Acta Palaeobot. 34 (1): 27–81, 1994

PLANT MACROFOSSILS FROM THE MIDDLE MIOCENE OF LIPNICA MAŁA (ORAWA-NOWY TARG BASIN, POLAND)

Szczątki makroskopowe roślin środkowego miocenu z Lipnicy Małej (Kotlina Orawsko-Nowotarska, Polska).

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ABSTRACT. The remains of fossil plants such as fruits, seeds, fragmentary shoots and epiderms come from a profile of Neogene deposit at Lipnica Mała in the western part of the Orawa-Nowy Targ Basin. They belong to 51 taxa of phanerogams and 3 taxa of cryptogams. Several species new for the Tertiary of Poland have been distinguished, e.g. *Toddalia* cf. *maerkeri* Gregor, *Sparganium* cf. *crassum* Nikitin, *Sparganium* cf. *tanaiticum* Dorof. The fruitlets and seeds of *Saururus bilobatus* (Nikitin) Mai are comparatively abundant and well preserved. This fossil flora represents a restricted community, rather poor in respect of composition, of a swamp forest with dominant *Glyptostrobus europaea* and a community of marsh and peatbog plants. Arctotertiary element dominate in the flora, the palaeotropical element constitues 7%.

KEY WORDS: Middle Miocene, Orawa Beds, fruit-seed flora, arctotertiary element

INTRODUCTION

The Orawa-Nowy Targ Basin lies within the Podhale fault-trough in the south of Poland; it extends over a space of about 60 km. On the north side it is bounded by the High Beskids and Orawa Divides, on the south by the Klippen Belt. The bottom of the Basin (490–650 a.s.l.) is lined with Tertiary fluvial and limnic deposits (gravels, clays, sands and lignites) and tectonic and erosional processes contributed very much to its formation (Klimaszewski 1972).

The initial studies of plant macrofossils from deposits of the Neogene of the Orawa-Nowy Targ Basin included the Upper Miocene of the Krościenko region and the Pliocene of Mizerna (Szafer 1946–1947, 1954). Materials for a palaeobotanical study were collected from the cone of Domański Wierch in 1948–1958 and from lignite clays of Orawa at the villages Chyżne, Koniówka, Podczerwone, Lipnica Mała, Lipnica Wielka in 1962–1968 (Fig. 1). The deposits from the deep drillings made by the Institute of Geology on Domański Wierch in 1956–57 and at Czarny Dunajec and Koniówka in

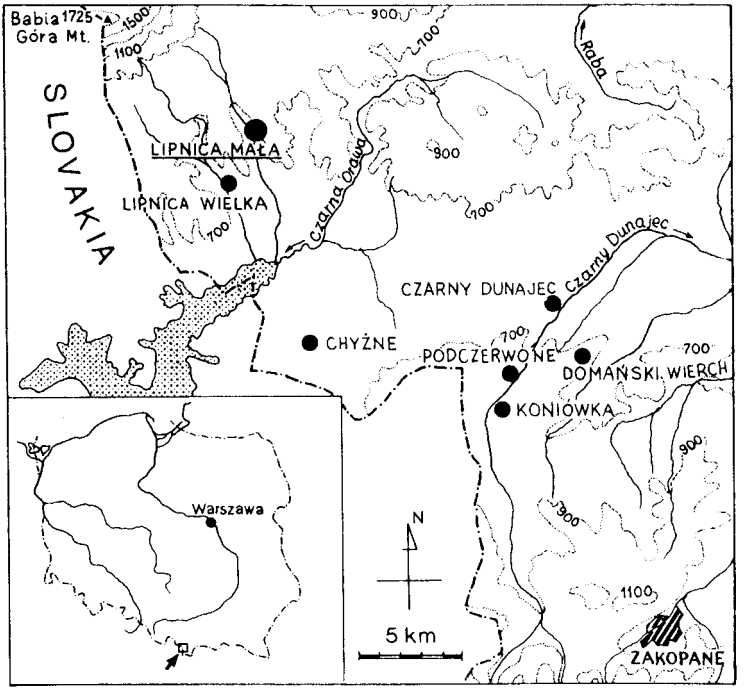


Fig. 1. Location of Lipnica Mała and some Miocene and Pliocene fossil floras of western part of the Orawa-Nowy Targ Basin

1968–69 were also studied geologically (Birkenmajer 1954, 1958, 1963, Urbaniak 1960, Watycha 1976) and palynologically (Oszast 1970, 1973, Tran Dinh Nghia 1974, Oszast & Stuchlik 1977). As regards the macroscopic floras, only that of leaves from Domański Wierch was given a comprehensive study (Zastawniak 1972). From among the remaining abundant and qualitatively rich materials of fruit and seed remains from the western part of the Basin, the floras of Domański Wierch, Chyżne, Lipnica Wielka, Koniówka, Podczerwone and Czarny Dunajec have been preliminarily investigated (Łańcucka-Środoniowa 1965, 1980a-g.)

