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On the problems of the Pliocene floras in Lusatia and Lower Silesia*

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ABSTRACT. The fossil macrofloras of Nochten-Ost 4803 near Weißwasser (Upper Lusatia) with 67 and Ruszów near Żary (Lower Silesia) with 146 species of plants are not rich in taxa. They originate from discordant sequences in the upper part of the Poznań Series (Gozdnica Series) above coloured clays ("flamy clays"). Traditionally they were placed in the Pliocene. The age of both localities remains problematical after a comparison with fossil floras of localities in the immediate neighbourhood or with dated sequences of Central Europe. Fifty four so-called "Pliocene" species were described and evaluated. In the view of this investigation a reference to the period from the Upper Miocene to Early Pliocene seems possible. Both floras have only 16 species in common. Nochten-Ost 4803 represents a mixed coniferous broad-leaved deciduous forest (hornbeam-beech-spruce-forest); Ruszów, on the other hand, a mesophytic mixed deciduous forest (oak-hornbeam-chestnut forest) together, with a mixed taxodiaceous-broad-leaved wetland forest, as well as water- and swamp-plant communities.

KEY WORDS: macrofloras, Upper Miocene, Early Pliocene, Upper Lusatia, Lower Silesia

INTRODUCTION

A great number of Pliocene floristic localities in Central Europe are well known and more or less well documented palaeobotanically. Except for a few localities which are not reliably dated biostratigraphically. These exceptions refer to a little number of mammalian-palaeontological investigated places in the Lower Rhine, the Wetterau, the Fore-Harz Mountain Block and in Thuringia. All the other localities are allocated to the Pliocene by their position in the local profiles or the comparison of their floristic content (by palynology, palaeocarpology and leaf assemblages). This procedure resulted in very problematic and unreliable subdivisions. Generally based the best data on the well differentiated and rich of species local profiles in the Lower Rhine Basin, which are local-stratigraphically distinguished especially by Zagwijn (1959) and Zagwijn and Hager (1987). This differentiation of stages, used by many authors, was rejected by Krutzsch (1988). Even in the Mainz Basin and at the margin of the Northwest German-Polish Basin let establish a great number of fossil floras even, dated with mammalian faunas into the Mein's (1975) MN-zones 14 to 17 in Rheinhessen, the Wetterau and Thuringia. But unfortunately these dated floras come from isolated ridges, basins or depressions without any clear correlation with the standard profiles of the large sedimentary basins. They are therefore of uncertain value with regard to a biostratigraphic standard-differentiation. Fossil floras in the Carpathian, which Szafer (1954) used to establish the uppermost Pliocene stages (comp. "stages of Mizerna I to III") are of less relevance in such a differentiation.

Some macrofloras were found in the last years in the Northwest German-Polish Basin with its well differentiated and nearly gapless profiles, which were referred to the Pliocene on the basis of their high position in the local profiles and the composition of species. In all

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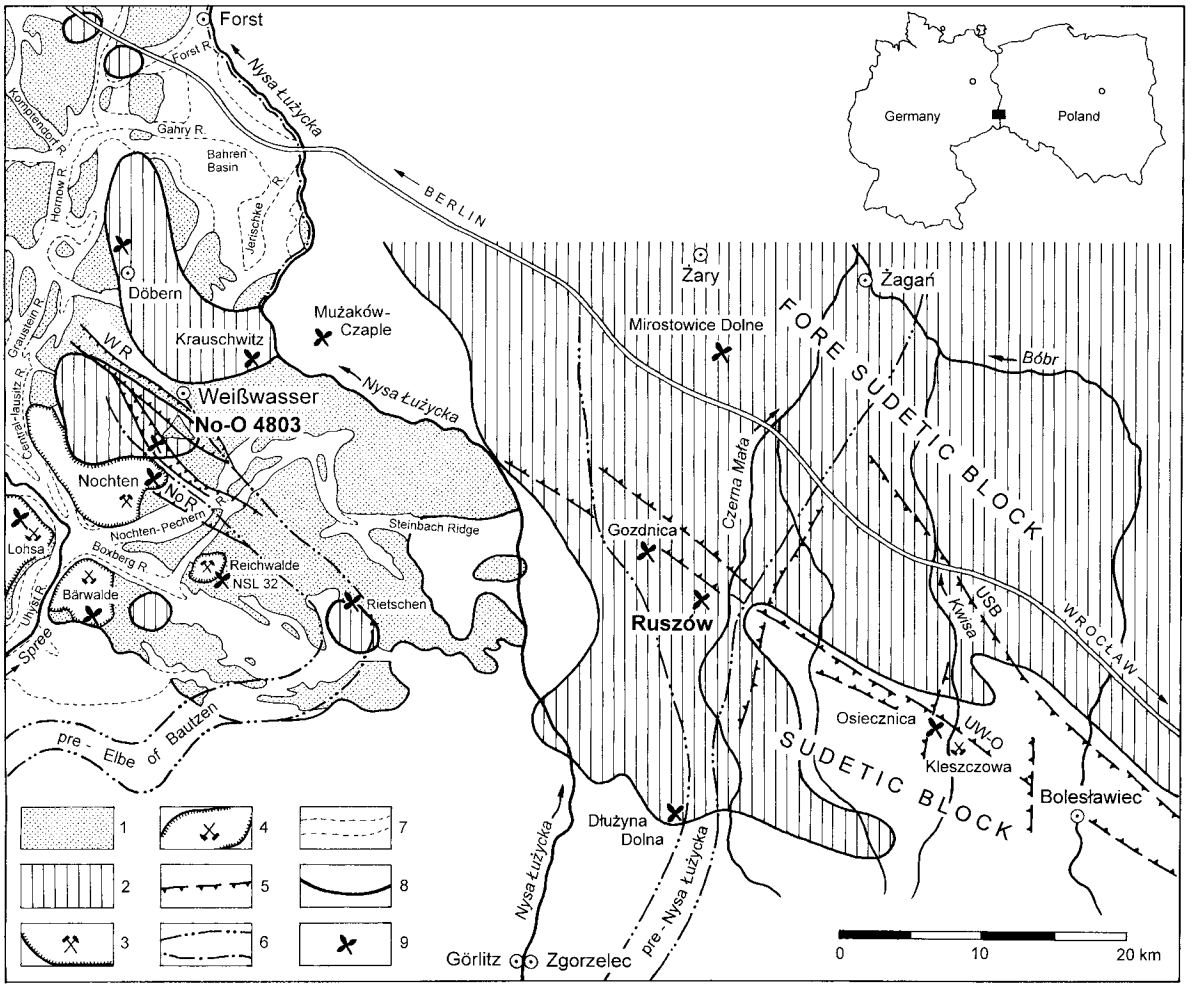

Fig. 1. Geological map showing the location of Miocene and Pliocene fossil floras in the Lusatian (Germany) and Silesian area (Poland): **1** – Tertiary sediments older than the Poznań Series rsp. Rauno Sequence, **2** – extend of the Poznan Series in south-western part of the basin, **3**, **4** – outcrops of the browncoal mines, in or out of order, **5** – main fault belts active during the Tertiary, **6** – extend of the Pliocene alluvial fans of the pre-Nysa Łużycka river and pre-Elbe river, **7** – Pleistocene channels which eroded the second Lusatian seam, **8** – erosion border of the Tertiary sediments in the southern foreland (Lusatian and Sudetic block), **9** – locality of fossil flora. Abbreviations: No-O 4803 – drillhole Nochten-Ost 4803/78, NOR-Nochten ridge, USB – middle Sudetic fault, UW-O – Warta-Osiecznica fault, WR= Weißwaser ridge (adapted from Dyjor et al. 1992 and Nowel et al. 1997)

cases the Middle to Upper Miocene Poznań Series was eroded by alluvial fans or fluviatile ridges in which plant detritus sedimented in oxbow-lakes or open ponds. Examples therefore are the localities Gozdnica, Ruszów near Żary/Lower Silesia, Kłodzko-Ustronie at the margin of the Sudeten and Nochten-Ost 4803 near Weißwasser/Upper Lusatia (Fig. 1). The fossil material from the outcrops is known since 1967 (Ruszów), 1971 (Gozdnica), 1978 (Nochten-Ost 4803) and 1984 (Kłodzko-Ustronie) and it is only partially investigated or documented. The material is stored in the collections of the University of Wrocław, the Museum of the Earth, Polish Academy of Sciences in Warszawa, the Władysław Szafer Institute of Botany, Polish Academy of Sciences in Kraków, and the Natural History Museum of the Humboldt-University in Berlin. The authors have examined most, but not all of the material.

GEOLOGY AND STRATIGRAPHY OF "PLIOCENE" SEDIMENTS IN THE LUSATIAN – LOWER SILESIAN REGION

NOCHTEN-OST 4803/78

The youngest sequence of the Lusatian Tertiary profile in the territory of the Trebendorf Highland, the "Series of Weißwasser", was protected against erosion by tectonic subsidence

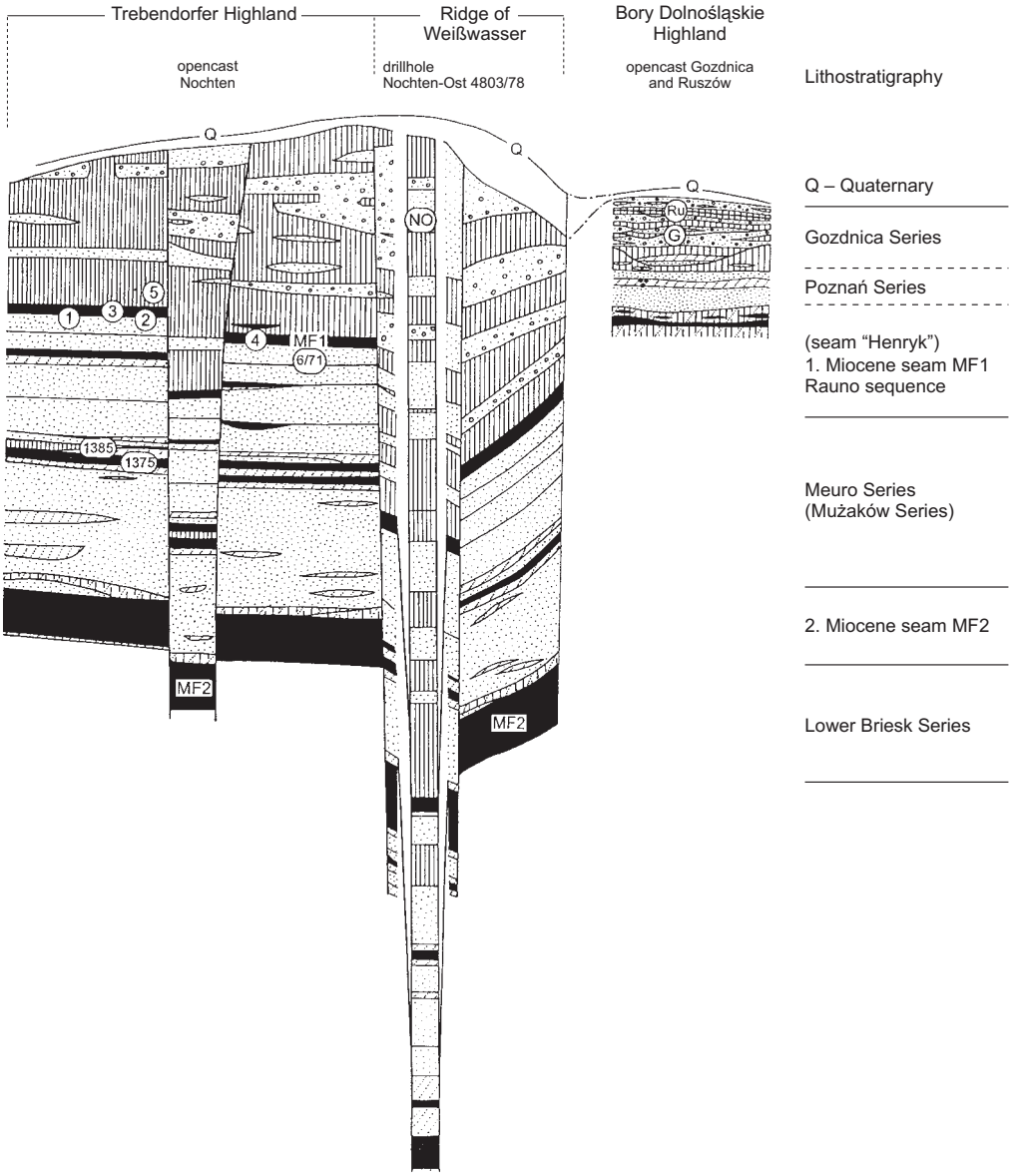

Fig. 2. Geological profiles in the younger Tertiary from the Trebendorf Highland, the ridge of Weißwasser to the Bory Dolnośląskie Highland. Signatures see Fig. 1. Abbreviations: **G** – flora of Gozdnica, **Ru** – flora of Ruszów, **MF1** – Miocene browncoal seam 1 (seam Henryk), **MF2** – Miocene browncoal seam 2, **NO** – flora of Nochten-Ost 4803/78, **Q** – Quaternary sediments, numbers 1 to 5 – localities of fossil floras in the open mine Nochten, **6/71** – flora of drillhole Nochten 6/71, **1375** – flora of drillhole Nochten-West 1375, **1385** – flora of drillhole Nochten-West 1385 (Polish part of the profile after Dyjor et al. 1998, German part original)

in a small area in the Ridge of Weißwasser (Nowel et al. 1997; see Figs 1–2). It contains quartz gravels, sands and strongly red to yellow spotted clays, which Cepek (1958) compared with the "Poznań flamy clays" and classified to the Pliocene according the stratigraphy of the Poznań Series in Poland. These layers can be up to 20 m thick south of the city of Weißwasser. Here they are developed above grayish, olive-coloured or brown, mostly fat clays, which correspond to the Upper Miocene "bottle-clays" of the Rauno sequence in their petrography and geological setting. At the top mostly follow discordant transfer gravels and sands of the "Bautzen pre-river of Elbe" or the equivalents of the pre-Neisse river, which are dated uncertainly in the Early Pleistocene (Fig. 2).

RUSZÓW

The outcrops of the brickyard at Ruszów near Żary in Lower Silesia are situated in the Bory Dolnośląskie Highland near a deep fault system between the Fore-Sudetic and Sudetic block (Fig. 1). A thin brown coal seam (seam

"Henryk", 1. Lusatian seam) underlies the clayey deposits of the Poznań Series. These series originated in a freshwater basin by gentle to quiet sedimentation and is reduced in Ruszów in the marginal part of the Polish Lowland Basin up to 20 m. An intensification of deposition by tectonic movements was followed by erosion. Palaeo-channels out into the Poznań Series were subsequently filled by the sandy-gravel deposits of the so-called "Gozdnica Series". The exposure at Ruszów reveals a cut-off meander (= oxbow lake) of an abandoned river-channel. The deposits comprise alternating layers of sands, mudstones, clayey silts and clays with plant detritus and wood remains (Fig. 2). The age of the Gozdnica Series has been determined palaeobotanically as Late Miocene (Pannonian) to Late Pliocene (Stachurska et al. 1971). According to Hummel (1983) the flora is of "similar age as flora of

Table 1. List of macrofossil plant remains from the Pliocene horizon of the locality Nochten-Ost 4803/78 (after Wähnert 1998)

Taxon	Type of remains
Lycopsida	
Selaginella pliocenica Dorofeev	mgs
Filicales	
Salvinia miocenica Dorofeev	mgs
Coniferopsida	
Abies sp.	l
Chamaecyparis obtusa Siebold & Zuccarini *foss.*	t
Cunninghamia sp.	t
Glyptostrobus europaeus (Brongn.) Heer	t
Picea rotunde-squamosa (Ludwig) Mai & Walther	t, l
Picea sp.	s, l
Pinus aff. *hampeana* (Unger) Heer	c
Pinus palaeostrobus Ettingshausen	t, l
Pinus sp.	s, l
Tsuga sect. *Eutsuga* Engelm.	l
Angiospermae – Dicotyledones	
Acer berganum Mai & Walther	fr
Acer campestre L. *foss.*	fr
Acer cyclospermum Goeppert	fr
Actinidia faveolata C. & E.M. Reid	s
Ajuga reptans Linné fossilis.	fr
Alnus kefersteinii (Goeppert) Unger	fr
Betula pubescens Ehrhardt *foss.*	fr
Carpinus betulus L. *foss.*	fr
Carpolithus minimus (Szafer) Mai	fr
Chenopodiaceae indet.	s
Cirsium palustre (L.) Scop. *foss.*	fr
Corylus avellana L. *foss.*	fr
Crataegus nodulosa E.M. Reid	fr
Engelhardia macroptera (Brongn.) Unger	fr
Eucommia europaea Mädler	fr
Euphorbia platyphyllos L. *foss.*	s
Fagus decurrens C. & E.M. Reid	fr
Fagus sp.	l
Hypericum cf. hirsutum L. *foss.*	s
Ilex aquifolium L. *foss.*	fr
Liriodendron geminata (C. & E.M. Reid) Kirchheimer	s
Ludwigia chandlerae Knobloch	s
Menispermaceae indet.	s
Morus aldanensis Dorofeev	fr
Ostrya szaferi Mai	fr
* *Oxalis corniculata* L. *foss.*	s
Peucedanum moebii (Kinkelin) Mädler	fr
Physalis alkekengi L. *foss.*	fr
Physocarpus europaeus Mai & Walther	s
Pilea cantalensis E.M. Reid	fr
Polygonum leporimontanum Kirchheimer	fr
Polygonum persicaria L. *foss.*	fr
Prunus tenerirugosa Mai	fr
* *Pterocarya fraxinifolia* Spach. *foss.*	fr
Ranunculus reidii Szafer	fr
Rubus fruticosus L. *foss.*	fr
* *Rubus idaeus* L. *foss.*	fr
Rubus indet.	t
Rumex hydrolapathum Hudson *foss.*	fr
Rumex sp.	fr
Salix sp.	l
Sambucus pulchella C. & E.M. Reid	s
Teucrium tatjanae Nikitin	fr
Viola neogenica Mai & Walther	s
Viscum miquelii (Geyler & Kinkelin) Czeczott	fr
Vitis parasylvestris Kirchheimer	s
Angiospermae – Monocotyledonae	
Carex flagellata C. & E.M. Reid	fr
Carex pilulifera L. *foss.*	fr
Carex praehirta Mai & Walther	fr
Carex pseudocyperus L. *foss.*	fr
Carex sp.	fr
* *Dulichium arundinaceum* (L.) Britton *foss.*	fr
Potamogeton dubnanensis Knobloch	fr
Scirpus sylvaticus L. *foss.*	fr

Abbreviations: mgs – megaspore, mcs – microspore, fr – fruit, s – seed, c – cone scale, l – leaf, st – stem, t – twig
* new identification in this paper

Sośnica (Lower Pliocene) ..." and "cannot be considered as Upper Pliocene". Stratigraphically the sediments of the channel filling of the Ruszów oxbow lake must be younger than the Poznań green and blue clays, because clay balls of the Poznań Series occur within sandy lenses with the Ruszów flora. The Gozdnica Series is the last sedimentation series of the Tertiary in south-western Poland.

THE FOSSIL FLORAS OF NOCHTEN-OST 4803 AND RUSZÓW

A fossil assemblage was collected from these "Series of Weißwasser" for the first time by D.H. Mai on July, 25th 1978 in the hope of clarifying the age of the sediments. The assemblage came from a detrital layer above the "coloured series" in the Nochten-Ost 4803/78 well, from a depth of 30.4 to 30.7 m (Fig. 2). A core with a length of 30 cm and a diameter of 10 cm, from a position 40 m above the Upper coal-seam (first Lusatian seam, seam "Henryk" in Poland) was later attained by the Natural History Museum in Berlin, where the material (Inv.No. 1993/10434–10502) was investigated (see Mai 1994; Wähnert 1998).

The fossil assemblage from the Nochten-Ost 4803 well is poorly known until now (Mai 1994). A first description of species was made by Wähnert (1998). With only 67 species the seed-flora is very poor, but comparable with other fossil floras in the late Neogene of Central Europe and biostratigraphically remarkable (see Tab. 1).

