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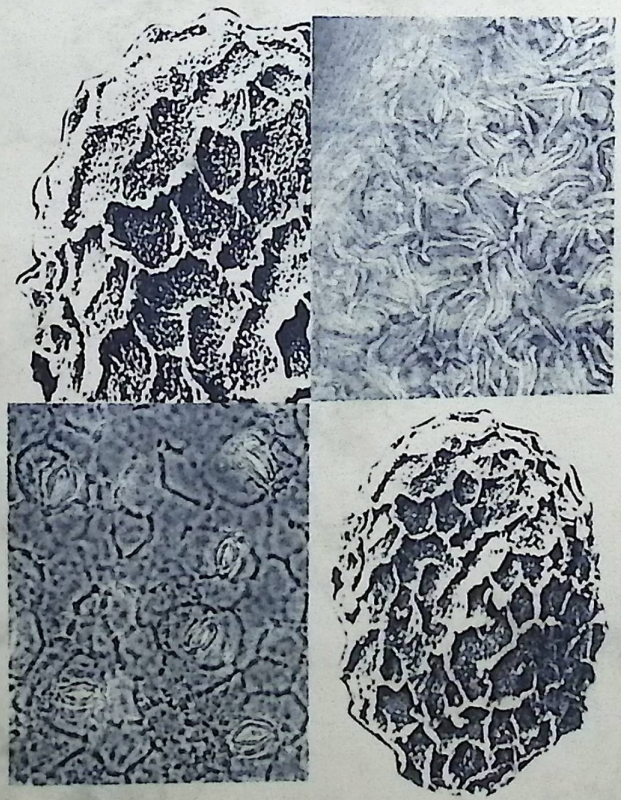
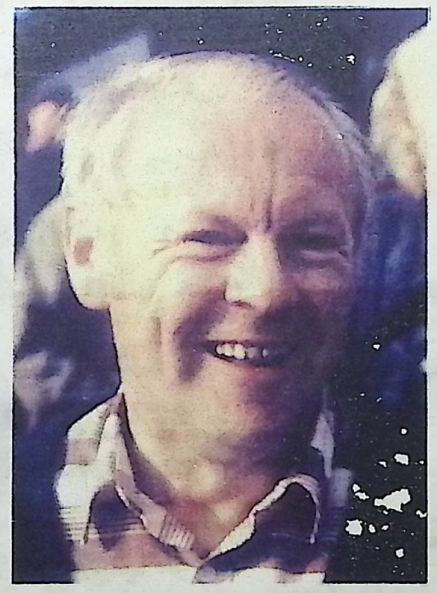
Teil 1: Miocene Megafloras of Poland

G. WOROBIEC.& J. KASIŃSKI:
Boreholes from "Ruja" lignite

M. LESIAK: Miocene of Lipnica Wielka





In memoriam

Erwin Knobloch †

1934-2004

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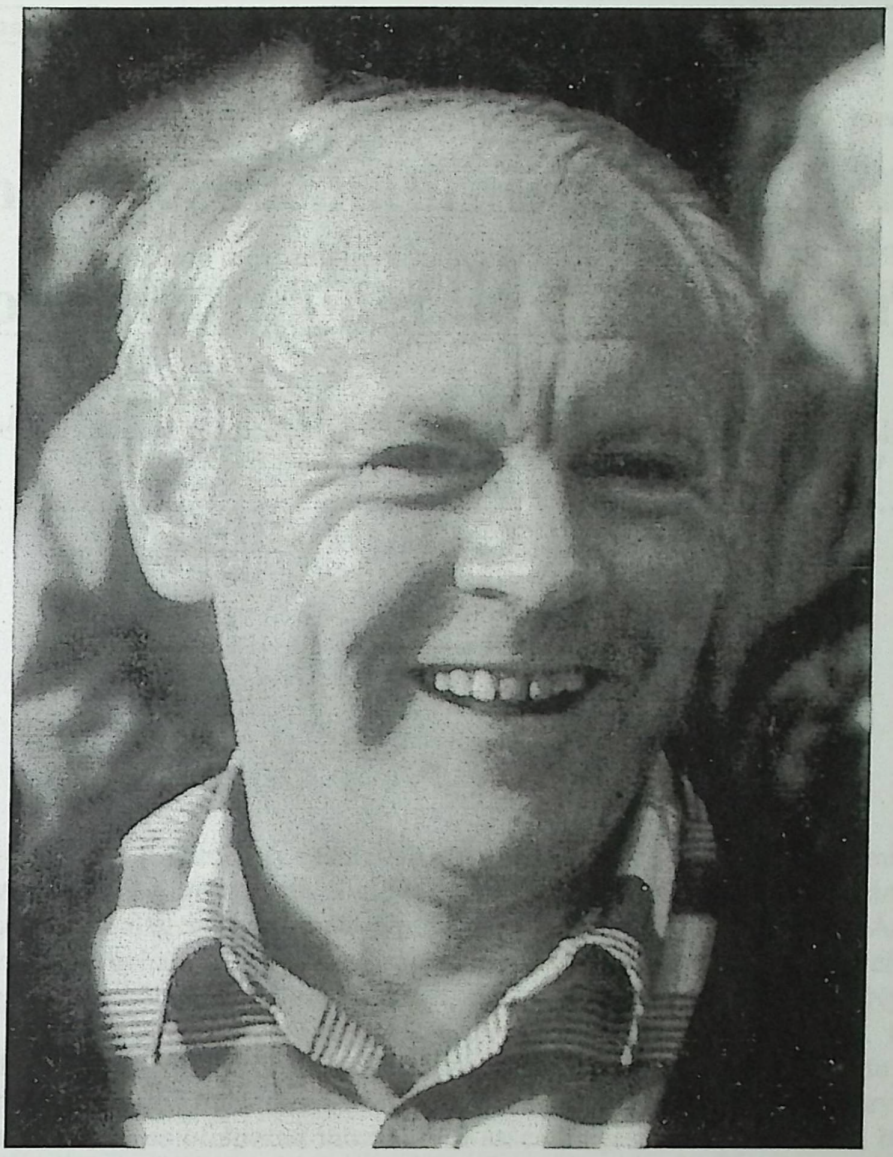

In memoriam Erwin Knobloch † 1934-2004

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Inhalt von Teil 1

G. WOROBIEC.& J. KASIŃSKI: Plant macroremains from boreholes from "Ruja" lignite deposit near Legnica, Lower Silesia, Poland (preliminary results).....1-11

M. LESIAK: New Fossil Finds and Interesting Plant Species for the Miocene of Lipnica Wielka , Southern Poland (Nowy Targ-Orawa Basin).....13-35

Documenta naturae	155	1	p.1-11	2 tabs.	2 plates	München	2005

Plant macroremains from boreholes from "Ruja" lignite deposit near Legnica, Lower Silesia, Poland (preliminary results)

WOROBIEC, G.& KASIŃSKI, J.

Summary

The paper present preliminary results of investigation on plant macroremains (mainly leaves) from two boreholes form "Ruja" lignite deposit near Legnica, Lower Silesia, Poland. In the fossil plant assemblages were found over 30 taxa belonging to the families Aceraceae, Alismataceae vel Hydrocharitaceae, Altingiaceae, Betulaceae, Blechnaceae, Cercidiphyllaceae, Fagaceae, Hydrocharitaceae, Juglandaceae, Malvaceae s.l., Myricaceae, Nyssaceae, Osmundaceae, Poaceae, Salicaceae, Taxodiaceae, Ulmaceae and Zingiberaceae. Common occurrence of the fossil leaves of *Salix hausruckensis* KOVAR-EDER, considered to be most similar to recent species *Salix floridana* CHAPMAN, endangered, subtropical, Tertiary relict of south-eastern part of USA is of special interest. All assemblages are characterised by almost absolute dominance of floristic elements of azonal wetland vegetation (swamp and riparian). Floristic composition of all investigated levels with plant macroremains points to their probably Late Miocene age and suggest warm temperate climatic conditions with very mild winters (presence of representatives of family Zingiberaceae).

Keywords: fossil plant macroremains; "Ruja" lignite deposit; azonal wetland vegetation; warm temperate climate; *Salix hausruckensis* KOVAR-EDER; Late Miocene; Poland; Lower Silesia

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1. Introduction

Several levels with abundant accumulations of macroremains of plants (mainly leaf compressions) were found in two cores from the boreholes in the prospective lignite deposit "Ruja" near Legnica (Lower Silesia). "Ruja" lignite deposit were found in the beginning of nineties of the last century as the result of the exploratory investigations (drillings) on the south-east from Legnica area (PIWOCKI 1989). The deposit lies on the Fore-Sudetic Block. Cenozoic deposits overlie Proterozoic granitoids and Palaeozoic phyllites which are strongly weathered, probably during Palaeogene. Praecenozoic basement deposits are covered by low dimensions basaltic domes most probably of the earliest Miocene age (JERZMAŃSKI & MACIEJEWSKI 1968). The overlying Neogene sedimentary series 8,0 to 200,0 m (on average 115,8 m) thick with lignite seams is built of clays, silts, sands, and gravels. Lignites from "Ruja" deposit up to 22,5 m thick which belong to the 2nd Lusatian Lignite Seam occur at depth between 164,2 and 40,0 m. Compact seam from central part of the basin splits up towards West and North into 2-3 beds or several thin layers (DYLĄG 1995).

