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Early Miocene carpological material from the Czech part of the Zittau Basin*

VASILIS TEODORIDIS

Charles University, Institute of Biology and Environmental Education, Faculty of Education, M.D. Rettigové 4,
116 39 Prague 1; Institute of Geology and Palaeontology, Albertov 6, 128 43 Prague 2, Czech Republic;
e-mail: vasilis@natur.cuni.cz

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ABSTRACT. The studied carpological material has been obtained from several cores which are situated in the Czech part of the Zittau Basin. Two conifers and 39 angiosperms (including 5 taxa with uncertain systematic position) have been identified from different stratigraphical levels of the above-mentioned cores, which stratigraphically belong to the roof of the basal coal seam, the lower, middle and upper coal seams and their adjacent clastic deposits. According to the floristic analysis, assemblages of the lower, middle and upper coal seams are comsparable with the Floristic Assemblage Eichelskopf-Wiesa of Early Miocene age. Vegetation is comparable with the extant Mixed Mesophytic forests from SE-Asia. The basal coal seam is not dated by macroscopic remains, the occurrence of the Oligocene index microfossil *Boehlensipollis hohli* W. Kr. is noteworthy.

KEY WORDS: fruits, seeds, Early Miocene, the Zittau Basin, Czech Republic

INTRODUCTION

The Zittau Basin is situated on the border of Germany, Poland and the Czech Republic. This typical palaeobotanical area was intensively studied during the last century in connection with the progressive mining of lignite in this area. The first geological and paleobotanical research was given by e.g. Poppe (1866), Engelhardt (1870), Heinke (1932) or Kirchheimer (1935, 1936). Mai (1964, 2000b) completely studied fruit and seed material from many localities of the German part of the Zittau Basin. Similarly a team of Polish palaeobotanists (under leadership of Prof. H. Czeczott), described abundant fossil carpological and leaf material from the locality Turów (Czeczott & Skirgiełło 1959, 1961, 1967, 1980, Juchniewicz 1975, Baranowska-Zarzycka 2001). Plant fossil record of the Czech part of the Zittau Basin was hitherto represented only by fossils from the locality Kristina, which was studied by Holý (1974, 1975b, 1976) in the case of seeds and fruits and by Kvaček (1966) in the case of the leaf material.

GEOLOGICAL SETTING

Early Miocene sediments of the Zittau Basisn occur in the Czech Republic in larger surroundings of Hrádek upon Nisa (Neisse) and Chotyně (Fig. 1). The geological structure of the Czech area was studied during the sixties and the seventies of the 20th century (Václ & Čadek 1962). These authors suppose the origin and evolution of sediments in the Czech area of the Zittau Basin in two sedimentary cycles. Psammitic and psephitic deposits including volcanic material, variegate clay, claystone

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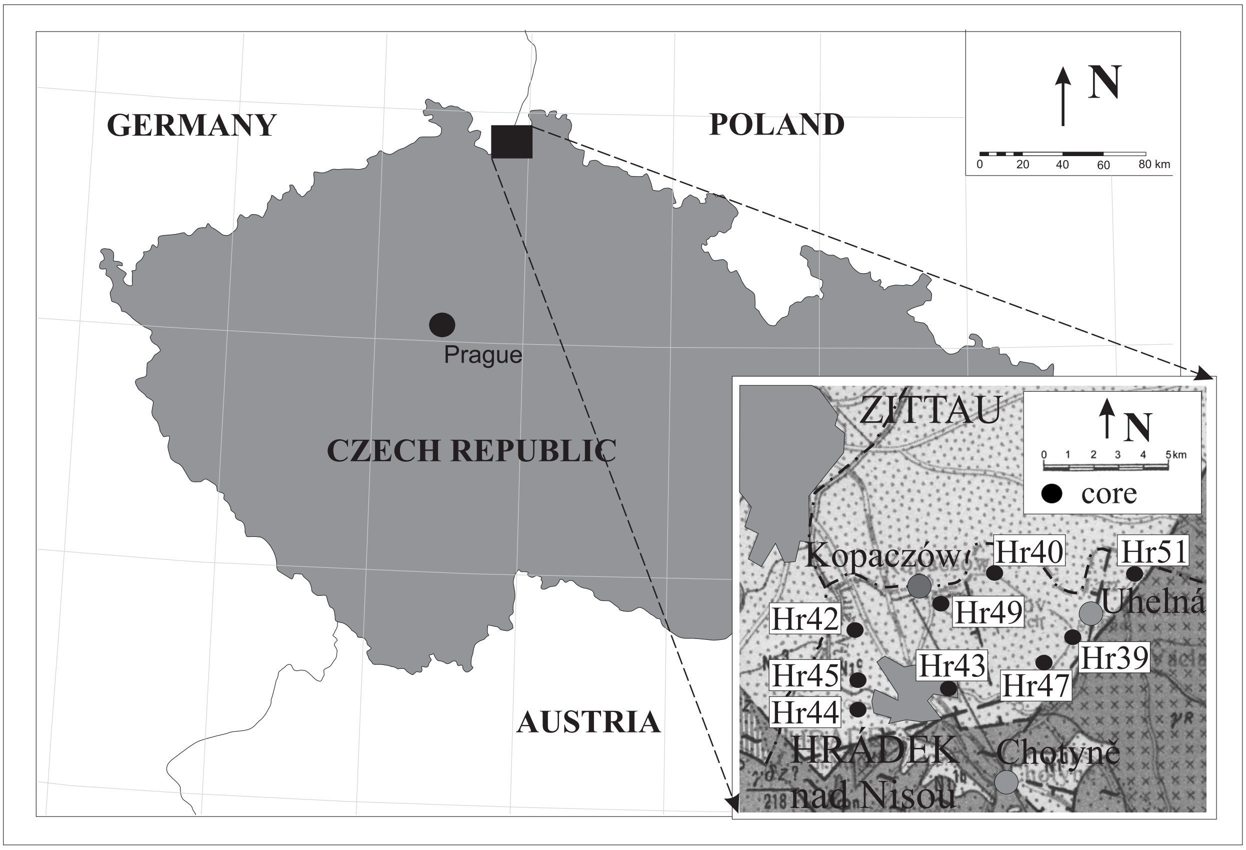

Fig. 1. Location of the Czech part of the Zittau Basin and investigated cores

and sandstone and also a basal coal seam represent the first sedimentary cycle. These sediments have southwestern provenience and form close underlying of the lower coal seam. The second sedimentary cycle includes deposits of the lower, middle and upper coal seams, always grading upwards into the clastic complexes. The provenience of the second cycle's sediments is from southeast.

The subject of the present investigation is carpological material, which was collected by F. Holý from several cores – Hr 39, Hr 40, Hr 42, Hr 43, Hr 44, Hr 45, Hr 47, Hr 49 and Hr 51 (detailed drilling documentation in Zabystřan 1967). Generally, 4 stratigraphical levels have been distinguished on the basis of the carpological material in the above-mentioned cores, i.e., the roof of the basal coal seam, the lower, middle and upper coal seams. The delimitation of these stratigraphical levels in large sense (sensu lato) always contains, besides coal seams, also the closest underlying and overlying clastic deposits. A correlation of several levels is based on palaeobotanical data and, in the cases of its absence, on the basis of similarity in lithological facies (Fig. 2).

The investigated material is housed in the collections of the National Museum in Prague and is marked by catalogue numbers, e.g. G 8000. Symbols, which are used in the systematic part of this paper (especially in the material section), designate the number of the core and the depth in meters from the drilling base.

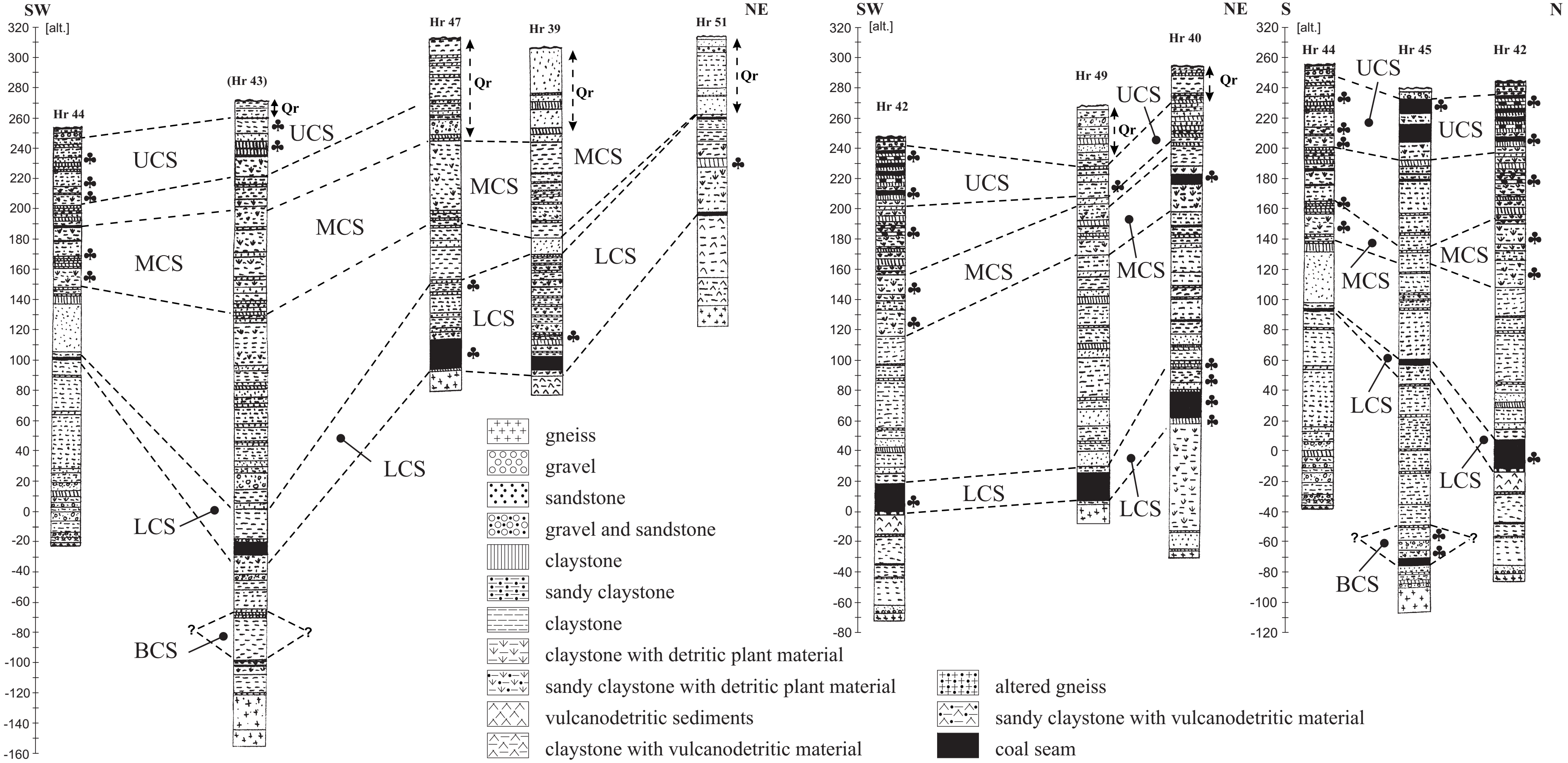

Fig. 2. Schematic profiles of investigated cores and their correlation. **Qr** – redeposited glaciofluvial material (Quaternary + Tertiary), **BCS** – roof of basal coal seam s. l. (sensu lato), **LCS** – lower coal seam s. l., **MCS** – middle coal seam s. l., **UCS** – upper coal seam s. l., ♣ – fossiliferous layer

SYSTEMATIC PART

Taxodiaceae

Sequoia Endlicher

Sequoia abietina (Brongniart in Cuvier) Knobloch

Pl. 1, figs 1, 2, 5–10, Pl. 2, figs 1, 4–6, 10

1822 *Phyllites abietina* Brongniart in Brongniart & Cuvier, p. 360.
1964 *Sequoia abietina* (Brongniart in Brongniart & Cuvier) Knobloch, p. 125–126.
1964 *Sequoia langsdorfii* (Brongniart) Heer, Mai, p. 10, 69, 85, Pl. 1, fig. 1.
1959 *Sequoia langsdorfii* (Brongniart) Heer, Zalewska, p. 77–80, 117, Pl. 9, figs 1–4.

Material. 4 seed-cones, 8 cone scales and 20 seeds (Hr 39: 185.0, Hr 44: 21.0–22.0, 103.7, 104.0, 111.7).

Description. Mature seed-cones 2.9–9.6 mm long and 2.6–7.4 mm broad, oval to globular, composed of 10 to12 scales, secondarily flattened. Scales oval to rhomboidal in outline, 0.9–9.6 mm long, 0.6–1.5 mm broad, always longer than broader, with distinctly developed escutcheon and stalk, abaxial side wrinkled including a visible central mucro, adaxial side longitudinally ribbed, stalk wedge-shaped, narrowed, attached in the center. Winged seeds 2.5–3.2 mm long and 1.6–1.9 mm broad, ovate to triangular in outline, flat, rarely slightly bent, with distinct apical slightly concave hilum area, width of hilum matching the seed, broad, basal area obtuse, rarely with a small prominent tip, seed variable in size, oblong to elliptic, wings bifacial, often symmetric, upper surface poorly preserved, covered by longitudinal rows of rectangular and oblong cells.

Remarks. Representatives of the family Taxodiaceae are very common elements in the European Tertiary. Most frequent occurrences are mainly seed-cones, isolated scales, seeds and sterile twigs of *Taxodium* L.C. Rich., *Glyptostrobous* Endlich., *Sequoia* Endlich. and *Quasisequoia* Shrinivasan & Friis emend. Kunzmann. Delimitation of the two latter mentioned taxa, i.e. *Quasisequoia couttsiae* (Heer) Kunzmann and *Sequia abietina* (Brongniart in Cuvier) Knobloch is clear by the epidermal structure (e.g. Kvaček 1985), but it is more problematic in case of carpological analyses due to similar morphological features of seeds and cones of both taxa. Pingen (1994) referred bigger seeds with greater oblong embryo with broader hilum and not parallel structure in wings to *Quasisequoia couttsiae*. Similarly, she defined differences between seed-cones (also in Mai & Walther 1978). Seed-cones and isolated cone scales of *Sequia abietina* are known also from other localities of the Zittau Basin (Mai 1964, Zalewska 1959), where they occurred in association with *Quasisequoia couttsiae* and *Glyptostrobus europaeus*. *Sequia abietina* is comparable with recent *Sequia sempervirens* (Don) Endl., which occurs as a coastal element (till 1000 m alt.) in N-California and SW-Oregon. Ecologically, *Sequia abietina* can be interpreted as an element, which preferred a non-permanent waterlogged substrate and was situated in the periphery of the basin.

Glyptostrobus Endlicher

Glyptostrobus europaeus (Brongniart) Unger

Pl. 1, figs 3, 4, 11–14, Pl. 2, figs 2, 3, 7

1833 *Taxodites europaeus* Brongniart, p. 168.
1850 *Glyptostrobus europaeus* (Brongniart) Unger, p. 434.

Material. Great quantity of sterile twigs, incomplete cones, scales, seeds and fragments (Hr 39: 185.0, Hr 40: 241.0, 265.5, Hr 42: 21.0–22.0, 31.0–32.0, 87.3, 240.0, Hr 44: 31.0–32.0, 42.0, 95.0, 96.0, 103.7, 104.0, 107.0, Hr 45: 39.3, 287.5, Hr 49: 39.3).

Description. Sterile twigs covered by scale-like, spirally arranged leaves, closely appressed to the axis or slightly protruding. Incomplete seed cones 1.3–1.9 mm long and 8.5–1.2 mm broad, obovate to globular, only basal part usually preserved, apex obtuse, base cuneate to broadly cuneate, consisting of 8 scales (fragmentary), scale complexes rhombic to deltoid, in the lower part formed by bract scale, in the upper part by seed scale. Bract scales wedge-shaped, base narrowed, apical part mucronate, small umbo, abaxial side wrinkled, seed scale rounded or triangular with notched margin, small notches numbering of 6 to 8, sculptured by radial furrows, seed scales overgrow about 2 to 4 mm beyond the bract scale. Seeds 3.2–5.5 mm long and 1.3–2.1 mm broad, apically winged, oblong in outline, distinctly bent, flat, seed bodies oval, situated in lower third of seeds, finely longitudinally sculptured, seed wings bent, starting at basal parts, forming basal rims, bordered seeds towards obtuse apices, distinct concave sides crest-shaped, descending to convex sides, upper surface distinctly perforated.

