part; venation simple craspedodromous, midrib strong, moderately narrowed, secondary veins thinner, alternate, straight to curved, tertiary veins alternate percurrent, straight to sinuous, looping by the margin, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle smooth, reflecting polygonal cells ca. 25-50 µm in diameter, abaxial cuticle very thin, cell structure differently preserved in sub-macerated samples, non-modified cells polygonal, 15-25 µm, anticlines in some specimens mostly straight, in others slightly wavy (sun vs. shade leaves), stomata anomocytic or/to actinocytic, 20-28(-30) µm long, in sub-macerated samples showing polar T-pieces and broad stomatal ledges, in fully macerated samples only with a short narrow oval outer cavity, two kinds of trichomes present except fully glabrous leaves (SS 38, SS 228), simple circular bases ca. 12 µm in diameter, in various density in different samples, rarely with rests of serial trichomes attached by the full width to the basal cell, and exceptionally (SS 470) stellate trichomes with 4 rays, each about 30 µm long.

Remarks: Leaf fossils of similar gross morphology and epidermal anatomy have been variously assigned to *Castanea* MILL. or *Quercus* L. (for the review see WOROBIEC 2003, p. 30, as "*Castanea*" *kubinyii* KOVÁTS ex ETTINGSH. sensu KNOBLOCH & KVAČEK). Indeed, the epidermal anatomy of some living species of chestnut (e.g., *C. sativa* MILL.) and oaks (e.g., *Q. variabilis* BLUME) matching each other in sharply dentate leaves are hardly distinguishable from the material at hand and from other sites (FERGUSON 1971, KNOBLOCH & KVAČEK 1976). Unfortunately, the type area of this morphospecies from the Sarmatian of southern Slovakia and Hungary did not yield well-preserved material with cuticles. Therefore, it seems premature to attempt resolving its affinities without a broader study of various records in Europe. The simple type of glandular trichome bases found sparsely in the present material as well as from elsewhere (KNOBLOCH & KVAČEK 1976, text-fig. 13; HABLY et al. 1997) is not the same as in the chestnut, where the glandular trichome is attached by a narrow scar on a broad basal cell (BŮŽEK et al. 1985, pl. 5, fig. 6, as *Castanea* sp. from the Vildštejn flora).

***Quercus* cf. *praeerucifolia* STRAUS**
Pl. 5, figs 1-3; Pl. 18, figs 8-9

Material: Leaf fragments (SS 188, 219, NM K 695).

Description: Leaf fragments, lamina probably obovate, pinnately lobed, 34 mm and 33 mm long, 37 mm and 24 mm wide, base rounded, apex not preserved, margin of lobes with second order teeth, lobes acute to rarely rounded, sinuses rounded, broadly opened; venation simple

craspedodromous, midrib strong, moderately narrowed, secondary veins thinner, alternate, straight, tertiary veins alternate percurrent, sinuous to straight, looping by the margin, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle fragmentary, reflecting polygonal non-modified cells 20-40 µm in diameter, abaxial cuticle thicker, non-modified cells polygonal, 10-15 µm in diameter, usually not recognizable due to dense stomata and pubescence, stomata broadly oval, rarely sub-circular, ? anomocytic, 15-20 (-25) µm long, with thick stomatal ledges reaching almost to the poles, forming a broadly oval outer cavity, pore narrow oval and very short, trichomes fasciculate to stellate, dense, with 4 rays (in SS 188 also with 6 and more), each 80-100 µm long, trichome bases not much thickened, basal parts of glandular serial trichomes also dense, up to 40 µm long, thin-walled and narrowed apically, without preserved head, attached to a cylindrical basal cell 10-12 µm in diameter, adhering to the leaf surface.

Remarks: Complete specimens of leaves of a similar fossil oak called *Q. praerucifolia* are known from the type locality Willershausen (STRAUS 1956, KNOBLOCH 1998). The fragments available differ in widely toothed basal lobes, as known in a few roburoid oaks (e.g., *Q. pubescens* WILLD.). In respect of epidermal anatomy the studied fragments are similar to modern *Q. pedunculiflora* K. KOCH (syn. *Q. erucifolia* STEV.) and differ from *Q. pubescens* in sessile, not stipitate stellate trichomes (UZUNOVA & PALAMAREV 1992a, fig. 9 vs. UZUNOVA & PALAMAREV 1992b, fig. 15). Although similar in lobes with second order teeth, *Q. cerris* L. differs in less hairy leaves with massive trichome bases typical of the subgenera *Sclerophyllodrys* SCWARZ and *Cerris* (SPACH) OERST. (UZUNOVA & PALAMAREV 1985).

***Quercus roburoides* GAUDIN**
Pl. 5, figs 4-11; Pl. 18, figs 6-7

1973 *Quercus* aff. *petraea* LIEBL.; GEISSERT, fig. 5

Material: Incomplete leaves and leaf fragments (SS 13, 122, 186, 187, 189-192, 194, 196, 199-200, 210, 214, 216, 217, 220-223, 322, 328, 329, NM K 650, K 652-654, K 658).

Description: Leaves petiolate, with often complete petiole up to 22 mm long, lamina obovate, pinately lobed in basal and medial parts, 48-(66)-82 mm long and 38-(48)-52 mm wide, base rounded or cuneate to decurrent apex slightly attenuate to obtuse, margin entire in basal and medial parts, coarsely simply dentate in the apical part, teeth obtuse to rounded, sinuses rounded, slightly opened to broadly opened; venation simple craspedodromous, midrib strong, moderate, secondary veins thinner, alternate, straight to curved, tertiary veins alternate precurrent, sinuous to straight, looping by the margin, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle extremely thin and rarely preserved, reflecting polygonal straight-walled cells ca. 30-40 µm in diameter. Abaxial cuticle also thin, non-modified cells mostly 15-20 µm, with slightly wavy anticlines, stomata anomocytic, broadly oval, in submacerated samples with thicker outer stomatal ledges and polar I-pieces, fully macerated with only narrow ledges, outer cavity elliptic, pore short, narrow oval to slit-like, stellate to fasciculate trichomes widely dispersed, in some samples (SS 328) denser, sidewards adppressed, with 2-8 rays , each up to 80 µm long, basal part not much thickened, leaving indistinct bases, glandular trichome bases rounded, 10-12 µm in diameter, variable in density and thickness (quite dense in SS 328), often with a thin rest of serial trichome, adppressed, rarely in pairs.

Remarks: Roburoid oaks are widely distributed in the Late Neogene floras of Europe, but epidermal anatomy is rarely known to help elucidate affinities of the fossils assigned to this well confused group. It is therefore difficult to state, if *Quercus roburoides* in the current use represents a single or more natural species. The material at hand recalls the Pliocene records from Hungary (HABLY et al. 1997, as *Quercus pseudorobur* KOVÁTS) but differs in the lack of wax cover (shagreen cuticles). The foliage from Alsace is variable in the density of pubescence. It differs in smaller density of pubescence from *Quercus* cf. *praeerucifolia* described above and well compares in epidermal pattern and gross morphology with the Pliocene population from Brunssum (VAN DER BURGH 1993). It obviously belongs to the living group of *Q. petraea* (MATT.) LIEBL.

4.2.6 Betulaceae GRAY
cf. *Alnus* MILL.
cf. *Alnus* sp.
Pl. 5, fig 12; Pl. 6, fig. 5; Pl. 18, figs 10-11

Material: Incomplete leaf (SS 150).

Description: Leaf with fragmentary petiole, lamina broadly elliptic, 67 mm long and 54 mm wide, apex not preserved, base cuneate, margin irregularly simple serrate, teeth acute to mucronate, sinus angular, venation semicraspedodromous, midrib straight, moderately narrowed, strong, secondaries alternate, thinner, regularly spaced, curved, looping, tertiary veins alternate percurrent, straight to curved, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle very fine striate, showing polygonal cells 25-60 μm in diameter with almost straight to slightly curved anticlines. Abaxial cuticle smooth, non-modified cells polygonal, 25-35 μm in diameter with wavy to shallow undulate anticlines, stomata widely scattered, anomocytic to actinocytic consisting of a circle of radially or irregularly disposed hardly modified subsidiary cells and guard cells, guard cell pairs oval, variable in size, 20-38 μm long, outer cavity spindle-shaped to oval, not reaching to the poles, stomatal ledges thickened in the centre, pore slit-like, inner cavity occasionally preserved, narrow spidle-shaped, shorter than the outer, a single trichome base observed polycellular, broadly oval, 50 μm in longer diameter, composed of 6 sub-radially disposed short cells not much thickened, 15-18 μm long.

Remarks: This single fragment differs in the semicraspedodromous venation from the common morphotypes of *Alnus* known in the fossil state in the European Neogene. The overall pattern of stomata and the trichome base suggest either *Alnus* or *Betula*. However, such a venation type never occurs in birches and is known in living alders (e.g., *A. nepalensis* D. DON., *A. cordata* (LOISEL.) DESF.). Analogous fossils (for discussion see KOLAKOVSKII 1964) are not known in respect of epidermal anatomy, which prevented us from a more detailed comparison.

***Carpinus* L.**
***Carpinus* sp.**
Pl. 5, fig 13; Pl. 6, figs 1-4, 6; Pl. 18, figs 12-13

Material: Leaves and fragments (SS 138, 151-163, 334, 343-346, 473-475), involucres (SS 505-508).

Description: Leaves petiolate with relatively strong petiole, 14 mm long, lamina elliptic to broadly elliptic or ovate, 34-(55)-84 mm long, 26-(50)-73 mm wide, apex attenuate to acute, base broadly cuneate to rounded or subcordate, rarely asymmetric, margin irregularly double serrate, teeth acute, sinus angular, venation simple craspedodromous, midrib distinct, straight to zig-zag, moderately narrowed, secondaries thinner, alternate, often regularly spaced, straight, tertiary veins thin, alternate percurrent, straight to sinuous, venation of the higher orders polygonal reticulate, areolation well developed, often 4 sided, veinlets lacking. Cuticles extremely thin, adaxial cuticle shagreen, showing polygonal non-modified cells ca. 35-30 μm in diameter with wavy anticlines, solitary stomata at leaf margin, abaxial cuticle smooth, showing non-modified cells ca. 30-38 μm in diameter, with anticlines looking straight but after focusing clearly fine undulate, stomata anomocytic, variable in size, broadly oval to circular to transversally oval, 22-50 μm long, outer cavity broadly oval, bordered by broad ledges, pore slit-like, inner cavity often preserved, broad spindle-shaped, much shorter than the outer, polygonal simple trichome bases ca. 13-15 μm in diameter on veins, occasionally densely concentrated (? in axiles), rounded simple trichome bases with rests of glandular trichomes rarely observed.

Remarks: The gross morphology and epidermal structure of the described leaves is comparable with both *Carpinus* L. and *Ostrya* SCOP. (in particular *O. carpinifolia* SCOP.). It is fairly difficult to distinguish these genera morphologically as well as by epidermal structure. Our material differs in having larger stomata and undulate anticlinal walls adaxially from the Oligocene (WALTHER in MAI & WALTHER 1978) as well as Pliocene records of *Carpinus grandis* UNG. (HUMMEL 1991). In this respect it matches the modern *Carpinus betulus* L. (incl. also *C. caucasica* GROSSHEIM – HUMMEL 1991, fig. 3). The leaves described above are accompanied in the collection studied by several fruits (involucres) of *Carpinus betulus* L. type. GEISSERT (1987, p. 8, pl. 2, figs 1, 2) published similar fruit remains from Soufflenheim and Sessenheim as *Carpinus* cf. *betulus* L. and *Carpinus* cf. *betulus* L. var., respectively. The variation in morphology of the presently described foliage and involucres (Pl. 15, fig. 13) falls within the variation of the living *Carpinus betulus.*

***Corylus* L.**
***Corylus* sp.**
Pl. 10, figs 4-6, Pl. 21, figs 6-7

Material: Leaf fragments (SS 73, 327)

Description: Leaves fragmentary petiolate, lamina broadly elliptic or ovate, 31 mm and 80 mm long, 44 mm and 55 mm wide, apex not preserved, base slightly subcordate, margin irregularly double serrate, teeth acute, sinus angular, venation simple craspedodromous, midrib distinct, straight, secondaries thinner, alternate, regularly spaced, straight, tertiary veins thin, alternate irregularly spaced, percurrent, often straight, rarely forked, venation of the higher orders polygonal reticulate, areolation well developed, often 4 sided, veinlets lacking. Adaxial cuticle smooth, showing polygonal cells 20-30 μm in diameter with almost straight anticlines, abaxial cuticle faintly striated, hardly showing non-modified cells, stomata ? anomocytic, oval, 17-30 μm long, peripheral wall of the guard cell pairs occasionally thickened, outer cavity spindle-shaped to narrow oval, pore narrow spindle-shaped, ledges slightly thickened, inner cavity spindle-shaped, shorter than the outer; trichomes of two types, thin-walled non-glandular trichomes, ca. 5-15 μm thick at the base and well over 50 μm long, densely spaced on veins, and much more rarely observed globular short trichomes ca. 20 μm in diameter.

Remarks: *Corylus avellana* L. corresponds with the above described remains in gross morphology as well as in general features of epidermal anatomy (type of trichomes, size and type of stomata) but differs by denser indumentum of its foliage. The leaf fragments from the Pliocene of Ruszów described as *Corylus avellana* L. *fossilis* (HUMMEL 1991) do not compare to the above described material, particularly in the lack of pubescence but this difference may be due to poor preservation of the Polish material.

4.2.7 Ulmaceae MIRB.
***Ulmus* L.**
***Ulmus carpinoides* GÖPPERT**
Pl. 6, figs 7-9

Material: Complete leaves (SS 15, 292, 258, NM K 674).

Description: Leaves petiolate, complete petiole up to 10.5 mm long, lamina broadly elliptic, 27-(44)-54 mm long and 21-(39)-57 mm wide, base distinctly asymmetric, rounded to slightly cordate, apex acute, margin irregularly double-serrate, apices acute, primary teeth rectangular, secondary teeth finer; venation simple craspedodromous, midrib strong and straight, secondary veins distinct, alternate to opposite, usually forked by the margin, thinner ones innervating secondary tooth apices, tertiary veins alternate percurrent, straight to sinuous, venation of the higher orders regular polygonal reticulate, areolation well developed, areoles 3 or 4 sided, veinlets 1 branched. Cuticles extremely thin; adaxial cuticle smooth, without well visible (?) straight anticlines. Abaxial cuticle smooth, without visible anticlines of non-modified cells, stomata recognizable only as spindle-shaped to narrow oval apertures 10-15 µm long, solitary glandular trichomes 25 µm long, obovoid in shaped, with cylindrical head, serially divided stalk and thickened base 5 µm in diameter, no simple trichome bases observed, even on veins.

Remarks: This broader form of elm leaves is well comparable with *Ulmus carpinoides* GÖPP. from Sośnica. Three forms of fruits co-occur at this type locality in Poland (GÖPPERT 1855), of which those with broader wings may belong to *U. carpinoides*. We are not well informed about the associated elm fruits in the Alsacian Pliocene. GEISSERT & MÉNILLET (1979, pl. 4, fig. 1; GEISSERT 1987, p. 9, pl. 3, fig. 6) illustrated a few fossils as elm fruits that have been later recognized as fruit valves of *Pteleaecarpum* WEYLAND (BŮŽEK et al. 1989) and re-assigned to *Craigia* SMITH & EVANS (KVAČEK et al. 1991).

***Ulmus pyramidalis* GÖPPERT**
Pl. 6, figs 10-12

1973 *Ulmus* sp.; GEISSERT, fig. 17 (Auenheim)
1973 *Ulmus* cf. *longifolia* UNGER; GEISSERT, fig. 18 (Auenheim)

Material: Complete leaves and leaf fragments (SS 21, 264, 266-270, 349, NM K 660-667, K 669, K 672, K 682, K 685, K 688).

Description: Leaves shortly petiolate, with rarely complete petiole 5-8 mm long, lamina oblong to narrow ovate, 47-(64)-91 mm long and 20-(25)-35 mm wide, base asymmetric rounded to slightly cordate apex attenuate; margin double-serrate to partly tripli-serrate, primary teeth rectangular, secondary teeth usually finer; venation craspedodromous, midrib strong, moderate, curved; secondary veins thinner, distinct, alternate to opposite (mainly in the basal part), parallel, numerous; tertiary veins alternate percurrent, straight to sinuous, venation

of the higher orders regular polygonal reticulate, areolation well developed, areoles 3 or 4 sided, veinlets 1 branched. Adaxial cuticle smooth, showing polygonal straight-walled cells 25-50 μm in diameter and solitary simple trichome bases 12 μm in diameter on vein forkings, abaxial cuticle extremely delicate, smooth, occasionally showing spindle-shaped apertures of stomata ca. 17-20 μm long.

Remarks: The abundant slender leaves from the Alsace Pliocene match best those of *Ulmus pyramidalis*, particularly its type population at Sośnica (GÖPPERT 1855). This morphospecies is widely distributed in the European Neogene and belongs according to the co-occurring fruits with narrow wings and the persistent perianth shifted on the fruit stalk (BŮŽEK 1971) to an extinct species close to the sect. *Chaetoptelea* (LIEBM.) SCHNEID. Similar but shorter leaves of *Ulmus plurinervia* UNGER (type locality Parschlug, Styria, Middle Miocene) co-occur with similar fruits of *U. parschlugiana* KOVAR-EDER et al. (2004).

***Zelkova* SPACH**
***Zelkova zelkovifolia* (UNGER) BŮŽEK & KOTLABA**
Pl. 6, figs 13, 14; Pl. 7, figs 1-5

? 1967 *Zelkova ungeri* KOVÁTS; GEISSERT, p. 98, pl. 1, fig. 9 (Sessenheim)
1973 *Zelkova ungeri* KOVÁTS; GEISSERT, fig. 20 (Auenheim)

Material: Complete leaves and leaf fragments (SS 251-257, SS 282, SS 307-321, NM K 679, K 683, K 689-690).

Description: Leaves shortly petiolate with rarely preserved petiole up to 5 mm long, lamina ovate to oblong, asymmetrical, 12-(38)-68 mm long and 9-(19)-28 mm wide, base broadly cuneate to slightly cordate, apex shortly acute to attenuate; margin coarsely simple serrate; venation craspedodromous, midrib strong, moderate, straight; secondary veins distinct, alternate, straight or curved; tertiary veins straight, thin, often alternate percurrent; venation of the higher orders regular polygonal reticulate, areolation well developed, areoles 3 or 4 sided, veinlets 1-branched. Cuticles extremely thin and fragmentary, without preserved cells structure.

Remarks: Isolated leaves of *Zelkova* are quite common in the Alsacian Pliocene. Probably due to taphonomical process they are not attached to fertile twigs (contrary to the type locality of Parschlug - KOVAR-EDER et al. 2004 and elsewhere in the Eurasian Tertiary). Nevertheless, they show a certain degree of dimorphism of smaller leaves on deciduous short shoots and ordinary larger leaf forms. The Pliocene populations of *Zelkova* in Europe may show more similarities to the extant populations of *Zelkova sicuta* DI PASQUALE, GARFI & QUÉZEL (Sicily) and *Z. abeliacea* (LAMARK) BOISS. (Crete) than to the other living species *Z. carpinifolia* (PALL.) K. KOCH (Caucasus).