2. Material and methods

Macroremains of plants were found in boreholes no 97/72 and 97/73 made on area of the "Ruja" Lignite deposit. In the core from 97/72 drilling plant remains occurred in the levels from depth of 78-79 m, 105-106 m, 106-108 m, 112-115 m, and 117 m. In the core 97/73 plant remains occurred in the levels from depth of 77-78 m, 102-105 m, 107-110 m, and 110-111 m. Impressions and carbonized macroremains of plants, mainly leaf compressions and twigs, very rarely carpological remains were investigated in respect of their macromorphology and in case of the leaf compression micromorphology (cuticular analysis).

3. Results

As the result of investigation of 278 specimens of plant remains from the two discussed cores over 30 taxa belonging to the families Aceraceae, Alismataceae vel Hydrocharitaceae, Altingiaceae, Betulaceae, Blechnaceae, Cercidiphyllaceae, Fagaceae, Hydrocharitaceae, Juglandaceae, Malvaceae s.l., Myricaceae, Nyssaceae, Osmundaceae, Poaceae, Salicaceae, Taxodiaceae, Ulmaceae and Zingiberaceae were determined. Individual plant assemblages from the cores are characterised by diverse taxonomical abundance from one taxon in case of level 77-78 m from borehole 97/73 to 27 taxa in underlying level 102-105 m of the same borehole. The taxonomical composition of the plant macroremains found in the investigated cores is as follows.

Borehole Ruja 97/72

Level depth	Taxonomical composition of plant assemblage
78-79 m	cf. *Byttneriophyllum tiliaefolium* (AL. BRAUN) KNOBLOCH et Z. KVAČEK, *Glyptostrobus europaeus* (BRONGNIART) UNGER, *Liquidambar* sp., *Myrica lignitum* (UNGER) SAPORTA sensu lato (Pl. 2, Fig. 5), *Osmunda parschlugiana* (UNGER) ANDREÁNSZKY, *Phragmites oehningensis* Heer, *Salix hausruckensis* KOVAR-EDER, *Salix varians* GOEPPERT sensu lato, *Salix* sp., *Sequoia abietina* (BRONGNIART) KNOBLOCH, cf. *Zingiberoideophyllum liblarense* KRÄUSEL et WEYLAND
105-106 m	*Acer tricuspidatum* BRONN sensu PROCHÁZKA et BŮŽEK, *Alnus julianiformis* (STERNBERG) Z. KVAČEK et HOLÝ, *Alnus menzelii* RANIECKA-BOBROWSKA, *Byttneriophyllum tiliaefolium* (AL. BRAUN) KNOBLOCH et Z. KVAČEK (Pl. 2, Fig. 2), *Cyperacites* sp. SCHIMPER sensu Z. KVAČEK et HURNÍK, Dicotyledones incertae sedis, *Glyptostrobus europaeus* (BRONGNIART) UNGER (twigs and cones, Pl. 1, Fig. 5), cf. *Myrica lignitum* (UNGER) SAPORTA sensu lato, *Salix hausruckensis* KOVAR-EDER (Pl. 1, Fig. 1, 3; Pl. 2, Fig. 1, 3), *Salix* sp., *Woodwardia muensteriana* (C.PRESL IN STERNBERG) KRÄUSEL
106-108 m	*Acer* sp. (Pl. 1, Fig. 6), *Cyperacites* sp. SCHIMPER sensu Z. KVACEK et HURNIK, Dicotyledones incertae sedis, *Phragmites oehningensis* HEER, *Salix varians* GOEPPERT sensu lato
112-115 m	*Acer tricuspidatum* BRONN sensu PROCHAZKA et BUZEK, *Alnus menzelii* RANIECKA-BOBROWSKA, *Byttneriophyllum tiliaefolium* (AL. BRAUN) KNOBLOCH et Z. KVACEK (Pl. 1, Fig. 2C), *Cyperacites* sp. SCHIMPER sensu Z. KVACEK et HURNIK, Dicotyledones incertae sedis, cf. *„Ficus" truncata* HEER sensu BUZEK, *Pterocarya paradisiaca* (UNGER) ILINSKAYA (Pl. 1, Fig. 2B), *Quercus gigas* GOEPPERT emend. WALTHER et ZASTAWNIAK, *Ulmus ruszovensis* HUMMEL (Pl. 1, Fig. 2A), *Ulmus* sp.
117 m	*Glyptostrobus europaeus* (BRONGNIART) UNGER, *Osmunda parschlugiana* (UNGER) ANDREANSZKY, *Salix hausruckensis* KOVAR-EDER

Borehole Ruja 97/73

Level depth	Taxonomical composition of plant assemblage
77-78 m	*Osmunda parschlugiana* (UNGER) ANDREÁNSZKY
102-105 m	*Acer* sp., *Acer tricuspidatum* BRONN sensu PROCHÁZKA et BŮŽEK, *Alnus menzelii* RANIECKA-BOBROWSKA, *Byttneriophyllum tiliaefolium* (AL. BRAUN) KNOBLOCH et Z. KVAČEK, cf. *„Ficus" truncata* HEER sensu BŮŽEK, cf. *Carpinus grandis* UNGER, cf. *Populus* sp., Dicotyledones incertae sedis, *Glyptostrobus europaeus* (BRONGNIART) UNGER (twigs and cones), Monocotyledones incertae sedis, *Myrica lignitum* (UNGER) SAPORTA sensu lato, *Phragmites oehningensis* HEER, *Populus populina* (BRONGNIART) KNOBLOCH (Pl. 2, Fig. 6), *Salix* cf. *holzeri* KOVAR-EDER et KRAINER, *Salix hausruckensis* KOVAR-EDER, *Salix varians* GOEPPERT sensu lato, *Salix* sp., *Ulmus pseudopyramidalis* Z. KVAČEK et HABLY, *Ulmus ruszovensis* HUMMEL, *Ulmus* sp., *Zelkova zelkovifolia* (UNGER) BŮŽEK et KOTLABA
107-110 m	Alismataceae vel Hydrocharitaceae, *Alnus menzelii* RANIECKA-BOBROWSKA, *Byttneriophyllum tiliaefolium* (AL. BRAUN) KNOBLOCH et Z. KVAČEK, *Cercidiphyllum crenatum* (UNGER) R.W.BROWN emend. KVAČEK et KONZALOVÁ (Pl. 1, Fig. 4), Dicotyledones incertae sedis, *„Ficus" truncata* HEER sensu BŮŽEK, *Glyptostrobus europaeus* (BRONGNIART) UNGER (twigs and cones), *Nyssa ornithobroma* Unger, *Salix hausruckensis* KOVAR-EDER, *Salix* sp., *Spirematospermum wetzleri* (HEER) CHANDLER, *Ulmus* cf. *ruszovensis* HUMMEL, *Ulmus* sp., *Zingiberoideophyllum liblarense* KRÄUSEL et WEYLAND (Pl. 2, Fig. 4)
110-111 m	*Byttneriophyllum tiliaefolium* (AL. BRAUN) KNOBLOCH et Z. KVAČEK, *Taxodium* vel *Sequoia*

Very interesting is common occurrence in the most of investigated levels of *Salix hausruckensis* KOVAR-EDER (Pl. 1, Fig. 1, 3; Pl. 2, Fig. 1, 3), recently described by KOVAR-EDER & WÓJCICKI (2001) from the Late Miocene flora from Hinterschlagen in Austria. KOVAR-EDER & WÓJCICKI (op. cit.) considered recent Florida Willow, *Salix floridana* CHAPMAN as most similar to the fossil *Salix hausruckensis*. Florida Willow, subtropical,

Tertiary relict (KOVAR-EDER & WÓJCICKI 2001) today grow in swamps and along rivers only on limited area in the southern part of Georgia and in the northern and central Florida in few disjunctive areas and was placed in the list of endangered plants of USA (USDA, NRCS 2004).

4. Discussion

All levels with plant macroremains assemblages are characterised by almost absolute dominance of floristic elements of the azonal wetland vegetation. In the assemblages from levels 78-79 m, 105-105 m, and 106-108 m from the borehole Ruja 97/72 and from levels 77-78 m, 107-110 m, and 110-111 m from the borehole Ruja 97/73 were found exclusively taxa typical for wetland vegetation, especially those of swamp associations. In the assemblage from depth 107-110 of the borehole 97/73 were found fossil water plants with floating leaves from the families Alismataceae and/or Hydrocharitaceae, typical of water reservoirs with stagnant or slowly flowing water.

Only in levels 112-115 m from the borehole Ruja 97/72 and 102-105 m from the borehole Ruja 97/73 very scarce remains of *Quercus gigas* and cf. *Carpinus grandis* considered as representatives of zonal, mesophytic, deciduous broad-leafed forests vegetation were found. Among the mentioned taxa only *Quercus gigas* from the borehole Ruja 97/72 is relatively abundant (16 specimens) whereas *Carpinus grandis* is represented only by one specimen.