Remarks. The genus *Glyptostrobus* Endlicher is unequivocally proved by seed-cones, isolated cone scales and seeds in the Zittau Basin as well as in Northern Bohemia (e.g. Engelhardt 1878, Holý 1974, Bůžek & Holý 1964). The sterile scale-like twigs are morphologically identical with *Quasisequoia couttsiae* (Heer) Kunzmann, which often occurs in association with *Glyptostrobus* or with other representatives of the family Taxodiaceae. The main difference in epidermal structure of both taxa is noticed by Kvaček (1985) and recently revised by Sakala (2000). The above-described huge material shows great morphological variability, especially seeds, which can be separated in two morphotypes at least. Mai and Walther (1988) newly combined *G. brevisiliquata* (Ludwig) Mai & Walther based only on seed material from the Pliocene locality of Wetterau (Mai 1973) however, twigs and cones were described as *G. europaeus*, which partially match the investigated material (Mai, pers. comm.). But more than morphological variability of seeds it is more probably to assign it to *G. europaeus* due to common occurrence with sterile twigs and seed cones in some fossiliferous layers. Similarly, it was known from other localities of the Zittau Basin and Lower Lusatia, e.g. Kummersberg, Schmeckwitz-Piskowitz, Merka-Quatitz, Hartau, Kristina and Turów (Holý 1974, Mai 1964, Zalewska 1959). *Glyptostrobus europaeus* is an autochthonous, dominant element of the swamp association, which prefers permanently, waterlogged substrate, and it is ecologically connected with distal part of basin. According to Novák (1972), the genus *Glyptostrobus* is monotypic today. A single living species *G. pensilis* (Stount) Koch occupies humid biotopes on the riverbanks or near the seacoast in southern China (Sveshnikova 1963), which is an evident autecological change.

Magnoliaceae

Magnolia L.

Magnolia burseracea (Menzel) Mai

Pl. 1, figs 15, 18, 19, 22, Pl. 2, figs 8–9

1913 *Carpolithus burseraceus* Menzel, p. 84–85, Pl. 7, figs 10–12.
1964 *Magnolia sinuata* Kirchheimer, Mai, p. 61, 76, 105, Pl. 7, fig. 17, Pl. 9, figs 7–9, Pl. 13, figs 26–28.
1966 *Magnolia sinuata* Kirchheimer, Bůžek, Holý & Kvaček, p. 257.
1975 *Magnolia burseracea* (Menzel) Mai, p. 567, Pl. 35, figs 24–33.

Material. Great quantity of seeds (Hr 40: 257.0, Hr 42: 90.7, 95.0, 111.7, Hr 43: 32.0, Hr 44: 49.7, 103.0, 104.0, Hr 47: 218.0)

Description. Seeds 6–(7)–9 mm long and 3.5–(5)–7 mm broad, orbiculate, broadly obovate to broadly triangular in outline, rarely asymmetric, apex obtuse, micropyle subterminal, base rounded, chalaza region rounded, heteropyle distinctly concave, rounded (1–2 mm in diameter) with wedge-shaped condylus, including conically enlarged raphe (0.6 mm long), testa-wall relatively thin, 0.1 mm (base) and 0.5 mm (apex), built by radial prismatic sclerenchyma, external surface of sclerotesta smooth.

Remarks. This material contains more or less two different morphotypes from boreholes of the Zitava Basin. One population of longer seeds does not correspond in all morphological aspects with *Magnolia burseracea* (mainly size), and shows rather affinity to *M. lignita* (Unger) Mai. According to common occurrence of the two forms in the same fossiliferous horizon (Hr 44:103.0–104.0) and identity in the testa thickness, it is possible to interpret both forms as intra-specific variation of *M. burseracea*. This taxon is based on the original Menzel's material from the locality Nirm by Aachen, which was revised by Mai (1975). Similarly, *M. burseracea* has been known from many localities, e.g. Hartau by Zittau, Merka by Bautzen, Hrádek on the Neisse, Piskowitz and Wiesa by Kamenz (Kirchheimer 1938, 1939, 1957, Mai 1964, Bůžek et al. 1966, Holý 1974), which belong to the Floristic Assemblage Eichelskopf-Wiesa (Mai 1995) or zone VI in the sense of Mai (1967). Besides the above-mentioned species also other seeds have been known, which are described as *M. cor* and

M. lusatica. These taxa differ in the seed size, shape of chalaza region, thickness of the testa, presence of the prominent condylus in the case of *M. cor* and have been usually described from the Middle or Late Miocene to Pliocene localities (e.g. Klettwitz, Düren, Wetterau, Rippersroda, Reuver). According to Mai (1975), no extant species of the genus *Magnolia* L., which could be correlated with *M. bursercea*, exists. This author supposes possible analogous among some subtropical or tropical evergreen magnolias from S-Asia, which grow in association of the Evergreen Broad-leaved Forests, the Mountain Tropic Rain Forest or Mountain Boreal Coniferous Forest.

Hamamelidaceae

Distylium cf. ***uralense*** Kolesnikova

Pl. 1, figs 20, 23–25

1961 *Distylium uralense* Kolesnikova, p. 1818, fig. 1.

Material. 12 incomplete seeds and fragments (Hr 40: 257.6, Hr 43: 32.0).

Description. Seeds oblong to narrowly obovate in outline, 4.8–6.5 mm long and 2.8–3.5 mm broad, base asymmetrically cuneate, apex obtuse, often with micropylar tip, hilum big, oval to elliptic, covering first third of seed, external surface smooth, testa hard and lustrous.

Remarks. The above-described seeds are morphologically similar with seeds of *Distylium uralense* Kolesnikova from Bashkirien (Kolesnikova 1961) and from Hartau, Wiesa, Kristina and Sandförstgen (Mai 1964, 1999b, Holý 1974). It is similar in form and location of the hilum, but usually differs in smaller size of seeds. On the other hand, seeds of *D. protagaeum* Mai from Delitzsch-NW are comparable in size of seeds, but differ in form (Mai &Walther 1991). According to Mai and Walther (1991), *D. uralense* is correlated with recent *D. racemosum* Sieb. & Zucc. from SE-China.

Fagaceae

Fagus L.

Fagus cf. ***decurrens*** C. & E.M. Reid

Pl. 3, figs 1–4

1915 *Fagus decurrens* C. & E.M. Reid, p. 78–79, Pl. 5, figs 19, 20, 22–28.

1974 *Fagus decurrens* C. & E.M. Reid, Holý, p. 32–34, Pl. 5, figs 15–17.

Material. 5 fragments of cupules (Hr 44: 44.0–45.0).

Description. Secondarily compressed cupules regularly broadly ovate to oblong ovate, their fragments are 8–11 mm long and 8–10 mm broad, base rounded to broadly cuneate, narrowed abruptly into fragmentary stalk (1 mm long), 4 valves incomplete, ovate to broadly lanceolate, external surface finely wrinkled, covered by fragments of triangular appendices, probably originally narrowed into fine spines.

Remarks. Two taxa, i.e. *Fagus decurrens* C. & E.M. Reid and *Fagus deucalionis* Ung., are frequent in the Tertiary of Central Europe, and probably create transitional forms during the Miocene. *F. decurrens* has relatively big cupules (more than 15 mm long) with typical rounded or broadly cuneate base contrary to smaller cupules with cordate base and long and thin stalk of *F. deucalionis*. Holý (1974) described a great quantity of complete cupules and achenes from the locality Kristina, which are typical unequivocal representatives of *Fagus decurrens*. But in the case of our material, the determination is doubtful due to incompleteness of finds. According to Łańcucka-Środoniowa (1966), *F. sylvatica* L., *F. orientalis* L., and *F. grandifolia* Ehrh. are extant analogues of *Fagus decurrens*. Besides, Holý (1974) considers *F. crenata* Bl. as the closest relative.

Trigonobalanopsis Z. Kvaček & Walther

Trigonobalanopsis exacantha (Mai) Z. Kvaček & Walther

Pl. 3, figs 5–8

?1964 *Carpolithes minimus* (Chandl.) Mai, p. 51, 118, Pl. 2, figs 22–35, Pl. 6, fig. 11, Pl. 16, fig. 13.

1970a *Trigonobalanus exacantha* Mai, p. 384–387, Pl. 1, figs 19–26, Pl. 2, figs 1–20, Pl. 3, figs 1–6, 14–19.

1974 *Trigonobalanus exacantha* Mai, Holý, p. 35–36, Pl. 5, figs 11–14.

1978 *Trigonobalanus exacantha* Mai, Gregor, p. 22, Pl. 3, figs 3–10.

1988 *Trigonobalanopsis exacantha* (Mai) Z. Kvaček & Walther, p. 404, Pl. 47, figs 1–14, Pl. 48, figs 1–3.

2001 *Trigonobalanus exacantha* Mai, Baranowska-Zarzycka, p. 145–147, Pl. 1, figs 1–11.

Material. 16 incomplete cupules and 9 fragments of achenes (Hr 44: 109.0).

Description. Cupules 7–(9)–11 mm long and 3–(5)–7 mm broad, pyramidal to broadly ovate, base cuneate to broadly cuneate, narrowed into oblique, short stalk (1.5 mm long), usually 3–valved, rarely 2 or 4, distinct keels, free from lower third or middle, external surface wrinkled. Achenes secondarily flattened, pyramidal with convex sides, base rounded, apical part and styles not preserved, triangular on cross section, sharp-edged to winged.

Remarks. Systematic position of these cupules and achenes were doubtful for a long time (Kirchheimer 1957, Mai 1964). Mai (1970b) revised all hitherto known material and assigned it to the recent genus *Trigonobalanus* Forman. He defined three new species (i.e. *T. andreanszkyi, T. exacantha, T. minima*), which stratigraphically cover the period from the Late Eocene to Middle Miocene. Kvaček and Walther (1988) newly revised the material from Hartau (Mai 1964), Wackersdorf (Gregor 1978, 1980) and Kristina (Holý 1974) including the study of the cuticular structures and re-assigned it to the extinct genus *Trigonobalanopsis*. Besides, the authors pointed to association of these cupules and leaves of *Trigonobalanopsis rhamnoides*, based on common occurrence of both taxa (e.g. Kvaček 1966, Holý 1974 – Kristina or Baranowska-Zarzycka 2001 – Turów) and similarity of the epidermal structure. These taxa are paleoecologically interpreted as an extinct evergreen mesophytic element, which is known mainly from thermophilous associations of the Floristic Assemblage Hordle- Zeitz (“older” mastixioid floras) and of the Floristic Complex Eichelskopf-Wiesa (“young” mastixioid floras) – see e.g. Mai (1995). *Trigonobalanus doichangensis* (Camus) Forman, which is distributed in Thailand and southern China, has been regarded as a recent analogue on the basis of the pollen (Erdtman 1967) and cupules morphological analysis. On the other hand, *T. exacantha* shows affinity to recent *Trigonobalanus excelsa* due to higher similarity in epidermal structure (Kvaček & Walther 1988).

Betulaceae

Alnus Miller

Alnus lusatica Mai

Pl. 3, fig. 10

1987 *Alnus lusatica* Mai, p. 111–112, Pl. 6, figs 4–10, text–figs 1a–c.

Material. 1 nutlet (Hr 44: 104.0).

Description. Nutlet 3.4 mm long and 2.1 mm broad, membranous-leathery, obovate to elliptic in outline, narrowed and thinly winged, apical part mucronate, apex attenuate (0.5 mm long), basal part truncate with distinct broad attachment scar, upper surface smooth, rarely irregular wrinkles, with distinct middle rib.

Remarks. Morphologically similar fruitles often occurring in association with oblong strobiles are relatively frequent in Western and Central Europe from Late Oligocene to Pliocene (Mai 1987). This complete fruit is identical with nutlets from the locality Horka (Mai 1997, Pl. 7, figs 16–18) and very similar with the fruits from Schlabendorf (Mai 1987, Pl. 6, figs 2, 3, 9). Fruits of *A. lusatica* are morphologically interchangeable with nutlets of other fossil alder i.e. *A. kefersteinii* (Goepp.) Ung., which differ only in size (relatively smaller and broader). But these two taxa absolutely vary in form and size of their strobiles (e.g. Mai 1997). According to Mai (1987), it is possible to correlated *A. lusatica* with recent *A. nitida* Endl. (Himalayas, Kashmir) and *A. nepalensis* (Sikkim, Nepal, Burma and Yunnan), based on comparison of strobiles. According to fruit analyses, *A. lusatica* is best comparable with *A. rugosa* Sprengel. and *A. maritima* Nutt. from North America (Mai 1987).

***Alnus* sp.**

Pl. 3, fig. 9

Material. 2 strobiles (Hr 44: 94–95, Hr 44: 103.7).

Description. Strobile (infructescence) 9 and 13 mm long, 6 and 8 mm broad, abraded, oblong to elliptic, with fragment of stalk (4 mm long), scales poorly preserved.

Remarks. The character of preservation in the case of the above-described strobiles does not allow precise determination at the specific level. However, these strobiles show affinity to *Alnus lusatica* Mai on the basis of their form and co-occurrence with nutlet within the same stratigrafical level of the core Hr 44.

Juglandaceae

Pterocarya Kunth

Pterocarya limburgensis C. & E.M. Reid

Pl. 3, figs 11, 12

1915 *Pterocarya limburgensis*. C. & E.M. Reid, p. 73, Pl. 4, figs 15–21
1961 *Pterocarya* cf. *stenoptera* DC. fossilis, Czeczott & Skirgiełło, p. 104–105, Pl. 16, figs 1–6.
1964 *Pterocarya raciborskii* Zablocki, Mai, p. 103–104, Pl. 13, fig. 7.
1974 *Pterocarya raciborskii* Zablocki, Holý, p. 31–32, Pl. 5, figs 8–10.

Material. 2 incomplete nuts (Hr 45: 39.3, Hr 47: 169.5).

Description. Nuts 4.9 mm and 4.4 mm long, 4.8 mm and 4.5 mm broad, broadly ovate in outline, secondarily flattened, base rounded, apex attenuate, external surface ornamented by ten longitudinal winged ribs, distinct in lower third to half, rarely forked and joining, towards to indistinct apex.

Remarks. These two incomplete nuts are morphologically similar to the material from Hartau and Turów (Mai 1964, Czeczott & Skirgiełło 1961) and identical in the case of the finds from the locality Kristina (Holý 1974). The stratigraphical range of *Pterocarya limburgensis* is from Early Miocene to Pliocene. C. & E.M. Reid (1915) and Holý (1974) compared these nuts with recent *Pterocarya hupehensis* Scan, which grows in the Mixed Mesophytic forests in SE-China.

Myricaceae

Myrica L.

Myrica ceriferiformis Kownas

Pl. 3, figs 13–21, Pl. 4, figs 1, 4

1955 *Myrica ceriferiformis* Kownas, p. 459–461, figs 8a, b.
1964 *Myrica ceriferiformis* Kownas, Mai, p. 60, Pl. 7, fig. 5.
1974 *Myrica ceriferiformis* Kownas, Holý, p. 25, Pl. 4. figs 1, 2.

Material. 87 endocarps and exocarps (Hr 40: 257.0, Hr 42: 30.8, Hr 44: 49.7, Hr 51: 82.0).

Description. Endocarps 1.3–(2.3)–3.3 mm long and 1.1–(2.1)–2.3 mm broad, rounded to rarely oval, secondarily flattened, base rounded, apex obtuse, often with distinct tip (basal part of style), suture of dehiscence poorly distinct, thin, locule ovate, external surface often ornamented by polygonal pits or smooth. Exocarps formed by one layer of rounded resin warts (8 to12 pieces in equatorial plane), not densely crowded.

Remarks. The above-described material is assigned to *M. ceriferiformis* due to morphological structure of the exocarps and endocarps, which more or less copy the shape of the exocarps or are partially covered by warts. The material morphologically matches that from Dobrzyń (Kownas 1955) including the number of warts. Occurrences from Piskowitz (Mai 1964) and Kristina (Holý 1974) are very similar, but the warts are somewhat smaller. According to Mai (1999b), *M. ceriferiformis* is well comparable with recent *M. pensylvanica* Loisel. or *M. cerifera* L. from the Atlantic area of N-America.

Myrica ceriferiformoides Bůžek & Holý

Pl. 3, figs 22–34, Pl. 4, figs 2, 3, 6

1964 *Myrica ceriferiformoides* Bůžek & Holý, p. 118–119, Pl. 5, figs 10–16.

Material. 76 endocarps and 8 exocarps (Hr 42: 111.7, Hr 43: 32.0, Hr 44: 94.0–95.0, 104.0, Hr 45: 287.5, Hr 47: 169.5, Hr 51: 81.0).

Description. Endocarps 1.6–(1.8)–3.3 mm long and 1.2–(1.5)–2.6 mm broad, rounded or oval in outline, secondarily flattened, base rounded, apex obtuse to acute (oval type), external surface smooth. Locule rounded to drop-shaped in outline, endocarp wall relatively thick (0.22–0.36 mm), often thicker in apical part. Exocarps fragmentary, irregular or globular to oval in outline, formed by obconical wedges, distally covered by a mosaic of warts, situated on the surface close to each other.

Remarks. The structure of the exocarps is analogous with the type material from Hošnice near Chomutov (Bůžek & Holý1964). But the character of the endocarps is in some cases equivocal due to similarity of the morphological parameters of *Myrica ceriferiformis* and

M. suppanii Kirchh. or *M. boveyana* (Heer) Chandler. Problems with determination of endocarps have three reasons. The first reason is based on the imprecise or, better, wide original diagnoses of *M. ceriferiformis*, *M. suppanii*, *M. boveyana* and *M. ceriferiformoides* allow equivocal assigning to relatively clear exocarps (especially different thickness of the endocarp wall in apical, medial or basal part). The second one is wide morphological variability of the endocarps and subjective criteria for delimiting of intra- and interspecific variation. The last one is a character of the preservation. Bůžek and Holý (1964) warned identity of *M. ceriferiformoides* and *M. suppanii* and supposed a possible mistake in differentiation of these endocarps. Gregor (1975) confirmed this eventuality. According to detailed study, the endocarps show affinity to *M. ceriferiformoides*, but some of them have also affinity to *M. ceriferiformis* (Pl. 3, figs 20, 21, 23) – globular forms or with *M. boveyana* (Pl. 3, figs 27–29) – oblong forms. According to Mai (1999b), it is possible to connect *M. ceriferiformoides* with recent *M. faya* Ail., which grows in the Canary Islands as an element of the laurel forests.