4.2.9 Rosaceae JUSS.
***Malus* MILL.**
cf. *Malus pulcherrima* GIVULESCU
Pl. 7, figs 6-7; Pl. 19, figs 1-2

Material: Fragment of lobed leaf (SS 301).

Description: A single fragmentary lobed leaf with petiole 4 mm long, lamina probably 2- or ? 3- lobed, lateral lobe slightly obovate, 28 mm long and 10 mm wide, apex acute, base broadly rounded margin irregularly simply serrate, teeth acute to mucronate, sinuous angular, venation semicraspedodromous, primaries straight, moderate, distinct, secondary veins distinctly thinner, alternate, curved, looping, tertiary veins alternate percurrent to polygonal reticulate, straight to sinuous, venation of the higher orders well developed, areolation 3 to 4 sided, veinlets lacking. Adaxial cuticle strongly parallel striate to granulate-striate, showing straight-walled polygonal cells ca. 25-50 μm in diameter, abaxial cuticle smooth to very faintly short striate among stomata, non-modified cells straight-walled, 20-50 μm in diameter, stomata anomocytic, broadly oval, 35-50 μm long, with distinct peripheral wall, outer cavity reaching almost to the poles, 30-45 μm long bordered by broad and thick ledges, pore long, spindle-shaped, solitary simple trichome bases 10 μm in diameter on veins.

Remarks: The fragment recalls more complete leaves ascribed to *Malus* and occurring in various late Neogene sites of Europe (GIVULESCU 1980 – Chiuzbaia; KNOBLOCH 1998 – Willershausen). According to KNOBLOCH (1998) many species from East Asia (*Malus sieboldii* (REGEL) REHDER), *M. floribunda* SIEBOLD ex VAN HOUTTE, *M. sargentii* REHDER, *M. kansuensis* (BATALIN) C.K. SCHNEID., *M. transitoria* (BATALIN) C.K. SCHNEID., *M. trilobata* (POIR.) C. K. SCHNEID. etc.), and even USA (*M. glabrata* REHDER), develop similar leaves.

4.2.10 Leguminosae JUSS.
***Gleditsia* L.**
cf. *Gleditsia* sp.
Pl. 7, fig 11

Material: Incomplete thorn (SS 352)
Description: Thorn branched with 2 incomplete partial thorns preserved, 40.2 mm and 25.9 mm long, 1.81 mm and 1.75 mm thick, the third fragmented, originating at a right angle from short base, 6.63 mm in diameter, thorn apices spiny, slightly curved and broadened basally.

Remarks: This fossil is similar to thorns of recent *Gleditsia triacanthos* L. from North America.

***Leguminosites* sp.**
Pl. 7, figs 8-10

Material: Complete leaflets (SS 283, 285).

Description: Leaflets short petiolate, with a short and thick petiole, lamina obovate, 34 mm and 15 mm long, mm 18 mm and 10 mm wide, apex obtuse, base slightly asymmetric, rounded, margin subentire with solitary minute rounded widely spaced teeth, venation brochidodromous – semicraspedodromous, midrib strong, moderately narrowed, secondary veins alternate to sub-opposite in the basal part, tertiary veins random reticulate, venation of the higher orders dichotomizing, areolation moderately developed.

Remarks: Such legume leaflets are hardly assignable to a particular species, and certainly not to a natural genus.

4.2.11 Sapindaceae JUSS. s. l.
***Acer* L.**
***Acer integerrimum* (VIVIANI) MASSALONGO**
Pl. 7, figs 12, 13; Pl. 19, figs 11-12

? 1973 *Acer* cf. *monspessulanum* L.; GEISSERT, fig. 2 (Auenheim)

Material: Leaf fragment (SS 75).

Description: Leaf fragmentary, lamina palmately 3(?)-lobed, 46 mm long and 34 mm wide, leaf apex, base and petiole not preserved, side lobe triangular, acute, margin entire, sinus acute, widely opened; venation probably basal actinodromous, 2 preserved fragments of primary veins strong, moderate, secondary veins thinner, alternate, looping, tertiary veins alternate to opposite percurrent, curved to sinuous, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle fragmentary, smooth, showing quadrangular-polygonal cells 17-30 µm in diameter with straight to slightly curved anticlines, abaxial cuticle extremely thin, smooth, anticlines straight, rarely visible, non-modified cells polygonal, 20-25 µm in diameter, stomata anomocytic, rounded, uniform in size, 22-25 µm long, with thickened peripheral wall, outer cavity broadly oval, 10-12 µm long, pore slit-like, on and near veins solitary simple trichomes (prickle hairs) up to 250 µm long, with rounded base ca. 18 µm, broader than the thickness of the trichome itself (ca. 10 µm near the base).

Remarks: The leaf morphology of this single fragment (entire margin, acute lobe apex) suggests an affinity to *Acer integerrimum* as characterized by PROCHÁZKA & BŮŽEK (1975). According to the leaf morphology it falls within the groups of *A. mono* MAXIM. (incl. *A. pictum* THUNB.) or *A. cappadocicum* GLED. Both mentioned species differ in narrower outer cavities of stomata and striated adaxial cuticle. This is the additional more complete information on epidermal structure of *Acer integerrimum* to WALTHER (in MAI & WALTHER 1991) and STRÖBITZER-HERMANN (2002).

***Acer* cf. *tricuspidatum* BRONN forma *productum* (A. BRAUN) PROCHÁZKA & BŮŽEK**
Pl. 7, figs 14-18; Pl. 19, figs 3-4

Material: Leaf compressions, partly fragmentary (SS 14, 30, 79, 90, NM K 616, K 627)

Description: Leaves very long petiolate, petiole up to 28 mm long, lamina ovate, palmately sub 3-lobed, 39-(44)-51 mm long and 25-(33)-46 mm wide, medial lobe triangular to widely triangular, lateral ones mostly indistinct to lacking, apices acute, base rounded to slightly cordate, margin irregularly simply bluntly serrate, tooth apices obtuse (mainly in basal part) to acute (often in the apical part), venation basal actinodromous, 3 primary veins, straight, strong, moderately thick, secondary veins thinner, alternate, straight, tertiary veins alternate to opposite percurrent, curved to sinuous, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle smooth to faintly striated, cells polygonal, straight-walled, 17-37 µm in diameter, in SS 90 with solitary stomata and trichomes, abaxial cuticle smooth on veins, finely punctate among stomata, densely hairy, showing non-modified cells polygonal, flat or rarely slightly domed, 12-20 µm in diameter, stomata anomocytic (actinocytic in rare up to 25 µm long giant stomata), broadly oval, uniform in size, mostly 15-20 µm long, outer cavity broadly oval, often truncate at poles, ca. 13 µm long, ledges thickened, reaching almost to the stomatal poles, pore indistinct, short

linear, trichomes simple unicellular, densely irregularly spaced on veins and intercostal areas, slightly bent, thick-walled, with short longitudinally oriented dashes on the surface, 70-120 µm long, ca. 7 µm thick, attached to a simple not thickened base, shape broadly oval, 5-8 µm in diameter.

Remarks: Similar leaf forms from the Pliocene have often been assigned to living *Acer tataricum* L. native in southern Europe (PALAMAREV & KITANOV 1977). However, none of these records yielded epidermal features to confirm such identification. The present material strongly deviates from all representatives of the *A. tataricum* L. group by the densely pubescent abaxial surface, slightly domed cells with epicuticular punctate sculpture (? wax) and the stomatal pattern. The Late Miocene to Pliocene occurences from Europe (Vegora – KVAČEK et al. 2002, Cerdagna – BARRON 1996, Ceresole d'Alba – CIANGHEROTTI et al. 2007), partly with more distinct trilobate leaf forms have usually been assigned to *Acer pyrenaicum* RÉROLLE or to *Acer tricuspidatum* BRONN ssp. *lusaticum* WALTHER (in MAI & WALTHER 1988). Indeed, in the case of Vegora they showed a very similar epidermal anatomy both to the type material of *A. tricuspidatum* (Salzhausen - WALTHER 1968, 1972) and to the present material. Due to considerable differences in epicuticular striation, which is very distinct on the abaxial leaf side of the type specimen of *Acer tricuspidatum* ssp. *lusaticum* WALTHER (1972, pl. 50, fig. 3) and almost none in the material studied here, and leaf morphology (lack of distinctly trilobate forms), we compare the Alsacian material material tentatively with that described by HUMMEL (1983) from the Pliocene of Ruszów, Poland, as *Acer tricuspidatum* forma *productum* (A. BRAUN) PROCHÁZKA & BŮŽEK (HUMMEL 1983, pl. 47, figs. 1-3, pl. 48, figs. 7-10). STRÖBITZER-HERMANN (2002) assigned this maple to *Acer pyrienaicum* RÉROLLE and reduced the latter to a forma of *Acer tricuspidatum*. This assignement remained unpublished.

***Acer* cf. *pseudoplatanus* L.**
Pl. 8, figs 1-3; Pl. 19, figs 5-6

Material: Incomplete leaves (SS 74, 76, NM K 628).

Description: Leaves fragmentary, lamina ovate, palmately 3- or sub 5- lobed, 53-(57)-64 mm long and 41-(59)-68 mm wide, medial lobe widely triangular, lateral ones triangular, apices obtuse, base not preserved probably rounded to slightly cordate, margin irregularly simply coarsely irregularly bluntly serrate, tooth apices obtuse, venation basal actinodromous, 3 or 5 primary veins, straight, moderate, secondary veins thinner, alternate to rarely opposite, straight, tertiary veins alternate percurrent, curved to sinuous in the lower part of the lamina to almost polygonal reticulate in the apical part of the lamina, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial epidermis slightly striate, glabrous, composed of polygonal cells 25-40 µm in diameter, with curved to slightly wavy anticlines; abaxial epidermis strongly papillate around stomata, ordinary cells slightly domed, with curved anticlines, 20-30 µm in diameter, stomata hidden under circles of small papillae on the stomatal periphery, cyclocytic, guard cell pairs almost circular, 12-20 µm in diameter, outer stomatal ledges thin, widely open, stomatal slit linear, trichomes solitary on veins, simple, up to 100 µm long, trichome bases oval, rarely thickened.
Remarks: Similar maple leaves occurring in the European Pliocene were referred to or compared with *A. pseudoplatanus L.* foss. (e.g., PALAMAREV & KITANOV 1977, KNOBLOCH 1998). Leaf fragments from the Pliocene of Frankfurt u. M. (MÄDLER 1939, pl. 9, figs 5, 9, 10 as *Acer trilobatum* A. BR. and *A. brachyphyllum* HEER) may also show similarities in the leaf morphology. However, epidermal features of none of these records are

known to corroborate the suggested relationship. The affinity of the above described material to sect. *Acer* is corroborated by the characteristically papillate abaxial leaf surface. Only *A. pseudoplatanus* comes into consideration matching both in morphology and epidermal anatomy while *A. heldreichii* ORPH. ex BOISS. differs in more deeply dissected laminas. STRÖBITZER-HERMANN et al. (2000) examined the variation in epidermal anatomy stressing the diagnostic value of the stomatal size when comparing the living populations of *A. heldreichii*, *A. heldreichii* ssp. *trautveterii* (MEDW.) MURRAY and *A. pseudoplatanus.* The mean values of the stomatal length in all three taxa (26-28 µm, 28-32 µm and 26-27 µm, respectively) exceed distinctly the values obtained from the studied material (17-20 µm). The smaller stomatal size may reflect an evolutionary process in sect. *Acer* during the latest Cenozoic. A fragmentary co-occurring fruit of *Acer* sp. (SS 506, Pl. 15, fig. 15) recalls by its swollen fruit part also *A. pseudoplatanus* and similar fossils (cf. MAI 1995, p. 163, fig. 59.7) and may belong to the same plant.

***Acer* sp. 1**
Pl. 8, figs 4, 5; Pl. 19, figs 7-8

Material: Incomplete leaf (SS 24).

Description: Leaf fragmentary, lamina ovate, palmately 3-lobed, 43 mm long and 47 mm wide, medial lobe widely triangular, lateral triangular, apices obtuse (?), not fully preserved, base subcordate, margin entire, venation basal actinodromous, 3 primary veins, straight, strong, moderate, secondary veins thinner, alternate, curved, tertiary veins alternate percurrent, curved to sinuous, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial epidermis almost smooth, composed of polygonal cells 20-25 µm in diameter, glabrous, abaxial epidermis smooth, non-papillate, dense on veins, sparse in intercostal areas, non-modified cells polygonal, variable in shape, ca. 20 µm in diameter, with almost straight anticlines, stomata incompletely cyclocytic, subsidiary cells 2 – 4, narrow, surrounding rounded guard cells pairs in average 20-25 µm long, weekly cutinized except thickened peripheral wall, outer stomatal ledges thin, bordering widely open elliptical outer cavity, pore slit-like, trichomes about 10-12 µm thick, mostly 150-300 µm long, curved or wavy.

Remarks: This leaf may represent a mere aberrant form of *Acer integerrimum* (VIVIANI) MASSALONGO, because it corresponds well in the epidermal structure with the fragment of this species (SS 75) described above.

***Acer* sp. 2**
Pl. 8, figs 6, 7; Pl. 19, figs 9-10

Material: Incomplete leaf (SS 25).

Description: Leaf fragmentary, lamina ovate, palmately 3-lobed, 47 mm long and 33 mm wide, medial lobe widely triangular, apex shortly attenuate, lateral lobes almost indistinct, apex missing, base probably rounded to slightly cordate, margin entire, venation basal actinodromous, 3 primary veins, straight, strong, moderate, secondary veins thinner, alternate, straight, looping, tertiary veins alternate to opposite percurrent, curved to sinuous, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle slightly striate, cells polygonal, 25-50 µm in diameter with almost straight to slightly wavy anticlines, abaxial cuticle fragmentary, strongly papillate, without anticlines visible,

stomata surrounded by a circle of papillae, rounded, 15-20 µm in diameter, outer cavity widely oval, ca. 12-14 µm long, pore slit-like, fragments of simple slender trichomes more than 200 µm long occasionally observed.

Remarks: The fragment recalls morphologically *Acer integerrimum* (VIVIANI) MASSALONGO but clearly differs in the papillate abaxial surface. It may represent an aberrant form of the maple described above as *Acer* cf. *pseudoplatanus* L.

4.2.12 Nyssaceae JUSS. ex DUMORT.
***Nyssa* L.**
***Nyssa* sp.**
Pl. 8, figs 8, 9; Pl. 20, figs 1-2

Material: Incomplete leaf (SS 302).

Description: Leaf petiolate with incomplete petiole 12 mm long, lamina obovate, 21 mm long and 18 mm wide, apex damaged, artificially emarginate, base broadly cuneate, margin entire, venation brochidodromous, midrib strong and straight, secondaries distinctly thinner, alternate curved, looping, tertiary veins alternate to opposite percurrent, straight to sinuous, venation of the higher orders well developed, areolation 3 to 4 sided, veinlets lacking. Adaxial cuticle delicate, showing polygonal cells, 20 to 30 µm in diameter with straight, thin anticlines, abaxial cuticle fragmentary, partly faintly striated, non-modified cells polygonal, 20 to 25 µm in diameter, stomata anomocytic, mostly seen in Phase contrast light as broadly (to narrowly) oval outer cavities, 20-30 µm long bordered by thin stomatal ledges, trichomes unicellular spatulate, rarely preserved, 55-60 µm long and 12-30 µm wide, attached to a small rounded base 8-10 µm in diameter, thicker simple trichome bases 12-15 µm in diameter scattered on veins.

Remarks: The affinity to *Nyssa* is suggested by spatulate trichomes and a wide size variation of anomocytic stomata. Contrary to the so far known fossil foliage of *Nyssa* from the Lower – Late Miocene (KVAČEK & BŮŽEK 1972, KVAČEK et al. 2004, Bílina, KNOBLOCH & KVAČEK 1976, Wackersdorf, KOVAR-EDER & HABLY 2006, Mataschen) related to the *Nyssa javanica* (BLUME) WANGERIN complex with papillate or radially striated abaxial cuticle, the present record is close to the *Nyssa sylvatica* MARSHALL – *N. sinensis* OLIV. complex with smooth abaxial cuticle. Similar dispersed cuticles have been described from the Middle Miocene lignite of Nochten in Saxony as *Clavaecutis lignita* SCHNEIDER (2004, p. 47; 2007, p. 226).

4.2.13 Aquifoliaceae BERCHT. & J. PRESL
***Ilex* L.**
***Ilex aquifolium* L. *fossilis* ENGELHARDT**
Pl. 8, figs 10-13; Pl. 20, figs 3-5

1973 *Ilex* aff. *cornuta* LINDL. *fossilis*; GEISSERT, figs. 6-8, 10 (Auenheim)
1973 *Ilex* aff. *aquifolium* L. *fossilis*; GEISSERT, fig. 9 (Auenheim)

Material: Incomplete leaves (SS 56, 57, 58, NM K 606a-d, K 607)

Description: Leaves petiolate, with robust fragmentary petiole up to 2.5 mm long, lamina obovate, 48-(52)-54 mm long, 42-(45)-48 mm wide, base rounded to truncate or slightly

cordate; margin coarsely simple dentate; teeth large, spiny; venation semicraspedodromous; midrib straight, strong, moderate; secondary veins alternate, straight; tertiary veins distinct straight to convex, random reticulate, quaternary and higher-order veins thin, regular polygonal reticulate; areolation well developed, areoles 3 or more sided; with ultimate veinlets 2-branched, thick intramarginal lamella well developed. Leaf hypostomatic, adaxial epidermis thickly cutinized, outer surface of epidermis shagreen, non-modified cells irregular polygonal, 38-(46)-51 x 9-(26)-36 μm, with straight to coarsely undulate anticlinal walls, Ω- shaped, trichome bases simple, circular 20 μm in diameter, trichomes thick-walled unicellular, peg-like, on leaf edges and thick veins; abaxial epidermis thickly cutinized, outer surface of epidermis shagreen, non-modified cells irregular, 35-(46)-55 x 13-(19)-28 μm, with straight to undulate anticlinal walls; stomata anisocytic to cyclocytic, with up to 6 narrow to slightly broader subsidiary cells, randomly oriented and distributed, guard cells pairs not sunken, broadly oval to rounded, 49-(54)-59 x 36-(45)-58 μm in size, polar I or T-pieces, stomatal ledges bordering a broadly oval to roundish, outer cavity, darker stained, pore oval to fusiform.