The fossil flora of Ruszów was first collected and described by Stachurska et al. (1967), later by Hummel (1983, 1991), Hummel and Zarzycka (1985), Baranowska-Zarzycka (1983, 1988), Sadowska (1995) and Dyjor et al. (1998). The rich floral assemblage consists of 120 species of fruits, seeds, leaves, wood, pollen and spores. Since 1986 the outcrop is a "monument of nature".

During an excursion of the 5th European Palaeobotanical – Palynlogical Conference on the 3rd of July 1998 the authors and S. Schultka collected samples of material from the typelocality of the fossil flora. We obtained a seed-flora of 67 species of fossil plants by preparation and washing (MfN Berlin, Inv.No. 1999/262-333). 26 species are new(*) for the locality Ruszów. Some of them are biostratigraphically significant (see Tab. 2).

DESCRIPTION OF SELECTED SPECIES (IN STRATIGRAPHICAL ORDER)

Incertae sedis

Carpolithus minimus (Szafer) Mai

Pl. 5 fig. 16

1947 *Carpinus minimus* Szafer, p. 66, Pl. 5, figs 20–24.
1988 *Carpolithus minimus* (Szafer) Mai; Mai & Walther, p. 209, Pl. 40 figs 14–17

Material. Nochten-Ost 4803: MfN 1993/ 10469.

Description. Nutlets ovate to egg-shaped, one-loculed, dehiscense two valved. Base rounded, in some cases with stalk remains, apex narrowed, cliped, with cushion-like style base (stylopod). The surface has three flat ribs on every side, diverging from the base and suddenly terminating below the stylopod. The surface is coarsely punctate, sometimes with skinny shreds of the epicarp (or of a cover). Walls relatively thin, two layered. Loculi large, inside smooth, without distinct seed remains, but nearly completely filled by a single seed. Length 1.7–2.7 mm, width 1.2–2.0 mm.

Remarks. Martinetto (in press) prefered an assignment to *Thalictrum* (Ranunculaceae).

Occurrence. Lower and Upper Miocene of Lower Lusatia (Floral zones III and XIII, Mai 1967); Pliocene of Krościenko, Mizerna and Huba in the Carpathians (Szafer 1946, 1947, 1954), Italy (Martinetto in press).

Cupressaceae

Chamaecyparis obtusa Siebold & Zuccarini *fossilis*

Pl. 1 fig. 1

1975 *Chamaecyparis obtusa* Siebold & Zuccarini *fossilis* Chochieva, p. 58, Pl. 12 figs 1a, b, 3.

Material. Nochten-Ost 4803: MfN 1993/ 10450.

Description. Branches compressed, flat, marginal leaves with blunt tips, incurved towards the top, long fused at the bases. The blunt facial leaves, nearly without a middle edge, are almost completely covered by the marginal leaves.

Remarks. This species is characterized by branches with evergreen leaves. The marginal leaves are sickle-shaped, to the top incurved and show a long fused base. Chochieva (1975) identified such organs as typical for

Table 2. List of the macrofossil plant remains from the deposits of Ruszów near Żary (Lower Silesia, SW Poland, after Dyjor et al. 1998, changed and supplemented)

Taxon	Type of remains
Musci	
Eurhynchium schwartzii Curnov *foss.*	t
Neckera pennata (L.) Hedwig *foss.*	t
Lycopsida	
Selaginella pliocenica Dorofeev	mgs
Filicales	
Azolla glabra Nikitin	mgs
# *Azolla nikitinii* Dorofeev	mgs
Azolla tomentosa Nikitin	mgs
# *Salvinia crispa* Dorofeev var. *verruculosa* Negru	mgs
Salvinia sp.	mcs
Coniferopsida	
# *Glyptostrobus europaeus* (Brongn.) Heer (= *G. brevisiliquatus* (Ludwig) Mai)	t, s
Juniperus sp.	s
# *Taxodium dubium* (Sternberg) Heer	t, s
Angiospermae – Dicotyledones	
#* *Acer cyclospermum* Goeppert	fr
Acer cf. *integerrimum* (Viv.) Massalongo	l
#* *Acer polymorphoides* Mai	fr
# *Acer limburgense* C. & E.M. Reid	fr
Acer sp.	fr
Acer sp. aff. *A. palmatum* Thunberg	fr
# *Acer* sp. cf. *A. tricuspidatum* Bronn	fr
# *Acer tricuspidatum* Bronn sensu Procházka & Bůžek	l
#* *Actinidia faveolata* C. & E.M. Reid	s
# *Alnus julianaeformis* (Sternberg) Kvaček & Holý	l
Alnus menzelii Raniecka-Bobrowska	l
Alnus sp.	l
Anagallis sp.	fr
# *Arctostaphylos* sp.	fr
# *Betula longisquamosa* Mädler	fr
# *Betula plioplatyptera* Hummel	l
Betula sp.	l
Betula subpubescens Goeppert	l
#* *Boehmeria lithuanica* Dorofeev	fr
# *Carpinus betulus L. foss.*	fr
Carpinus grandis Unger emend. Heer	l
Carpinus grandis Unger sensu Berger	fr
Carya cf. *angulata* C. & E.M. Reid	fr
Carya serraefolia (Goeppert) Kräusel	l
Castanea cf. *sativa* Mill.	l
Celtis sp.	l, s
#* *Cephalanthus pusillus* Friis	fr
Cerastium sp.	s
# *Ceratophyllum* cf. *demersum* L.	fr
# *Ceratophyllum pannonicum* Dorofeev	fr
# *Ceratophyllum submersum* L. *foss.*	fr
Cicuta virosa L.	fr
Cirsium sp.	fr
# *Corylus avellana* L. *foss.*	l, fr
Decodon globosus (E.M. Reid) Nikitin	s
Decodon sp.	s
Drosera intermedia Hayne *foss.*	s
# *Fagus silesiaca* Walther & Zastawniak	l
Fagus sp. aff. *F. ferruginea* Ait.	fr
cf. *Frangula alnus* Mill.	s
# *Fraxinus angusta* Hummel	l
#* *Glechoma hederacea* L. *foss.*	fr
Hypericum sp.	s
Hypericum sp. 1	s
Hypericum sp. 2	s
Liquidambar europaea A. Braun	l
# *Liriodendron geminata* Kirchheimer	s
#* *Lobelia pliocenica* (Dorofeev) Mai	s
Ludwigia chandlerae Knobloch	s
# *Magnolia cor* Ludwig	s
# *Meliosma wetteraviensis* (Ludwig) Mai	s
# *Menyanthes germanica* (Ludwig) Kirchheimer	s
#* *Mercurialis perennis* L. *foss.*	s
#* *Mespilus germanica* L. *foss.*	fr
Microdiptera parva Chandler	s
# *Microdiptera menzelii* (E.M. Reid) Mai (*Mneme menzelii* (E.M. Reid) Eyde)	s
#* *Morus* sp.	fr
#* *Myrica ceriferiformis* Kownas	fr
Myrica lignitum (Unger) Sap. sensu stricto	l
# *Nyssa ornithobroma* Unger	fr
Ostrya carpinifolia Scop. *foss.*	l
Ostrya sp.	fr
Ostrya vel *Carpinus*	l
#* *Padus* cf. *racemosa* (Lamb.) Gilib. *foss.*	fr
Parrotia pristina (Ettingshausen) Stur	l
#* *Parrotia reidiana* Kirchheimer	s
# *Phellodendron elegans* C. & E.M. Reid	s
Phyllites sp. 1 (Hummel 1983)	l
Phyllites sp. 2 (Hummel1983)	l
Phyllites sp. 3 (Hummel 1983)	l
Phyllites sp. 4 (Hummel 1983)	l
Physalis alkekengi L. *foss.*	s
# *Populus populina* (Brongn.) Knobloch	l
#* *Polygonum wolfii* (Kinkelin) Mädler	fr
# *Proserpinaca reticulata* C. & E.M. Reid	fr
Pterocarya sp.	fr
# *Pyracantha acuticarpa* (C. & E.M. Reid) Szafer	s
Quercus cerrisaecarpa Kolakovski	fr
# *Quercus gigas* Goeppert emend. Walther & Zastawniak (= *Q. czeczottiae* Hummel)	l
Quercus sapperi (Menzel) Mai ex Hummel ssp. *latisquamosa*	fr

Table 2. Continued

Taxon	Type of remains
Quercus sapperi (Menzel) Mai ex Hummel ssp. *sapperi*	fr
Quercus sp. div. sect. *Cerris* Spach (= *Q. pontica-miocenica* Kubat)	l
Quercus variabiliformis Hummel	fr
#* *Ranunculus* cf. *convexus* Negru	fr
#* *Rosa obtusistyla* Mai	fr
#* *Rosa rostellata* Mai	fr
# *Rubus idaeus* L. *foss.*	fr
Rubus laticostatus Kirchheimer	fr
Rubus sp.	fr
#* *Rumex microspermus* C. & E.M. Reid	fr
Salix sp.	l
Sambucus ebulus L. *foss.*	s
# *Sambucus lucida* Dorofeev	s
#* *Sambucus pulchella* C. & E.M.Reid	s
#* *Saururus bilobatus* (Nikitin) Dorofeev	s
Scrophularia sp.	s
#* *Stachys palustris* L. *foss.*	fr
Stellaria sp.	s
Swida sp.	fr
# *Trapa* sp.	fr
Ulmus ruszovensis Hummel	l
#* *Urtica pliocenica* Dorofeev	fr
Vaccinium sp.	s
Veronica sp.	fr
# *Vitis parasylvestris* Kirchheimer	s
Vitis sp.	s
# *Weigela kryshtofovichiana* Dorofeev	s
Zelkova sp.	fr
Angiospermae – Monocotyledonae	
# *Aracispermum canaliculatum* Nikitin ex Dorofeev	fr
# *Butomus umbellatus* L. *foss.*	s
# *Carex flagellata* C. & E.M. Reid	fr
#* *Carex gothanii* Mai	fr
Carex gracilis Curt. *foss.*	fr
#* *Carex klettvicensis* Mai	fr
Carex lasiocarpa Ehrh. *foss.*	fr
#* *Carex hartauensis* Mai	fr
# *Carex* sp. div.	fr
#* *Caricoidea globosa* (C. & E.M. Reid) Mai	fr
Damasonium sp.	s
# *Dulichium arundinaceum* (L.) Britton *foss.*	fr
# *Dulichium vespiforme* C. & E.M. Reid	fr
# *Epipremnites reniculus* (Ludwig) Mai	fr
Juncus sp.	fr
# *Najas flexilis* (Willdenow) Rostk. & Schm. *foss.*	fr
Potamogeton aff. *dravertii* Dorofeev	fr
#* *Potamogeton minimus* Dorofeev	fr
Potamogeton aff. *pseudonatans* Dorofeev	fr
#* *Potamogeton nochtensis* Mai	fr
Rhizocaulon zingiberoides Kownas	st
#* *Scirpus pliocenicus* Szafer	fr
#* *Scirpus sylvaticus* L. *foss.*	fr
# *Sparganium* aff. *pulchellum* Dorofeev	fr
# *Sparganium haentzschelii* Kirchheimer	fr
#* *S. microcarpum* (Neum.) Čelak. *foss.*	fr
Sparganium neglectum Beeby *foss.*	fr
Sparganium ramosum Hudson *foss.*	fr
# *Sparganium minimum* Fr. *foss.*	fr
#* *Spirematospermum wetzleri* (Heer) Chandler	s

Abbreviations: see Table 1
species from samples collected during the excursion 1998 (see p. 167)
* species only in the MfN Berlin collection 1998

Chamaecyparis obtusa Siebold & Zuccarini. The parts of branches from Stare Gliwice (Middle Miocene) and Krościenko (Pliocene), illustrated by Szafer (1947, 1961), also belong to this species, not to *Chamaecyparis pisifera* Siebold & Zuccarini on account of their acute shape. The same can be said of *C.* cf. *lawsoniana* Parl. from Willershausen (Pliocene) by Straus (1952).

This Japanese species grows in Honshu in the zone of deciduous woods and extends into the coniferous wood zone up to 2300 m (for instance Fujiyama). This plant is cultivated in Europe and prefers a humid habitat in half shade. Drought in the summer months can be fatal for it.

Occurrence. Middle Miocene (Szafer 1961, Mai 2000c) to Upper Pliocene (Mai & Walther 1988, Bülow & Mai 1992).

Fagaceae

Fagus decurrens C. & E.M. Reid

Pl. 1 figs 2–6

1915 *Fagus decurrens* C. & E.M. Reid, p. 78, Pl. 59, figs 19, 20, 22–28.

Material. Nochten-Ost 4803: MfN 1993/10452.

Description. Cupula 14–18 mm long, with wedge-shaped – roundish base, borne on a short stalk. Valve generally narrower than in *Fagus sylvatica* L., pointed, with more loosely

spaced appendices on the whole surface. These appendices are pointed, subulate, thicker than in other species, sometimes furcate, on the base in every case sharp downward current, so that the surface seems to being ribbed. Fruits ovoid – triangular, wing-edged, 11–13 mm long, 6 mm wide.

Remarks. It is very difficult to distinguish the cupules and fruits of the closely related species *Fagus decurrens* C. & E.M. Reid and *F. deucalionis* Unger.

Occurrence. Middle Miocene of Hungary (Andreánszky 1959), Poland (Szafer 1961), Łańcucka-Środoniowa 1963), but common in the Pliocene from Western Europe (C. & E.M. Reid 1915, Mädler 1939, Geissert 1972) and the Carpathians (Szafer 1946, 1947, 1954).

Magnoliaceae

Magnolia cor Ludwig

1857 *Magnolia cor* Ludwig, p. 97, Pl. 21 figs 1a-e.
1998 *Magnolia cor* Ludwig; Dyjor et al., Pl. 3 fig. 8.

Description. Seeds heart-shaped, 9–5 mm long, 10–5 mm wide; chalazal region convex to straight, flat, with distinct large heteropyle and a prominent condyle; in direction of the micropyle acute, with a flat raphae sinus. Testa smooth, 7 mm thick, composed of five to eight cell layers.

Remarks. Closely related to *Magnolia stellata* Maxim. (after Mai 1975).

Occurrence. Upper Miocene of the Rhine Embayment, Pliocene of Western and Middle Europe (Ludwig 1857, Szafer 1946, 1947, Mai 1975, van der Burgh 1978).

Juglandaceae

Pterocarya fraxinifolia (Lam.) Spach *fossilis*

Pl. 1 fig. 7

1958 *Pterocarya pterocarpa* (Michaux) Kunth *fossilis* Dorofeev; in Kolakovski, p. 335, Pl. 17 figs 9–13.
1998 *Pterocarya* sp.; Dyjor et al. 1998, p. 41.

Material. Nochten-Ost 4803: MfN 1993/10470.

Description. Endocarps (nuts) obovate to wide rhomboid, ribed, pointed at the top in a long and strong style remain, rounded at the base, extended maximal nearly at, or a little above the middle, ribs anastomosed, exceptionally in the upper third, less sharp, often short. Secondary septum low, nearly straight. Apical lacunes distinctly developed, mostly large. Diameter of the nuts 3.5–6 mm.

Remarks. The fruits correspond in the majority to the extant *Pterocarya fraxinifolia* (Lam.) Spach (= *P. pterocarpa* (Michaux) Kunth). This species is recently a Tertiary relic in Transcaucasia, Armenia, Western Iran and Kurdistan. In floodplain and riverside woods, often common (Iljinskaya 1953).

Occurrence. Upper Miocene of Rypin (Łańcucka-Środoniowa 1957) and Apsheron (Dorofeev 1964); Pliocene from West Europe to Georgia; Early Pleistocene, rare in the Middle Pleistocene of Middle Europe (Kräusel 1937).

Menyanthaceae

Menyanthes germanica (Ludwig) Kirchheimer

1936 *Menyanthes germanica* (Ludwig 1857) Kirchheimer, p. 122, pl. 13, figs 5a-e.
1998 *Menyanthes trifoliata* L.; Dyjor et al., p. 41.

Description. Seeds lense-shaped to oval, flattened, with a small marginal hilar-groove; 2.0–3.1 mm × 1.4–2.3 mm in diameter. Epidermis of the testa thick, 0.06 – 0.07 mm, brown-black in colour, cells of the epidermis elongated and small. Testa with more than eight layers of parenchyma.

Remarks. The structure of the testa of *Menyanthes germanica* is exactly the same as the structure of the testa of the modern *M. trifoliata* seeds (Jentys-Szaferowa & Truchanowiczówna 1953). A perennial herb in different peat-swamp types, especially in fens of the holarctic region from Hokkaido to Iceland.

Occurrence. Up to the Lower Miocene (Mai 2000a), Middle Miocene of Salzhausen (Kirchheimer 1936), Upper Miocene (Stachurska et al. 1971), often in the Pliocene (Ludwig 1857, Palamarev 1970, Geissert 1972) and Pleistocene.

Vitaceae

Vitis parasylvestris Kirchheimer

Pl. 1, fig. 8

1941 *Vitis parasilvestris* Kirchheimer, p. 650, fig. 9.
1998 *Vitis parasylvestris* Kirchheimer; Dyjor et al., Pl. 3 fig. 16.

Material. Nochten-Ost 4803: MfN 1993/10494.

Description. Seeds wide egg-shaped to

semispherical, dorsaly strongly convex. Chalaza-node large, roundish or ovoid, in the upper third of the seed, sometimes with a vascular appendix. Base with a little notch. Apex with a short, cylindrical prolongation, truncated and strongly verrucate. Ventral side with deep, wide or narrow invaginations, which some times reach to the upper quarter of the seed. Sometimes a little radially furrowed. Length 3.5–6 mm.

Remarks. The seeds from Klettwitz-Wilhelminensglück, described and figured by Kirchheimer (1941, fig. 9; 1957, fig. 95) must be the lectotype of this species. The description "dorsal side non-furrowed" is not correct for these specimens. Comparable with *Vitis sylvestris* Gmelin (riverplains in South-eastern Europe).

Occurrence. In the Lower Miocene rarely (Mai 2000a), Middle Miocene and Upper Miocene (Szafer 1961, Łańcucka-Środoniowa 1963, Kirchheimer 1941), mostly Pliocene (Szafer 1946, 1947, Kirchheimer 1957, Geissert 1972).

Caprifoliaceae

Sambucus pulchella C. & E.M. Reid

Pl. 1 figs 9–11

1915 *Sambucus pulchella* C. & E.M. Reid, p. 135, Pl. 17 figs 7–10.
1998 *Sambucus pulchella* C. & E.M. Reid; Dyjor et al., Pl. 3 fig. 15.

Material. Nochten-Ost 4803: MfN 1993/10447; Ruszów: MfN 1999/286.

Description. Seeds elliptical – ovoid, pointed, flattened to roundish – triangular at the base and the apex in cross-section, generally a little vaulted to the dorsal side, 1.8–2.5 mm long and 1.3–1.6 mm wide. Surface black, with many sinuate, transversal rolls, which are narrowed.

Remarks. Possible to compare with the small seeded species *Sambucus chinensis* Lindl., *S. javanica* Bl. (East Asia) or *S. canadensis* L. and *S. intermedia* Carr. (North America). Deciduous shrubs in different woods.

Occurrence. Lower Miocene (Holý 1975), Middle and Upper Miocene (Łańcucka-Środoniowa 1957, Dorofeev 1955a, Knobloch 1976), common in the Pliocene (C. & E.M. Reid 1915, Szafer 1946, 1947, Nikitin 1957, Palamarev 1970, Zagwijn 1963, Mai & Walther 1988).

Selaginellaceae

Selaginella pliocenica Dorofeev

Pl. 1 fig. 12

1957a *Selaginella pliocenica* Dorofeev, p. 489, Pl. 1 fig. 1.
1988 *Selaginella pliocenica* Dorofeev; Baranowska-Zarzycka, p. 24.

Material. Nochten-Ost 4803: MfN 1993/10559.

Description. Trilete megaspores, spherical, 0.4–0.8 mm in diameter; surface reticulate, single meshes mostly square to hexagonal. Muri mostly bended, flat, of low differences, partly thickened. The surface is sulfur-yellow to greenish-bluish, slightly iridescent.