Nyssaceae

Nyssa L.

Nyssa ornithobroma Unger

Pl. 5, figs 2–4

1861 *Nyssa ornithobroma* Unger, p. 16.
1959 *Nyssa disseminata* (Ludw.) Kirchh., Czeczott & Skirgiełło, p. 109–111, Pl. 20, figs 1–4.
1964 *Nyssa disseminata* (Ludw.) Kirchh., Mai, p. 41, 62, 80, Pl. 7, figs. 16, Pl. 9, figs 14, 15.
1974 *Nyssa ornithobroma* Unger, Holý, p. 82–84, Pl. 18, figs 1–6.

Material. Great quantity of endocarps (Hr 40: 80.4, 82.0, 85.0, 257.8, Hr 42: 30.8, 87.3, 111.7, 240.0, Hr 43: 26.4, 32.0, Hr 44: 49,7 94.0, 95.0, 104.0, Hr 45: 39.3, Hr 49: 39.3).

Description. Secondarily flattened endocarps 6–(9)–14 mm long and 3–(5)–7 mm broad, often obovate to elliptic, apex acute by elliptic forms or obtuse by obovate form, base rounded to broadly cuneate, germination valve small triangular in subapical part, testa wall thin, external surface sculptured by distinct ribs, (12)–14–(15) in number.

Remarks. Two representatives of the genus *Nyssa* are very common elements in the Tertiary of Europe, i.e., *Nyssa disseminata* (Ludwig) Kirchheimer and *Nyssa ornithobroma* Unger Both taxa are morphologically very similar, but differ in the shape and size of germination valves and endocarps and also in the number of loculi (e.g. Holý 1974, Meller 1998). Finally, both taxa differ also in the stratigraphical range, where *Nyssa disseminata* is a typical element of Late Miocene to Pliocene floras, while *Nyssa ornithobroma* occurs often from the Middle Oligocene to Late Miocene. The latter mentioned species is also known from the whole three parts of the Zittau Basin (Mai 1964, Czeczott & Skirgiełło 1959, Holý 1974). *Nyssa ornithobroma* is best comparable with recent species *N. sinensis* Oliv. due to similarity of the size, the upper structure and the loculi number. This recent taxon occupies an area of southeastern China as an element of the Mixed Mesophytic forests. But ecologically *Nyssa ornithobroma* is similar to recent *N. biflora* Walt. and *N. aquatica* L., which are significant elements of swamp forests in the southeastern part of the USA.

Mastixiaceae

Mastixia Blume

Mastixia lusatica Mai

Pl. 5, fig. 5

1964 *Mastixia amygdalaeformis* (Schloth.) Kirchheimer, Mai, p. 42–43, 63, 81, 90. 97, 114, Pl. 7, fig. 3, Pl. 8, fig. 12, Pl. 9, figs 6,7, Pl. 12, figs 16, 17, Pl. 15, figs 15, 16.
1966 *Mastixia amygdalaeformis* (Schloth.) Kirchheimer, Bůžek, Holý & Kvaček, p. 209.
1970b *Mastixia lusatica* Mai, p. 466–477, Pl. 64, figs 1–10, text–figs 9 f, l.
1974 *Mastixia lusatica* Mai, Holý, p. 86–87, Pl. 18, figs 7–13.
1975 *Mastixia amygdalaeformis* (Schloth.) Kirchheimer, Czeczott & Skirgiełło, p. 31–36, Pl. 9, figs 2,3.
1975a *Mastixia lusatica* Mai, Holý, p 131–133, Pl. 1, figs 20–39.

Material. 1 endocarp (Hr 42: 47.9).

Description. Endocarp 15 mm long and 5 mm broad, bisymmetric, oblong to fusiform, base cuneate, apex probably attenuate, rounded on cross section, ventral side convex, dorsal side straight with relatively deep and broad furrows, relatively thick, external surface sculptured by numerous longitudinal furrows, ribs or ledges.

Remarks. According to a key of the family Mastixiaceae (Holý 1975a), relatively short, ovate or fusiform endocarps with convex ventral and straight dorsal sides including furrows and sharp or rounded ribs on the external surface define the genus *Mastixia* Blume. Mai (1970a) separated the original material of *Mastixia amygdalaeformis* (Schloth.) Kirchheimer in two newly defined species, i.e. *M. amygdalaeformis* and *M. lusatica*. The studied fruit shows the same morphological features as the specimens from Wiesa by Kamenz (Mai 1964) and Kristina (Holý 1974, 1975a) and it is very similar to finds from Turów (Czeczott & Skirgiełło 1975). Representatives of the fossil Mastixiaceae and other climatically sensitive elements (e.g. Symplocaceae) create termophilous assemblages, which have two peaks during the Tertiary. The first maximal expansion is known from the Eocene (e.g. Hordle-Zeitz floristic assemblages) and has been called as “older mastixiod floras”. The second one is limited to the Early Miocene to Middle Miocene (Eichelskopf-Wiesa or Düren floristic assemblage) and it has been named as “young mastixiod floras” (Kirchheimer 1938, Mai 1964, 1995). According to Van der Burgh (1987), the fossil Mastixiaceae of Europe provides some references for a deduction of wet to moist eutrophic to mesotrophic soils and humid subtropical to warm-temperate climate. Present distribution of living genus *Mastixia* (25 species) is confined to S-Asia (Indo-Malaya area), where mastixias usually occupy evergreen rain forests growing between latitudes about 10°S to 25°N or biotopes along rivers in cloud forests of savannah region (Holý 1975a).

Tectocarya Kirchheimer vel *Mastixicarpum* Chandler

Tectocarya elliptica (Unger) Holý vel ***Mastixicarpum limnophilum*** (Unger) Kirchheimer

Pl. 5, fig. 6

Material. 1 incomplete fruit (Hr 43: 32.0).

Description. Incomplete fruit 17.9 mm long and 10.5 mm broad, secondary flattened, oval or slightly obovate in outline, epicarp fragmentary, closely joining endocarp, apex obtuse, probably provided with a stylar base, basal part not complete, probably round, base rounded with distinct pit in its centre.

Remarks. The assigning of this fruit is problematic due to its incompleteness and a poorly preserved apical part with unclear structure resembling a stylar base. The incomplete fruit has morphologically affinity to *Tectocarya elliptica* (Ung.) Holý and *Mastixicarpum limnophilum* (Ung.) Kirchh., which are known in considerable number from the whole area of the Zittau Basin (Mai 1964, Czeczott & Skirgiełło 1975, Holý 1975a). Both taxa match well in form and size, therefore it is impossible to differentiate them in this stage of preservation and the absence of transversal section.

Haloragaceae

Proserpinaca L.

***Proserpinaca* sp.**

Pl. 4, figs 9, 10, Pl. 8, figs 1, 2

Material. 2 incomplete fruits (Hr 44: 95.0, 104.0).

Description. Fruits 1.61 mm and 1.87 mm long, 1.0 mm and 1.28 mm broad, asymmetrical in outline, secondarily flattened, the number of loculi unknown, barrel- shaped, apical part flat with distinct fragments of perianth, basal part asymmetric, narrowed to incomplete tip, upper surface variable, ornamented by distinct irregular, longitudinal vascular vessels, joined by diagonal or oblique thinner ledges (the smaller finds) or created irregular polygonal pits with enlarged corner, extremely differing in form and size.

Remarks. The two similar fruits are assigned only to the generic level due to poor preservation of this material, especially their deformation during lateral compression. The determination of the genus *Proserpinaca* is based on the presence of a typical incomplete perianth in the apical region of the fruits and similar size and structure of the upper surface with the hitherto described material from the Tertiary of Europe (e.g. Meller 1998, Mai 2000a). Holý (1974) described a new species *P. ervinii* from the locality Kristina, which is similar in size with above-described material, but varies in character of upper surface (indistinct ornamentation by *P. ervinii*). According to

Holý (1974, 1976), the fruits of *P. ervinii* are very similar to *P. pterocarpa* Dorof. and *P. reticulata* C. & E.M. Reid. The latter mentioned species is also known from the Most Basin (Bůžek & Holý 1964). According to similar pattern of the upper surface, the material from the core Hr 44 matches fruits of *P. pterocarpa* due to their well-developed distinct reticulate venation. But, both taxa differ in the shape, which is highly trapeziform by *P. pterocarpa*. Besides, fruits of *P. reticulata* are bigger than the studied material. The representatives of *Proserpinaca* occupy today an area in North and Central America as submerged aquatic elements.

Rosaceae

Rubus L.

***Rubus* sp. 1**

Pl. 4, figs 11,12, Pl. 5, fig. 1, Pl. 6, figs 2, 3

Material. 28 complete endocarps (Hr 42: 8.5, 21.0–22.0, 99.7, 111.7, Hr 44: 25.0, 104.0, Hr 45: 39.3, 297.5, Hr 51: 80.0, 82.0).

Description. Endocarps 1.3–(1.48)–1.51 mm long and 0.93–(0.95)–0.97 mm broad, asymmetric, ovate, base rounded, apex acute, secondarily flattened, ventral margin straight to slightly convex, dorsal margin rounded, external surface distinctly ornamented, pits irregular, polygonal, rounded or elongate. Spines not preserved due to abrasion during washing of the rocks.

Remarks. The endocarps are variable in size and character of the upper surface. They have a typical asymmetric “teary” shape and are smaller than endocarps of *Rubus* sp. 2. This morphotype is comparable with *Rubus microspermus* C. & E.M. Reid and *R. laticostatus* Kirchheimer (e.g. Mai 1997), which were described from the localities Wiesa and Hartau (Mai 1964). This very common frutescent element is not known from the Polish part of the Zittau Basin, which is surprising in view of large-scale investigations of the Czeczott’s team.

***Rubus* sp. 2**

Pl. 4, fig 13, Pl. 5, fig. 1, Pl. 6, fig. 1

Material. 4 complete endocarps (Hr 44: 104.0).

Description. Endocarps 1.64–(1.75)–2.1 mm long and 0.92–(1.0)–1.1 mm broad, oblong ovate to oval, base rounded, apex obtuse, secondarily flattened, ventral margin straight, rarely slightly convex, dorsal margin rounded, external surface distinctly ornamented, pits irregular, polygonal, rounded or elongate. Spines not preserved.

Remarks. These endocarps are absolutely different in size and form from *Rubus* sp. 1. They are bigger and slender and have a typical oblong ovate to oval shape. According to morphological parameters (mainly oval form) these four fruits probably correspond to *R. semirotundatus* Łańcucka-Środoniowa from the locality Nowy Sącz (Łańcucka-Środoniowa 1979) or Saxony (Mai 1997). Holý (1974) described about 20 fruits as *Rubus* sp. div. from the locality Kristina. These fruits correspond to both presented morphotypes of the genus *Rubus*.

Theaceae

Eurya Thunberg

Eurya stigmosa (Ludwig) Mai

Pl. 4, figs 5, 7, 8

1860 *Potamogeton stigmosus* Ludwig, p. 60, pl. 8, fig. 13.
1960 *Eurya stigmosa* (Ludwig) Mai, p. 79, pl. 4, figs 8–17.
1964 *Eurya stigmosa* (Ludwig) Mai, p. 38–39, 62, 79, 112.
1971 *Eurya stigmosa* (Ludwig) Mai, p. 329–330, Pl. 34, figs 27–28.
1974 *Eurya stigmosa* (Ludwig) Mai, Holý, p. 48–50, Pl. 8, figs 1–4.

Material. 18 complete seeds (Hr 42: 21–22, 47.9, Hr 43: 32, Hr 45: 287.5, Hr 47: 169.5, Hr 51: 81.0).

Description. Seeds 1.0–1.38 mm long and 1.13–1.58 mm broad, discoid to horseshoe-shaped, asymmetric, base narrowed, slightly excurrent to straight, distal part rounded, shorter than seed radius, apex obtuse or mucronate, sides arched and concave to straight, elliptic condylus extending from basal part to centre of seed, externally showing as distinct elevation, hilum conical, seed cavity horseshoe-shaped, apex and base rounded, testa 0.056–0.14 mm broad, thinner at apical and sides part, external surface distinctly ornamented, lustrous, pits irregular, polygonal or round, arranged in concentric arched lines.

Remarks. High variability in size and shape and large stratigraphical range of this taxon (from Palaeocene to Pliocene) suggest a cumulative character of this species. Similarly, *E. stigmosa* is known only from the German part of the Zittau Basin (Mai 1964) and also from the locality Kristina (Holý 1974). According to Holý (1974), *Eurya stigmosa* is comparable with extant *Eurya japonica* Thunb., which is an element of shrubby understorey of the Mixed Mesophytic forests in SE-China or occupies mountain areas of the tropical zone (Himalayas).

Hypericaceae

Hypericum L.

Hypericum septestum Nikitin

Pl. 6, figs 4–6

1948 *Hypericum septestum* Nikitin, p. 1104.
1957a *Hypericum septestum* Nikitin, Dorofeev, p. 307, Pl. 4, fig. 18.
1963a *Hypericum septestum* Nikitin, Dorofeev, p. 225–226, Pl. 40, figs 8–20.
1974 *Hypericum septestum* Nikitin, Holý, p. 50, Pl. 8, fig. 5.

Material. 1 incomplete seed (Hr 42: 8.5).

Description. Seed 0.91 mm long and 0.42 mm broad, oval, secondarily flattened, chalaza rounded, punctate, raphe lateral, thin, external surface ornamented by 22 longitudinal rows of distinct, irregular, polygonal pits, often with rounded corners, creating reticular structure, pits with distinct enlarged cell-walls (average 0.014 to 0.028 mm).

Remarks. This incomplete seed is identical with two seeds from the Kristina mine (Holý 1974) and morphologically similar with *Hypericum miocenicum* Dorof. emend. Mai, which is known as a frutescent element in all Europe from the Late Oligocene to Pliocene. The difference of both taxa is especially in the structure of the upper surface, i.e. the number of the longitudinal rows is lower in *H. miocenicum* (varying from 12 to16). *H. septestum* was described from the Late Oligocene of west Siberia (Dorofeev 1957) and from the Middle and Late Miocene of Europe (e.g. Mai 2001). The first finds from the Early Miocene are the above-mentioned material from the locality Kristina and the incomplete seed from the bore hole (Hr 42:8.5). According to Mai (2001) *H. septestum* is comparable with recent *H. scabrum* L.

Ulmaceae

Trema Lour.

Trema lusatica Mai

Pl. 5, figs 15, 16, Pl. 6, fig. 7

1964 *Trema lusatica* Mai, p. 22, 105, Pl. 4, figs 21, 22, Pl. 6, fig. 10, Pl. 13, figs. 23–25.
1974 *Trema lusatica* Mai, Holý, p. 39–40, Pl. 6, figs 7, 8.

Material. 2 endocarps (Hr 42: 8.5, 47.9).

Description. Endocarps 1.4 and 1.88 mm long, 1.13 and 1.25 mm broad, lens-shaped to ovoid in outline, apex obtuse, base rounded, chalaza sub-apical, punctate, peripheral keel distinct, rounded, external surface ornamented by a system of irregular rounded ledges.

Remarks. These endocarps are morphologically comparable with those from the localities of Hartau, Wiesa, and Kristina (Mai 1964, Holý 1974). Mai (1999b) compared fossil *Trema lusatica* with extant *T. velutina* Planch (Hong Kong), *T. lamarckiana* Benth. (Bermudas,West Indies) and *T. micrantha* Decaisne (Mexico). The representatives of *Trema* are spread in the pantropical zone of the North Hemisphere as elements of evergreen or deciduous forests and pioneer plant assemblages (Mai 1999b).

Staphyleaceae

Turpinia Vent.

Turpinia ettingshausenii (Engelhardt) Mai

Pl. 5, fig. 7, Pl. 6, fig. 14

1870 *Leguminosites ettingshausenii* Engelhardt, p. 42, Pl. 11, figs 8, 9
1964 *Turpinia ettingshausenii* (Engelhardt) Mai, p. 95–97, 108, Pl. 12, figs 14, 15, Pl. 14, figs 6–14.
1974 *Turpinia ettingshausenii* (Engelhardt) Mai, Holý, p. 68–69, Pl. 13, figs 1–6.

Material. 1 complete seed (Hr 42: 8.5).

Description. Seed 5.9 mm long and 3.2 mm broad, oblong oval to slightly obovate, apex obtuse, base rounded, distinct hilar fosse in suprabasal part, oval in outline, 1.4 mm long and 1.1 mm broad, external surface lustrous, ornamented by polygonal, irregular pits (average 0.042 mm)

Remarks. The complete seed from core Hr 42: 8.5 is identical in all morphological aspects with the seeds from the locality Krisitna (Holý 1974), Hartau and Kummersberg (Mai 1964). *Turpinia ettingshausenii* is well comparable with extant species *T. montana* Kohd. (N-Kalimantan) and *T. formosana* Nakai (Taiwan).