Remarks: The leaf fragments studied exactly correspond to the material from the Pliocene of Niederrad at Frankfurt u. M. It must be stressed that leaves of the living *Ilex aquifolium* L. are sharply dentate only in younger plants and entire in mature specimens. GEISSERT (1972) suggested comparing the fossil leaves with always dentate foliage of *Ilex cornuta* LINDL. & PAXTON from East Asia. However, none of the two corresponds in details of epidermal anatomy to the fossil material at hand. *Ilex cornuta* differs in incompletely cyclocytic and smaller stomata, *Ilex aquifolium* by often distinctly striated adaxial cuticle.

4.2.14 Buxaceae DUMORT.

***Buxus* L.**

***Buxus pliocaenica* SAPORTA**

Pl. 9, figs 1-5; Pl. 20, figs 6-7

Material: Complete leaves (SS 49-55).

Description: Leaves sub-sessile, with very short and thick petiole, lamina elliptic to ovate, 11-(18)-27 mm long and 4-(8)-10 mm wide, apex slightly emarginate, base decurrent, margin entire, venation cladodromous, midrib distinct, strong, moderately narrowed, straight, secondary veins thinner, numerous, opposite, often forked and joining into intramarginal vein at margin, venation of the higher orders dichotomizing, areolation poorly developed. Leaves hypostomatic, adaxial epidermis thickly cutinized, outer surface of epidermis smooth, non-modified cells irregular, polygonal, 15-(23)-34 x 10-(12)-18 μm in size, with straight thickly cutinized anticlinal walls; abaxial epidermis thickly cutinized, outer surface of epidermis smooth, ordinary cells irregular, polygonal, 15-(21)-28 x 11-(13)-17 μm in size, with straight thickly cutinized anticlinal walls, stomata 24-(27)-31 x 26-(40)-32 μm in size, laterocytic, guard cells partly sunken, subsidiary cells elongate, stomatal ledges distinct on the inner part of the subsidiary cells.

Remarks: The above-described leaves are identical in all details of venation and epidermal anatomy with other records of this sort from the European late Neogene (SZAFER 1961; MÄDLER 1939 as *Buxus sempervirens* L. *fossilis* ENGELHARDT; KVAČEK et al. 1982; KOVAR-EDER & HABLY 2006).

4.2.15 Viscaceae BATSCH
***Viscum* L.**
***Viscum miquelii* (GEYLER & KINKELIN) CZECZOTT**
Pl. 9, figs 6-9; Pl. 20, figs 8-10

1973 *Viscophyllum miquelii* GEYLER & KINKELIN; GEISSERT, fig. 4 (Aueheim).

Material: Complete leaves (SS 42-43, 45-48, NM K 609, K 610) and twig (SS 350).

Description: Leaves short petiolate, lamina obovate in outline, 34-(37)-40 mm long and 25-(26)-28 mm wide, base cuneate to decurrent, apex obtuse, margin entire; venation acrodromous, looping by the margin, thicker midrib and 2 or 3 lateral veins on either side, venation of the higher orders alternate percurrent consists of sinuous veins, areolation lacking; twig flattened, 30 mm long and 4 mm wide slightly enlarged in its apical part. Leaves amphistomatic, stomatal density and cell structure approximately the same on either leaf surface, epidermis thickly cutinized, outer surface of epidermis smooth, non-modified cells irregular, polygonal, 50-(66)-82 x 25-(39)-55 μm, with straight thickly cutinized anticlinal walls, outer periclinal walls with one central circular papilla; stomata 61-(78)-99 x 64-(81)-119 μm in size, brachyparacytic, guard cells sunken, subsidary cells elongated, stomatal ledges distinct, forming a fusiform outer cavity.

Remarks: Similar broadly oval to almost rounded leaves of Viscaceae were described from the Pliocene of Niederrad at Frankfurt u. M. (ENGELHARDT & KINKELIN 1908, pl. 32, figs 5a-p, as *Viscophyllum miquelii* (GEYER & KINKELIN) ENGELHARDT) and various other localities, mostly from the Upper Miocene and Pliocene (see KVAČEK & KNOBLOCH 1976, table 5; KOVAR-EDER & KRAINER 1991). They differ from relatively similar *Viscum morlotii* (KNOLL) KNOBLOCH & KVAČEK by length/width index in the mean lower than 2.

***Viscophyllum* KNOLL**
***Viscophyllum pliocaenicum* (ENGELH.) MÄDLER**
Pl. 9, figs 10-12; Pl. 20, fig. 11

Material: Leaf fragments SS 304-306.

Description: Leaves shortly petiolate, with a short thickened petiole, lamina linear, 21-(27)-35 mm long and 5-(6)-8 mm wide, base narrow cuneate, apex not preserved, margin entire; venation acrodromous-parallel, 5-veined, midrib thicker, accompanied on either side by 2 lateral parallel veins, secondary veins at irregular distances very steep, partly in form of anastomoses, intersecondaries sub-parallel, tertiaries dense, originating at various angles and forming together with very thin higher order veins dichotomizing pattern, areolation lacking. Leaves amphistomatic, epidermis of either side identical in cell structure, thickly cutinized, outer surface of epidermis smooth, non-modified cells irregular, polygonal, 7-(17)-31 x 37-(43)-62 μm in size, with straight thickly cutinized anticlinal walls, stomata 39-(48)-55 x 41-(61)-84 μm in size, brachyparacytic, guard cells sunken, subsidary cells elongate, stomatal ledges distinct, forming fusiform outer cavity.

Remarks: Similar narrow linear leaves undoubtedly belonging to Viscaceae according to the epidermal pattern occurred in the Pliocene of Niederrad at Frankfurt u. M. (ENGELHARDT & KINKELIN 1908, as *Potamogeton pliocaenicum* ENGELHARDT). Our material represents

leaf blades with a very peculiar venation pattern, contrary to some other records ascribed to this species and partly based on twigs (Middle Miocene of Poland – WĄS 1956, WOROBIEC 2003, Upper Miocene of Transilvania – GIVULESCU 1981, 1984). JÄHNICHEN (1991) suspected this problem and included *Potamogeton pliocaenicum* and all synonyms into *Viscum miquelii* (GEYLER & KINKELIN) CZECZOTT. The present material challenges such an interpretation at least for the present records and the type material from Niederrad.

4.2.16 Cucurbitaceae JUSS.
***Trichosanthes* L.**
***Trichosanthes* sp.**
Pl. 9, figs 13-16; Pl. 10, figs 1-3, Pl. 20, figs 12-14

Material: Incomplete leaves SS 22, 23, 36, 77, 78, 293

Description: Leaves fragmentary, lamina palmately 3-5 lobed, 40-(53)-62 mm long, 40-(55)-71 mm wide, apices acute to acuminate, base cordate, lobes triangular (central more distinct), sinuses rounded, open; margin entire to undulate to irregularly minutely dentate, teeth if present, acute to rounded; venation actinodromous, preserved 3 primary veins strong, moderate, innervating apices of the lobes, secondary veins, simple craspedodromous or camptodromous, alternate, tertiary veins straight or forked, alternate, percurrent, venation of the higher orders regular polygonal reticulate, areolation well developed, 3- to 4-sided. Adaxial cuticle thin, faintly striate, cells polygonal, ca. 20-45 μm in diameter, with straight to slightly wavy anticlines, narrow cone-shaped blunt trichomes dispersed on veins, about 12-30 μm long, partly serial (?), on a base 5-12 μm in diameter. Abaxial cuticle extremely thin, hardly reflecting cell structure, mostly only spindle-like outer cavities of stomata visible, variable in length of 10- 20 μm, in some samples (SS 78, 293) abaxial cuticle reflecting straight-walled polygonal cells 20-25 μm in diameter, stomata anomocytic, very variable in size, oval, 12-28 μm long, guard cells extremely thin, usually without visible peripheral wall, outer cavity spindle-shaped, narrow, reaching almost to the stomatal poles, ledges medium thick, pore not visible, groups of simple trichomes variously curved mostly over 250 μm long and up to 30 μm thick on veins. Occasional polycellular rounded scales 35-50 μm in diameter sunken in the mesophyllous tissue on a biserial thickly cutinized base (SS 23).

Remarks: This is the first record of the Cucurbitaceae foliage co-occurring with the seeds of *T. fragilis* E.M. REID (1920) from Alsace (GEISSERT 1987, GEISSERT et al. 1990). This morphotype is similar in gross morphology to maples but it is claerly differentiated by the epidermal anatomy. A preliminary study of a limited comparative collection of the modern Cucurbitaceae confirmed the affinity of the above described maple-like leaves to Cucurbitaceae. Particularly *Trichosanthes* L. (East Asia to Northern Australia) matches in the same type of trichomes, scales on the leaves and stomata variable in size. Similar leaves are known also from the Pliocene of Niederrad at Frankfurt u. M. (MÄDLER 1939, pl. 9, figs. 17, 18) also in the association with the same type of seeds of *Trichosanthes* (MÄDLER 1939). Contrary to the above data, another leaf morphotype quite different from our material and ascribed also to *Trichosanthes* (KOLAKOVSKII 1964) has now been suggested to belong to *Epimedium praeasperum* (ANDREÁNSZKY) GIVULESCU (KVAČEK submitted).

4.2.17 Salicaceae MIRB.
***Salix* L.**
***Salix* sp.**

Pl. 10, figs 7-14; Pl. 11, figs 1-2; Pl. 13, figs 7, 8; Pl. 14, figs 11, 12; Pl. 21, figs 1-5; Pl. 23, fig. 3; Pl. 24, figs 1-2.

Material. Incomplete leaves and leaf fragments (SS 6, 7, 8, 9, 10, 11, 61, 62, 63, 91, 94, 101-113, NM K 691, K 693-694, K 696-697, K 699-700).

Description: Leaves petiolate, incomplete petiole 5-10 mm long, lamina narrow elliptic to oblong, 28-(59)-81 mm long and 7-(17)-24 mm wide, apex acute to attenuate, base cuneate to broadly cuneate or rounded, margin entire in the basal part, in the upper one regularly simply serrate, teeth acute to rounded or rarely mucornate, glandular, sinus angular to slightly opened, venation semicraspedodromous to eucamptodromous, midrib strong, straight, moderately narrowed, secondaries almost opposite to alternate, distinctly thinner, numerous, curved, originating at acute or rarely right angles, tertiary veins alternate to opposite percurrent, straight to convex or sinuous, marginal veinlets entering teeth apices, venation of the higher orders regular polygonal reticulate, areolation well developed, 3 to 4 sided, veinlets 1-branched. Adaxial cuticle thinly striate, rarely shagreen, non-modified cells polygonal, straight-walled, 20-25 μm in diameter, on margin conspicuous rounded trichome bases ca. 18 μm in diameter, exceptionally solitary stomata near mid-vein, trichome bases rounded to elliptic, ca. 10 μm in diameter, scattered near and above the midrib area, abaxial cuticle to variable degree with a wax cover, sometimes very dense wax flakes covering the course of anticlines, non-modified cells polygonal, ca. 20 and more μm in diameter, stomata brachyparacytic, subsidiary cells widely crescent-shaped, guard cell pairs narrow oval to elliptical, with distinct peripheral wall, partly thinner at poles, 12-30 μm long, some specimens (SS 98) with smaller stomata ca. 12 μm long, outer stomatal ledges parallel to the guard cell outlines, thickened medially, forming a spindel-shaped outer cavity, pore hardly visible, linear, trichome bases rounded, thickened, ca. 12 μm in diameter, particularly dense in some specimens on veins.

Remarks: The *Salix* specimens studied is somewhat variable in venation details as well as in epidermal structure, particularly in distinctness of abaxial cell structure, which is at variable degree covered by wax. Morphologically similar willow leaves occur in the Pliocene at Niederrad near Frankfurt u. M. (MÄDLER 1939, as *Salix denticulata* HEER), Reuver (LAURENT & MARTY 1923, as *Salix alba* L. *fossilis*) and elsewhere in the European Neogene, but none of the so far described cuticle patterns corresponds to that found in our population. Due to variation in gross morphology and venation the above described morphotype needs not to be a fully natural unit and may include more than one species. Among living willows various species share waxy leaf abaxial leaf surface but also in many cases they differ in amphistomatic leaves (e.g., *S. alba* L., *S. fragilis* L.) and other respects. According to a brief inspection of the comparative willow cuticles containing about 200 species we were able to find only *S. bonplandiana* HBK whose leaves are similar in the striated adaxial cuticle without stomata and with a wax cover abaxially.

***Populus* L.**
***Populus* cf. *balsamoides* GÖPPERT sensu lato**
Pl. 11, figs 3-6; Pl. 21, figs 8-9

Material: Incomplete leaves and leaf fragments (SS 34, 146, 148, 298, NM K 614, K 615).

Description: Leaves with fragmentary petiole 18 mm long, petiole not pulvinate, probably terete, without adjacent glands, lamina ovate, 57-(68)-89 mm long and 27-(37)-54 mm wide,

apex incompletely preserved, acuminate, base truncate, rounded to subcordate, simple regularly crenate-serrate up to the very base, exceptionally sub-entire (SS 298), teeth fine, rounded, exceptionally acute, glandular at tips; venation semicraspedodromous, midrib strong, moderately narrowing, straight, secondary veins thinner, alternate to sub-opposite, basal opposite, looping near the margin, marginal veinlets very short, entering close to the sinuses into the teeth apices, intersecondaries solitary or lacking, tertiary veins widely spaced, percurrent, straight to sinuous, perpendicular to slightly oblique to secondaries, venation of the higher orders regular polygonal reticulate, areoles 3 to 4 sided. Adaxial cuticle faintly to distinctly striated, cells polygonal, 25-40 µm in diameter, anticlines straight to slightly curved, stomata not observed, abaxial cuticle irregularly striated, non-modified cells polygonal, 25-30 µm in diameter, anticlines shallow undulate, hardly visible, with pitting, stomata brachyparacytic, subsidiary cells large, strongly striated perpendicularly to stomatal length, guard cell pairs narrow oval to almost rounded, variable in size, 17-30 µm long, stomatal ledges reaching almost to the poles, thickened, bordering outer spindle-shaped outer cavity, pore slit-like, oval simple trichome bases 12-25 µm in longer axis on veins, fragments of simple trichomes rarely attached.

Remarks: The epidermal structure corresponds largely to that described from the Paleogene *Populus zaddachii* HEER (WALTHER in MAI & WALTHER 1978, REUSCHEL & WALTHER 2006) except for stronger striation on both leaf sides and larger stomata in our material. In respect of age the Late Miocene occurrences of *P. balsamoides* GÖPP. or *P. emarginata* GÖPP. with similar gross morphology are more likely to be connected with the above described morphotaxon. ILJINSKAYA (in BUDANTSEV 2005) separates *P. balsamoides* and *P. emarginata* on the basis of gross morphology. However, both morphotypes are variable in leaf form and the cuticular revision of the Sośnica type material is wanting. The poplar foliage assigned to *P. balsamoides* from the Late Miocene flora of Rheinland (BELZ & MOSBRUGGER 1994) differs from our material by smooth cuticles. Our material should be included in sect. *Tacamahaca* PAX but no exact living species can be suggested that would match in all details.

***Populus* cf. *glandulifera* HEER**
Pl. 11, figs 7, 8; Pl. 21, figs 11-12

Material: Complete leaves and leaf fragments (SS 126, 132, 147, 331, NM K 617).

Description: Leaves fragmentary petioled, lamina rounded to broadly ovate to broadly deltoid, 40-(50)-58 mm long and 34-(43)-44 mm wide, apex shortly acuminate to acute, base rounded to subcordate, in some cases (SS 126, 132) with single glands near the top of petiole, margin simple dentate - crenate, teeth rounded, directed apically, glandular at tips, sinuses narrow rounded; venation triveined semicraspedodromous, midrib moderately strong, narrowing, straight; secondary veins thinner, distinct, basal pair originating slightly above the leaf base, ascending to the middle of lamina or lower, higher secondaries irregularly spaced, alternate to sub-opposite, originating at angles of 40-50° to the midrib, single intersecondaries present, tertiary veins straight or curved percurrent, and partly forked, quaternary veins polygonal reticulate, areolation well developed, 3-4 sided, ultimate veinlets 2- or more branched. Adaxial cuticle smooth, non-modified cells polygonal, 20-45 µm in diameter, straight-walled, anticlines thin, smooth, solitary stomata present, abaxial cuticle smooth, non-modified cells polygonal, 20-40 µm in diameter, anticlines straight to wavy to undulate, with short swellings and pitting, stomata brachyparacytic, subsidiary cells wide, occasionally with faint striation perpendicular to stoma length, guard cell pairs narrow oval, with thin periphery, little variable

in size, ca. 20-25 µm long, stomatal ledges medially thickened, bordering narrow spindle-shaped outer cavity, no trichome bases observed on either leaf side.

Remarks: The described morphotaxon is characteristic in its epidermal structure (glabrous surface, thickened abaxial anticlines, narrow stomatal cavities) but less so in gross morphology. It matches one of the poplar species from Oehningen, *P. glandulifera* HEER (1856). However, the epidermal structure from the type material from Oehningen is wanting. According to the distribution of stomata, the specimens studied do not belong to sect. *Aigeiros* with amphistomatic leaves, although some of them do recall the *Populus nigra* L. group from this section in leaf shape. An affinity to sect. *Leucoides* SPACH suggested by basal glands is not in line with the smooth abaxial cuticle. A more thorough comparison is needed to assess relationship to living species.

***Populus populina* (BRONGNIART) KNOBLOCH**
Pl. 11, figs 9-12; Pl. 21, figs 13-14

Material: Complete leaves and leaf fragments (SS 89, 123, 125, 131, 133-137, 139-143, NM K 612, K 613, K 618, K 619, K 625, K 626).

Description: Leaves very long petiolate, petiole up to 47 mm long, laterally flattened, lamina transversally ovate to rounded to obovate, 43-(53)-74 mm long and 50-(52)-92 mm wide, base rounded to cordate, apex broadly acute to rounded; margin regularly coarsely dentate to crenate to shallow undulate, teeth blunt, rounded, occasionally glandular at tips; venation semicraspedodromous, tri-veined, midrib strong, moderate, straight; secondary veins thinner, distinct, basal opposite pair ascending towards the upper third of the lamina, higher secondaries alternate to sub-opposite originating at wide angles, tertiary veins opposite to alternate, percurrent, sinuous in course, quaternary veins regular polygonal reticulate, areolation well developed, 3-4 sided, ultimate veinlets not visiable. Adaxial cuticle thin, smooth, non-modified cells polygonal, straight-walled, 17-25 µm in diameter, abaxial cuticle at variable degree wrinkled, non-modified cells polygonal, ca. 15 µm and more in diameter anticlines less distinct, usually hidden by surface ornamentation, stomata brachyparacytic, variable in size, subsidiary cells wide, in larger stomata with striation-wrinkles perpendicular to the stoma length, guard cell pairs narrow oval, 15-30 µm long, seen mostly as thickened stomatal ledges forming a spindle-shaped outer cavity, trichome bases small, circular, 5-7 µm in diameter, denser on veins.