On the basis of obtained results reconstruction of the presumably character of the local vegetation of the "Ruja" lignite deposit during the period of sedimentation of investigated parts of the profile of Neogene deposits could be done. During this period on the Ruja area dominated azonal wetland vegetation with swamp and riparian forests. Swamp forest was inundated for the most of the year and its stand was composed of *Acer tricuspidatum, Alnus menzelii, Byttneriophyllum tiliaefolium, Nyssa ornithobroma, Glyptostrobus europaeus, Myrica lignitum, Osmunda parschlugiana, Woodwardia muensteriana*, Zingiberaceae (*Spirematospermum* and *Zingiberoideophyllum*), representatives of the association *Glyptostrobus-Byttneriophyllum* (MAI 1995). Presence of *Myrica lignitum* indicates that locally association of bog forest could existed and the accumulation of wood, which later on formed lignite seams, may have occurred in this bog forest. Slightly drier areas probably on mineral soils that were inundated only periodically, were overgrown with the riparian forests as indicated by the presence of such taxa as *Cercidiphyllum crenatum, Liquidambar* sp.,

Populus populina, Pterocarya paradisiaca, Salix ssp., *Ulmus ruszovensis, Zelkova zelkovifolia* (KOVAR-EDER 2003). Abundance of remains of leaves of various species of *Salix* (*Salix hausruckensis, Salix* cf. *holzeri, Salix varians, Salix* sp.) points to the presence of the riparian willow communities. The shore of the water reservoirs was covered by reeds with *Phragmites oehningensis* and *Cyperacites* sp., on the open surface of them were floating leaves of water plants (Alismataceae and/or Hydrocharitaceae). On the more elevated places with low ground water level and beyond the range of periodical flood inundation were grown mesophytic forests. Due to very poor representation of this group of plants in the fossil assemblages from Ruja (?*Carpinus* and *Quercus*) we can only say that most probably there were deciduous broad-leafed forests (KOVAR-EDER 2003) of the association *Quercus-Carpinus-Castanea* (MAI 1995).

Floristic composition of all investigated levels with plant macroremains points to their similar age corresponding to the Middle or Late Miocene. Absence of the species *Quercus rhenana* (KRÄUSEL & WEYLAND) KNOBLOCH et Z. KVAČEK, very characteristic of the Central European Early Miocene swamp vegetation and common in swamp associations of this period and absence of the members of the family of Lauraceae and palms (Arecaceae) exclude Early Miocene age of this part of the Neogene sediments of the "Ruja" lignite deposit. Domination of the deciduous, warm temperate climate species in all plant assemblages and presence of taxa absent or very rare in the Pliocene floras of Poland (*Byttneriophyllum tiliaefolium, Glyptostrobus europaeus, Zingiberoideophyllum liblarense*) allows to presume the Late Miocene age of them.

Fossil plant taxa found in the investigated part of sediments of the "Ruja" lignite deposit suggest warm temperate climate during the period of formation of macroremains assemblages. Presence of the genera *Spirematospermum* and *Zingiberoideophyllum*, representatives of the family Zingiberaceae, points to very mild winters with the absolute minimum of temperature that not fall below –5 °C.

Investigations on the fossil plant assemblages from boreholes from the "Ruja" lignite deposit will be continued. They will be supplemented with results of the palynological investigation of samples taken from the parts of boreholes cores with plant macroremains.

5. Acknowledgements

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Plate 1

Fig. 1, 3: *Salix hausruckensis* KOVAR-EDER

Fig. 1: General view, KRAM-P 243/B/7

Fig. 3: Enlargement of leaf margin, KRAM-P 243/B/34

Fig. 2: A - *Ulmus ruszovensis* HUMMEL, B - *Pterocarya paradisiaca* (UNGER) ILINSKAYA, C - *Byttneriophyllum tiliaefolium* (AL. BRAUN) KNOBLOCH et Z. KVAČEK, KRAM-P 243/D/3/I – III

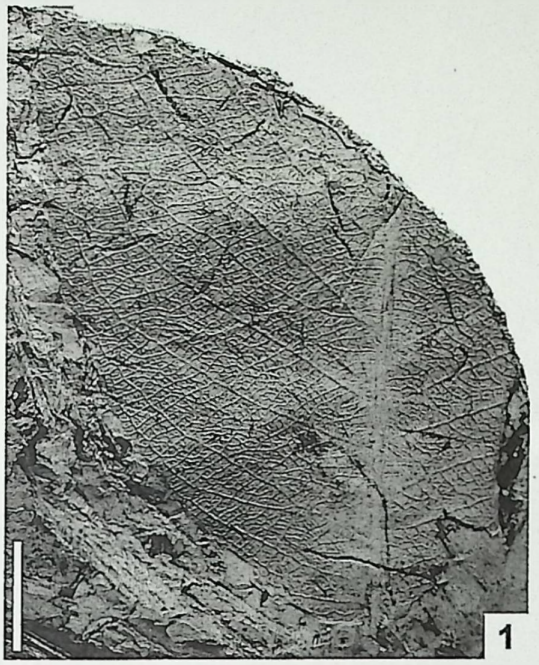
Fig. 4: *Cercidiphyllum crenatum* (UNGER) R.W.BROWN emend. KVAČEK et KONZALOVÁ, KRAM-P 244/C/12

Fig. 5: *Glyptostrobus europaeus* (BRONGNIART) UNGER, cone, KRAM-P 243/B/15

Fig. 6: *Acer* sp., samara, KRAM-P 243/C/5/IV

Scale = 1 cm

Plate 1



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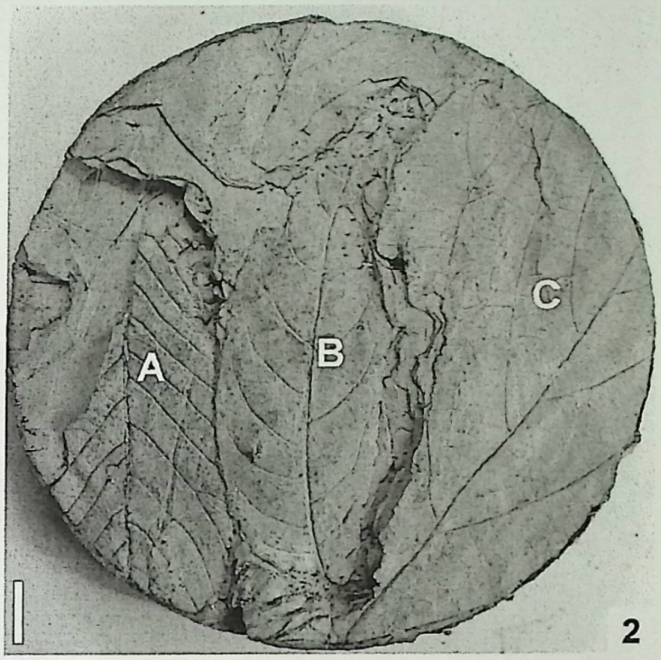

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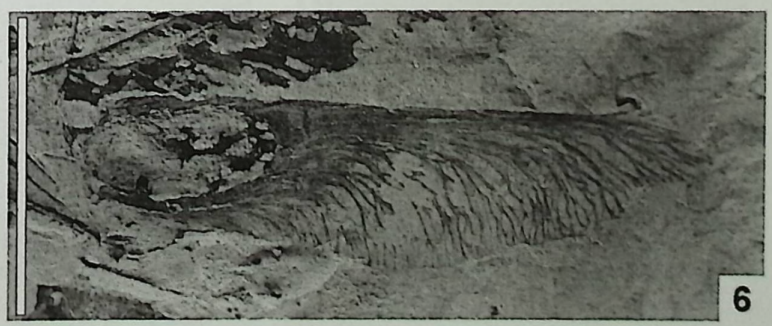

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Plate 2

Fig. 1, 3: *Salix hausruckensis* KOVAR-EDER,

Fig. 1: Upper epidermis of leaf, KRAM-P 243/B/3/I

Fig. 3: Lower epidermis of leaf, KRAM-P 243/B/19

Fig. 2: *Byttneriophyllum tiliaefolium* (AL. BRAUN) KNOBLOCH et Z. KVAČEK, lower epidermis of leaf with stomata and trichomes, KRAM-P 243/B/26

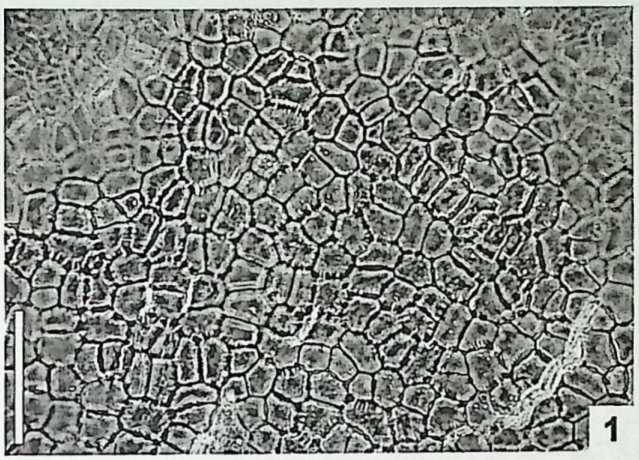
Fig. 4: *Zingiberoideophyllum liblarense* KRÄUSEL et WEYLAND, lower epidermis of leaf, KRAM-P 244/C/21