Symplocaceae

Symplocos Jacquin

Symplocos lignitarum (Quenstedt) Kirchheimer

Pl. 5, figs 8–10

1867 *Carpolithus lignitarum* Quenstedt, p. 914, Pl. 86, fig. 17.
1950 *Symplocos lignitarum* (Quenstedt) Kirchheimer, p. 14–15, Pl. 1, fig. 4, Pl. 2, fig. 15.
1964 *Symplocos lignitarum* (Quenstedt) Kirchheimer, Mai, p. 47, 63, 98, 116, Pl. 12, fig. 23.
1967 *Symplocos lignitarum* (Quenstedt) Kirchheimer, Czeczott & Skirgiełło, p. 127, Pl. 10, figs 1, 2.
1974 *Symplocos lignitarum* (Quenstedt) Kirchheimer, Holý, p. 54–55, Pl. 10, figs 1–7.

Material. 24 complete and incomplete endocarps (Hr 40: 257.0).

Description. Endocarps 4.5–6.3 mm long and 2.5–5.8 mm broad, trilocular, oblong cylindrical to obovoid, sides convex, often asymmetrical and bent in basal part, narrowed, rounded with small central fosse (0.2–0.3 mm in diameter), apex straight truncate, apical fosse shallow, 1.2–2.5 mm in diameter, external surface sculptured by numerous parallel longitudinal ribs, narrowly spaced.

Remarks. *Symplocos lignitarum* is the most frequent element of the European Tertiary, which is morphologically well determinable, according to typical cylindrical or oval endocarps with distinct longitudinal, relatively sharp ledges. Besides this typical finds, relatively short specimens (often considerable compressed) are known e.g. from the locality Kristina (Holý 1974). These endocarps have an affinity to *S. salzhausensis*. The above-described material is identical with the endocarps from the localities Hartau, Turów and Kristina (Mai 1964, Czeczott & Skirgiełło 1967, Holý 1974). Czeczott and Skirgiełło (1967) compared this fossil taxon with extant species *S. touranensis* Guill., which occurs as a mountain element in southern Vietnam (1000–1500 m alt.) and *S. yunnanensis* Brand from Thailand (1530 m alt.).

Symplocos lusatica Mai

Pl. 5, fig. 12

1964 *Symplocos lusatica* Mai, p. 116, Pl. 16, figs 3–5.
1967 *Symplocos lusatica* Mai, Czeczott & Skirgiełło, p. 128–129, Pl. 9, figs 2–6.

Material. 1 complete endocarp (Hr 44: 44.0–45.0).

Description. Endocarp 6.7 mm long and 4.5 mm broad, probably trilocular, ellipsoidal to cylindrical in outline, secondarily flattened, sides convex, base rounded with central fosse, apex truncate with apical rounded fosse, 2.1 mm in diameter, 0.3 mm broad, external surface ornamented by 12 longitudinal ribs.

Remarks. This endocarp is morphologically identical with the material from Hartau and Turów (Mai 1964, Czeczott & Skirgiełło 1967). *Symplocos lusatica* is similar to *S. lignitarum*, which is also known from the mentioned localities and Kristina, Wiesa, Schmeckwitz-Piskowitz and Kummersberg (Mai 1964, Holý 1974). It differs in longer dimensions and in more densely spaced and more prominent ribbing. Mai (2000a) compared *S. lusatica* with recent *S. adenophylla* Wall. from SE-Asia.

Symplocos salzhausensis (Ludwig) Kirchheimer

Pl. 5, figs 11, 13, 14

1860 *Carpinus salzhausensis* Ludwig, p. 100–101, Pl. 33, fig. 8.
1936 *Symplocos salzhausensis* (Ludwig) Kirchheimer, p. 96, Pl. 10, figs 2a–g.
1964 *Symplocos salzhausensis* (Ludwig) Kirchheimer, Mai p. 48, 83, 98, 117, Pl. 5, figs 16, 17, Pl. 9, fig. 16, Pl. 12, fig. 24, Pl. 16, figs 8–10.
1967 *Symplocos gothanii* Kirchheimer, Czeczott & Skirgiełło, p. 127–129, Pl. 7, fig. 3, 11–13, Pl. 10, fig. 5.

Material. 4 complete endocarps (Hr 51: 82.0, Hr 44: 95.0).

Description. Endocarps 4.1–4.8 long, 3.8–4.2 broad, trilocular, globular in outline, secondarily flattened, base rounded with distinct tip (Hr 51:82) and central fosse, 0.3–0.6 mm in diameter, apex obtuse to truncate, apical central fosse shallow, rounded or triangular in outline, 1.6 mm in diameter, external surface sculpted by relatively inconspicuous, low, rounded, longitudinal ledges, varying to oblong tubers.

Remarks. This representative of the family Symplocaceae is not so common in the Zittau Basin, but its stratigraphical range is from the Late Oligocene to Late Miocene. Recently it was proved in the Pliocene (Bertoldi & Martinetto 1995). *Sympolocos salzhausensis* is based on the original endocarps from Salzhausen (Ludwig 1860, Kirchheimer 1936), which are typically globular, with relatively small apical fosse and low, rounded longitudinal ledges. These basic morphological features differentiate *S. salzhausensis* from untypical finds of *Symplocos lignitarum*. Kirchheimer (1937, 1941, 1957) used the name *S. gothanii* Kirchheimer for completely identical endocarps from the locality Wiesa. This taxonomical name is usually reserved for morphologically similar, but younger finds, based on the material from the locality Konzendorf (Kirchheimer1935). Similarly, Czeczott and Skirgiełło (1967) described uniform specimens from Turów. According to Holý (1974), both taxa are very similar, but endocarps of *S. gothanii* are more oblong to shortly cylindrical with broader apical fosse (more than one half of endocarp's diameter) and are usually ornamented by irregularly disconnected flattened ledges.

Lythraceae

Microdiptera Chandler

Microdiptera uralensis (Dorofeev) Mai

Pl. 5, figs 17, 18, 21, Pl. 6, figs 9–11

1970 *Diclidocarya uralensis* Dorofeev, p. 60, Pl. 15, figs 1–5, text-fig. 12.
1972 *Mneme uralensis* Eyde, p, 114.
1987 *Microdiptera uralensis* (Dorofeev) Mai, p. 113, Pl. 7, figs 13, 14.

Material. 19 seeds (Hr 42: 8.5, Hr 44: 104.0).

Description. Winged seeds 1.1–1.5 mm long and 0.8–1.3 mm broad (l:w index 1.15–1.71), oblong trapezoid or angularly obovate in outline, sides straight or rarely slightly concave, apex and base rounded, ventral side concave with oblong spine border by distinct two lateral ledges, ventral side convex, lower part covered by oblong germination lid, sculptured by longitudinal rows of polygonal cells 8–12 in number.

Remarks. These typical winged seeds are usually assign to the genus *Microdiptera* Chandler or *Mneme* Eyde. Both taxa contain morphologically similar seeds, which differ in some details (detailed in Chandler 1957, Holý 1976). According to morphological analyses, the above-described material is best comparable with two species, i.e. *Microdiptera uralensis* (Dorofeev) Mai and *Mneme donata* Holý. The mutual taxonomical relation of both mentioned taxa is doubtful. Holý (1974, 1976) permit morphological similarity, but notes that *M. uralensis* have longer and slender seeds (l:w index 1.55–1.92) contrary to *M. donata* (l:w index 1.1–1.5). Material from core Hr 42:8.5 and Hr 44:104.0 shows mutual morphological features of both taxa and belongs to same stratigraphical position as the material from Kristina. Therefore, it is possible to reassigned seeds of *M. donata* to *M. uralensis* and interpret to morphological differences as intraspecific variation of this taxon. A similar seed was originally described as *Microdiptera parva* Chandler from the locality Hartau (Mai 1964, 2000a).

Decodon J.F. Gmelin

Decodon gibbosus (E.M. Reid) Nikitin

Pl. 5, figs 19, 20, 23, Pl. 6, fig 8, Pl. 8, figs 4, 7

1920 *Diclidocarya gibbosa* E.M. Reid, p. 82, Pl. 4, figs 23, 25.
1929 *Decodon gibbosus* (E.M. Reid) Nikitin, p. 37, Pl. 589, figs 8, 9.

Material. Great quantity of seeds (Hr 51: 81.0–82.0).

Description. Seeds 0.9–1.1 mm long and 0.8–0.9 mm broad, variable in form, secondarily flattened, often irregularly pyramidal with cuneate base and rounded apical part, ventral side triangular, flat or slightly concave, partly covered by smooth germination valve (smaller than one-half of ventral side), dorsal side convexly rounded, built by aerenchym.

Remarks. The fossil seeds of the genus *Decodon* are common elements in the Eurasian Tertiary (e.g. Raniecka-Bobrowska 1957, Dorofeev 1977, Mai 1985, 2000a), which are usually described under several forms or species (e.g. *D. gibbosus*, *D. globosus*, *D. tetraedriformis*, *D. vectensis*, *D. sibiricus*, *D. tav-*

densis, or *D. antiquus*). The determination of these seeds and mainly distinguishing of species or forms is very problematic, especially in the case of the *D. gibbosus* and *D. globosus*, due to form variability of isolated seeds or in frame of one fruit (Kirchheimer 1957: 617, Kvaček & Sakala 1999: 216–217).

Vitaceae

Vitis L.

Vitis cf. ***teutonica*** Al. Braun

Pl. 5, fig. 22, Pl. 6, fig. 12

1857 *Vitis teutonica* Al. Braun, p. 147, Pl. 3, figs 8–15.

Material. 16 seeds (Hr 42: 30.2, 31.0–32.0, 47.9, Hr 40: 265.5).

Description. Seeds 2.8–3.5 mm long, 2.2–2.4 mm broad, ovate in outline, apex acute, base rounded with raphe joined relatively small, oval to rounded, central or subcentral chalaza, dorsal side often smooth, ventral side slightly convex, smooth, distinct medial keel including straight raphe, lateral area flattened or with shallow caverns.

Remarks. These seeds are assignable to *Vitis* cf. *teutonica* Al. Br. due to presences of the relatively small rounded, central chalaza and similarity in form and size of seeds. On the other hand, most of the above-described material shows also an affinity to small specimens of *V. lusatica* Czeczott & Skirgiełło, which are a very common element in the Zittau Basin (Czeczott & Skirgiełło 1959, Mai 1964, Holý 1974). Stratigraphical range of *V. teutonica* is from the Late Oligocene to Pliocene of whole Europe and it is similar to some East Asian recent species, i.e. *V. balsamaeana* Planch. from Hainan and *V. thunbergii* Sieb. & Zucc. from Japan, China, Korea, and Taiwan (Mai 1997).

Ampelopsis Michaux

Ampelopsis ludwigii (Al. Br.) Dorofeev

Pl. 6, fig. 13, Pl. 7, figs 1, 2

1857 *Vitis ludwigii* Al. Braun, p. 184.
1957b *Ampelopsis ludwigii* (Al. Br.) Dorofeev, p. 644–645, Pl. 1, figs 1, 2.
1957 *Ampelopsis ludwigii* (Al. Br.) Dorofeev, Kirchheimer, p. 717, Pl. 22, fig. 97.
1959 *Vitis ludwigii* Al. Br., Czeczott & Skirgiełło, p. 102–103, Pl. 17, figs 1–3.
1964 *Ampelopsis ludwigii* (Al. Br.) Dorofeev, Mai, p. 34–35, 89, 110, Pl. 3, figs 28–29, Pl. 14, figs 25, 26.
1974 *Ampelopsis ludwigii* (Al. Br.) Dorofeev, Holý, p. 78–79, Pl. 16, figs 7–12.

Material. 13 complete seeds and fragments (Hr 49: 39.3, Hr 42: 30.2, Hr 51: 82.0).

Description. Seeds 4.1–4.5 mm long and 2.5–3.1 mm broad, ovate in outline, base distinctly cordate, apex broadly acute, narrowed to conical micropyle (0.5 mm broad in basal part), dorsal side slightly convex, distinct knot of the marginal, oval chalaza, ornamented by distinct, radial wrinkles around the testa near the chalaza, ventral side convex, relatively deep lateral caverns along narrow triangular keel with finely raphe.

Remarks. These seeds are morphologically comparable with the seed material from Hartau, Wiesa, Kleinsaubernitz, Kristina and Turów (Czeczott & Skirgiełło 1959, Mai 1964, Holý 1974). The above-described material is morphologically also similar to the seeds, which are assigned to *Vitis parasilvestris* Kirchh. and occur in association with *A. ludwigii* in Kristina (Mai 1964, Holý 1974). The both taxa are practically identical in the size and shape, but differ in absence of the distinct ornamentation on dorsal side and presence of relatively bigger the marginal chalaza in the case of *A. ludwigii*. According to Mai (1964), it is possible to connect *A. ludwigii* with recent *A. leeoides* Planch. from southern Japan.

Ampelopsis rotundata Chandler

Pl. 7 figs 5, 6

1926 *Ampelopsis rotundata* Chandler, p. 33, Pl. 5, figs 5a–c.
1959 *Vitis teutonica* Al. Br., Czeczott & Skirgiełło, p. 102, Pl. 16, figs 4, 5.
1964 *Ampelopsis rotundata* Chandler, Mai, p. 78, 110–111, Pl. 9, fig. 12, Pl. 14, figs 27, 28.
1974 *Ampelopsis rotundata* Chandler, Holý, p. 78–79, Pl. 17, figs 1–4.

Material. 9 complete seed and fragments (Hr 42: 8.5, 30.2).

Description. Seeds 2.9–3.5 mm long, 2.2–2.4 mm broad, ovate to rounded in outline, apex acute, base rounded with distinct raphe joining small, oval to rounded, subcentral or marginal chalaza, dorsal side often smooth or rarely ornamented by fine, radial wrinkles around chalaza, ventral side slightly convex, smooth, distinct medial keel including straight raphe, lateral area flattened or with relatively deep caverns, usually broken through, wall thin (thickening of 0.17 mm).

Remarks. The above-described seeds are morphologically identical with the material from Kristina, Hartau and Merka (Holý 1974, Mai 1964). Czeczott and Skirgiełło (1959) described identical material from Turów as *Vitis teutonica* Al. Br.. Holý (1974) or Mai (1997) assign to this taxon also similar seeds of *Ampelopsis heerii* Dorof. and *A. europaea* Dorof. The stratigraphical range of this taxon is from the Late Eocene to Early Pliocene (Mai 2001). Mai (1999b) compares *A. rotundata* with extant *A. heterophylla* Sieb. & Zucc., *A. fargesii* Gagnep. and *A. megaphylla* Diels & Gilg from the Mixed Mesophytic forests in eastern China.

Tetrastigma Planchon

***Tetrastigma* sp.**

Pl. 5, fig. 27

Material. 1 fragment of seed (Hr 42: 30.2).

Description. Fragment of seed 4.0 mm long and 2.1 mm broad, probably oval in outline, base cordate, apex suddenly narrowed to a fragment of conical micropyle, dorsal side not preserved, half of ventral side preserved, finely convex with fragment of narrow keel and thin raphe, sculpted by longitudinal relatively deep furrow along the keel and short perpendicular furrows, creating convex lobes, testa thin (0.14 mm).

Remarks. The above-described fragment of the ventral side is morphologically very similar to seeds of the genus *Tetrastigma*. The main diagnostic feature is a deep transversal furrow creating convex lobes. The determination to the species level is equivocal due to fragmentary character. *Tetrastigma chandleri* Kirchheimer and *Tetrastigma lobata* Chandler has been known from the Kristina mine, Turów, Wiesa, Merka-Quatitz and Hartau (Mai 1964, Holý 1974). The material from core Hr 40:30.2 shows affinity to *T. lobata* due to its size.

Vitaceae gen. et spec. indet.

Material. Incomplete seeds and fragments (Hr 42: 8.5, 87.3).

Remarks. This material is impossible to assign to the above-described taxa of the family Vitaceae due to fragmentary character and poor preservation of the investigated seeds. Besides the mentioned taxa, other representatives of the genus *Tetrastigma* Planchon have been known from Kristina, Wiesa, Turów, Merka-Quatitz and Hartau (Czeczott & Skirgiełło 1959, Mai 1964, Holý 1974).

Sabiaceae

Meliosma Blume

Meliosma wetteraviensis (Ludwig) Mai

Pl. 5, figs 24–26

1857 *Hamamelis wetteraviensis* Ludwig, p. 105, Pl. 20, fig. 27 a–b.
1973 *Meliosma wetteraviensis* (Ludwig) Mai, p. 105–106, Pl. 5, figs 7–9.
1980 *Meliosma wetteraviensis* (Ludwig) Mai, Gregor, p. 33, Pl. 8, fig. 15.
1998 *Meliosma wetteraviensis* (Ludwig) Mai, Meller, p. 550, Pl. 22, figs 6–8.

Material. 22 complete endocarps and fragments (Hr 42:87.3, 90.7, Hr 44:15.0, Hr 51:80.0).

Description. Endocarps rounded to discoid in outline, slightly asymmetric, secondarily flattened, in diameter 4.9–7.0 mm, double valvate, dorsoventral dehiscence, chalaza fosse oval to triangular (2.5–4.0 mm long), filled in placental plug, peripheral keel medial and blunt, upper surface smooth or slightly wrinkled around chalaza region, wall 0.5 mm thin and hard.

Remarks. *Meliosma wetteraviensis* is exactly defined and is well identifiable due to its form and size of the endocarp and chalaza region, and especially due to the thickness of the endocarp's wall from other representatives of *Meliosma*, e.g. *M. pliocaenica* (Szafer) Gregor or *M. miessleri* Mai. The latter mentioned species is known from the localities Hartau and Kristina (Mai 1964, Holý 1974). The stratigraphical range of this taxon is from the Late Oligocene of West Europe and Siberia to Pliocene (Mai 2000a). Recent *M. veitchorum* Hemsl. and *M. alba* (Schlechtend.) Walp. show the most similar endocarps with the fossil *M. wetteraviensis*. Both species occupy an area of SE China as elements of Mixed Mesophytic forests and *M. alba* is also known from Mixed Oak forests in Mexico (Mai 2000a).