Remarks: The studied material of this common Neogene poplar is variable in leaf form as well as epidermal structure. In general, it corresponds to the other records known in respect of epidermal anatomy (KNOBLOCH & KVAČEK 1976, Lower-Middle Miocene of Wackerdorf; HUMMEL 1983, Pliocene of Ruszów; BELZ & MOSBRUGGER 1984, Upper Miocene of Rheinland). There is no doubt that it belongs to sect. *Populus* (former *Leuce* DUBY) on account of its overall leaf form and wrinkled abaxial cuticle.

***Populus* sp. 1**
Pl. 12, figs 1-4; Pl. 21, fig. 10; Pl. 22, figs 1-2

1979 *Populus angulata = P. carolinensis* FOUG.; GEISSERT & MÉNILLET, pl. 4, fig. 8, Auenheim.

Material: Incomplete leaves (SS 64, 114, 115, 116, 338, NM K 622).

Description: Leaves preserved without petiole, lamina ovate, 24-(45)-57 mm long and 35-(43)-50 mm wide, apex acute, base rounded or slightly cordate, margin regularly finely serrate, teeth glandular, blunt; venation semicraspedodromous, midrib strong, moderately narrowing, straight; secondary veins thin, sometimes forked, alternate, originating at the base at wide, higher up at acute angles, 1-3 intersecondaries often present, tertiary veins very oblique-straight, opposite to alternate percurrent, venation of the higher orders regular polygonal reticulate, areolation well developed, 4 sided. Adaxial cuticle smooth, fragmentary, cells polygonal, 20-40 μm in diameter, anticlines almost straight to wavy, solitary stomata present, abaxial cuticle smooth, thin, cells not well visible, stomatal type unclear, stomata preserved as guard cell pairs broadly oval, 17-30 μm in length, outer cavity oval, mostly widely open, pore narrow, solitary trichome bases simple, ca. 12 μm in diameter.

Remarks: This large-leaved poplar recalls broad-leaved willows (e.g., *Salix caprea* L.) and may have been mistaken for this genus. However, it is differentiated by irregular spacing of the secondaries. STRAUS (1930) described a very similar fragmentary leaf from the Pliocene of Willershausen as *Salix* cf. Sect. *Capreae*. Similar fossil foliage from the Pliocene of Ukraina was assigned to *P. platyphylla* (GÖPP.) W. SCHIMPER by ILJINSKAYA (in BUDANTSEV 2005). The type material from the Late Miocene flora of Sróza (Poland – GÖPPERT 1852, as *Populites platyphyllus* GÖPP.) needs leaf epidermal revision. The exact living counterpart is so far unknown. ILJINSKAYA (in BUDANTSEV 2005) suggested *P. angulata* AIT. Also GEISSERT and MÉNILLET (1979) assigned a similar leaf from Auenheim to the same living species. Poplars with similar foliage also occur in E Asia (e.g., *P. suaveolens* FISCH.).

***Populus* (sect. *Aeigiros* DUBY) sp. 2**
Pl. 12, figs 7, 8; Pl. 22, figs 3-4

Material: Incomplete leaf (SS 347).

Description: Leaf without preserved petiole, lamina deltoid ovate, 64 mm long and 50 mm wide, apex not preserved, base widely cuneate with fragmentary petiole, margin simple regularly serrate-crenulate, teeth glandular, tips blunt, broad; venation semicraspedodromous, midrib strong at the base, moderately narrowing, straight, secondary veins thinner, alternate to opposite (in the basal part), widely spaced, looping, sending side veinlets directly into the glandular teeth, tertiary veins alternate, rarely opposite, percurrent, straight to sinuous, venation of the higher orders regular polygonal reticulate areols, 3 to 4 sided, wihtout free veinlets; leaf amphistomatic, with a narrow translucent zone on the margin, adaxial cuticle smooth, non-modified cells polygonal, up to 38 μm and more in diameter, anticline straight, pitted, stomata brachyparacytic, widely irregularly scattered, subsidiary cells crescent-shaped, guard cell pairs regular in size, ca. 25 μm long, outer stomatal ledges as well the peripheral wall thickened, outer cavity oval-spindle-like, not reaching to the poles, pore slit-like, abaxial cuticle thinner, smooth to faintly striate, non-modified cells less distinct, straight-walled, 17-50 μm in diameter, stomata paracytic, variable in size, guard-cell pairs 20-38 μm long, outer stomatal ledges thickened narrow oval pore slit-like, solitary simple trichome bases adaxially only.

Remarks: Similar amphistomatic poplar foliage was recorded as “Taxon X” from the Miocene of Kreuzau (FERGUSON 1971) but an exact living counterpart was not suggested. *Populus nigra* L. (N. Africa, western Eurasia) looks similar in epidermal anatomy.

***Populus* sp. 3**
Pl. 12, figs 5, 6; Pl. 22, figs 5, 6

Material: Incomplete leaf (SS 129)

Description: Leaf petiolate with fragmentary petiole 15 mm long, lamina transversally oval, 69 mm long and 67 mm wide, apex not preserved, base broadly cuneate, margin entire in the basal part, otherwise regularly finely serrate, teeth glandular, blunt, widely spaced; venation semicraspedodromous tri-veined, midrib strong, moderate, straight; lateral primaries steeply ascending well above the two third of the lamina length, sending a regular side vein running subparallel to the lamina base and looping near the margin, secondary veins thinner, alternate, irregularly spaced, originating in acute angles, tertiary veins straight to curved, widely spaced, mostly oblique to secondaries, quaternary regular polygonal reticulate, areolation well developed, 4 sided. Adaxial cuticle smooth, non-modified cells polygonal, 20-35 μm in diameter, anticlines straight, smooth, abaxial cuticle smooth, outer periclinal walls slightly dome-shaped, non-modified cells polygonal, quite small, 10-25 μm in diameter, partly indistinctly cutinized, stomata brachyparacytic, subsidiary cells large, crescent-shaped, guard cell pairs narrow oval, with indistinct outer wall, 1-22 μm long, outer stomatal ledges thickened, forming a spindle-like outer cavity, pore slit like, distinct, tiny rounded trichome bases 5-8 μm in diameter solitary on veins.

Remarks: The form of this incomplete leaf recalls an aberrant *Populus populina* L. with fine dentation, from which it decidedly differs in smooth and dome-shaped cells of the abaxial epidermis. Its affinities are enigmatic.

***Populus* sp. 4**
Pl. 12, figs 9, 10; Pl. 22, figs 7-9

Material: Incomplete leaf (SS 124)

Description: Leaf with thick fragmentary petiole, lamina broadly transversally oval to rounded, 74 mm long and 60 mm wide, base asymmetric (?), deeply cordate, apex obtuse; margin coarsely undulate to crenulate; venation actinodromous, semicraspedodromous, midrib distinct, moderately wavy, lateral primaries two on either side, curved, sending parallel side veins towards the margin, secondary veins thinner, alternate, curved, irregularly spaced, looping near the margin, sending short veinlets into teeth, tertiary veins quite dense, percurrent or occasionally forked, straight to curved, oblique to perpendicular to secondaries, venation of the higher orders regular polygonal reticulate, areolation well developed, 4 sided. Adaxial cuticle smooth, non-modified cells polygonal, straight-walled, 15-30 μm in diameter, abaxial cuticle shagreen, non-modified cells irregularly polygonal, 15-25 μm in diameter, anticlinal walls almost straight to shallow undulate, pitted, stomata brachyparacytic, subsidiary cells wide, striated perpendicularly to the stoma length, guard cell pairs with indistinct peripheral wall, oval, 12-22 μm long, outer stomatal ledges very thickened, bordering narrow spindle-shaped outer cavity, pore slit-like, trichome bases simple, rounded, 5-7 μm in diameter, rare on veins.

Remarks: This single specimen may represent an aberrant form (shade leaf) of the morpho-type described above as *Populus* cf. *glandulifera* HEER.

***Populus* sp. 5**
Pl. 15, fig. 8, Pl. 24, fig. 11

Material: Incomplete leaf (SS 348)

Description: Leaf petiolate, petiole fragmentary, incomplete lamina probably oval, base rounded, apex missing, margin widely crenulate to entire, teeth as small swellings, ? glandular, venation semicraspedodromous, tri-veined, mid-vein stout, bent, basal secondaries steeply ascending from the very base, giving off outer veinlets looping near the margin and sending a small vein into the teeth, higher secondaries widely spaced, tertiary veins quite dense, straight to curved, oblique to perpendicular to secondaries, venation of the higher orders regular poorly preserved, polygonal reticulate, areolation well developed, 4 sided. Adaxial cuticle smooth, non-modified cells polygonal, straight-walled, 20-35 μm in diameter, abaxial cuticle smooth, non-modified cells polygonal, 15-20 μm in diameter, anticlines undulate, with lens-shaped thickenings, stomata brachyparacytic, subsidiary cells large, smooth, guard-cell pairs oval, 20-30 μm long, outer stomatal ledges very thickened forming more or less wide outer cavity, no trichome bases observed.

Remarks: This poplar is very aberrant in its abaxial cuticle with undulate anticlines. Due to fragmentary nature its affinities remain doubtful. In the abaxial cuticle it recalls the previously described morphotype.

***Populus* sp. 6**
Pl. 15, figs 5-7; Pl. 24, figs 5-6

Material: Incomplete leaves (SS 461, 462).

Description: Leaves without petiole preserved, lamina ovate, 58 mm and 59 mm long, 40 mm and 32 mm wide, apex acute to shortly attenuate, rounded at tip, base broadly cuneate, margin entire in the basal part, higher regularly simple serrate, teeth glandular, blunt, sinus slightly opened, venation semicraspedodromous, midrib straight to shallow zig-zag, moderately narrowed, secondaries distinctly thinner, basal pair opposite, higher ones alternate, irregularly spaced, curved, looping, tertiary veins alternate percurrent, straight to sinuous, venation of the higher orders regular polygonal reticulate, areolation well developed, 4 sided, veinlets 1 to 2 branched. adaxial cuticle smooth, non-modified cells polygonal, straight-walled, ca. 15-30 μm in diameter, abaxial cuticle smooth, non-modified cells polygonal, 15-25 μm in diameter, anticlines almost straight, pitted, with narrow thickenings, stomata brachyparacytic, with wide subsidiary cells, guard cell pairs oval, with thin periphery 22-30 μm long, stomatal ledges thickened medially, touching the poles, outer cavity narrow spindle-like, pore linear .

Remarks: This morphotaxon is in its leaf form similar to the living *Populus simonii* CARRIÈRE from China.

4.1.18 Malvaceae JUSS. sensu lato

***Dombeyopsis* UNGER**

***Dombeyopsis lobata* UNGER**
Pl. 12, figs 11, 12; Pl. 24, figs 12-13

Material: Incomplete leaf (SS 1).

Description: Leaves petiolate with thick petiole 15 mm long, lamina rounded or slightly 3 to 5-lobed, 55 mm long, and 43 mm wide, base asymmetric, cordate, apex not preserved, side lobe with obtuse apex; margin entire to widely minutely toothed; venation basal actinodromous, 5 to 7 primaries, distinct, lateral ones curved, secondary veins thinner, alternate, curved, tertiary veins alternate to opposite percurrent, densely spaced, straight to sinuous, venation of the higher orders regular polygonal reticulate, areolation well developed, 4 sided. Adaxial cuticle medium thick, shagreen, non-modified cells rounded-polygonal, 10 to 25 µm in diameter, anticlines straight to curved, on the veins solitary simple trichomes. Abaxial cuticle very finely striate, anticlines hardly seen except over veins, straight, size of non-modified cells not observed, stomata anomocytic, broadly elliptic, with thin periphery, 17-32 µm long, outer stomatal ledges slightly thickened, bordering a wide spindle-shaped outer cavity, pore narrow lineal, trichomes of two kinds – glandular trichomes scattered on veins, barrel-shaped, up to 50 µm long, with 3 storeys of cells in the head and a rounded base about 12 µm in diameter, non-glandular trichomes mostly stellate, thickly covering the whole abaxial side, with (2-) 4-6 (? and more) rays, those on veins fasciculate, with stronger rays up to 300 µm long, among veins thin-walled, adpressed, with ca. 75 µm long rays, bases rounded, thin, about 15-20 µm in diameter.

Remarks: The single recovered compression corresponds in its epidermal structure to the type material from the Early Miocene flora of Bílina (KVAČEK 2005) and other occurrences, e.g., at Ponholz (KNOBLOCH & KVAČEK 1976). *Dombeyopsis lobata* is currently considered to belong to the fruits of *Craigia bronnii* (UNG.) KVAČEK, BŮŽEK & MANCHESTER (see KVAČEK et al. 2005, pl. 15, fig. 12). The co-occurring fruit valves at Auenheim (Pl. 15, fig. 12) brought important anatomical details that helped to elucidate the affinities of this fossil species considered previously as fruits of *Ulmus* (GEISSERT & MÉNILLET 1979) or an extinct genus *Pteleaecarpum* (BŮŽEK et al. 1989).

4.2.19 Vacciniaceae DC. ex PERLEB

Vacciniaceae gen. et sp. indet.
Pl. 13, fig. 1

Material: Complete leaf (SS 284).

Description: Leaf subsessile, lamina almost rounded, 7 mm long and 6.5 mm wide, base rounded, apex obtuse, margin entire; venation brochidodromous, looping by the margin, secondary veins thinner, alternate, widely spaced, venation of the higher orders random reticulate, areolation poorly developed.

Remarks: Based on the gross morphology only, the identification of this leaf remains tentative.

4.2.20 Oleaceae HOFFMANNS. & LINK

***Fraxinus* L.**
***Fraxinus* sp.**
Pl. 13, figs 2-6; Pl. 15, fig. 14; Pl. 22, figs 10-12

Material: Complete and incomplete leaflets (SS 4, 5, 65, 330, 335, NM K 611) and incomplete fruit (SS 505).

Description: Leaflets petiolultae, with fragmentary petiolule 14-16 mm long, lamina elliptic to broadly elliptic, 54-(53)-59 mm long and 19-(28)-37 mm wide, apex obtuse to shortly

attenuate, base cuneate to asymmetrically rounded, margin regularly simply serrate, teeth acute to rounded, glandular, sinuses angular to broadly open; venation semicraspedodromous, midrib distinct, strong, straight, secondaries distinctly thinner, alternate straight and percurrent (often in basal part) to curved and originating at an acute angle, looping near the margin, tertiary veins more or less reticulate, rarely percurrent, straight to sinuous, at the margin thinner innervating teeth sinus, venation of the higher orders regular polygonal reticulate, areolation well developed, areoles 3 to 4 sided. Texture firm, compressions yellow brown in transmitted light. Adaxial cuticle smooth, showing polygonal cells (25-) 30-40 µm in diameter with V-shaped wavy anticlines, and rounded trichome bases 12 µm in diameter. Abaxial cuticle smooth to fine striated, anticlines of non-modified cells not visible, stomata anomocytic (?) with thin periphery and spindle-shaped outer cavities bordered by thin stomatal ledges, unevenly sized, 15-27 µm long, peltate glandular trichomes scattered 35-55 µm in diameter, with the shield composed of ca. 12 wedge-shaped semi-radially disposed cells and a rounded basal cell 12 µm in diameter.

Remarks: The leaflets correspond in leaf anatomy (peltate trichomes), and particularly in smooth adaxial cuticle composed of cells with V-shaped wavy anticlines to extant *Fraxinus excelsior* L. Most other modern species differ in papillate abaxial leaf side (e.g., *F. biltmoreana* BEADLE, *F. americana* L.), strongly striated adaxial leaf side (e.g., *F. ornus* L., *F. griffithii* C.B. CLARKE), and / or almost straight (e.g., *F. cuspidate* TORR.) or U-shaped undulate adaxial anticlines (e.g., *F. platypoda* OLIV.). The fossil *F. angusta* HUMMEL (1983) from the Pliocene of Poland shares most leaf epidermal traits except strongly striated adaxial cuticle. *F. ettingshausenii* KOVAR-EDER (in KOVAR-EDER & KRAINER 1991) from the Late Miocene of Austria differs in the striate adaxial epidermis composed of cells with almost straight anticlines. The Early Miocene *F. bilinica* (UNG.) KVAČEK & HURNÍK (KNOBLOCH & KVAČEK 1976, as *F. ungeri* (GAUDIN) KNOBLOCH & KVAČEK) from Wackersdorf and the type material of Bílina (Z.K., own observation) is more similar to the latter by adaxial straight, non-wavy anticlines but shares with our material the smooth adaxial surface. The fruits of *Fraxinus* co-occurring at Auenheim (GEISSERT & MÉNILLET 1979, pl. 4, fig. 3; also illustrated in our Pl. 15, fig. 14) belong obviously to this foliage. More detailed comparisons will be necessary to clarify the affinities of the material studied from Alsace.

4.2.21 Eudicotylenoidae fam. indet.
***Dicotylophyllum* SAPORTA**
***Dicotylophyllum* cf. *heerii* (ENGELHARDT) KVAČEK & WALTHER**
Pl. 13, figs 9-13; Pl. 23, figs 1-2

Material: Incomplete leaves and leaf fragments (SS 35, 67, 70, NM K 629, 630).

Description: Leaves petiolate, with thick petiole, lamina narrow elliptic to obovate, 34-(45)-61 mm long and 13-(22)-25 mm wide, apex obtuse, base cuneate to decurrent; margin irregularly simple serrate to crenate, teeth obtuse; venation semicraspedodromous, midrib distinctly strong, secondary veins looping, alternate, curved, innervating tooth sinuses, tertiary veins indistinctly admedially ramified to convex, very oblique to secondaries, higher order venation regularly polygonal reticulate, areolation well developed, 3 to 4 sided. Adaxial cuticle thin, smooth, non-modified cells 12-25 µm and more in diameter, anticlines in some specimens almost straight, pitted, in others (SS 67, 100) finely undulate, with thickened sinuses, abaxial cuticle thin, smooth, non-modified cells smaller than on the adaxial cuticle, 20-30 µm in diameter, invariably with undulate anticlines, stomata in dense groups, cyclocytic, subsidiary

cells slightly thicker, not well demarcated, about 3-4 in number, forming a narrow circle around the guard cells, guard cell pairs subcircular to broadly elliptic, 20-25 µm, rarely up to 30 µm long, with a distinct peripheral wall, stomatal ledges moderately thick through their length, forming a large wide oval outer cavity, pore, slit-like.

Remarks: The morphotype described above matches in most details of gross morphology the Early Oligocene type material from Kundratice, North Bohemia (KVAČEK &WALTHER 1976) but differs in well recognizable cyclocytic stomata and smooth cuticles. The epidermal structure recalls that of *Laurocerasus* spp. (Rosaceae JUSS.).

***Dicotylophyllum* sp. 1**
Pl. 14, figs 1, 2, 4; Pl. 23, figs 4-5

Material: Incomplete leaves or leaflets (SS 342, 354).