The study presented in this paper includes the profile from Lipnica Mała, palynologically analysed by Tran Dinh Nghia (1974). Collected in the sixties and subjected to pollen analysis, the material from the Neogene deposits of the western part of the Orawa-Nowy Targ Basin was obtained from three short profiles at Lipnica Mała, Lipnica Wielka and Chyżne. Tran Dinh Nghia (1974) assumed Upper Miocene age for them and described the climate of that time as humid, subtropical of a montane nature, and approximating warm temperate. On the basis of later spore-and-pollen analyses of the deposits of two deep Neogene profiles from Koniówka and Czarny Dunajec the palynological profiles obtained by Tran Dinh Nghia from these three sites were acknowledged to be the same age and included in the Sarmatian (Oszast & Stuchlik 1977).

The purpose of the present study was to establish the composition of the macrofossil flora from Lipnica Mała, the circumstances of its occurrence and an attempt to compare the results of the present investigation of macrofossils with those of an earlier pollen analysis.

BRIEF GEOLOGICAL DESCRIPTION

The Orawa-Nowy Targ Basin, situated in the northern part of the extensive trough between the Tatra Mts. and the Beskids, is filled with Neogene terrestrial deposits over a space of about 380 km^2. These deposits lie for the most part on the erosionally worn-away formations of the Magura nappe and in its small area on the series of the Pieniny Klippen Belt and the Podhale flysch. Their characteristic trait is coal-bearingness (Kołcon & Wagner 1991). In the Lipnica Mała region they penetrate fairly deep into the High Beskids (Watycha 1976). The Neogene of the Basin is represented by freshwater and terrestrial deposits, which form one of the largest areas of their occurrence in the Carpathians. In the Neogene the floor of the Basin lay high above sea level and despite its continuous subsidence never fell below the present bottom of the trough, which excluded the possibility of marine transgression (Watycha op. cit.).

During the period from the Oligocene to early Quaternary the Basin bottom was subsiding, while its edges were periodically uplifted, which led to the formation of a narrow intermontane trough. In the places where streams entered the valleys alluvial cones were formed, fine-grained material being transported further and deposited on the alluvial plains. On the plain the streams formed periodical shallow ponds which gradually changed into peat-bogs, lasting for about 5000–15000 years (Kołcon & Wagner 1991).

The Neogene deposits in the Basin are lithologically diversified: river sediments, alluvial cones, sequences of marsh sediments in the form of lignite lenses and, amidst clays, loose accumulations of xylites can be distinguished in them. The Orawa Middle Miocene Beds are represented by sands with inserts of conglomerates, clays and brown coal at Lipnica Wielka, Lipnica Mała and Stare Bystre (Watycha 1976, Kołcon & Wagner 1991).

A lower part of the Orawa Beds is exposed in the left bank of the Syhlec stream, about 1.5 km east of Lipnica Mała (Kołcon & Wagner 1991, p. 309, Fig. 2). The exposure is about 40 m in length and 7 m in height. In this exposure the profile of Tertiary formations is dichotomous. The bottom part, about 3 m thick, is built of blue-grey clays, which pass into grey and and brown clays towards the top of the profile. The brown coal bed, which forms an anticline with unequal wings, is overlain by variegated loamy gravels and Quaternary clays of a total thickness of about 4 m. According to Kołcon and Wagner (1991), the uncovered part of the Orawa Beds at Lipnica Mała represents the upper part of the Carpatian and the lower part of the Badenian, which agrees with the stratigraphic determinations of the age of the Orawa Beds in this part of the Basin performed by Stuchlik (1970), Woźny (1976) and Watycha (1976).

MATERIAL AND METHODS

For carpological analysis 13 samples were taken from a 2.75-metre section of the profile (6.75–4.00 m) at intervals of 10–25 cm. Each sample corresponded to 3–5 palynological samples of the profile collected by Tran Dinh Nghia (1974, Fig. 3). Some material was besides taken from the outcrop.

The samples of sediment were gradually solved in water, washed through 0.50 and 0.25 mm mesh sieves and next examined under a binocular microscope. Heavily loamed samples were slowly heated with an addition of KOH till they boiled. The fossil material was identified by comparing it with pre-

sent-day fruits and seeds from the comparative collection of the Palaeobotanical Department, W. Szafer Institute of Botany, Polish Academy of Sciences in Cracow and with fossil taxa from various Tertiary floras stored at the Museum of this Department. Illustrated textbooks and publications were also used (Hutchinson 1973, Berggren 1969, Takhtajan 1974, 1982, etc.).

