

SUPPLEMENTARY MATERIAL TO:

Kowalski, R., Tietz, O., Worobiec, E. & Worobiec, G., 2024. New floras from the Tetta Clay Pit, Upper Lusatia, late Oligocene–Early Miocene, Germany. *Annales Societatis Geologorum Poloniae*, 94: 19–59.

SYSTEMATIC PALAEOBOTANY

Family Pinaceae Sprengel ex F. Rudolphi, 1830

Genus *Pseudolarix* Gordon, 1858

Pseudolarix schmidtgenii Kräusel, 1938

Fig. 5A–I

1938 *Pseudolarix schmidtgenii* sp. nov. – Kräusel, p. 26, pl. 3, fig. 7.

2001 *Pseudolarix schmidtgenii* (Kräusel) – Czaja, p. 29, pl. 2, figs 3, 4.

Material: Tet.k 1205, 1237–24 specimens; Tetta IV/1–31 specimens (MZ VII/134/1, 2, 10); Tetta IV/2–102 specimens (MZ VII/134/3, 15, 151); Tetta IV/3–57 specimens (MZ VII/134/4, 150); Tetta VI/6–1 scale (MZ VII/134/5).

Description: See Mai (1997).

Remarks: The bract-scale complex and seeds from Tetta do not appear significantly different from *Pseudolarix amabilis* Rehder (1919). According to LePage and Basinger (1995), this fact would justify assigning the fossils of the present authors to this extant species. Nonetheless, without knowing the needle structure, it is probably safer to assign these organs to fossil *P. schmidtgenii* (see Mai, 1997).

Distribution: Central Europe, from the upper Oligocene to Pliocene (Mai, 1997).

Genus *Tsuga* (Endlicher) Carrière, 1855

Tsuga moenana Kirchheimer, 1935a

Fig. 5M

*1935a *Tsuga moenana* sp. nov. – Kirchheimer, p. 433, pl. 5, figs 1–4.

2005 *Tsuga moenana* (Kirchheimer) – Kunzmann and Mai, pp. 99–106, text–fig. 9, pl. 11, figs 2–10.

Material: Tetta IV/1–2 cones (MZ VII/134/6).

Description: First seed cone ovoid, 3.3 cm long and 1.6 cm wide, consists of ca. 23 cone scale complexes; ovuliferous scales (in the lower part of the cone) ca. 1 cm wide, thin, with curved apical margins; bracts fan-shaped, with undulate (slightly denticulate? or jagged?) apical margins (mostly incomplete). Second cone apically broken, abraded, 2.1 cm long and 1.5 cm wide, with 3 mm long peduncle.

Remarks: The first seed cone is better preserved, but is abraded along $\frac{2}{3}$ of its length, so that only its basal part is complete. With respect to their shape, size, and other bract

characteristics, the cones most closely resemble those of fossil *Tsuga moenana*. This rare species has been reported so far from two German sites in the Pliocene of Groß-Steinheim and the Lower Miocene of Wiesa (Kirchheimer, 1935a; Kunzmann and Mai, 2005).

Among the coniferous remains found, Tetta *Tsuga* is represented by both seed cones and needles.

According to LePage (2003), bract and ovuliferous scale morphology are useful in distinguishing between the *Tsuga* species. Kunzmann and Mai (2005) suggested that living specimens, comparable to *Tsuga moenana*, are to be found in Southeast Asia: *T. chinensis* (Franch.) E. Pritzel in Diels (1900), *T. dumosa* Eichler (1889), and *T. forrestii* Downie (1923).

Tsuga sp.

Fig. 21C, F, G

1976 *Tsuga* sp. – Knobloch and Kvaček, pp. 13–14, text–fig. 3, pl. 2, figs 6–9, pl. 12, fig. 21, pl. 151, fig. 12.

Material: Tetta IV/1–2 needles (MZ VII/134/314, 316); Tetta IV/3–4 needles (MZ VII/134/317–319, 329).

Description: Macromorphology. Needle fragments up to 3.5 cm long and up to 1.5 mm wide. Needle base obtuse. Needles entire-margined. Inside needles visible remains of one vascular bundle.

Micromorphology: Epidermal cells rectangular, rather elongate, cell walls with characteristic pits/perforations. Stomatal bands composed of single row of stomata. Longer axes of stomata parallel to midvein. Stomata cyclocytic, elliptic, outer stomatal ledge aperture narrow elliptic or spindle-shaped. Polar T-shaped cuticular thickenings visible but in many cases indistinct.

Remarks: Needles from Tetta with respect to their shape and micromorphology of epidermis are much the same as *Tsuga* sp. from the Miocene plant assemblage at Wackersdorf (Germany), locality Oder 2a (Knobloch and Kvaček, 1976). Especially characteristic are pits observed in cell walls of epidermis of needles, both from Tetta (Fig. 21C, F, G) and Wackersdorf. These pits could be observed in two modern representatives of Hemlock from North America: *T. canadensis* Carrière, 1855 and *T. caroliniana* Engelman, 1881. Both modern species prefer humid habitats,

T. canadensis prefer moist to very moist localities (benches, flats, and swamp borders) with good drainage (Burns and Honkala, 1990) while *T. caroliniana* could be found along exposed ridges in the southern Appalachian Mountains, also it could occur streamside along ravines in moist, cool settings (Austin *et al.*, 2016). Similarly, fossil *Tsuga* sp. at Tetta most probably preferred humid, riparian to swamp localities.

Genus *Pinus* Linnaeus, 1753

Pinus palaeostrobis Ettingshausen, 1853

Fig. 7C

1853 *Pinites palaeostrobis* sp. nov. – Ettingshausen, p. 35, pl. 6, figs 22, 23.

1997 *Pinus palaeostrobis* (Ettingshausen) – Mai, p. 10, pl. 3, figs 23–25, pl. 4, figs 7, 8.

Material: Tetta IV/2–4 specimens (MZ VII/134/19).

Description: See Mai (1997).

Remarks: The present authors have assigned these dwarf shoots to *Pinus palaeostrobis*, on the basis of only on five needles in fascicles. Epidermal structure and resin ducts have not been examined. It has become widely accepted to assign such types of dwarf shoots to one/a single collective species, though according to Mai (1997), they most likely represents more than one just species of the former *Strobis* and *Cembra* Sections.

Distribution: Central Europe, from the upper Eocene to Pliocene (Mai, 1997).

Family Cupressaceae Gray, 1821

Genus *Sequoia* Endlicher, 1847a

Sequoia abietina (Brongniart) Knobloch, 1964

Fig. 7A, B

Material: Tetta VI/1–43 specimens (MZ VII/134/20, 25); Tetta IV/2–94 specimens (MZ VII/134/21, 24, 28); Tetta IV/3–10 specimens (MZ VII/134/22); Tetta II/4–7 specimens (MZ VII/134/27); Tetta VI/6–9 specimens (MZ VII/134/23).

Description and remarks: See Kunzmann and Mai (2005).

Distribution: Europe, from the upper Eocene to Pliocene (Mai, 1997).

Genus *Tetraclinis* Masters, 1892

Tetraclinis salicornioides (Unger) Kvaček, 1986

Fig. 5J–L, N

Material: Tet.k 1241, 1253–62 specimens; Tetta VI/6–13 specimens (MZ VII/134/12, 13); IV/3–23 specimens (MZ VII/134/11); IV/2–11 specimens (MZ VII/134/9, 14, 15); IV/1–25 specimens (MZ VII/134/8, 10).

Description: See Kvaček *et al.* (2000).

Remarks: At Tetta, *Tetraclinis* is represented almost exclusively by isolated, cladode-like branch segments of *T. salicornioides*, while remains of seed cones (*T. brongniartii* (Endlicher) Kräusel, 1938) are scarce.

Two types of *Tetraclinis* foliage are known in the European Cenozoic, a “xeromorphic” type, represented by *Tetraclinis brachyodon* (Brongniart) Mai and Walther, 1985, and a “humid” type, represented by *T. salicornioides*.

Depending on the author, they can be seen as separate species (Kvaček *et al.*, 2000), or simply as ecotypes of a single species (Mai, 1994).

Distribution: Europe, from the lower Eocene to Upper Miocene (Mai, 1997).

Family Taxaceae Gray, 1821

Genus *Cephalotaxus* Siebold

and Zuccarini ex Endlicher, 1842

Cephalotaxus miocenica (Krausel) Gregor, 1979

Fig. 7D–H

1920 *Torreya miocenica* sp. nov. – Kräusel, pp. 342–345, pl. 17, figs 11–14, pl. 18, fig. 3, text-fig. 2.

1961 *Cephalotaxus ittate* Hooker foss. – Szafer, pp. 13–15, pl. 3, figs 7–10.

1979 *Cephalotaxus rhenena* sp. nov. – Gregor, pp. 4–5, pl. 1, figs 1a–f, 2a, b.

1979 *Cephalotaxus miocenica* (Krausel) Gregor – Gregor, pp. 2–4, pl. 1, figs 6, 7.

2001 *Cephalotaxus miocenica* (Krausel) Gregor – Czaja, p. 33, pl. 2, figs 5–7.

Material: Tet.k 1193, 1198, 1230–8 specimens; Tetta IV/1–8 seeds (MZ VII/134/16); Tetta IV/2–2 seeds (MZ VII/134/18); Tetta VI/6–1 seed (MZ VII/134/17).

Description: Seeds ovate, 1.3–1.5 cm long and 0.6–1 cm wide, rounded or acuminate at the base and acuminate at the apex, fusiform or ellipsoid in cross-section, suture between the two halves, frequently flattened and extended along almost the whole length of the seed. Surface of the seeds covered with black tubercles and striated, striae more or less parallel to the length of the seed. Testa 0.2–0.5 mm thick, composed of two layers.

Remarks: There is little data in the literature on *Cephalotaxus* seed morphology, but those available indicate that, with respect to dimensions and shape, seeds show considerable uniformity between species. In most species, the length of seeds generally varies from 1.2 mm to 2.8 mm. The one exception is *C. lanceolata* Feng ex Cheng, Fu and Cheng, 1975, which stands out from the others by exceeding 3.5 cm in length (Lang *et al.*, 2013). It seems that inter- and intra-specific variations of shape generally overlap (Szafer, 1961) and are not therefore very useful; they only help to distinguish between certain species (*C. oliveri* Masters, 1898; Fu *et al.*, 1999; Lang *et al.*, 2013). According to Szafer (1961), the position of the broadest part of the seed is the only reliable feature that helps to separate out these species, though this is an opinion based on no more than a couple of species.

The authors have found that in *C. fortunei* Hooker, 1850 and *C. harringtonii* Koch, 1873a the testa is ≥ 0.6 mm thick, whereas in *C. sinensis* (Rehder and E. H. Wilson) H. L. Li, 1953 and *C. sinensis* subsp. *wilsoniana* (Hayata) Silba, 2007, it was less than 0.3 mm thick. In this respect, the few measurements the authors made indicate that there can be some variability between species. However, without knowledge of the remaining species and their usefulness, these decisions will remain open to debate.

Three fossil-species of *Cephalotaxus* in the European Cenozoic have been described, using seed characteristics.

According to Gregor (1979), the major difference between *C. bowerbanki* Reid and Chandler (1933) from the Eocene of Sheppey and *C. miocenica* is the shape of seeds, while between *C. miocenica* and *C. rhenana* Gregor (1979) is the testa thickness (0.4–0.7 mm versus 0.2–0.4 mm respectively) and the contribution each of the two layers make to the over-all testa thickness.

Among the specimens from Tetta, the authors have observed both thick (*C. miocenica* type) and thin-walled (*C. rhenana* type) specimens. The observation of the authors correspond to those of Szafer (1961), who drew attention to the variability of the seed-wall thickness (0.3–0.65 mm) among the seeds from Stare Gliwice. Even though the seeds from Stare Gliwice combine features of *C. miocenica* and *C. rhenana*, Gregor (1979) assigned this material to *C. miocenica*.

Most specimens collected at Tetta represent the thin-walled, *C. rhenana* type, their external layer of radial cells being mostly of the same thickness as or sometimes even thicker than the internal layer of cells. This is at odds with the characteristics, provided by Gregor (1979) for *C. rhenana*, where the internal layer is thicker than the external. Czaja (2001) already raised the problem of distinguishing between these two species.

Despite the variability described above, the present authors considered it unlikely that the two *Cephalotaxus* species were present at the same time and in the same area; the authors therefore considered all seeds at Tetta to be *C. miocenica*. Moreover, it is the opinion of the authors that seed-wall thickness, and the proportion between the thickness of testa layers reflect more their state of preservation than species differences. The authors also consider the separate position of *C. bowerbanki* as questionable, since morphologically it is very close to *C. miocenica*. However, the authors refrain from resolving formally these questions until the type materials are examined and the diagnostic seed features recognized among living *Cephalotaxus* species.

Distribution: Central Europe, from the Lower to Middle Miocene (Mai, 1999b).

Family Magnoliaceae Jussieu, 1789

Genus *Magnolia* Linnaeus, 1753

Magnolia ludwigii Ettingshausen, 1868

Fig. 7E, I, J, N, O

Material: Tet.k 1203, 1234–6 specimens; Tetta III/11–8 seeds; Tetta I/8–1.

Description: See Kowalski (2017) and Mai (1975).

Remarks: The seeds documented here represent the longer-than-broad type of *Magnolia* seeds, which in European and Russian literature (Dorofeev, 1974; Mai, 1975) is represented by at least ten different species. If only specimens from the mid- and upper Cenozoic of Central Europe are considered, the most common representatives are *M. ludwigii* and *M. burseracea*. They are very close, sharing all key features, including a smooth surface, “moat and stalk” type of chalaza, raphal sinus and internal keel, and rounded nucellar end. According to Mai (1975), the seeds of *M. ludwigii* are bigger (on average 8.5 x 6.4 mm versus 6.9 x 6.1 mm for *M. burseracea*), longer than they are wide, and have slightly thicker (0.58 mm) sclerotesta than *M. burseracea* (0.42 mm

– Mai 1997). *M. boveyana* Chandler, 1957 is another, but rare species of the “longer-than-broad type”, known from the Oligocene to Lower Miocene (Mai, 1999a). In the opinion of the authors, it closely resembles *M. ludwigii*, from which it differs only in its smaller size (6–7 x 3–4.5mm) and slightly thinner sclerotesta (0.4 mm; Chandler, 1957; Mai, 1999a).

The authors analyzed the size ranges of *M. ludwigii* from Salzhäusen and *M. burseracea* from Sandförstgen that were provided by Mai (1975) and, contrary to Mai’s view, they think that these species are not so clearly separable (see also Schneider, 2007). This observation is confirmed in the Middle Miocene flora at Lubstów (Kowalski, 2017), where seeds combine the L/W ratio of *M. ludwigii* with sizes typical for *M. burseracea* or *M. boveyana*.

The observations that the authors have made on living and fossil seeds indicate that the thickness of sclerotesta may only have minor diagnostic value as it seems to be largely related to the size of the seed. It may also depend on the state of preservation. Developmental abnormalities may also arise in a thicker sclerotesta.

In the light of these comments, the authors believe that *M. ludwigii*, *M. boveyana*, and *M. burseracea* should not be separated as postulated by Kirchheimer (1957) and expressed in *M. sinuata*. Tiffney (1977) seems to be of a similar view, arguing that morphological closeness between *M. ludwigii* and *M. burseracea* may indicate an evolutionary relationship between these species, though may as well result from an overreaching interpretation.

Despite the skepticism of the authors, they provisionally separated seeds from Tetta into *M. ludwigii* and *M. burseracea*, because they were unable to formally resolve the relationship between these three species without examining the types and comparing all available features. Particularly important would be to compare cell patterns on the sclerotesta surface (Tiffney, 1977).

Distribution: Central Europe, from the Lower Miocene to Pliocene (Mai, 1999a).

Magnolia burseracea (Menzel) Mai, 1975

Fig. 7F, G

Material: Tetta IV/1–1 specimen; Tetta VI/6–1 specimen; Tetta III/11–6 specimens.

Description: See Kowalski (2017) and Mai (1975).

Remarks: The present authors also assigned here two seeds of the *M. subcircularis* Reid and Chandler (Reid and Chandler, 1933; Chandler, 1961) type which they found at Tetta. They conform to this species from the Eocene of London Clay in respect to size, L/W ratio, and sclerotesta thickness but are probably abnormally developed seeds of *M. burseracea*.

Distribution: Central Europe, from the upper Oligocene to Upper Miocene (Mai, 1999a).

Genus *Liriodendron* Linnaeus, 1753

Liriodendron geminata Kirchheimer, 1957

Fig. 7K–M

Material: Tetta IV/1–52 seeds (MZ VII/134/36, 37); Tetta IV/2–13 seeds (MZ VII/134/38); Tetta IV/3–9 seeds (MZ VII/134/39); Tetta VI/6–6 seeds (MZ VII/134/40).

Description: Seeds fusiform, elliptic, or oval, single or in pairs, frequently asymmetric, or slightly curved, 1.5–5 mm long and 1–2 mm wide. Surface covered with small warts aligned parallel to the length of the seed. Chalazal end with terminal pore, with slightly raised rim; nucellar end rounded or beaked.

Remarks: The seeds of *Liriodendron*, found in the Oligocene and Neogene of Central Europe, have usually been assigned to *L. geminata* Kirchheimer (1957), but according to Mai (1987, 1997), the seeds found in the upper Oligocene and Lower Miocene differ substantially from those found in younger sediments in terms of size and sculpture and can be separated as an *L. fragilis*. They are smaller (up to 4.5 mm long), have more delicate warts on the surface, and less frequently occur in pairs. Studying the Tetta seeds the authors have found that a many of them closely correspond to *L. fragilis*, especially with respect to size, but in the same samples some seeds reach up to 5 mm and are therefore closer to *L. geminata*. Comparing specimens from other sites (Ruszów, Turów) the authors have found that the size of warts increases proportionally to the size of the seed and that the length of the seeds varies within one population (between 3–5.5 mm). This observation strengthened the conviction of the authors that all seeds from Tetta must belong to a single *Liriodendron* species. Accordingly, the authors believe that distinguishing *L. fragilis* from *L. geminata* is unjustified.

Family Lauraceae Jussieu, 1789
Genus *Cinnamomum* Schaeffer, 1760
Cinnamomum costatum (Mai) Pinggen, Ferguson
and Collinson, 1994
Fig. 8A, B

Material: Tetta IV/2–1 endocarp (MZ VII/134/42); Tetta IV/1–2 endocarps (MZ VII/134/41).

Description: Endocarps elliptic, rounded at both ends, 8.5–9 mm long and 3–4.5 mm wide; Apical ridge inconspicuous, two lateral ridges on dorsal and ventral sides apparent. Endocarp's wall ca. 200 µm thick, composed of a single layer of radially oriented cells.

Remarks: The seeds documented here correspond to *Cinnamomum costatum*, as evidenced by shape, size, two lateral ridges, and endocarp structure (single, radially oriented sclereid layer). However, the authors assign their seeds to *C. costatum* with caution, because of a minor difference in endocarp wall thickness between the specimen of the authors and those described by Pinggen *et al.* (1994) which are respectively 200 µm versus 250–500 µm. Additionally, the specimens of the authors are compressed, the surface is rather poorly preserved, and the endocarp cells in surface view difficult to observe.

Distribution: Central Europe, from the Lower to Upper Miocene (Mai, 1999a).

Genus *Daphnogene* Unger, 1850
Daphnogene polymorpha (Al. Braun) Ettingshausen, 1851
Fig. 21B, D, E

1851 *Daphnogene polymorpha* (Al. Braun) Ettingshausen – Ettingshausen, p. 16, pl. 2, figs 23–25.

Material: Tetta IV/1.

Description: Fragments of entire-margined coriaceous leaves, leaf base attenuate. Venation pinnate. Secondary venation acrodromous. Primary vein branched above leaf base. The branches give rise to outer, loop-forming veins. Between primary vein and its two main branches run more or less percurrent tertiary veins. Higher-order venation reticulate. Areoles well developed. Veinlets sometimes present, simple. Marginal ultimate venation forms a fimbrial vein. Leaves hypostomatic. Adaxial epidermis composed of polygonal, isodiametric, or slightly elongate cells with straight to undulate and irregularly thickened cell walls. Abaxial epidermis composed of variable-shaped cells, with pitted cell walls. Stomata mostly brachyparacytic, irregularly wide elliptic. Outer stomatal ledge aperture irregularly elliptic. Trichome bases present, trichomes not preserved. In leaf mesophyll, scattered, roundish idioblast secretory cells sometimes preserved.

Remarks: The characteristic venation of the leaf remains allowed their identification as *Daphnogene polymorpha* (Al. Braun) Ettingshausen, artificial fossil morpho-genus given to fossil leaves with acrodromous venation of the Lauraceae family. Leder (2007) earlier reported from Tetta leaves of *Daphnogene* as *Daphnogene cf. billinica* (Ung.) Knobloch, 1969. *Daphnogene polymorpha* (Al. Braun) Ettingshausen usually shows great morphological and anatomical variability of leaves and according to Kvaček and Walther (1978), it results from the influence of various habitat conditions (sun or shade localities, soil humidity) influencing leaf morphology. According to Kvaček (1971), the fossil leaves of *Daphnogene* may have belonged to different genera of the Lauraceae family, with leaf morphology similar to the fossil *Daphnogene*, i.e., *Cryptocarya* R. Brown, 1810, *Litsea* Lamarck, 1792, *Lindera* Thunberg, 1783, and *Neolitsea* (Benth.) Merrill, 1906. In central Europe, *Daphnogene* is frequently found in Paleogene and Miocene floras.