Description: Leaves or leaflets petiolate, with fragmentary petiole 22 mm and 17 mm long, lamina broadly elliptic, 75 mm and 69 mm long and 60 mm and 54 mm wide, apex not preserved, base rounded, margin irregularly simple serrate, teeth sharp and acute; venation simple craspedodromous, midrib straight, strong, secondary veins thinner, straight, alternate, tertiary veins percurrent straight to sinuous, higher order venation regular polygonal reticulate, areolation well developed, 3 to 4 sided. Cell structure not preserved.

Remarks: This morphotype recalls some representatives of Rosaceae similar in foliage, e.g., *Sorbus alnifolia* (SIEB. & ZUCCARINI) K. KOCH from China.

***Dicotylophyllum* sp. 2**
Pl. 14, figs 3, 5; Pl. 23, figs 6-8

Material: Incomplete leaf (SS 325).

Description: Leaf incomplete, long petiolate, complete petiole 17 mm long, lamina narrow oblong, 52 mm long and 21 mm wide, apex not preserved, base cuneate, margin entire in the basal part and simple regularly serrate upwards, teeth mucronate, sinus angular to slightly opened, venation semicraspedodromous, midrib strong, straight, secondaries distinctly thinner, alternate, curved, looping, tertiary veins often opposite percurrent, straight to sinuous, venation of the higher orders regularly polygonal reticulate, areolation well developed, 3 to 4 sided, veinlets lacking. Adaxial cuticle very thin, faintly striate, showing polygonal straight walled cells ca. 20 µm in diameter, abaxial cuticle slightly thicker, but without anticlines visible, stomata seen only as outer and inner cavities, ca. 20 µm long, trichomes thin-walled, longitudinally striate, bent, up to 20 µm in diameter, 80-100 µm long scattered even in intercostal areas.

Remarks: No suggestion as to the affinity.

***Dicotylophyllum* sp. 3**
Pl. 14, figs 6-8; Pl. 23, figs 9-10

Material: Leaf fragments (SS 117, 119, NM K 631)

Description: Leaves fragmentary, probably simple, petiolate, petiole completely preserved, relatively thick, curved, 17 mm long, lamina probably elliptic to oblong or ovate, 52 mm long and 49 mm wide, apex not preserved, base rounded, margin entire, venation brochidodromous, midrib strong, straight, secondaries thinner, distinct, alternate, moderately wide apart, slightly curved and looping close to the margin, basal secondaries very near the margin, intersecondaries present in the apical area, tertiary veins alternate percurrent, straight to sinuous, running obliquely to secondaries, higher order venation regularly polygonal reticulate, areolation well developed, 3 to 4 sided, veinlets 1 branched. Adaxial cuticle thick, smooth, only very finely granulate outside, cells polygonal, 25-35 µm in diameter, anticlines partly straight, partly zig-zag wavy, thick-walled, curved simple trichomes 60-100 µm long in various density (less dense in SS 119, very dense in SS 118) on veins, abaxial cuticle smooth, reflecting cells 20-45 µm in diameter with very vaguely visible wavy anticlines, stomata anomocytic, oval to rounded, 20-30 µm long with indistinct I pieces, outer cavity oval, shorter than the guard cells, bordered with distinct stomatal ledges, inner cavity very narrow, pore slit-like, on veins frequent simple or paired unicellular trichomes, partly curved, 10 µm in diameter and 100-600 µm long, attached to a thicker foot.

Remarks: Arrangement and form of trichomes recall some evergreen representatives of Ericaceae JUSS. with anomocytic stomata.

***Dicotylophyllum* sp. 4**
Pl. 14, figs 13, 14; Pl. 24, figs 7-8

Material: Incomplete leaf (SS 296).

Description: Leaf with fragmentary petiole 3 mm long, lamina probably lobed and obovate, 28 mm long and 19 mm wide, apex not preserved, base cuneate, margin irregularly simply serrate, teeth sharp, acute, sinuous angular, venation basal actinodromous, probably triveined 2 primary veins preserved, strong, moderately narrowed, curved, outer primary veins sending abmedial strong veins into marginal teeth, secondaries (a pair incompletely preserved) thinner, alternate, curved, tertiary veins widely spaced, opposite percurrent, straight to curved, venation of the higher orders regular polygonal reticulate, areolation well developed, 4 sided, veinlets lacking. Cuticles extremely fragmentary, adaxial cuticle slightly striate, non-modified cells straight-walled, ca. 30 µm in diameter, abaxial cuticle papillate-striate, non-modified cells hardly visible, ca. 12-20 µm in diameter, anticlinal wells curved, stomata anomocytic (?), 10-15 µm long, stomatal ledges thin, sub-parallel in medial part, forming a spindle-shaped outer cavity, no trichome bases / trichomes observed.

Remarks: The fragment is very incomplete and recalls foliage of *Celtis* L., which, of course, strongly deviates in epidermal anatomy (paracytic stomata, conical strong trichomes in *Celtis*). Leaflets of Vitaceae are sometimes also similar and are more probable pending a wider comparative study.

***Dicotylophyllum* sp. 5**
Pl. 15, figs 2, 4; Pl. 24, figs 9-10

Material: Incomplete leaf (SS 299).

Description: Leaf petiolate, with fragmentary petiole, 2 mm long, lamina obovate (?), 18 mm long and 13 mm wide, base cuneate, apex not preserved, margin entire, venation

brochidodromous, midrib distinctly strong, curved, moderately narrowed, secondaries alternate, thinner, curved and looping, tertiary veins opposite to rarely alternate percurrent, sinuous to curved, venation of the higher orders regularly polygonal reticulate, areolation well developed, 3 to 4 sided, veinlets lacking. Adaxial cuticle very fragmentary, striate, non-modified cells straight-walled, ca. 20-25 µm in diameter, adaxial cuticle with waxy cover, non-modified cells straight-walled, polygonal, ca. 20-30 µm in diameter, stomata brachyparacytic, with wide subsidiary cells, guard cell pairs oval, 20-30 µm long, stomatal ledges thickened, forming a spindle-shaped outer cavity, simple thickened trichome bases ca. 12 µm in diameter on veins.

Remarks: Probably an aberant fragmentary leaf of a willow.

4.2.22 Monocotyledonidae fam. indet.
Poaceae vel Cyperaceae gen. et sp. indet
Pl. 15, fig 9

Material: Leaf fragment (SS 291)

Description: Leaf fragment oblong in outline, 21 mm long and 4 mm wide, apex acute, base truncate, margin entire, venation parallelodromous, 9 distinct, strong, parallel veins, higher order venation not preserved.

Remarks: The fragmentary nature of the compression does not allow a more accurate identification.

5. Flora, vegetation reconstruction and palaeoecology

The studied plant assemblage consists of 10 gymnosperms and 51 angiosperms represented by conifer needles, needle shoots and dicotyledonous leaves or leaflets (for detail see Table 1). Arboreal elements prevail; fossils of vines and small shrubs are less frequent. Single fossils may represent herbs. Ferns and fern-like plants are lacking. Regarding fruit remains recovered in the fossiliferous horizon at Auenheim, most correspond to the recovered elements based on foliage (*Carpinus*, *Fraxinus*, *Acer*, *Craigia*, *Eucommia*). The omly exception is *Liriodendron*, which is represented exclusively by fruits (Pl. 15, fig. 11).

The study applies in many instances open nomenclature and in this respect must be considered preliminary. The combination of leaf anatomical and gross morphological characteristics has revealed a great variation and convergent gross-morphology in some taxa (*Populus*, maples and maple-like fossils). This makes comparisons with the so far established but not fully revised fossil taxa from Auenheim difficult. Affinities of several morphotypes have not been resolved in spite of excellently preserved epidermal and venation features. We were unable to confirm the occurrence of some elements identified by previous authors (GEISSERT 1973, GEISSERT & MÉNILLET 1979, etc.) exclusively based on macromorphology. A definite assessment of the Pliocene Alsacian flora will require further studies and a complex approach including other organs, in particular fruits and seeds.

From the sedimentary setting of the Auenheim site it is evident that the plant assemblage of the main fossiliferous horizon accumulated from riparian forests bordering the ancient Rhine River. Taphonomic processes mixed up various plant remains from different habitats, which are difficult to decipher in their original composition. Most of the elements dominating the assemblage (deciduous Fagaceae, *Carpinus*, Salicaceae, etc.) belong to the moist riparian broad-leaved forests outside swampy and flooded habitats. Only a few woody species can be considered true swamp plants, namely *Taxodium*. In Auenheim this tree typical of swamps of

SE USA today, is not accompanied by other swampy elements of the European Neogene, like *Glyptostrobus*, *Cercidiphyllum*, *Liquidambar*, *Myrica*, etc. or these elements are partly represented by single fragmentary fossils (*Alnus*, *Nyssa*). Contrary, some more likely mesophytic woody elements are better represented, e.g., *Zelkova*, *Acer* spp., *Buxus*, *Carpinus* and others. Deciduous Juglandaceae, namely *Carya* and *Pterocarya*, may have entered both mesophytic and riparian non-flooded areas together with *Ulmus*, *Zelkova*, *Fraxinus*, *Gleditsia*, and Salicaceae. Vines (*Trichosanthes*) and shrubs (*Ilex*, cf. Vacciniaceae) are relatively rare, possibly due to taphonomic bias. Also all recorded gymnosperms except *Taxodium*, such as *Ginkgo*, Pinaceae, and *Torreya* belong to mesophytic representatives of mixed coniferous and broad-leaved deciduous forests. Termophilous elements, such as evergreen Fagaceae, Lauraceae, Theaceae and others, which may indicate the Mixed Mesophytic Forest of East Asia are largely absent. Exceptions are *Cathaya* and *Craigia*, two relictual living genera, whose fossil representatives need not have shared the climate requirements climate as today. The autecology of the most characteristic components suggests that most likely analogous recent forest vegetation is found in Korea and Japan in higher zones of *Fagus* forest or the northern part of the area of *Taxodium* in USA. Relatively close affinities of the Pliocene forests of Auenheim can be found also in the Caucasus area with *Fagus orientalis*, *Parrotia persica*, *Pterocarya*, *Zelkova*, and *Buxus*. The present vegetation of the Mediterranean area arose due desiccation of the summer season during the late Neogene and changed towards an ethesian climatic regime. Hence, the Mediterranean forests are certainly not a good match in our study. A high representation of East Asiatic woody elements in the Alsacian Pliocene flora is noteworthy. As already discussed in the systematic part, the Pliocene elements in Europe may share relationships to more living counterparts distributed in the Asa-Gray disjunctions (*Nyssa sylvatica* - *sinensis* complex, *Torreya*, *Populus* spp.) and corroborate an ancient origin of several lineages before their extinction in the Quaternary.

Explanation to table 1.

Table 1: Summary of the floristic composition of the studied locality Auenheim including suggestion of the Nearest Living Relatives. – Frequency categories: "*" single (1 specimen), "**" rare (2-5 specimens), "***" common (6-15 specimens), "****" predominant (over 16 specimens).

Taxa	Frequency	Nearest Living Relatives
Abies cf. *albula* (LUDWIG) MÜLLER-STOLL	*	*Abies pectinata* DC.
Acer cf. *pseudoplatanus* L.	**	*A. pseudoplatanus* L
Acer cf. *tricuspidatum* BRONN forma *productum* (A. BRAUN) PROCHÁZKA & BŮŽEK	**	*A. dasycarpum* L.
Acer integerrimum (VIVIANI) MASSALONGO	*	*A. mono* MAXIM., *A. pictum* THUNB., *A. cappadocicum* GLED.
Acer sp. 1	*	*A. mono* MAXIM., *A. pictum* THUNB., *A. cappadocicum* GLED.
Acer sp. 2	*	*A. pseudoplatanus* L
cf. *Alnus* sp.	*	?
Buxus pliocaenica SAPORTA	***	*Buxus sempervirens* L.
Carpinus sp.	****	*Carpinus betulus* L.
Carya sp.	**	?
Cathaya sp.	*	*C. argyrophylla* CHUNG & KUANG, *C. nanchuanensis* CHUNG & KUANG

Taxa	Frequency	Nearest Living Relatives
Corylus sp.	**	*Corylus avellana* L.
Dicotylophyllum cf. *heerii* (ENGELHARDT) KVAČEK & WALTHER	**	*Laurocerasus* spp.
Dicotylophyllum sp. 1	**	*Sorbus alnifolia* (SIEB. & ZUCCARINI) K. KOCH
Dicotylophyllum sp. 2	*	?
Dicotylophyllum sp. 3	**	?
Dicotylophyllum sp. 4	*	?
Dicotylophyllum sp. 5	*	?
Dombeyopsis lobata UNGER	*	*Craigia yunnanensis* W.W. SMITH & SVAND
Eucommia sp.	**	*E. ulmoides* OLIV.
Fagus kraeuselii KVAČEK & WALTHER	****	? *F. sylvatica* L. ssp. *orientalis* (LIPSKY) GREUTER & BURDET
Fraxinus sp.	***	*Fraxinus excelsior* L.
Ginkgo adiantoides (UNGER) HEER	***	*G. biloba* L.
cf. *Gleditsia* sp.	*	*Gleditsia triacanthos* L.
Ilex aquifolium L. *fossilis* ENGELHARDT	**	? *I. aquifolium* L., *I. cornuta* LINDL. & PAXTON
Leguminosites sp.	**	?
Nyssa sp.	*	*N. sylvatica* MARSHALL, *N. sinensis* OLIV.
Parrotia pristina (ETTINGSH.) STUR	***	*P. persica* C.A. MEY.
Picea echinata MÜLLER-STOLL	**	*Picea torano* (SIEBOLD ex K. KOCH) KOEHNE
Pinaceae gen. et sp. indet.	*	?
Poaceae vel Cyperaceae gen. et sp. indet	*	?
Populus (sect. *Aeigiros* DUBY) sp. 2	*	*Populus nigra* L.
Populus cf. *balsamoides* GÖPPERT sensu lato	**	*Populus* L. sect. *Tacamahaca* PAX
Populus cf. *glandulifera* HEER	**	Populus L. sect. *Leucoides* SPACH
Populus populina (BRONGNIART) KNOBLOCH	****	*Populus* L. sect. *Populus* (*Leuce* DUBY)
Populus sp. 1	***	*P. suaveolens* FISCH.
Populus sp. 3	*	*Populus* L. sect. *Populus* (*Leuce* DUBY
Populus sp. 4	*	?
Populus sp. 5	*	?
Populus sp. 6	**	*Populus simonii* CARRIÈRE
Pseudotsuga sp.	*	*P. menziesii* (MIRB.) FRANCO
Pterocarya paradisiaca (UNGER) ILJINSKAYA	**	*P. pterocarpa* (MICHX.) KUNTH
Quercus cf. *kubinyii* (KOVÁTS ex ETTINGSH.) CZECZOTT	***	?
Quercus cf. *praeerucifolia* STRAUS	**	*Q. pedunculiflora* K. KOCH
Quercus gigas GÖPP. emend. WALTHER & ZASTAWNIAK	**	*Quercus* sect. *Cerris* SPACH
Quercus pseudocastanea GÖPP. emend. WALTHER & ZASTAWNIAK	***	*Quercus* sect. *Cerris* SPACH

Taxa	Frequency	Nearest Living Relatives
Quercus roburoides GAUDIN	****	*Q. petraea* (MATT.) LIEBL.
Salix sp.	****	*S. bonplandiana* HBK
Sassafras cf. *ferretianum* MASSALONGO & SCARABELLI	*	*S. tzumu* (HEMSL.) HEMSL.
Taxodium cf. *dubium* (STERNB.) HEER	****	*T. distichum* (L.) RICH.
Torreya sp.	**	?
Trichosanthes sp.	***	*Trichosanthes* sp.
Tsuga (sect. *Hesperopeuce* ENGELM.) sp.	*	?
Tsuga (sect. *Tsuga*) sp.	*	?
Ulmus carpinoides GÖPPERT	**	*Ulmus carpinifolia* L.
Ulmus pyramidalis GÖPPERT	****	*Ulmus* L. sect. *Chaetoptelea* (LIEBM.) SCHNEID.
Vacciniaceae gen. et sp. indet.	*	?
Viscophyllum pliocaenicum (ENGELH.) MÄDLER	**	?
Viscum miquelii (GEYLER & KINKELIN) CZECZOTT	***	*Viscum album* L.
Zelkova zelkovifolia (UNGER) BŮŽEK & KOTLABA	****	*Zelkova sicuta* DI PASQUALE, GARFI & QUÉZEL, *Z. abeliacea* (LAMARK) BOISS., *Z. carpinifolia* (PALL.) K. KOCH

6. Comparison with Pliocene floras

The flora of Auenheim shares most elements with the Pliocene flora from the Rhine River deposits at Frankfurt/M. This well known flora of Niederrad is still not revised but the preliminary studies suggest that it belongs to the same type of the floral assemblage of Brunssum sensu MAI (1995). In Auenheim, the leaf assemblage seems impoverished of various exotic plants recorded by carpological research (*Stewartia*, *Rehderodendron*, *Tectocarya*, *Toddalia*, *Symplocos*). The Alsacian Pliocene area is not completely uniform and the discussed flora from Auenheim lies above the well known carpological assemblage of the "Saugbagger-Flora" from the Sessenheim quarry that looks more ancient. In their computer analytical GÜNTHER & GREGOR (1989) study assigned the Frankfurter leaf assemblage to the Late Pliocene but the "Saugbagger Flora" to the undivided Pliocene. The whole complex of Early Pliocene floras in Boreal Europe needs more thorough comparisons as we are trying now.

Comparisons with other Pliocene sites in Central Europe are less satisfactory. Ruszów, which includes only a few common elements, is clearly biased by swampy habitats and is too poor in species. The same applies to the Reuverian leaf assemblages in the Netherlands, still not revised, but similar in representation of deciduous Fagaceae, Salicaceae and *Acer tricuspidatum* forma *productum*. (LAURENT & MARTY 1923, pl. 3, fig. 10, as *Betula alba foss.*). However, the Reuverian lacks typical "Miocene – Early Pliocene" elements, e.g. *Ginkgo*, *Torreya*, *Craigia*, and others represented in the Auenheim flora. In this respect the well known flora of Willershausen (STRAUS 1992, KNOBLOCH 1998) compares in many respects much better, namely in the just mentioned plants, although it is assigned to the Late Pliocene by many authors. Perhaps the most promising comparisons can be made with the section of the Hambach Mine, Düren (e.g., VAN DER BURGH & ZETTER 1998). The assemblages from level 9 ("Rotton") of the local stratigraphy seem to have much in common

with the carpological records of Sessenheim. However, the study of the Hambach section is not yet completed, particularly in respect of the leaf assemblages (also see profile fig. 2)..

7. Acknowledgments

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Explanation to plates.

Plate 1

1. *Ginkgo adiantoides* (UNGER) HEER, bilobate leaf with complete petiole, SS 339, scale bar 10 mm.

2. *Ginkgo adiantoides* (UNGER) HEER, non-lobate leaf, SS 341, scale bar 10 mm.

3. *Ginkgo adiantoides* (UNGER) HEER, leaf fragment with long petiole and brachyblast, SS 165, scale bar 10 mm.