Remarks. Dorofeev (1957a) compared this species with recent North American *Selaginella apoda* (L.) Fern. and *S. densa* Rydb. But there are a lot of species with reticulate megaspores, so that this comparison is not sure.

Occurrence. Middle Miocene of Lusatia (Mai 2000c) and Upper Miocene of Poland (Łańcucka-Środoniowa 1963, 1966, Dyjor et al. 1992), Ukraine (Dorofeev 1955b), commonly in the Pliocene (Dorofeev 1957a; Palamarev 1970, Mai & Walther 1988).

Cyperaceae

Caricoidea globosa (C. & E.M. Reid) Mai

Pl. 1 figs 13–14

1988 *Caricoidea globosa* Mai; Mai & Walther, p. 87, Pl. 13 figs 2–4.

Material. Ruszów: MfN 1999/288.

Description. Fruits roundish – egg-shaped or heart-shaped, primary without edges, secondary mostly flatted, 1.2–2 mm long, with a spongy-parenchymatic exocarp, always only with two marginal nervs. Endocarp thin, but hard, a hilar groove basically not very wide, with a micropylar tip on the top, sometimes with preserved style remain.

Remarks. By C. & E.M. Reid (1915) wrongly classified to *Hippuris*. Later by Nikitin (1957) described as *Aracites johnstrupii* with diagnosis and typus, but in relation to *Carpolithus johnstrupii* Hartz (1909, Pl. 3 figs 11–13) the common features (see: *Myrica suppanii* Kirchheimer 1957: 107).

Occurrence. Miocene of Western Siberia (Dorofeev 1963a), Middle Miocene of the Lusatia (Mai 2000c), Upper Miocene of Gozdnica (Dyjor et al. 1992), Pliocene of Europe, in Eastern Europe to the Middle Pleistocene (Dorofeev 1959).

Lobeliaceae

Lobelia pliocenica (Dorofeev) Mai

1960a *Typha pliocenica* Dorofeev, p. 20, Pl. 1 figs 8–14.
1998 *Typha pliocenica* Dorofeev; Dyjor et al., p. 42.
2000d *Lobelia pliocenica* Mai, p.107, Pl. 21 figs 5–9.

Description. Seeds cigar-shaped, slightly curved, turgid in the middle and at the base, less 3 times longer than broad. Apical neck short and broad. Micropylar-hump deeply sunken. Raphae distinct as a furrow in longitudinal direction. Base cutted. Mesh-layer with oval to hexagonal big cells, with an inner sculpture of thin, parallel dividing walls. Length 0.9–0.6 mm; breadth 0.4–0.2 mm.

Remarks. Formerly determinated as "*Typha*" (Dorofeev 1960a) or "*Gentiana*" (Mai, Majewski & Unger 1963), but very similar to the seeds of *Lobelia dortmanna* L. Euro-American element in oligotrophic ponds and lakes.

Occurrence. Middle Miocene of Meuro/Lusatia (Mai 2000d), Upper Miocene of Poznań Clay, Pliocene of Bashkiria (Dorofeev 1960a, 1962a), Voronesh, Belarus (Dorofeev 1960b), Latvia (Velichkevich 1975, 1990) and Thuringia (Mai & Walther 1988).

Rutaceae

Phellodendron elegans (Reid) C. & E.M. Reid

1907a *Stratiotes elegans* C. & E.M. Reid, p. 21, Pl. 3 figs 87–89.
1915 *Phellodendron elegans* C. & E.M. Reid, p. 105–106, Pl. 10 figs 10–12.
1988 *Phellodendron elegans* C. & E.M. Reid; Baranowska-Zarzycka, p. 24.

Description. Seeds large, half ovoid to half-moon-shaped, compressed. Ventral side nearly straight or subapically slightly concave. Apex a little curved. Micropyle subterminal – ventral. Dorsal side and apex rounded. Testa relatively thin, fragile, with flat, more or less regular furrows in more than 12 longitudinal lines. Length 3.5–7 mm, width 2.3–4 mm, thickness up to 2.2 mm.

Remarks. The seeds differ from *Phellodendron japonicum* Maxim. in some pattern (Szafer 1946, 1947).

Occurrence. Miocene of Western Siberia (Dorofeev 1963a), Middle Miocene of the Pre-Caucasia (Dorofeev 1964), in the Pliocene of Bashkiria (Dorofeev 1960a), the Carpathians (Szafer 1946, 1947, 1954) to the Rhine area (C. & E.M. Reid 1915, Geissert 1972), Early Pleistocene of the Netherlands (Nelson & van der Hammen 1950) and Italy (Martinetto, pers. comm.).

Betulaceae

Carpinus betulus Linné *fossilis*

Pl. 2 figs 1–2

1908 *Carpinus betulus* Linné *fossilis* Engelhardt & Kinkelin, p. 232; Pl. 8 fig. 10.
1967 *Carpinus betulus* Linné; Stachurska et al., Pl. 1 figs 1–11.

Material. Nochten-Ost 4803: MfN 1993/10437; Ruszów: MfN 1999/272.

Description. Involucrum with three main nerves (only in abnormal cases with an interdental and more basal nerves). Middle lobus twice to one and a half times longer than the side lobes, without teeth or only less dentate, bluntly terminated, 18–45 mm long. Nutlets free, ovoid, about 5 mm, mostly over 4.5 mm long, often nearly as wide as long, with different angular ribs. Three to seven ribs on every side, without style, but with stylopodium, base arcuate over 145°. Pericarp very thick, in the middle cells with great lumina.

Remarks. Biometrical studies at the nuts (Jentys-Szaferowa 1958, 1960, 1964) reveals no differences in the shape, variability and anatomical structure of extant, Pleistocene and Upper Tertiary specimens. Before the Upper Pliocene the nutlets are smaller and are in accordance with a Mio-Pliocene type (see *C. miocenica* Negru 1969; 1972).

Occurrence. From the Upper Miocene to today, often very common (Mai 2000d).

Eucommiaceae

Eucommia europaea Mädler

Pl. 2 fig. 3

1939 *Eucommia europaea* Mädler, p. 103, Pl. 8 figs 29–31, Pl. 11 figs 9–11.

Material. Nochten-Ost 4803: MfN 1993/10462.

Description. The parts of the fruit are 1.5 mm long, elongate, elliptical, winged. The surface of the mesocarp is strongly structured and covered with numerous gum vessels, which are on the both acute ends condensed to a fur. They are white, really stable and remember at tight sheep wool. The surface of the brown fruits is covered with numerous longitudinal nerves of first and second order, which anastomated and formed elongate, more or less rhomboid cell-like meshes. The part with a remain of the stigma is remarkably thinner, than the rest of the flattened fruit. Width 4–5 mm.

Remarks. The original by Engelhardt & Kinkelin (1908) was described as an egg cocoon of a spider. From the extant *Eucommia ulmoides* Oliv. the fruits are distinguished by the larger size (Mädler 1939).

Occurrence. The fossil species was distributed in the younger Tertiary of the Northern Hemisphere. In Middle Europe from the Miocene (Szafer 1961) to the Uppermost Pliocene (C. & E.M. Reid 1907a, Baas 1932).

Cyperaceae

Scirpus sylvaticus Linné *fossilis*

Pl. 2 figs 4–5

1908 *Scirpus sylvaticus* Linné *fossilis* Schröder & Stoller, p. 426, 431.

Material. Nochten-Ost 4803: MfN 1993/10476; Ruszów: MfN 1999/326.

Description. Fruits triangular, 0.9–1.2 mm long and 0.5–0.8 mm wide, one side broader than the two others. Style short, thick, truncated. Base narrowed, but not pedicellate. Surface smooth, punctate, with cells in rows.

Remarks. The extant species grows in the suboceanic territories of Eurasia as plants of humid, eutrophic forests or moist meadows.

Occurrence. Middle Miocene of Poland (Łańcucka-Środoniowa 1966), Middle and Upper Miocene of Lusatia (Mai 2000c), Pliocene of Thuringia (Mai & Walther 1988), interglacials from Middle Europe to West Siberia (Schröder & Stoller 1908, Nikitin 1940).

Onagraceae

Ludwigia chandlerae Knobloch

Pl. 2 figs 6–7

1963 *Ludwigia palustris* (Linné) Elliot *fossilis* Mai et al., p. 786, Pl. 4 figs 14, 15.
1988 *Ludwigia chandlerae* Knobloch, p. 109–110, Pl. 2, figs 1–10.
1998 *Ludwigia palustris* (Linné) Elliot *fossilis*; Dyjor et al., Pl. 4 fig. 10.

Material. Nochten-Ost 4803: MfN 1993/10492; Ruszów: MfN 1999/279.

Description. Seeds oblong – oblique to broadly elliptical, anatropous, asymmetrical, 0.4–0.7 mm long, 0.3–0.4 mm wide. Large micropyle on a terminal beak, with oblique, pointed or blunt basal chalaza. Raphae as elevated strip marginal and angular, distinctly structured, with lateral punctate cell structure. Cells longitudinally arranged in 30 to 40 rows.

Remarks. *Ludwigia chandlerae* Knobloch has, after Knobloch (1988), another shape and a different micropylar area than the seeds of the *L. palustris* (Linné)Elliot. We do not agree with this opinion.

Occurrence. Middle Miocene of Klettwitz/Lusatia (Mai 2000d), Upper Miocene of Slovakia and Moravia (Knobloch 1988), Pliocene from Belarus to the Netherlands (Mai & Walther 1988); in Eastern Europe although in the last interglacial (Velichkevich 1973).

Sparganiaceae

Sparganium microcarpum (Neumann) Čelakovsky *fossilis*

1963b *Sparganium microcarpum* (Neumann) Čelakovsky *fossilis* Dorofeev, p. 90, Pl. 2 figs 13–26.

Material. Ruszów: MfN 1999/301.

Description. Endocarps bottle-shaped to oval, ribbed. Base broadly rounded, abruptly blunted. Ribs obtuse. Maximal length only 3 mm.

Remarks. The fossil stones are somewhat smaller than the recent fruit stones, which were described as *Sparganium ramosum* Hudson *fossilis* or *S. ovale* E.M. Reid (1920).

Occurrence. Middle Miocene of Rietschen/Lusatia (Mai 2000c), Upper Miocene to Pliocene common, Meotian of Odessa (Negru 1986), interglacials (Velichkevich 1973).

Ceratophyllaceae

Ceratophyllum pannonicum Dorofeev

Pl. 2 figs 8–9

1974 *Ceratophyllum pannonicum* Dorofeev, p. 86, Pl. 116, figs 5–6.
1998 *Ceratophyllum pannonicum* Dorofeev; Dyjor et al., Pl. 4 fig. 11.

Material. Ruszów: MfN 1999/273.

Description. Fruit with a long, thorn-like, permanent style remain and 4 to 5 spines at the margins, the lowest spine greatly developed, between them remains a thin band. Surface tuberculate, pericarp thin. Length (without stylus) 3.0 mm, breadth 2.3 mm.

Remarks. *Ceratophyllum balcanicum* Palamarev (1982) may be the same species.

Occurrence. Middle Miocene of Klettwitz/Lusatia (Mai 2000d), Upper Miocene of the Ukraine (Dorofeev 1974) and Pliocene of Bulgaria (Palamarev 1982).

Cyperaceae

Carex flagellata C. & E.M. Reid

Pl. 2 figs 10–11

1915 *Carex flagellata* C. & E.M. Reid, p. 69, Pl. 3 pro parte; only fig. 22.
1988 *Carex flagellata* C. & E.M. Reid; Baranowska-Zarzycka, p. 25.

Material. Nochten-Ost 4803: MfN 1993/10465; Ruszów: MfN 1999/290.

Description. Nutlets ovoid, large, the three edges rounded. Fruit with egg-shaped, blowed up, polyvenated utricle. Utricle terminal narrowed, terminated in a long tip, on both sides 10–12 nervous, up to 5 mm long and 3 mm wide. Fruit on the base with stuffed, strong accented discus, summit slightly narrow with a short to mid-long, thick, straight style remain. The suface structure is honeycomb like to coarse foveolate, with relatively thick and strong muri. Fruits (without style remain) 2.5–3.3 mm long, 1.3–1.7 mm wide.

Remarks. Very similar nutlets to be found in the American species *Carex lupulina* Mühlenb. and *C. lurida* Wahlenb.

Occurrence. Middle Miocene of Stare Gliwice (Szafer 1961), Upper Miocene and Pliocene of the whole Europe, of the Lusatia (Mai 2000c) as well as Lower Silesia (Dyjor et al. 1998).

Aceraceae

Acer campestre Linné *fossilis*

Pl. 2 figs 12–13

1907a *Acer campestre* Linné; C. & E.M. Reid, p. 17, Pl. 1 figs 32.

Material. Nochten-Ost 4803: MfN 1993/10446.

Description. Endocarps ovoid – roundish semiangular to roundish quadrangulate, some asymmetrical, 4.8 – 6.0 mm high, 5.0–6.3 mm long, flat, with more or less large swellings in the middle of the side, which are inserated at the ventral pore. Ventral side nearly straight to s-shaped. Ventral pore roundish to oval, surrounded by a thickened ring. Stylus rudiment as a distinct nose. The endocarp is thick and stone-hard.

Remarks. These endocarps of the series *Campestria* (Pax) Pojarkova are very close related to *A. campestre* L. by the morphology. Occurs as a tree in Europe, North Africa, Caucasia, Western Asia in the deciduous broad-leaved forests.

Occurrence. Middle Miocene of Stare Gliwice (Szafer 1961), Upper Miocene of France (Grangeon 1958) and Lusatia (Mai 2000d), common in the Pliocene and the interglacials of Central Europe.

Cyperaceae

Carex pseudocyperus Linné *fossilis*

Pl. 2 fig. 14

1928 *Carex pseudocyperus* Linné *fossilis* Firbas & Grahmann, Pl. 12 fig. 10.
1979 *Carex pseudocyperoides* Łańcucka-Środoniowa; p. 91, Pl. 14 figs 14–17.

Material. Nochten-Ost 4803: MfN 1993/10489.

Description. Nutlets sharply triangular, shape lanceolate to rhomboid, their largest breadth occurs exactly in the middle of the length. Style remain in every case curved. Base with or without a discus, mostly with “little ears”. Pericarp strikingly thin walled, surface cellular-foveolate. Length (without style remain) 1.4–1.7 mm, width 0.8–0.9 mm. Utricle elliptical, narrow, at the top elongated and deeply bifurcated, strong nerved with five or eight nerves on both sides. Beak at the style thin, long, bent at the base.

Remarks. A species of the extant section *Pseudocypereae*, probably a little different of

the species *Carex pseudocyperus* L. and *C. comosa* Boott; both on wet places in Europe and North America.

Occurrence. Lower Miocene of the Lusatia (Mai 1999a), Middle Miocene of Poland (Łańcucka-Środoniowa 1979), Upper Miocene of Odessa (Negru 1986) and Pliocene of Bashkiria (Dorofeev 1977) to Middle Europe (Mai & Walther 1988), common in the Pleistocene interglacials.

Rosaceae

Prunus tenerirugosa Mai

Pl. 2 figs 15–16

1984 *Prunus tenerirugosa* Mai, p. 320, Pl. 50 figs 6–9.

Material. Nochten-Ost 4803: MfN 1993/10461.

Description. Endocarps subglobular, flat and brown, without any clear pedicell, only with a short, thick foot, ca 4.9–5.2 mm × 4.3–5.0 mm. The outer surface is structured by nine longitudinal ribs, running arcuately from the base nearly up to the middle, as blunt humps. Ventral suture thickened, vascular bundles going into the locule in the upper third. The wall of the endocarp is ca 0.2–0.4 mm thick. The surface is reticulate structured on the inside.

Remarks. A species of the section *Phyllomahaleb* (Koehne) Rehder with nearest relation to *Prunus maximoviczii* Ruprecht (East Asia; deciduous hardwood forests from Japan to Korea).

Occurrence. This species is known only from the Pliocene under the name *Prunus maximoviczii* Ruprecht *fossilis* (C. & E.M. Reid 1915), but appears probably already in the Middle Miocene (Szafer 1961).

Corylaceae

Corylus avellana Linné *fossilis*

Pl. 3 figs 1–2

1887 *Corylus avellana* Linné *fossilis* Geyler & Kinkelin, p. 24, Pl. 2 figs 14–16.
1998 *Corylus avellana* Linné *fossilis*; Dyjor et al., p. 40.

Material. Nochten-Ost 4803: MfN 1993/10484; Ruszów MfN 1999/275.

Description. Nuts with shape and size of recent hazelnuts, with a high variability, on average 10–17 mm long and nearly just as wide, apically truncate or pointed, the basal inseration of attachment is very variable in size. Involucrum in two parts, lobes irregular, short frayed or slited.

Remarks. No differences to fossil species *Corylus wickenburgii* Unger (1852) and *C. inflata* Ludwig (1857).

Occurrence. Very rare in the Middle Miocene (Szafer 1961, Łańcucka-Środoniowa 1963), common in the Pliocene and Pleistocene (Mai & Walther 1988).

Aquifoliaceae

Ilex aquifolium Linné *fossilis*

Pl. 3 figs 3–5

1893 *Ilex aquifolium* Linné *fossilis* C.A. Weber, p. 10.

Material. Nochten-Ost 4803: MfN 1993/10464.

Description. Fruit stones 6–7 mm long, 2.5–3 mm wide. Dorsal side with three to five longitudinal ribs, between which are situated oblique or net-like branched anastomoses especially near the edge. Planes of the side with one to four net-like branched, rarely longitudinal ribs.

Remarks. Fossils with the stones identical to the recent species but mostly a little smaller in dimensions due to fossilisation. An important indicator of humid climate with moderate winter temperatures.

Occurrence. Middle Miocene in Europe (Szafer 1961), sometimes in Pliocene (C. & E.M. Reid 1915, van der Burgh 1978). In the climate optimum of all interglacials from Middle Europe and widely spread to east beyond the recent distribution border (C.A. Weber 1893, Stoller 1908, Lang 1994).

Betulaceae

Betula pubescens Ehrhardt *fossilis*

Pl. 3 fig. 6

1923 *Betula pubescens* Ehrhardt *fossilis* Kozłowska, p. 219, Fig. 19.

Material. Nochten-Ost 4803: MfN 1993/10481.

Description. Bracts with three lobes. Length: 2.5 mm, width 1.5 mm, at the base 0.2 mm. Nutlets without preserved wings, pointed-ovate. The tip is much wider than the base. A surface structure is not visible.

Remarks. The winged fruits and bracts are

typical for the genus *Betula* section *Albae* Regel, but not clearly for the recent *B. pubescens* Ehrhardt.

Occurrence. Until now known from different interglacials and glacials of the Pleistocene, mainly by the winged nutlets and pollen.

Rosaceae

Rubus idaeus Linné *fossilis*

Pl. 3 fig. 7

1893 *Rubus idaeus* Linné *fossilis* C.A. Weber, p. 1.
1998 *Rubus idaeus* Linné; Dyjor et al., p. 41.

Material. Ruszów: MfN 1999/285.

Description. Fruit stone narrow, nearly halfmoon-shaped, oblique inverted ovoid or semicircular, flat, basally and apically rounded, (1.7) 2.0–2.7 mm long. The surface is foveolate-reticulate, with narrow, deep pits, angular to roundish, not much elongated, at the base a little bit longitudinal, laterally setted on the apex. Net-ribs wide, blunt. The dorsal side with a blunt, the straight ventral side with a wide, low keel.

Remarks. The stones of the typical species of the sction *Ideobati* Focke are shorter and more rounded than the real blackberries. The stones determined by Mai et al. (1963, Pl. 3 figs 15, 16) as *Rubus caesius* L. belong to *R. idaeus* L.

Occurrence. Earliest finds of Stare Gliwice (Middle Miocene, Szafer 1961) and Kunovice in Moravia (Upper Miocene, Knobloch 1976, pl. 2, fig. 2). Fossils very often in interglacials and interstadials (comp. Weber 1893, Nötzold 1961) of the whole Europe; also in the Pliocene widely distributed, especially in East Europe.