Potamogetonaceae

Potamogeton L.

Potamogeton wiesaensis Kirchheimer

Pl. 7 figs 3, 4, 9–10, Pl. 8 figs 8, 9

1957 *Potamogeton wiesaensis* Kirchheimer, p. 271, 354, Pl. 13, figs 61a–c.

Material. 13 complete endocarps (Hr 51/82).

Description. Endocarps 1.4–(1.5)–1.8 mm long and 1.0–1.1 mm broad, oval in outline, base rounded, apical part obtuse, distinctly narrowed in relatively broad base of fragmentary style (0.1–0.25 mm long), lateral sides flattened, finely concave with central oval depression without perforation in the middle (0.2–0.4 mm in diameter), ventral side straight or convex, rarely slightly concave in the base, germinal valve rounded with distinct keel, upper surface smooth.

Remarks. These endocarps are possible to assign to *Potamogeton wiesaensis* Kirchheimer, which is based on the fossil material from the locality Wiesa (Kirchheimer 1957). The main diagnostic feature is a well-developed keel of the germinal valve, which is lacking in *P. nochtensis* Mai or *P. heinkei* Mai (Mai 1964, 1987). The both later mentioned taxa occur frequently in the Kristina mine (Holý 1974, 1976). On the other hand, some endocarps of the material from core Hr 51, which have smaller size, relatively indistinct keel and shallow central depresion, show affinity to *P. nochtensis* rather than *P. wiesaensis.* According to Mai (1999a), a recent analogue is a representative of *P. polygonifolius* Pour. group.

Cyperaceae

Dulichium Persoon

Dulichium marginatum (C. & E.M. Reid) Dorofeev

Pl. 7, figs 7, 8, 11, Pl. 8, figs 5, 12

1915 *Dulichium spathaceum* var. *marginatum* C. & E.M. Reid, p. 66, Pl. 3, figs 5, 6.

1963a *Dulichium marginatum* (C. & E.M. Reid) Dorofeev, p. 117–118, Pl. 13, figs 17–23.

1964 *Dulichium vespiforme* C. & E.M. Reid, Mai, p. 102–103, Pl. 13, fig. 6.

1974 *Dulichium marginatum* (C. & E.M. Reid) Dorofeev, Holý, p. 95, Pl. 20, figs 11, 12.

Material. 7 incomplete fruits (Hr 44: 44.0–45.0, Hr 42: 41.0–42.0).

Description. Fruits 1.75–2.75 mm long and 0.8–0.95 mm broad, elliptic to oval in outline, bordered by narrow winged-edge (24–32 μm broad), with short or attenuate style (0.4 mm long), base narrowed to short neck, joining to basal disc (0.2 mm × 0.3 mm) with 2 incomplete and thin bristles, external surface leathery, ornamented by longitudinal rows of polygonal pits18–(30)–42 μm long and 12–18 μm broad:.

Remarks. These incomplete fruits are very similar with the material from the localities Kristina and Hartau (Holý 1974, Mai 1964). The stratigraphical range of *Dulichium. marginatum* is from the Late Oligocene to Late Pliocene of West Europe and West Siberia. Besides, morphologically very close *D. vespiforme* C. & E.M. Reid appears in the Middle Miocene of West Siberia and dominates in Europe during the Pliocene to Middle Pleistocene (Mai 1999a). Both mentioned taxa differ mainly in the form, size and the character of the basal disc and styles and are connected with the same recent analogue, i.e. *D. arundinaceum* (L.) Britt. (Mai 1997).

Sparganiaceae

Sparganium L.

Sparganium camenzianum Kirchheimer

Pl. 7, figs 12–16, Pl. 8, fig. 6

1941 *Sparganium camenzianum* Kirchheimer, p. 228–227, fig. 18.

1964 *Sparganium camenzianum* Kirchheimer, Mai, p. 15, 101.

1974 *Sparganium camenzianum* Kirchheimer, Holý, p. 95–96, Pl. 20, figs 13–16.

Material. 80 complete and incomplete endocarps (Hr 42: 8.5, 21.0–22.0, 85.0, Hr 43: 32.0, Hr 44: 104.0, Hr 45: 287.5, Hr 51: 80.0, 82.0).

Description. Endocarps obovate to long obovate, smaller urn-shaped, 1.0–2.1 mm long and 0.76–0.94 mm broad, base often pointed and immediately narrowed, rarely rounded to wedged- shaped (oblong forms), apical part narrowed to conical or cylindrical neck with apical pore (0.17–0.24 mm long and 0.22–0.34 mm broad), upper surface smooth.

Remarks. The described endocarps are morphologically variable. Therefore, it is easy to define some different morphological forms, which vary mainly in the shape and size, and assign them as different species. But, similarly as Kirchheimer (1941), Mai (1964) and Holý (1974), morphological diversity of the above-described material is possible to interpret as intraspecific variation of *Sparganium camenzianum*. Endocarp, which is figured on Pl. 7, fig. 13, has affinity to *S. haentzschelii* Kirchh. due to acute and smaller neck. Mai (1999a) compared fossil endocarps of *S. camenzianum* with extant *S. emersum* Rehm. and *S. glomeratum* Laest. (both from Japan).

Arecaceae

Calamus L.

Calamus daemonorhops (Unger) Chandler

Pl. 7, figs 17, 18

1861 *Palaeospathe daemonorhops* Unger, p. 9, Pl. 2, figs 9–12.
1957 *Calamus daemonorhops* (Unger) Chandler, p. 88–89, Pl. 12, figs 24–42.
1964 *Palmacites daemonorhops* (Unger) Heer, Bůžek & Holý, p. 125–126, Pl. 1, fig. 5, Pl. 7, figs 14–16.
1964 *Calamus daemonorhops* (Unger) Chandler, Mai, p. 17, 71, Pl. 10, figs 5–7.
1974 *Calamus daemonorhops* (Unger) Chandler, Holý, p. 97–98, Pl. 21, fig. 2.
1980 *Spinophyllum daemonorops* (Unger) Huard, Czeczott & Juchniewicz, p. 26–28, Pl. 4–8.

Material. About 20 carbonised fragments of prickles and their groups (Hr 42: 111.7).

Description. Prickles fragmentary, very delicate, slowly narrowed, beard or needle-shaped, secondarily flattened, variable in size, apex acute, base shortly conically broadened, usually three prickles grouped together (the longest one in the middle), often smooth, rarely striated on external surface.

Remarks. Similar fragments of prickles and their groups, which rarely occur in association of the fruit and flower remains and often with fragments of the bark or aerial roots (e.g. Chandler 1957, Czeczott & Juchniewicz 1980), are problematically assigned to the generic level due to great variability of thorns and their distribution on the bark. This phenomenon allows using a great quantity of generic names in connection with various extant analogues. Similar material was described as *Calamus daemonorhops* from the localities Wiesa, Merka-Quatitz and Kristina (Mai 1964, Holý 1974) and from Turów as *Spinophyllum daemonorops* (Unger) Huard (Czeczott & Juchniewicz 1980). Ecologically, these palms are interpreted as elements of the swamp forest.

Zingiberaceae

Spirematospermum Chandler

Spirematospermum wetzleri (Heer) Chandler emend. Koch & Friedrich

Pl. 7, figs 19, 20, 27, Pl. 8, fig. 3

1859 *Gardenia wetzleri* Heer, p. 192, Pl. 141, figs 81–103.
1925 *Spirematospermum wetzleri* (Heer) Chandler, p. 17, Pl. 1, figs 5, 8a–c.
1971 *Spirematospermum wetzleri* (Heer) Chandler emend. Koch & Friedrich, p. 1–46, Pl. 1–15.
1980 *Spirematospermum wetzleri* (Heer) Chandler emend. Koch & Friedrich, Czeczott & Skirgiełło, p. 17–18, Pl. 2, figs 16, 17.

Material. 30 endocarps and 3 fragments of fruits (Hr 42: 87.3, Hr 51: 81.0–82.0).

Determination. Seeds variable in size, 5–8 mm long and 2–3.8 mm broad, oval to elliptic in outline, secondarily flattened, maximal breadth in the middle seed part, apex acute, rarely obtuse, base cuneate, often truncate, external surface smooth, spirally structured, lustrous. Fragments of fruits, probably oblong ligneous pods, seeds orientated in 2 longitudinal rows.

Remarks. These typical striated endocarps are identical with the fossil material from the locality Turów in the Polish part of the Zittau Basin (Czeczott & Skirgiełło 1980). *Spirematospermum wetzleri* is the oldest known fossil finds of the family Zingiberaceae, which were described as *Gardenia wetzleri* by Heer (1859). This species is very frequent in Eurasia from the Late Eocene to Early Pliocene (Bůžek 1962). Czeczott and Skirgiełło (1980) compared fossil *S. wetzleri* with the living species *Cenolophon oxymitrum* (Schuman) Holltum from Thailand, based on morphological and anatomical similarity.

Plantae incerte sedis

***Carpolithes* sp. 1**

Pl. 7, figs 24–26, Pl. 8, figs 10, 11

Material. 6 incomplete fruits, endocarps or buds (Hr 40: 257.6, Hr 45: 31.3, 39.7).

Description. Fruits, endocarps or buds 2.8–3.1 mm long and 3.0–3.4 mm broad, secondarily flattened, globular, base round with short stalk, apex round, external surface smooth with 6 longitudinal furrows, wall thick (0.15 mm).

Remarks. The determination of these globular objects is unclear. Morphologically similar material is described as buds of Tiliaceae (e.g. Mai & Walther 1991, Mai 2001, Pingen et al. 2001), which are relatively common in the European Miocene. According to Mai (pers. comm.), stalked objects, i.e. in Pl. 8, figs 10–11, can be interpreted as buds of *Craigia* Smith & Evans, and the material shown in Pl. 7, figs 25–26 has probably affinity to the family Ericaceae.

***Carpolithes* sp. 2**

Pl. 7, fig. 21

Material. 1 incomplete endocarp (Hr 40: 241.0).

Description. Incomplete endocarp 3.4 mm long, 1.7 mm broad, ellipsoidal or ovoid in outline, probably base broadly cuneate, upper surface sculptured by distinct 2 lateral and medial longitudinal furrows in both sides.

Remarks. The above-described incomplete endocarp is similar to seeds of the fossil genus *Aracispermum* Nikitin (e.g. Mai 1999a, 2000c). This affinity can be assumed the basis of characteristic structure of the upper surface, but the assigning is equivocal due to a fragmentary character of the specimen and uniqueness of the find.

***Carpolithes* sp. 3**

Pl. 7 figs 22, 23

Material. 18 complete seeds or endocarps and fragments (Hr 40: 257.6).

Description. Complete or incomplete seeds or endocarps 3.0–4.1 mm long and 2.0–2.5 mm broad, ovoid in outline, poorly preserved, base rounded, apex acute or ovate, upper surface not distinct, most of units show oval structure similar to slightly curved locule in the central part.

Remarks. Relatively numerous nearly unidentifiable seeds or endocarps are poorly preserved. The character of the upper surface does not allow recognizing the detail structure. Therefore the determination is not possible. On the other hand these objects show an affinity to the genus *Ternstroemia* Mutis ex L. (e.g. Holý 1975b, Bůžek et al. 1996, Mai 2000a, 2001).

***Carpolithes* sp. 4**

Pl. 1, figs 16, 17, 21

Material. 40 fruits and 41 isolated apical embryotegas [caps] (Hr 42: 87.3, 90.7, 111.7, Hr 44: 94.0–95.0, 95.1, 104.0, Hr 49: 80.0–81.0, 82.0).

Description. Fruits 3.5–(4.2)–5 mm long and 3–(5)–5.5 mm broad, rounded to ovate in outline, secondarily flattened, apex obtuse, base rounded, rounded to oval chalaza in apical part covered cap, joining distinct longitudinal hilum, led towards base. External surface smooth, rarely ornamented by pits around apices, secondarily wrinkled. Caps 1.4–1.8 mm long and 1.1–1.7 mm broad, rounded to ovate in outline, smooth collar in ventral side, thickness of 0.1–0.2 mm (equivalent with thickness of the testa), internal part convex, often with distinct concentric line in the centre, dorsal side flat in the middle concave with fragment of vascular bundle (0.1–0.25 mm in diameter).

Remarks. The above-described fruits are similar to some representatives of the family Nympheaceae s. l. in several morphological aspects, mainly the form and size of the fruits and embryotegas (Dorofeev in Takhtajan 1974, Collinson 1980). According to the character of caps and chalaza region, fruits from Hr 42, 44 and 49 show affinity to *Eoeuryale* Miki. or *Nuphar* Sibth. & Sm.. This determination must remain doubtful without a detailed study of testa and fruit upper surface. The solution of this problem is beyond the scope of this work and it will be the topic of the next paper.

Buds indet.

Pl. 7, figs 28, 29

Material. 16 complete buds (Hr 40: 82.0).

Description. Buds variable in size and shape, ovate to oblong, 5.5 to 9.8 mm long, 2.6 to 7.2 mm broad, base rounded, rarely stalk asymmetrically attached, apex acute to ovate, bracts oblong to triangular in form, often notched in apical part, but originally entire.

Remarks. Morphologically variable buds belong probably to one species on account of a similar form and upper surface of several bracts. The systematic affinity to fossil or recent taxa is uncertain.

FLORISTIC COMPOSITION AND ECOLOGICAL INTERPRETATION OF THE VEGETATIVE COVER

The investigated cores, i.e. Hr 39, Hr 40, Hr 42, Hr 43, Hr 44, Hr 45, Hr 47, Hr 49 and Hr 51 have yielded 2 conifers and 39 angiosperms (including 5 taxa with uncertain systematic position) from different stratigraphical levels, which belong to the roof of the basal coal seam and the lower, middle and upper coal seams s. l. (Fig. 2, Tab. 1). The floristic association (see Fig. 3) of the roof sediments of the basal seam contains these species: *Glyptostrobus europaeus*, *Myrica ceriferiformoides*, *Eurya stigmosa*, *Rubus* sp. 1 and *Sparganium camenzianum*. The floristic association of the lower seam s. l. includes: *Sequoia abietina*, *Glyptostrobus europaeus*, *Cupressospermum saxonicum* Mai (additional observation, Teodoridis) *Magnolia burseracea*, *Distylium* cf. *uralense*, *Myrica ceriferiformis*, *Myrica ceriferiformoides*, *Nyssa ornithobroma*, *Rubus* sp. 1, *Pterocarya limburgensis*, *Eurya stigmosa*, *Symplocos salzhausensis*, *Symplocos lignitarum*, *Decodon gibbosus*, *Vitis* cf. *teutonica*, *Ampelopsis ludwigi*, *Meliosma wetteraviensis*, *Potamogeton wiesaensis*, *Sparganium camenzianum*, and *Spirematospermum wetzleri*. A similar assemblage has been obtained from deposits of the middle seam s. l., which, besides the above-mentioned taxa, contains *Trigonobalanopsis exacantha*, *Proserpinaca* sp., *Rubus* sp. 2, *Calamus daemonorhops*, *Microdiptera uralensis*, *Alnus lusatica*, and *Alnus* sp. Finally, the flora of the upper seam s. l. contains also the mentioned representatives of the Taxodiaceae, Magnoliaceae, Lauraceae, Hamamelidaceae, Myricaceae, Theaceae, Rosaceae, Lythraceae, Vitaceae, Sabiaceae, Sparganiaceae in association with new taxa, i.e. *Mastixia lusatica*, *Tectocarya elliptica* vel *Mastixicarpum limnophilum*, *Fagus* cf. *decurrens*, *Hypericum septestum*, *Trema lusatica*, *Turpinia ettingshausenii*, *Symplocos lusatica*, *Ampelopsis rotundata*, *Tetrastigma* sp., and *Dulichium marginatum*.