4. *Ginkgo adiantoides* (UNGER) HEER, detail of leaf, mesophyllous narrow spindle-shaped oil cells (arrow), SS 339, scale bar 5 mm.

5. *Abies* cf. *albula* (LUDWIG) MÜLLER-STOLL, incomplete needle, SS 281, scale bar 10 mm.

6. *Abies* cf. *albula* (LUDWIG) MÜLLER-STOLL, needle base, SS 281, scale bar 5 mm.

7. *Taxodium* cf. *dubium* (STERNB.) HEER, fragmentary long shoot, SS 178, scale bar 10 mm.

8. *Taxodium* cf. *dubium* (STERNB.) HEER, fragmentary long shoot, SS 174, scale bar 10 mm.

9. *Taxodium* cf. *dubium* (STERNB.) HEER, shoot with short needles, SS 170, scale bar 10 mm.

10. *Cathaya* sp., incomplete needle, SS 171, scale bar 10 mm.

11. *Picea echinata* MÜLLER-STOLL, needle, SS 168, scale bar 5 mm.

12. *Picea echinata* MÜLLER-STOLL, needle, SS 279, scale bar 5 mm.

13. *Picea echinata* MÜLLER-STOLL, incomplete shoot, SS 300, scale bar 5 mm.

14. *Pseudotsuga* sp., incomplete needle, SS 277, scale bar 5 mm.

15. *Pseudotsuga* sp., needle base, SS 277, scale bar 2 mm.

16. *Tsuga* (sect. *Tsuga*) sp., needle, SS 278, scale bar 5 mm.

17. *Tsuga* (sect. *Tsuga*) sp., needle base, SS 278, scale bar 2 mm.

18. *Tsuga* (sect. *Hesperopeuce*) sp., incomplete needle, SS 280, scale bar 5 mm.

19. Pinaceae gen. et sp. indet., incomplete needle, SS 276, scale bar 5 mm.

20. *Torreya* sp., incomplete needle with spiny apex, SS 169, scale bar 5 mm.

21. *Taxodium* cf. *dubium* (STERNB.) HEER, unusually wide needle, SS 275, scale bar 5 mm.

Plate 2

1. Sassafras cf. ferretianum MASSALONGO & SCARABELLI, leaf fragment, SS 120, scale bar 10 mm.
2. Sassafras cf. ferretianum MASSALONGO & SCARABELLI, detail of the middle leaf, SS 120, scale bar 5 mm.
3. Sassafras cf. ferretianum MASSALONGO & SCARABELLI, detail of venation, SS 120, scale bar 10 mm.
4. Parrotia pristina (ETTINGSH.) STUR, leaf, SS 81, scale bar 10 mm.
5. Parrotia pristina (ETTINGSH.) STUR, detail of venation showing domatia, SS 81, scale bar 2 mm.
6. Parrotia pristina (ETTINGSH.) STUR, leaf, SS 83, scale bar 10 mm.
7. Parrotia pristina (ETTINGSH.) STUR, leaf, SS 20, scale bar 10 mm.
8. Carya sp., leaflet with fragmentary petiole, SS 355, scale bar 10 mm.
9. Carya sp., incomplete leaflet, SS 326, scale bar 10 mm.
10. Carya sp., fragmentary leaflet with complete petiole, SS 93, scale bar 10 mm.
11. Carya sp., leaflet, SS 71, scale bar 10 mm.
12. Carya sp., detail of venation and margin, SS 71, scale bar 5 mm.
13. Carya sp., leaflet, SS 149, scale bar 10 mm.
14. Carya sp., detail of venation and margin, SS 149, scale bar 5 mm.
15. Carya sp., detail of venation and margin, SS 93, scale bar 5 mm.
16. Carya sp., detail of teeth, SS 326, scale bar 2 mm.

Plate 3

1. Pterocarya paradisiaca (UNGER) ILJINSKAYA, incomplete leaflet, SS 290, scale bar 10 mm.
2. Pterocarya paradisiaca (UNGER) ILJINSKAYA, incomplete leaflet, SS 289, scale bar 10 mm.
3. Pterocarya paradisiaca (UNGER) ILJINSKAYA, incomplete leaflet, SS 92, scale bar 10 mm.
4. Pterocarya paradisiaca (UNGER) ILJINSKAYA, detail of venation and margin, SS 92, scale bar 5 mm.
5. Pterocarya paradisiaca (UNGER) ILJINSKAYA, detail of venation and margin, SS 289, scale bar 2 mm.
6. Fagus kraeuselii KVAČEK & WALTHER, leaf, SS 32, scale bar 10 mm.
7. Fagus kraeuselii KVAČEK & WALTHER, leaf with incomplete petiole, SS 60, scale bar 10 mm.
8. Fagus kraeuselii KVAČEK & WALTHER, leaf, SS 245, scale bar 10 mm.
9. Fagus kraeuselii KVAČEK & WALTHER, leaf with complete petiole, SS 233, scale bar 10 mm.
10. Fagus kraeuselii KVAČEK & WALTHER, leaf, SS 351, scale bar 5 mm.
11. Fagus kraeuselii KVAČEK & WALTHER, broader form of leaf, SS 232, scale bar 10 mm.
12. Fagus kraeuselii KVAČEK & WALTHER, detail of almost entire margin, SS 60, scale bar 5 mm.
13. Fagus kraeuselii KVAČEK & WALTHER, detail of toothed margin, SS 32, scale bar 5 mm.

Plate 4

1. Quercus pseudocastanea GÖPP. emend. WALTHER & ZASTAWNIAK, leaf with incomplete petiole, SS 121, scale bar 10 mm.

2. Quercus pseudocastanea GÖPP. emend. WALTHER & ZASTAWNIAK, leaf, SS 198, scale bar 10 mm.

3. Quercus pseudocastanea GÖPP. emend. WALTHER & ZASTAWNIAK, leaf fragment, SS 197, scale bar 10 mm.

4. Quercus pseudocastanea GÖPP. emend. WALTHER & ZASTAWNIAK, detail of apical venation and margin, SS 198, scale bar 5 mm.

5. Quercus pseudocastanea GÖPP. emend. WALTHER & ZASTAWNIAK, detail of lobe, SS 197, scale bar 5 mm.

6. Quercus gigas GÖPP. emend. WALTHER & ZASTAWNIAK, leaf fragment, SS 227, scale bar 10 mm.

7. Quercus gigas GÖPP. emend. WALTHER & ZASTAWNIAK, sharply toothed leaf apex, SS 225, scale bar 10 mm.

8. Quercus gigas GÖPP. emend. WALTHER & ZASTAWNIAK, leaf fragment, SS 353, scale bar 10 mm.

9. Quercus gigas GÖPP. emend. WALTHER & ZASTAWNIAK, detail of coarsely toothed margin and venation, SS 225, scale bar 5 mm.

10. Quercus gigas GÖPP. emend. WALTHER & ZASTAWNIAK, detail of finely toothed margin and venation, SS 353, scale bar 5 mm.

11. Quercus cf. kubinyii (KOVÁTS ex ETTINGSH.) CZECZOTT, toothed leaf fragment, SS 467, scale bar 10 mm.

12. Quercus cf. kubinyii (KOVÁTS ex ETTINGSH.) CZECZOTT, leaf with venation details, SS 37, scale bar 10 mm.

13. Quercus cf. kubinyii (KOVÁTS ex ETTINGSH.) CZECZOTT, petiolate leaf base, SS 18, scale bar 10 mm.

14. Quercus cf. kubinyii (KOVÁTS ex ETTINGSH.) CZECZOTT, anomalous leaf, SS 38, scale bar 10 mm.

15. Quercus cf. kubinyii (KOVÁTS ex ETTINGSH.) CZECZOTT, detail of tooth and venation, SS 37, scale bar 5 mm.

16. Quercus cf. kubinyii (KOVÁTS ex ETTINGSH.) CZECZOTT, detail of teeth, SS 38, scale bar 5 mm.

Plate 5

1. Quercus cf. praeerucifolia STRAUS, leaf fragment, SS 188, scale bar 10 mm.
2. Quercus cf. praeerucifolia STRAUS, leaf fragment, SS 219, scale bar 10 mm.
3. Quercus cf. praeerucifolia STRAUS, detail of lobe and venation, SS 188, scale bar 5 mm.
4. Quercus roburoides GAUDIN, leaf fragment, SS 13, scale bar 10 mm.
5. Quercus roburoides GAUDIN, leaf apex, SS 122, scale bar 10 mm.
6. Quercus roburoides GAUDIN, leaf base with fragmentary petiole, SS 186, scale bar 10 mm.
7. Quercus roburoides GAUDIN, leaf apex, SS 194, scale bar 10 mm.
8. Quercus roburoides GAUDIN, leaf base with complete petiole, SS 223, scale bar 10 mm.
9. Quercus roburoides GAUDIN, leaf fragment, SS 322, scale bar 10 mm.
10. Quercus roburoides GAUDIN, detail of undulate margin and venation, SS 122, scale bar 5 mm.
11. Quercus roburoides GAUDIN, detail of lobes and venation, SS 13, scale bar 5 mm.
12. cf. Alnus sp., leaf fragment, SS 150, scale bar 10 mm.
13. Carpinus sp., almost complete leaf with fragmentary petiole, SS 344, scale bar 10 mm.

Plate 6

1. Carpinus sp., leaf apex, SS 159, scale bar 10 mm.
2. Carpinus sp., almost complete leaf with petiole, SS 346, scale bar 10 mm.
3. Carpinus sp., leaf apex, SS 138, scale bar 10 mm.
4. Carpinus sp., leaf, SS 334, scale bar 10 mm.
5. cf. Alnus sp., detail of leaf venation and margin, SS 150, scale bar 5 mm.
6. Carpinus sp., detail of leaf venation and margin, SS 159, scale bar 5 mm.
7. Ulmus carpinoides GÖPPERT, leaf with complete petiole, SS 258, scale bar 10 mm.
8. Ulmus carpinoides GÖPPERT, almost complete leaf, SS 15, scale bar 5 mm.
9. Ulmus carpinoides GÖPPERT, detail of venation and margin, SS 15, scale bar 5 mm.
10. Ulmus pyramidalis GÖPPERT, leaf with attenuate apex, SS 269, scale bar 10 mm.
11. Ulmus pyramidalis GÖPPERT, leaf with asymmetric base, SS 21, scale bar 10 mm.
12. Ulmus pyramidalis GÖPPERT, detail of venation and margin, SS 21, scale bar 5 mm.
13. Zelkova zelkovifolia (UNGER) BŮŽEK & KOTLABA, sessile leaf, SS 381, scale bar 5 mm.
14. Zelkova zelkovifolia (UNGER) BŮŽEK & KOTLABA, petiolale leaf, SS 251, scale bar 10 mm.

Plate 7

1. Zelkova zelkovifolia (UNGER) BŮŽEK & KOTLABA, larger leaf, SS 252, scale bar 10 mm.
2. Zelkova zelkovifolia (UNGER) BŮŽEK & KOTLABA, complete leaf with fragmentary petiole, SS 253, scale bar 10 mm.
3. Zelkova zelkovifolia (UNGER) BŮŽEK & KOTLABA, narrow leaf, SS 257, scale bar 10 mm.
4. Zelkova zelkovifolia (UNGER) BŮŽEK & KOTLABA, detail of venation and margin, SS 251, scale bar 5 mm.
5. Zelkova zelkovifolia (UNGER) BŮŽEK & KOTLABA, detail of margin and venation, SS 257, scale bar 5 mm.
6. cf. Malus pulcherrima GIVULESCU, fragmentary leaf, SS 301, scale bar 5 mm.
7. cf. Malus pulcherrima GIVULESCU, detail of margin and venation, SS 301, scale bar 3 mm.
8. Leguminosites sp., leaflet, SS 283, scale bar 5 mm.
9. Leguminosites sp., almost complete leaflet, SS 285, scale bar 5 mm.
10. Leguminosites sp., detail of margin, venation and fragmentary petiole, SS 285, scale bar 3 mm..
11. cf. Gleditsia sp., incomplete thorn, SS 352, scale bar 10 mm.
12. Acer integerrimum (VIVIANI) MASSALONGO, leaf, SS 75, scale bar 10 mm.
13. Acer integerrimum (VIVIANI) MASSALONGO, detail of leaf margin and venation, SS 75, scale bar 5 mm.
14. Acer cf. tricuspidatum BRONN forma productum (A. BRAUN) PROCHÁZKA & BŮŽEK, complete leaf, SS 79, scale bar 10 mm.
15. Acer cf. tricuspidatum BRONN forma productum (A. BRAUN) PROCHÁZKA & BŮŽEK, detail of margin and venation, SS 79, scale bar 5 mm.
16. Acer cf. tricuspidatum BRONN forma productum (A. BRAUN) PROCHÁZKA & BŮŽEK, incomplete leaf, SS 30, scale bar 10 mm.
17. Acer cf. tricuspidatum BRONN forma productum (A. BRAUN) PROCHÁZKA & BŮŽEK, complete leaf, SS 14, scale bar 10 mm.
18. Acer cf. tricuspidatum BRONN forma productum (A. BRAUN) PROCHÁZKA & BŮŽEK, detail of margin and venation, SS 14, scale bar 5 mm.

Plate 8

1. Acer cf. pseudoplatanus L., incomplete leaf, SS 76, scale bar 10 mm.
2. Acer cf. pseudoplatanus L., incomplete leaf, SS 74, scale bar 10 mm.
3. Acer cf. pseudoplatanus L., detail of margin and venation, SS 76, scale bar 5 mm.
4. Acer sp. 1, leaf with slightly cordate base, SS 24, scale bar 10 mm.
5. Acer sp. 1, detail of margin and venation, SS 24, scale bar 5 mm.
6. Acer sp. 2, leaf fragment, SS 25, scale bar 10 mm.
7. Acer sp. 2, detail of margin and venation, SS 25, scale bar 5 mm.
8. Nyssa sp., leaf, SS 302, scale bar 5 mm.
9. Nyssa sp., detail of margin and venation, SS 302, scale bar 5 mm.
10. Ilex aquifolium L. fossilis ENGELHARDT, almost complete leaf, SS 57, scale bar 10 mm.
11. Ilex aquifolium L. fossilis ENGELHARDT, leaf base, SS 56, scale bar 10 mm.
12. Ilex aquifolium L. fossilis ENGELHARDT, detail of spiny lobe, SS 120, scale bar 5 mm.
13. Ilex aquifolium L. fossilis ENGELHARDT, detail of basal venation, SS 120, scale bar 2.5 mm.

Plate 9

1. Buxus pliocaenica SAPORTA, leaf with emarginate apex, SS 51, scale bar 5 mm.
2. Buxus pliocaenica SAPORTA, incomplete leaf, SS 50, scale bar 5 mm.
3. Buxus pliocaenica SAPORTA, complete leaf with fragmentary petiole, SS 49, scale bar 5 mm.
4. Buxus pliocaenica SAPORTA, leaf with complete petiole, SS 55, scale bar 5 mm.
5. Buxus pliocaenica SAPORTA, detail of venation and margin, SS 50, scale bar 5 mm.
6. Viscum miquelii (GEYLER & KINKELIN) CZECZOTT, almost complete leaf, SS 42, scale bar 10 mm.
7. Viscum miquelii (GEYLER & KINKELIN) CZECZOTT, fragmentary leaf, SS 45, scale bar 10 mm.
8. Viscum miquelii (GEYLER & KINKELIN) CZECZOTT, almost complete leaf with petiole, SS 46, scale bar 10 mm.
9. Viscum miquelii (GEYLER & KINKELIN) CZECZOTT, twig, SS 350, scale bar 10 mm.
10. Viscophyllum pliocaenicum (ENGELHARDT) MÄDLER, leaf base, SS 305, scale bar 5 mm.
11. Viscophyllum pliocaenicum (ENGELHARDT) MÄDLER, leaf fragment, SS 304, scale bar 10 mm.
12. Viscophyllum pliocaenicum (ENGELHARDT) MÄDLER, leaf base with petiole, SS 306, scale bar 5 mm.
13. Trichosanthes sp., leaf fragment, SS 23, scale bar 10 mm.
14. Trichosanthes sp., complete half of leaf, SS 77, scale bar 10 mm.
15. Trichosanthes sp., leaf base with rounded lobes, SS 293, scale bar 5 mm.
16. Trichosanthes sp., leaf fragment, SS 36, scale bar 10 mm.

Plate 10

1. Trichosanthes sp., detail of venation of a lobe, SS 77, scale bar 5 mm.
2. Trichosanthes sp., detail of basal venation, SS 293, scale bar 5 mm.
3. Trichosanthes sp., leaf apex, SS 22, scale bar 5 mm.
4. Corylus sp., incomplete leaf, SS 73, scale bar 10 mm.
5. Corylus sp., leaf base with fragmentary petiole, SS 327, scale bar 10 mm.
6. Corylus sp., detail of venation and margin, SS 73, scale bar 5 mm.
7. Salix sp., leaf apex, NM K 694, scale bar 10 mm.
8. Salix sp., detail of venation and margin, SS 94, scale bar 5 mm.
9. Salix sp., petiolate leaf base, SS 91, scale bar 10 mm.
10. Salix sp., complete leaf with petiole, SS 62, scale bar 10 mm.
11. Salix sp., incomplete leaf, SS 111, scale bar 10 mm.
12. Salix sp., leaf base with complete petiole, SS 102, scale bar 10 mm.
13. Salix sp., attenuate leaf apex, SS 10, scale bar 10 mm.
14. Salix sp., detail of venation and margin, SS 62, scale bar 5 mm.

Plate 11

1. Salix sp., leaf base, SS 11, scale bar 10 mm.

2. Salix sp., detail of venation and margin, SS 11, scale bar 5 mm.

3. Populus cf. balsamoides GÖPPERT s. l., petiolate leaf, SS 146, scale bar 10 mm.

4. Populus cf. balsamoides GÖPPERT s. l., almost complete leaf, NM K 614, scale bar 10 mm.

5. Populus cf. balsamoides GÖPPERT s. l., petiolate leaf fragment, SS 34, scale bar 10 mm.

6. Populus cf. balsamoides GÖPPERT s. l., detail of venation and margin, NM K 614, scale bar 5 mm.

7. Populus cf. glandulifera HEER, leaf with glands in the base, SS 132, scale bar 10 mm.

8. Populus cf. glandulifera HEER, detail of venation and margin, SS 132, scale bar 5 mm.

9. Populus populina (BRONGNIART) KNOBLOCH, long petiolate leaf, SS 143, scale bar 10 mm.

10. Populus populina (BRONGNIART) KNOBLOCH, almost complete leaf with shortly attenuate apex, SS 139, scale bar 10 mm.

11. Populus populina (BRONGNIART) KNOBLOCH, wider leaf, SS 142, scale bar 10 mm.

12. Populus populina (BRONGNIART) KNOBLOCH, detail of venation and margin, SS 142, scale bar 5 mm.

Plate 12

1. Populus sp. 1, incomplete leaf, SS 338, scale bar 10 mm.
2. Populus sp. 1, leaf base, SS 114, scale bar 10 mm.
3. Populus sp. 1, incomplete leaf base, SS 64, scale bar 10 mm.
4. Populus sp. 1, detail of venation and margin, SS 338, scale bar 5 mm.
5. Populus sp. 3, leaf fragment, SS 129, scale bar 10 mm.
6. Populus sp. 3, detail of venation and margin, SS 129, scale bar 5 mm.
7. Populus (sect. Aeigiros DUBY) sp. 2, almost complete leaf, SS 347, scale bar 10 mm.
8. Populus (sect. Aeigiros DUBY) sp. 2, detail of venation and margin, SS 347, scale bar 10 mm.
9. Populus sp. 4, incomplete leaf with fragmentary petiole, SS 124, scale bar 10 mm.
10. Populus sp. 4, detail of apical venation, SS 124, scale bar 10 mm.
11. Dombeyopsis lobata UNGER, leaf fragment with complete petiole, SS 1, scale bar 10 mm.
12. Dombeyopsis lobata UNGER, detail of lateral lobe, SS 1, scale bar 5 mm.