Sparganiaceae

Sparganium minimum (Wallr.) Fries *fossilis*

1915 *Sparganium minimum* (Wallr.) Fries *fossilis* C. & E.M. Reid, p. 57, Pl. 1 fig. 18.
1967 *Sparganium minimum* Fr.; Stachurska et al. 1967, Pl. 2 fig. 11.

Description. Endocarps ovate, pedunculate, smooth with neither ribs nor grooves. Length 1.4–3.4 mm, breadth 0.9–1.5 mm. Index length to breadth 1 : 1.6.

Remarks. The extant species is a typical element of shallow water in peat swamps and bogs, mostly circum-boreal in North America and Eurasia.

Occurrence. Middle Miocene of Stare Gliwice (Szafer 1961), Upper Miocene (Knobloch 1976 as *Sparganium nanum* Dorofeev; van der Burgh 1987), Pliocene from Rhine embayment to Russia, common in the Pleistocene (Firbas & Grahmann 1928).

Rosaceae

Rubus fruticosus Linné s. l. *fossilis*

1892 *Rubus fruticosus* Linné *fossilis* C. Reid; p. 338.

Material. Nochten-Ost 4803: MfN 1993/10445.

Description. Fruit stones ovoid to roundish – egg-shaped, flat. Apex pointed. Ventral side straight or vaulted to the outer side. Dorsal side rounded. Surface reticulate – foveolate with narrow, deep pits. Length 2.0–2.8 mm; breadth up to 1.5 mm.

Remarks. This is a collective name for the most European species of the section *Moriferi* Focke of the subgenus *Rubus* Linné (real blackberries), very variable in shape of the fruit stones.

Occurrence. Possibly in the Middle Miocene of Stare Gliwice (Szafer 1961). In the Pliocene of Mizerna/Carpathians (Szafer 1954); common in the interglacials and interstadials of Ireland, England, Danmark, Northwest Germany, Poland (Firbas & Grahmann 1928).

Caprifoliaceae

Weigela kryshtofovichiana Dorofeev

1957b *Weigela kryshtofovichiana* Dorofeev, p. 309, Pl. 4 figs 21–22.
1988 *Weigela* cf. *kryshtofovichiana* Dorofeev; Baranowska-Zarzycka, p. 25.

Description. Seeds lanceolate, somewhat curved, compressed at the sides, obtusely acuminated at the base and the apex, with small wings. The surface foveolate, ornamented with hexagonal cells. The cells of the wings radially elongated. Length (without wings) 1.4–1.8 mm; breadth 0.5–0.6 mm.

Remarks. Similar in the seed-shape to *Weigela japonica* Thunberg or *W. coraense* Thunberg (East Asia).

Occurrence. Oligocene and Miocene of Siberia (Dorofeev 1957b), Upper Miocene of

Schipkau (Mai 2000d), Belarus (Dorofeev 1967), Pliocene of Bashkiria (Dorofeev 1960a).

Urticaceae

Pilea cantalensis (E.M. Reid) Dorofeev

Pl. 3 fig. 8

1963a *Pilea cantalensis* Dorofeev, p. 164, Pl. 25 figs 21–27.

Material. Nochten-Ost 4803: MfN 1993/10482.

Description. Nutlet flat, ovate pointed, a little bit asymmetric. Style remain apically to one side something displaced, often oblique, subbasally with a small stalk or hump of funiculus. Walls thin. The surface is slightly and regularly foveolate – punctate; mostly with oblong dark spots, which sometimes fuse together. Length 1.0–1.7 mm, width 0.5–0.9 mm.

Remarks. The nutlets are comparable with these of *Pilea pumila* A. Gray (Atlantic part of Northern America) on wet, shady places in broad-leaved deciduous forests. E.M. Reid (1921) described the first fossil remains under this name of the extant species.

Occurrence. In the Miocene from Western Siberia to the Atlantic coast, Pliocene and Early Pleistocene of the whole Europe (E.M. Reid 1921, 1923, Dorofeev 1982, Mai & Walther 1988). Upper Miocene of Schipkau, Konin, Southern Moravia (Mai 2000d, Raniecka-Bobrowska 1959, Knobloch 1976).

Ranunculaceae

Ranunculus reidii Szafer

Pl. 3 fig. 9

1947 *Ranunculus reidii* Szafer, p. 98, Pl. 9 figs 1–5.

Material. Nochten-Ost 4803: MfN 1993/10486.

Description. Small fruits oblong to roundish – obovate, flat, with edged hem, without style remain 1.2 – 1.9 (2.1) mm long, more or less irregularly covered with warts. The surface is punctate to foveolate, warts rarely rubed off.

Remarks. Fruits larger than those of the extant *Ranunculus lateriflorus* DC. (Southern Europe, Caucasia, Siberia). More tuberculated as those of *R. nodiflorus* L. (Southern and Western Europe).

Occurrence. Middle and Upper Miocene of the Lusatia (Mai 2000d), Pliocene from Georgia (Dorofeev in Kolakovski 1958) to Western Europe (Mai & Walther 1988).

Lamiaceae

Ajuga reptans Linné *fossilis*

Pl. 3 fig. 10

1892 *Ajuga reptans* Linné *fossilis* C. Reid, p. 358.
1915 *Ajuga antiqua* C. & E.M. Reid, p. 132, Pl. 16 figs 13–14.

Material. Nochten-Ost 4803: MfN 1993/10498.

Description. Nutlets elliptical to narrow egg-shaped, large reticulate, 1.8–2.4 mm long and 1.0–1.5 mm wide. Ventral side nearly straight, with a contact area, which is over the half of the length of the seed.

Remarks. After Szafer (1947) there are no differences between the seeds of *Ajuga antiqua* C. & E.M. Reid and the extant *A. reptans* L.

Occurrence. Upper Miocene of Lusatia (Mai 2000d), Upper Miocene of Odessa (Dorofeev 1955a), Rhine embayment (van der Burgh 1987), often in the Pliocene (Mai & Walther 1988), in the interglacials from Ireland to West Sibiria (Kats et al. 1965).

Pinaceae

Picea rotunde-squamosa (Ludwig) Mai & Walther

Pl. 3 figs 11–15

1988 *Picea rotunde-squamosa* (Ludwig) Mai & Walther, p. 63, Pl. 2 figs 12–20.

Material. Nochten-Ost 4803: MfN 1993/10434.

Description. Cones 60–90 mm long, cylindrical, scales small, with a smooth, non dentated edge, roundly arched, without a tip. Seeds with ovate wings until 18 mm long. Needles rhomboidal in cross-section, 12–17 mm long, 0.7–2.0 mm width, keeled on both sides, long spiny-tiped, on every side with 3–7 lines of stomata, slightly bended.

Remarks. The rounded cone scales and the spiny-tiped needles seems to be related to the Japanese *Picea polita* Carr. (Morinda-type of cones). In our opinion they should have been described under one name. Müller-Stoll (1938) doesn't notice the name for the cones and needles by Ludwig (1857) and gave a new name, *P. echinata* Müller-Stoll, for the needles from the Pliocene of Dernbach.

Occurrence. Upper Miocene of the clay-pit Ilse near Großräschen (Mai 2000c), Upper Miocene of Inden Formation (van der Burgh 1987), common in the Pliocene (Müller-Stoll 1938, Szafer 1946, 1947, Bůžek et al. 1985, Mai & Walther 1988).

Apiaceae

Peucedanum moebii (Kinkelin) Mädler

Pl. 4 figs 1,2

1939 *Peucedanum moebii* Mädler, p. 134, Pl. 9 fig. 25.

Material. Nochten-Ost 4803: MfN 1993/10485.

Description. Fruits oblong – elliptical, all around with slashed of seam wing. Over the back with three thin angular ribs and four dark oil stripes with cross-separation. Apically a short style rudiment enclosed between the wings. Length 3.0–4.5 mm, width without wing seam 2.0–2.5 mm, wing seam ca 1.0 mm wide.

Remarks. With *Peucedanum palustre* (L.) Moench very well comparable, but only with a little smaller mericarp than the recent species.

Occurrence. Upper Miocene gray clay of Nochten in the Lusatia (Mai 2000d), Pliocene of the Main region, the Netherlands (Mädler 1939), the Upper Rhine Valley (Geissert 1972) and of the Carpathians (Szafer 1946, 1947, 1954).

Potamogetonaceae

Potamogeton dubnanensis Knobloch

Pl. 4 figs 3–4

1977 *Potamogeton dubnanensis* Knobloch, p. 33, Pl. 1 figs 1–19.

Material. Nochten-Ost 4803: MfN 1993/10467.

Description. Endocarps flat, more or less roundish, that means one side concave bended, the other straight and basically in the upper third convex curved. The sinuosity to the base starts directly below the keeled micropyle. The endocarps are 1.9–2.1 mm long and 1.2–1.8 mm wide. A microstructure at the surface is not visible.

Remarks. A relatively polymorphic species with a relationship to the circum-holarctic species *Potamogeton lucens* L., but in details different.

Occurrence. Upper Miocene (Pannonian and Sarmatian) of Southern Moravia and Slovakia (Knobloch 1977), possibly also in the Poznań clay of Konin ("*Potamogeton* sp. 1" Raniecka-Bobrowska 1959).

Urticaceae

Boehmeria lithuanica Dorofeev

Pl. 4 fig. 5

1982 *Boehmeria lithuanica* Dorofeev, p. 56, Pl. 132 figs 11–17.

Material. Ruszów: MfN 1999/316.

Description. Nutlets broadly ovate, with a distinct broad marginal seam, a small warty, somewhat obliquely orientated style remain and a basal hump of the funicule; both sides at the middle vaulted. Surface punctate, in the middle sometimes furrowed. Pericarp thin, two layers of large surface cells with sinuate walls and inner layer of tangential cells. Length 1.0–1.2 mm, breadth 0.9–1.0 mm.

Remarks. Related with the extant *Boehmeria cylindrica* Willd. Southern states of North America, Antilles, Mexico, on moist and swampy soils, peat bogs.

Occurrence. Upper Miocene of Lusatia (Mai 2000d), and Inden sequence (van der Burgh 1987), Pliocene of Latvia (Dorofeev 1982), Don (Nikitin 1957) and Thuringia (Mai & Walther 1988).

Cyperaceae

Dulichium arundinaceum (Linné) Britton *fossilis*

Pl. 4, figs 6–7

1904 *Dulichium spathaceum* Rich. *fossilis* Hartz, p. 13.
1998 *Dulichium arundinaceum* (Linné) Britton *fossilis*; Dyjor et al., Pl. 4 fig. 4.

Material. Nochten-Ost 4803: MfN 1993/10487; Ruszów: MfN 1999/294.

Description. Nutlets small linear – oblongate with nearly parallel edges. Small stalks in most cases long, gradually pass into the fruit body. Basis with long bristles, longer than the fruit body. Style base rounded, edges not winged. The style remain indicate that the length of the style is minimum third of the length of fruit body. Length 3.0–4.0 mm, width 0.8–1.0 mm. Index of length : width = (4–4.7) : 1.

Remarks. *Dulichium arundinaceum* is a perennial sedge of open wetlands and swamps

in the Atlantic part of North America, rare in California and British Columbia. It prefers places with temporary inundation, avoides dry habitats.

Occurrence. Pontian of the Ukraine (Dorofeev 1955c), Pliocene of the Netherlands (C. & E.M. Reid 1915), the Mainz Basin (Mädler 1939), Italy (Martinetto 1995), Bashkiria (Dorofeev 1965). Pleistocene, very common in the European interglacials.

Polygonaceae

Polygonum persicaria Linné *fossilis*

Pl. 4 figs 8, 9

1907b *Polygonum persicaria* Linné *fossilis* C. & E.M. Reid, p. 219; Pl. 14 fig. 123.

Material. Nochten-Ost 4803: MfN 1993/10442.

Description. Nutlets narrow to wide egg-shaped, one or both sides convex, with a prominent fruit stalk, on which sticked mostly remains of the perigon. Style remain distinct. Nutlets 2.0–2.5 mm long, 1.75 mm wide. Surface black shining.

Remarks. The cosmopolitan species is a typical plant of wet open places.

Occurrence. In the Meotian of Ukraine (Negru 1986) not sure. Upper Pliocene of the Rhine embayment (Zagwijn 1963), Carpathians (Szafer 1954), often in the Pleistocene from England (C. & E.M. Reid 1907b) to the Ural (Kats et al. 1965).

Butomaceae

Butomus umbellatus Linné *fossilis*

1963c *Butomus umbellatus* Linné *fossilis* Dorofeev, p. 613, fig. 352.
1998 *Butomus umbellatus* Linné; Dyjor et al.; 37–45.

Description. Seeds linear, nearly straight or somewhat curved, with rounded ends, with 7 longitudinal ribs, small toothed. Transversal section roundish. Cells of the surface between the ribs in straight prolonged rows. Length 1.75–2.0 mm, breadth 0.45–0.6 mm.

Remarks. *Butomus umbellatus* Linné growth in the reeds of ponds and lakes or slowly running waters in Eurasia.

Occurrence. Upper Miocene of Odessa (Dorofeev 1955b), Pliocene of Eastern Europe from the Ural to Belarus (Dorofeev 1967, Velichkevich 1975) and Bulgaria (Palamarev 1970); common in East European interglacials (Velichkevich 1973).

Polygonaceae

Rumex hydrolapathum Hudson *fossilis*

Pl. 4 figs 10, 11

1907b *Rumex hydrolapathum* Hudson *fossilis* C. & E.M. Reid, p. 219, Pl. 14 fig. 128.

Material. Nochten-Ost 4803: MfN 1993/10488.

Description. Nutlets sharp triangular, at both ends pointed, with vertical and horizontal symmetry axis, small stalk ca 0.4 mm wide, side plains of the fruit smooth, edges acute and contrasted. Fruit 2.0–3.0 mm long. Lobes of the perigon rhombic, entire, large, 5.7 mm long, nearly twice as long as wide, blunt, elevated reticulate; all have a large oblong callosity.

Remarks. The very large nutlets with remains of rhomboid perigon-lobes can only be referred to the species *Rumex hydrolapathum* Hudson. It lives in whole Europe on muddy riversides and lakes.

Occurrence. Upper Miocene of Ukraine (Negru 1986), Pliocene at the Main (Baas 1932) and the Dniepr (Velichkevich 1975), in Pleistocene deposits of England (C. & E.M. Reid 1907b) to Russia (Nikitin 1957).

Lamiaceae

Stachys palustris Linné *fossilis*

Pl. 5 fig. 1

1899 *Stachys palustris* Linné *fossilis*, C. Reid, p. 136

Material. Ruszów: MfN 1999/311.

Description. Nutlets obovate, not much compressed, convex to concave; ventral side change to the base into a blunt rib. Attachment basiventral, as a large, oval scar. Length 1.7–2.4 mm, width 1,0–1.7 mm.

Remarks. *Stachys palustris* Linné is a widespread reed-plant in Eurasia.

Occurrence. First remains possibly in the Meotian (Negru 1986), Pliocene of East Europe (Nikitin 1957; Dorofeev 1966a, 1967, 1977) and the Rhine area (van der Burgh & Zetter 1998), Pleistocene from England to Western Siberia (Kats et al. 1965).

Rosaceae

Padus racemosa (Lam.) Gilib. *fossilis*

Pl. 4 fig. 12

1899 *Prunus padus* Linné *fossilis* C. Reid, p. 114
1962b *Padus racemosa* (Lam.) Gilib. *fossilis* Dorofeev, p. 382.

Material. Ruszów: MfN 1999/325.

Description. Fruit stones ovoid, without a pedicellus, only with a short, thick foot. Vascular bundle running into the locule in the lower third of the suture. Surface with high and broad wrinkles branching in twice, ridges blunted or pointed. Length 4.5–6.5 mm, breadth 3.5–4.5 mm.

Remarks. Morphologically identical with the fruit stones of *Prunus padus* L. (Europe to Western Siberia, woods on riversides).

Occurrence. Miocene of Western Siberia (Dorofeev 1962b), possibly Middle Miocene of Stare Gliwice (Szafer 1961), Pliocene of the Carpathians and the Rhine embayment, Alsace (Mai 1984), Pleistocene interglacials.

Rosaceae

Mespilus germanica Linné *fossilis*

Pl. 4 fig. 13

1988 *Mespilus germanica* Linné *fossilis* Mai, p. 430, Pl. 31 fig. 7.

Material. Ruszów: MfN 1999/324.

Description. Fruit stones obliquely obovate, in cross-section clearly wedge-shaped. Length about 7.5 mm, breadth 5.0 mm. Dorsal edge straight, subbasally sinuous, with the entering point of the vascular bundle in a slits near the basal beak. Ventral side arched and rounded, with a broad furrow in the middle, without any hypostyle or style remain at the blunt apex. Dehiscence in two equal halfs.

Remarks. *Mespilus germanica* Linné is a deciduous tree or shrub in the submediterranean Near East and the Balcan Peninsula (diverse Quercetea).

Occurrence. Upper Miocene of Hambach (coll. Mai), Pliocene of Sessenheim/Alsace (Mai 1988).

Euphorbiaceae

Mercurialis perennis Linné *fossilis*

Pl. 5 fig. 10

1892 *Mercurialis perennis* Linné *fossilis* C. Reid, p. 358.

Material. Ruszów: MfN 1999/319.

Description. Seeds nearly globose, hollow-wrinkled or reticulate-wrinkled; keel of the raphae a third of the circumference. Diameter 3.0–6.0 mm.

Remarks. Extant species in shady deciduous broad-leaved forests in Europe (= Querceto-Fagetalia).

Occurrence. Pleistocene interglacials of England (C. Reid 1892), Denmark (Andersen 1961) and Germany (Mania & Mai 1969).

Rosaceae

Physocarpus europaeus Mai & Walther

Pl. 4 fig. 14

1988 *Physocarpus europaeus* Mai & Walther, p. 159, pl. 29, fig. 2.

Material. Nochten-Ost 4803: MfN 1993/10554.

Description. Seed anatrop, oblong – ovate, oblique, the micropyle-pole is tiped, the chalaza-pole is rounded, blowed up, with a subapical, ventrally displaced, long, oblique hilum and short raphae edge, which is disappearing near the chalaza-pole. Dehiscence along the raphae first slit-shaped, second two–flaped. The testa is hard, but thin, build by roundish-polygonal sclereids. Inside the seed-locule with oblong-reticulate structure, outside strong shining, small-cellular-foveolate to smooth. Seeds 1.3–1.8 mm long, 0.7–1.0 mm wide.

Remarks. Related with the East Asiatic species *Physocarpus amurensis* Maxim. (northern hardwood forests: Manchuria, Korea).

Occurrence. Only locus typicus at Berga in Thuringia (Pliocene, Mai & Walther 1988).

Aceraceae

Acer berganum Mai & Walther

Pl. 5 figs 2, 3

1988 *Acer berganum* Mai & Walther, p. 172, Pl. 32, figs 2, 3.

Material. Nochten-Ost 4803: MfN 1993/10457.

Description. Endocarps oblique-ovate, a little blowed up, 6–7 mm long, with nearly straight ventral side, only at the dorsal side keeled. On the surface in the upper third one to two thin, furcate ribs. Style rudiment short. Ventral pore large. Walls moderate thick, horn-like fibrous, compressed (fruit wings until now unknown).

Remarks. One species of the section *Acer* Linné. Endocarps very similar to *Acer heldreichii* Orph. (Balkan Peninsula), but fossils only of a third part of size of the recent endocarps.

Occurrence. Only the Pliocene of Berga (Thuringia, Mai & Walther 1988).

Cyperaceae

Carex praehirta Mai & Walther

Pl. 5 figs 4, 5

1988 *Carex praehirta* Mai & Walther, p. 85; Pl. 12 fig. 20.

Material. Nochten-Ost 4803: MfN 1993/10454.

Description. Nutlets triangular, in the outline lanceolate, with stalk-like narrowed base. Style remain thick, medium-sized and rounded. The surface is small-celled, honeycomb-like. Length (without style remain) 2.3 mm, width 1.2 mm. The largest width is to be found over the middle. Fossil utricles unknown.

Remarks. A little similar to the nutlets of *Carex hirta* L. (sedge of meadows, banks and shores in Europe).

Occurrence. Only Pliocene of Middle and East Europe (Mai & Walther 1988).