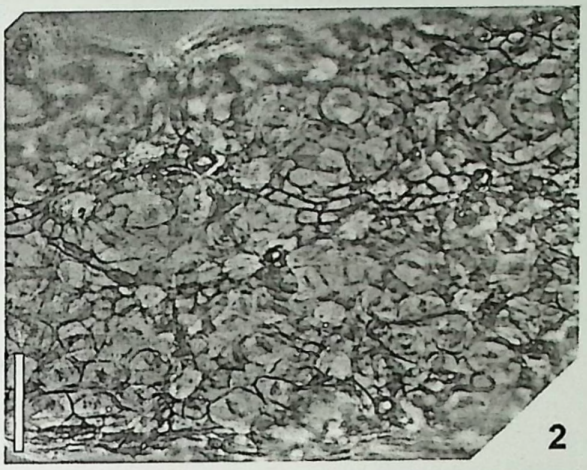
Fig. 5: *Myrica lignitum* (UNGER) SAPORTA sensu lato, lower epidermis of leaf with characteristic peltate trichomes, KRAM-P 243/A/2

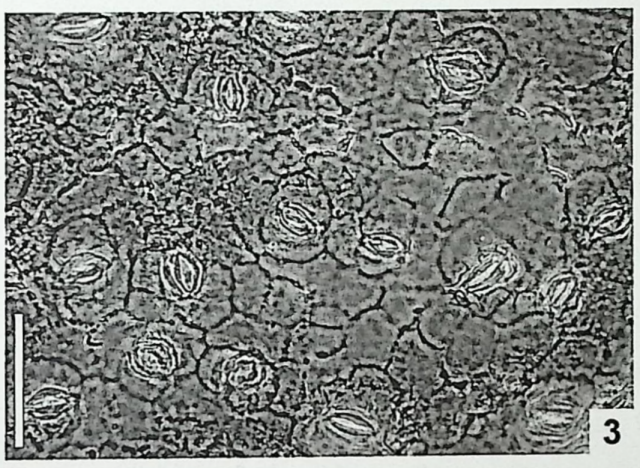
Fig. 6: *Populus populina* (BRONGNIART) KNOBLOCH, lower epidermis of leaf, visible strongly developed striations of cuticle, KRAM-P 244/B/6/II

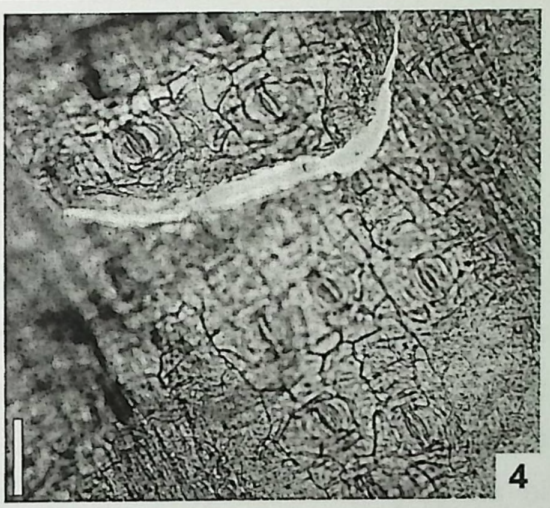
Scale = 50 μm

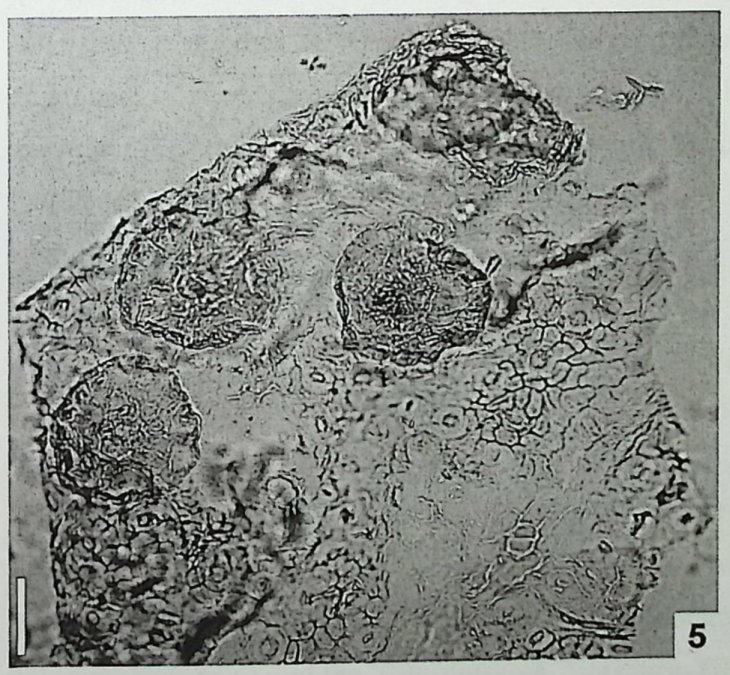
Plate 2











Documenta naturae	155	1	p. 13-35	5 plates	München	2005

New Fossil Finds and Interesting Plant Species for the Miocene of Lipnica Wielka , Southern Poland (Nowy Targ-Orawa Basin)

M. LESIAK

Abstract

One cone and seeds of *Tsuga oraviensis* sp.nov., seeds of Cupressaceae (cf. *Thujopsis dolabrata* (L) SIEB.et ZUCC. and remains of eight other fossil taxa were found among abundant material of studied megafossils in the Miocene deposits from Lipnica Wielka (western part of the Nowy Targ- Orawa Basin, Western Carpathians). Megaspores of *Selaginella magdae* KNOBLOCH and *S.* aff. *kunovicensis* KNOBLOCH, one seed of *Schisandra moravica* (MAI in KNOBLOCH) GREGOR, and one of *Naumburgia subthyrsiflora* (NIKITIN) NIKITIN and *Lysimachia* sp. and also fruits and seeds of *Parrotia reidiana* KIRCHH. were described. Remains of Ericaceae and Vitaceae were also distinguished.

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Content	Seite
Abstract	13
1 Introduction	14
2 Systematic Description:	16
2.1. Selaginellaceae	16
2.2. Pinaceae	17
2.3. Cupressaceae (cf. *Thujopsis dolabrata* (L.) SIEB. et ZUCC.)	18
2.4. Schisandraceae	19
2.5. Hamamelidaceae	20
2.6. Ericaceae (cf. *Pieris* sp.)	21
2.7. Primulaceae	21
2.8. Vitaceae gen.	22
3. Acknowledgements	23
References	23
Plates	26

1 Introduction

Palaeobotanical, geological and petrological investigations of the Neogene deposits of the the intramontane Nowy Targ - Orawa Basin were reported in the former work (LESIAK 1994 and LESIAK in prep.). The basin is situated in southern Poland at the boundary of the Inner and Outer Carpathians and it is a tectonic depression formed during Neogene times and enlarged in its NE part in the Late Pliocene and Early Quaternary. The basin of a pull-apart origin is filled with the Upper Badenian through Pontial, fluvial series (BAUMGART-KOTARBA 1996).

A tonstein layer which occurs in brown coal Orawa Beds at Lipnica Wielka (Fig.1) in Nowy Targ-Orawa Basin was preliminary correlated with the Chodenice layers from the sub-Carpathian Foredeep and asigned to the lower part of the Upper Badenian (probably kosovian, MATL et WAGNER 1987, KOŁCON et WAGNER 1991).

The fruit-seed palaeoflora obtained from the Lipnica Wielka outcrop in 1962 (sands, sandy clays, grey clays) contained remains of many trees, shrubs and also herbs. Taxodiaceae, Pinaceae and Cupressaceae families predominated in the total number of megafossils. It should be noticed that the high diversity of conifers is remarkable. The macroscopic plant remains comprise fossil fruits, seeds and a lot of Coniferae twigs. The whole results of the carpological studies on Lipnica Wielka plant remains will be published later (LESIAK in prep.).

New plants for the Tertiary of Poland in the fossil flora of Lipnica Wielka from the families: Selaginellaceae, Pinaceae, Cupressaceae, Schisandraceae, Primulaceae, Hamamelidaceae, Ericaceae and Vitaceae were distinguished. Their occurence in this flora

supplements the knowledge of the vegetational cover of the Central Parathetys at the Miocene. These new and interesting finds are of importance for the vegetation and climatic history of the West Carpathians region.