Plate 13

1. Vacciniaceae gen. et sp. indet., complete leaf, SS 284, scale bar 2.5 mm.
2. Fraxinus sp., terminal leaflet, SS 330, scale bar 10 mm.
3. Fraxinus sp., lower side leaflet, SS 4, scale bar 10 mm.
4. Fraxinus sp., detail of venation and margin, SS 4, scale bar 5 mm.
5. Fraxinus sp., standard leaflet, SS 65, scale bar 10 mm.
6. Fraxinus sp., long petiolate leaflet, SS 5, scale bar 10 mm.
7. Salix sp., leaf, SS 61, aberrant scale bar 10 mm.
8. Salix sp., detail of venation and margin, SS 61, scale bar 2.5 mm.
9. Dicotylophyllum cf. heerii (ENGELH.) KVAČEK & WALTHER, leaf base, SS 35, scale bar 10 mm.
10. Dicotylophyllum cf. heerii (ENGELH.) KVAČEK & WALTHER, incomplete petiolate leaf, SS 70, scale bar 10 mm.
11. Dicotylophyllum cf. heerii (ENGELH.) KVAČEK & WALTHER, incomplete petiolate leaf, SS 67, scale bar 10 mm.
12. Dicotylophyllum cf. heerii (ENGELH.) KVAČEK & WALTHER, detail of venation and margin, SS 35, scale bar 5 mm.
13. Dicotylophyllum cf. heerii (ENGELH.) KVAČEK & WALTHER, detail of venation and margin, SS 70, scale bar 5 mm.

Plate 14

1. Dicotylophyllum sp. 1, leaf base with long petiole, SS 342, scale bar 10 mm.
2. Dicotylophyllum sp. 1, leaf base with complete petiole, SS 354, scale bar 10 mm.
3. Dicotylophyllum sp. 2, leaf base with long petiole, SS 325, scale bar 10 mm.
4. Dicotylophyllum sp. 1, detail of venation and margin, SS 342, scale bar 5 mm.
5. Dicotylophyllum sp. 2, detail of venation and margin, SS 325, scale bar 5 mm.
6. Dicotylophyllum sp. 3, leaf base with petiole, SS 117, scale bar 10 mm.
7. Dicotylophyllum sp. 3, fragment of leaf base, SS 119, scale bar 5 mm.
8. Dicotylophyllum sp. 3, detail of venation and margin, SS 117, scale bar 5 mm.
9. Eucommia sp., almost complete leaf with long petiole, SS 17, scale bar 10 mm.
10. Eucommia sp., detail of venation and margin, SS 17, scale bar 5 mm.
11. Salix sp., aberrant leaf apex, SS 63, scale bar 5 mm.
12. Salix sp., detail of venation and margin, SS 63, scale bar 2.5 mm.
13. Dicotylophyllum sp. 4, leaf fragment, SS 296, scale bar 10 mm.
14. Dicotylophyllum sp. 4, detail of venation and margin, SS 296, scale bar 5 mm.

Plate 15

1. Eucommia sp., broader leaf, SS 16, scale bar 10 mm.
2. Dicotylophyllum sp. 5, leaf fragment, SS 299, scale bar 5 mm.
3. Eucommia sp., detail of venation and margin, SS 16, scale bar 5 mm.
4. Dicotylophyllum sp. 5, detail of venation and margin, SS 299, scale bar 2.5 mm.
5. Populus sp. 6, leaf apex, SS 461, scale bar 10 mm.
6. Populus sp. 6, incomplete leaf, SS 462, scale bar 10 mm.
7. Populus sp. 6, detail of venation and margin, SS 461, scale bar 5 mm.
8. Populus sp. 5, leaf base, SS 348, scale bar 10 mm.
9. Poaceae vel Cyperaceae gen. et sp. indet., leaf fragment, SS 291, scale bar 5 mm.
10. Eucommia sp., fruit, SS 500, scale bar 10 mm.
11. Liriodendron sp., fruitlet, SS 503, scale bar 10 mm.
12. Craigia bronnii (UNG.) KVAČEK, BŮŽEK & MANCHESTER, fruit valve, K 209 (NM), scale bar 3 mm.
13. Carpinus sp., involucre, SS 504, scale bar 10 mm.
14. Fraxinus sp., fruit, SS 505 (Hag. 70), scale bar 10 mm.
15. Acer sp., fruit, SS 506, scale bar 10 mm.

Plate 16

1. Ginkgo adiantoides (UNGER) HEER, adaxial cuticle, SS 165, scale bar 100 µm.
2. Ginkgo adiantoides (UNGER) HEER, abaxial cuticle, SS 165, scale bar 100 µm.
3. Taxodium cf. dubium (STERNB.) HEER, adaxial cuticle, SS 174, scale bar 100 µm.
4. Taxodium cf. dubium (STERNB.) HEER, abaxial cuticle, SS 174, scale bar 100 µm.
5. Abies cf. albula (LUDWIG) MÜLLER-STOLL, cuticle, SS 281, scale bar 100 µm.
6. Cathaya sp., abaxial cuticle, SS 171, scale bar 100 µm.
7. Picea echinata MÜLLER-STOLL, cuticle, SS 279, scale bar 100 µm.
8. Pseudotsuga sp., abaxial cuticle and mesophyll scleroids, SS 277, scale bar 100 µm.
9. Tsuga (sect. Hesperopeuce ENGELM.) sp., adaxial cuticle, SS 280, scale bar 100 µm.
10. Tsuga (sect. Hesperopeuce ENGELM.) sp., abaxial cuticle, SS 280, scale bar 100 µm.
11. Tsuga (sect. Tsuga) sp., abaxial cuticle, SS 278, scale bar 100 µm.
12. Torreya sp., abaxial cuticle, SS 169, scale bar 100 µm.

Plate 17

1. Sassafras cf. ferretianum MASSALONGO & SCARABELLI, adaxial cuticule, SS 120, scale bar 30 µm.
2. Sassafras cf. ferretianum MASSALONGO & SCARABELLI, abaxial cuticule, SS 120, scale bar 30 µm.
3. Parrotia pristina (ETTINGSH.) STUR, adaxial cuticle, SS 20, scale bar 50 µm.
4. Parrotia pristina (ETTINGSH.) STUR, abaxial cuticle, SS 20, scale bar 50 µm.
5. Carya sp., abaxial cuticle, SS 71, scale bar 50 µm.
6. Carya sp., abaxial cuticle, SS 71, scale bar 50 µm.
7. Pterocarya paradisiaca (UNGER) ILJINSKAYA, adaxial cuticle, SS 290, scale bar 50 µm.
8. Pterocarya paradisiaca (UNGER) ILJINSKAYA, abaxial cuticle, SS 289, scale bar 50 µm.

9. Fagus kraeuselii KVAČEK & WALTHER, adaxial cuticle, SS 351, scale bar 50 µm.
10. Fagus kraeuselii KVAČEK & WALTHER, abaxial cuticle, SS 351, scale bar 50 µm.
11. Quercus pseudocastanea GÖPP. emend. WALTHER & ZASTAWNIAK, abaxial cuticle, SS 198, scale bar 50 µm.
12. Quercus pseudocastanea GÖPP. emend. WALTHER & ZASTAWNIAK, abaxial cuticle, SS 198, scale bar 50 µm.

Plate 18

1. Quercus gigas GÖPP. emend. WALTHER & ZASTAWNIAK, abaxial cuticle, SS 225, scale bar 50 µm.
2. Quercus gigas GÖPP. emend. WALTHER & ZASTAWNIAK, abaxial cuticle, SS 225, scale bar 50 µm.
3. Quercus cf. kubinyii (KOVÁTS ex ETTINGSH.) CZECZOTT, adaxial cuticle, SS 224, scale bar 50 µm.
4. Quercus cf. kubinyii (KOVÁTS ex ETTINGSH.) CZECZOTT, adaxial cuticle, SS 470, scale bar 50 µm.
5. Quercus cf. kubinyii (KOVÁTS ex ETTINGSH.) CZECZOTT, abaxial cuticle, SS 38, scale bar 50 µm.
6. Quercus roburoides GAUDIN, adaxial cuticle, SS 328, scale bar 50 µm.
7. Quercus roburoides GAUDIN, abaxial cuticle, SS 328, scale bar 50 µm.
8. Quercus cf. praeerucifolia STRAUS, adaxial cuticle, SS 219, scale bar 50 µm.
9. Quercus cf. praeerucifolia STRAUS, abaxial cuticle, SS 219, scale bar 50 µm.
10. cf. Alnus sp., adaxial cuticle, SS 150, scale bar 50 µm.
11. cf. Alnus sp., adaxial cuticle, SS 150, scale bar 50 µm.
12. Carpinus sp., adaxial cuticle, SS 138, scale bar 50 µm.
13. Carpinus sp., abaxial cuticle, SS 138, scale bar 50 µm.

Plate 19

1. cf. Malus pulcherrima GIVULESCU, adaxial cuticle, SS 301, scale bar 100 µm.
2. cf. Malus pulcherrima GIVULESCU, abaxial cuticle, SS 301, scale bar 100 µm.
3. Acer cf. tricuspidatum BRONN forma productum (A. BRAUN) PROCHÁZKA & BŮŽEK, abaxial cuticle, SS 79, scale bar 100 µm.
4. Acer cf. tricuspidatum BRONN forma productum (A. BRAUN) PROCHÁZKA & BŮŽEK, abaxial cuticle, SS 79, scale bar 100 µm.
5. Acer cf. pseudoplatanus L., adaxial cuticle, SS 74, scale bar 100 µm.
6. Acer cf. pseudoplatanus L., abaxial cuticle, SS 74, scale bar 100 µm.
7. Acer sp. 1, adaxial cuticle, SS 24, scale bar 100 µm.
8. Acer sp. 1, abaxial cuticle, SS 24, scale bar 100 µm.
9. Acer sp. 2, adaxial cuticle, SS 25, scale bar 100 µm.
10. Acer sp. 2, abaxial cuticle, SS 25, scale bar 100 µm.
11. Acer integerrimum (VIVIANI) MASSALONGO, adaxial cuticle, SS 75, scale bar 100 µm.
12. Acer integerrimum (VIVIANI) MASSALONGO, abaxial cuticle, SS 75, scale bar 100 µm.

Plate 20

1. Nyssa sp., adaxial cuticle, SS 302, scale bar 50 µm.
2. Nyssa sp., abaxial cuticle, SS 302, scale bar 50 µm.
3. Ilex aquifolium L. fossilis ENGELHARDT, adaxial cuticle, SS 241, scale bar 50 µm.
4. Ilex aquifolium L. fossilis ENGELHARDT, adaxial cuticle, SS 57, scale bar 50 µm.
5. Ilex aquifolium L. fossilis ENGELHARDT, abaxial cuticle, SS 56, scale bar 50 µm.
6. Buxus pliocaenica SAPORTA, abaxial cuticle, SS 51, scale bar 50 µm.
7. Buxus pliocaenica SAPORTA, adaxial cuticle, SS 51, scale bar 50 µm.
8. Viscum miquelii (GEYLER & KINKELIN) CZECZOTT, adaxial cuticle, SS 45, scale bar 25 µm.
9. Viscum miquelii (GEYLER & KINKELIN) CZECZOTT, abaxial cuticle, SS 45, scale bar 25 µm.
10. Viscum miquelii (GEYLER & KINKELIN) CZECZOTT, abaxial cuticle of shoot, SS 350, scale bar 25 µm.
11. Viscophyllum pliocaenicum (ENGELHARDT) MÄDLER, adaxial cuticle, SS 304, scale bar 25 µm.
12. Trichosanthes sp., adaxial cuticle, SS 36, scale bar 50 µm.
13. Trichosanthes sp., abaxial cuticle, SS 293, scale bar 50 µm.
14. Trichosanthes sp., abaxial cuticle, SS 293, scale bar 50 µm.

Plate 21

1. Salix sp., adaxial cuticle, SS 8, scale bar 50 µm.
2. Salix sp., abaxial cuticle, SS 8, scale bar 50 µm.
3. Salix sp., adaxial cuticle, SS 102, scale bar 50 µm.
4. Salix sp., abaxial cuticle, SS 112, scale bar 50 µm.
5. Salix sp., abaxial cuticle, SS 112, scale bar 50 µm.
6. Corylus sp., adaxial cuticle, SS 327, scale bar 50 µm.
7. Corylus sp., abaxial cuticle, SS 327, scale bar 50 µm.
8. Populus cf. balsamoides GÖPPERT s. l., adaxial cuticle, NM K 614, scale bar 50 µm.
9. Populus cf. balsamoides GÖPPERT s. l., abaxial cuticle, NM K 614, scale bar 50 µm.
10. Populus sp. 1, abaxial cuticle, SS 114, scale bar 50 µm.
11. Populus cf. glandulifera HEER, adaxial cuticle, SS 132, scale bar 50 µm.
12. Populus cf. glandulifera HEER, abaxial cuticle, SS 132, scale bar 50 µm.
13. Populus populina (BRONGNIART) KNOBLOCH, adaxial cuticle, SS 134, scale bar 50 µm.
14. Populus populina (BRONGNIART) KNOBLOCH, abaxial cuticle, SS 142, scale bar 50 µm.

Plate 22

1. Populus sp. 1, adaxial cuticle, SS 115, scale bar 50 µm.
2. Populus sp. 1, abaxial cuticle, NM K 622, scale bar 50 µm.
3. Populus (sect. Aeigiros DUBY) sp. 2, adaxial cuticle, SS 347, scale bar 50 µm.
4. Populus (sect. Aeigiros DUBY) sp. 2, abaxial cuticle, SS 347, scale bar 50 µm.
5. Populus sp. 3, adaxial cuticle, SS 129, scale bar 50 µm.
6. Populus sp. 3, abaxial cuticle, SS 129, scale bar 50 µm.
7. Populus sp. 4, adaxial cuticle, SS 124, scale bar 50 µm.
8. Populus sp. 4, abaxial cuticle, SS 124, scale bar 50 µm.
9. Populus sp. 4, abaxial cuticle, SS 124, scale bar 50 µm.
10. Fraxinus sp., adaxial cuticle, SS 5, scale bar 50 µm.
11. Fraxinus sp., abaxial cuticle with peltate trichome, SS 5, scale bar 50 µm.
12. Fraxinus sp., adaxial cuticle with trichome base, SS 65, scale bar 50 µm.

Plate 23

1. Dicotylophyllum cf. heerii (ENGELH.) KVAČEK & WALTHER, adaxial cuticle, SS 67, scale bar 50 µm.
2. Dicotylophyllum cf. heerii (ENGELH.) KVAČEK & WALTHER, abaxial cuticle, SS 67, scale bar 50 µm.
3. Salix sp., adaxial and abaxial cuticle, SS 61, scale bar 50 µm.
4. Dicotylophyllum sp. 1, abaxial cuticle, SS 342, scale bar 50 µm.
5. Dicotylophyllum sp. 1, adaxial cuticle, SS 342, scale bar 50 µm.
6. Dicotylophyllum sp. 2, adaxial cuticle, SS 325, scale bar 50 µm.
7. Dicotylophyllum sp. 2, adaxial cuticle, SS 325, scale bar 50 µm.
8. Dicotylophyllum sp. 2, abaxial cuticle, SS 325, scale bar 50 µm.
9. Dicotylophyllum sp. 3, adaxial cuticle, SS 119, scale bar 50 µm.
10. Dicotylophyllum sp. 3, abaxial cuticle, SS 119, scale bar 50 µm.
11. Eucommia sp., adaxial cuticle, SS 17, scale bar 50 µm.
12. Eucommia sp., abaxial cuticle, SS 17, scale bar 50 µm.
13. Eucommia sp., abaxial cuticle, SS 17, scale bar 50 µm.

Plate 24

1. Salix sp., abaxial cuticle, SS 63, scale bar 50 µm.
2. Salix sp., abaxial cuticle, SS 63, scale bar 50 µm.
3. Eucommia sp., adaxial and abaxial cuticle, SS 16, scale bar 50 µm.
4. Eucommia sp., abaxial cuticle, SS 16, scale bar 50 µm.
5. Populus sp. 6, adaxial cuticle, SS 461, scale bar 50 µm.
6. Populus sp. 6, abaxial cuticle, SS 461, scale bar 50 µm.
7. Dicotylophyllum sp. 4, abaxial cuticle, SS 296, scale bar 50 µm.
8. Dicotylophyllum sp. 4, adaxial cuticle, SS 296, scale bar 50 µm.
9. Dicotylophyllum sp. 5, adaxial cuticle, SS 299, 50 µm.
10. Dicotylophyllum sp. 5, abaxial cuticle, SS 299, 50 µm.
11. Populus sp. 5, abaxial cuticle, SS 348, scale bar 50 µm.
12. Dombeyopsis lobata UNGER, adaxial cuticle, SS 1, scale bar 50 µm.
13. Dombeyopsis lobata UNGER, abaxial cuticle, SS 1, scale bar 50 µm.