Cyperaceae

Carex pilulifera Linné *fossilis*

Pl. 5 figs 6–8

1953 *Carex pilulifera* Linné *fossilis* Mitchell, p. 225.

Material. Nochten-Ost 4803: MfN 1993/10451.

Description. Nutlets strongly blowed up, clavate to spherical, mostly strongly depressed. At the base relatively narrow, style remain thick, straight cliped, very short to nearly absent. The edges of the fruit are shown as light lines. The surface is punctate, nearly smooth and dark. Length 1.5–1.7 mm, width 1.2 mm. The largest width is close below the point, where the style is advertised. Fossil utricles unknown.

Remarks. Nutlets of the type of the sedges of section *Montanae* Fries, which are mostly blowed up.

Occurrence. Pliocene of Mizerna/Poland and Thuringia (Mai & Walther 1988), Pleistocene (late glacial) of Ireland (Mitchell 1953), Pre-Elsterian of Mahlis in Saxony (Fuhrmann et al. 1977).

Hypericaceae

Hypericum cf. ***hirsutum*** Linné *fossilis*

Pl. 5 fig. 9

1907b *Hypericum hirsutum* Linné *fossilis* C. & E.M. Reid, p. 214, Pl. 2 fig. 28.

Material. Nochten-Ost 4803: MfN 1993/10493.

Description. Seed cylindrical, on both poles rounded, 0.7 mm long. Surface tomentose and warty, foveolae arranged in 10 to 14 longitudinal rows.

Remarks. The fossil seeds are somewhat smaller than the seeds of recent species. This is a species of the deciduous forests, common in Southern Europe, rare in the mountains and in Northwest Europe.

Occurrence. Pliocene of Thuringia (Mai & Walther 1988), Pre-glacial of Britain (C. & E.M. Reid 1907b).

Ericaceae

***Arctostaphylos* sp.**

1998 *Arctostaphylos* sp.; Dyjor et al., p. 40.

Description. Fruit stones semiglobose, strongly compressed, ventrally keeled, dorsal side without keel, rounded, one-loculed. Length 4.5 mm, width 3.0 mm. The dorsal part is relatively wide and is semicircular in shape, the ventral part is narrow and stright.

Remarks. There is a similarity with *Arctostaphylos uva-ursi* (L.) Sprengel. Boreal forests in Europe, Asia and America.

Occurrence. Middle Miocene of Southern Poland (Łańcucka-Środoniowa 1963), Pliocene of Fortuna-Garsdorf, Rhine area (van der Burgh 1978), Starodvortsy, Belarus (Dorofeev 1967), often in Pleistocene interglacials or interstadials.

Najadaceae

Najas flexilis (Willdenow) Rostkoff & Schmidt *fossilis*

1932 *Najas flexilis* (Willdenow) Rostkoff & Schmidt *fossilis* Baas, p. 309, Pl. 2 fig. 4.
1998 *Najas flexilis* (Willdenow) Rostkoff & Schmidt; Dyjor et al., p. 42.

Description. Seeds elliptical, 2.3–3.0 mm long, 0.8–0.9 mm broad; testa outside nearly smooth, shining, three-layered. Cells of the epidermis regulary prolongated or square, with thick walls. Structure of the surface looks punctate.

Remarks. *Najas flexilis* (Willdenow) Rostkoff & Schmidt lives recently in North Europe in far separated places. The main distribution area is North America. Submerse waterplant in lakes and ponds.

Occurrence. Ruszów (Dyjor et al. 1998), Upper Pliocene of Schwanheim/Main (Baas 1932), Buchenau, Hassica (Leschik 1952), Rippersroda in Thuringia (Mai & Walther 1988), Starodvortsy, Belarus (Dorofeev 1967), mainly in the Pleistocene (Stark et al. 1932, Velichkevich 1973).

Urticaceae

Urtica pliocenica Dorofeev

Pl. 5 fig. 11

1982 *Urtica pliocenica* Dorofeev, p. 51, Pl. 126 figs 1–10.

Material. Ruszów: MfN 1999/318.

Description. Fruits smaller than 1.5–2.0 mm in length, nearly ovate, strongly compressed, but often vaulted on both sides, apically short pointed, without style remain, basally oblique passing over a short, thick stalk. Surface mostly small-punctate to smooth, sometimes with a few fine, small warts. Wall thin, with large, less thickened sclereids with crossed-over walls and inner tangential cell layer.

Remarks. Fruits smaller than *Urtica dioica* L., more comparable with *U. angustifolia* Fisch. and *U. platyphylla* Wedd. from the Far East, Korea and Japan.

Occurrence. Upper Miocene (Pontian) of the Ukraine, Pliocene of Western Siberia, Bashkiria, Belarus, Voronesh and also Reuverian of the Netherlands (Dorofeev 1982).

Lamiaceae

Glechoma hederacea Linné *fossilis*

Pl. 5 figs 12, 13

1933 *Glechoma hederacea* Linné *fossilis* Nikitin, p. 65.

Material. Ruszów: MfN 1999/317.

Description. Nutlets obovate, rounded slightly-triangulate, ventral part slightly vaulted, dorsal part flattened, smaller, clearly contrasted at the base. Hilum small. Surface black, not shining, areolate. Length 1.5–1.7 mm, breadth 1.0 mm.

Remarks. *Glechoma hederacea* Linné is common in Eurasia on riversides, in woodlands and on meadows.

Occurrence. Pleistocene of England, Poland (Środoń 1965), Volga embayment and Western Siberia (Nikitin 1933, 1940).

Aceraceae

Acer limburgense C. & E.M. Reid

Pl. 5 figs 14, 15

1915 *Acer limburgense* C. & E.M. Reid, p. 111, Pl. 11 fig. 8.
1988 *Acer pseudodiabolicum* Baranowska-Zarzycka, p. 26, Pl. 1 figs 1, 3, 4, 6, 7, 9, 10, 11.

Material. Ruszów: MfN 1999/286.

Description. Winged fruits with large, thick, roundish-triangular endocarps. Fruit wing only partly preserved, but at the base subparallel, with coarse reticulate, distinctly elevated nerves. Divergence of fruits acute – angled to right – angled. Endocarps mostly a half and more longer than high, at the straight ventral edge over 7 mm in average, thickened, at the side with thick callosity and few ribs, extending to the edges. Between the ribs and in the surrounding of the distinct style nose with short hairs. Endocarps 6.0–8.5 mm long, 4.8 mm high. Wing size unknown.

Remarks. A species of the section *Trifoliata* Pax (not section *Lithocarpa* Pax) in the youngest Tertiary of Europe. Recently this section is disjunct distributed in North America (section *Macrophylla* Pojarkova) and East Asia (section *Grisea* Pojarkova) (see Mai 1999c).

Occurrence. Only at the Upper Pliocene type-locality Tegelen in Limburg/Netherlands (C. & E.M. Reid 1915) and Ruszów (Baranowska-Zarzycka 1988).

Oxalidaceae

Oxalis corniculata Linné *fossilis* E.M. Reid

Pl. 5 fig. 17

1921 *Oxalis corniculata* Linné *fossilis* E.M. Reid, p. 129, Pl. 9 fig. 9.

Material. Nochten-Ost 4803: MfN 1993/10555.

Description. Seeds ovate to widely elliptical, with nine to ten sharp ribs. The surface is built by regular hexagonal cells with a central hill. Seeds 1.0–1.2 mm long.

Remarks. The distribution area of this recently by human activity nearly over the whole world distributed species is called as austral-tropic-temperate-oceanic. Natural occurence are in south-western Europe and at the Canary Islands, mostly in *Pinus* associations on sandy soils.

Occurrence. Pliocene of Berga (Mai & Walther 1988), Preglacial of Durham, Great Britain (E.M. Reid 1921) and Tegelen (Rusell Tiglia; coll. Mai).

DISCUSSION OF THE "PLIOCENE" PLANT SPECIES

The Pliocene epoch started approximately 5.3 million years after the end of the salinity crisis in the Mediterranean Sea which corresponds with the end of the Messinian sedimentation sequence. Therefore a great number of fossil assemblages that have been described as Pliocene in the older scientific literature must be excluded from the Pliocene as it is currently defined. These floras include the Pannonian F to G floras, the Pontian floras in the Paratethys area, the Susterian ("Fischbach") floras of the Lower Rhine embayment and also the floras of the French Central Massif, in each case with absolute ages between 7.1 and 5.6 million years. These floras belong to the Upper Miocene and are equivalents of the Messinian. In this situation a palaeobotanically justified boundary from the Miocene to Pliocene seems to become more and more unlikely. The "West European floral region" (after Dorofeev 1966b in Mai 1995) is distinguished in this transitional phase and during the Pliocene by deciduous broad-leaved forest-floras, dominated mostly by *Fagus* and with a prevalence of *Quercus*, *Carpinus* and *Castanea*. In addition appeared a variable quantity of thermophilous trees and shrubs of East Asiatic and North American relationship ("regional exotes"). Such deciduous forest-floras are typically for dated sequences between France and the Ukrainian Carpathians, from Slesvig-Holstein and Latvia to North Italy and the intracarpathian basins. Five different floral complexes in this region demonstrate that important floristic and climatic changes occurred during the Pliocene. The permanent increase of species that are extant (recent) species in Europe in plant communities including forests, herbaceous-, water- and swamp-plant coenoses is remarkable. All of these extant, extinct and exotic species from dated Pliocene floras will be considered as "Pliocene" plant taxa and they are known partly from Pliocene as also dated Miocene floras (see Fig. 3).

CHARACTERISTICS, BIOSTRATIGRAPHY AND COMPARISON OF THE LUSATIAN AND LOWER SILESIAN FOSSIL FLORAS

In the Lusatian and Lower Silesian sedimentary series the biostratigraphical arrangement of the fossil floras is very closely related with their relative position in the local profiles. Throughout the Miocene four different "floral complexes" are available: "Wiesa", "Kleinleipisch", "Klettwitz", "Schipkau – Konin" (after Mai 1995, 1999a, 2000 b), which occur also in Lower Silesia.

The "Wiesa" floral complex is fixed in the space of time at the boundary between the Lower to Middle Miocene, and is evident in the region under investigation by such fossil assemblages as Reichwalde NSL32, Bärwalde, Döbern (mine Providentia), Lohsa (Mai 2000b) and possibly Osiecznica (= Kliczków–Osieczów Raniecka-Bobrowska 1962), Dłużyna Dolna (Mai 1970) and Mużaków-Czaple (mine Babina). Warm temperate evergreen laurel forests ("mixed laurel forests" Raniecka-Bobrowska 1962; "*Trigonobalanus*-Lauraceae forest" Mai 1970) were developed at this time. They contain chiefly laurophyllous elements e.g. *Trigonobalanopsis exacantha*, evergreen *Quercus*-, *Laurophyllum*- and *Daphnogene* species, *Castanopsis schmidtiana*, *Cinnamomum costatum*, *Symplocos germanica*, *Ternstroemia sequoioides*, *Eurya stigmosa*, *Ilex saxonica*, *Ficus potentilloides*, *Magnoliaespermum geinitzii*

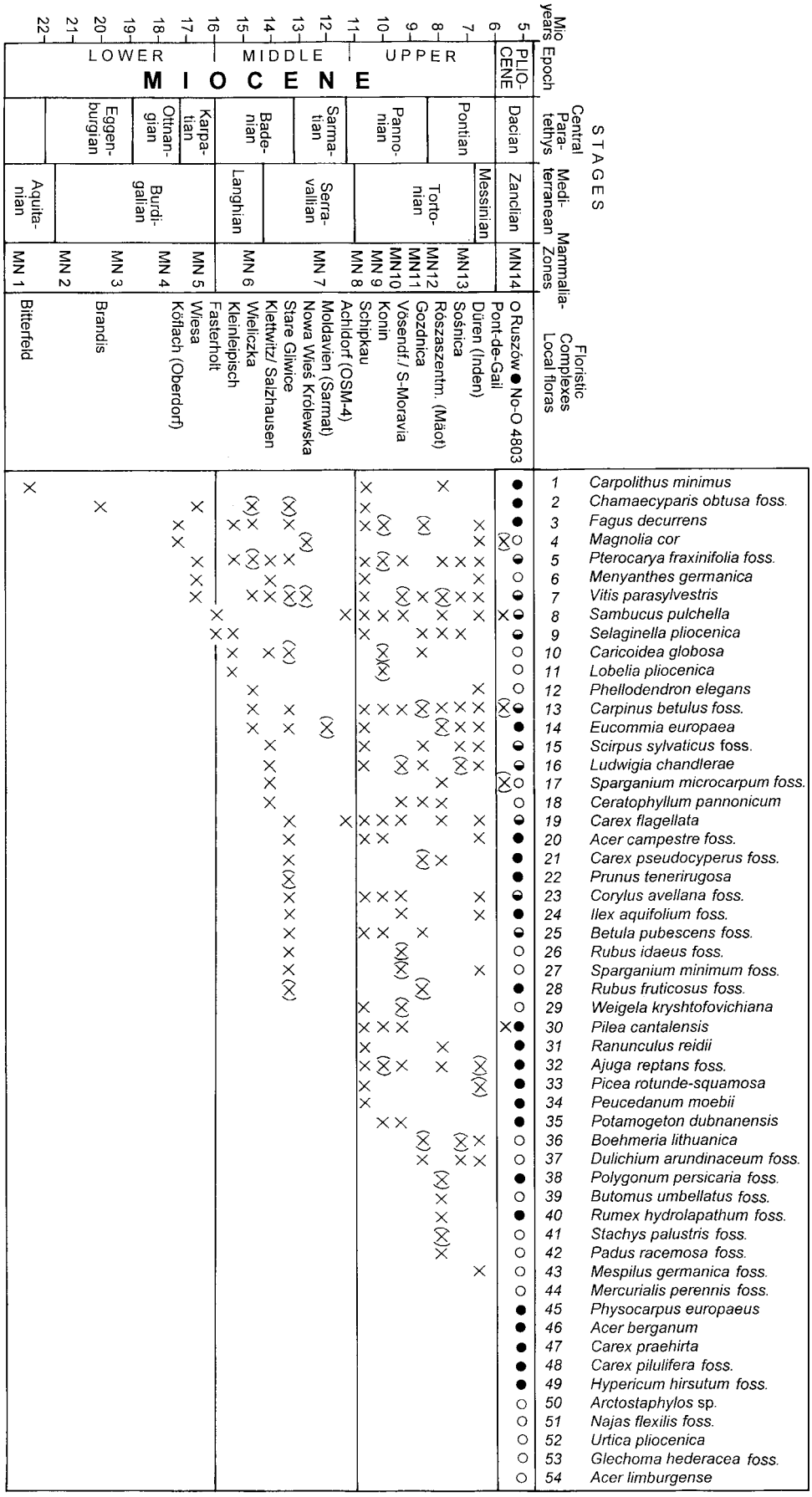

Fig. 3. Biostratigraphical table of the Miocene and Pliocene selected plant species from Ruszów and Nochten-Ost 4803/78 (timetable after Steininger et al. 1969)

and so on. The contemporaneous browncoal coniferous forests were distinguished firstly by *Quasisequoia couttsiae, Cunninghamia miocenica, Sequoia abietina, Sciadopitys tertiaria, Pinus hampeana, Castanopsis salinarum, Quercus rhenana, Magnolia burseracea, Comarostaphylis globula, Palmoxylon bacillare* and others (Kräusel 1920, Potonié 1930, Gothan 1936, Mai 2000b).

Two floras, until now recognized with restricted species numbers, followed in the lower Meuro sequence in the Nochten open mine (drillholes Nochten-W1375/66 and –W1385/66, "intermediate seam" and "special clay"), which present limited evidence of the "Kleinleipisch" floral complex. In these floras the species *Comarostaphylis globula, Epacridicarpum colwellense, Microdiptera uralensis* and *Salvinia crassiuscula* still occur, the last as an immigrant from the East European Pontian. Laurophyllous elements are rare.

The "Klettwitz" floral complex has an important part namely the "1st Lusatian seam" or the "seam Henryk" (in Poland), and also includes the accompanying clayey and sandy horizons that are well known in this region. A species rich assemblage comes from the claybrickyard in Rietschen with some elements of the mastixioidean flora, e.g. *Tectocarya elliptica, Sphenotheca incurva* and *Ficus potentilloides*. Numerous younger species are also evident including *Boehmeria lithuanica, Carpinus miocenica, Crataegus nodulosa, Magnolia ludwigii, Quercus sapperi, Sparganium microcarpum fossilis* and *Vitis parasylvestris*. From the profile at the "1st Lusatian seam" prominent floras were collected in the Nochten open mine at four different collection points (localities "Nochten 1 to 4"). Temperate rainforests are developed in connection with a great number of thermophilous and evergreen elements: *Aracispermum canaliculatum, Comarostaphylis globula, Eurya stigmosa, Lyonia danica, Myrica suppanii, Quercus* cf. *rhenana, Symplocos germanica, S. ludwigii* and *S. tetraporina*. Thermophilous conifers such as *Cathaya bergeri, Cunninghamia miocenica, Sciadopitys tertiaria, Sequoia abietina* became more frequent. Conspicuous is a regular and abundant appearance of temperate, mostly deciduous tree-layers in the forests. Significant forms of the younger Miocene/Pliocene would be perhaps *Caricoidea globosa, Magnolia ludwigii* and *Microdiptera menzelii*. The first browncoal seam horizon in the core-well Nochten-W1417/67 shows the Upper Miocene/ Pliocene species *Selaginella pliocenica* and also contains the contemporary flora observed in the Krauschwitz clay-brickyard. This flora supplemented the impressions of a warmth-demanding "Klettwitz" floral complex including such taxa as *Eurya stigmosa, Myrica suppanii, Symplocos lignitarum* and *Toddalia maii* (Mai 2000c, d).

The uppermost, latest floral complex of the continuous Lower Lusatian profile, is the "Schipkau – Konin" complex. This is recognized by only one very typical flora in the region: locality 5 in the Nochten open mine (Wähnert 1998). This assemblage came from the horizon of the "gray clay" in the transgressive Poznań Series at a western part of the basin, and in it is documented the "*Byttneriophyllum – Glyptostrobus* – association" characteristic of these series. In the flora exists a great number of Upper Miocene floral elements, e.g. *Azolla nikitinii, A. tegeliensis, A. tomentosa, Ajuga reptans, Banisteriaecarpum giganteum, Hemitrapa heissigii, Ludwigia chandlerae* and *Peucedanum moebii*. The members of a deciduous forest are displaced in the reason of palustric facies development.

The flora from Mirostowice Dolne near Żary/Lower Silesia, just as other Upper Miocene floras from the bottom of the Poznań Series, depicts swampy coniferous forests with *Glyptostrobus* and *Taxodium* (Zastawniak 1978). The deciduous trees and shrubs are representated only by eight taxa and in addition, climbing and monocotyledonous plants (*Phragmites oehningensis*) have been found. The picture of vegetation is enriched by taxa unknown from other localities of this age including *Fraxinus praedicta, Periploca* sp., *Phellodendron* cf. *amurense, Vitis strictum,* or those taxa that are hitherto unknown in Silesian or Lusatian fossil floras such as *Clerodendron silesiacum, Photinia szaferi, Salix microserrata* and *Vaccinium pseudouliginosum*. The majority of the distinguished genera are today connected with a temperate, moderately warm climate.

The period of the Gozdnica Series in western Poland is dated by the palynological profiles from the outcrops at Gozdnica and Gozdnica-Stanisław (Stachurska et al. 1971, Dyjor et al. 1992, 1998). The sediments in discontinuity to the Poznań Series were mainly

silty-sandy and clayey deposits and they contain numerous remains of macro- and microfloras. The proportion of swamp communities in the palynological picture is reduced, however, in the macroscopic flora it is still abundant with numerous characteristic elements including *Taxodium dubium, Nyssa disseminata, Proserpinaca brevicarpa* and *Aldrovanda praevesiculosa*. The whole area was overgrown by luxuriant mixed mesophytic forests with the dominant tree genera being *Pinus, Sequoia* and *Fagus*, and containing high percentages of arctotertiary (67%) and native (46%) elements, but also with a very high proportion of palaeotropical elements (33%) and extinct genera (12%). The presence of such species as *Eomastixia saxonica, Eurya stigmosa, Magnolia ludwigii, Mastixia thomsonii, Sphenotheca incurva, Symplocos lignitarum, S. minutula, S. salzhausensis, S. schereri, Tectocarya elliptica, Ternstroemia sequoioides* and *Tetrastigma chandleri* in the Gozdnica flora is a peculiar feature. The flora of Gozdnica belongs to the so-called younger mastixioidean floras (Mai 1964).