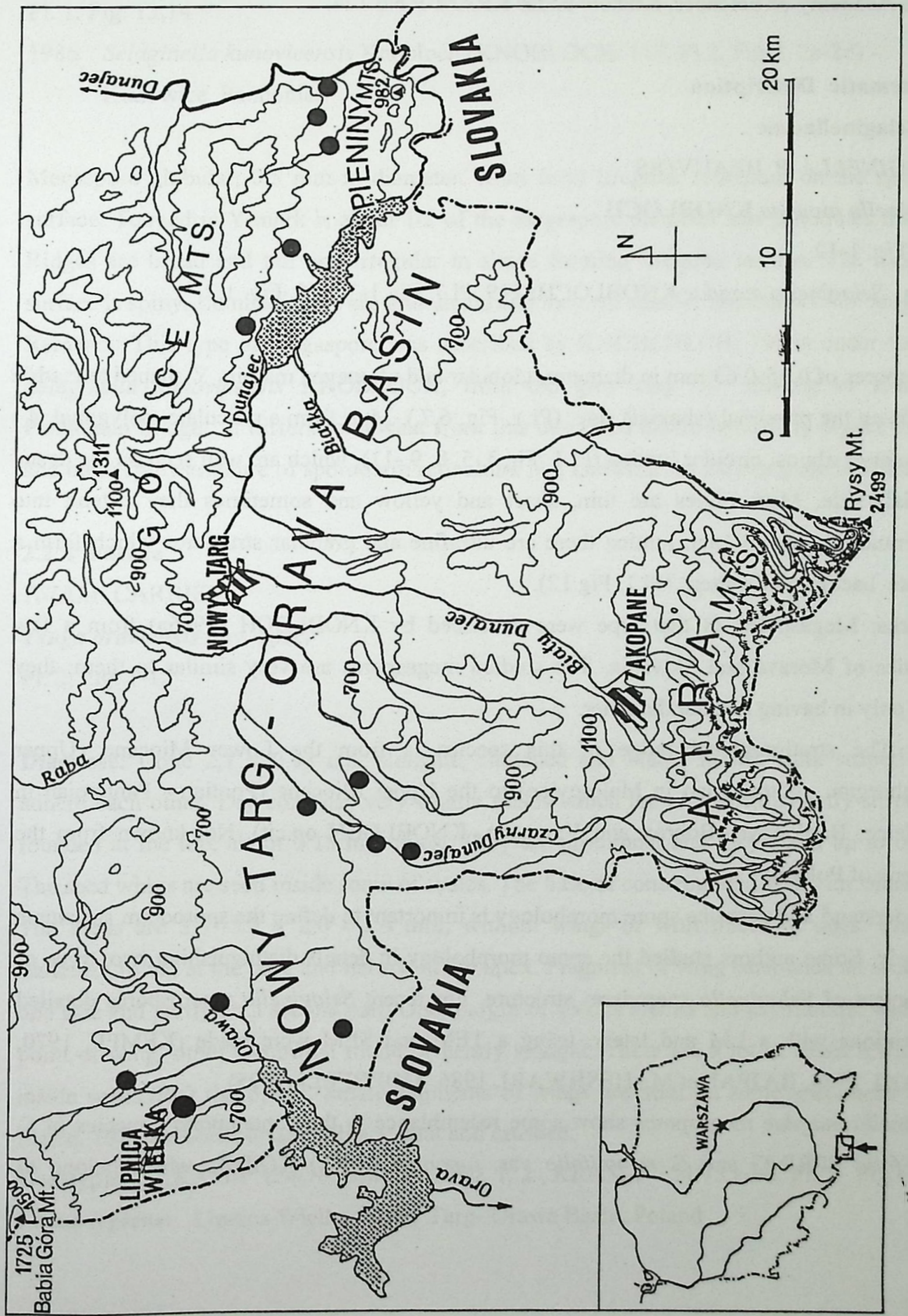

Fig. 1: Geographic map of the Nowy – Targ – Orava - Basin

Dry megafossils were stuck with glue on holders, mounted on a specimen ring, coated with gold in an ion sputter-coating unit Jeol and then examined and photographed using the Tesla BS-301 SEM. Some specimens were also studied under a light microscope (LM).

The species are stored at the Museum of Palaeobotany, W.Szafer Institute of Botany, Polish Academy of Sciences, Kraków under KRAM-P No 124.

2 Systematic Description

2.1. Selaginellaceae

SELAGINELLA P. BEAUVOIS

***Selaginella magdae* KNOBLOCH**

Pl. 1, Fig. 1-12

1986a *Selaginella magdae* KNOBLOCH: 119, Pl.7, Fig.1-3, Pl.8, Fig. 1,2

Megaspores of 0.35-0.63 mm in diameter, globular and of uneven margin. Y-shaped tetraedric mark is on the proximal (abaxial) side (Pl.1, Fig. 6,7,). Muri form a reticulate, polygonal, 4 - 5 angular or almost circular lumina (Pl.1, Fig.3, 5, 8, 9 -11), which are well seen on the dystal (adaxial) side. Muri ridges are thin, short and yellow and sometimes they extend into membranes. Inside of each lumina there are ultrafine and granular structures which form a delicate background pattern (Pl.1, Fig.12).

Remarks: Megaspores of that type were described by KNOBLOCH (1986a) from a few localities of Morava and Slovakia. The studied megaspores are very similar to them; they differ only in having smaller diameter.

The stratigraphical range of this species is from the Lower Miocene (Upper Eggenburgian - Ottnangian in Malesovice) to the Upper Miocene (Pontian - Pannonian in Mikuleice, Bardooovo, Bobrov and Vavreeko, KNOBLOCH op.cit). Not known from the Neogene of Poland.

To understand and describe spore morphology is important to define the sporoderm structures precisely. Some authors studied the spore morphology in details distinguishing two, three or four layers of *Selaginella* sporoderm structure. For recent *Selaginella* macrospores detailed observations with a LM and lately, using a TEM and SEM were made (KEMPF, 1970, MINAKI, 1984, BAJPAI, et MAHESHWARI, 1986, MORBELLI, 1995).

Selaginella magdae megaspores show some resemblance to the contemporary species of *S. remotifolia* SPRING and *S. remotifolia* var. *japonica* (MIQ.) KOIDZ., which belong to

subgenus *Stachygynandrum,* serie Decumbenthes based on the sporophyte morphology (MINAKI, 1984). They grow in some forests of Japan, Formosa and Philippines.

***Selaginella* aff. *kunovicensis* KNOBLOCH**

Pl. 1, Fig. 13,14

1986 *Selaginella kunovicensis* Knobloch (KNOBLOCH: 117, Pl.2, Fig.2, 2a-2d) - Kunowice, Pannonian

Megaspore globular, 0.5 mm in diameter. Muri form irregular reticulum on the sporoderm surface. Tetraedric Y-mark is about 1/2 of the megaspore diameter and penetrates into muri. Ridges are broad and tall and irregular in shape forming irregular lumina. The megaspore surface is spiny. Lumina inside are granulated and they are smaller than ones of *S. magdae*.
Remarks: This type of megaspore was described by KNOBLOLCH, 1986a under the name *Selaginella kunovicensis* KNOBLOCH, from the grey clay of drilling of Kunowice, Pannonian in age. It differs somewhat from this described above by having bigger diameter and more spinystructure of sporoderm reticulum. Not known from the Neogene in Poland.

2.2. Pinaceae

TSUGA CARRIÈRE

***Tsuga oraviensis* nov. spec.**

Pl. 2, Fig. 1-12

Diagnose: Cone 2,1 x 0.98 cm, elongate, flattened and black, in wet state striped scales adhere each other. Dry cone has very fragile scales which are elongate,distinctly striped and rounded at the top, about 0.15 mm thick. They are prominent and they stand up to outside. The seed wings are seen inside some of scales. The base of cone rounded and with small stalk. The seeds are 3.5 -5.2 x 2.0 - 2.6 mm, without wings or with traces of ones. They are flattened, round at the base and narrow at the apex. Fragment of wing surrounds all seed from one side and partly on a second part. One margin of seed is arched and asymmetric with stick point of wing, other somewhat round or nearly straight. There are a lot of fossil resin drops inside seeds.(Pl.2,figs.5,7,8). Small fragments of wings are seen on some specimens (Pl. 2, Figs.6, 10). The seed surface is black, mat and crushed.

Holotypus: KRAM-P 124/78: cone, Pl.2 Fig. 1, 2 ; KRAM-P 124/75:seed, Pl. 2, Fig.4

Locus typicus: Lipnica Wielka, Nowy Targ- Orawa Basin, Poland

Stratum typicum: Orawa Beds, Miocene

Derivatio nominis: From the name of the region = Orawa

The features of the fossils clearly indicate relationship to the contemporary *Tsuga.* It should be stressed that all fossil material of *Tsuga oraviensis* sp.nov was compared with the recent material and the fossil collections both in Kraków (Museum of Palaeobotany, W.Szafer Institute of Botany, PAN) and the Natural History Museum of Humboldt University in Berlin. No one of cones was similar to the cone of *T. oraviensis* sp.nov. Although fossil seeds are similar in shape, less in size, with the contemporary *T. sieboldi* CARR. and *T. yunnanensis* MAST., it was necessary to establish new species.

Tsuga europaea and *T. moenana* are known from Tertiary of Europe (KIRCHHEIMER 1957, MAI 1980). They differ from this above described by having thicker cone scales.

Tsuga oraviensis is a new species for Tertiary in Europe.