Family Araceae Jussieu, 1789
Genus *Urospathites* Gregor and Bogner, 1984
Urospathites visimensis (Dorofeev) Gregor and Bogner,
1989
Fig. 8G

1970 *Epipremnum visimense* sp. nov. – Dorofeev, pp. 35–36, pl. 5, figs 1–3.

1989 *Urospathites visimensis* gen. nov. – Gregor and Bogner, p. 19, fig. 3.

1997 *Epipremnites ornatus* (Reid and Chandler) Gregor and Bogner – Mai, p. 88, pl. 13, figs 12–14.

Material: Tetta I/8–1 seed (MZ VII/134/43).

Description: Seed hook-like, flat, 1.8 mm long and 1.2 mm wide, with unevenly indented keel along the dorsal side, small knobs grouped in a row parallel to the dorsal keel; surface irregularly pitted. Micropylar end with a broad, funnel-shaped aperture. Hilum within depression on ventral side of the seed.

Remarks: This seed certainly can be included with the *Urospathites*, which also includes several morphologically related species. Taking into account the relatively poorly

developed keel and small size, the seed of the present authors most closely corresponds to *Urospathites visimensis* from the Oligocene of Novy Log, Siberia (Dorofeev, 1970, 1988; Gregor and Bogner, 1989). Despite certain differences, it seems that *Urospathites visimensis* and *U. dalgasii* (Hartz) Gregor and Bogner may represent two morphological variants of a single species. In the opinion of the present authors, size variability in *Urospathites* was probably high, like that in *Epipremnites reniculus* (Ludwig) Mai, 1989 (observation of the first author).

Family Hydrocharitaceae Jussieu, 1789

Genus *Vallisneria* Linnaeus, 1753

Vallisneria vittata Mai in Mai and Walther, 1991

Fig. 8C

1991 *Vallisneria vittata* sp. nov. – Mai in Mai and Walther, p. 129, pl. 16, figs 8–10.

Material: Tetta IV/2–1 seed (MZ VII/134/297).

Description: Seed elongated-elliptic, slightly curved, flat, 1.7 mm long and 0.5 mm wide, base rounded, with short (0.07 mm), thick (0.1 mm) collar, apex rounded with the minute micropylar beak. Seed coat translucent, opaque only around the base; seed surface longitudinally wrinkled.

Remarks: Considering size, shape, structures visible on both ends of the seed, and characteristics of the surface, this seed corresponds to *Vallisneria vittata*. Testa collar at the base is much shorter than those described for this species, but the present authors think that this delicate structure may have been broken either during taphonomic processes or during extraction. This species was reported only once from the Lower Miocene (III floristic zone) of Rōsa-Sausedlitz (Mai and Walther, 1991).

Family Typhaceae Jussieu, 1789

Genus *Sparganium* Linnaeus, 1753

Sparganium aff. *pusilloides* Mai in Mai and Walther, 1978

Fig. 8E

1978 *Sparganium pusilloides* sp. nov. – Mai in Mai and Walther, pp. 149–150, pl. 48, figs 19–26.

Material: Tet.k 1223–2 endocarp; Tetta II/5–42 endocarps (MZ VII/134/47).

Description: Endocarps fusiform or narrowly ovate, 0.9–2 mm long and 0.5–0.8 mm wide, broadest in the sub-apical part, with a short neck at the apex, gradually narrows to a basal stalk. Surface rough, vascular bundles poorly visible. Endocarp wall thin.

Remarks: Considering the shape and poorly visible vasculature, the endocarps from Tetta most closely resemble *Sparganium pusilloides*, while with respect to size the closest is *S. nanum* Dorofeev, 1979. The first mentioned species has been recorded from the middle Oligocene to Middle Miocene of Central Europe, and the second is known from the Lower Miocene to Pliocene (Mai and Walther, 1978; Mai, 1999b, 2008).

Family Cyperaceae Jussieu, 1789

Genus *Dulichium* Persoon, 1805

Dulichium hartzianum Mai in Mai and Walther, 1978

Fig. 8H

Material: Tetta IV/2–3 achenes (MZ VII/134/48, 49).

Description: Achenes elongate-elliptic, planoconvex, 1.8 mm long and 0.8 mm wide, with well-articulated edges. Gradually taper into the short style base. General shape of lower half of the achene rounded, abruptly contracted into a very short basal stipe with remains of three delicate, thin bristles, the longest preserved as long as fruit. Achene surface with fine, isodiametric, polygonal cells, ca. 18 μm in diameter, with concave outer periclinal walls and very thick anticlinal walls.

Remarks: These achenes most closely resemble *Dulichium hartzianum*, as they share size, an elongated shape, and short basal stipe (see Mai, 1997). The assignment by the present authors does not consider surface micromorphology, as it has not been documented in this species.

Dulichium hartzianum is the oldest representative of this genus, which has been reported in Central Europe from the upper Eocene to Middle Miocene. According to Mai and Walther (1991), smaller and broader achenes of *Dulichium hartzianum* gradually give way to longer and broader *Dulichium marginatum* (C. and E. M. Reid) Dorofeev, 1959, which begin to appear in the upper Oligocene (Mai and Walther, 1978). In the Middle Miocene, *Dulichium vespiforme* C. Reid and E. M. Reid, 1908 begins to enter the fossil record and along with *Dulichium marginatum* they are both present until the end of the Pliocene (Mai, 2000b).

Truchanowiczówna (1973), on the basis of her own work, suggested an evolutionary trend to gradual elongation and narrowing of the fruit in *Dulichium*, but this does not seem to be reflected in the morphological changes, observed between successive *D. hartzianum*, *D. marginatum*, and *D. vespiforme*.

It is worth mentioning that *Dulichium marginatum* was documented at Tetta by Leder (2009) and occurs also among unpublished materials, found by Alexander Czaja in the uppermost part of the profile, exposed in Tetta in 1999 (Tet.k 1311).

Genus *Cyperus* Linnaeus, 1753

Cyperus aff. *leptodermis* Mai, 1997

Fig. 8D

Material: Tet.k 1296–3 achene; Tetta II/5–1 achene (MZ VII/134/50).

Description: Achenes narrowly obovate, trigonous, equilateral, 0.65 mm long and 0.4 mm wide. Surface without a cellular pattern, tuberculate.

Remarks: Considering the very small size of this achene, an affinity to *Cyperus* is very probable. Among fossil representatives of this genus, the only one comparable in size is *Cyperus leptodermis*. This species has been reported at a few sites in the Lusatia region from the upper Oligocene to the Middle Miocene (Mai, 1999b; Czaja, 2003). Unfortunately, surface micromorphology has not been documented for *Cyperus leptodermis* (Mai, 1997) and therefore, it is not

possible to make comparisons. Until surface micromorphology in type material is documented, the assignment of the Tetta specimen by the present authors to *Cyperus leptodermis* will remain provisional.

Genus *Carex* Linnaeus, 1753

Carex plicata Łańcucka-Środoniowa, 1979

Fig. 9A

Material: Tetta II/5–2 achenes (MZ VII/134/51, 52).

Description: Achenes elliptical and trigonous; the more complete specimen 1.2 mm long and 0.45 mm wide. Sidewalls of equal width, with sharp margins. Epidermal cells large, 28–39 µm in diameter, polygonal, with concave outer periclinal walls and relatively thin, much-elevated anticlinal walls. Apex broken in both specimens. Base with short stipe and indistinct callus.

Remarks: Lack of a utricle makes the assigning of this fruit to *Carex* less certain. However, according to Jiménez-Mejías and Martinetto (2013) and Jiménez-Mejías *et al.* (2016), a smooth surface and large, polygonal epidermal cells confirm an affinity to *Carex*. Among the fossil representatives of *Carex*, *C. plicata* seems to be the closest to the material of the present authors with respect to general morphology, size, and surface micromorphology. This species has been documented in a few Lower Miocene sites in Germany and Poland (Łańcucka-Środoniowa, 1979; Mai, 1999b).

According to (Jiménez-Mejías *et al.*, 2016), distinguishing between *C. plicata* and *C. limosioides* Negru, 1986 is problematic, while *C. plicata* itself needs verifying, as the typical specimens selected by Łańcucka-Środoniowa (1979) are highly variable morphologically. It is worth noting that specimens from Oberleichtersbach, assigned by Mai (2008) to *Carex plicata*, more closely resemble *Carex pseudocyperoides* Łańcucka-Środoniowa, 1979.

Genus *Scirpus* Linnaeus, 1753

Scirpus brevicornis Mai, 2000b

Fig. 9B

Material: Tetta II/5–1 achene (MZ VII/134/56).

Description: Achene elliptical, 1.05 mm long and 0.45 mm wide, length to width ratio 2.3, distinctly trigonous only in the lower part, upper part plano-convex with longitudinal rib in the middle. One side wider than the others, margins in the lower part sharp, with translucent extensions. Style broken. Stipe not expressed, achene gradually narrows into a relatively wide base with short, fine, and smooth bristles, callus not apparent. Surface smooth, epidermal cells relatively small, ca. 20 µm in diameter, rectangular to slightly elongated, arranged in rows, parallel to the achene length, outer periclinal walls concave.

Remarks: Considering fossil Cyperaceae documented in the Cenozoic sediments of Central Europe, the specimen of the present authors can be compared only with *Scirpus brevicornis* and *Scirpus nymphaeus* Mai, 1999a, but the first-mentioned is closer regarding the ratio of length to width. The authors relate their specimen to *Scirpus brevicornis* without knowing this species' micromorphology, which has not been documented. *Scirpus brevicornis* has been reported

so far only in a few Middle and Upper Miocene floras of the Lusatia region (Mai, 2000b).

The generic affinity of this fossil-species is unclear, because morphologically comparable fruits can be also found in *Eriophorum* Linnaeus, 1753 and *Trichophorum* Persoon, 1805.

Family Lardizabalaceae R. Brown, 1821

Genus *Decaisnea* Hooker fil. and Thomson, 1855

Decaisnea bornensis Mai in Mai and Walther, 1991

Fig. 9C

Material: Tetta IV/2–2 seed (MZ VII/134/57).

Description: Seed elliptical, skewed, 5.9 mm long and 4 mm wide, flat, rounded at the base with partially broken apex, hilar bugle at the margin close to the seed base, slightly elevated. Surface rough, mostly abraded, with tubercles and longitudinal stripes around hilar bulge. Testa wall ca. 0.1 mm thick, strongly coalified, glossy, and black, highly sclerified cells preserved in some parts.

Remarks: Shape of the seed, location of the hilum, surface ornamentation and testa thickness correspond to the characteristics of *Decaisnea bornensis* from the upper Oligocene of Borna-Ost (Mai and Walther, 1991). However, the specimen of the present authors is slightly smaller than the seeds from Borna-Ost, and instead of two layers, the seed wall in their specimen consists of only one layer of highly sclerified, perpendicular cells. However, surface irregularities indicate that the external sclereid cell layer could have disappeared through abrasion.

Family Sabiaceae Blume, 1851

Genus *Meliosma* Blume, 1823

Meliosma miesslereri Mai, 1964

Fig. 9I

Material: Tetta IV/1–3 specimens (MZ VII/134/59); Tetta IV/2–5 specimens (MZ VII/134/60); Tetta VI/6–3 specimens (MZ VII/134/61); Tetta I/8–2 specimens (MZ VII/134/62); Tetta VII/12–1 specimen (MZ VII/134/114).

Description: Endocarps subglobose to ellipsoid, 3–4 mm high and 3–3.9 mm long, 2–2.2 mm wide, with median, low keel; lateral surface smooth, with few delicate ribs; ventral side with a narrow and shallow depression filled with a small, elliptic, elevated plug.

Remarks: With respect to size, the presence of ribs on the sides, the shape of the ventral side, and the shape of the plug, these endocarps undoubtedly represent *Meliosma miesslereri*. So far it has been documented from the Oligocene to the Lower Miocene of Germany and Czech Republic (Bůžek *et al.*, 1976; Mai and Walther, 1991; Mai, 2000a). According to van Beusekom (1971), endocarps of this fossil-species correspond with modern representatives of sect. *Meliosma*, distributed in SE Asia.

Meliosma pliocaenica (Szafer) Gregor, 1978a

Fig. 9D, E

Material: Tetta IV/1–1 specimen (MZ VII/134/63); Tetta VI/6–2 specimens (MZ VII/134/64); Tetta I/8–1 specimen

(MZ VII/134/117); Tetta III/11–1 specimen (MZ VII/134/65); Tetta VII/12–1 specimen (MZ VII/134/113).

Description: Endocarps circular, flattened, ca. 4 mm in diameter, median keel absent; lateral surface smooth. Preservation variants (depend on the direction of deformation): 1st – laterally compressed endocarp with elongated, and slightly elevated plug tightly inserted between two lobes of the endocarp, 2nd – vertically compressed endocarp, plug within depression on both sides of the endocarp.

Remarks: These endocarps differ from the above-described species with respect to size, smooth surface, elongated plug, and correspond to *Meliosma pliocaenica*. There have been suggestions (Czaja and Berner, 1999; Mai, 2000a) that *Meliosma pliocaenica* and *M. wetteraviensis* (Ludwig) Mai, 1973 may represent a single, morphologically variable species (see also Martinetto, 2001). However, van Beusekom (1971), who extensively investigated the problem, believes each of them correspond to different living species, i.e., consecutively with *Meliosma alba* (Schlechtend.) Walpers, 1843 and *Meliosma veitchiorum* Hemsley, 1906. Endocarps of *M. pliocaenica* and the corresponding *M. alba* are smaller but have an endocarp wall thicker than in *M. wetteraviensis* and *M. veitchiorum* (Gregor, 1978a), also ventral depression is respectively narrow and shallow in the first group and more distinct and wider in the second group. The authors have therefore followed the opinion of van Beusekom (1971; see also Gregor, 1978a).

Distribution: Central Europe, from the Lower Miocene to Pliocene (Meller, 1998).

Family Platanaceae Lestiboudois, 1826

Genus *Platanus* Linnaeus, 1753

Platanus neptuni (Ett.) Bůžek, Holý and Kvaček, 1967

Fig. 9F–H

Material: Tetta IV/1–4 staminate inflorescences (MZ VII/134/66, 67); Tetta IV/2–1 staminate inflorescence; Tetta IV/3–2 staminate inflorescences (MZ VII/134/68); Tetta VI/6–1 receptacular core (MZ VII/134/71).

Description: Flattened staminate inflorescences up to 10.5 mm in diameter formed of densely crowded, long stamens, represented mostly by thin straps of filaments, less frequently with slightly domed or peltate connectives, anthers pale brown preserved only in one specimen; receptacle not seen. Peduncle ca. 3 mm thick with annular rim.

Strongly abraded receptacular core, 6 mm in diameter, with scars.

Remarks: Considering the prominent thickening on the peduncle, the present authors can safely assign these inflorescences to *Platanus neptuni*. However, the connectives do not seem to be apiculate, as suggested for *Platanus neptuni* (Bůžek *et al.*, 1967; Kvaček and Manchester, 2004; Manchester and Kvaček, 2010), and more closely resemble those in living *Platanus x hispanica* Münchhausen, 1770 (see von Balthazar and Schönenberger, 2009).

Distribution: Europe, from the middle Eocene to Middle Miocene (Mai, 1997).

Family Altingiaceae Horaninov, 1841

Genus *Liquidambar* Linnaeus, 1753

Liquidambar europaea A. Braun, 1847

Figs 9J, 10A

Material: Tetta I/8–6 infructescence (MZ VII/134/69); Tetta III/11–3 infructescence (MZ VII/134/70).

Description: See Mai (1997).

Remarks: Shape, size, and typical honeycomb-like appearance of peripheral rims of these infructescences relate them to *Liquidambar*. At least three fossil-species have been described from the European Cenozoic on the basis of the size of infructescence and number of fruits per infructescence, including *L. europaea*, *L. pliocaenica* Geyler and Kinkelin, 1887 and *L. magniloculata* Czeczott and Skirgiełło, 1959. According to Mai (1997), *L. pliocaenica* and *L. magniloculata* can be used as synonyms for *L. europaea*, which has nomenclatural priority. The authors agree with this opinion. It has been suggested that smooth peripheral rims closely relate (Reid and Reid, 1915; Czeczott and Skirgiełło, 1959; Mai, 1997) or even equate (Łańcucka-Środniowa, 1966) *L. europaea* to living *L. orientalis* Miller, 1768.

Distribution: Europe, from the middle Oligocene to Upper Pliocene (Mai, 1997).

Family Hamamelidaceae Brown, 1818

Genus *Distylium* Siebold and Zuccarini, 1841

Distylium uralense Kolesnikova, 1961

Fig. 10D

Material: Tetta III/11–3 seeds (MZ VII/134/72).

Description: Seeds long elliptical in outline, 6.8–7.3 mm long and 3.8–4 mm wide, dorsoventrally compressed, apex rounded or narrowed, hilar end more or less obliquely truncate. Hilar scar of similar shape and size on both sides of seed, relatively narrow, reaching nearly 1/2 of the seed length. Seed coat black, more or less shiny.

Remarks: Size of the seeds and relatively narrow to pointed, obliquely truncate hilar end relate these seeds to *Distylium uralense* (Mai, 1999a).

Fruit remains found along with seeds appear to be lacking a floral cup. If they could be connected with seeds described above, this would indicate that they truly represent a *Distylium* (Endress, 1993).

Distribution: Central Europe, only in the Lower Miocene floras of the Wiesa-Eichelskopf floristic complex (Mai, 1999a) and the Middle Miocene, Kleinleipisch-Františkove Lazne floristic complex (Czaja, 2003).

Distylium protogaeum Mai in Mai and Walther, 1991

Fig. 10B, C

Material: Tetta IV/1–11 seeds (MZ VII/134/73); Tetta IV/2–1 seed (MZ VII/134/74); Tetta I/8–2 seeds (MZ VII/134/76); Tetta IV/1–2 seeds (MZ VII/134/77); Tetta III/11–9 seeds (MZ VII/134/78).

Description: Seeds drop-shaped, 4.5–6.5 mm long and 2.5–4 mm wide, dorsoventrally compressed, or semi-circular in cross-section; apex rounded, hilum end mostly pointed, micropylar tip long and straight. Hilum scar of similar size and

shape on both sides of seed, ca. 1/3 of the seed length. Seed coat black, more or less shiny.

Remarks: With respect to size and pointed base, these seeds closely resemble *Distylium protogaeum*, which, according to Mai (Mai and Walther 1991), differs from fossil *D. uralense*, in terms of size and the thickness of testa (Gregor, 1980; Mai and Walther, 1991; Mai, 1997). Seeds of *Distylium protogaeum* have been compared to living *D. myricoides* Hemsley, 1907 (Mai and Walther, 1991).

In the opinion of the authors, assigning seeds of this type to *Distylium* is open to discussion. According to Endress (1989) seed shape in Hamamelidaceae is strictly related to the ejection mechanism, which constricts variability of shape and significantly impedes distinguishing between taxa. On the other hand, despite relative unification, seeds in some Hamamelidoideae can be distinguishable, and even general morphology can be useful. An example of this is *Hamamelis*, which has generally large, elongated-fusiform seeds, with horizontal hilum end with short hilum scars that are easily distinguished from those of other genera. On the other hand, teardrop-shaped seeds like those of *Distylium protogaeum* occur in living *Distylium*, *Sycopsis* (*S. sinensis* Oliver, 1890) and occasionally in *Fothergilla gardenii* Linnaeus, 1774 (first author observation), but what can be problematic is that it is not consistent for all *Distylium* species, as in *D. racemosum* Siebold and Zuccarini, 1841 and *D. buxifolium* (Hance) Merrill, 1937, fusiform and narrowly ellipsoid seeds also occur and seem to be much more common than teardrop-shaped.

Distribution: Central Europe, from the upper Oligocene to the Lower Miocene (Mai, 1997).

Genus *Fortunearia* Rehder and Wilson, 1913

"*Fortunearia*" *altenburgensis* Mai in Mai and Walther, 1978

Fig. 10F

Material: Tetra IV/1–3 seeds (MZ VII/134/79); Tetra IV/2–3 seeds (MZ VII/134/80).

Description: Seeds elliptic, 4.5–5.5 mm long and 2.2–2.9 mm wide, dorsoventrally compressed; apex rounded to narrowed-round, hilum end obliquely truncated. Hilum scar relatively broad, more or less of similar size and shape on both sides of the seed, ca. 1/3 of the seed length. Micropylar tip pointed, slightly curved. Seed coat black, more or less shiny.