The occurence of mastixioidean remains in the deposits younger than the Sarmatian proves that the vegetation of those times developed in a period of warm climatic oscillations, which probably took place in the Pannonian. No doubt, it was very significant and had a large geographical extent as the presence of mastixiodean remains can also be seen in the vegetation of that time in the Lower Lusatica (Mai 1989, 2000d) and the Rhineland (van der Burgh 1987).

The results obtained provide evidence for the sedimentation of the Gozdnica Series in the area in question as early as the uppermost Miocene, probably in the Pannonian—Pontian period, in consideration of a high proportion of the arctotertiary and native elements (Dyjor et al. 1992). Such native and very young species are: *Azolla filiculoides, A. nikitinii, A. tomentosa, Andromeda carpathica, Ceratophyllum submersum foss., Chenopodium album foss., Ludwigia palustris foss., Potentilla supina foss., Caricoidea globosa, Scirpus sylvaticus foss., Carex pseudocyperus foss., Dulichium arundinaceum foss.* and others.

The higher lying deposits of the Gozdnica Series at Ruszów contain numerous and perfectly preserved plant remains, represented by leaves, fruits, seeds and pollen. The fossil flora from Ruszów reflect the communities of rich mesophytic deciduous broad-leaved forests (oak-hornbeam-chestnut forests) of moderatly damp biotopes, growing under temperate climates, as well as the communities of water and swamp vegetation. The coniferous trees *Taxodium* and *Glyptostrobus* and accompanying angiospermous genera *Alnus, Carya, Myrica, Nyssa, Populus, Salix* and *Ulmus* indicate the occurence of mixed deciduous wetland forests. Communities of water and subaquatic plants were composed of *Ceratophyllum, Potamogeton, Sparganium, Trapa, Typha,* the water ferns *Azolla* and *Salvinia* and also *Butomus, Calla, Carex, Decodon, Dulichium, Menyanthes, Najas* and *Proserpinaca*. The number of thermophilous taxa is very small in these communities and the plants of temperate regions are dominant. As such the fossil flora of Ruszów is characterized by high proportion of arctotertiary and European elements (above 87%, Dyjor et al. 1992). The extinct genera *Aracispermum* (*A. canaliculatum*), *Epipremnites* (*E. reniculus*), *Microdiptera* (*M. menzelii, M. parva*) and S*pirematospermum* (*S. wetzleri*), the taxa *Glyptostrobus europaeus, Taxodium dubium, Fagus silesiaca, Quercus sapperi, Liquidambar europaea, Liriodendron geminata, Nyssa ornithobroma, Cephalanthus pusillus, Meliosma wetteraviensis, Sparganium haentzschelii* confer on the whole flora a distinctly Miocene aspect. Characteristic of a Pliocene aspect are the large numbers of extant species and the high proportion of herbaceous plants: e.g. *Ceratophyllum* cf. *demersum, Cicuta virosa, Drosera intermedia, Glechoma hederacea, Ludwigia palustris, Menyanthes trifoliata, Mercurialis perennis, Physalis alkekengi, Stachys palustris, Butomus umbellatus, Carex gracilis, C. lasiocarpa, Dulichium arundinaceum, Najas flexilis, Scirpus sylvaticus, Sparganium microcarpum* and *S. minimum*. The same fact is visible by a great number of recent woody species: *Carpinus betulus, Castanea* cf. *sativa, Corylus avellana,* cf. *Frangula alnus, Ostrya carpinifolia, Padus* cf. *racemosa, Rubus idaeus* and *Sambucus ebulus*. The age of the flora, found at Ruszów, was first determined as Late Pliocene (Stachurska et al. 1967) but later the results of macrofloral studies resulted in it being considered as latest Early Pliocene (Hummel 1983, Hummel & Zarzycka 1985). This subordination as Pliocene was traditionally made

without connection to marine or mammal zonations. In this opinion the Poznań Series in Lower Silesia seems to have been deposited from the Late Badenian (= Middle Miocene) to Early Pliocene (Dyjor et al. 1998).

Another fossil flora of similar age but one, that is non-comparable in taxa and communities, is the assemblage recorded from Nochten-Ost 4803/78. The locality is situated in a distance of 40 km west of Ruszów and occurs at the top of the Poznań Series ("flamy clays") in the Weißwasser ridge. The plant communities, with 67 taxa, are very low in species representing a mixed coniferous-broadleaved deciduous forest (hornbeam-beach-spruce forest). In this a number of dominant taxa co-occurred, including *Ostrya szaferi, Liriodendron geminata, Acer campestre foss., Picea rotunde-squamosa, Viscum miquelii* and *Abies* sp. Equal with Ruszów are only 16 species. Important Tertiary elements are: *Acer cyclospermum, Actinidia faveolata, Chamaecyparis obtusa foss., Cunninghamia* sp., *Engelhardia macroptera, Eucommia europaea, Fagus decurrens, Glyptostrobus europaeus, Liriodendron geminata, Morus aldanensis, Picea rotunde-squamosa, Pinus* aff. *hampeana, Prunus tenerirugosa, Tsuga* sect. *Eutsuga* in the tree and shrub layer; *Carex flagellata, Peucedanum moebii, Pilea cantalensis, Polygonum leporimontanum, Potamogeton dubnanensis, Ranunculus reidii, Salvinia miocenica, Selaginella pliocenica, Teucrium tatjanae* and *Viola neogenica* in the herbaceous or the aquatic flora. The proportion of recent species in this flora is high: *Acer campestre, Betula pubescens, Carpinus betulus, Corylus avellana, Ilex aquifolium, Pterocarya fraxinifolia, Rubus fruticosus, R. idaeus* at the trees and shrubs; *Ajuga reptans, Carex pilulifera, C. pseudocyperus, Cirsium palustre, Dulichium arundinaceum, Euphorbia platyphyllos, Hypericum hirsutum, Ludwigia palustris, Oxalis corniculata, Physalis alkekengi, Polygonum persicaria, Rumex hydrolapathum, Scirpus sylvaticus* at the herbs. This seems to be typical of the Middle European floras of Pliocene age. The age was fixed traditionally also in Nochten-Ost 4803 on the position in the local profile, but not on the base of palaeozoological data.

In a biostratigraphic survey of "Pliocene" plants (Fig. 3) the relevant species of the younger Tertiary with palaeocarpological evidence have been considered in a scheme of floral complexes and local floras, incorporating the succession of mammalia zones after Mein (1975) and the stages in the Mediterranean and the Central Parathetys after Steininger et al. (1996). The macrofloras used were more or less species-rich and well investigated carpological collections. From more than hundred recognized species in the local assemblages of Nochten-Ost 4803 and Ruszów, only 54 species are connected with Neogene stages. They appeared successively up to the Lower Miocene, but were abundant mostly in the Upper Miocene. In the Pliocene appeared exclusively only 11 species from Middle Europe (No. 44–54 in Fig. 3). From it is restricted to Ruszów six, to Nochten-Ost 4803 five species exclusively. This evidence suggests that in the view of the floras considered, a biostratigraphic correlation within the Pliocene remains problematical. The space of time must be extended at the greater interval of the Upper Miocene and Lower Pliocene, which contains the Tortonian and Messinian resp. Pannonian and Pontian as far as the Zanclian (or Brunssumian). In this time between ca 11 million to 6 million years, the assemblages of the Rauno sequence (Schipkau), the Poznań Series (Konin), from Gozdnica and Sośnica (Goeppert 1855, Łańcucka-Środoniowa et al. 1981) belong into the neighbourhood of our localities. As an upper limit for dating the flora of Kłodzko-Ustronie (Jahn et al. 1984) could be used, as this has been dated from the highest stage of the Gozdnica Series and into the Late Pliocene (Mizerna II-stage). The flora of that locality points to a distinct cooling episode and documents a considerable rise in the portion of dark-needle conifers, especially spruce, an increase in the herbs (90%) and the distinct dominance of Quaternary/extant species (30 species) over Tertiary taxa (20 species). However, the date of this sequence has not been examined orthochronologically.

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REFERENCES

ANDERSEN S.T. 1961. Vegetation and its environment in Denmark in the Early Weichselian Glacial (Late Glacial). Danm. Geol. Unders., Ser. 2, 75: 5–175.

ANDREÁNSZKY G. 1959. Die Flora der sarmatischen Stufe in Ungarn. Akademia Kiadó, Budapest.

BAAS J. 1932. Eine frühdiluviale Flora im Mainzer Becken. Z. Bot., 25(6/7): 289–371.

BASILICI G., MARTINETTO E., PAVIA G. & VIOLANTI D. 1997. Paleoenvironmental evolution in the Pliocene marine-coastal succession of Val Chiusella (Ivrea, NW Italy). Boll. Della Societa Paleont. Italiana, 36(1/2): 32–52.

BARANOWSKA-ZARZYCKA Z. 1983 (unpubl.). Plioceńskie owoce i nasiona z Ruszowa. Materiały z Sesji Naukowej poświęconej pamięci Profesor Hanny Czeczottowej (5–6 października 1982). Muzeum Ziemi Polskiej Akademii Nauk, Warszawa. (in Polish).

BARANOWSKA-ZARZYCKA Z. 1988. Main features of the Pliocene fruit-seed flora from Ruszów near Żary (West Poland). Acta Palaeobot., 28(1/2): 23–27.

BÜLOW W. von & MAI D.H. 1992. Die südlichen Trebser Schotter aus dem Oberpliozän Südwest-Mecklenburgs. Eiszeitalter u. Gegenwart, 42: 25–39.

BŮŽEK Č., KVAČEK Z. & HOLÝ F. 1985. Late Pliocene palaeoenvironment and correlation of the Vildštejn floristic complex within Central Europe. Rozpr. Česk. Akad. Věd., Mat. Přirod., 95(7): 1–72.

CEPEK A.E. 1958. Zum Pliozän in Brandenburg. Ber. Geol. Ges. DDR, 3(2/3): 158–170.

CHOCHIEVA K.I. 1975. Khvarbetsky iskopaemy khvojny les (The fossil wood of coniferous trees in Khvarbeti). Publishing House Metsniereba, Tbilisi. (in Russian).

DOROFEEV P.I. 1955a. Iskopaemaya flora s reki Bol'shoy Yuksy v Zapadnoy Sibiri (Fossil Flora from the Great Yuksy River in West Siberia). Dokl. Akad. Nauk SSSR, 102(6): 1207–1210. (in Russian).

DOROFEEV P.I. 1955b. Meoticheskaya flora iz okrestnostey g. Odessy (The Meotian Flora of the vicinity of the town Odessa). Trudy Bot. Inst. Akad. Nauk SSSR, ser. 1, 11: 109-143. (in Russian).

DOROFEEV P.I. 1955c. O nakhodke ponticheskoy flory na Ukraine (On the find of the Pontian Flora in Ukraine). Dokl. Akad. Nauk SSSR, 102(5): 1017–1018. (in Russian).

DOROFEEV P.I. 1957a. Novye dannye o pliotsenovoy flore Kamy (New data on the Pliocene Flora of Kama). Dokl. Akad. Nauk SSSR, 117(3): 487–490. (in Russian).

DOROFEEV P.I. 1957b. Materialy k poznaniyu zapadnosibirskoy tretichnoy flory (Iskopaemaya flora s. Ekaterininskovo bliz g. Tary) (Contribution to the study of the Tertiary Flora in western Siberia (Fossil flora from Ekaterininskoe near upper Tara): 277–312. In: Dorofeev P.I. (ed.) Sbornik pamyati A.N. Krishtofovicha, (Case studies dedicated to Prof. A.N. Kristofovich). Akademia Nauk SSSR, Moskva-Leningrad. (in Russian).

DOROFEEV P.I. 1959. O rannechetvertichnoy flore d. Zhidovshchizny na Nemane (On the Early Quaternary Flora of Zhidovshchizna on the Neman River). Dokl. Akad. Nauk SSSR, 124(2): 421–423. (in Russian).

DOROFEEV P.I. 1960a. O pliotsenovoy flore Bashkirskovo Predural'ya. (On the Pliocene Flora of Bashkiria Predural'). In: Voprosi geol. Vostochn. Okrainy Russk. Platformy i Juzhnovo Urala, 5: 15–24, Gorno-geol. Inst. AN SSSR. (in Russian).

DOROFEEV P.I. 1960b. O tretichnoy flore Belorussii (summary: On the Tertiary Flora of Belarus). Bot. Zhurn., 45(10): 1418–1434. (in Russian).

DOROFEEV P.I. 1962a. O pliotsenovoy flore Bashkirii (On the Pliocene Flora of Bashkiria). Bot. Zhurn., 47(6): 787–801. (in Russian).

DOROFEEV P.I. 1962b. O florach Beshcheul'skoy svity Irtysha (On the floras of the vicinity of the Irtysh River at Beshcheul'). Dokl. Akad. Nauk SSSR, 145(2): 381–383. (in Russian).

DOROFEEV P.I. 1963a. Tretichnye flory Zapadnoy Sibirii (The Tertiary floras of Western Siberia). Akad. Nauk SSSR, Moskva-Leningrad. (in Russian).

DOROFEEV P.I. 1963b. Novye dannye o pleystotsenovykh florakh Belorussii i Smolenskoy oblasti (New data of the Pliocene floras of Belarus and Smolensk district). Mater. Istorii Flory i Rastitel'n. SSSR 4: 5–180. (in Russian).

DOROFEEV P.I. 1963c. Podklass Monocotyledones. Porjadok 1. Alismatales: 613–615. In: Takhtajan A.L. (ed.). Osnovy Paleontologii. Golosemennye i pokrytosemennye (The basics of Palaeontology. Gymnosperms and Angiosperms). Akad. Nauk SSSR, Moskva. (in Russian).

DOROFEEV P.I. 1964. Sarmatskaya flora g. Apsheronska (The Sarmatian Flora of the town Apsheronsk). Dokl. Akad. Nauk SSSR, 156(1): 82–84. (in Russian).

DOROFEEV P.I. 1965. Novye dannye o pliotsenovoy flore Bashkirii (New data on the Pliocene flora of Bashkiria): 191–208. In: Stratigrafiya chetvertichnykh (antropogenovykh) otlozhenij Urala. (Stratigraphy of the Quaternary of the Ural sediments). Nedra, Moskva. (in Russian).

DOROFEEV P.I. 1966a. Paleokarpologicheskyje dannye k stratigrafii neogena Zakarpat'ya (Palaeocarpological data of the Neogene stratigraphy): 28–30. In: Ermolova T.H. (ed.) Problemy Geologii i Rudonosnost'i Neogena Zakarpat'ya. Izdat. Ruskova Universiteta. (in Russian).

DOROFEEV P.I. 1966b. O flore epokhi Gippariona (On the flora of Hipparion epoch). Paleont. Zhurn., 1: 124–134. (in Russian)..

DOROFEEV P.I. 1967. O pliotsenovoy flore Belorussii (On the Pliocene Flora of Belarus): 92-110. In: Goretsky G.I. & Kriger N.I. (eds) Nizhny Pleystotsen lednikovykh rayonov Russkoy Ravniny (Lower Pleistocene of the glacial districts of the Russian Plane). Izdat. Nauka Moskva. (in Russian).

DOROFEEV P.I. 1974. Cabombaceae, Nymphaeaceae, Ceratophyllaceae, etc., 52–88. In: Takhtajan A.L. (ed.) Iskopaemye tsvetkove rastenya SSSR, 1 (Fossil flowering plants of the USSR, 1). Nauka, Leningrad. (in Russian).

DOROFEEV P.I. 1977. Simbuginskaya flora (Flora of Simbugino): 35–86. In: Goretsky G.I. (ed.) Fauna i flora Simbugino. Nauka, Moskva. (in Russian).

DOROFEEV P.I. 1982. Ulmaceae, Moraceae, Cannabaceae, Urticaceae, Fagaceae, Betulaceae. semena i plody (fruits and seeds): 7–176. In: Takhtajan A.L. (ed.) Iskopaemye tsvetkove rastenya SSSR, 2 (Fossil flowering plants of the USSR, 2). Nauka, Leningrad. (in Russian).

DYJOR S., KVAČEK Z., ŁAŃCUCKA-ŚRODONIOWA M., PYSZYŃSKI W., SADOWSKA A. & ZASTAWNIAK E. 1992. The Younger Tertiary Deposits in the Gozdnica Region (SW Poland) in the light of recent palaeobotanical research. Polish Bot. Stud., 3: 1–129.

DYJOR S., SADOWSKA A., HUMMEL A., BARANOWSKA-ZARZYCKA Z. & ZASTAWNIAK E. 1998. Geological position and flora of the younger Neogene deposits in Lower Silesia: 37–54. In: Sadowska A. & Szynkiewicz A. (eds) Tertiary-Quaternary (Pleistocene) floras of Bełchatów (Middle Poland) and several localities in south-western Poland. Guide to Excursion 2: The 5th European Palaeobotanical and Palynological Conference, June 26–30, 1998. Kraków.

ENGELHARDT H. & KINKELIN F. 1908. Oberpliozäne Flora des Untermaintales. Abh. Senckenberg. Naturforsch. Ges., 29(3): 151–281.

FIRBAS F. & GRAHMANN R. 1928. Über jungdiluviale und alluviale Torflager in der Grube Marga bei Senftenberg (Niederlausitz). Abh. Math.-Phys. Kl. Sächs. Akad. Wiss., 40(4): 1–63.

FUHRMANN R., HEINRICH W.D., MAI D.H. & WIEGANK F. 1977. Untersuchungen am präelsterkaltzeitlichem Löß von Mahlis (Bezirk Leipzig). Z. Geol. Wiss., Berlin, 5(6): 717–743.

GEISSERT F. 1972. Neue Untersuchungen im Pliozän der Hagenauer Umgebung (nördliches Elsass). Mainzer Naturwiss. Arch., 11: 191–221.

GEYLER TH. & KINKELIN F. 1887. Oberpliozänflora aus den Baugruben des Klärbecken bei Niederrad und der Schleuse bei Höchst a. M. Abh. Senckenberg. Naturforsch. Ges., 15: 1–47.

GOEPPERT H.R. 1855. Die tertiäre Flora von Schoßnitz in Schlesien. Heynsche Buchhandl., Görlitz.

GOTHAN W. 1936. Paläontologische Braunkohlenstudien. Braunkohlenarchiv, 45: 3–9.

GRANGEON P. 1958. Contribution a l'étude de la paléontologie végétale du Massif de Coiron (Ardéche). Mém. Soc. Hist. Nat. Auvergne, 6: 1–299.

HARTZ N. 1904. *Dulichium spathaceum*, en nordamerikanisk Cyperacé i danske interglaciale Moser. Medd. Dansk Geol. Foren., 10: 13–22.

HARTZ N. 1909. Bidrag til Danmarks tertiaere og diluviale Flora. Danm. Geol. Undersøg. 2. R., 20: 1–292.

HOLÝ F. 1975. Representatives of the family Mastixiaceae Calestan 1905 in the Bohemian Tertiary. Sborník Nár. Muz. Praze, B, 31: 123–147.

HUMMEL A. 1983. The Pliocene leaf flora from Ruszów near Żary in Lower Silesia, SW Poland. Prace Muz. Ziemi, 36: 9–104.

HUMMEL A. 1991. The Pliocene leaf flora from Ruszów near Żary in Lower Silesia, SW Poland. Part II. Betulaceae. Acta Palaeobot., 31(1,2): 73–151.

HUMMEL A. & ZARZYCKA 1985. Plioceńska flora liściowa i owocowo-nasienna z Ruszowa: 13–15. In: Dyjor S. (ed.) Plioceńska i eoplejstoceńska sieć rzeczna i związane z nią kompleksy osadów gruboklastycznych w Polsce. Krajowa Konferencja Naukowa we Wrocławiu 1985.06.18–20. Polska Akademia Nauk, Wrocław. (in Polish).