The vegetation cover of the above-described plant assemblage from these three levels of coal seams s. l. is comparable with the extant Mixed Mesophytic forests from SE-Asia. Generally, five partial ecological associations can be distinguished, which are mutually inte-

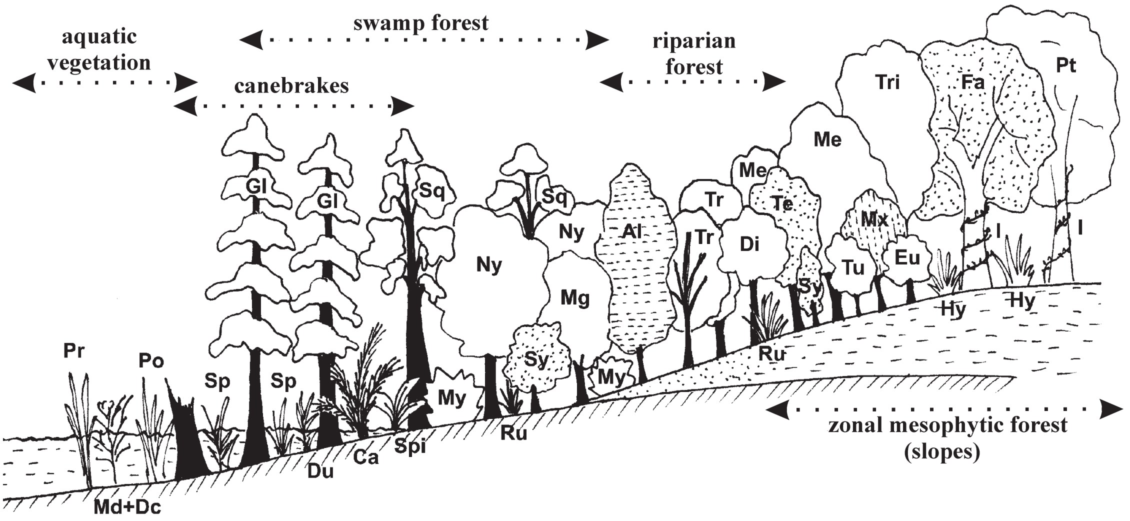

Fig. 3. Reconstruction of the plant cover. **Al** – *Alnus* sp., **Ca** – *Calamus daemonorhops*, **Di** – *Distylium* cf. *uralense*, **Du** – *Dulichium marginatum*, **Eu** – *Eurya stigmosa*, **Fa** – *Fagus* cf. *decurrens*, **Gl** – *Glyptostrobus europaeus*, **Hy** – *Hypericum septestum*, **l** – lianes (Vitaceae), **Md** + **Dc** – *Microdiptera uralensis* + *Decodon gibbosus*, **Me** – *Meliosma wetteraviensis*, **Mg** – *Magnolia burseracea*, **Mx** – *Mastixia lusatica*, **My** – *Myrica* sp., **Ny** – *Nyssa ornithobroma*, **Po** – *Potamogeton wiesaensis*, **Pr** – *Proserpinaca* sp., **Pt** – *Pterocarya limburgensis*, **Ru** – *Rubus* spp., **Sp** – *Sparganium camenzianum*, **Spi** – *Spirematospermum wetzleri*, **Sq** – *Sequoia abietina*, **Sy** – *Symplocos* sp., **Te** – *Tectocarya elliptica* vel *Mastixicarpum limnophilum*, **Tr** – *Trema lusatica*, **Tri** – *Trigonobalanopsis exacantha*, **Tu** – *Turpinia ettingshausenii*

Table 1. Summary of the floristic composition on several stratigraphical levels (i.e., BCS – roof of basal coal seam s. l., LCS – lower coal seam s. l., MCS – middle coal seam s. l., UCS – upper coal seam s. l.); frequency classes: * – rare, ** – common, *** – dominant

Taxon	Stratigraphical levels			
	BCS	LCS	MCS	UCS
Alnus lusatica			*	
Alnus sp.			**	
Ampelopsis ludwigii		*		**
Ampelopsis rotundata				**
Buds		*	*	
Calamus daemonorhops			*	
Carpolithes sp. 1		*		*
Carpolithes sp. 2		*		
Carpolithes sp. 3		**		
Carpolithes sp. 4		***		**
Decodon gibbosus		**		
Distylium cf. *uralense*		*		*
Dulichium marginatum				**
Eurya stigmosa	*	**		***
Fagus cf. *decurrens*				*
Glyptostrobus europaeus	*	***	***	***
Hypericum septestum				*
Magnolia burseracea		***	***	**
Mastixia lusatica				*
Meliosma wetteraviensis		*	**	*
Microdiptera uralensis			*	*
Myrica ceriferiformis		***	***	*
Myrica ceriferiformoides	*	***	***	*
Nyssa ornithobroma		**	***	***
Potamogeton wiesaensis		*		
Proserpinaca sp.		*		
Pterocarya limburgensis		*		*
Rubus sp. 1	*	**	***	***
Rubus sp. 2			*	
Sequia abietina		*	***	*
Sparganium camenzianum	*	**	**	***
Spirematospermum wetzleri		*	*	
Symplocos lignitarum		*		
Symplocos lusatica				*
Symplocos salzhausensis		*	*	
Tectocarya elliptica vel *Mastixicarpum limnophilum*				*
Tetrastigma sp.				*
Trema lusatica				**
Trigonobalanopsis exacantha			*	
Turpinia ettingshausenii				*
Vitaceae gen. et spec. indet.			*	*
Vitis teutonica		*		***

grated on their ecotones and differ in specific floristic composition in connection with specific ecological conditions (Fig. 3). The first association corresponds to a swamp forest. The most common elements are representatives of the Taxodiaceae, namely *Sequoia abietina* and *Glyptostrobus europaeus*. These elements occur together, therefore the comparison with the succession suggested by Schneider (1990) cannot be used in this case. A more probable interpretation is a lateral transition of these elements with affinity of *Sequoia abietina* to the basin periphery (i.e. non-permanent waterlogged substrate), besides free water table biotopes, which is suitable for *Glyptostrobus europaeus*. The Taxodiaceae are accompanied by *Magnolia burseracea*, *Myrica ceriferiformis*, *Myrica ceriferiformoides*, *Nyssa ornithobroma*, *Symplocos lusatica*, *Symplocos salzhausensis*, *Symplocos lignitarum*, and *Rubus* spp. These taxa form the shrubby and lower tree storeys of the *Sequoia* stands. The swamp forest is bordered by the canebrakes, which include *Calamus daemonorhops*, *Spirematospermum wetzleri*, *Sparganium camenzianum*, and *Dulichium marginatum*. Distally, this association is connected to the aquatic vegetation, which is characteristic of *Potamogeton wiesaensis*, *Microdiptera uralensis*, *Proserpinaca* sp., and *Decodon gibbosus*. These mentioned associations, except the last one, are autochthonous and often belonged to coal seam levels. The next association of wet soils contains riparian elements, which prefer the waterlogged substrate, i.e. *Distylium* cf. *uralense*, *Alnus lusatica*, *Alnus* sp., and *Trema lusatica*. The last association of slopes is typical of mesophytic elements, which are in principle zonal. It comprises *Pterocarya limburgensis*, *Eurya stigmosa*, *Meliosma wetteraviensis*, *Trigonobalanopsis exacantha*, *Mastixia lusatica*, *Tectocarya elliptica* vel *Mastixicarpum limnophilum*, *Fagus* cf. *decurrens*, *Hypericum septestum*, *Turpinia ettingshausenii*, *Vitis* cf. *teutonica*, *Ampelopsis rotundata*, *A. ludwigi*, and *Tetrastigma* sp. The both latter mentioned associations are apparently allochthonous and are bound to clastic deposits.

STRATIGRAPHY, FLORISTIC CORRELATION AND CLIMATE SIGNALS

According to the floristic analysis, the plant assemblages of the lower, middle and upper coal seam s. l., are on the whole correlative with the Floristic Assemblage of Eichelskopf-Wiesa (Mai 1995, 2000b), i.e. the floristic zone VI sensu Mai (1967). This correlation is based on common occurrence of mastixias and other thermophilous elements (Theaceae, Fagaceae, Symplocaceae, Arecaceae, and Vitaceae) in the studied plant assemblages and other floras from the Zittau Basin, i.e. Kristina, Hartau, Zittau and Turów (e.g. Czeczott, & Skirgiełło 1959, 1961, Holý 1974, Kvaček 1966, Mai 1964, 2000b). The floristic composition of the upper coal seam s. l. is well comparable with the flora of the Kristina Mine and the flora “C” of Hartau 1/69 (depth of 267.05–268.75 m), due to common occurrence of *Mastixia lusatica*, *Tectocarya elliptica* vel *Mastixicarpum limnophilum*, *Turpinia ettingshausenii*, *Ampelopsis rotundata*, *Tetrastigma* sp., and *Dulichium marginatum*. The occurrences of *Trigonobalanopsis exacantha* and other common elements in association of the middle coal seam s. l. match the flora “B” of Zittau 2/69 or the floras from Hartau. Similarly, the occurrences of *Cupressospermum saxonicum*, *Symplocos salzhausensis*, and *Symplocos lignitarum* in the plant association of the lower coal seam s. l. show an affinity in floristic composition with the flora “B” of Zittau 1/69 and flora “D” of Hartau1/69. The correlation of the flora from the roof of the basal coal seam s. l. is doubtful, because it contains only five elements, which are very common during Neogene (except *Eurya stigmosa*). Konzalová & Ziembińska-Tworzydło (1999, 2000) enlarged the floristic composition of the basal coal seam in the Czech and Polish part of the Zittau Basin by their palynological studies. The occurrence of *Boehlensipollis hohli* W. Kr. from the Rybaszewice core (depth of 249 m) shows a possible correlation with Oligocene floras and floristic assemblages (Konzalová & Ziembińska-Tworzydło 1999, 2000).

The climate type of the Eichelskopf-Wiesa floristic assemblage matches the zone Cfa:i with MAT 18–21°C and MAP 800–2000 mm (Gregor 1978, 1980, Mai 2000b).

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PLATES

Plate 1

1. *Sequoia abietina* (Brongn. in Cuvier) Knob., seed cone, G 8027 (Hr 44: 104.0.0), × 5
2. *Sequoia abietina* (Brongn. in Cuvier) Knob., seed cone, G 8028 (Hr 44: 104.0.0), × 13
3. *Glyptostrobus europaeus* (Brongn.) Ung., seed cone, G 7962 (Hr 44: 94.0–95.0), × 4
4. *Glyptostrobus europaeus* (Brongn.) Ung., seed cone, G 7963 (Hr 47: 218.0.0), × 3
5. *Sequoia abietina* (Brongn. in Cuvier) Knob., cone scale, G 8025 (Hr 42: 21.0–22.0), × 13
6. *Sequoia abietina* (Brongn. in Cuvier) Knob., seed, G 8032.0 (Hr 47: 218.0.0), × 13
7. *Sequoia abietina* (Brongn. in Cuvier) Knob., seed, G 8033 (Hr 47: 218.0.0), × 13
8. *Sequoia abietina* (Brongn. in Cuvier) Knob., seed, G 8030 (Hr 44: 104.0.0), × 10
9. *Sequoia abietina* (Brongn. in Cuvier) Knob., seed, G 8031 (Hr 44: 104.0.0), × 10
10. *Sequoia abietina* (Brongn. in Cuvier) Knob., seed, G 8029 (Hr 42: 21.0–22.0), × 17
11. *Glyptostrobus europaeus* (Brongn.) Ung., seed, G 7964 (Hr 42: 21.0–22.0), × 8
12. *Glyptostrobus europaeus* (Brongn.) Ung., seed, G 7965 (Hr 42: 21.0–22.0), × 8
13. *Glyptostrobus europaeus* (Brongn.) Ung., seed, G 7966 (Hr 47: 218.0), × 6
14. *Glyptostrobus europaeus* (Brongn.) Ung., seed, G 7967 (Hr 47: 218.0), × 6
15. *Magnolia burseracea* (Menzel) Mai, seed, G 7973 (Hr 44: 104.0), × 5
16. *Carpolithes* sp. 4., fruit, G 7969 (Hr 42: 87.3), × 8
17. *Carpolithes* sp. 4., fruit, G 7970 (Hr 42: 87.3), × 8
18. *Magnolia burseracea* (Menzel) Mai, seed, G 7972 (Hr 43: 32.0), × 5
19. *Magnolia burseracea* (Menzel) Mai, seed, G 7975 (Hr 47: 218.0), × 6
20. *Distylium* cf. *uralense* Kolesnikova, seed, G 7948 (Hr 40: 257.6), × 8
21. *Carpolithes* sp. 4., lid of fruit, G 7971 (Hr 44: 95.1), × 17
22. *Magnolia burseracea* (Menzel) Mai, seed, G 7974 (Hr 44: 49.7), × 5
23. *Distylium* cf. *uralense* Kolesnikova, seed, G 7949 (Hr 40: 257.6), × 8
24. *Distylium* cf. *uralense* Kolesnikova, seed, G 7950 (Hr 40: 257.6), × 8
25. *Distylium* cf. *uralense* Kolesnikova, seed, G 7951 (Hr 40: 257.6), × 8


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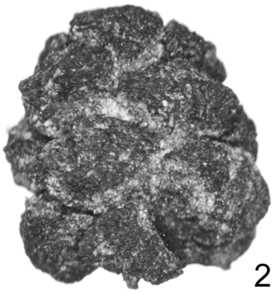
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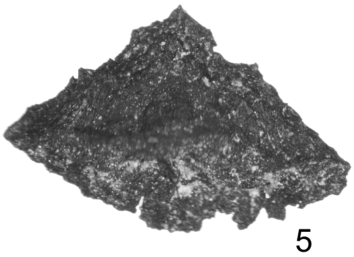
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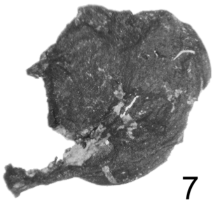
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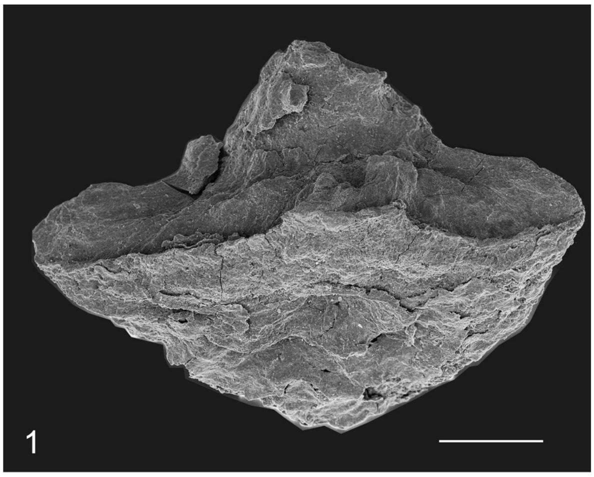
Plate 2

1. *Sequoia abietina* (Brongn. in Cuvier) Knob., cone scale, G 8026 (Hr 42: 21.0–22.0), scale 1 mm
2. *Glyptostrobus europaeus* (Brongn.) Ung., seed, G 7966 (Hr 42: 218.0), scale 1 mm
3. *Glyptostrobus europaeus* (Brongn.) Ung., seed, G 7967 (Hr 42: 218.0), scale 1 mm
4. *Sequoia abietina* (Brongn. in Cuvier) Knob., seed, G 8029 (Hr 42: 21.0–22.0), scale 1 mm
5. *Sequoia abietina* (Brongn. in Cuvier) Knob., seed, G 8030 (Hr 44: 104.0), scale 500 µm
6. *Sequoia abietina* (Brongn. in Cuvier) Knob., striation on cone scale, G 8025 (Hr 42: 21.0–22.0), scale 500 µm
7. *Glyptostrobus europaeus* (Brongn.) Ung., detail of seed, G 7967 (Hr 47: 218.0), scale 50 µm
8. *Magnolia burseracea* (Menzel) Mai, prismatic screlenchyma layers of testa-wall, G 7975 (Hr 47: 218.0), scale 100 µm
9. *Magnolia burseracea* (Menzel) Mai, detail of heteropyle, G 7975 (Hr 47: 218.0), scale 500 µm
10. *Sequoia abietina* (Brongn. in Cuvier) Knob., detail of hilum area, G 8029 (Hr 42: 21.0–22.0), scale 500 µm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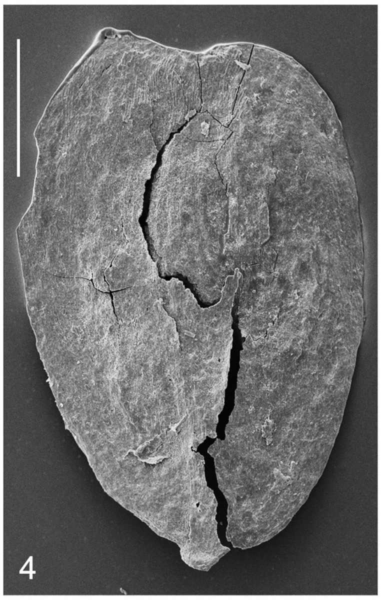
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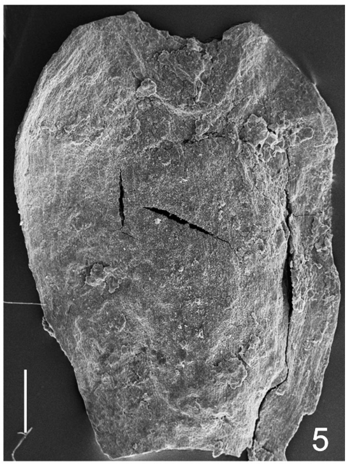
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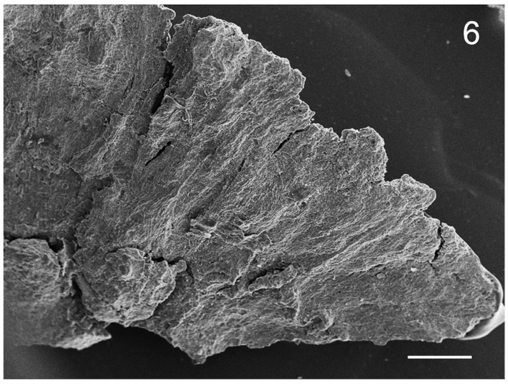
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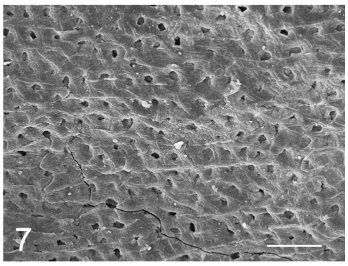
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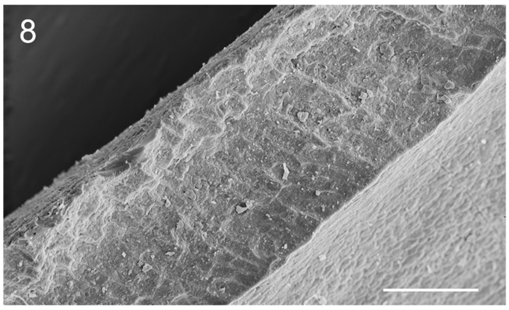
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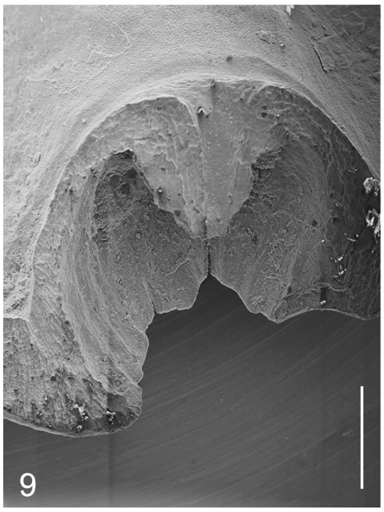
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Plate 3