Remarks: These seeds correspond to *Fortunearia altenburgensis* (Mai and Walther, 1978, 1991), but this assignment is based only on size and morphology. Another issue is whether seeds of this fossil-species can be safely assigned to *Fortunearia*; because firstly, seeds of *F. altenburgensis* are much smaller than those of the living *F. sinensis* Rehder and Wilson, 1913 (Zhang *et al.*, 2003), and secondly, in living *Fortunearia* raphe occurs on both sides of the seed (Manchester, 1994), while the course of raphe is unknown in *F. altenburgensis* (Mai and Walther, 1978, 1991; Mai, 1998). In their seeds, the authors were unable to trace the raphe channel.

Distribution: Central Europe, from the middle Oligocene to the Lower Miocene (Mai and Walther, 1991).

Genus *Fothergilla* Linnaeus, 1774

Fothergilla europaea Szafer, 1947

Fig. 10E

Material: Tetra III/11–6 seeds (MZ VII/134/307).

Description: Halves of two different specimens, elliptic, 5–6 mm long, and 2.9–3.4 mm wide, apex rounded, hilar end obliquely truncated. Hilar scar broad, ca. 1/3 of the seed length. Micropylar tip curved. Seed coat dark brown, matte or more or less shiny. Raphe channel only on one side of the seed.

Remarks: With respect to size and general morphology, these seeds correspond to *Fothergilla europaea*. In comparison to above-described "*Fortunearia*" *altenburgensis*, they are wider, and their apex seems more rounded and the micropylar tip is curved.

Distribution: Central Europe, from the Middle Miocene (Kowalski, 2017).

Family Cercidiphyllaceae Engler, 1907

Genus *Cercidiphyllum* Siebold and Zuccarini, 1846

Cercidiphyllum helveticum (Heer) Jähnichen, Mai and Walther, 1980

Fig. 10G–J

Material: Tetra IV/3–10 fruits (MZ VII/134/83); Tetra IV/2–20 fruits (MZ VII/134/82); Tetra IV/1–6 fruits (MZ VII/134/81).

Description: For detailed description, see Jähnichen *et al.* (1980).

Remarks: These remains without a doubt represent foli- cles of *Cercidiphyllum helveticum*. This species is relatively common in the fossil record from Oligocene to Pliocene, but mostly in Central Europe (Mai and Walther, 1988; Meller, 1998; Mai, 2001a; Gümbel and Mai, 2002). *Cercidiphyllum helveticum* has been compared with living *C. japonicum* Siebold and Zuccarini, 1846 (Jähnichen *et al.*, 1980).

Family Vitaceae Jussieu, 1789

Genus *Ampelopsis* Michaux, 1803

Ampelopsis rotundata Chandler, 1925

Fig. 10L, M

Material: Tetra IV/1–1 seed; Tetra II/4–2 seeds.

Description: Seeds narrow, triangular, 2.5 mm long and 1.5 mm wide, and 1.3 mm thick in transverse section. Apical notch barely visible. Gradually tapers into a long and narrow beak at the base. Ventral infolds deep, extending from the base, relatively long, more or less parallel to the raphal ridge. Raphal ridge evenly broad, elevated above the ventral side. Chalaza in the upper part of the dorsal side, pyriform in shape, domed, below the surrounding area; remains of funiculus wrap around the apex and run along the raphal ridge.

Remarks: The pyriform shape of the chalaza and its closeness to the apex indicate that these seeds represent *Ampelopsis*. Among fossil-species of this genus, the closest is *Ampelopsis rotundata* (Chandler, 1925; Mai and Walther, 1978).

Distribution: Europe, from the upper Eocene to the Lower Pliocene (Mai, 2001a).

Genus *Vitis* Linnaeus, 1753
Vitis parasilvestris Kirchheimer, 1940
 Fig. 10K, N

Material: Tetta I/8–2 seeds (MZ VII/134/90); Tetta III/11–12 seeds (MZ VII/134/91); Tetta IV/3–3 (MZ VII/134/88); Tetta IV/2–5 (MZ VII/134/87); Tetta IV/1–7 seeds (MZ VII/134/986); Tetta VI/6–14 seeds (MZ VII/134/89).

Description: Seeds elliptic, 4.8–5.2 mm long (including beak) and 3.3–3.7 mm wide. Apical notch present, shallow, and narrow. Beak well-articulated, short, robust, wide (generally ≥ 0.8 mm), extended at the end, and knobbed. Ventral infolds short, ca. a half of the seed length, tight, open, parallel to the raphal ridge, or slightly diverged. Raphal ridge relatively thick, evenly broad, or gradually tapering toward the seed apex, slightly elevated above the adjoining areas. Chalaza more or less circular, \geq one quarter of the seed width, slightly sunken, more or less in the center of the dorsal side. Seeds nearly smooth, with radial striae around chalaza. Ventral side more or less planar.

Remarks: The seeds described above with respect to general shape and size, relatively short ventral infolds, shape and position of the chalaza correspond to *Vitis parasilvestris* and *V. lusatica* Czechtz and Skirgiełło, 1959. The first mentioned was never formally described by Kirchheimer, therefore, the authors compared their materials with the specimen from Wilhelminensglück, near Klettwitz (see Kirchheimer, 1957, fig 95a), which was informally designated by Mai (Wähnert and Mai, 2000; Mai, 2001a) as lectotype. The authors also closely examined the type specimens of *V. lusatica* from Turów. Comparing both species, the authors found only small differences between them. The lectotype of *V. parasilvestris* seems to be slightly bigger and has a nearly smooth dorsal surface, while the holotype of *V. lusatica* seems slightly smaller and has delicate, but clear, radial folds (see also Mai, 2001a). Considering shape, size, the short and wide beak, and the radial striae (instead of folds), seeds from Tetta correspond to *V. parasilvestris*.

According to Mai (2001a), *V. lusatica* and *V. parasilvestris*, along with *V. tomskiana* Dorofeev, 1963 from the Oligocene and Miocene of Siberia represent a closely related group of species, with a smooth transition between them. In the opinion of the authors, *V. eolabrusca* Tiffney and Barghoorn, 1976 from the Lower Miocene of the Brandon Lignite, USA, and *V. messelensis* Collinson, Manchester and Wilde (Collinson *et al.*, 2012) from the middle Eocene of Messel, Germany (especially SM.B Me 4025II, pl. 42, figs e, f), also can be included in this group.

Distribution: Central Europe, from the Lower Miocene floras of the Eichelskopf-Wiesa floristic complex (Holý *et al.*, 2012) to Pliocene (Mai, 2001a).

Vitis aff. *teutonica* A. Braun, 1854
 Fig. 10O, P

Material: Tetta IV/1–15 seeds (MZ VII/134/93); Tetta IV/2–4 seeds (MZ VII/134/94); Tetta IV/3–4 seeds (MZ VII/134/95); Tetta I/8–1 seed (MZ VII/134/96); Tetta III/11–4 seeds (MZ VII/134/97).

Description: Seeds elliptic, 3.8–4.8 mm long (including beak) and 2.6–3.1 mm wide. Apical notch present, variable in respect of depth and width. Base more or less rounded or triangular, beak more or less articulated, conical, or cylindrical at the lower part, relatively narrow (< 0.6 mm – measured at the junction with seed), long ($<$ one sixth of the seed length), lobed or knobbed at the end. Ventral infolds short, ca. 1/2 of the seed length, wide open, parallel to the raphal ridge, or slightly diverged. Raphal ridge relatively thin, evenly broad, or gradually tapering toward the seed apex, only slightly elevated above the adjoining areas. Chalaza more or less circular to elliptical, mostly $<$ one quarter of the seed width, sunken, located more or less in the centre of the seed, in some specimens closer to the apex, distance between upper chalaza margin and upper seed margin < 1.3 mm, apical groove narrow. Seeds on the dorsal surface with indistinct radial undulations, ventral side more or less planar.

Remarks: In terms of morphology, the seeds described here combine the features of *Vitis parasilvestris*, *V. lusatica*, and *Vitis teutonica* as described by Mai (1997, 2000a). What differentiates the seeds of the present authors from *V. lusatica* is a less articulated, but much longer and narrower beak and the nearly smooth surface around the chalaza. The seeds of the authors and *Vitis parasilvestris* share a nearly smooth dorsal surface, but they are smaller, have a more delicate structure and a long and narrow beak. *Vitis teutonica* seem to be the closest to the seeds of the authors. The only feature that makes the Tetta seeds different is a constriction at the junction between the seed base and the beak.

A noticeable resemblance can be found also in *Vitis rostrata* from the Lower Miocene of Brandon Lignite (USA), described by Tiffney and Barghoorn (1976), and *Vitis stipitata* from the Oligocene of Heathfield, documented by Chandler (1957, pl. 15, figs 128, 129). The second mentioned one differs only with respect to the size of the chalaza.

Distribution: Europe, from the upper Oligocene to the Pliocene (Mai, 2001a).

Genus *Parthenocissus* Planchon, 1887
Parthenocissus britannica (Heer) Chandler, 1957
 Fig. 11A, B

Material: Tetta III/11–2 seeds (MZ VII/134/98); Tetta VI/6–1 seed (MZ VII/134/99).

Description: See Chandler (1957)

Remarks: Long and divergent ventral infolds and long, oval chalaza relate these seeds to *Parthenocissus* (see Chen and Manchester, 2007, 2011). Relatively large size (ca. 5 mm) and not depressed chalaza (Chandler, 1957; Mai and Walther, 1991) are characteristic of *P. britannica*.

Distribution: Europe, from the Oligocene to the Middle Miocene (Mai, 2001a).

Family Hypericaceae Jussieu, 1789
 Genus *Hypericum* Linnaeus, 1753
Hypericum septestum Nikitin ex Arbuzova, 2005a
 Fig. 11I

Material: Tetta II/5–1 seed (MZ VII/134/100).

Description: Seeds elliptic, straight, 0.7 mm long and 0.3 mm wide, with protruding mucro on both ends. Surface reticulate, epidermal cells isodiametric, relatively large 40–50 µm in diameter, tetra to heptagonal, more or less arranged in 9 rows (counting only one side) parallel to the length of the seed; anticlinal walls relatively thick, with a groove on a border between cells.

Remarks: The key for fossil *Hypericum* seeds, proposed by Mai (2001a), led the present authors to *Hypericum bornense* Mai in Mai and Walther (1978) but it was difficult to verify this assignment because this species was poorly described and illustrated and has been reported only once from the Oligocene of Borna-Ost.

The authors also compared their seeds with fossil-species, reported in Central Europe, without using the key and found that they are most closely related to *Hypericum septestum*. However, the characteristics of this species, available in the literature, are quite imprecise, confusing and do not fully agree with the designated types. On one hand, they are described as cylindrical or elongated (Mai, 1997; Arbuzova, 2005a); on the other, isotype and many illustrated specimens are rather short and elliptical to only slightly cylindrical (Mai, 2000a; Arbuzova, 2005a). The authors must note also that judging from the illustration provided by Arbuzova (2005a), there is a slight discrepancy in shape between the holotype, designated by Nikitin (1965), and the isotype. The first is cylindrical (pl. 110, fig. 1) and the second (pl. 110, fig. 2) is elliptical, but both the type and isotype are twice as long as they are wide, unlike other specimens, assigned to this species, which are longer. In respect of shape and length/wide-ratio, the seed of the present authors matches the isotype of *Hypericum septestum* (Arbuzova, 2005a, pl. 110, fig. 2), while with regard to size, number of cell rows, shape, and size of epidermal cells, it corresponds to the specimen 60/1 (Arbuzova, 2005a, pl. 110, fig. 7 and pl. 111, fig. 1) from the Oligocene of Lagernyi Sad (see also diagnostic features in Mai, 1997).

The present authors doubt the results provided by the key, which in their opinion is affected by errors (see also Meseguer and Sanmartín, 2012). The authors decided to relate their materials to *Hypericum septestum*, since it was better defined.

Family Salicaceae Mirbel, 1815
Genus *Poliothyrsis* Oliver, 1889
Poliothyrsis eurorimosa Mai, 1980
Fig. 11J

Material: Tet.k 1314–1 specimen; Tetta IV/2–1 specimen (MZ VII/134/288); Tetta IV/3–2 specimens (MZ VII/134/289, 290).

Description: See Mai (1980).

Remarks: Shape, size, and the way the testa breaks into longitudinal stripes unequivocally relate these seeds to *Poliothyrsis eurorimosa*. In living *P. sinensis* Oliver, fully developed and preserved seeds are 5–10 mm long and are completely covered by arillus, which expand on both sides in form of a wing (Mai, 1980, 1997). Seeds of all described fossil-species, assigned to this genus, are much smaller and lacking wings. According to Mai (1980), arillus easily

comes off, therefore, it must have been abraded in all fossil seeds of this type. However, in the opinion of Manchester *et al.* (2009), without the presence of wings, it is difficult to prove the relationship of these fossil seeds to *Poliothyrsis*.

Distribution: Central Europe, from the upper Oligocene to the Middle Miocene (Mai, 2001a).

Family Rosaceae Jussieu, 1789
Genus *Prunus* Linnaeus, 1753
Prunus scharfii Gregor, 1978a
Fig. 11D

Material: Tetta IV/1–1 half of the drupe (MZ VII/134/102).

Description: Drupe elliptic, 13.5 mm long and 8 mm wide, with up to 1 mm thick wall, only ventral upper part 1.5 mm thick, without swelled ventral suture, apically and basally rounded, surface more or less smooth. Vascular bundle canal reaches the upper half of the locule.

Remarks: Despite poor preservation, this half of the drupe can be assigned to *Prunus scharfii* on the basis of its elongated shape, thin endocarp wall, and location of the end-point of the vascular bundle canal in the upper half of the locule (Gregor, 1978a; Mai, 1984a). This species has been documented so far from the middle Oligocene to the Middle Miocene of Germany (Gregor, 1978a; Mai, 1984a). The relationship with living representatives is not clear. Gregor (1978a) compared it to *Prunus napaulensis* (Ser.) Steudel, 1841 and *Prunus bracteopadus* Koehne, 1910 of subgenus *Padus*, while Mai (1984a) suggested a relationship with representatives of the subgenus *Cerasus*.

Prunus leporimontana Mai, 1984a
Fig. 11H

Material: Tet.k 1298–1 drupe (det. Mai D.H. 28.02.2000); Tetta VII/12–1 drupe (MZ VII/134/103).

Description: See Mai (1984a, 2000a).

Remarks: Small size (7 mm), circular shape, relatively smooth surface without wrinkles and swelled ventral suture, relatively thin shell (ca. 0.5 mm) relate this fossil drupe with *Prunus leporimontana* (Mai, 1984a, 2000a; Mai and Walther, 1991). This species has been documented only in the Lower Miocene (Mai, 2000a).

Genus *Rubus* Linnaeus, 1753
Rubus microspermus C. and E. M. Reid, 1910
Fig. 11F, G

Material: Tetta I/8–6 endocarps (MZ VII/134/105); Tetta IV/1–3 endocarps (MZ VII/134/104).

Description: Endocarps elongate more or less elliptic, asymmetric ovate to more or less semi-circular, basally, and apically rounded, sometimes with a lateral rounded lobe at the apex, 1.2–1.8 mm long and 0.8–1 mm wide. Dorsal keel lacking or indistinct. Lateral surface reticulate, with elevated reticulum parts (compartments), variable in size, isodiametric in the center and elongated on the margins and near the endocarp base or gradually elongating toward the endocarp base, anticlinal walls of the reticulum relatively thin, with sharp or rounded ridges.

Remarks: These endocarps closely match *Rubus microspermus* (Reid and Reid, 1910; Mai and Walther, 1978; Łańcucka-Środoniowa, 1979) considering their size, difference between size of reticulum cells, and relatively narrow anticlinal walls of reticulum cells (if compared to *Rubus laticostatus* Kirchheimer, 1942).

Distribution: Europe, from the upper Eocene to the Pliocene (Mai, 2000a).

Rubus semirobundatus Łańcucka-Środoniowa, 1979

Fig. 11C, E

Material: Tetta IV/3–2 endocarps (MZ VII/134/106); Tetta VI/6–1 endocarp (MZ VII/134/107).

Description: Endocarps 2 mm long, with a distinct, sharp keel at the dorsal side. Lateral surface reticular, reticulum parts elevated, broad, polygonal, mostly isodiametric, anticlinal walls of the reticulum thin and apically sharp, reaching to the dorsal edge of the endocarp.

Remarks: Features that relate these endocarps with *Rubus semirobundatus* are: 1) spacious reticulum areolae, 2) thin and sharp reticulum walls, and 3) reticulum reach to the dorsal edge of the endocarp. In Central Europe, this species is known from the upper Oligocene to Middle Miocene (Mai, 1997, 2000a).

Genus *Cotoneaster* Medicus, 1789

Cotoneaster wackersdorfensis Gregor, 1978a

Fig. 12E

Material: Tet.k 1213–1 specimen; Tetta III/11–1 specimen (MZ VII/134/304).

Description: See Mai (2001a).

Remarks: Original shape of the pyrene (MZ VII/134/304) found by the present authors is unclear, owing to strong compression, however, considering its size, length, and location of hypostyle, this specimen resembles *Cotoneaster wackersdorfensis*, illustrated by Mai (2001a, text-fig 3a).

Distribution: Central Europe, from the upper Oligocene to the Upper Miocene (Mai, 2008).

Genus *Pyracantha* M. Roemer, 1847

Pyracantha acuticarpa (C. and E. M. Reid) Szafer, 1961

Fig. 12A–C, G

Material: Tet.k 1238, 1249–34 specimens; Tetta III/11–8 specimens (MZ VII/134/111); Tetta I/8–3 specimen (MZ VII/134/110); Tetta VII/12–1 specimen (MZ VII/134/112).

Description: See Mai (2000a).

Remarks: These pyrenes represent *Pyracantha acuticarpa*, which is evidenced by size, shape, the position of style base (apically, in prolongation of ventral margin), and length of hypanthium remains (1/2–1/3 pyrenes length).

Pyrenes of *Pyracantha*, *Cotoneaster*, and *Crataegus* Linnaeus, 1753 can be very similar, but according to Mai (2001a), they can be distinguished on the basis of the extent, to which pyrenes are covered by hypanthium and the location of the style base. Mai argued that in *Pyracantha* the style base is apical, whereas in *Cotoneaster* it occurs generally in the lower part of the ventral side. However, the authors

have observed that in *Cotoneaster* the position of the style base varies between species and it may as well be located apically (see *C. salicifolius* Franchet, 1885). The number of pyrenes has been sometimes suggested as another diagnostically useful feature (Friis, 1985). Admittedly, fruits in most *Cotoneaster* consists of 2–3 pyrenes (Flinck and Hylmö, 1966), but there can be five pyrenes in representatives of sect. *Cotoneaster*, *Acuminati*, *Glomerulati*, *Bullati*, *Salicifolii* (Flinck and Hylmö, 1966), which corresponds to *Pyracantha* (Phipps, 1983; Kalkman, 2004). In *Crataegus*, there can be 1–5 pyrenes in a fruit (Phipps, 1983). Large variability of fruit size among species of *Cotoneaster* and *Crataegus* makes this parameter of little use, so that it can be used only in the case of large-fruited *Crataegus* species.

Potentially useful is the fact that pyrenes in *Pyracantha* and *Cotoneaster* are generally contiguous, whereas in *Crataegus* they are separated by fleshy tissue of the hypanthium (Aldasoro *et al.*, 2005).

All these make pyrenes of some *Cotoneaster* and *Crataegus* (i.a., *Cotoneaster franchetii* Bois, 1902 or *Crataegus spathulata* Michaux, 1803 – personal observation) very similar to *Pyracantha*.

In conclusion, even cursory observations by the present authors show that discriminating between *Pyracantha*, *Cotoneaster*, and *Crataegus* on the basis of pyrene morphology can be problematic, owing to overlapping features. Considering the arguments given above, attributing *P. acuticarpa* to *Pyracantha* remains questionable (see also Kirchheimer, 1957).

Distribution: Central Europe, from the middle Oligocene to Pliocene (Mai, 2000a).

Family Rhamnaceae Jussieu, 1789

Genus *Frangula* Miller, 1754

Frangula solitaria Gregor, 1977

Fig. 12F

Materials: Tetta I/8–1 drupe (MZ VII/134/115).

Description: See Kowalski 2017.

Remarks: Despite poor preservation, this drupe indisputably represents *Frangula solitaria*, a species known from the Neogene of Germany and Poland (Gregor, 1977; Mai and Walther, 1991; Mai, 2000a, 2001a; Kowalski, 2017). *Frangula hordwellensis* Chandler from the Eocene of England (Chandler, 1961) differs from the specimen of the present authors in having an emarginate base.

It was suggested that *F. solitaria* morphologically resembles the extant European *F. rupestris* (Scop.) Schur, 1866 and *F. alnus* Miller, 1768 (Gregor, 1977), or Asiatic species *F. crenata* (Sieb. and Zucc.) Miquel, 1867 (Mai, 2000a).

Genus *Paliurus* Miller, 1754

Paliurus favonii Unger, 1847

Fig. 12D, H

Material: Tet.k 1304–1 (det. Czaja, 1999); Tetta I/8–1 specimen (MZ VII/134/116).

Description: Fruit fragmentarily preserved, basal part with remains of receptacle ca. 3.3 mm in diameter, short fragment of the pedicel preserved, external part of one locule

with complete seed inside. Seed circular, flat, 2.5 mm in diameter, surface rough, area around the micropyle smooth and darker than remaining part of the seed.