Appendix:

Informal number Coll. Prague	Formal number Nature Museum Augsburg	Taxon
SS 1	2006-200/534	*Dombeyopsis lobata*
SS 4	2006-201/534	*Fraxinus* sp.
SS 5	2006-202/534	*Fraxinus* sp.
SS 8	2006-203/534	*Salix* sp.
SS 9	2006-204/534	*Salix* sp.
SS 10	2006-205/534	*Salix* sp.
SS 11	2006-206/534	*Salix* sp.
SS 13	2006-207/534	*Quercus roburoides*
SS 14	2006-208/534	*Acer* cf. *tricuspidatum* forma *productum*
SS 15	2006-209/534	*Ulmus carpinoides*
SS 16	2006-210/534	*Eucommia* sp.
SS 17	2006-211/534	*Eucommia* sp.
SS 18	2006-212/534	*Quercus* cf. *kubinyii*
SS 20	2006-213/534	*Parrotia pristina*
SS 21	2006-214/534	*Ulmus pyramidalis*
SS 22	2006-215/534	*Trichosanthes* sp.
SS 23	2006-216/534	*Trichosanthes* sp.
SS 24	2006-217/534	*Acer* sp. 1
SS 25	2006-218/534	*Acer* sp. 2
SS 30	2006-219/534	*Acer* cf. *tricuspidatum* forma *productum*
SS 32	2006-220/534	*Fagus kraeuselii*
SS 34	2006-221/534	*Populus* cf. *balsamoides*
SS 35	2006-222/534	*Dicotylophyllum* cf. *heerii*
SS 36	2006-223/534	*Trichosanthes* sp.
SS 37	2006-224/534	*Quercus* cf. *kubinyii*
SS 38	2006-225/534	*Quercus* cf. *kubinyii*
SS 42	2006-226/534	*Viscum miquelii*
SS 43	2006-227/534	*Viscum miquelii*
SS 45	2006-228/534	*Viscum miquelii*
SS 46	2006-229/534	*Viscum miquelii*
SS 47	2006-230/534	*Viscum miquelii*
SS 49	2006-231/534	*Buxus pliocaenica*
SS 50	2006-232/534	*Buxus pliocaenica*
SS 51	2006-233/534	*Buxus pliocaenica*
SS 52	2006-234/534	*Buxus pliocaenica*
SS 53	2006-235/534	*Buxus pliocaenica*
SS 54	2006-236/534	*Buxus pliocaenica*
SS 55	2006-237/534	*Buxus pliocaenica*
SS 56	2006-238/534	*Ilex aquifolium* L. *fossilis*

Informal number Coll. Prague	Formal number Nature Museum Augsburg	Taxon
SS 57	2006-239/534	*Ilex aquifolium* L. *fossilis*
SS 58	2006-240/534	*Ilex aquifolium* L. *fossilis*
SS 60	2006-241/534	*Fagus kraeuselii*
SS 61	2006-242/534	*Salix* sp.
SS 63	2006-243/534	*Salix* sp.
SS 64	2006-244/534	*Populus* sp. 1
SS 65	2006-245/534	*Fraxinus* sp.
SS 67	2006-246/534	*Dicotylophyllum* cf. *heerii*
SS 70	2006-247/534	*Dicotylophyllum* cf. *heerii*
SS 71	2006-248/534	*Carya* sp.
SS 74	2006-249/534	*Acer* cf. *pseudoplatanus*
SS 75	2006-250/534	*Acer integerrimum*
SS 76	2006-251/534	*Acer* cf. *pseudoplatanus*
SS 79	2006-252/534	*Acer* cf. *tricuspidatum* forma *productum*
SS 81	2006-253/534	*Parrotia pristina*
SS 82	2006-254/534	*Parrotia pristina*
SS 83	2006-255/534	*Parrotia pristina*
SS 84	2006-256/534	*Parrotia pristina*
SS 85	2006-257/534	*Parrotia pristina*
SS 86	2006-258/534	*Parrotia pristina*
SS 87	2006-259/534	*Parrotia pristina*
SS 88	2006-260/534	*Parrotia pristina*
SS 89	2006-261/534	*Populus populina*
SS 92	2006-262/534	*Pterocarya paradisiaca*
SS 93	2006-263/534	*Carya* sp.
SS 94	2006-264/534	*Salix* sp.
SS 101	2006-265/534	*Salix* sp.
SS 102	2006-266/534	*Salix* sp.
SS 103	2006-267/534	*Salix* sp.
SS 104	2006-268/534	*Salix* sp.
SS 105	2006-269/534	*Salix* sp.
SS 106	2006-270/534	*Salix* sp.
SS 107	2006-271/534	*Salix* sp.
SS 108	2006-272/534	*Salix* sp.
SS 109	2006-273/534	*Salix* sp.
SS 110	2006-274/534	*Salix* sp.
SS 111	2006-275/534	*Salix* sp.
SS 112	2006-276/534	*Salix* sp.
SS 113	2006-277/534	*Salix* sp.
SS 114	2006-278/534	*Populus* sp. 1
SS 115	2006-279/534	*Populus* sp. 1
SS 116	2006-280/534	*Populus* sp. 1

Informal number Coll. Prague	Formal number Nature Museum Augsburg	Taxon
SS 117	2006-281/534	*Dicotylophyllum* sp. 3
SS 119	2006-282/534	*Dicotylophyllum* sp. 3
SS 120	2006-283/534	*Sassafras* cf. *ferretianum*
SS 123	2006-284/534	*Populus populina*
SS 124	2006-285/534	*Populus* sp. 4
SS 125	2006-286/534	*Populus populina*
SS 128	2006-287/534	*Populus* cf. *balsamoides*
SS 129	2006-288/534	*Populus* sp. 3
SS 131	2006-289/534	*Populus populina*
SS 132	2006-290/534	*Populus* cf. *glandulifera*
SS 133	2006-291/534	*Populus populina*
SS 134	2006-292/534	*Populus populina*
SS 135	2006-293/534	*Populus populina*
SS 136	2006-294/534	*Populus populina*
SS 137	2006-295/534	*Populus populina*
SS 138	2006-296/534	*Carpinus* sp.
SS 139	2006-297/534	*Populus populina*
SS 140	2006-298/534	*Populus populina*
SS 141	2006-299/534	*Populus populina*
SS 142	2006-300/534	*Populus populina*
SS 143	2006-301/534	*Populus populina*
SS 146	2006-302/534	*Populus* cf. *balsamoides*
SS 147	2006-303/534	*Populus* cf. *glandulifera*
SS 148	2006-304/534	*Populus* cf. *balsamoides*
SS 149	2006-305/534	*Carya* sp.
SS 150	2006-306/534	cf. *Alnus* sp.
SS 151	2006-307/534	*Carpinus* sp.
SS 152	2006-308/534	*Carpinus* sp.
SS 153	2006-309/534	*Carpinus* sp.
SS 154	2006-310/534	*Carpinus* sp.
SS 155	2006-311/534	*Carpinus* sp.
SS 156	2006-312/534	*Carpinus* sp.
SS 157	2006-313/534	*Carpinus* sp.
SS 158	2006-314/534	*Carpinus* sp.
SS 159	2006-315/534	*Carpinus* sp.
SS 160	2006-316/534	*Carpinus* sp.
SS 161	2006-317/534	*Carpinus* sp.
SS 162	2006-318/534	*Carpinus* sp.
SS 163	2006-319/534	*Carpinus* sp.
SS 165	2006-320/534	*Ginkgo adiantoides*
SS 166	2006-321/534	*Ginkgo adiantoides*
SS 167	2006-322/534	*Ginkgo adiantoides*

Informal number Coll. Prague	Formal number Nature Museum Augsburg	Taxon
SS 168	2006-323/534	*Picea echinata*
SS 169	2006-324/534	*Torreya* sp.
SS 170	2006-325/534	*Taxodium* cf. *dubium*
SS 171	2006-326/534	*Cathaya* sp.
SS 172	2006-327/534	*Taxodium* cf. *dubium*
SS 173	2006-328/534	*Taxodium* cf. *dubium*
SS 174	2006-329/534	*Taxodium* cf. *dubium*
SS 175	2006-330/534	*Taxodium* cf. *dubium*
SS 176	2006-331/534	*Taxodium* cf. *dubium*
SS 177	2006-332/534	*Taxodium* cf. *dubium*
SS 178	2006-333/534	*Taxodium* cf. *dubium*
SS 179	2006-334/534	*Taxodium* cf. *dubium*
SS 180	2006-335/534	*Taxodium* cf. *dubium*
SS 181	2006-336/534	*Taxodium* cf. *dubium*
SS 182	2006-337/534	*Taxodium* cf. *dubium*
SS 186	2006-338/534	*Quercus roburoides*
SS 187	2006-339/534	*Quercus roburoides*
SS 189	2006-430/534	*Quercus roburoides*
SS 190	2006-341/534	*Quercus roburoides*
SS 191	2006-342/534	*Quercus roburoides*
SS 192	2006-343/534	*Quercus roburoides*
SS 193	2006-344/534	*Quercus pseudocastanea*
SS 194	2006-345/534	*Quercus roburoides*
SS 195	2006-346/534	*Quercus pseudocastanea*
SS 196	2006-347/534	*Quercus roburoides*
SS 197	2006-348/534	*Quercus pseudocastanea*
SS 198	2006-349/534	*Quercus pseudocastanea*
SS 199	2006-350/534	*Quercus roburoides*
SS 200	2006-351/534	*Quercus roburoides*
SS 210	2006-352/534	*Quercus roburoides*
SS 212	2006-353/534	*Quercus* cf. *kubinyii*
SS 213	2006-354/534	*Quercus* cf. *kubinyii*
SS 214	2006-355/534	*Quercus roburoides*
SS 215	2006-356/534	*Quercus pseudocastanea*
SS 216	2006-357/534	*Quercus roburoides*
SS 217	2006-358/534	*Quercus roburoides*
SS 218	2006-359/534	*Quercus* cf. *kubinyii*
SS 219	2006-360/534	*Quercus* cf. *praeerucifolia*
SS 220	2006-361/534	*Quercus roburoides*
SS 221	2006-362/534	*Quercus roburoides*
SS 222	2006-363/534	*Quercus roburoides*
SS 223	2006-364/534	*Quercus roburoides*

Informal number Coll. Prague	Formal number Nature Museum Augsburg	Taxon
SS 224	2006-365/534	*Quercus* cf. *kubinyii*
SS 225	2006-366/534	*Quercus gigas*
SS 226	2006-367/534	*Quercus gigas*
SS 227	2006-368/534	*Quercus gigas*
SS 228	2006-369/534	*Quercus gigas*
SS 229	2006-370/534	*Quercus* cf. *kubinyii*
SS 230	2006-371/534	*Quercus* cf. *kubinyii*
SS 231	2006-372/534	*Quercus cf. kubinyii*
SS 232	2006-373/534	*Fagus kraeuselii*
SS 233	2006-374/534	*Fagus kraeuselii*
SS 234	2006-375/534	*Fagus kraeuselii*
SS 235	2006-376/534	*Fagus kraeuselii*
SS 236	2006-377/534	*Fagus kraeuselii*
SS 237	2006-378/534	*Fagus kraeuselii*
SS 238	2006-379/534	*Fagus kraeuselii*
SS 239	2006-380/534	*Fagus kraeuselii*
SS 240	2006-381/534	*Fagus kraeuselii*
SS 241	2006-382/534	*Fagus kraeuselii*
SS 242	2006-383/534	*Fagus kraeuselii*
SS 243	2006-384/534	*Fagus kraeuselii*
SS 244	2006-385/534	*Fagus kraeuselii*
SS 245	2006-386/534	*Fagus kraeuselii*
SS 246	2006-387/534	*Fagus kraeuselii*
SS 251	2006-388/534	*Zelkova zelkovifolia*
SS 252	2006-389/534	*Zelkova zelkovifolia*
SS 253	2006-390/534	*Zelkova zelkovifolia*
SS 254	2006-391/534	*Zelkova zelkovifolia*
SS 255	2006-392/534	*Zelkova zelkovifolia*
SS 256	2006-393/534	*Zelkova zelkovifolia*
SS 257	2006-394/534	*Zelkova zelkovifolia*
SS 258	2006-395/534	*Ulmus carpinoides*
SS 266	2006-396/534	*Ulmus pyramidalis*
SS 267	2006-397/534	*Ulmus pyramidalis*
SS 268	2006-398/534	*Ulmus pyramidalis*
SS 269	2006-399/534	*Ulmus pyramidalis*
SS 270	2006-400/534	*Ulmus pyramidalis*
SS 274	2006-401/534	*Torreya* sp.
SS 275	2006-402/534	*Taxodium* cf. *dubium*
SS 276	2006-403/534	Pinaceae gen. et sp. indet.
SS 277	2006-404/534	*Pseudotsuga* sp.
SS 278	2006-405/534	*Tsuga* (sect. *Tsuga*) sp.
SS 279	2006-406/534	*Picea echinata*

Informal number Coll. Prague	Formal number Nature Museum Augsburg	Taxon
SS 280	2006-407/534	*Tsuga* (sect. *Hesperopeuce*) sp.
SS 281	2006-408/534	*Abies* cf. *albula*
SS 283	2006-409/534	*Leguminosites* sp.
SS 284	2006-410/534	Vacciniaceae gen. et sp. indet.
SS 285	2006-411/534	*Leguminosites* sp.
SS 289	2006-412/534	*Pterocarya paradisiaca*
SS 290	2006-413/534	*Pterocarya paradisiaca*
SS 291	2006-414/534	Poaceae vel Cyperaceae gen. et sp. indet
SS 293	2006-415/534	*Trichosanthes* sp.
SS 296	2006-416/534	*Dicotylophyllum* sp. 4
SS 299	2006-417/534	*Dicotylophyllum* sp. 5
SS 300	2006-418/534	*Picea echinata*
SS 301	2006-419/534	cf. *Malus pulcherrima*
SS 302	2006-420/534	*Nyssa* sp.
SS 304	2006-421/534	*Viscophyllum pliocaenicum*
SS 305	2006-422/534	*Viscophyllum pliocaenicum*
SS 306	2006-423/534	*Viscophyllum pliocaenicum*
SS 307	2006-424/534	*Zelkova zelkovifolia*
SS 308	2006-425/534	*Zelkova zelkovifolia*
SS 309	2006-426/534	*Zelkova zelkovifolia*
SS 310	2006-427/534	*Zelkova zelkovifolia*
SS 311	2006-428/534	*Zelkova zelkovifolia*
SS 312	2006-429/534	*Zelkova zelkovifolia*
SS 313	2006-430/534	*Zelkova zelkovifolia*
SS 314	2006-431/534	*Zelkova zelkovifolia*
SS 315	2006-432/534	*Zelkova zelkovifolia*
SS 316	2006-433/534	*Zelkova zelkovifolia*
SS 317	2006-434/534	*Zelkova zelkovifolia*
SS 318	2006-435/534	*Zelkova zelkovifolia*
SS 319	2006-436/534	*Zelkova zelkovifolia*
SS 320	2006-437/534	*Zelkova zelkovifolia*
SS 321	2006-438/534	*Zelkova zelkovifolia*
SS 322	2006-439/534	*Quercus roburoides*
SS 325	2006-440/534	*Dicotylophylum* sp. 2
SS 326	2006-441/534	*Carya* sp.
SS 327	2006-442/534	*Corylus* sp.
SS 330	2006-443/534	*Fraxinus* sp.
SS 334	2006-444/534	*Carpinus* sp.
SS 335	2006-445/534	*Fraxinus* sp.
SS 336	2006-446/534	*Fagus kraeuselii*
SS 337	2006-447/534	*Fagus kraeuselii*
SS 338	2006-448/534	*Populus* sp. 1

Informal number Coll. Prague	Formal number Nature Museum Augsburg	Taxon
SS 339	2006-449/534	*Ginkgo adiantoides*
SS 340	2006-450/534	*Ginkgo adiantoides*
SS 341	2006-451/534	*Ginkgo adiantoides*
SS 342	2006-452/534	*Dicotylophylum* sp. 1
SS 343	2006-453/534	*Carpinus* sp.
SS 344	2006-454/534	*Carpinus* sp.
SS 345	2006-455/534	*Carpinus* sp.
SS 346	2006-456/534	*Carpinus* sp.
SS 348	2006-457/534	*Populus* sp. 5
SS 350	2006-458/534	*Viscum miquelii*
SS 353	2006-459/534	*Quercus gigas*
SS 354	2006-460/534	*Dicotylophylum* sp. 1
SS 355	2006-461/534	*Carya* sp.
SS 461	2006-462/534	*Populus*sp. 6
SS 462	2006-463/534	*Populus*sp. 6

documenta naturae Nr. 155 Veröffentlichte Teile

Teil	Erscheinungsjahr	Inhalt
Einleitung	**2005**	Einführung von H.-J. GREGOR: **Erwin Knobloch**, ein Wissenschaftler, Kollege und Freund – ein persönlicher Nachruf - von einem alten Freund
Part 1	**2005**	WOROBIEC, G. & KASIŃSKI boreholes from "Ruja" lignite deposit near Legnica, Lower Silesia, Poland (preliminary results) LESIAK, M.: New Fossil Finds and Interesting Plant Species for the Miocene of Lipnica Wielka , Southern Poland (Nowy Targ-Orawa Basin)
Teil 2	**2005**	L. RÜFFLE, L.: Reste von Annonaceen-Blüten in der Oberkreide von Jebel Mudaha, Sudan RÜFFLE, L. & KRUTZSCH, W.: Bestimmbare Blattreste aus dem mitteldeutschen Maastricht (Oberkreide) und ihr Bezug zum Alttertiär Nordamerikas
Teil 3	**2005**	HANTKE, R.,OBERLI, U. & GREGOR, H.-J.: Die mittelmiozäne Megaflora von Risi/Wattwil (Kanton St. Gallen, Schweiz) – Geologie, (Klima-)Stratigraphie und Paläoökologie
Teil 4	**2005**	SCHNEIDER, W.: *Piliparicutis hradekensis* (KVAČEK & BŮŽEK 1966) SCHNEIDER & GRÖSCHKE 2003 (Lauraceae, Ocotea Aubl. 1775) in miozänen Taphocoenosen der Lausitz (Ostdeutschland)
Part 5	**2005**	KONZALOVÁ, M.: Upper Miocene (Pannonian, Pontian) palynomorphs from the South Moravian extention of the Vienna basin (Czech republic)
Teil 6	**2006**	H.-J. GREGOR: *Tetraclinis* MAST. – der Araarbaum als Modell für die Problematik paläoökologisch-paläoklimatischer Rekonstruktionen
Teil 7	**2006**	FISCHER, T. C. & BUTZMANN, R.: The Infructescence of *Paulownia inopinata* BUTZMANN & FISCHER – Emendation of the Species Definition GREGOR, H.-J.: Eine neue Art des Granatapfels, *Punica kuhnii* nov. spec., aus der Oberen Süsswassermolasse von Unterwohlbach bei Hohenkammer (Freising/Bayern) GREGOR, H.-J.: *Campsis seehuberi* nov. spec. – Erstnachweis einer fossilen "Trompetenblumen"-Frucht" in der Oberen Süßwassermolasse Bayerns (Unter-/Mittelmiozän von Burtenbach
Teil 8	**2006**	GREGOR, H.-J.: Erstnachweis von fossilen Motten-Schildläusen mit *Molassodina friedei* nov. gen. et spec. auf Pappeln (*Populus latior*) in Sedimenten der westlichen Oberen Süßwassermolasse bei Burtenbach (Bayern). GREGOR, H.-J.: Erstfund des Elsbeerbaumes, *Sorbus praetorminalis* KRYSHTOF. & BAIKOVSK. in der Oberen Süßwassermolasse von Aubenham bei Oberbergkirchen (Kreis Mühldorf)
Teil 9	**2007**	GREGOR, H.-J.: Die Problematik paläoökologisch-paläoklimatischer Rekonstruktionen anhand geologisch-paläontologischer Beispiele
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