1. *Fagus* cf. *decurrens* C. & E.M. Reid, cupule, G 7958 (Hr 40: 44.0–45.0), × 3
2. *Fagus* cf. *decurrens* C. & E.M. Reid, cupule, G 7959 (Hr 40: 44.0–45.0), × 3
3. *Fagus* cf. *decurrens* C. & E.M. Reid, cupule, G 7960 (Hr 40: 44.0–45.0), × 3
4. *Fagus* cf. *decurrens* C. & E.M. Reid, cupule, G 7061 (Hr 40: 44.0–45.0), × 3
5. *Trigonobalanopsis exacantha* (Mai) Kvaček & Walther, cupule, G 8054 (Hr 44: 109.0), × 5
6. *Trigonobalanopsis exacantha* (Mai) Kvaček & Walther, cupule, G 8055 (Hr 44: 109.0), × 5
7. *Trigonobalanopsis exacantha* (Mai) Kvaček & Walther, cupule, G 8056 (Hr 44: 109.0), × 6
8. *Trigonobalanopsis exacantha* (Mai) Kvaček & Walther, cupule, G 8057 (Hr 44: 109.0), × 6
9. *Alnus* sp., strobile, G 7927 (Hr 44: 94–95), × 6
10. *Alnus lusatica* Mai, nutlet, G 7926 (Hr 44: 49.7), × 13
11. *Pterocarya limburgensis* C. & E.M. Reid, nut, G 8021 (Hr 47: 169.5), × 6
12. *Pterocarya limburgensis* C. & E.M. Reid, nut, G 8020 (Hr 45: 39.3), × 6
13. *Myrica ceriferiformis* Kownas, exocarp, G 7992 (Hr 42: 30.8), × 10
14. *Myrica ceriferiformis* Kownas, endocarp, G 7987 (Hr 51: 82.0), × 13
15. *Myrica ceriferiformis* Kownas, endocarp, G 7988 (Hr 51: 82.0), × 13
16. *Myrica ceriferiformis* Kownas, endocarp, G 7989 (Hr 51: 82.0), × 13
17. *Myrica ceriferiformis* Kownas, endocarp, G 7990 (Hr 51: 82.0), × 13
18. *Myrica ceriferiformis* Kownas, endocarp, G 7983 (Hr 40: 257.0), × 13
19. *Myrica ceriferiformis* Kownas, endocarp, G 7984 (Hr 42: 30.8), × 5
20. *Myrica ceriferiformis* Kownas, exocarp, G 7993 (Hr 42: 30.8), × 10
21. *Myrica ceriferiformis* Kownas, endocarp, G 7986 (Hr 44: 49.7), × 4
22. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 7994 (Hr 40: 257.6), × 5
23. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 7995 (Hr 40: 257.6), × 5
24. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 7997 (Hr 51: 82.0), × 13
25. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 7996 (Hr 40: 257.6), × 5
26. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 7998 (Hr 51: 82.0), × 13
27. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 7999 (Hr 51: 82.0), × 13
28. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 8000 (Hr 51: 82.0), × 13
29. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 8001 (Hr 51: 82.0), × 13
30. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 8002 (Hr 51: 82.0), × 13
31. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 8003 (Hr 51: 82.0), × 13
32. *Myrica ceriferiformoides* Bůžek & Holý, exocarp, G 8007 (Hr 51: 82.0), × 8
33. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 8004 (Hr 51: 82.0), × 13
34. *Myrica ceriferiformoides* Bůžek & Holý, Exocarp, G 8008 (Hr 51: 82.0), × 13


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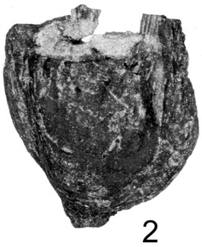
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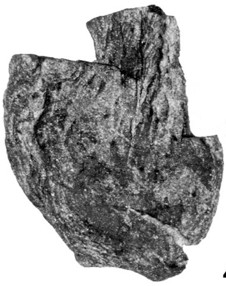
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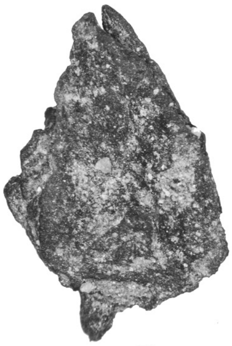
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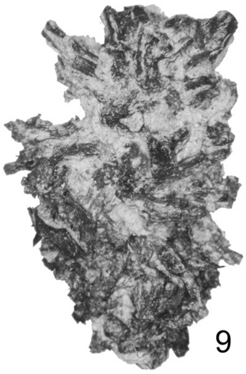
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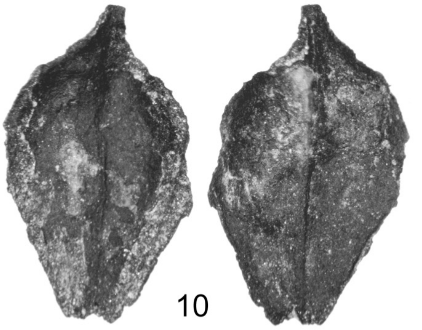
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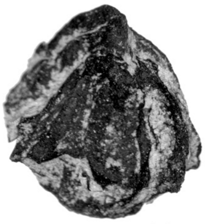
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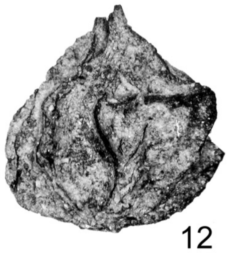
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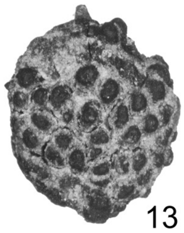
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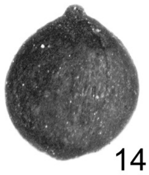
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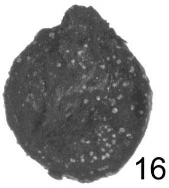
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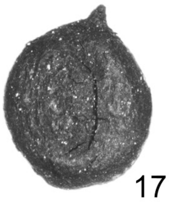
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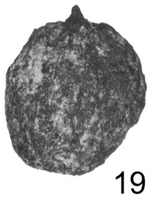
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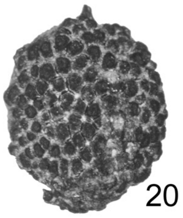
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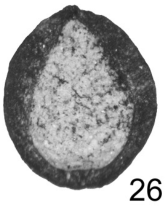
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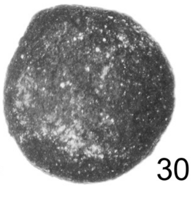
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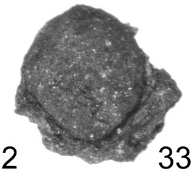
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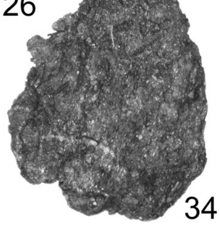
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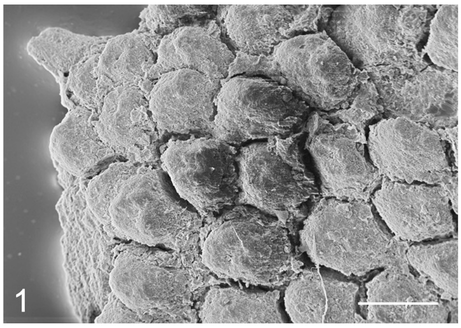
Plate 4

1. *Myrica ceriferiformis* Kownas, detail of exocarp, G 7992 (Hr 42: 30.8), scale 250 µm
2. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 8005 (Hr 51: 82.0), scale 500 µm
3. *Myrica ceriferiformoides* Bůžek & Holý, endocarp, G 8006 (Hr 51: 82.0), scale 500 µm
4. *Myrica ceriferiformis* Kownas, endocarp, G 7985 (Hr 42: 30.8), scale 500 µm
5. *Eurya stigmosa* (Ludwig) Mai, detail of testa, G 7956 (Hr 42: 21.0–22.0), scale 100 µm
6. *Myrica ceriferiformoides* Bůžek & Holý, endocarp with fragmentary exocarp, G 7991 (Hr 51: 82.0), scale 500 µm
7. *Eurya stigmosa* (Ludwig) Mai, embryonic horseshoe cavity, G 7956 (Hr 42: 21.0–22.0), scale 250 µm
8. *Eurya stigmosa* (Ludwig) Mai, seed, G 7957 (Hr 42: 21.0–22.0), scale 250 µm
9. *Proserpinaca* sp., fruit, G 8017 (Hr 44: 104.0), × 17
10. *Proserpinaca* sp., fruit, G 8018 (Hr 44: 95.0), × 17
11. *Rubus* sp. 1, endocarp, G 8021 (Hr 44: 104.0), × 17
12. *Rubus* sp. 1, endocarp, G 8022 (Hr 44: 104.0), × 17
13. *Rubus* sp. 2, endocarp, G 8023 (Hr 44: 104.0), × 17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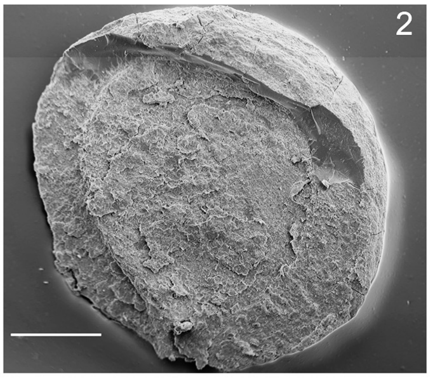
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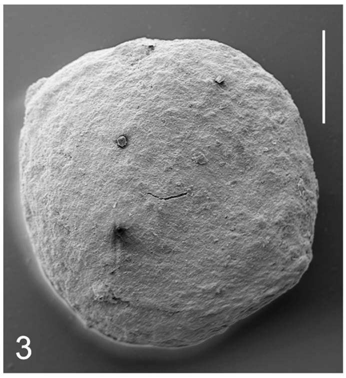
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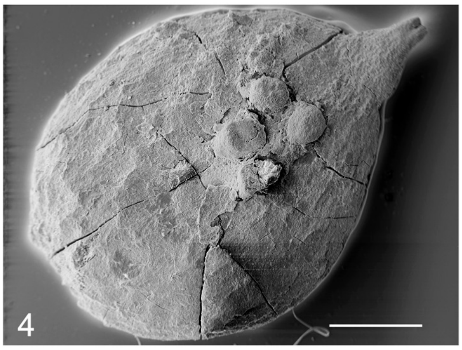
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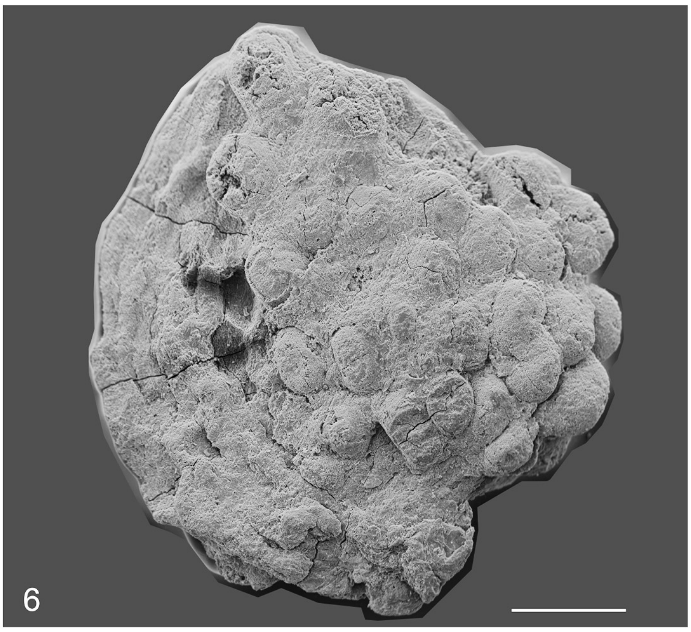
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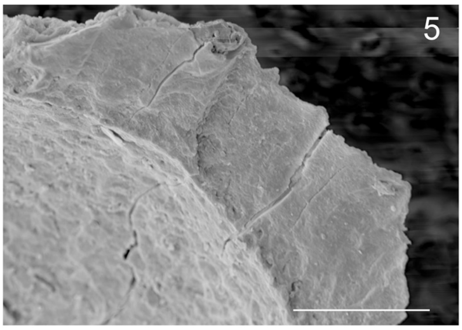
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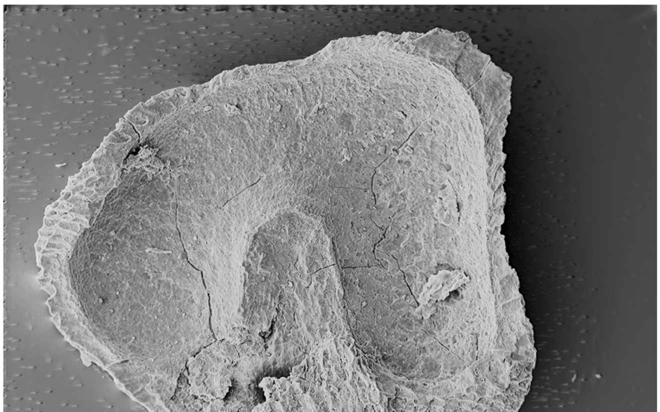
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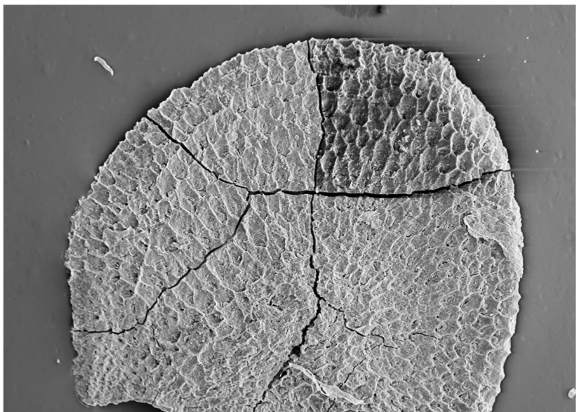
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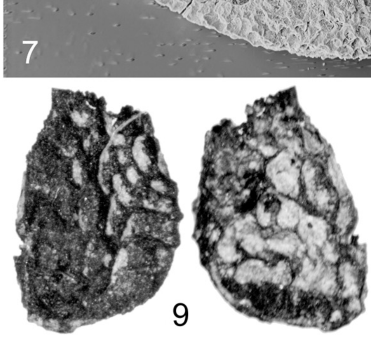
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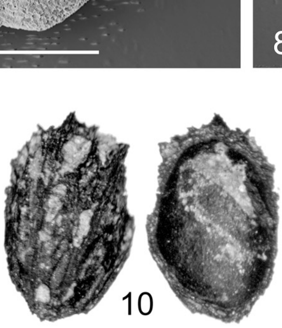
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Plate 5