Remarks: Despite the poor state of preservation, there is no doubt that the fossil of the present authors represents *Paliurus favonii*. This is evidenced by the circular receptacle at the fruit base and the shape, size, and surface of testa around the micropyle (Mai and Walther, 1991).

Distribution: Central Europe, from the upper Oligocene to the Upper Miocene (Mai, 2008).

Family Cannabaceae Martinov, 1820
Genus *Girroniera* Gaudichaud, 1844
Girroniera carinata Mai, 1970a
Fig. 12I

Material: Tetta VI/6–1 specimen (MZ VII/134/118).

Description: Drupe ovate, more or less flat, 3 mm in diameter; apex pointed, subapically occurs placental groove without a plug, groove connected with short canal (visible on the plane of dehiscence). Border between drupe halves marked by rim. Pericarp surface dimpled and grooved. Pericarp wall ca. 0.25 mm thick.

Remarks: This fossil drupe clearly corresponds to *Girroniera carinata* (Mai, 1970a), reported so far only from the upper Oligocene to Middle Miocene of Germany (Mai, 1970a, 2008; Gregor, 1978a; Czaja, 2003).

Girroniera verrucata Mai in Mai and Gregor, 1982
Fig. 12J

1982 *Girroniera verrucata* sp. nov. – Mai in Mai and Gregor, pp. 406–407, pl. 18, figs 7–11.

Material: Tet.k 1293, 1247–3 specimens; Tetta IV/1–8 specimens (MZ VII/134/119); Tetta IV/2–5 specimens (MZ VII/134/120); Tetta IV/3–2 specimens (MZ VII/134/121); Tetta III/11–1 specimen (MZ VII/134/123); Tetta VI/6–10 specimens (MZ VII/134/122)

Description: See Mai and Gregor (1982).

Remarks: These distinctive endocarps leave no doubt as to their affinity. Among the diagnostic characters are shape (circular-lenticular), size (3–4 mm), relatively widely spaced verrucae, and thin endocarp wall (ca. 0.1–0.2 mm) consisting of radially arranged sclereids. This species was described from the Middle Miocene of Salzhausen (Mai and Gregor, 1982), but since then it has been reported in many localities from the upper Oligocene and Lower Miocene of Lower Lusatia (Mai, 1997).

Family Moraceae Gaudichaud, 1835
Genus *Ficus* Linnaeus, 1753
Ficus lucida Chandler, 1962
Fig. 12M

Material: Tetta IV/1–6 specimens (MZ VII/134/124).

Description: See Chandler (1962).

Remarks: These relatively large, elongated achenes, with only a small mucro, punctate, semi-lustrous surface and thin achene wall (ca. 0.05 mm) correspond to *Ficus lucida*.

Distribution: Central Europe, from Eocene to the Lower Miocene (Mai and Walther, 1991).

Ficus lutetianoides Mai, 1987
Fig. 12L

Material: Tetta IV/1–2 specimens (MZ VII/134/125); Tetta IV/2–2 specimens (MZ VII/134/126).

Description: See Mai (1987).

Remarks: Considering elongated mucro, cellular structure on the surface, and very thin achene wall, these fossils correspond to *Ficus lutetianoides*.

Distribution: Central Europe, from the upper Oligocene to the Lower Miocene (Mai, 2008).

Family Urticaceae Jussieu, 1789
Genus *Laportea* Gaudichaud, 1830
Laportea europaea Dorofeev, 1988
Fig. 12K

Material: Tetta I/8–2 specimens (MZ VII/134/130); Tetta II/5–1 specimen (MZ VII/134/131); Tetta IV/3–5 specimens (MZ VII/134/129); Tetta IV/2–3 specimens (MZ VII/134/128); Tetta IV/1–2 specimens (MZ VII/134/127).

Description: Achenes Reuleaux triangle in shape, flat, 1.2 mm in diameter, ventral side with style remains reflexed toward apex, base with short, straight stipe. Surface uneven and verrucate.

Remarks: These remains undoubtedly represent *Laportea europaea*, species that commonly occurs in the upper Oligocene and Miocene sediments of the Lusatia area (Mai, 1997) and Russia (Dorofeev, 1988). It was compared with living *L. gracilipes* Elmer, 1910, and *L. platycarpa* Weddell, 1854 (Dorofeev, 1988).

Three fossil-species of *Laportea* have been described so far from Central Europe, but following a newer classification (Friis, 1993) *Fleurya staakowensis* Mai (Mai, 1999a) should also be assigned to this genus. The question for further studies would be to confront the morphology and anatomy of fossil-species with the most recent comparative carpological works on the living representatives of the Urticaceae family (especially see Kravtsova, 2009). In the light of these studies, fossils assigned to the *Laportea* genus must be reinvestigated with particular attention to pericarp structure, as its characteristic is crucial for distinguishing between living tribes, genera, and species in Urticaceae.

Laportea nemejcii Mai, 1997
Fig. 12O

Material: Tetta II/5–1 specimen (MZ VII/134/283).

Description: (Mai, 1999a).

Remarks: In size and shape, this achene corresponds with Urticaceae. Among fossil representatives of this family, *Laportea nemejcii* seems to be the closest, but the characteristic cellular structure on the surface of this species is vague in the specimen of the present authors, probably resulting from abrasion. Because of the poor preservation state, the authors were unable to analyze the possible relationship with modern Urticaceae. However, they agree with Mai (1999b), that this fossil-taxon morphologically also resembles *Hesperocnide* Torrey, 1856 (see also Kravtsova, 2009).

Distribution: Central Europe, from the upper Oligocene to the Lower Miocene (Mai, 1999a), Middle Miocene (Czaja, 2003).

Family Fagaceae Dumortier, 1829

Genus *Fagus* Linnaeus, 1753

Fagus deucalionis Unger emend. Denk and Meller, 2001
Fig. 13A–C

1915 *Fagus decurrens* sp. nov. – Reid and Reid, pp. 78–79, pl. 5, figs 19, 20, 22–28.

v 1999 *Fagus decurrens* (C. and E. M. Reid) – Czaja and Berner, p. 442, pl. 2, figs 6, 7.

2001 *Fagus deucalionis* (Unger) – Denk and Meller, pp. 881–889, pls 11, 12, 13.

Material: Tet.k 1194, 1200, 1232, 1246, 1258–124 specimens; Tetta I/9–1 fruit (MZ VII/134/142); Tetta III/11–349 fruits (MZ VII/134/139–141); Tetta I/8–253 fruits (MZ VII/134/138); Tetta VI/6–93 fruits (MZ VII/134/137); Tetta II/5–26 fruits (MZ VII/134/136); Tetta II/4–110 fruits (MZ VII/134/135); Tetta IV/3–8 fruits (MZ VII/134/134); Tetta IV/2–53 fruits (MZ VII/134/133); Tetta IV/1–26 fruits (MZ VII/134/132).

Description and remarks: For detailed description, see Denk and Meller (2001).

Distribution: Europe, from Oligocene to Pliocene (Denk and Meller, 2001).

Fagus castaneifolia Unger, 1847

Fig. 21A

1847 *Fagus castaneifolia* sp. nov. – Unger, p. 104, pl. 28, fig. 1.

1991 *Fagus saxonica* (Unger) Kvaček and Walther – Kvaček and Walther, p. 482, pl. 15, figs 1–3, 5, 6, pl. 16, figs 1–5.

Material: Tetta II/5.

Description: Leaves narrow ovate to elliptic, leaf base obtuse, apex attenuate. Leaf margin simple serrate, teeth upwardly curved, apical sides of teeth concave to acuminate, basal sides acuminate to convex, tooth apex acute to rounded. Venation pinnate, primary vein of moderate thickness. Secondary venation mostly simple craspedodromous. Secondaries numerous, straight, sometimes slightly upwardly curved entering nearest tooth. Tertiary venation percurrent, tertiaries numerous. Higher-order venation reticulate. Areoles well developed. Veinlets simple, rarely none, occasionally branched once. Marginal ultimate venation looped. Leaf epidermal features not known.

Remarks: The morphology of the above-described fossil beech leaves, including mainly rather numerous secondary veins, point to the fossil-species *Fagus castaneifolia* Unger, typical for upper Oligocene to upper Lower Miocene fossil plant assemblages from Europe to Central Asia (Denk, 2004). Some beech leaves reported by Leder (2007) from Tetta as *Fagus* cf. *menzelii* Kvaček and Walther, 1991 that show numerous secondary veins and narrow ovate/elliptic shape (Leder, 2007, pl. 6, figs a, c, f, h) most probably represent *Fagus castaneifolia*. Morphologically, *Fagus castaneifolia*

resembles modern *Fagus longipetiolata* Seemen, 1897 from China and *F. grandifolia* Ehrhart, 1788 from Eastern North America and Mexico (Denk, 2004). In fossil assemblages, leaves of *F. castaneifolia* are often associated with fruits of *Fagus deucalionis* and pollen grains of *Faguspollenites bockwitzensis* (Walther and Zetter) Kohlman-Adamska and Ziemińska-Tworzydło, 2014 (Denk, 2004) and the same is the case with the Tetta sample II/5. Some other leaf remains found at Tetta, morphologically showing some similarities with leaves of the fossil and modern *Fagus* but considerably differing from *Fagus castaneifolia*, presumably could be related to other fagaceous fossil-genera (e.g., *Eotrigonobalanus* Kvaček and Walther, 1989, *Trigonobalanopsis* Kvaček and Walther, 1988).

Genus *Trigonobalanopsis* Kvaček and Walther, 1988

Trigonobalanopsis exacantha (Mai) Kvaček and Walther, 1988

Fig. 13D–F

Material: Tet.k 1211 – 2 specimens; Tetta – 3 specimens (MZ VII/134/274).

Description: For detailed description, see Mai (1970b).

Remarks: There is no doubt that these distinctive cupules belong to *Trigonobalanopsis exacantha*, which is a well-known species, reported from the upper Oligocene to Pliocene, but in the Lusatia, it seems to disappear from the fossil record at the end of the Early Miocene (Mai, 2001b).

Family Myricaceae Richard ex Kunth, 1817

Genus *Comptonia* L'Héritier, 1789

Comptonia aff. *goniocarpa* Mai in Mai and Walther, 1978
Fig. 12N

Material: Tetta I/8–1 nut (MZ VII/134/143).

Description: Nut ovate, 3.4 mm long and 2 mm wide, heavily compacted, apically pointed, basally rounded. Surface rough, with delicate, inconspicuous, longitudinal ribs and very faint vascular bundles in-between. Pericarp wall very thin, (ca. 0.05 mm).

Remarks: The nut described above corresponds with *Comptonia goniocarpa* in size and ornamentation, but it has a rather unusual shape. Nuts of this species are more or less narrowed at the base, but without a stipe. The specimen of the authors is rounded, but the natural base seems to be displaced to the side because of compaction. The specimen from Tetta has a very thin pericarp, but there is no information in the literature on pericarp thickness for this species (Mai and Walther, 1978, 1991; Mai, 1997, 1998, 1999a). Living (Kowalski, 2016) and most fossil (Friis, 1979; Dorofeev, 1994) *Comptonia* species have a much thicker pericarp than the authors observe in their specimen. Only *C. longistyla* Dorofeev has pericarp of the same thickness (0.04–0.07 mm – Dorofeev, 1994). Pericarp thickness among fossil remains of this genus is probably related to the degree of compression and fossilization. A similar effect was evidenced in the case of fossil *Carpinus* (Jentys-Szaferowa, 1961).

Distribution: Central Europe, from the upper Eocene to the Lower Miocene (Mai, 1997).

Family Juglandaceae DC. ex Perleb, 1818
 Genus *Carya* Nuttall, 1818
Carya ventricosa (Sternb.) Unger, 1861
 Fig. 13Q, S

Material: Tet.k 1197, 1229, 1259–17 specimens; Tetta VII/12–66 specimens (MZ VII/134/145); Tetta III/11–21 specimens (MZ VII/134/144).

Description: For detailed description, see Mai (1981) and Manchester (1987).

Remarks: This species has been recorded in many Central European sites from Miocene to Pliocene (Zabłocki, 1928; Kirchheimer, 1957; Czacott and Skirgiełło, 1961; Mai, 1981; Czaja and Berner, 1999; Czaja, 2003). Nuts from Niederpleis near Siegburg/Western Germany documented by (Kirchheimer, 1938) have been suggested as the oldest remains of this species, however, there is uncertainty as to the late Oligocene age of this flora (Kvaček and Martinetto, 2016).

Genus *Pterocarya* Kunth, 1824
Pterocarya aff. *margaritana* Mai, 1997
 Fig. 13G, H, J, K, P

Material: Tetta VI/6–2 specimens (MZ VII/134/149); Tetta IV/3–2 specimens (MZ VII/134/148); Tetta IV/2–3 specimens (MZ VII/134/147); Tetta IV/1–8 specimens (MZ VII/134/146).

Description: Nutlets 2–4 mm wide and 3–3.5 mm long. Two preservation types: 1) obovate, with elevated apical ribs, short apical tip, widest part located in the upper part of the fruit, 2) ovate with relatively long apical tip, widest part located more or less on the equatorial area; both types with 8–11, not wing-like ribs of varied high. Secondary septa relatively well developed, without cusp-like projections.

Remarks: Lack of cusp-like projections around the base of secondary septa relates these nutlets with section *Pterocarya* (Manning, 1975; Rix, 2007). In Central Europe, the most common fossil-species of this section is *P. limburgensis* Reid and Reid, 1915, which has been documented so far from the uppermost Miocene (but see Hrádek Formation, Kvaček and Teodoridis, 2007) to the Lower Pleistocene (Mai, 1999a). In respect of shape and morphology, the specimens of the present authors correspond well with this species, but they are generally smaller than *P. limburgensis* (3.5–8 mm; Mai, 1999a) and in this respect, they can be compared only with *P. margaritana* (2.5–3.5 mm; Mai, 1997), which is the second fossil-species attributed by Mai (1999a) to the section *Pterocarya*. *Pterocarya margaritana* has been reported so far only from the upper Oligocene of Horka and Spremberg (Mai, 1997). According to Mai (1997), this species differs from the others in that it is smaller and has asymmetric nutlets with elongated stylar rostrum (tip). However, in the opinion of the present authors, asymmetric shape represents rather a preservation state, not a specific trait. Considering the array of possible deformations and documented natural variability of shape and morphology within *P. limburgensis*, the taxonomic distinctness of *P. margaritana* is disputable. Nutlets in the type of *P. margaritana* can easily be found in some populations of *P. limburgensis* (see Martinetto, 2015, pl. 2, fig. 6a, b). Size seems to be the

only feature that separates these two species, but *P. margaritana* may represent a small-fruited type of *P. limburgensis*.

Family Betulaceae Gray, 1821
 Genus *Carpinus* Linnaeus, 1753
Carpinus cordataeformis Mai, 1963
 Fig. 13N, R

Material: Tet.k 1244–6 fruits; Tetta I/8–42 fruits (MZ VII/134/152–154); Tetta III/11–21 fruits (MZ VII/134/155)

Description: Nuts ovate or elliptic, apically more or less rounded, dorsoventrally flattened, 3.3–5.8 mm long and 2.3–3.7 mm wide, length to width ratio 1.5–1.6, apex angle generally obtuse (90–137°), pericarp wall <90 µm thick. Nut surface wrinkled, rarely preserved three, low, longitudinal ribs; few specimens with delicate, short hairs on perigone. Involucrum fragmentary preserved, up to 2/3 or the full length of the nut, rarely on both sides of the nut, with five to eight, equal primary veins radiating from the base of the bract, veins mostly only on one side of the nut; nuts frequently with up to 3.5 mm long stipe at the base; hairs rarely on the bract surface.

Remarks: According to Jentys-Szaferowa and Białobrzeska (1953), several morphological characters could be helpful for distinguishing not only between isolated fruits of *Ostrya* and *Carpinus*, but also between *Carpinus* sect. *Carpinus* and *Distegocarpus*. On the basis of these suggestions, the present authors used the shape, length to width ratio, apex angle, and position of the widest part, to distinguish three morphological types among their materials: elliptic-*Carpinus cordata* type, ovate-type shared by both *Carpinus* and *Ostrya*, and narrowly ovate-*Ostrya* type.

Specimens in the category of *Carpinus cordata* were assigned to the fossil *Carpinus cordataeformis*, which was erected on the basis of imprints and adpressions of involucrum from the Oligocene of Seifhennersdorf/Germany (Mai, 1963) and later complemented with the description of isolated fruits from Haselbach (Mai and Walther, 1978). This fossil-species was related to living *C. cordata* Blume, 1851 (Sect. *Distegocarpus*; Mai, 1997) from China, Japan, Korea, and Russian Far East (Li and Skvortsov, 1999).

Among the *C. cordataeformis* type of fruits, many specimens sit on a robust stipe, which can be identified as a fragment of the pedicel. In living representatives of *Carpinus* pedicels is usually rather short and thin.

Some specimens have delicate hairs on the involucrum, which have been reported in both *Carpinus* and *Ostrya*, but they seem to be more common in the first genus (at least in 7 species) than in the second (documented in *O. knowltonii* Conville, 1894 and *O. trichocarpa* Fang and Wang, 1983; Li and Skvortsov, 1999; Yoo and Wen, 2002).

Other important features observed on the *C. cordataeformis* fruits from Tetta are: 1) a thin pericarp wall, 2) remains of bract on both sides of the fruit, and 3) a wrinkled surface. The first two could be used as additional arguments that reinforce the probable relationship between *C. cordataeformis* and *C. cordata*. The nut enclosed by the involucre is specific to *Carpinus* Sect. *Distegocarpus* and *Ostrya*.

Thin pericarp distinguishes *C. cordata* and *C. japonica* Blume, 1851 from other *Carpinus* species (Jentys-Szaferowa

and Białobrzaska, 1953), but in the case of fossil fruits, an additional reduction in pericarp thickness results from fossilization and compaction (see Jentys-Szaferowa, 1961).

In the opinion of the authors, specimens described by Czaja and Berner (1999) from Tetta as *Ostrya* cf. *szaferi* Mai represent in fact *Carpinus cordataeformis*.

Distribution: Central Europe, from the upper Oligocene to the Lower Miocene (Mai, 1997).

Genus *Ostrya* Scopoli, 1760
Ostrya scholtzii Gregor, 1982
Fig. 14C, D

Material: Tetta I/8–39 fruits (MZ VII/134/156, 157); Tetta III/11–2 fruits (MZ VII/134/158).

Description: Nutlets narrowly ovate, elongated, acute, apex pointed, apex angle 30–59°. Nutlets dorsoventrally flattened, 4.5–7 mm long, and 1.8–2.5 mm wide, length to width ratio 2.5–3.5 (2.8 on average). Pericarp wall ca. 95 µm thick. Nut surface wrinkled, rarely with three, low, longitudinal ribs. Involucrum fragmentary, at the lower part of the fruit, rarely visible 7–8 radiating veins, long and broad stipe at the base, rarely preserved.

Remarks: Perianth preserved in some of the specimens of the authors is not collar-like, as can be found in *O. carpiniifolia* Scopoli, 1771, *O. virginiana* (Mill.) Koch, 1873b and *O. japonica* Sargent, 1893, but seems to be undulated or divided into rounded lobes as in *O. trichocarpa* or *O. multinervis* Rehder, 1938 (Li and Skvortsov, 1999).

Distribution: Europe, from the upper Oligocene to Pliocene (Mai, 2008).

Genus *Betula* Linnaeus, 1753
Betula cf. *dryadum* Brongniart, 1828
Fig. 13T

Material: Tetta IV/3–3 specimens (MZ VII/134/163); Tetta IV/2–3 specimens (MZ VII/134/162).

Description: Nutlets flat, fusiform, slender, elongated on both ends, 2.9–3 mm long, and 1.2–1.5 mm wide (without the wings), one specimen with partially preserved, narrow membranous wings at the base.

Remarks: Long and narrow basal stipe and apical style suggest that these fossil seeds may belong to *B. dryadum*, but this assignment should be treated with caution, as it is based only on wingless nutlets. The specimens of the authors are slightly smaller than typical *B. dryadum*, but they consider that the size differences may be neglected, as this is a consequence of preservation and desiccation.

According to Mai (1995, 1997), *Betula dryadum* closely resembles *B. maximowicziana* Regel, 1868, and therefore could be assigned to the section *Acuminatae* Regel of subgenus *Betula*. Considering the shape of the wings and the fact that they are attached to the nutlet at the base of the style (see Brongniart, 1828, pl. 3, fig. 5), there can be no doubt that *B. dryadum* represents the subgenus *Betula* (see Skvortsov, 2002). However, the authors are skeptical about relating this fossil-species with the section *Acuminatae* or other sections within the subgenus *Betula* only on the basis of the characters of the wings.

Distribution: Europe, from the middle Oligocene to the Lower Pliocene (Mai, 1997).

Betula cf. *longisquamosa* Mädlar, 1939
Fig. 13M

Material: Tet.k 1320–1 specimen (det. Czaja, 1999); Tetta I/8–1 specimen (MZ VII/134/164).

Description: Nutlet flat, ovate, 2.2 mm long and 1.3 mm wide (without the wings), base broad, truncate, apex short and acuminate. Surface hairy, hairs gradually diminish toward the base of the nutlet.