All the identified plant remains are kept at the Museum (Coll. No 121) of the Palaeobotanical Department, W. Szafer Institute of Botany, Polish Academy of Sciances, in Cracow (KRAM-P).

SYSTEMATIC DESCRIPTION OF MACROSCOPIC PLANT REMAINS

Fungi

Amphisphaeriaceae

Trematosphaerites lignitum (Heer) Beck

Pl. 1 fig. 1

1863. *Sphaeria lignitum* Heer; p. 1049, Pl. 55, figs 1–3
1882. *Trematosphaerites lignitum* (Heer) Beck; p 752, Pl. 31, fig. 1

Material. Samples: 1, 2, 13; No 121/113, 114 KRAM-P: 6 single perithecia.

Description. Perithecia conical in shape, of approximately diameter 0.75–0.95 mm. All of them are apically open, with a small apertures at the top which are traces left after falling-out of the ostioles.

Remarks. The species was recorded from the Tertiary of Europe. In Poland it is known from the Pliocene and Miocene (Zabłocka 1931, Skirgiełło 1961, Łańcucka-Środoniowa 1963, 1966, 1979, 1980 a-g).

Sphaeriaceae

Rosellinites congregatus (Beck) Meschinelli

Pl. 1 fig. 2

1887. *Rosellinia congregata* (Beck) Engelhardt; pp. 33–35, Pl. I, figs 5–9
1898. *Rosellinites congregatus* Meschinelli; p. 16, Pl. 9, figs 10–14
1941. *Rosellinites congregatus* (Beck) Meschinelli; Kirchheimer p. 193, Pl. 1, figs a-d

Material. Samples 8, 13 and outcrop; No 121/82, 83 KRAM-P: 5 groups of perithecia.

Description. Specimens 1.5–5.3 mm in diameter consist of groups of numerous perithecia, half-embedded with a common stoma. Perithecia black, hard, subglobose, closely contacting with one another. Their apical parts are flattened and furnished with ostioles.

Remarks. The species was known from the Oligocene European floras (Kirchheimer 1941). In Poland it is common in the Miocene and Pliocene (Zabłocka 1931, Skirgiełło 1961, Łańcucka-Środoniowa 1980 a-g).

Pteridophyta

Selaginellaceae

Selaginella pliocenica Dorofeev

Pl. 1 figs 3, 4

1957. *Selaginella pliocenica* Dorofeev; p. 489, Fig. 1/1

Material. Sample 2; No 121/96, 97 KRAM-P: 13 megaspores.

Description. Globular megaspores 0.50–0.85 mm, some of them are damaged and flattened. Tetradic scar is visible on the surface of two specimens. Megaspores with characteristic network formed by projecting ridges on their surface. Small facets polygonal, oval or irregular. Ridges among facets low and even, in some specimens ridges higher, with pointed ends.

Remarks. These types of megaspores described by Dorofeev (1957) as *Selaginella pliocenica* have often been recorded from the numerous Neogene floras of Europe and West Siberia (Dorofeev 1957, 1963, Łańcucka-Środoniowa 1963, 1980 a-g, Knobloch 1981, Negru 1986, Mai & Walther 1988).

In Negru's (1986) opinion *S. pliocenica* could be treated as polymorphic taxon joining morphological features of some relative species which grow in similar biotopes. A comparison to the contemporary North American species *Selaginella apoda* (L.) Fern. and *S. densa* Rydb. should be accepted (Łańcucka-Środoniowa 1979, Mai & Walther 1988).

Coniferae

Taxodiaceae

Glyptostrobus brevisiliquata (Ludwig) Mai

Pl. 1 figs 5–7

1822. *Carpolithus secalis* v. Schlotheim; p. 99, figs 10a, b
1857. *Genista brevisiliquata* Ludwig ; p. 101, Pl. 20, fig. 18
1974b. *Glyptostrobus pannonica* Dorofeev; p. 59, Pl. 1, figs 15–21
1988. *Glyptostrobus brevisiliquata* (Ludwig) Mai: Mai & Walther; p. 68, Pl. 6, figs 4–9

Material. Samples 5, 6, 7, 9, 10 and outcrop; Nos. 121/56, 57, 58, 60, 61, 62, 66, 68, 69 KRAM-P: 105 seeds.

Description. Seeds 3.80–6.65 x 1.60–2.90 mm (average 5.01 x 2.11 mm; 36 specimens were measured), elongated, pipe-like, somewhat curved or almost straight. The apex and the base are rounded or nearly narrowed. Some specimens are winged. The seed surface is delicately longitudinal striped and wrinkled.