2.3. Cupressaceae (cf. *Thujopsis dolabrata* (L.) SIEB. et ZUCC.)

Pl. 2, Fig. 13, 16, Pl. 3, Fig. 1 – 13, Pl.4, Fig. 1 – 6

Seeds are 2.5 - 3.2 x 1.1 - 1.8 mm, triangular in shape, elongate, without wings or with narrow and delicately striped fragment of wings. The base is narrow, the apex with hilum is rounded. If fragments of wings are present, they overtops the apex. The surface with remnants of coat is black and longitudinally folded or striped at the bottom part of seed. The seeds are widest at the 1/3-1/4 their length. In some seeds an embryo is seen (Pl. 2 Fig. 16)

Remarks: The fossil record of *Thujopsis* leafy twigs is scarcely known from the Tertiary flora of the world, although there are known some doubful species as *T. gracilis* (HEER) JENNINGS from the Oligocene flora of Montana, USA, and *T. europaea* SAPORTA from the Palaeocene flora of Greenland (TANAI et SUZUKI 1963). Tertiary distribution of *Thujopsis* and its relationships to the ancient and modern flora was presented by MAI (1980, 1995). In Japan, fossil twigs of *T. dolabrata* were described by Miki from the Pliocene and Pleistocene sediments at 10 localities of Honshu (MIKI 1958). For the next time *Thujopsis miodolabrata* TANAI et SUZUKI was recorded from the Miocene flora of Kaminokuni of southwestern Hokkaido, Japan (TANAI et SUZUKI 1963). Later shoots of *T. miodolabrata* TANAI et SUZUKI was described from the Tertiary of Korea (HUZIOKA 1972) and from Late Miocene Miyata flora of northeastern Honshu (HUZIOKA et UEMURA 1973).

The contemporary genus *Thujopsis* with one species *Thujopsis dolabrata* (L.) SIEB.et ZUCC. and two well-marked varieties var. *hondai* MAKINO and var. *australis* (HENRY) DALLIMORE is distributed in Japan mainly in Honshu, Shikoku and Kyushu. It is forming a luxuriant growth in forests at altitudes of 1100-1800 m a.s.l., associated with *Fagus crenata* L., *Tsuga diversifolia* MAXIM., *Quercus crispula* L., *Pterocarya rhoifolia* SIEB.et ZUCC., *Sorbus comixta* HEDD.and *Clethra barbinervis* SIEB. et ZUCC.(TANAI et SUZUKI 1963). These fossil seeds were compared with recent material and their resemblance is almost clear. Before cooking their size was 3.2 - 5.2 mm, after then, respectively less: 3.1 - 3.4 x 1.2-1.3 mm. Five seeds were examined due to the opporunity given to the present author by Prof. D.H. MAI at the Museum für Naturkunde HU, Berlin.

2.4. Schisandraceae

SCHISANDRA MICHAUX

***Schisandra moravica* (MAI in KNOBLOCH) GREGOR**

Pl. 4, Fig. 7 – 11

1978 *Kadsura moravica* MAI. - KNOBLOCH: 157, Pl.1, Fig. 21,22

1982 *Schisandra moravica* (MAI in KNOBLOCH) GREGOR: 98,99, Pl.13, Fig. 20-

1986b *Schisandra moravica* (MAI in KNOBLOCH) GREGOR. - KNOBLOCH: 30,31, Pl.1, Fig.1

It is a fragment of entire seed 3.0 x 3.25 mm, reniform, at the apex a large, ornamented hilum to be seen. Hilum is filled with tongue-shaped sclerenchymatic tissue of characteristic structure (Pl.4, Figs 9-11). The testa is 3-layers thick, black and lustrous. Its inner layer is composed of circular and flattened cells (Pl.4, Fig.10).

Remarks: The seed of *Schisandra moravica* was recognized for the first time from the Lower Miocene of Šafov (KNOBLOCH 1978). It was also reported later from several localities of the Miocene: Viehhausen (Lower Torton), Langenau (Ottnangian) and Steinebach („Upper Miocene", Torton?); (GREGOR 1981, 1982). Lipnica Wielka has been so far the fifth locality of the occurrence of this species in the Miocene of Europe. JÄHNICHEN gave some information on extinct and recent *Schisandra* (1976).

The living eqiuvalent of this fossil species is *Schisandra elongata* (Blume) HOOK et THOMSON which grows in China as a shrub.

The contemporary family contains 2 genera and 47 species: *Schisandra* (25, China, the Himalayas, Japan, Birma, Malesia) and *Kadsura* (22, India, Japan) (Engler 1964, Takhtajan 1987).

Schisandra chinensis is planted in Europe as ornamental climbing plant having fruit of lemon taste.

2.5. Hamamelidaceae

PARROTIA C.A. MEYER

***Parrotia reidiana* KIRCHHEIMER**

Pl. 4, Figs. 12 – 16

1932 *Parrotia* cf. *persica* C.A.MEY. - BAAS: 330 - 334; Pl.3. Figs 42-47

1957 *Parrotia reidiana* KIRCHHEIMER: 250-251, p.492; Fig.126a

The fruits are 9.2 x 6.2 , 7.4 x 5.8 and 8.3 x 5.0 mm in size. They are capsules 3-lobed, splitted on tops, strongly flattened and bear remnants of perianth at the base. They are splitted from about 1/2 of their length (Pl. 4, Fig.12).

The seeds are 5.7 - 6.6 x 2.5 -3.5 mm in size, narrowed at the base, rounded at the apex and flattened. They are widest at the 1/2-1/3 of their length and have hilum at the base (Pl.4, Fig. 13). The surface is black and slightly pitted at some places and tiny celled (Pl.4, Fig.16).

Remarks: Fossil leaves described as *P. pristina* (ETT.) STUR.or *P. fagifolia* (UNG.) GOEPP. have been known from various localities of Neogene (Lower Miocene to Upper Pliocene) in Europe (HUMMEL1980, MAI et WALTHER 1988). The leaves are known from Poland from some localities: Stare Gliwice (Miocene), Młyny (Sarmatian) and Domański Wierch (Pliocene, ZASTAWNIAK 1972).

Three capsules of this species from the Pliocene of Domański Wierch named as *P. persica* C.A.MEY are known (KRAM-P, 71/517) being determined by Prof. ŁAŃUCKA-ŚRODONIOWA.

The oldest locality of *Parrotia* leaves are known from the Palaeogene of Japan and from Burdigal of France in Europe (HUMMEL 1983).

All the previously known records of this species were confined to the Early/Middle Miocene in East Asia and also from the Late Miocene sediments (Takamine Flora, UEMURA 1988).

This species is closely similar to *P. persica* C.A.MEY, the only modern representative of the genus in Iran and Caucasus. It grows as a small tree or shrub.

Although fossil fruits of the species were mentioned earlier (from the Pliocene flora of Domański Wierch), thus fossil seeds are recorded for the first time from Neogene in Poland.

2.6. Ericaceae (cf. *Pieris* sp.)

cf. *PIERIS* D. DON

The genus comprise about 10 species of evergreen, subtropical shrubs and small trees. It plays some role in subtropical mountainous forests in North Hemisphere (MAI 1999).

cf. *Pieris* sp.

Pl. 5, Fig. 1-3

Two fruits of ca 8,0 mm in diameter, globose and flattened. At the base a distinct ring of a calyx remnant is visible. The apex splits into 5 lobes. The walls are woody, smooth and mat.It differs in size and shape from *Pieris quinquealata* (MENZEL) MAI described by MENZEL in 1913 as *Guajacum quinquealatum* from the Middle Miocene of Herzogenrath in the Rhenish basin and from Lower Miocene of Saxony (MAI 1999, CZAJA 2003).

2.7. Primulaceae

LYSIMACHIA LINNÉ

***Lysimachia* sp.**

Pl. 5 , Figs 4, 5

The seed is 1.7 x 1.05 mm, flattened and slightly elongated at the base. The dorsal side is somewhat convex or flat, almost smooth. The ventral side has raised margin and in the middle of the seed a distinct roll with central linear hilum can be seen. There are some indistinct wrinkles around the hilum. The testa is about 0.15 mm thick and it has 2 layers: external layer is built of fragile corky, light and cream-coloured palisade cells (epithelium) and the inner one consists of elastic, dark, brown or black tiny, pitted cells. The hilum is about 1/2 of seed length, it is 0.625 mm long. On the seed margin the cells are 6-angular and very distinct.

Remarks.The genus for the first time noted in the Miocene of Poland. The author did not find similar species in reference collection.

NAUMBURGIA MOENCH

***Naumburgia subthyrsiflora* (NIKITIN) NIKITIN**

Pl. 5, Figs.1 – 3

1935 *Lysimachia subthyrsiflora* NIKITIN: 134 (nomen nudum)

1957 *Naumburgia subthyrsiflora* NIKITIN: 179-180, Pl.7, Figs.31,32

1987 *Naumburgia subthyrsiflora* (NIKITIN) NIKITIN. - MAI et WALTHER: 157, Pl.27, Fig.17

One seed is 1.5 x 1.2 mm, thick, oval and flattened. The surface is corky and cream-coloured. The base and the apex are rounded. The dorsal side is flat and smooth. On the edge are 6-angular cells. The ventral side is damaged, without hilum and filled with tissue which could be a remnants of a tissue of central bed.

The species is known from the Miocene of East Europe and Siberia (DOROFEEV 1959, 1963) and Pliocene of Bashkiria, Wetterau and Thuringia (DOROFEEV 1960, MAI 1963, MAI et WALTHER 1988).The species is described for the first time from the Miocene of the Carpathians, southern Poland. The type of the genus derives from the Middle Pliocene of the village Krivobore at the river Don (NIKITIN 1957).