Remarks: This nutlet is rather small as for *Betula longisquamosa*, but still falls into the size range for this species. The indumentum observed on the surface has been highlighted by Mai (1999a) as one of the characteristics of *Betula longisquamosa*. However, hairs covering the nutlets are common among living species of *Betula* therefore the authors suspect that the fact they are present in their specimen and specimens described so far may be associated with the state of preservation more than with characteristics of this species. Since the authors know nothing about wings, they are careful about linking their specimen with *B. longisquamosa*.

Betula longisquamosa was compared by Mai (1999a) with several living *Betula* species (i.a., *B. delavayi* Franchet, 1899 or *B. grossa* Siebold and Zuccarini, 1846). According to the classification proposed by Skvortsov (2002), the first and second mentioned species represent subgenus *Asperae* Nakai whereas the last two represent subgenus *Betula*. Skvortsov (2002) also recognized several essential differences in nutlets morphology between representatives of the two mentioned subgenera. One of the important features is the position of the wings in relation to style, in the subgenus *Asperae* wings climb along the lower part of the styles, whereas in the subgenus *Betula*, they reach just below the style base. Considering the pictures that document specimens with wings from the Upper Miocene of Schipkau (Mai, 2001a, pl. 9, fig. 23), it seems that wings continue along the lower part of the style arms, which resembles subgenus *Asperae*. On the other hand, according to Mai (Mai and Walther, 1988) wings reach not higher than the style base and that would rather indicate the subgenus *Betula*.

Distribution: Europe, from the Lower Miocene to Pliocene (Mai, 1999a).

Genus *Alnus* Miller, 1754
Alnus latibracteosa Mai, 1987
Figs 13O, 14E, J

1987 *Alnus latibracteosa* sp. nov. – Mai, pp. 110–111, pl. 5, fig. 12, pl. 6, fig. 1, text-fig. 1d–f.

Material: Tetta I/8–22 specimens (MZ VII/134/165); Tetta III/11–13 specimens (MZ VII/134/166).

Description: Fan-shaped scales, up to 5 mm wide, consist of five bracts, the broadest and most robust primary bract on the abaxial surface, remaining four bracts (two secondary and two tertiary bracts) on the adaxial surface, uniform in size, spatulate, with rounded distal margin, much narrower than primary bract. Nutlets circular or elliptic, 3–3.5 mm

in diameter, base horizontally truncated or concave. Wings narrow, not membranous, ca. 1/6 as wide as nutlets; wing begins to spread from the subbasal area and continues to the apical part, reach only to the style base. Style short and bifid.

Remarks: In size and shape of the tertiary bracts, but especially the size and shape of seeds, these remains can be safely assigned to *Alnus latibracteosa*. This species was described on the basis of remains from the Lower Miocene of Muldenstein/Germany (Mai, 1987), but since then, it has been reported from several other sites, from the upper Oligocene to Middle Miocene of E Germany (Mai, 1999a). The intrageneric position of the *Alnus latibracteosa* is ambiguous. According to Mai (1987), infructescences compared to this species can be found in several living representatives, including *A. cordata* (Loisel.) Duby, 1828, *A. japonica* (Thunb.) Steudel, 1840, *A. subcordata* C. A. Meyer, 1831, of the subgenera *Alnus* and *A. formosana* (Burk.) Makino, 1912 of the subgenera *Clethropsis* (Chen and Li, 2004).

Alnus lusatica Mai, 1987

Fig. 14A, B, F

Material: Tetra IV/3–5 specimens (MZ VII/134/169, 170); Tetra IV/2–6 specimens (MZ VII/134/168); Tetra IV/1–13 specimens (MZ VII/134/167).

Description: Infructescence long elliptic, 15 mm long and 7 mm wide, flattened. Scales up to 3 mm wide, tertiary bracts narrower than secondary bract, subspatulate or oblong, with rounded or triangulate distal margin. Nutlets pentagonal, ca. 2 mm long and 1.9–2.2 wide, base concave. Wings narrow, not membranous, 1/8–1/6 as wide as nutlets, begin to spread from the subbasal area and continue to the apical part, reach only to the style base. Style relatively long and bifid.

Remarks: Mai (1987) related this species to Subgen. *Clethropsis*, seeing a morphological affinity with *A. nitida* Endlicher, 1847b and *A. nepalensis* Don, 1825. However, in the opinion of the present authors, this comparison is not fully justified because there are significant differences in nutlets of these two species and *A. lusatica*. In both mentioned living species, there are much wider wings, and in *A. nepalensis* they are obcordate in shape. Pentagonal shape and narrow wings like in *Alnus lusatica* can be found in *A. glutinosa* Gaertner, 1790, *A. rhombifolia* Nuttall, 1842, *A. serrulate* Willdenow, 1805 (personal observation).

Distribution: Western and Central Europe from the upper Oligocene to Pliocene (Mai, 1999a).

Family Lythraceae J. Saint-Hilaire, 1805

Genus *Microdiptera* Chandler, 1957

Microdiptera lusatica Mai, 1987

Fig. 14K, L

Material: Tetra II/5–2 specimens.

Description: See Mai (1987).

Remarks: In respect of size (1.3–1.4 mm long and 0.87–1 mm wide), thin and sharp lateral margins, and germination valve, which is 3/4 length of the seed, these fossils closely match the characteristics of *Microdiptera lusatica*. This

species has been reported so far from the upper Oligocene to the Lower Miocene of Germany (Mai, 2000a).

Microdiptera aff. *parva* Chandler, 1957

Fig. 14M

Material: Tetra I/8–1 specimen (MZ VII/134/172).

Description: Seed trapezoidal, 1 mm long and 1 mm wide, lateral margins thin and sharp, wings indistinct, surface reticulate; germination valve ca. 1/2 length of the seed, covered with well expressed, isodiametric cells arranged in 7 longitudinal rows.

Remarks: In respect of the shape, size, and length of the germination valve the specimen of the authors closely matches *M. minor* (Chandler) Mai. On the other hand, distinctive reticulation observed on the lateral margins was suggested (Chandler, 1957; Mai and Walther, 1978) as characteristic of *M. parva*. The specimen has no distinct, strongly extended wings. Most documented specimens of *M. parva* have widely expanded wings, but specimens with unusual narrow wings were also reported (Chandler, 1957, pl. 15, figs 146–149). Given the above, the specimen most likely represents *M. parva*, but because of narrow wings it should be seen as an aberrant form.

Distribution: West and Central Europe, from the middle Eocene to the Middle Miocene (Mai, 2008).

Microdiptera minor (Chandler) Mai in Mai and Walther, 1985

Fig. 14G

Material: Tetra II/5–1 specimen (MZ VII/134/306).

Description: Seed trapezoidal, 1 mm long and 1.1 mm wide, lateral margins not tapered, angular; germination valve less than 1/2 length of the seed, covered with well expressed, isodiametric cells. Deep grooves along raphe ridge.

Remarks: Considering the size, lack of wings, short germination valve, and deep grooves on the raphe-side, the seed of the authors corresponds to *Microdiptera minor* (Mai, 1997). This species has been reported so far from the Eocene to the Lower Miocene (IV floristic zone; Mai and Walther, 1991).

Family Staphyleaceae Martinov, 1820

Genus *Staphylea* Linnaeus, 1753

Staphylea rotundata Dorofeev, 1963

Figs 14H, I, I2

Material: Tetra IV/3–1 specimen (MZ VII/134/300); Tetra VII/12–1 specimen (MZ VII/134/301).

Description: Seeds more or less ovoid, compressed, 4–4.2 mm long, and 3–3.2 mm wide, rib obtuse, on the lateral margin, starts to rise in the upper part of the seed. Hilar scar elliptic, 1 mm long and 0.5 mm wide, bordered by a lip-like rim.

Surface of the seed smooth, mat, or semi-lustrous, cellular, faveolate structure partially preserved. Seed coat ca. 0.12 mm thick, lumina of the cells clearly visible, relatively narrow.

Remarks: The difference in inclination of the hilar scar between specimens (MZ VII/134/301 – oblique, MZ VII/134/300 – horizontal) the authors considered as an intraspecific variation. Therefore, the authors provisionally assigned both specimens to one species. There is a relatively

large number of morphologically similar *Staphylea* species in the European Cenozoic established on seeds. Some of them are poorly documented, which causes a lot of confusion and problems with identification (Tiffney, 1979). Among the nine fossil-species described, three seem to be equally close with respect to size and general characteristics, these include *S. rotundata* Dorofeev, *S. tymensis* Dorofeev (Dorofeev, 1963), and *S. bessarabica* Negru (Negru, 1972). The authors provisionally assigned seeds from Tetta to *S. rotundata*, as they are the closest to the size range of this species. However, the morphological difference between all three above-mentioned species is so small that they could be considered as one species.

In respect of size, seeds documented here correspond the most with living *S. bumalda* Candolle, 1825.

Distribution: So far only Oligocene and Miocene of W Siberia (Dorofeev, 1963).

Genus *Turpinia* Ventenat, 1807

Turpinia ettinghausenii (Engelh.) Mai, 1964

Fig. 14P1, P2

Material: Tet.k–1242, 1254–2 specimens; Tetta III/11–3 specimens (MZ VII/134/175); Tetta IV/1–1 specimen (MZ VII/134/173); Tetta IV/2–specimens (MZ VII/134/174).

Description: See Mai (1964).

Remarks: The latest molecular phylogenetic analysis, carried out by Harris *et al.* (2017), suggests five lineages within the family, including Old World and Asian-North American *Staphylea* clades, Old and New World *Turpinia* clades, and *Euscaphis* Siebold and Zuccarini, 1840. These authors also argue that mentioned five taxonomic groups do not contradict the previous classification by Takhtajan (1997) which well correlates with differences in seed morphology between *Staphylea*, *Turpinia*, and *Euscaphis* (Mai, 1964, 1980; Tiffney, 1979; Huang *et al.*, 2015).

Significantly, seeds of living East Asian species of *Turpinia* are more or less angular, while seeds from New World species are generally bigger and rounded (Tiffney, 1979). Although angular forms were reported (Mai, 1964; Gregor, 1978a), most seeds of *T. ettinghausenii* are more or less rounded (personal observation). On the other hand, the distinctive, domed (mammillate) outer periclinal wall of the epidermal cells that occurs in *T. ettinghausenii* can be found only in two Asiatic living species, i.e., *T. formosana* Nakai, 1924 (see Mai, 1964) and *T. arguta* Seemann, 1857 (see Tiffney, 1979). This indicates that *T. ettinghausenii* links characteristics of both Old and New World lineages.

Turpinia ettinghausenii has been reported mostly from the upper Oligocene to the Middle Miocene (Mai, 2001a).

Family Sapindaceae Jussieu, 1789

Genus *Acer* Linnaeus, 1753

Acer aff. *angustilobum* Heer, 1859

Fig. 14N, X

Material: Tetta IV/3–2 achenes (MZ VII/134/176, 177).

Description: Complete fruits (with the wing) up to 3 cm long; achene flat or flattened, robust, 4 mm high (ventral margin) and 5 mm long (distance measured perpendicular to

ventral margin; see Mai 1999a), style remains short, surface slightly wrinkled on both sides, low, longitudinal infold on one side closer to the distal margin of the fruit. Wing ca. 2.5 cm long and 0.9 cm wide (at the widest part), junction area (sulcus) 3 mm wide, proximal margin of achene and wing more or less straight, slightly depressed in the junction area. Attachment angle ca. 35°.

Remarks: The present authors used the key proposed by Mai (1999a) for identification. They assumed that infolds observed on the sides of the above-described specimens were probably formed when the originally convex pericarp was compacted. In respect of the size and shape of the wing, the materials of the authors most closely resemble samaras associated with leaves of *Acer angustilobum*. However, the specimens do not exactly match the type because the wing in the specimens is longer than that given by Mai (1999a). *Acer angustilobum* was originally described from the Upper Miocene of Schrotzburg/Germany (Heer, 1859) as leaves and associated fruits, which however, were not found in physical connection. Mai (1999a) provisionally used one name for two organs because they were frequently observed together (Heer, 1859). The authors took this approach.

Fruits like this are common and have been reported from many sites in Germany, Austria, the Czech Republic, and Switzerland from the upper Oligocene to the Upper Miocene (Kirchheimer, 1957; Mai, 1995; Kvaček and Walther, 2004).

On the basis of the observation of the authors, the specimens from Tetta seem especially close to living *A. buergerianum* Miquel, 1865, *A. pseudoplatanus* Linnaeus, 1753, or *A. heldreichii* Boissier, 1856. This conclusion corresponds with previous suggestions on the possible affinity of *Acer angustilobum* (Mai, 1995, 1999a).

Acer hercynicum Mai in Mai and Walther, 1991

Fig. 14O, R, S

Material: Tetta IV/3–11 specimens (MZ VII/134/186); Tetta IV/2–6 specimen (MZ VII/134/189); Tetta IV/1–5 specimens (MZ VII/134/188).

Description: Endocarps in the shape of distorted half-ellipse (more or less triangulate), relatively thin-walled, flat (or flattened?), 4 mm high and 3–4 mm long. Ventral side s-shaped, style base clearly expressed. Oblique longitudinal rib on both sides of endocarp.

Remarks: These endocarps can be safely assigned to *Acer hercynicum*, which is evidenced by the shape, small size, and longitudinal rib on the endocarp sides. They only differ in that they are slightly longer than the specimens described by Mai and Walther (1991).

According to Mai (1995), living *A. sempervirens* Linnaeus, 1767 and *A. monspessulanum* Linnaeus, 1753 can be compared with *A. hercynicum*.

Distribution: Central Europe, from the middle Oligocene to the Lower Miocene (Mai and Walther, 1991).

Acer sp. 1

Fig. 15A–D

Material: Tetta IV/2–2 specimens (MZ VII/134/190); Tetta IV/3–8 specimens (MZ VII/134/185).

Description: Nutlets elliptic, ovate, 2.5–3 mm wide (shorter axis), 3–5 mm high; ventral margin constricted, 1.5–2.5 mm long, style remains short; pericarp surface wrinkled, with 1–2 longitudinal, straight ribs. Nutlets flattened in various directions.

Remarks: Judging from the fact that each specimen is flattened in a slightly different way, the authors suspect that pericarps could be originally inflated or spheroidal.

Considering the morphology of endocarps, the authors can see a strong resemblance between their endocarps and those in living *A. pseudosieboldianum* Komarov (see Mai, 1984b).

Acer sp. 2
Figs 14T–W, 15E, I

Material: Tetta IV/1–13 (MZ VII/134/187); Tetta IV/2–83 specimens (MZ VII/134/178, 184); Tetta IV/3–27 specimens (MZ VII/134/179).

Description: Nutlets in the shape of slightly distorted half-ellipse or half-circle, 3.5–5 mm long and 4–5 mm high, flat, thin-walled; ventral margin (attachment scar) straight, not constricted, frequently with projection that connect fruit with pedicel (proximal keel); divergent angle obtuse, wing remains on the distal margin of the nutlet reaches almost to the fruit base. Veins of vascular bundles on the pericarp surface hardly visible.

Remarks: These nutlets in respect of size, shape, and straight ventral margin resemble *Acer menzelii* Mai, 1987. However, in comparison to the type specimens (seen in MfN 25.05.2022), which is higher than long, the endocarps of the present authors are more or less equally as high as long and have no constricted ventral margin. Specimens from Tetta seem to be originally flat and thin walled, whereas endocarps of *A. menzelii* were described as thick-walled and convex, comparable to the living *A. palmatum* Thunberg, 1784 and *A. circinatum* Pursh, 1814. However, these features are of rather limited use in the case of compacted specimens. Because of the doubts mentioned above, the authors remain unresolved about the affinity of their specimens.

Family Rutaceae Jussieu, 1789
Genus *Zanthoxylum* Linnaeus, 1753
Zanthoxylum giganteum Gregor, 1978b
Fig. 15H

Material: Tet.k 1308–1 specimen (det. Czaja, 1999); Tetta III/11–2 specimens (MZ VII/134/299).

Description: Fragments of two seeds, the bigger specimen represents the micropylar end, 3 mm long and 2.1 mm wide, hilar margin more or less straight, external surface with distinctive rugae, and warts; seed wall ca. 0.1 mm thick.

Remarks: Specimens are only fragmentarily preserved, but they can certainly be attributed to *Zanthoxylum giganteum* on the basis of the shape of the micropylar part and external ornamentation (Gregor, 1978b). This species has been reported so far only from the Lower Miocene floras of the Wiesa floristic complex (Gregor, 1978b; Mai, 2000a).

Family Malvaceae Jussieu, 1789
Genus *Burretia* Mai, 1961
aff. *Burretia* sp.
Fig. 15F

Material: Tetta III/11–1 specimen (MZ VII/134/305).

Description: See Mai (2000a).

Remarks: General characteristic of this bud matches that of *Burretia*, but with a diameter of 5.5 mm it is bigger than both *B. insculpta* (Mai) Mai (Mai and Walther, 1991) and *B. instructa* R. Potonie (Mai, 1961). Pollen analysis could verify the affinity of this flower bud, but since only one specimen has been found, the authors decided to leave it intact.

Distribution: Central Europe, from Oligocene to Miocene (Mai, 2000a).

Genus *Craigia* W. W. Smith and W. E. Evans, 1921
Craigia bronniei (Unger) Kvaček,
Bůžek and Manchester, 1991
Fig. 15G

Material: Tetta IV/3–single fruit (MZ VII/134/195).

Description: See Kvaček *et al.* (1991, 2002).

Remarks: Size, shape, and details of the wing's venation unequivocally relate this fragmentarily preserved specimen with *Craigia bronniei*.

Distribution: Europe, from the lower Oligocene to the Upper Pliocene (Kvaček *et al.*, 2002).

Family Polygonaceae Jussieu, 1789
Genus *Persicaria* Miller, 1754
Persicaria aff. *polesieana* Arbusova, 2005b
Fig. 16A

Material: Tetta I/8–2 fruits (MZ VII/134/196, 197).

Description: Fruits elliptical, ca. 2.4 mm long and 1.5 mm wide, bilateral, length to width ratio 1,6, base conspicuously stipitate with perianth remains, apex acuminate, gradually narrows to short style base or rounded with short cylindrical style base. Surface in the middle part of the pericarp wall with clear cellular structure, epidermal cells more or less polygonal, 30–60 µm in diameter, anticlinal walls strongly thickened and tuberculated, thicker than the lumen of the cells, outer periclinal walls collapsed. Epidermal cells strongly elongated on the margins of fruit.

Remarks: Despite the difference in shape, the authors assigned both specimens to the same taxon, because they share the same pericarp micromorphology. Fruits are two-sided, broadly ovate in outline, and have an alveolate surface, which indicates that they can be related to *Persicaria*. Bilateral fruits can also be found among representatives of *Polygonum* sect. *Tephis*, but they have much less expressed or smooth ornamentation (Ronse Decraene *et al.*, 2000).

In respect of pericarp micromorphology, the fruits described here resemble *Persicaria. polesieana* Arbusova from the Oligocene and Miocene of Belarus (Arbusova, 2005b), except that *P. polesieana* is smaller and unlike the specimens of the authors, its surface is less alveolate.

Persicaria polesieana was compared to the living *P. hydropiper* (L.) Spach, 1841. Whereas the fruits of the authors

with regard to pericarp micromorphology more closely correspond to the living *P. humilis* (Meisner) H. Hara, 1978 and *P. nepalensis* (Meisner) H. Gross, 1913 of section *Cephalophilon* (see Kong and Hong, 2018).

Polygonum sp. 1

Fig. 16C

Material: Tetta II/5–6 fruits (MZ VII/134/198, 199).

Description: Fruits elliptic or fusiform, 1.8–2 mm long and 0.8–1 mm wide, triquetrous, with relatively long stipe at the base. Surface black, semi-matt, and pitted.

Remarks: With respect to size and shape, the fruits described above resemble *Polygonum bramborense* from the Lower Miocene of Germany (Mai 1999a). However, this could be only a superficial similarity, because the pericarp sculpture of *Polygonum bramborense* Mai, 1999a is undocumented. Pericarp sculpture and anatomy have great taxonomic value in Polygonaceae (Ronse Decraene *et al.*, 2000).

Polygonum sp. 2

Fig. 16B

Material: Tetta II/5–3 specimens (MZ VII/134/200, 201).

Description: Fruits elliptic, 2.9–3 mm long and 1–1.2 mm wide, triquetrous, with a relatively long stipe at the base; perianth preserved fragmentarily. Achenes smooth, semimatt, and brown. Anticlinal walls of epidermal cells highly digitated.

Remarks: These fruits differ from *Polygonum* sp. 1 in respect of size, shape, colour, and pericarp micromorphology. They may represent *P. leporimontanum* Kirchheimer, 1942 (Kirchheimer, 1957; Mai, 1999a, 2001a), but without detailed observation of pericarp sculpture in this species this assumption cannot be confirmed.

Family Caryophyllaceae Jussieu, 1789

Moehringia Linnaeus, 1753

Moehringia miocaenica Mai in Mai and Walther, 1991

Fig. 15J, L

Material: Tet.k 1287–2 seeds (det. Czaja); Tetta I/8–1 seed (MZ VII/134/286).