ILJINSKAYA I.A. 1953. Monografya roda *Pterocarya* Kunth. (Monography of the genus *Pterocarya* Kunth.). Trudy Bot. Inst. Akad. Nauk SSSR, Ser. 1, 10: 7–123. (in Russian).

JAHN A., ŁAŃCUCKA-ŚRODONIOWA M. & SADOWSKA A. 1984. Stanowisko utworów plioceńskich w Kotlinie Kłodzkiej (summary: The site of Pliocene deposits in the Kłodzko Basin, Central Sudetes). Geol. Sudet., 18(2): 7–43.

JENTYS-SZAFEROWA J. 1958. The genus *Carpinus* in Europa in the paleobotanical literature. Monogr. Bot., 7: 3–59.

JENTYS-SZAFEROWA J. 1960. Morphological investigations of fossil *Carpinus*-nutlets from Poland. Acta Palaeobot., 1(1): 1–43.

JENTYS-SZAFEROWA J. 1964. The biometrical method in investigations of the historical evolution of plants. Acta Soc. Bot. Polon., 33(1): 77–99.

JENTYS-SZAFEROWA J. & TRUCHANOWICZÓWNA J. 1953. Nasiona *Menyanthes* L. w Polsce od pliocenu po okres współczesny (summary: Seeds of *Menyanthes* L. in Poland from the Pliocene to the present time). Prace Inst. Geol., 10: 37–59.

KATS N.YA., KATS S.V. & KIPIANI M.G. 1965. Atlas i opredelitel' plodov i semyan vstrechayushchikhsya v chetvertichnykh otlozhenyach SSSR (Atlas and keys of fruits and seeds occurring in the Quaternary deposits of the USSR). Nauka, Moskva. (in Russian).

KIRCHHEIMER F. 1936. Beiträge zur Kenntnis der Tertiärflora. Palaeontographica, B, 82: 71–141.

KIRCHHEIMER F. 1941. Aus der geologischen Geschichte wichtiger Kulturpflanzen. Umschau, 45: 648–650.

KIRCHHEIMER F. 1957. Die Laubgewächse der Braunkohlenzeit. Verlag VEB W. Knapp, Halle/Saale.

KNOBLOCH E. 1976. Samen und Früchte aus dem Pannon von Kunovice (Mähren) Věstník Ústředn. Úst. Geol., 51: 221–230.

KNOBLOCH E. 1977. Fossile *Potamogeton*-Funde aus dem tschechoslowakischen Jungtertiär und Altquartär. Čas. Mineral. Geol., 22 (1): 29–42.

KNOBLOCH E. 1988. New records of fruits and seeds from the Upper Miocene and Lower Pliocene of Moravia and Slovakia. Tertiary Res., 9(1–4): 107–116.

KOLAKOVSKI A.A. 1958. Pervoe dopolnenie k Duabs'koy pliotsenovoy flore (The first addition for the Duabskaya Pliocene Flora). Trudy Sukhumsk. Bot. Sada, 11: 311-397. (in Russian).

KOZŁOWSKA A. 1923. Flora międzylodowcowa spod Rakowa. Acta Soc. Bot. Polon., 1(4): 213–232. (in Polish).

KRÄUSEL R. 1920. Nachträge zur Tertiärflora Schlesiens I. Jb. Preuss. Geol. Landesanst., 39: 329–460.

KRÄUSEL R. 1937. Pflanzenreste aus den diluvialen Ablagerungen im Ruhr-Emscher-Lippe-Gebiete. Decheniana, A, 95: 207–240.

KRUTZSCH W. 1988. Kritische Bemerkungen zur Palynologie und zur klimastratigraphischen Gliederung des Pliozäns bis tieferen Altpleistozäns in Süd-, Südwest-, Nordwest- und pro parte Mitteleuropa sowie die Lage der Pliozän/Pleistozän-Grenze in diesem Gebiet. Quartärpaläont., 7: 7–51.

LANG G. 1994. Quartäre Vegetationsgeschichte Europas. Methoden und Ergebnisse. Verlag G. Fischer, Jena, Stuttgart, New York.

LESCHIK G. 1952. Mikrobotanisch-stratigraphische Untersuchungen der jungpliozänen Braunkohle von Buchenau (Kr. Hünfeld). Paläontographica, B, 92(1–2): 1–51.

LUDWIG R. 1857. Fossile Pflanzen aus der jüngsten Wetterauer Braunkohle. Palaeontographica, 5(3–4): 81–108.

ŁAŃCUCKA-ŚRODONIOWA M. 1957. Mioceńska flora z Rypina na Pojezierzu Dobrzyńskim (summary: Miocene flora at Rypin in Dobrzyń Lake District). Prace Inst. Geol., 15: 5–76.

ŁAŃCUCKA-ŚRODONIOWA M. 1963. Stan badań paleobotaniczych nad miocenem Polski Południowej (summary: Palaeobotanical investigations on the Miocene of Southern Poland). Roczn. Polsk. Tow. Geol., 33 (2): 129–158.

ŁAŃCUCKA-ŚRODONIOWA M. 1966. Tortonian flora from the "Gdów-Bay" in the South of Poland. Acta Palaeobot., 7(1): 3–135.

ŁAŃCUCKA-ŚRODONIOWA M. 1979. Macroscopic plant remains from the freshwater Miocene of the Nowy Sącz basin (West Carpathians, Poland). Acta Palaeobot., 20(1): 1–116.

ŁAŃCUCKA-ŚRODONIOWA M., WALTHER H. & ZASTAWNIAK E. 1981. A preliminary report on a new study of the Neogene flora from Sośnica near Wrocław in Lower Silesia, West Poland (leaf and fruit-seed floras). Acta Palaeobot., 21(2): 101–114.

MÄDLER K. 1939. Die pliozäne Flora von Frankfurt a. M. Abh. Senckenberg. Naturforsch. Ges., 446: 1–202.

MAI D.H. 1964. Die Mastixiodeen-Floren im Tertiär der Oberlausitz. Pal. Abh., B, 2(1): 1–192.

MAI D.H. 1967. Die Florenzonen, der Florenwechsel und die Vorstellungen über den Klimaablauf im Jungtertiär der Deutschen Demokratischen Republik. Abh. Zentr. Geol. Inst., 10: 55–81.

MAI D.H. 1970. Die tertiären Arten von *Trigonobalanus* Forman (Fagaceae) in Europa. Jb. Geol., 3: 381–409.

MAI D.H. 1975. Beiträge zur Bestimmung und Nomenklatur fossiler Magnolien. Feddes Repert., 86(9–10): 559–578.

MAI D.H. 1984. Karpologische Untersuchungen der Steinkerne fossiler und rezenter Amygdalaceae (Rosales). Feddes Repert., 95(5–6): 301–330.

MAI D.H. 1988. Einige exotische Gehölze in den Interglazialfloren der Mitteleuropäischen Florenregion. Feddes Repert., 99: 419–461.

MAI D.H. 1989. Die fossile Flora des Blättertons von Wischgrund und anderer gleichaltriger Fundstellen der Klettwitzer Hochfläche. Natur und Landschaft, Cottbus, 11: 3–44.

MAI D.H. 1994. Florenzonen und Klimawechsel im Tertiär der Lausitz. Brandenburger Geowiss. Beiträge, 1(1): 84–93.

MAI D.H. 1995. Tertiäre Vegetationsgeschichte Europas. Methoden und Ergebnisse. Verlag G. Fischer, Jena, Stuttgart, New York.

MAI D.H. 1999a. Die untermiozänen Floren aus der Spremberger Folge und dem 2. Flözhorizont in der Lausitz. Teil I: Farnpflanzen, Koniferen und Monokotyledonen. Palaeontographica, B, 250(1–3): 1–76.

MAI D.H. 1999b. Die untermiozänen Floren aus der Spremberger Folge und dem 2. Flözhorizont in der Lausitz. Teil I: Polycarpicae und Apetale. Palaeontographica, B, 251(1–3): 1–70.

MAI D.H. 1999c. Beiträge zur Kenntnis einiger Holzgewächse im europäischen Tertiär. Feddes Repert., 110(1–2): 37–72.

MAI D.H. 2000a. Die untermiozänen Floren aus der Spremberger Folge und dem 2. Flözhorizont in der Lausitz. Teil III: Dialypetale und Sympetale. Palaeontographica, B, 253(1–3): 1–106.

MAI D.H. 2000b. Die untermiozänen Floren aus der Spremberger Folge und dem 2. Flözhorizont in der Lausitz. Teil IV: Fundstellen und Paläobiologie. Palaeontographica, B, 254(4–6): 65–176.

MAI D.H. 2000c. Die mittelmiozänen und obermiozänen Floren aus der Meuroer und Raunoer Folge in der Lausitz. Teil I: Farnpflanzen, Koniferen und Monokotyledonen. Palaeontographica, B, 256: 1–68.

MAI D.H. 2000d. Die mittelmiozänen und obermiozänen Floren aus der Meuroer und Raunoer Folge in der Lausitz. Teil II: Dicotyledonen. Palaeontographica, B, 257: 1–140.

MAI D.H., MAJEWSKI J. & UNGER K.P. 1963. Pliozän und Altpleistozän von Rippersroda in Thüringen. Z. Geol., 12(6): 765–815.

MAI D.H. & WALTHER H. 1988. Die pliozänen Floren von Thüringen. Quartärpaläontol., 7: 55–295.

MANIA D. & MAI D.H. 1969. Warmzeitliche Mollusken und Pflanzenreste aus dem Mittelpleistozän des Geiseltals (südlich von Halle). Z. Geol., 18(6): 674–690.

MARTINETTO E. 1995. Significato cronologico e paleoambientale dei macrofossili vegetali nell'inquadramento stratigrafico del villafranchiano di alcuni setteri del Piemonte (Italia NW) (summary: Chronological and paleoenvironmental meaning of plant macrofossils in the stratigraphical framing of the "Villafranchiano" unit in some districts of the Piemonte region (NW Italy). Tesi di Dottorato di Ricerca VII Ciclo 1992–94 Consorzio Torino-Genova-Cagliari. Universitá degli Studi di Torino, Torino.

MARTINETTO E. (in press). Studies on some exotic elements of the Pliocene floras of Italy. Palaeontographica B.

MEIN F. 1975. Biozonation du Neogene mediterranien a partir des Mammiferes. Rep. Comm. Mediterr. Neog. Stratigr. Work Group, Bratislava.

MITCHELL G.F. 1953. Further identifications of macroscopic plant fossils from Irish Quaternary deposits especially from a late-glacial depositat at Mapastown, Co. Louth. Proc. Roy. Irish Acad., B, 55: 225–281.

MÜLLER-STOLL W.R. 1938. Die jüngsttertiäre Flora des Eisensteins von Dernbach (Westerwald). Beih. Bot. Centralbl., B., 48: 376–434.

NEGRU A.G. 1969. O sistematicheskom polozheny miotsenovykh ostatkov *Carpinus* v Moldavii (About taxonomical state of the Miocene *Carpinus* remains in Moldavia). Bot. Zhurn., 54(5): 760–765. (in Russian).

NEGRU A.G. 1972. Ranniesarmatskaya flora severovostoka Moldavii (The Early Sarmatian Flora from North-East of Moldavia). Schtiintsa, Kishinev. (in Russian).

NEGRU A.G. 1986. Meoticheskaya flora Severno-Zapadnogo Prichernomor'ya (The Meotian Flora of North-Western Prichernomorye). Schtiintsa, Kishinev. (in Russian).

NELSON H.W. & VAN DER HAMMEN T. 1950. Een kwartair-geologisch onerzoek van het S. – W. – deel van Noord-Brabant. Geol. Mijnbouw, 12: 251–252.

NIKITIN P.A. 1933. Chetvertichnye flory nizovogo Powolzh'ya (The Quaternary floras of the Lower Powolzhye). Trudy Kom. Izuch. Chetvert. Perioda (Papers of the Comission of Quaternary investigations), 3(1): 65–120. (in Russian).

NIKITIN P.A. 1940. Chetvertichnye semennye flory beregov r. Obi (The Quaternary seeds floras of the Ob' River banks). Materialy Geol. Zapadnoy Sibiri, 12: 54. (in Russian).

NIKITIN P.A. 1957. Pliotsenovye i chetvertichnye flory Voronezhskoy oblasti (Pliozäne und pleistozäne Floren im Gebiet von Woronesh). Akad. Nauk SSSR, Moskva-Leningrad. (in Russian).

NÖTZOLD T. 1961. Pleistozäne Pflanzenreste von Ockrilla bei Meißen. Jahrb. Staatl. Mus. Geol. Dresden, Jg. 1961: 65–96.

NOWEL W., BÖNISCH R., SCHNEIDER W. & SCHULZE H. 1997. Geologie des Lausitzer Braunkohlereviers. Lausitzer Braunkohle AG, Senftenberg.

PALAMAREV E. 1970. Fosilni flory ot tri v'glishni baseyna v jugozapadna B'lgariya (Fossile Floren aus drei Braunkohlenbecken in Südwest-Bulgarien). Izv. Bot. Inst. Bulg. Akad. Naukite, 20: 35–79. (in Bulgarian).

PALAMAREV E. 1982. Neogenskata karpoflora na Melniskija baseyn (The Neogene carpoflora from the Melnik-Basin). Palaeont., Stratigr.Lithol., 16: 3–44. (in Bulgarian).

POTONIÉ R. 1930. Über den Muskauer Faltenbogen, seine Oberflächenformen und deren Abhängigkeit von der Beschaffenheit und Tektonik der Braunkohlen. Jb. Preuss. Geol. Landesanst., 51: 392–416.

RANIECKA-BOBROWSKA J. 1959. Trzeciorzędowa flora nasienna z Konina (summary: Tertiary seed-flora from Konin, Central Poland). Biul. Inst. Geol., 130: 159–252.

RANIECKA-BOBROWSKA J. 1962. Trzeciorzędowa flora z Osieczowa nad Kwisą (Dolny Śląsk) (summary: Tertiary flora from Osieczów on the Kwisa river (Lower Silesia). Pr. Inst. Geol., 30: 81–223.

REID C. 1892. The Pleistocene deposits of the Sussex Coast, and their equivalents in other districts. Quart. J. Geol. Soc., 48: 344–364.

REID C. 1899. The Origin of the British Flora. Dulau & Co., London.

REID E.M. 1920. Recherches sur quelque graines pliocénes du Pont-de-Gail (Cantal). Bull. Soc. Géol. France, Sér. 4, 20: 48–87.

REID E.M. 1921. On two preglacial floras from Castle Eden and a comparative review of Pliocene floras. Quart. J. Geol. Soc., 76(2): 104–161.

REID E.M. 1923. Nouvelles recherches sur les Graines du Pliocéne inférieur du Pont-de-Gail (Cantal). Bull. Soc. Géol. France, 23: 308–355.

REID C. & REID E.M. 1907a. The flora of Tegelen-sur-Meuse, near Venloo, in the province Limburg. Versl. Kon. Akad. Wetensch., sect. 2, 13(6): 1–26.

REID C. & REID E.M. 1907b. On the Pre-Glacial Flora of Britain. J. Linn. Soc. (Bot.), 38: 206–233.

REID C. & REID E.M. 1915. The Pliocene floras of the Dutch-Prussian border. Meded. Rijksopspor. Delfstoffen, 6: 1–178.

SADOWSKA A. 1995. Palinostratygrafia i paleoekologia neogenu przedgórza Sudetów (summary: Palynostratigraphy and palaeoecology of Neogene of the Sudetic Foreland). Materiały Sesji Geologia i Ochrona Środowiska Bloku Przedsudeckiego (Proceed.: Geology and Environmental Protection of the Fore-Sudetic Block). Roczn. Polsk.Tow. Geol., spec. vol.,: 37–47.

SCHRÖDER H. & STOLLER, J. 1908. Wirbeltierskelette aus den Torfen von Klinge bei Kottbus. Jb. Preuss. Geol. Landesanst., 26: 418–435.

STACHURSKA A., DYJOR S. & SADOWSKA A. 1967.

Plioceński profil z Ruszowa w świetle analizy botanicznej (summary: Pliocene section at Ruszów in the light of botanical analysis). Kwart. Geol., 11(2): 353–371.

STACHURSKA A., DYJOR S., KORDYSZ M. & SADOWSKA A. 1971. Charakterystyka paleobotaniczna młodotrzeciorzędowych osadów w Gozdnicy na Dolnym Śląsku (summary: Palaeobotanic characteristics of Late Tertiary sediments at Gozdnica (Lower Silesia). Rocz. Polsk. Tow. Geol., 41(2): 359–386.

STARK P., FIRBAS F. & OVERBECK F. 1932. Die Vegetationsentwicklung des Interglazials von Rinnersdorf in der östlichen Mark Brandenburg. Abh. Naturwiss. Ver., Bremen, 28: 105–130.

STEININGER F.F., BERGREN W.B., KENT D.V., BERNOR R.L., SEN S. & AGUSTI J. 1996. Circum-mediterranean Neogene (Miocene and Pliocene) marine-continental chronologic correlations of European mammal units and zones: 7–46. In: Bernor R.L., Fahlbusch V. & Mittmann H.-W. (eds) The evolution of the Western Eurasian Neogene Mammal faunas. Columbia Press, New York.

STOLLER J. 1908. Beiträge zur Kenntnis der diluvialen Flora Norddeutschlands. I. Motzen, Werlte, Ohlsdorf-Hamburg. Jb. Preuss. Geol. Landesanst., 29: 102–121.

STRAUS A. 1952. Thallophyten, Kryptogamen und Gymnospermen aus dem Pliozän von Willershausen. Ber. Deutsch. Bot. Ges., 65: 74–79.

SZAFER W. 1946. The Pliocene flora of Krościenko in Poland. I. Rozpr. Polsk. Akad. Umiej.Wydz. Mat.-Przyr. PAU, B, 72(1): 1–162).

SZAFER W. 1947. The Pliocene flora of Krościenko in Poland. II. Rozpr. Polsk. Akad. Umiej.Wydz. Mat.-Przyr. PAU, B, 72(2): 1–213.

SZAFER W. 1954. Plioceńska flora okolic Czorsztyna i jej stosunek do plejstocenu (summary: Pliocene flora from the vicinity of Czorsztyn (West Carpathians) and its relationship to Pleistocene). Pr. Inst. Geol., 11: 1–238.

SZAFER W. 1961. Mioceńska flora ze Starych Gliwic na Śląsku (summary: Miocene flora from Stare Gliwice in Upper Silesia). Pr. Inst. Geol., 33: 1–205.

ŚRODOŃ A. 1965. *Vitis silvestris* Gmel. in the Interglacial flora at Suszno on the river Bug (East Poland). Acta Palaeobot., 6(1): 4.

UNGER F. 1852. Iconographia plantarum fossilium. Denkschr. Akad. Wiss. Wien, Math.-Nat. Kl., 4: 71–118.

VAN DER BURGH J. 1978. The Pliocene flora of Fortuna-Garsdorf I. Fruits and seeds of Angiosperms. Rev. Palaeobot. Palynol., 26(1–4): 173–211.

VAN DER BURGH J. 1987. Miocene floras in the Lower Rhine Basin and their ecological interpretation. Rev. Palaeobot. Palynol., 52: 299–366.

VAN DER BURGH J. & ZETTER R. 1998. Plant mega- and microfossil assemblages from the Brunssumian of “Hambach” near Düren, B.R.D. Rev. Palaeobot. Palynol., 101: 209-256.

VELICHKEVICH F. Yu. 1973. Antropogenovye flory Belorussii i smezhnykh oblastey (Antropogene floras of Belarus and adjacent regions). Nauka i Tekhnika, Minsk. (in Russian).

VELICHKEVICH F. Yu. 1975. Novye dannye o flore d. Dvorets na Dnepre (New data about flora from Dvorets-village on Dniepr): 110–133. In: Makhnach N.A. (ed.) Stratigrafya i Paleogeografya Antropogena. Nauka i Tekhnika, Minsk. (in Russian).

VELICHKEVICH F. Yu. 1990. Pozdnepliotsenovaya flora Dvortsa na Dnepre (The Late Pliocene Flora of Dvorets on the Dniepr River). Nauka i Tekhnika, Minsk. (in Russian).