Naumburgia is a monotypic genus of North Hemisphere in the temperate zone of Europe and North America. *N. thyrsiflora* (L.) RCHB. is a perennial which grows on peat bogs and mires on wet soils in shadow places and around water bodies.

2.8. Vitaceae gen.

Pl. 5, fig.11

Seed 3.6 x 2.8 mm, triangular in shape, the base is narrowed, the apex is rounded. The dorsal side is furnished with raphae which extends from the base to the apex. The ventral side has elongate chalaza which is about 1/2 of the seed length. There are indistinct wrinkles around the chalaza. The surface is black and cracked.

Remarks. This fossil seed belongs undoubtedly to the family Vitaceae. It differs however from often recorded in the Tertiary floras *Ampelopsis* and *Vitis* by having another shape and structure of chalaza. Some probably comparison with some species of the contemporary *Cayratia* might be observed, but it differs from described from the European Tertiary *Palaeocayratia* (Gregor 1982.).

3. Acknowledgements

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5. Plates

Plate 1

1-12: *Selaginella magdae* KNOBLOCH, megaspores

1. KRAM-P 124/87, x 42, LM
2. KRAM-P 124/87a, x 31.6, LM
3. distal side, KRAM-P 124/88, SEM no 4817, x 250
4. KRAM-P 124/86, SEM no 4815, x 200
5. the same, fragment of bigger megaspore, KRAM-P 124/86, SEM no 4816, x 500
6. proximal side with Y-mark, KRAM-P 124/88a, SEM no 4904, x 300
7. the same, fragment of sporoderm, SEM no 4905, x 1000
8. distal side, KRAM-P 124/88b, SEM no 4902, x 300
9. the same, ridges of muri and ornamentation of lumina, SEM no 4901, x 1000
10. distal side, KRAM-P 124/88c, SEM no 4906, x 280
11. the same, reticulate sporoderm, SEM no 4907, x 500
12. the same, ridges and background pattern of lumina

13-14: *Selaginella* aff. kunovicensis KNOBLOCH, megaspore

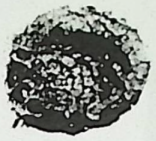
13. proximal side with Y-mark among muri, KRAM-P 124/89, SEM no 4909, x 420
14. the same, sporoderm of small-sized, ornamented and irregular lumina

Phot. A.Pachoński et Z.Petri

Figures 1 and 2 reflected light micrographs, all other figures SEM

Plate 1


1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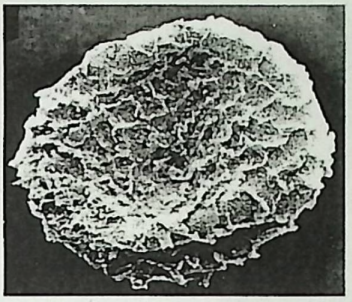

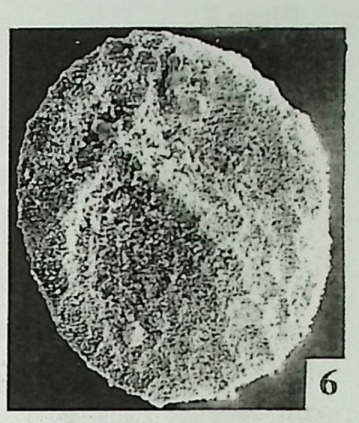
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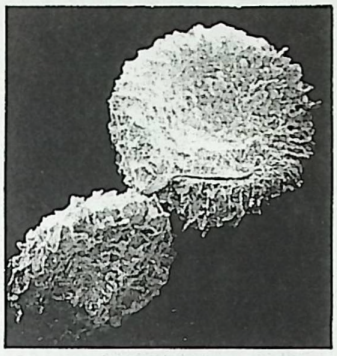
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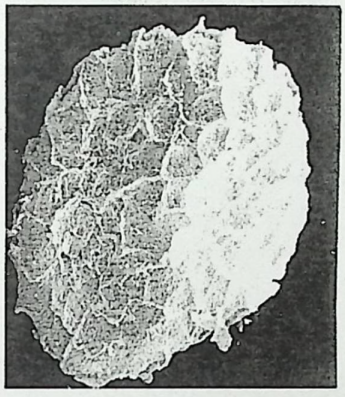
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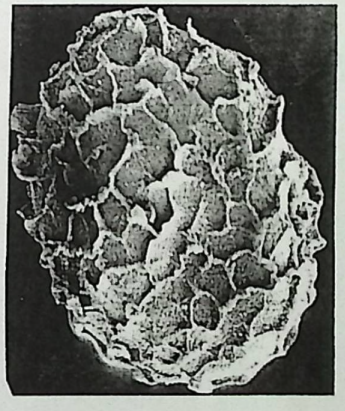
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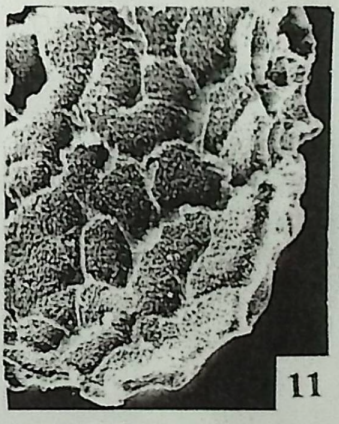
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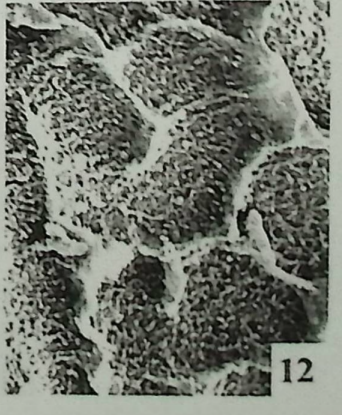
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Plate 2

1-12: *Tsuga oraviensis* sp.nov., cone and seeds

1, 2. holotype, cone from both sides, KRAM-P 124/78, x 2.7

3. detached cone scales, KRAM-P 124/78a, x 9

4. seed, KRAM-P 124/75, x 10.6

5. seed, KRAM-P 124/75a, x 10

6. seed with resin and remnants of wing, KRAM-P 124/76, 4836, x 45

7. the same, enlarged fragment of wing, 4835, x 400

8. seed with drops of resin, KRAM-P 124/76a, 4838, x 45

9. the same, fragment of seed surface, 4839, x 250

10. the same, fragment of wing, 4840, x 400

11, 12. the same, resin drops, 4841, 4842, x 250

13-16: Cupressaceae (cf. *Thujopsis dolabrata* (L.) SIEB.et ZUCC., seeds

13. KRAM-P 124/71, x 41

14. KRAM-P 124/72, x 42

15. KRAM-P 124/73, x 42

16. seed with two embryos and distinct hilum, KRAM-P 124/74, SEM no 4832, x 50

Phot. Z.Petri et A.Pachoński

Figures 1-4 and 13-15 reflected light micrographs, all other figures SEM

Plate 2


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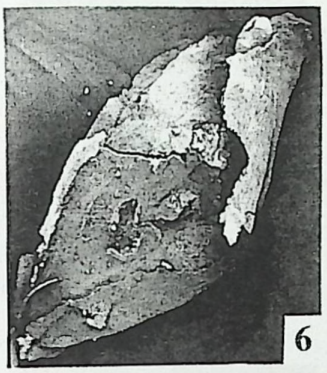
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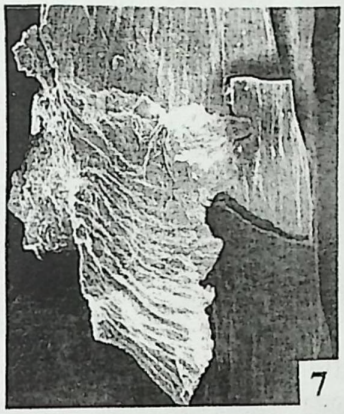
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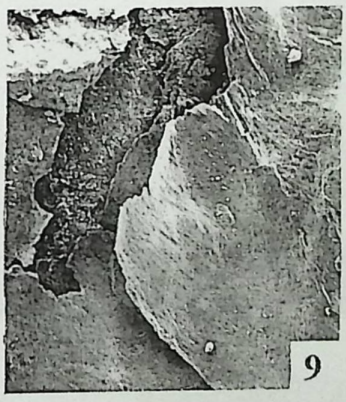
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Plate 3

1-13: Cupressaceae (cf. *Thujopsis dolabrata* (L.)SIEB.et ZUCC.), seeds

1. seed with remnants of seed coat, KRAM-P 124/71, 4830, x 60
2. the same, fragment of seed coat and wing remains, 4831, x 200
3. abraded seed with one embryo, KRAM-P 124/72, 5065, x 65
4. the same, fragment of upper part of seed with hilum, 5061, x 250
5. the same, fragment of surface showing abraded coat and some fine minerals
6. the same, fragment of abraded surface, 5063, x 500
7. the same, enlarged, 5062, x 2000
8. two-embryo seed with remnants of wing, KRAM-P 124/73, 5071, x 60
9. the same, enlarged, 5067, x 200
10. the same, enlarged, fragment of wing, 5068, x 400
11. the same, enlarged, fragment of wing formed of filamentous sclereids, 5069, x 2500
12. the same, fragment of seed base, 5070, x 500
13. the same, striped surface in the middle part of seed