Description and Remarks: See Mai and Walther (1991).

Distribution: Central Europe, from the upper Oligocene to the Middle Miocene (Mai, 2001a).

Family Nyssaceae Jussieu ex Dumortier, 1829

Genus *Eomastixia* Chandler, 1925

Eomastixia saxonica (Menzel) Holý, 1975a

Fig. 17A–C

Material: Tet.k–1199, 1231–8 specimens; Tetta III/11–5 fruits (MZ VII/134/271); Tetta VII/12–101 (MZ VII/134/270).

Description: See Mai (2000a).

Remarks: Seven species of *Eomastixia* have been described in Europe from the lower Eocene to the Upper Miocene, including four species, restricted to the Neogene (Mai, 1993). According to Mai (2000a), size is the major, but not always conclusive criterion for distinguishing between species,

Eomastixia hildegardis (Unger) Holý, 1975a and *E. saxonica* are an example of this. According to Holý (1975a), *E. hildegardis* can be separated from *E. saxonica* on the basis of smaller (9–30 mm x 8–16 mm) and narrower (L:W ratio 1.7–2.1) endocarps. However, in the opinion of the present authors, diagrams provided by this author do not present clearly separated clusters that would justify distinguishing *E. hildegardis* (see Holý, 1975a, text-fig. 9) from *E. saxonica*.

Looking through the large assemblage of *E. saxonica* from Turów, the authors have observed a wide range of sizes and shapes of endocarps. They can be separated into narrow (L:W ratio ≥ 2) in the type of *E. hildegardis*, broad (L:W ratio ≤ 1.6) in the type of *E. saxonica*, and intermediate. What is striking is that a significant number of the narrow type endocarps were longer than 3 cm. They have had relatively thin walls in comparison with the broad specimens, and those, which were examined in cross-section, had strongly constricted or clenched locules. Most of the studied specimens were eroded to varying degrees, so that they enabled a closer look into the pericarp structure (see also Kirchheimer, 1934, fig. 5). The authors could distinguish three types of preservation, depending on which layer is exposed. The most nearly complete endocarps were relatively smooth, covered only with wrinkles, which indicates that the most external layer consists of continuous, woody tissue. If the most external layer were lacking, the layer of longitudinal, relatively delicate lamellas would be exposed. The innermost part of the pericarp consists of a compacted and continuous, woody layer around locules. When comparing the isolated internal part with the complete pericarp, it is only slightly shorter but has half its width, which matches the proportion of *E. hildegardis*.

It is worth noting that narrow specimens can be also related to single-loculed fruits (Kirchheimer, 1934; Holý, 1975a; Mai, 1993).

The observation by the authors indicates that *E. hildegardis* may represent single loculed and eroded endocarps of *E. saxonica* (see also Kirchheimer, 1957).

Distribution: Central Europe, from the Lower to Middle Miocene (Mai, 2001a).

Genus *Mastixia* Blume, 1825

Mastixia amygdalaeformis (Schloth.) Kirchheimer, 1957

Figs 15R–T, 17F, H–J

Material: Tet.k 1195, 1204, 1235, 1248, 1261–44 specimens; Tetta IV/1–2 fruits (MZ VII/134/204); Tetta IV/2–3 fruits (MZ VII/134/206); Tetta IV/3–1 fruit (MZ VII/134/207); Tetta VI/6–17 fruits (MZ VII/134/205); Tetta I/8–13 fruits (MZ VII/134/208); Tetta III/11–41 fruits (MZ VII/134/210); Tetta VII/12–255 fruits (MZ VII/134/209).

Description: Endocarps elliptic, ovate, rarely fusiform, 8–19 mm long and 4.5–9 mm wide, mostly apically rounded. Sculpture variable, from nearly smooth to ribbed, uneven (ribs low or absent in the upper part, increase toward the base). Wall thickness varies, 1–2 mm. Endocarp infold straight or t-shaped in cross-section.

Remarks: Fruits among living *Mastixia* are quite uniform and cause serious problems in distinguishing between

species (Eyde, 1963; Matthew, 1976). The length of fruits in most species is between 1.5–3.5 cm, only *M. macrocarpa* Matthew, 1976 (4–4.5 cm) and *M. microcarpa* Liu and Peng, 2009 (0.5–0.6 cm) stand out in this respect. On the other hand, the difference between the smallest and the biggest fruits within one species can reach up to 2 cm (Matthew, 1976; Xiang and Boufford, 2005). Sculpture of the stones also varies between species, but still can be used only to separate a group of species (Kirchheimer, 1936). Characteristic of dorsal infold enables differentiation only between subgenus *Mastixia* and subgenus *Manglesia* (Matthew, 1976; Manchester and Collinson, 2019).

Mai (1970a) divided the fossil *Mastixia* fruits into two morphological groups, depending on the type of the apex. Those with rounded apex are represented by *M. menzelii* Kirchheimer, 1934, *M. thomsoni* Mai, 1970a and *M. meyeri* Kirchheimer, 1939, whereas *M. lusatica* Mai, 1970a, *M. amygdalaeformis*, and *M. boveyana* Chandler, 1957 represent the pointed-apex group. Species within each group are further separated in respect of size, shape, pericarp thickness, sculpture, and germination valve width.

Most endocarps found at Tetta represent the rounded-apex group. Analyzing the largest and most morphologically diverse assemblage from sample VII/12, the authors found that 75% of endocarps have rounded apex and more than 64% of them are below 1.3 cm, which places them within the range of *M. meyeri*. The remaining endocarps with respect to their length correspond to *M. thomsoni* (or *M. venosa* Holý, 1982). Only 10% of endocarps from sample VII/12 belong to the pointed-apex group and they are between 1.2–1.6 cm long, which places them within the range of *M. amygdalaeformis*.

In respect of endocarp thickness, the specimens of the authors correspond with *M. meyeri*, *M. thomsoni*, and *M. amygdalaeformis*.

Sculpture varies but it is rather not a specific trait; it results from the degree of abrasion.

On the basis of criteria proposed by Mai (1970a), morphological variability observed among endocarps from Tetta caused a serious problem of identification. The assemblage could be separated into *M. meyeri*, *M. thomsoni*, and *M. amygdalaeformis*, but this would be rather an unusual situation, difficult to reconcile with stratigraphic ranges.

Considering the characteristics of *M. thomsoni* and *M. meyeri* available in the literature, the authors believe that they are similar enough to be regarded as one species (see also Mai, 1970a). The fact that endocarps of both these types occur at Tetta in the same layer could further confirm this claim. The authors also cannot exclude the possibility that these species could be also equated with *M. venosa* from the middle Oligocene of Počerný/Czechia (Holý, 1982). Treating endocarps from Počerný as separate species seems unjustified, since they have been found only there and morphologically are very close to *M. thomsoni* and *M. meyeri*. Holý (1982) agreed with this, but refrained from equating these species, owing to the difference in preservation mode.

Studying endocarps from Turów, Wiesa, and Hoyerswerda (Museum of the Earth collection), the authors found that the apical process is relatively loosely connected with endocarp and the more poorly preserved the specimens, the easier the

apical process can be separated. This would explain why in the assemblage of highly abraded endocarps from Tetta, specimens with rounded apex (in the type of *M. thomsoni* and *M. meyeri*) significantly outnumber those with a pointed apex (in the type of *M. amygdalaeformis*). Considering this, it seems very likely that *M. thomsoni* and *M. meyeri* could be equated with *M. amygdalaeformis*. However, there is still the question of the difference in cellular structure between *M. amygdalaeformis* and *M. meyeri*, indicated by Kirchheimer (1957). Resolving this required an examination of type materials and goes beyond the scope of this paper. Moreover, the diagnostic value of the characters used so far in distinguishing between fossil-species should be also tested on living representatives.

With these in mind, the authors only provisionally assign all the endocarps documented here to *M. amygdalaeformis*.

Distribution: Central Europe, from the upper Oligocene to the Middle Miocene (Mai, 2001a).

Genus *Nyssa* Linnaeus, 1753

Nyssa ornithobroma Unger, 1861

Fig. 17D, E

Material: Tetta VI/6–2 specimens (MZ VII/134/269).

Description and Remarks: See Mai and Gregor (1982).

Distribution: Europe from the middle Oligocene to the Upper Miocene (Mai, 2001a).

Genus *Tectocarya* Kirchheimer, 1935b

Tectocarya elliptica (Ung.) Holy, 1975a

Fig. 17O

Material: Tet.k 1210, 1240–4 specimens; Tetta VI/6–1 specimen (MZ VII/134/273); Tetta III/11–1 specimen (MZ VII/134/272).

Description and Remarks: See Mai (2000a).

Distribution: Central Europe, from the Lower to Upper Miocene (Mai, 2001a).

Family Pentaphylacaceae Engler, 1897

Genus *Eurya* Thunberg, 1783

Eurya stigmosa (Ludwig) Mai, 1960

Fig. 15K, M

Material: Tet.k 1222, 1245, 1271, 1305–45 specimens; Tetta IV/1–1 seed (MZ VII/134/275); Tetta IV/2–8 seed (MZ VII/134/277); Tetta IV/3–3 seeds (MZ VII/134/278); Tetta I/8–1 seed (MZ VII/134/280); Tetta VI–2 seeds (MZ VII/134/279); Tetta III/11–31 seeds (MZ VII/134/281).

Description and Remarks: See Mai (1997).

Distribution: Europe, from Paleocene to Pliocene (Mai, 2001a).

Genus *Ternstroemia* Mutis ex Linnaeus.f., 1782

Ternstroemia sequoioides (Engelhardt)

Bůžek and Holý in Bůžek et al., 1996

Fig. 15Q

Material: Tet.k 1220, 1252–7 specimens; Tet.k 1294, 1295–8 specimens (det. Czaja, 1999); Tetta IV/1–3 seeds

(MZ VII/134/293); Tetta IV/3–2 seeds (MZ VII/134/296); Tetta I/8–1 seed (MZ VII/134/295); Tetta III/11–1 seed (MZ VII/134/294).

Description and Remarks: See Mai (2000a).

Distribution: West and Central Europe, from the lower Oligocene to the Middle Miocene (Mai, 2001a).

Family Symplocaceae Desfontaines, 1820

Genus *Symplocos* Jacquin, 1760

Symplocos casparyi Ludwig, 1857

Fig. 15N–P

Material: Tet.k 1207, 1239, –62 specimens; Tetta IV/1–7 specimens (MZ VII/134/213); Tetta IV/2–3 specimens (MZ VII/134/214); Tetta IV/3–4 specimens (MZ VII/134/215); Tetta II/4–10 specimens (MZ VII/134/216); Tetta VI/6–14 specimens (MZ VII/134/217); Tetta I/8–8 specimens (MZ VII/134/218); Tetta III/11–97 specimens (MZ VII/134/219); Tetta VII/12–69 specimens (MZ VII/134/220).

Description and Remarks: See Mai and Martinetto (2006).

Distribution: Europe, from the upper Oligocene to the Upper Pliocene (Mai and Martinetto, 2006).

Symplocos minutula (Sternberg) Kirchheimer, 1957

Fig. 16G

Material: Tetta I/8–1 specimen (MZ VII/134/221).

Description and Remarks: See Mai and Martinetto (2006).

Distribution: Europe, from the upper Oligocene to Pliocene (Mai and Martinetto, 2006).

Symplocos pseudogregaria Kirchheimer, 1938

Fig. 16F

Material: Tet.k 1208–1 specimen; Tetta III/11–2 specimens (MZ VII/134/212); Tetta VI/6–4 specimens (MZ VII/134/267).

Description: Fruits elliptic, slightly compressed, ca. 11 mm long and 5 mm wide. Apical pit 3 mm wide. Surface knobbed. Mesocarp thin, endocarp thicker, 4-loculed.

Remarks: These fruits correspond to *Symplocos pseudogregaria*, which is evidenced by size, number of locules, thin mesocarp, and a relatively narrow apical pit. According to Mai and Martinetto (2006), this species has been reported in Germany, the Czech Republic, Poland, and Austria from the upper Eocene to the Middle Miocene.

Symplocos scherereri Kirchheimer, 1935c

Fig. 16D, E

Material: Tet.k 1209–1 specimen; Tetta IV/1–4 specimens (MZ VII/134/222); Tetta IV/2–6 specimens (MZ VII/134/223); Tetta VI/6–3 specimens (MZ VII/134/224); Tetta III/11–9 specimens (MZ VII/134/225); Tetta VII/12–5 specimens (MZ VII/134/226).

Description and Remarks: See Mai and Martinetto (2006).

Distribution: Europe, from the Lower Miocene to the Middle Pliocene (Mai and Martinetto, 2006).

Family Styracaceae Candolle and Sprengel, 1821

Genus *Rehderodendron* Hu, 1932a

Rehderodendron ehrenbergii (Kirchheimer) Mai, 1970a

Fig. 17K, L

Material: Tet.k 1196–1 specimen; Tetta III/11–7 specimens (MZ VII/134/240); Tetta VII/12–2 specimens (MZ VII/134/241).

Description: See Mai (1970a).

Remarks: The affinity of these characteristic endocarps is clear and without a doubt, they can be assigned to *Rehderodendron*. Five fossil-species of this genus have been distinguished in the European Cenozoic (Mai, 1970a; Holý, 1975b; Mai and Petrescu, 1983). They were separated on the basis of the shape and length of the styler cone, number and shape of ribs, the relation between locules and fruit dimensions, and the number of locules, but the length of fruits was considered by Mai (1970a) and Mai and Petrescu (1983) as a major trait. The literature shows, however, that fruits in most living species are generally comparable in respect of size (4–8 cm long), only *R. indochinense* Hui-Lin, 1943 is significantly larger (7.5–11 cm long; Hwang and Grimes, 1996). There is also a wide range of length between the smallest and the biggest fruits and can reach up to 5.5 cm within one species (3.5–9 cm in *R. macrocarpum* Hu, 1932b; Hwang and Grimes, 1996). Arrangement and number of ribs can be regarded as diagnostic only for some species (see *R. truongsongense*, Zhao *et al.*, 2019).

Using the morphological key provided by Mai and Petrescu (1983), specimens from Tetta should be assigned to *R. ehrenbergii*. However, a cursory survey of the fruit variability among living *Rehderodendron* summarized above indicates that the classification of the fossil *Rehderodendron* species in European Cenozoic should be carefully re-examined.

Distribution: Central Europe, only in Miocene (Mai, 2000a).

Genus *Pterostyrax* Siebold and Zuccarini, 1835

Pterostyrax coronatus Mai in Mai and Walther, 1985

Fig. 18A–E

Material: Tetta IV/1–139 specimens (MZ VII/134/236); Tetta IV/2–33 specimens (MZ VII/134/230); Tetta IV/3–16 specimens (MZ VII/134/238); Tetta VI/6–20 specimens (MZ VII/134/234); Tetta III/11–10 specimens (MZ VII/134/282).

Description: Endocarps up to 12 mm long and 4 mm wide, with 7–11 thin, longitudinal ribs. Base not preserved, apical rostrum up to $\frac{1}{3}$ of the endocarp length, generally more or less rounded at the apex. Endocarp three-layered, internal layer consist of small, thick-walled cells, middle layer consists of fibrous cells parallel to the endocarp surface, external layer, the thickest, consist of fibrous cells perpendicular to the endocarp surface. Endocarps 3-locular.

Remarks: These endocarps are much less compacted, but more abraded than are those described above. They correspond to *Pterostyrax coronatus* with respect to size, the number of ribs, and elongated rostrum (Mai and Walther, 1985, 1991; Mai, 1998).

Pterostyrax coronatus is known from the upper Eocene of Borna-Ost, the Oligocene of Liebenwerda and Delitzsch-Süd and the Lower Miocene of Delitzsch-Nordwest (Mai and Walther 1985, 1991; Mai 1998).

Family Actinidiaceae Engler and Gilg, 1924
Genus *Actinidia* Lindley, 1836
Actinidia faveolata C and E. M. Reid, 1915
Fig. 18H, J

Material: Tet.k 1278–10 specimens (det. Czaja, 1999); Tetta IV/2–1 specimen (MZ VII/134/265); Tetta VI/6–3 specimens (MZ VII/134/266).

Description and Remarks: See Reid and Reid (1915) and Mai (1997).

Distribution: Europe, from the upper Oligocene to the Lower Pleistocene (Mai, 2008).

Family Ericaceae Jussieu, 1789
Genus *Leucothoe* D. Don, 1834
Leucothoe narbonensis (Saporta) Weyland, 1943
Fig. 18F, G

Material: Tet.k 1300–4 specimens (det. Czaja 1999); Tetta IV/1–2 specimens (MZ VII/134/284); Tetta IV/2–2 specimens (MZ VII/134/285).

Description and Remarks: See Mai (2000a).

Distribution: Europe, from the middle Oligocene to the Upper Miocene (Mai, 2000a).

Genus *Oxydendrum* Candolle, 1839
Oxydendrum europaeum Van der Burgh, 1983
Fig. 18K

Material: Tetta IV/3–4 fruits (MZ VII/134/242).

Description: Capsules elongate-ovoid, 3.5–4.9 mm long and 2–3 mm wide, five-locular, loculicidally dehisce. Calyx not articulated with pedicel, sepals short, narrow, ca. 1 mm long. Pedicel length more or less equal to the capsule, curved. Placenta at the base of the capsule.

Remarks: These fruits are devoid of seeds, but in the opinion of the authors, they can be quite confidently assigned to *Oxydendrum* on the basis of the elongated shape of capsules, curved pedicel, and basal placenta (see Kron *et al.*, 2002). Fossil representative of this genus has been documented on the basis of carpological remains of *O. europaeum* from the Pliocene of the Lower Rhine Basin (Van der Burgh, 1983), with which the specimens from Tetta correspond well. Very similar fruits were also observed by the first author among unpublished materials from the upper Oligocene flora at Rębiszów (Kowalski *et al.*, 2020).

Family Lamiaceae Martinov, 1820
Genus *Teucrium* Linnaeus, 1753
Teucrium aff. *martinae* Mai, 2001a
Fig. 19B

Material: Tetta I/8–3 specimens (MZ VII/134/243–245).

Description: Nutlets ovate, 1.9–2.5 mm long and 0.9–1.1 mm wide. Abscission scar, large, up to three-quarters of the fruit

length, oval. Ribs alveolate in the upper part, longitudinal in the lower part of the nuts, parallel to the length of the nut. Alveoli relatively shallow, more elevated at the upper margin of nut, trichomes rarely within some of them.

Remarks: Ornamentation and the characteristic of an abscission scar relate these nutlets to the subfamily Ajugoideae. The size of the nutlets and especially the length of the abscission scar relates the fossils of the authors with *Teucrium martinae*, except that nutlets of this species are broader and have less pronounced ornamentation. On the other hand, *Teucrium martinae* was described on the basis of a single specimen from the Middle Miocene of Klettwitz, therefore the authors suspect that the morphological variability of this species has not been fully recognized.

There may be some questions as to the generic assignment of these fossils, because comparable nutlets can be also found among other living Ajugoideae. From cursory comparisons representatives of *Ajuga* Linnaeus, 1753, *Schnabelia* Handel-Mazzetti, 1921, *Amethystea* Linnaeus, 1753, *Trichostema* Gronovius, 1753 (Wojciechowska, 1966; Martin *et al.*, 1994; Xiang *et al.*, 2018), *Discretitheca* Cantino in Cantino and Wagstaff, 1999, *Tripora* Cantino in Cantino and Wagstaff, 1999 (Harley *et al.*, 2004) seemed to us equally close to the fossils of the authors. However, more precise conclusions on relationships required extensive comparative studies, with special reference to nutlets micromorphology which was not possible considering the preservation state of the fossils of the authors.

Genus *Collinsonia* Linnaeus, 1753
Collinsonia cf. *europaea* Mai in Mai and Walther, 1991
Fig. 19A

1991 *Collinsonia europaea* sp. nov. – Mai in Mai and Walther, p. 125, pl. 15, fig 17.

Material: Tetta IV/1–2 specimens (MZ VII/134/246–247).

Description: Nutlets round, compressed, 1.9–2 mm in diameter, delicate reticulum on the surface, abscission scar poorly visible.

Remarks: The size, shape, and ornamentation of these fossils most closely resemble those in *Collinsonia europaea*, but poor preservation and how both specimens are compacted caused that the present authors have some doubts about the presence of an abscission scar.

This taxon has been reported in a few sites in Germany from the upper Oligocene (Mai and Walther, 1991) to Pliocene (Gümbel and Mai, 2004).

While the authors have rather no doubt that morphologically *Collinsonia europaea* corresponds with representatives of the tribe Elsholtzieae, they are careful about the generic affinity proposed by Mai (1991). According to Jeon *et al.* (2020) distinguishing between genera of this tribe is problematic, if based only on general morphology, even if supported by analysis of nutlets micromorphology.

Family Aquifoliaceae Berchtold and Presl, 1825
Genus *Ilex* Linnaeus, 1753
Ilex aff. *lotschii* Mai, 1970a
Fig. 20A

1970a *Ilex lotschii* sp. nov. – Mai, p.458, pl. 60, figs 11–13.