1. *Rubus* sp. 2, endocarp, G 8024 (Hr 44: 104.0), × 17
2. *Nyssa ornithobroma* Unger, endocarp, G 8009 (Hr 42: 200.0), × 3
3. *Nyssa ornithobroma* Unger, endocarp, G 8010 (Hr 42: 200.0), × 5
4. *Nyssa ornithobroma* Unger, endocarp, G 8011 (Hr 44: 49.7), × 4
5. *Mastixia lusatica* Mai, endocarp, G 7976 (Hr 42: 47.9), × 3
6. *Tectocarya elliptica* (Ung.) Holý vel *Mastixicarpum limnophilum* (Ung.) Kirchh., fruit, G 8050 (Hr 43: 32.0), × 2.5
7. *Turpinia ettingshausenii* (Engelhardt) Mai, seed, G 8058 (Hr 42: 8.5), × 8
8. *Symplocos lignitarum* (Quenstedt) Kirchheimer, endocarp, G 8043 (Hr 40: 257.0), × 8
9. *Symplocos lignitarum* (Quenstedt) Kirchheimer, endocarp, G 8044 (Hr 40: 257.0), × 8
10. *Symplocos lignitarum* (Quenstedt) Kirchheimer, endocarp, G 8045 (Hr 40: 257.0), × 8
11. *Symplocos salzhausensis* (Ludwig) Kirchheimer, endocarp, G 8047 (Hr 44: 95.0), × 8
12. *Symplocos lusatica* Mai, endocarp, G 8046 (Hr 44: 44.0–45.0), × 8
13. *Symplocos salzhausensis* (Ludwig) Kirchheimer, endocarp, G 8048 (Hr 44: 95.0), × 8
14. *Symplocos salzhausensis* (Ludwig) Kirchheimer, endocarp, G 8049 (Hr 51: 82.0), × 6
15. *Trema lusatica* Mai, endocarp, G 8052 (Hr 42: 47.9), × 17
16. *Trema lusatica* Mai, endocarp, G 8053 (Hr 42: 8.5), × 17
17. *Microdiptera uralensis* (Dorofeev) Mai, seed, G 7980 (Hr 42: 8.5), × 17
18. *Microdiptera uralensis* (Dorofeev) Mai, seed, G 7981 (Hr 42: 8.5), × 17
19. *Decodon gibbosus* (E.M. Reid) E.M. Reid in Nikitin, seed, G 7945 (Hr 51: 52.0), × 17
20. *Decodon gibbosus* (E.M. Reid) E.M. Reid in Nikitin, seed, G 7946 (Hr 51: 52.0), × 17
21. *Microdiptera uralensis* (Dorofeev) Mai., seed, G 7982.0 (Hr 42: 8.5), × 17
22. *Vitis* cf. *teutonica* Al. Br., seed, G 8059 (Hr 40: 265.5), × 13
23. *Decodon gibbosus* (E.M. Reid) E.M. Reid in Nikitin, seed, G 7947 (Hr 51: 52.0), × 17
24. *Meliosma wetteraviensis* (Ludwig) Mai, endocarp, G 7977 (Hr 42: 87.3), × 6
25. *Meliosma wetteraviensis* (Ludwig) Mai, endocarp, G 7979 (Hr 42: 90.7–95.0), × 6
26. *Meliosma wetteraviensis* (Ludwig) Mai, endocarp, G 7978 (Hr 42: 87.3), × 6
27. *Tetrastigma* sp., seed, G 8051 (Hr 42: 30.2), × 10


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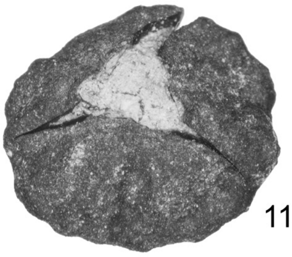
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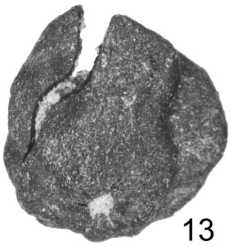
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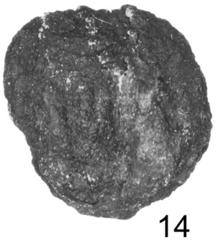
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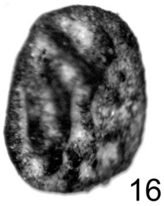
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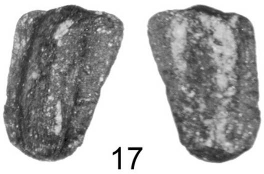
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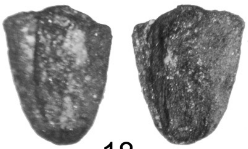
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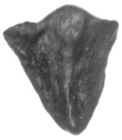
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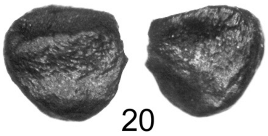
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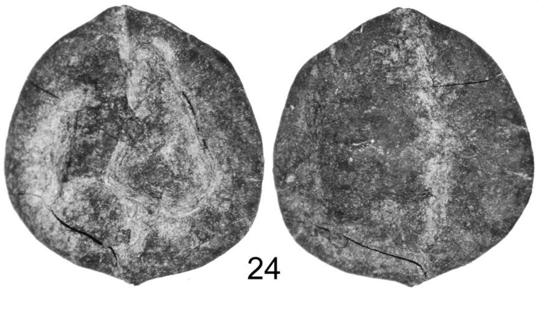
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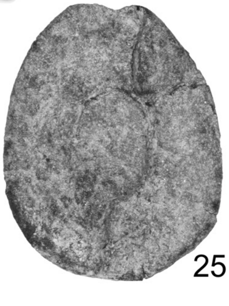
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Plate 6

1. *Rubus* sp. 2, endocarp, G 8023 (Hr 44: 104.0), scale 500 µm
2. *Rubus* sp. 1, endocarp, G 8024 (Hr 44: 104.0), scale 500 µm
3. *Rubus* sp. 1, detail of upper surface, G 8024 (Hr 44: 104.0), scale 100 µm
4. *Hypericum septestum* Nikitin, seed, G 7968 (Hr 42: 8.5), scale 250 µm
5. *Hypericum septestum* Nikitin, detail of inner structure, G 7968 (Hr 42: 8.5), scale 50 µm
6. *Hypericum septestum* Nikitin, detail of upper surface, G 7968 (Hr 42: 8.5), scale 25 µm
7. *Trema lusatica* Mai, endocarp, G 8052 (Hr 42: 47.9), scale 500 µm
8. *Decodon gibbossus* (E.M. Reid) E.M. Reid in Nikitin, seed, G 7946 (Hr 51: 52.0), scale 250 µm
9. *Microdiptera uralensis* (Dorofeev) Mai, detail of ventral seed side, G 7982.0 (Hr 42: 8.5), scale 500 µm
10. *Microdiptera uralensis* (Dorofeev) Mai, detail of dorsal seed side, G 7981 (Hr 42: 8.5), scale 500 µm
11. *Decodon gibbosus* (E.M. Reid) E.M. Reid in Nikitin, detail of aerenchym, G 7946 (Hr 51: 52.0), scale 50 µm
12. *Vitis* cf. *teutonica* Al. Br., seed, G 8060 (Hr 42: 31–32.0), × 13
13. *Ampelopsis ludwigii* (Al. Br.) Dorofeev, seed, G 7928 (Hr 42: 30.2), × 10
14. *Turpinia ettingshausenii* (Engelhardt) Mai, detail of upper surface, G 8058 (Hr 42: 8.5), scale 200 µm

Plate 6

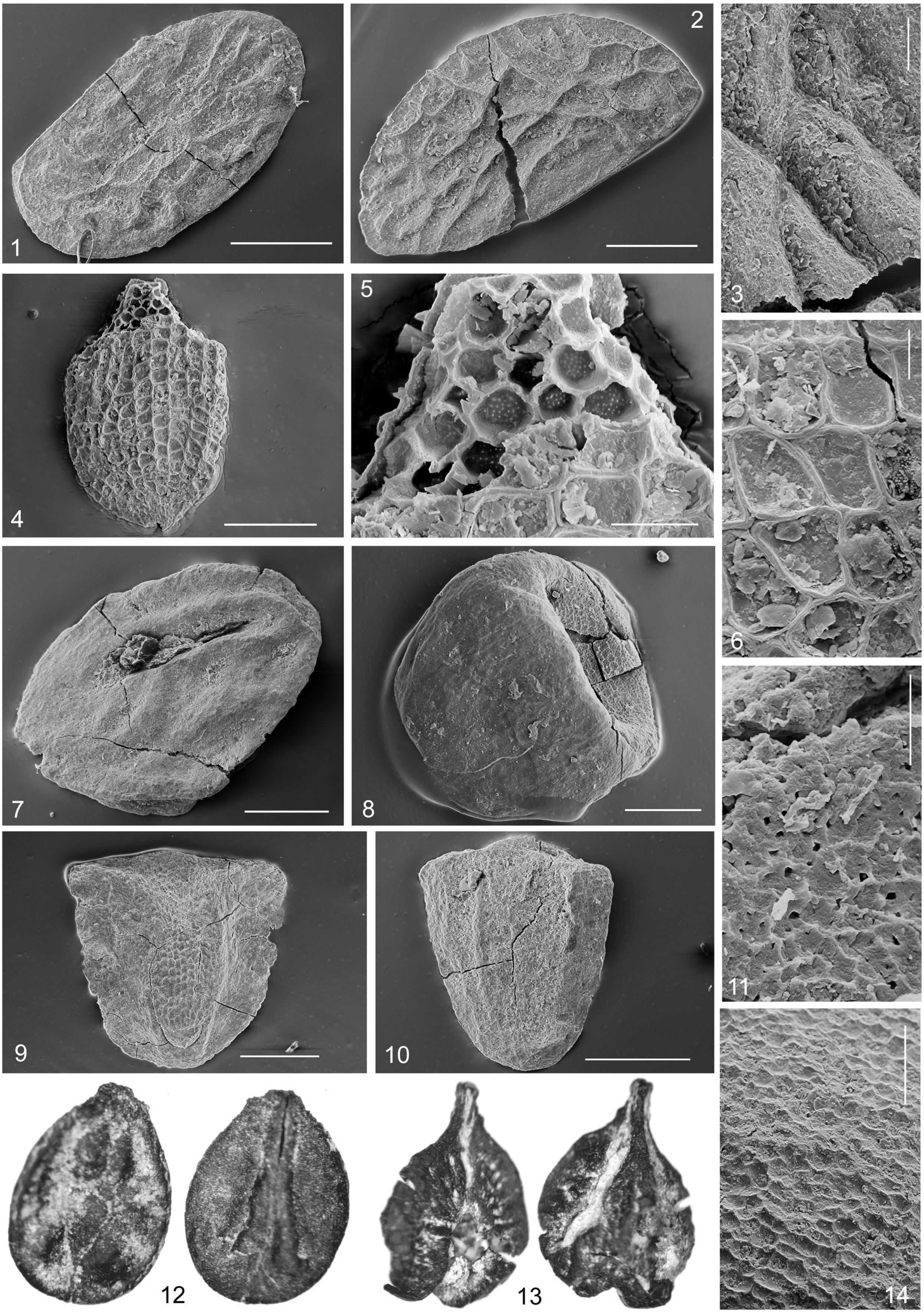
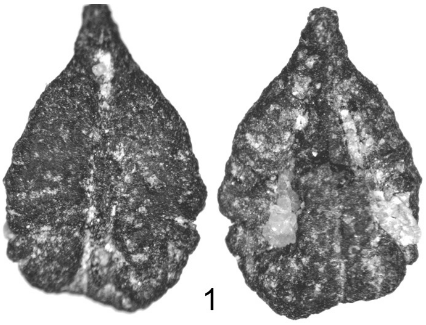


Plate 7

1. *Ampelopsis ludwigii* (Al. Br.) Dorofeev, seed, G 7929 (Hr 42: 30.2), × 10
2. *Ampelopsis ludwigii* (Al. Br.) Dorofeev, seed, G 7930 (Hr 42: 30.2), × 10
3. *Potamogeton wiesaensis* Kirchheimer, endocarp, G 8014 (Hr 51: 52.0), × 17
4. *Potamogeton wiesaensis* Kirchheimer, endocarp, G 8015 (Hr 51: 52.0), × 17
5. *Ampelopsis rotundata* Chandler, seed, G 7931 (Hr 42: 8.5), 13x
6. *Ampelopsis rotundata* Chandler, seed, G 7932.0 (Hr 42: 8.5), 13x
7. *Dulichium marginatum* (C. & E.M. Reid) Dorofeev, fruit, G 7952 (Hr 42: 41.0), × 17
8. *Dulichium marginatum* (C. & E.M. Reid) Dorofeev, fruit, G 7953 (Hr 40: 44.0–45.0), × 17
9. *Potamogeton wiesaensis* Kirchheimer, endocarp, G 8012 (Hr 51: 52.0), × 17
10. *Potamogeton wiesaensis* Kirchheimer, endocarp, G 8013 (Hr 51: 52.0), × 17
11. *Dulichium marginatum* (C. & E.M. Reid) Dorofeev, fruit, G 7954(Hr 42: 41.0), × 13
12. *Sparganium camenzianum* Kircheimer, endocarp, G 8034 (Hr 45: 287.5), × 17
13. *Sparganium camenzianum* Kircheimer, endocarp, G 8035 (Hr 45: 287.5), × 17
14. *Sparganium camenzianum* Kircheimer, endocarp, G 8036 (Hr 45: 287.5), × 17
15. *Sparganium camenzianum* Kircheimer, endocarp, G 8037 (Hr 45: 287.5), × 17
16. *Sparganium camenzianum* Kircheimer, endocarp, G 8038 (Hr 45: 287.5), × 17
17. *Calamus daemonorhops* (Ung.) Chandler, prickles, G 7935 (Hr 42: 111.7), × 6
18. *Calamus daemonorhops* (Ung.) Chandler, prickles, G 7936 (Hr 42: 111.7), × 6
19. *Spirematospermum wetzleri* (Heer) Chandler, endocarp, G 8040 (Hr 51: 82.0), × 6
20. *Spirematospermum wetzleri* (Heer) Chandler, endocarp, G 8041 (Hr 51: 82.0), × 6
21. *Carpolithes* sp. 2, seed, G 7937 (Hr 40: 241.0), × 13
22. *Carpolithes* sp. 3, seed or endocarp, G 7938 (Hr 40: 256.7), × 8
23. *Carpolithes* sp. 3, seed or endocarp, G 7939 (Hr 40: 256.7), × 8
24. *Carpolithes* sp. 1, fruit or endocarp, G 7943 (Hr 47: 218.0), × 10
25. *Carpolithes* sp. 1, fruit or endocarp, G 7942 (Hr 40: 257.6), × 10
26. *Carpolithes* sp. 1, fruit or endocarp, G 7944 (Hr 47: 218.0), × 10
27. *Spirematospermum wetzleri* (Heer) Chandler, fragment of fruit, G 8042 (Hr 51: 82.0), × 4
28. Bud indet., G 7933 (Hr 40: 82.0), × 5
29. Bud indet., G 7934 (Hr 40: 82.0), × 5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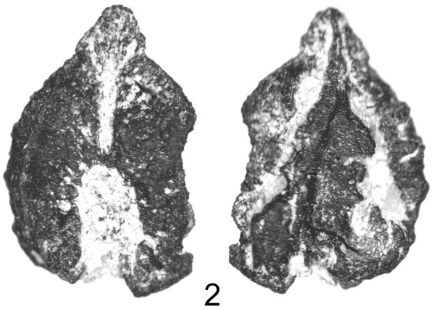
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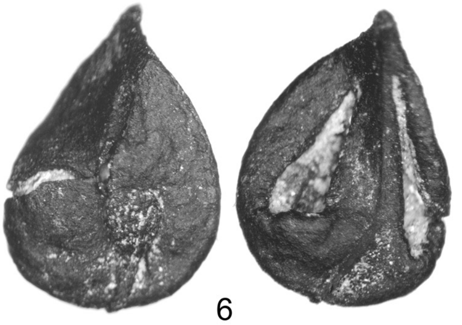
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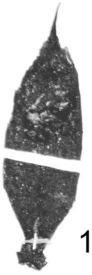
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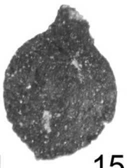
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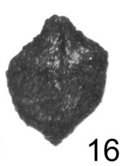
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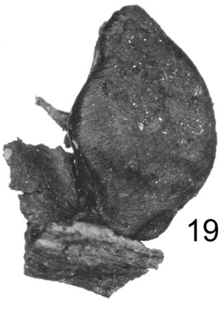
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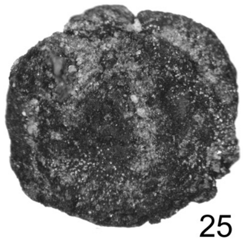
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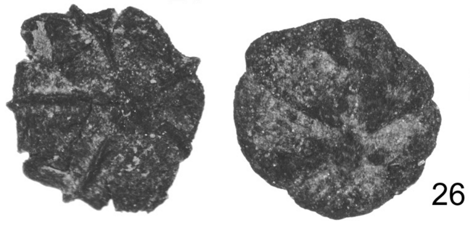
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Plate 8

1. *Proserpinaca* sp., fruit, G 8018 (Hr 44: 95), scale 1 mm
2. *Proserpinaca* sp., detail of sculptured fruit surface and wall, G 8018 (Hr 44: 95.0), scale 100 µm
3. *Spirematospermum wetzleri* (Heer) Chandler, detail of upper surface, G 8041 (Hr 51: 82.0), scale 100 µm
4. *Decodon gibbosus* (E.M. Reid) E.M. Reid in Nikitin, seed, G 7947 51: 52.0), scale 250 µm
5. *Dulichium marginatum* (C. & E.M. Reid) Dorofeev, fruit, G 7955 (Hr 42: 41.0), scale 500 µm
6. *Sparganium camenzianum* Kircheimer, endocarp, G 8039 (Hr 45: 287.5), scale 500 µm
7. *Decodon gibbosus* (E.M. Reid) E.M. Reid in Nikitin, seed, G 7945 (Hr 51: 52.0), scale 250 µm
8. *Potamogeton wiesaensis* Kirchheimer, endocarp, G 8016 (Hr 51: 52.0), scale 500 µm
9. *Potamogeton wiesaensis* Kirchheimer, endocarp, G 8013 (Hr 51: 52.0), scale 500 µm
10. *Carpolithes* sp. 1, bud, G 7940 (Hr 45: 39.7), scale 500 µm
11. *Carpolithes* sp. 1, bud, G 7941 (Hr 45: 39.7), scale 500 µm
12. *Dulichium marginatum* (C. & E.M. Reid) Dorofeev, fruit, G 7955 (Hr 42: 41.0), scale 100 µm

Plate 8