14: *Thujopsis dolabrata* (L.)Sieb. et Zucc., recent seed, upper part with hilum and wing, x 80

Phot. Z.Petri

All figures SEM

Plate 3


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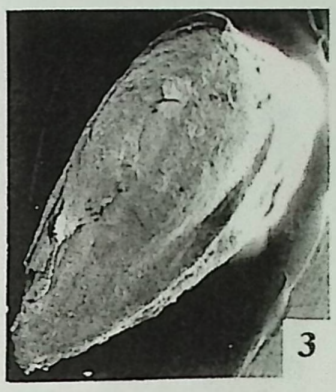
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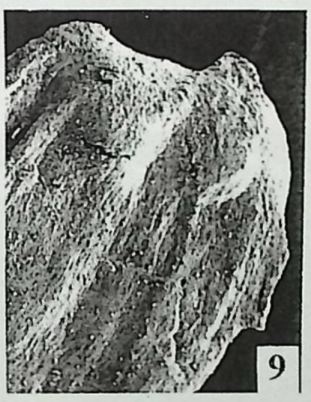
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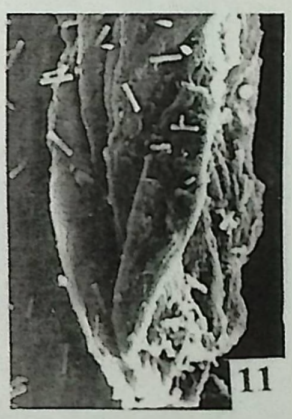
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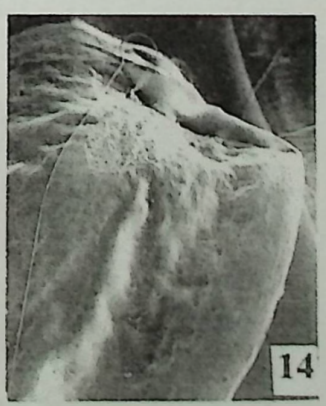
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Plate 4

1-6: *Thujopsis dolabrata* (L.) SIEB.et ZUCC., recent seed

1. seed with coat and wings, No 5036 and 5037, x 50
2. the same, upper part with remnants of style and fine celled coat surface, No 5039 x 250
3. the same, striped coat surface, 5038, x 1000
4. cooked seed without coat and wings, 5040, x 60
5. the same, enlarged, upper part, 5041, x 200
6. the same, enlarged, part of seed surface, 5042, x 200

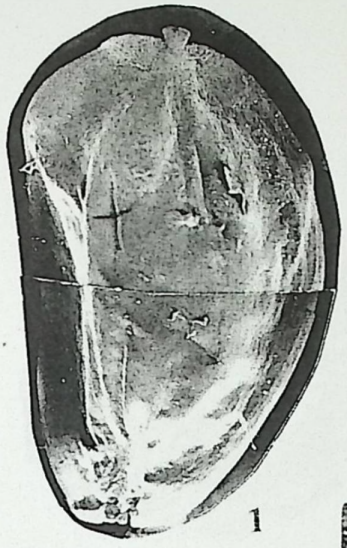
7-11: *Schisandra moravica* (MAI in KNOBLOCH) GREGOR, seed

7. crushed seed, KRAM-P 124/60, SEM 5055, x 50
8. the same, surface of seed testa, SEM 5056, x 200
9. the same, part of hilum filled with sclerenchymatic tissue, SEM 5053, x 200
10. the same, enlarged, a structure of 3-layers testa with flattened circular inner cells, SEM 5054, x 300
11. the same, fragment of ornamented hilum, SEM no 5052, x 300

12-16: *Parrotia reidiana* KIRCHHEIMER

12. fruit, KRAM-P 124/52, x 4.6, LM
13. seed, KRAM-P 124/53, x 7.5, LM
14. seed, KRAM-P 124/54, x 7.3, LM
15. seed, KRAM-P 124/55, SEM No 5170 and 5171, x 45
16. the same, enlarged, fragment of seed apex; delicately striped surface and some fine grained minerals are visible, SEM 5173, x 200

Plate 4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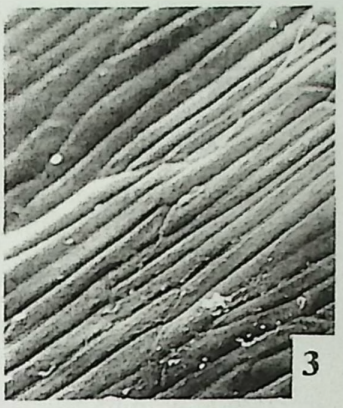
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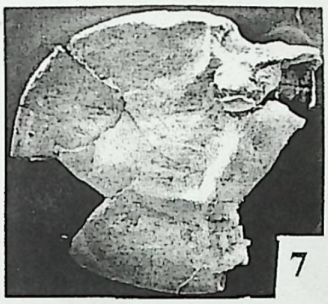
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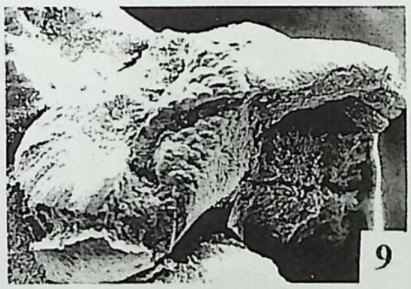
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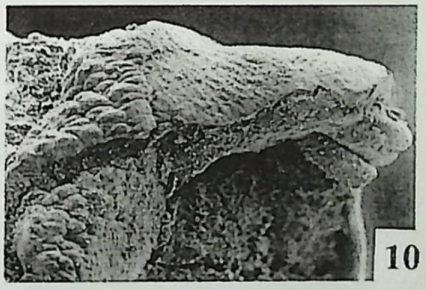
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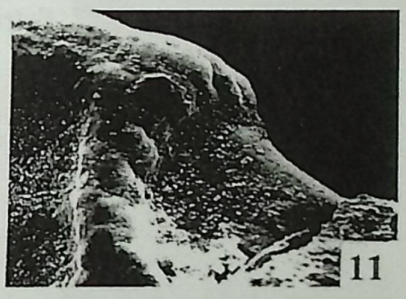
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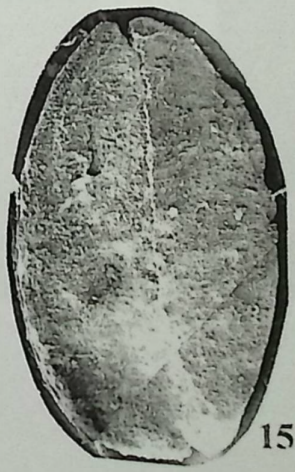
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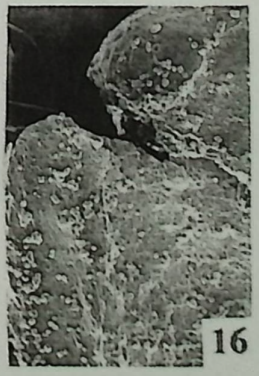
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Plate 5

1 -3. *Pieris* sp., fruits, LM

1. KRAM-P 124/56, x12.7
2. bottom part of capsule, KRAM-P 124/56a, x 11.2
3. the same fruit, lateral and upper part are visible, x 11.2

4, 5, 7-10 *Lysimachia* sp. seed, LM and SEM

4. dorsal side, KRAM-P no 124/51, x 18.2
5. the same, ventral side with hilum, x 18.2
7. The same, ventral side with hilum, x 110, SEM 4797
8. The same, x 200, SEM no 4798
9. The same, ornamentation of deed surface, x 800, SEM 4800
10. The same, fragment of seed surface enlarged, two-layers testa and some minerals are visible, x 1800, SEM 4803

6. *Naumburgia subthyrsiflora* (NIKITIN) NIKITIN, dorsal side of globular seed, KRAM-P 124/52, x 20, LM

11. Vitaceae, dorsal side of seed, KRAM-P 124/85, x 10, LM

Phot.A.Pachoński and Z. Petri

Plate 5


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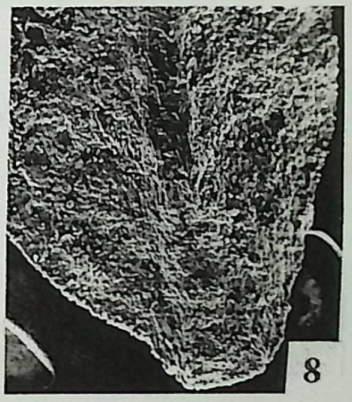
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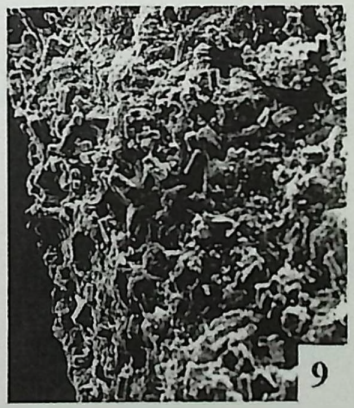
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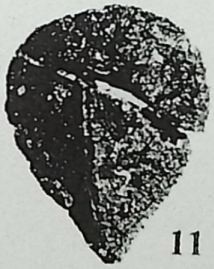
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