Material: Tetta I/8–1 specimen (MZ VII/134/248).

Description: Pyrene elliptic, compressed laterally, 6.6 mm long, and 3 mm wide, pointed at the apex, base rounded, with small tip turned towards the ventral margin. Lateral sides with faint, longitudinal lines and slight wrinkles, dorsal side with sharp, longitudinal rib, hardly discernible due to the compression.

Remarks: This pyrene in respect of ornamentation corresponds with *Ilex lotschii*, except that it is slightly bigger. One of the major features used by Mai (1970a) in the classification of the fossil pyrenes of *Ilex* is the angle, formed by lateral walls. Since all *Ilex* pyrenes found in Tetta are more or less compressed, it was difficult to determine this angle. However, the observations of the authors suggest that pyrenes, which were described as having an acute angle, are compressed laterally, but those, which were described as having a right angle, are compressed dorsoventrally.

Ilex lotschii has been reported so far from the Lower (floristic zone VII) and Middle (f.z. XI, XII) Miocene of Lusatia (Mai, 1970a, 2000a).

Ilex ovidrupacea Mai, 1970a

Fig. 19C, F

1970a *Ilex ovidrupacea* sp. nov. – Mai, p. 458, pl. 60, figs 5–9, pl. 61, fig. 4.

Material: Tet.k 1201–1 specimen, Tet.k 1297–1 specimen (det. Czaja 1999); Tetta IV/1–1 specimen (MZ VII/134/249); Tetta I/8–3 specimens (MZ VII/134/250); Tetta III/11–2 specimens (MZ VII/134/251); Tetta VII/12–1 specimen (MZ VII/134/252).

Description: Pyrenes elliptic, compressed dorsoventrally, 5–6 mm long and 2.9–3.2 mm wide, abruptly narrowed into a short, triangular apex. Lateral walls with faint knobs, longitudinal ornamentation lacking; dorsal side with delicate longitudinal, low ridges.

Remarks: The way the specimens are flattened indicates that the lateral walls were originally (see above) at a right angle. Size and ornamentation relate these pyrenes to *Ilex ovidrupacea*. This species has been reported from the lower (f.z. VI) to Middle Miocene of Germany (Lusatia and Upper Palatinate; Mai, 1970a, 2000a, 2001a; Gregor, 1978a).

Ilex saxonica Mai, 1964

Fig. 16H

1964 *Ilex saxonica* sp. nov. – Mai, p. 33, pl. 2, figs 2, 19–21, pl. 6, figs 7, 8.

Material: Tetta IV/2–1 specimen (MZ VII/134/253); Tetta II/4–1 specimen (MZ VII/134/254); Tetta I/8–1 specimen (MZ VII/134/255).

Description: Pyrenes semicircular, laterally compressed, 4.9–6.2 mm long and 2.9–3.2 mm wide, abruptly narrow into a short, triangular apex. Lateral sides with 1–2 ribs, dorsal side with longitudinal, winglike ribs.

Remarks: The authors relate these pyrenes with *Ilex saxonica* on the basis of moderate size (up to 5 mm in length),

acute angle between lateral walls, and well-expressed ribs on lateral and dorsal sides (Mai, 1970a). This relatively common species has been reported from the upper Oligocene (Mai and Walther, 1991) to the Middle Miocene (Mai, 2000a) of Lusatia.

Family Araliaceae Jussieu, 1789

Genus *Aralia* Linnaeus, 1753

Aralia rugosa Dorofeev, 1963

Fig. 19G, H

1963 *Aralia rugosa* sp. nov. – Dorofeev, p. 245, pl. 43, figs 13–16.

Material: Tetta I/8–2 specimens (MZ VII/134/257, 259); Tetta III/11–1 specimen (MZ VII/134/258).

Description: Endocarps semicircular, 1.9–2 mm long, and 1–1.1 mm wide, apex rounded, with short beak on a ventral side. Surface rough, silky shine, transversely striated, additionally with minute, continuous or intermittent folds, parallel to the dorsal margins nearly over the entire length of endocarp sides.

Remarks: These two specimens with respect to small size, robust construction of the walls, and the folded surface most closely correspond to the endocarps of *Aralia rugosa*, which has been documented so far only from the Oligocene and Miocene of the Western Siberia (Dorofeev, 1963).

Aralia lusatica Mai in Mai and Walther, 1991

Figs 19E, 20D

1991 *Aralia lusatica* sp. nov. – Mai in Mai and Walther, p. 114, pl. 14, fig 21.

Material: Tetta IV/1–8 specimens (MZ VII/134/260); Tetta IV/3–1 specimen (MZ VII/134/261).

Description: Endocarps semicircular to narrowly semicircular, 2.2–3 mm long and 1.2–2 mm wide, apically, and basally rounded. Dorsal margin not thickened. Surface rough-pitted and transversely striated. Wall moderately thick.

Remarks: Considering the above characteristics, these endocarps can be related to *Aralia lusatica*, species that have been reported in the upper Oligocene to Lower Miocene sediments of Germany (Mai, 1997, 2008).

Aralia intermedia Dorofeev, 1963

Fig. 20E

1963 *Aralia intermedia* sp. nov. – Dorofeev, p. 246, pl. 43, figs 22–30.

Material: Tetta IV/1–1 specimen (MZ VII/134/256).

Description: See Dorofeev (1963).

Remarks: Considering size (3 x 1.9 mm), slightly elongated shape, knobbed surface, and especially thickened dorsal margin, this endocarp corresponds with *Aralia intermedia*, a species that has been described from the Oligocene to Lower Miocene of the Western Siberia (Dorofeev, 1963). The thickened dorsal margin relates *Aralia intermedia* to *A. tertiaria* Dorofeev, 1963; the only difference between these two species is in the surface ornamentation (knobby versus nearly smooth).

Genus *Pentapanax* Seemann, 1864

Pentapanax tertiaris Mai, 1973

Fig. 20G

1973 *Pentapanax tertiaris* sp. nov. – Mai, p. 107, pl. 4, figs 1–3.

Material: Tet.k 1301–1 specimen (det. Mai D.H. 01.03.2000); Tetta IV/3–1 specimen (MZ VII/134/262); Tetta I/8–2 specimens (MZ VII/134/263).

Description: See Mai (1973, 2000a).

Remarks: Considering the relatively large size, semicircular shape, thin walls, and smooth and transversely striated surface, these endocarps most closely resemble *Pentapanax tertiaris*. This stratigraphically long-enduring species has been reported from several sites in Germany and France from the upper Eocene (Mai and Walther, 1985) to Pliocene (Mai and Walther, 1988).

Genus *Schefflera* J. R. Forster and G. Forster, 1776

Schefflera dorofeevii Łańcucka-Środoniowa, 1975

Fig. 20F

1975 *Schefflera dorofeevii* sp. nov. – Łańcucka-Środoniowa, p. 107, pl. 1, figs 10–13.

Material: Tetta IV/3–2 specimen (MZ VII/134/264).

Description: See (Łańcucka-Środoniowa, 1975).

Remarks: The authors related this endocarp with *Schefflera dorofeevii* on the basis of its size, elongated shape, extremely thin walls, smooth and flat surface, and longitudinal striation. Endocarps of this type have been reported so far from the upper Oligocene to Middle Miocene of Poland, Germany, and Czechia (Łańcucka-Środoniowa, 1975; Knobloch, 1981; Mai and Walther, 1991; Czaja, 2003).

Family Apiaceae Lindley, 1836

Genus *Umbelliferopsis* Gregor, 1982

Umbelliferopsis molassicus Gregor, 1982

Fig. 19D

1982 *Umbelliferopsis molassicus* sp. nov. – Gregor, p. 122, pl. 13, figs 26–33, text-fig. 11.

Material: Tetta IV/1–1 specimen.

Description and Remarks: See Gregor (1982).

Distribution: Central Europe, from the Lower (Wiesau-Eichelskopf floristic complex) to Middle Miocene (Czaja, 2003).

Family Adoxaceae E. Meyer, 1839

Genus *Sambucus* Linnaeus, 1753

Sambucus lucida Dorofeev, 1963

Fig. 20B, C

1963 *Sambucus lucida* sp. nov. – Dorofeev, p. 272, pl. 48, figs 1–14.

Material: Tet.k 1218–4 specimens; Tetta I/8–3 specimens; Tetta III/11–2 specimens

Description: Endocarps elliptic or triangular, 1.9–2.2 mm long and 0.9–1 mm wide, L/W ratio 2–2.2. Surface black, matt, or semi-lustrous, lumped; lumps connected and arranged in transverse, 12–17 ridges.

Remarks: Considering the size and well-expressed, robust ornamentation, these endocarps more closely correspond with *Sambucus lucida*. According to Dorofeev (1963), *S. lucida* differs from other species in that it has a lustrous and more ornamented surface. On the other hand, the difference between this species and *S. pulchella* C. and E. M. Reid, 1915 seems so small that they may as well be considered as one species. This problem could be resolved by surface microstructure analysis, (see Huang *et al.*, 2012). Dorofeev (1963) compared *S. lucida* with living *S. ebulus* Linnaeus, 1753, *S. chinensis* Lindley, 1826 and *S. nigra* Linnaeus, 1753, but considering characteristics and illustrations provided by Huang *et al.* (2012) seeds from Tetta seem to be closer to *S. buergeriana* Blume ex Nakai, 1926.

Distribution: Central Europe, from the upper Oligocene to Pliocene (Mai, 2001a).

FUNGAL REMAINS

Family ? Microthyriaceae Saccardo, 1883

Genus *Phragmothyrites* Edwards, 1922

Phragmothyrites cf. *concentricus*

Phipps and Rember, 2004

Fig. 21H, I

? 2004 *Phragmothyrites concentricus* sp. nov. – Phipps and Rember, pp. 69–72, figs 1–5.

Material: Tetta IV/3–(MZ VII/134/319₁₋₂; on cuticle of *Tsuga* sp.).

Description: Sporocarps suborbicular, entire-margined. Scutellum composed of both isodiametric and rectangular cells (*textura angularis/prismatica*). Cell walls straight or rounded. Ostiole absent.

Remarks: These fungal remains in respect of the morphology of sporocarps, especially shape, are similar to *Phragmothyrites concentricus* Carlie J. Phipps and Rember, described from Miocene of Idaho (Phipps and Rember, 2004). Owing to some differences in cellular structure of scutellum, the determination of the species is only tentative.

Family Micropeltidaceae Clements and Shear, 1931

Genus *Plochmopeltinites* Cookson, 1947

Plochmopeltinites cf. *masonii* Cookson, 1947

Fig. 21J

? 1947 *Plochmopeltinites masonii* sp. nov. – Cookson, p. 212, pl. 13, fig. 14.

Material: Tetta IV/3–(MZ VII/134/319₃; on cuticle of *Tsuga* sp.).

Description: Sporocarps orbicular to suborbicular, scutellum composed of elongated cells with strongly undulate walls (*textura epidermoidea*). Ostiole central, roundish. Collar distinct, dark.

Remarks: The morphology of above described fungal sporocarps corresponds to the fossil-genus *Plochmopeltinites* (scutellum composed of cells with undulate walls and distinct ostiole) and probably the fossil-species *Plochmopeltinites masonii* Cookson (Cookson, 1947; Kalgutkar and Jansonius, 2000).

Fungi *incertae sedis*Genus *Pesavis* Elsik and Jansonius, 1974*Pesavis tagluensis* Elsik and Jansonius, 1974

Fig. 22Z–BB

1974 *Pesavis tagluensis* sp. nov. – Elsik and Jansonius, p. 956, pl. 1, fig. 5.

Material: Tetta IV/3.

Description: Multicellular fungal remain, most probably conidium, composed of dark and thick-walled sell. A central cell with remnant of the attachment to stalk, bearing two septate crescentic arms with hyphae-like projections, each of some two to four cells, stretch toward the centre of the conidium.

Remarks: The morphology of these fungal remains is so unique that it surely represents the fossil-species *Pesavis*

tagluensis Elsik and Jansonius (Elsik and Jansonius, 1974). No modern counterpart to *Pesavis tagluensis* is known, but Smith and Crane (1979) suggest that it probably represents conidium of an extinct aero-aquatic fungus. *Pesavis tagluensis* is a good stratigraphic proxy, because it is practically only found in the Paleogene, ranging from Paleocene till upper Oligocene (Smith and Crane, 1979; Kalgutkar and Sweet, 1988; Ediger and Alişan, 1989; Pole *et al.*, 1993; Macphail and Hill, 1994; Kalgutkar and Jansonius, 2000). The only Neogene record of *Pesavis* concerns Middle Miocene Brassington Formation, United Kingdom (Pound *et al.*, 2022). However, it cannot be ruled out that the remains of *Pesavis tagluensis* found in Brassington Formation are in fact redeposited from older sediments. In contrast, the excellent state of preservation of *Pesavis tagluensis* from Tetta appears to exclude its redeposition.

Table S1

Palaeobotanical sites in the Tetta Clay Pit, collected by staff members of the State Natural History Museum Görlitz (1998–2006) and R. Kowalski (2018, 2019). The fossil finds from 2002 to 2006 have not yet been prepared or determined. Grey: important carpological site locality. DB = Dirt Band, C = Clay Seam, by C2 with sand bed numbers (compare with Fig. 2). Gauss-Krüger coordinates (Bessel Ellipsoid, DHDN, Potsdam Date).

Site	Coll. date	East	North	Altitude	Locality	Lithostratigraphic unit	Lithology
00	1998–2000	5479703	5672783	180–183 m	Initial pit, NE-corner	DB 1	Sand slope with dark coaly silt intercalations
0a1	24.09.2002	5479642	5672615	175 m	Old pit entrance from NE	DB 1	sand fan with carpological remnants
0a2	24.09.2002	5479641	5672591	177 m	Central part of pit	DB 1	lower sand lens (9 m thick)
0b	15.04.2004	5479789	5672589	178–183 m	New pit entrance from SW	DB 1	Sand with clay-silt, leaf, detritus lenses
0c1	15.04.2004	5479795	5672658	178–180 m	Central part of pit	DB 1	Sand with clay lenses with leaves (<i>Fagus</i>)
0c2	15.04.2004	5479778	5672675	176 m	3 m above deepest pit point (pump sump)	C1	Clay sample (04/04/15–4)
0d	15.04.2004	5479745	5672702	170–178 m	Old pit entrance from NW, N-slope	DB 1	Sand fan (with carpological samples)
0e	15.04.2004	5479908	5672694	173–179 m	SE corner of pit	DB1+2, C1	17 m profile documentation (carpological remains)
0f	06.12.2006	5479876	5672577	168 m	3 rd (lowest) slope	DB2	without fossils
0g	06.12.2006	5479859	5672638	168 m	3 rd (lowest) slope	Top of DB2	with leaves + carpo fossils in dark clay lenses
I	13.06.2018	5479769	5672240	179 m	New pit entrance from SW	C2–2, lower part	sand and gravel with organodetritic components
II	13.06.2018	5479881	5672292	165 m	Central part of pit, 2m above lowest point	DB3–5 (marginal thinning)	sandy layers with dark clay + plant fragments and <i>Fagus</i>
III	13.06.2018	5479846	5672225	176 m	SE corner of pit	DB1 (synclinale position)	local sand-gravel lenses with coaly silt + sand layers

Site	Coll. date	East	North	Altitude	Locality	Lithostratigraphic unit	Lithology
IV	13.06.2018	5479852	5672336	163 m	Western pit part, lowest pit point	DB2 (upper part)	Sand + gravel with dark sandy-clay-silt intercalations
IVa	13.06.2018	5479871	5672327	162 m	Western pit part, lowest pit point	DB2 (middle part)	sand with small dark clay-silt intercalations and xylites
V	17.10.2018	5479913	5672235	179 m	Southeastern pit part, 1 st (highest) slope	C2–3 (lower boundary)	Black-brown silty clay
VI	17.10.2018	5479916	5672270	172 m	Southeastern pit part, 2 nd (middle) slope	C2–3 (middle part)	Sand + gravel with dark clay-silt intercalations and xylites
VII	05.06.2019	5479991	5672396	180 m	Eastern pit part, 1 st (highest) slope	DB1 (lower remnant)	middle-coarse sand with organodetritic layers

Table S2

The list of taxa new to Tetta, found among unpublished materials, collected by Alexander Czaja and Olaf Tietz between 1998–1999, with the Senckenberg Museum für Naturkunde numbers.

<i>Carpolites antiquorum</i> (Heer) Czaja	Tet.k 1228	<i>Selaginella lusatica</i> Mai	Tet.k 1290
<i>Cephalanthus pusillus</i> Friis	Tet.k 1217, 1312, 1316	<i>Solanispermum reniforme</i> Chandler	Tet.k 1303
<i>Engelhardia macroptera</i> (Brongniart) Unger	Tet.k 1225, 1306	<i>Spirematospermum wetzleri</i> (Heer) Chandler	Tet.k 1216
<i>Magnoliaspermum geinitzii</i> (Engelhardt) Kirchheimer	Tet.k 1260	<i>Symplocos germanica</i> Mai	Tet.k 1251
<i>Physalis pliocenica</i> Szafer	Tet.k 1319		

Table S3

The list of taxa documented at Tetta, including (1) taxa published by Czaja and Berner (1999) and Czaja (2000, 2001); (2) published only by Leder (2009), only partially verified by the present authors; (3) taxa identified by A. Czaja (1999–2000) or D. H. Mai (2000) and (4) unidentified among unpublished materials collected by A. Czaja, O. Tietz, R. Leder and J. Czossek between 1999–2006; (5) taxa identified among materials collected between 2018–2019.

Fossil taxon	1	2	3	4	5	Fossil taxon	1	2	3	4	5
<i>Abies resinosa</i>	X					<i>Meliosma messleri</i>	X				X
<i>Acer</i> aff. <i>angustilobum</i>					X	<i>Meliosma pliocaenica</i>	X				X
<i>Acer</i> sp.					X	<i>Microdiptera</i> aff. <i>parva</i>					X
<i>Acer hercynicum</i>					X	<i>Microdiptera lusatica</i>					X
<i>Actinidia faveolata</i>				X	X	<i>Microdiptera minor</i>					X
<i>Alnus kefersteinii</i>	X					<i>Moehringia miocaenica</i>			X		X
<i>Alnus latibracteosa</i>					X	<i>Myrica stoppii</i>					X
<i>Alnus lusatica</i>					X	<i>Nyssa ornithobroma</i>					X
<i>Ampelopsis rotundata</i>	X					<i>Ostrya scholtzii</i>	X	X			
<i>Ampelopsis tertiaria</i>		X				<i>Oxydendrum europaeum</i>					X
<i>Aralia</i> cf. <i>tertiaria</i>	X					<i>Paliurus favonii</i>		?	X		X
<i>Aralia intermedia</i>					X	<i>Parthenocissus britannica</i>		X			X
<i>Aralia lusatica</i>					X	<i>Pentapanax tertiaris</i>			X		X
<i>Aralia rugosa</i>					X	<i>Persicaria</i> aff. <i>polesieana</i>					X
<i>Betula</i> cf. <i>dryadum</i>					X	<i>Physalis pliocenica</i>			X		
<i>Betula</i> cf. <i>longisquamosa</i>		X				<i>Pinus grossana</i>	X				