WÄHNERT V. 1998. (unpubl.). Beiträge zur fossilen Flora der “Bunten Tone” von Nochten. Diplomarbeit. Humboldt University, Berlin.

WEBER C.A. 1893. Über die diluviale Vegetation von Klinge und über ihre Herkunft. Bot. Jahrb. Syst., 17, Beibl., 40: 1–20.

ZAGWIJN W.H. 1959. Zur stratigraphischen und pollenanalytischen Gliederung der pliozänen Ablagerungen im Roertalgraben und Venloer Graben der Niederlande. Fortschr. Geol. Rheinld. Westfalen, 4: 5–26.

ZAGWIJN W.H. 1963. Pollen-analytic investigations in the Tiglian of the Netherlands. Meded. Geol. Stichting, 16: 49–71.

ZAGWIJN W.H. & HAGER, H. 1987. Correlations of continental and marine Neogene deposits in the South-Eastern Netherlands and the Lower Rhine district. Meded. Werkgr. Tert. Kwart. Geol., 24(1–2): 59–78.

ZASTAWNIAK E. 1978. Upper Miocene leaf flora from Mirostowice Dolne (Western Poland). Acta Palaeobot., 19(1): 41–66.

P L A T E S

Plate 1

1. *Chamaecyparis obtusa* Siebold & Zuccarini *fossilis*, part of twig from both sides, × 20, Nochten-Ost 4803, MfN 1993/10450

2–6. *Fagus decurrens* C. & E.M. Reid, × 4, Nochten-Ost 4803, MfN 1993/10452
2–5. cupules in different views, mostly from inside
6. single cupule-lobe with small protuberances

7. *Pterocarya fraxinifolia* (Lam.) Spach *fossilis*, nut from both sides, × 6.5, Nochten-Ost 4803, MfN 1993/10470

8. *Vitis parasylvestris* Kirchheimer, part of a dehiscented seed, left with the plug of the chalaza in the middle, × 10, Nochten-Ost 4803, MfN 1993/10494

9–11. *Sambucus pulchella* C. & E.M. Reid, × 20, Nochten-Ost 4803, MfN 1993/10447
9. seed from dorsal and ventral
10–11. other, smaller seeds

12. *Selaginella pliocenica* Dorofeev, megaspore with a perfect reticulum from both sides, × 50, Nochten-Ost 4803, MfN 1993/10559

13–14. *Caricoidea globosa* (C. & E.M. Reid) Mai, × 40, Ruszów, MfN 1999/288
13. nut from both sides, in the middle the conture of the locule
14. another nut, basically with the hilar-depression

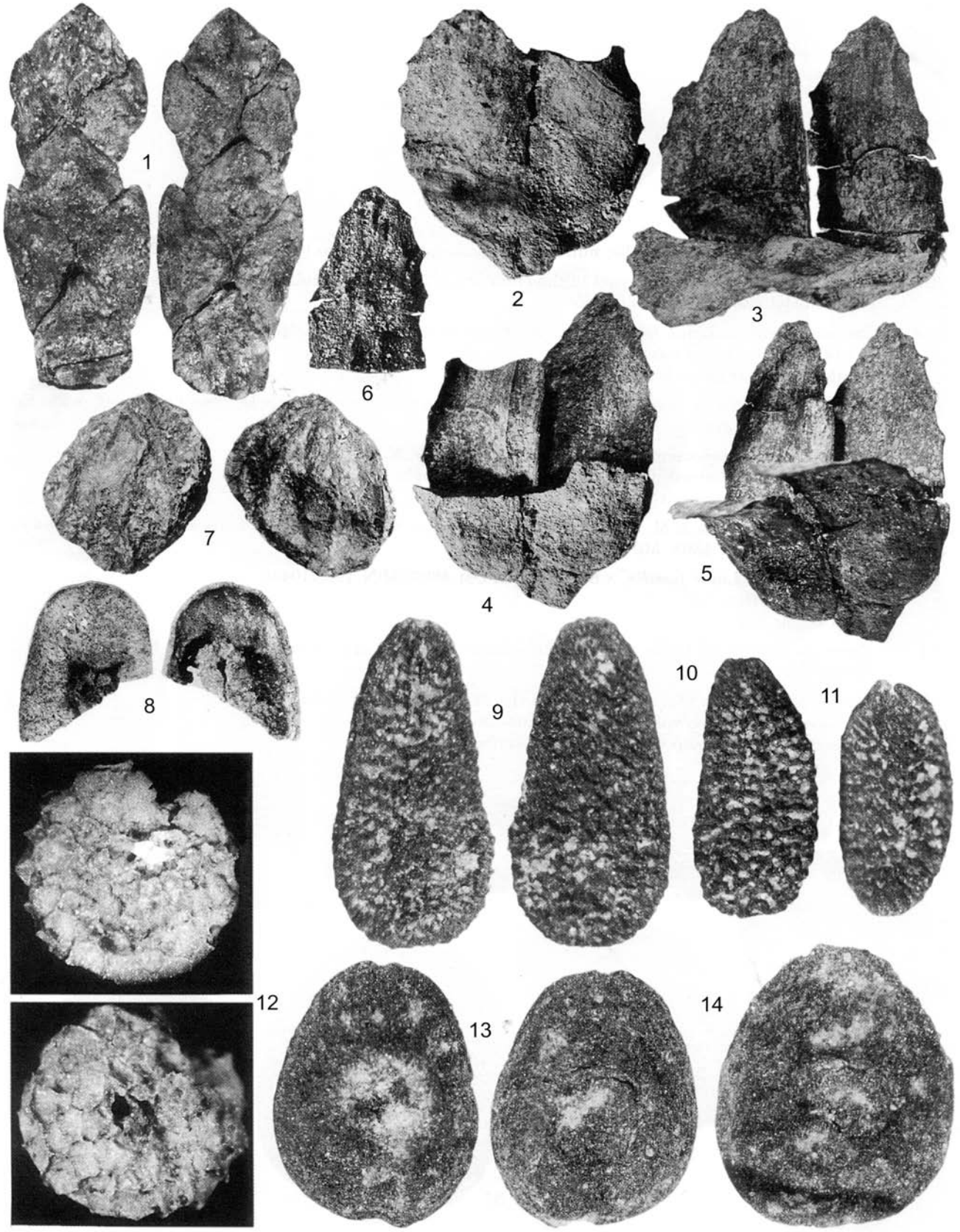
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Plate 2

1–2. *Carpinus betulus* Linné *fossilis,* nutlets from both sides, × 10, Nochten-Ost 4803, MfN 1993/10437

3. *Eucommia europaea* Mädler, part of the endocarp of a destroyed fruit with threads of guttapercha, × 4, Nochten-Ost 4803, MfN 1993/10462

4–5. *Scirpus sylvaticus* Linné *fossilis,* × 40, Nochten-Ost 4803, MfN 1993/10476
4. nutlet with a broad base
5. other nutlet from both sides

6–7. *Ludwigia chandlerae* Knobloch, seed with appendages near the micropyle, from both sides, × 25, Ruszów, MfN 1999/279

8–9. *Ceratophyllum pannonicum* Dorofeev, × 12, Ruszów, MfN 1999/273
8. nutlet with preserved appendages and a style remain
9. nutlet from inside, with vascular bundles

10–11. *Carex flagellata* C. & E.M. Reid, fruits from both sides with long style remains and a broad basal disc, × 20, Nochten-Ost 4803, MfN 1993/10465

12–13. *Acer campestre* Linné *fossilis,* × 6.5, Nochten-Ost 4803, MfN 1993/10446
12. endocarp from both sides
13. a larger and flattened endocarp

14. *Carex pseudocyperus* Linné *fossilis,* fruit somewhat crumpled from both sides, × 20, Nochten-Ost 4803, MfN 1993/10489,

15–16. *Prunus tenerirugosa* Mai, × 10, Nochten-Ost 4803, MfN 1993/10461
15. splitting endocarp with locule in inside-view,
16. endocarp (putamen) with ribs at the surface

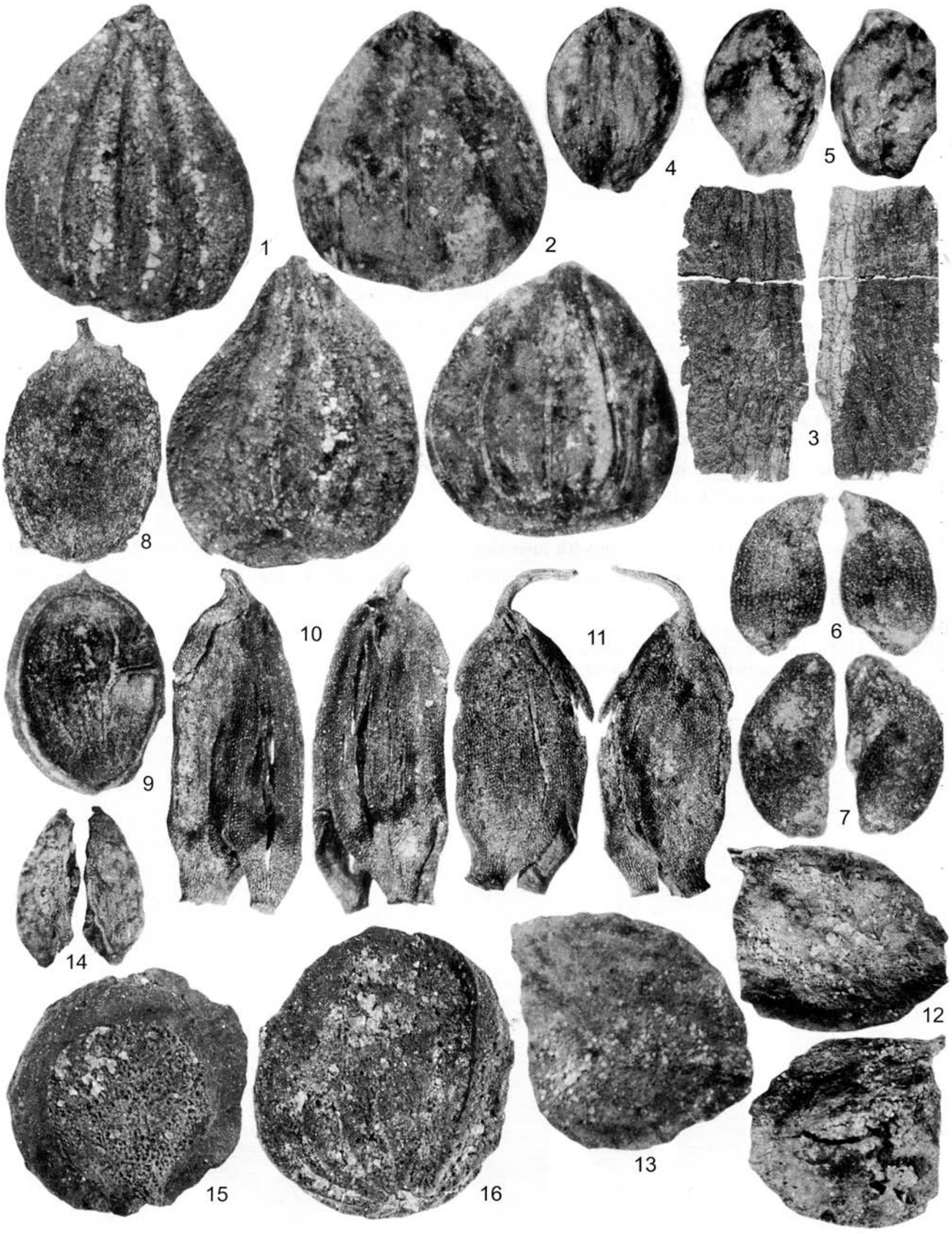
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Plate 3

1–2. *Corylus avellana* Linné *fossilis*, × 4,
1. nut from two sides, Ruszów, MfN 1999/275
2. basal scar of a splitted nut, Nochten-Ost 4803, MfN 1993/10484

3–5. *Ilex aquifolium* Linné *fossilis*, × 10, Nochten-Ost 4803, MfN 1993/10464
3. fragment of an endocarp from two sides
4. better preserved fruit stone
5. endocarp, well preserved, from two sides

6. *Betula pubescens* Ehrhardt *fossilis* (alboid group), nutlet with remains of the two styles and the marginal wings, × 20, Nochten-Ost 4803, MfN 1993/10481

7. *Rubus idaeus* Linné *fossilis*, nutlet from both sides, × 20, Ruszów, MfN 1999/285

8. *Pilea cantalensis* (E.M. Reid) Dorofeev, nutlet with wrinkled surface; × 30, Nochten-Ost 4803, MfN 1993/10482

9. *Ranunculus reidii* Szafer, nutlet with tubercles at the surface, × 25, Nochten-Ost 4803, MfN 1993/10486

10. *Ajuga reptans* Linné *fossilis*, nutlet from ventral and dorsal with an operculum, × 20, Nochten-Ost 4803, MfN 1993/10498

11–16. *Picea rotunde-squamosa* (Ludwig) Mai & Walther, × 10, Nochten-Ost 4803, MfN 1993/10434, × 10
11–15. needles and parts of needles in two views
16. part of a twig with leaf cushions

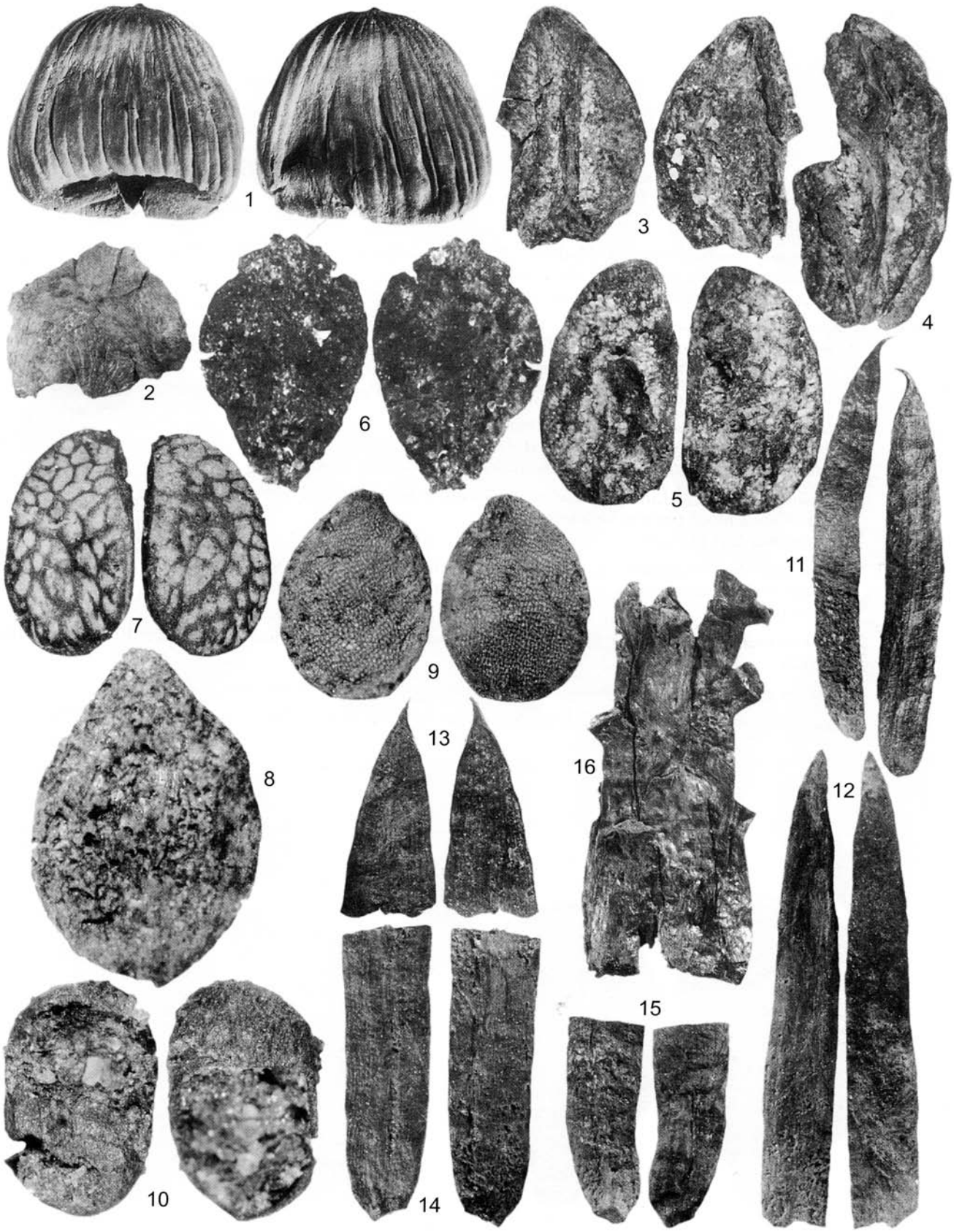
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Plate 4

1–2. *Peucedanum moebii* (Kinkelin) Mädler, × 15, Nochten-Ost 4803, MfN 1993/10485
1. mericarpium with remains of the marginal wing
2. fragment of another mericarp from both sides with clearly oil-weals

3–4. *Potamogeton dubnanensis* Knobloch, × 20, Nochten-Ost 4803,MfN 1993/10467
3. fruit stone from both sides, at right with foramen
4. another endocarp with keeled dehiscence valve

5. *Boehmeria lithuanica* Dorofeev, nutlet, well structured, × 25, Ruszów, MfN 1999/316

6–7. *Dulichium arundinaceum* (Linné) Britton *fossilis*, × 20
6. fruit from both sides with bristles, Ruszów, MfN 1999/294
7. fruit also basically with bristles, Nochten-Ost 4803, MfN 1993/10487

8–9. *Polygonum persicaria* Linné *fossilis*, × 25, Nochten-Ost 4803, MfN 1993/10442
8. nutlet with basal perigon remains
9. nutlet without perigon

10–11. *Rumex hydrolapathum* Hudson *fossilis*, × 25, Nochten-Ost 4803, MfN 1993/10488
10. fruit with remains of the perigon and a nutlet
11. isolated nutlet

12. *Padus racemosa* (Lam.) Gilib. *fossilis*, stonefruit with a stalked base and short ribs, × 10, Ruszów, MfN 1999/325

13. *Mespilus germanica* Linné *fossilis*, endocarp from both sides, × 10, Ruszów, MfN 1999/324

14. *Physocarpus europaeus* Mai & Walther, seeds from both sides, × 20, Nochten-Ost 4803, MfN 1993/10554


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Plate 5

1. *Stachys palustris* Linné *fossilis,* nutlet from both sides, × 25, Ruszów, MfN 1999/311

2–3. *Acer berganum* Mai & Walther, × 6.5, Nochten-Ost 4803, MfN 1993/10457
2. endocarp with part of the wings
3. endocarp, isolated from the fruit

4–5. *Carex praehirta* Mai & Walther, nutlets with persistent style from both sides, × 20, Nochten-Ost 4803, MfN 1993/10454

6–8. *Carex pilulifera* Linné *fossilis,* × 20, Nochten-Ost 4803, MfN 1993/10451
6. nutlet in different views
7–8. diverse nutlets from both sides

9. *Hypericum* cf. *hirsutum* Linné *fossilis,* seed from two sides, the micropyle is lost, × 40.Nochten-Ost 4803, MfN 1993/10493

10. *Mercurialis perennis* Linné *fossilis,* seed from two sides, × 20, Ruszów, MfN 1999/319

11. *Urtica pliocenica* Dorofeev, nutlet in two lightings, × 25, Ruszów, MfN 1999/318

12–13. *Glechoma hederacea* Linné *fossilis,* two nutlets of different structure and shape, from two sides, × 25, Ruszów, MfN 1999/317

14–15. *Acer limburgense* C. & E.M. Reid, two different endocarps from both sides with remains of the wings of the samarae, × 6.5, Ruszów MfN 1999/286

16. *Carpolithus minimus* (Szafer) Mai, nutlet dehiscented, from outside and inside, × 25, Nochten-Ost 4803, MfN 1993/10469

17. *Oxalis corniculata* Linné *fossilis,* seeds from both sides, a little cracked, × 25, Nochten-Ost 4803, MfN 1993/10555


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