Fossil taxon	1	2	3	4	5	Fossil taxon	1	2	3	4	5
aff. <i>Burretia</i>					X	<i>Pinus hampeana</i>	X				
cf. <i>Carex canescendoidea</i>		X				<i>Pinus palaeostrobis</i>					X
cf. <i>Carex klettviensis</i>		X				<i>Platanus neptuni</i>	X				X
<i>Carex plicata</i>					X	<i>Poliathyrsis eurorimosa</i>					X
<i>Carpinus</i> cf. <i>betulus foss</i>		X				<i>Polygonum</i> sp. 1					X
<i>Carpinus cordataeformis</i>				X	X	<i>Polygonum</i> sp. 2					X
<i>Carpinus grandis</i>		X				<i>Populus</i> cf. <i>balsamoides</i>		X			
<i>Carpinus miocenica</i>		X				<i>Prunus leporimontana</i>			X		
<i>Carpolites antiquorum</i>				X		<i>Prunus scharfii</i>					X
<i>Carya ventricosa</i>	X					<i>Pseudolarix schmidtgenii</i>	X	X	X	X	X
<i>Abies resinosa</i>	X					<i>Meliosma messleri</i>	X				X
<i>Acer</i> aff. <i>angustilobum</i>					X	<i>Meliosma pliocaenica</i>	X				X
<i>Acer</i> sp.					X	<i>Microdiptera</i> aff. <i>parva</i>					X
<i>Acer hercynicum</i>					X	<i>Microdiptera lusatica</i>					X
<i>Actinidia faveolata</i>				X	X	<i>Microdiptera minor</i>					X
<i>Alnus kefersteinii</i>	X					<i>Moehringia miocaenica</i>			X		X
<i>Alnus latibracteosa</i>					X	<i>Myrica stoppii</i>					X
<i>Alnus lusatica</i>					X	<i>Nyssa ornithobroma</i>					X
<i>Ampelopsis rotundata</i>	X					<i>Ostrya scholtzii</i>	X	X			
<i>Ampelopsis tertiaria</i>		X				<i>Oxydendrum europaeum</i>					X
<i>Aralia</i> cf. <i>tertiaria</i>	X					<i>Paliurus favonii</i>		?	X		X
<i>Aralia intermedia</i>					X	<i>Parthenocissus britannica</i>		X			X
<i>Aralia lusatica</i>					X	<i>Pentapanax tertarius</i>			X		X
<i>Aralia rugosa</i>					X	<i>Persicaria</i> aff. <i>polesieana</i>					X
<i>Betula</i> cf. <i>dryadum</i>					X	<i>Physalis pliocenica</i>			X		
<i>Betula</i> cf. <i>longisquamosa</i>		X				<i>Pinus grossana</i>	X				
aff. <i>Burretia</i>					X	<i>Pinus hampeana</i>	X				
cf. <i>Carex canescendoidea</i>		X				<i>Pinus palaeostrobis</i>					X
cf. <i>Carex klettviensis</i>		X				<i>Platanus neptuni</i>	X				X
<i>Carex plicata</i>					X	<i>Poliathyrsis eurorimosa</i>					X
<i>Carpinus</i> cf. <i>betulus foss</i>		X				<i>Polygonum</i> sp. 1					X
<i>Carpinus cordataeformis</i>				X	X	<i>Polygonum</i> sp. 2					X
<i>Carpinus grandis</i>		X				<i>Populus</i> cf. <i>balsamoides</i>		X			
<i>Carpinus miocenica</i>		X				<i>Prunus leporimontana</i>			X		
<i>Carpolites antiquorum</i>				X		<i>Prunus scharfii</i>					X
<i>Carya ventricosa</i>	X					<i>Pseudolarix schmidtgenii</i>	X	X	X	X	X
<i>Cathaya bergeri</i>	X					<i>Paranothotsuga jechorekiaie</i>	X				X
<i>Cephalanthus pusillus</i>			X			<i>Pterocarya margaritana</i>					X
<i>Cephalotaxus miocenica</i>	X					<i>Pterosinojackia lusatica</i>					X
<i>Ceratophyllum lusaticum</i>		X				<i>Pterostyrax coronatus</i>					X
<i>Cercidiphyllum helveticum</i>					X	<i>Pyracantha acuticarpa</i>	X	X	X	X	X
<i>Cinnamomum costatum</i>					X	<i>Pyracantha angusticarpa</i>		?			
<i>Collinsonia europaea</i>					X	<i>Quercus kubinyi</i>		X			
<i>Comptonia goniocarpa</i>					X	<i>Rehderodendron ehrenbergii</i>				X	X

Fossil taxon	1	2	3	4	5	Fossil taxon	1	2	3	4	5
<i>Cotoneaster integerima</i>		?				<i>Rubus laticostatus</i>	X	X			
<i>Cotoneaster wackersdorffensis</i>		?				<i>Rubus microspermus</i>		X			X
<i>Craigia brononii</i>					X	<i>Rubus semirobundatus</i>		X			X
<i>Crataegus nodulosa</i>		?				<i>Sambucus lucida</i>			X		X
<i>Cyperus leptodermis</i>			X		X	<i>Sambucus cf. pulchella</i>	X				
<i>Daphnogene cf. billinica</i>		X				<i>Schefflera dorofeevii</i>					X
<i>Daphnogene polymorpha</i>					X	<i>Scirpus brevicornis</i>					X
<i>Decaisnea bornensis</i>					X	<i>Selaginella lusatica</i>				X	
<i>Distylium protogaeum</i>					X	<i>Sequoia abietina</i>	X	?			X
<i>Distylium uralense</i>	X				X	<i>Solanispermum reniforme</i>			X		
<i>Dulichium hartzianum</i>					X	<i>Sparganium noduliferum</i>	X				
<i>Dulichium marginatum</i>		X		X		<i>Sparganium pusilloides</i>			X		X
<i>Engelhardia macroptera</i>			X			<i>Sparganium tuberculatum</i>					X
<i>Eomastixia saxonica</i>	X				X	<i>Sphenotheca sp.</i>	X				
<i>Epipremnites ornatus</i>	X					<i>Spirematospermum wetzleri</i>				X	
<i>Eurya stigmosa</i>	X	X	X	X	X	<i>Staphylea rotundata</i>					X
<i>Fagus deucalionis</i>	X	X	X	X	X	<i>Symplocos casparyi</i>	X	X	X	X	X
<i>Fagus castaneifolia</i>		X			X	<i>Symplocos pseudogregaria</i>			X		X
<i>Ficus lucida</i>					X	<i>Symplocos minutula</i>					X
<i>Ficus lutetianoides</i>					X	<i>Symplocos schereri</i>	X		X		
<i>Fortunearia altenburgensis</i>					X	<i>Taxodium dubium</i>	X				
<i>Fothergilla europaea</i>					X	<i>Tectocarya elliptica</i>	?		X		X
<i>Frangula solitaria</i>					X	<i>Ternstroemia sequoioides</i>		X	X		X
<i>Gironniera carinata</i>					X	<i>Tetraclinis brachyodon</i>	X				
<i>Gironniera verrucata</i>			X		X	<i>Tetraclinis brongniartii</i>	X				
<i>Glyptostrobus europaeus</i>	?			X		<i>Tetraclinis salicornioides</i>			X		X
<i>Hypericum septestum</i>					X	<i>Teucrium aff. martinae</i>					X
<i>Ilex aff. lotschii</i>					X	<i>Trigonobalanopsis exacantha</i>			X		X
<i>Ilex ovidrupacea</i>			X		X	<i>Tsuga moenana</i>					X
<i>Ilex saxonica</i>					X	<i>Tsuga/Nothotsuga (Pseudotsuga oceanites)</i>	X				
<i>Laportea europaea</i>					X	<i>Tsuga sp.</i>					X
<i>Laportea nemejcii</i>					X	<i>Turpinia ettinghausenii</i>	X				
<i>Laurocarpum sp.</i>	X		X			<i>Vallisneria vittata</i>					X
<i>Leucothoe narbonensis</i>	?		X		X	<i>Ulmus cf. carpinoides</i>		X			
<i>Liquidambar europaea</i>	X				X	<i>Umbelliferopsis molassicus</i>					X
<i>Liriodendron geminata</i>					X	<i>Urospathites visimensis</i>			X		X
<i>Magnolia ludwigii</i>				X	X	<i>Vitis aff. teutonica</i>			X		X
<i>Magnolia burseracea</i>	X				X	<i>Vitis lusatica</i>	X	X			
<i>Manglietia germanica</i>					X	<i>Vitis parasyvestris</i>	X				X
<i>Magnoliaspermum geinitzii</i>				X		<i>Zanthoxylum giganteum</i>			X		X
<i>Mastixia amygdalaeformis</i>	X	X	X	X	X	<i>Ziziphus striata</i>	X				

Table S4

Spores, pollen grains, and non-pollen palynomorphs recorded at Tetta Clay Pit. Taxonomy and affinity according to Stuchlik *et al.* (2001, 2002, 2009, 2014). Palaeofloristical elements distinguished: palaeotropical (P), including tropical (P1) and subtropical (P2), “arctotertiary” (A), including warm-temperate (A1) and temperate (A2), cosmopolitan (P/A), unassigned (X).

FOSSIL TAXA	BOTANICAL AFFINITY	ELEMENT	IV			II			VI	I	V
			1	2	3	4	5a	5b	7	9	10
SPORES OF PLANTS:											
<i>Baculatisporites</i> sp.	Osmundaceae: <i>Osmunda</i>	P/A			1	1	1			8	2
<i>Cicatricosisporites</i> cf. <i>chattensis</i> Krutzsch	Schizaceae: <i>Anemia</i>	P							5		
<i>Echinatisporis longechinus</i> Krutzsch + <i>E. miocenicus</i> Krutzsch and Sontag + <i>Echinatisporis</i> sp.	Selaginellaceae: <i>Selaginella</i>	P/A	1	1	1			1	1	2	1
<i>Foveotriletes</i> sp.	unknown	unknown					1				
<i>Laevigatosporites haardti</i> (Potonié and Venitz) Thomson and Pflug + <i>Laevigatosporites</i> sp.	Polypodiaceae, Davalliaceae, and other ferns	P/A	6	4	5	3	1	4	1	24	29
<i>Leiotriletes</i> sp.	Lygodiaceae and other ferns	P			2		1			7	2
<i>Muerrigerisporis</i> sp. 1 Grabowska	Selaginellaceae: <i>Selaginella</i>	P/A				2	1	1			
<i>Retitriletes</i> sp.	Lycopodiaceae: <i>Lycopodium</i>	A		1						2	
<i>Rudolphisporis</i> sp.	Anthocerothaceae	P/A								1	
<i>Selagosporis</i> sp.	Lycopodiaceae: <i>Huperzia</i>	P/A								2	
<i>Stereisporites</i> sp.	Sphagnaceae: <i>Sphagnum</i>	P/A	2							1	2
<i>Triplanosporites</i> sp.	unknown	P			1					1	
<i>Verrucatisporites tekeresensis</i> Nagy	Plagiogyriaceae	P			1						
<i>Verrucatosporites</i> sp. 1 Kohlman-Adamska + <i>Verrucatosporites</i> sp.	Davalliaceae, Polypodiaceae, and other ferns	P/A		2	2	1					
POLLEN OF GYMNOSPERMS:											
<i>Abiespollenites</i> sp.	Pinaceae: <i>Abies</i>	A					1			1	
<i>Cathayapollis wilsonii</i> (Sivak) Ziemińska-Tworzydło + <i>Cathayapollis</i> sp. + <i>Abietinaepollenites microalatus</i> Potonié	Pinaceae, incl. <i>Cathaya</i>	A1	23	9	13	69	61	61	16	10	12
<i>Cedripites parvisaccatus</i> (Zauer) Krutzsch + <i>Cedripites</i> sp.	Pinaceae: <i>Cedrus</i>	A1	4		1	4	7	2	5	2	2
<i>Cupressacites</i> sp.	Cupressaceae	A1	1	3			2	2	1		2
<i>Inaperturopollenites concedipites</i> (Wodehouse) Krutzsch + <i>I. dubius</i> (Potonié and Venitz) Thomson and Pflug	Cupressaceae: <i>Taxodium</i> , <i>Glyptostrobus</i>	P2/A1	56	115	108	15	38	25	3	26	21

FOSSIL TAXA	BOTANICAL AFFINITY	ELEMENT	IV			II			VI	I	V
			1	2	3	4	5a	5b	7	9	10
<i>Keteleeripollenites</i> sp.	Pinaceae: <i>Keteleeria</i> , <i>Pseudolarix</i>	A1				3	7	4			1
<i>Piceapollis sacculiforoides</i> Krutzsch + <i>Piceapollis</i> sp.	Pinaceae: <i>Picea</i>	A	13	4	4	42	50	46	64	16	34
<i>Pinuspollenites labdacus</i> (Potonié) Raatz + <i>Pinuspollenites</i> sp.	Pinaceae: <i>Pinus</i>	A	49	17	18	171	68	119	108	43	62
<i>Sciadopityspollenites</i> sp.	Sciadopityaceae: <i>Sciadopitys</i>	A1	2		3	1	1		1	9	2
<i>Sequoiapollenites gracilis</i> Krutzsch + <i>S. rotundus</i> Krutzsch + <i>Sequoiapollenites</i> sp.	Cupressaceae: <i>Sequoia</i> , <i>Sequoiadendron</i> , <i>Metasequoia</i> , <i>Cryptomeria</i>	A1	171	259	280	13	53	46	8	18	16
<i>Zonalapollenites</i> sp.	Pinaceae: <i>Tsuga</i>	A1				1		2		1	1
POLLEN OF ANGIOSPERMS:											
<i>Aceripollenites</i> sp.	Sapindaceae: <i>Acer</i>	A1		1	1						1
<i>Alnipollenites metaplasmus</i> (Potonié) Potonié + <i>A. verus</i> Potonié	Betulaceae: <i>Alnus</i>	P2/A	14	25	11	2	3	2	27	27	50
<i>Araliaceopollenites amplus</i> Ślodka	Araliaceae: <i>Dendropanax</i> , <i>Tetrapanax</i>	P/A1		1							
<i>Araliaceopollenites euphorii</i> (Potonié) Potonié	Araliaceae: <i>Acan-</i> <i>topanax</i> , <i>Aralia</i>	P/A1							1		
<i>Arecipites</i> sp.	Amaryllidaceae, Araceae, Arecaceae, Butomaceae	P/A									2
<i>Carpinipites carpinoides</i> (Pflug) Nagy	Betulaceae: <i>Carpinus</i>	P2/A1			1			1		1	
<i>Caryapollenites simplex</i> (Potonié) Raatz	Juglandaceae: <i>Carya</i>	A1		1		2	4	1	3	2	1
<i>Cercidiphyllites</i> <i>minimireticulatus</i> (Trevisan) Ziemińska-Tworzydło	Cercidiphyllaceae: <i>Cercidiphyllum</i>	A1			2		1	1			1
<i>Cornaceapollis major</i> (Stuchlik) Stuchlik	Cornaceae: <i>Cornus</i>	P/A			1			1			
<i>Cornaceapollis minor</i> (Stuchlik) Stuchlik	Cornaceae: <i>Cornus</i>	A	1		1						
<i>Cornaceapollis satzveyensis</i> (Pflug) Ziemińska-Tworzydło	Mastixiaceae	P1	7	9	4	3	13	16	25	1	2
<i>Corylopsispollenites microretic-</i> <i>ulatus</i> E. Worobiec	Hamamelidaceae: <i>Corylopsis</i>	A1	1	1			1	1		1	
<i>Cupuliferoipollenites oviformis</i> (Potonié) Potonié	Fagaceae: Castanoideae	P2/A1		1				1	10		2
<i>Cupuliferoipollenites pusillus</i> (Potonié) Potonié	Fagaceae: Castanoideae	P2/A1	4		2		1	1	3		3
<i>Cyperaceapollis neogenicus</i> Krutzsch	Cyperaceae	P/A		1		1				9	2
<i>Cyrollaceapollenites brühlensis</i> (Thomson) Durska	Cyrollaceae, Clethraceae	P	2	1							
<i>Cyrollaceapollenites exactus</i> (Potonié) Potonié	Cyrollaceae, Clethraceae	P	3		1			3		1	
<i>Cyrollaceapollenites</i> <i>megaexactus</i> (Potonié) Potonié	Cyrollaceae, Clethraceae	P	1	1			1			1	4

FOSSIL TAXA	BOTANICAL AFFINITY	ELEMENT	IV			II			VI	I	V
			1	2	3	4	5a	5b	7	9	10
<i>Edmundipollis edmundi</i> (Potonié) Konzalová, Słodkowska and Ziemińska-Tworzydło + <i>Edmundipollis</i> sp.	Cornaceae, Mastixiaceae, Araliaceae	P/A1	4	1	6	1	2	3	1	3	1
<i>Ericipites callidus</i> (Potonié) Krutzsch + <i>Ericipites</i> sp.	Ericaceae	P/A	4	1		1	4	3	1	1	1
<i>Faguspollenites bockwitzensis</i> (Walter and Zetter) Kohlman-Adamska and Ziemińska-Tworzydło + <i>F. minor</i> Nagy + <i>F. vivus</i> Raatz + <i>Faguspollenites</i> sp.	Fagaceae: <i>Fagus</i>	A	24	4	8	131	119	89	36	261	155
<i>Fraxinipollis</i> sp.	Oleaceae: <i>Fraxinus</i>	A								1	
<i>Fususpollenites</i> sp.	Fagaceae (incl. <i>Colombobalanus</i>)	P1	6	5	4						
<i>Ilexpollenites margaritatus</i> (Potonié) Thiergart + <i>Ilexpollenites</i> sp.	Aquifoliaceae: <i>Ilex</i>	P2	5	2	3		1	1		7	1
<i>Intratriporopollenites insculptus</i> Mai	Malvaceae: Brownlowioideae, Tilioideae	P/A1			1						
<i>Intratriporopollenites</i> sp.	Malvaceae: Tilioideae	P/A1									10
<i>Momipites quietus</i> (Potonié) Nichols + <i>M. punctatus</i> (Potonié) Nagy	Juglandaceae: Engelhardioideae	P, P2	1	2	4	9	9	4	7		
<i>Myricipites</i> sp.	Myricaceae	P2/A					2	3		1	
<i>Nyssapollenites</i> sp.	Nyssaceae: <i>Nyssa</i>	P2/A1	2		2	2	3	4	3	2	2
<i>Oleoidearumpollenites</i> sp.	Oleaceae	P2/A1	2			1				1	
<i>Oligopollis</i> sp.	unknown	unknown	1		1				1		
<i>Parthenopollenites marcodurensis</i> (Pflug and Thomson) Traverse	Vitaceae	P/A1	1					1	1		1
<i>Periporopollenites stigmosus</i> (Potonié) Pflug and Thomson + <i>Periporopollenites</i> sp.	Altingiaceae: <i>Liquidambar</i>	A1	1	1		8	2	5			11
<i>Platanipollis ipelensis</i> (Pacltová) Grabowska	Platanaceae: <i>Platanus</i>	P/A1	2		1	3	11	2			
<i>Platycaryapollenites</i> sp.	Juglandaceae: <i>Platycarya</i>	P2/A1			1	3	4		4		
<i>Polyatriopollenites</i> sp.	Juglandaceae: <i>Pterocarya</i>	A1	1	1							
<i>Polycolpites hexaradiatus</i> (Nakoman) Durska	Lamiaceae	P/A								1	
<i>Quercoidites henricii</i> (Potonié) Potonié, Thomson and Thiergart	Fagaceae: <i>Quercus</i>	P2/A1	17	4	6	3	10	9	10	4	5
<i>Quercoidites microhenricii</i> (Potonié) Potonié, Thomson and Thiergart	Fagaceae: Quercoideae	P2/A1	3	1	5		1				
<i>Quercopollenites</i> sp.	Fagaceae: <i>Quercus</i>	P2/A1	5		2	3		1	15		8
<i>Reevesiapollis triangulus</i> (Mamczar) Krutzsch + <i>R. microreticulatus</i> Krutzsch	Malvaceae: <i>Reevesia</i>	P	1						14		3
<i>Salixipollenites</i> sp.	Salicaceae: <i>Salix</i>	A						1	2		1
<i>Sapotaceoideaepollenites</i> sp.	Sapotaceae	P							1		

FOSSIL TAXA	BOTANICAL AFFINITY	ELEMENT	IV			II			VI	I	V
			1	2	3	4	5a	5b	7	9	10
<i>Sparganiaceapollenites</i> sp.	Sparganiaceae, Typhaceae	P/A	1			1	3	2		3	3
<i>Spinulaepollis arceuthobioides</i> Krutzschn	Santalaceae: <i>Arceuthobium</i>	P2/A1							2	7	
<i>Symplocoipollenites vestibulum</i> (Potonié) Potonié	Symplocaceae: <i>Symplocos</i>	P				1	1	2			2
<i>Tricolporopollenites dolium</i> (Potonié) Pflug and Thomson	Fagaceae?	unknown	14	6	3		1		5	1	4
<i>Tricolporopollenites fallax</i> (Potonié) Krutzschn	Fabaceae	P/A	1	1	1	2		1	3		
<i>Tricolporopollenites liblarensis</i> (Thomson) Hochuli	Fabaceae	P/A	1	1							
<i>Tricolporopollenites pseudocingulum</i> (Potonié) Thomson and Pflug	Fagaceae?, Styracaceae?	P/A1	11	6	2	5	18	24	98	3	22
<i>Tricolporopollenites rosacearum</i> Durska	Rosaceae	A		1	1						
<i>Tricolporopollenites staresedlo-</i> <i>ensis</i> Krutzschn and Pacltová	Hamamelidaceae	P2		1	2		4				
<i>Tricolporopollenites villensis</i> (Thomson) Thomson and Pflug	Fagaceae?	unknown	25	17	5	2	2	1	4		
<i>Trivestibulopollenites betuloides</i> Pflug	Betulaceae: <i>Betula</i>	A	2	2	1					2	1
<i>Ulmipollenites</i> sp.	Ulmaceae: <i>Ulmus</i>	A	1			1	2	1		1	10
<i>Vitispollenites tener</i> Thiele-Pfeiffer	Vitaceae: <i>Vitis</i>	P2/A1				1					2
other pollen grains	unknown	unknown	16	8	5	11	6	5	18	15	10
TOTAL			513	522	528	523	522	503	508	531	510
SELECTED NON-POLLEN PALYNOMORPHS:											
<i>Closteritetrapidites</i> sp.	Closteriaceae: <i>Closterium</i>	X						1			
<i>Desmidiaceasporites cosmarioformis</i> Hunger	Desmidiaceae	X			3	2	2	2			
<i>Ovoidites elongatus</i> (Hunger) Krutzschn + <i>O. spriggii</i> (Cookson and Dettmann) Zippi	Zygnemataceae: <i>Spirogyra</i>	X					1			2	
<i>Pesavis tagluensis</i> Elsik and Jansonius	Fungi	X			1						
<i>Pseudoschizaea rubina</i> Rossignol	algae?	X	1								
Sporocarps and conidia of fungi	Fungi	X	5	1	4	22	17	12	6	34	21

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