Remarks. These types of seeds which have been described under different names belong to *G. brevisiliqata* (Ludwig) Mai. It can be treated as polymorphic species not compared with the modern *G. pensilis* Koch. (Mai & Walther 1988). The species was reported from the Middle and Upper Miocene in Europe. It was known from the Miocene and Pliocene in Poland under the name *G. europaeus* (Łańcucka-Środoniowa 1966, 1979, Baranowska-Zarzycka 1988, Stuchlik et al. 1990).

Glyptostrobus europaea (Brongniart) Unger

Pl. 1 figs 8–13a

1833. *Taxodium europaeum* Brongniart; pp. 168–176, Pl. 3, Pl. 12
1850. *Glyptostrobus europaeus* (Brongniart) Unger; pp. 434–435
1991. *Glyptostrobus europaea* (Brongniart) Unger: Mai & Walther; p. 30, Pl. 2, fig. 7

Material. Samples 5–12 and outcrop; Nos 121/56–71 KRAM-P: 1061 fragments of leafed twigs and single leaves.

Description. Leafed twigs 2.0–25.0 mm long, the most are small fragments. Leaves

vary in size and shape; on a thicker twigs the leaves are somewhat protruding, irregular arranged, broadly running down of a shoot, poined or blunt at the top. On some twigs, towards the apex, the leaves are narrow, sometimes scaly, spiral clinging to the twigs. Two bands with rows of stomata on a lower and upper surface of the leaves have been observed (amphistomata leaves). This observation agree with the structure of epidermis in the genus *Glyptostrobus* (Zalewska 1959).

Remarks. The species was known from the Upper Eocene to the Pliocene in North Hemisphere (Depape 1922, Laurent & Marty 1923, Stoyanoff & Stefanoff 1929, Pop 1936, Knobloch 1969, Mai & Walther 1988, 1991). In Poland the remains of *G. europaea* have been known from several Miocene floras (Łańcucka-Środoniowa 1957, 1966, 1979, Stuchlik et al. 1990) up to the Pliocene (Baranowska-Zarzycka 1988). For the first time it was noted by Raciborski (1892) in the Orawa-Nowy Targ Basin. This species was present in several floras from different sites from the Basin: Chyżne, Lipnica Wielka, Koniówka and Podczerwone, Czarny Dunajec (Łańcucka-Środoniowa 1965, 1980a-g), what supports its significance in plant communities on great areas in the past.

Cupressospermum chamaecyparoides Mai

Pl. 1 fig. 14

1960. *Cupressospermum chamaecyparoides* Mai; pp. 75–76 Pl. 3, figs 8–11

Material. Sample 8, No 121/43 KRAM-P: 1 seed fragment.

Description. Seed 2.70 x 2.50 mm, flattened, almost oval, with broad wing. A small depression is visible at the base, the apical part was probably rounded. Seed surface with delicate longitudinal strips.

Remarks. Despite fragmentary the remain is similar to the species described by Mai (1960) from the Lower Miocene of Hasenberg and Wiesa. *Cupressospermum chamaecyparoides* has already been recorded from the Neogene floras of southern Poland: Chyżne and Lipnica Wielka (Łańcucka-Środoniowa 1980 a, g).

Angiospermae – Dicotyledones

Magnoliaceae

Magnolia cor Ludwig

Pl. 2 figs 1, 1a

1857. *Magnolia cor* Ludwig; Pl. 21, figs 1a-1e

Material. Samples 3, 5 and outcrop; Nos. 121/75, 76 KRAM-P: 1 half of seed and 2 seed fragments.

Description. Seed 6.25 mm long and 9.25 mm wide, reniform in shape. The base is rounded, at the apex shallow depression with oval-triangular chalaza is seen. Testa thick, the testa surface is mat and black and composed of the palisade cells.

Remarks. The species was known from the Miocene and Pliocene of Eurasia (Dorofeev 1974a, Mai 1975, Mai & Walther 1988). In Poland it was noted in the Pliocene of Mizerna (Szafer 1954), Miocene of the Nowy Sącz Basin and Neogene from Orawa (Łańcucka-Środoniowa 1979, 1980a-g).

The seeds of this species are closely related to the contemporary Japanese species *Magnolia kobus* DC.

Saururaceae

Saururus bilobatus (Nikitin) Mai

Pl. 2 figs 2–5; Fig. 2, 3

1965. *Carpolithus bilobatus* Nikitin; pp. 92–93, Pl. 18, figs 12, 13, Pl. 19, figs 1, 2
1978. *Saururus bilobatus* Mai; Mai & Walther: pp. 45–46, Pl. 25, figs 1, 2

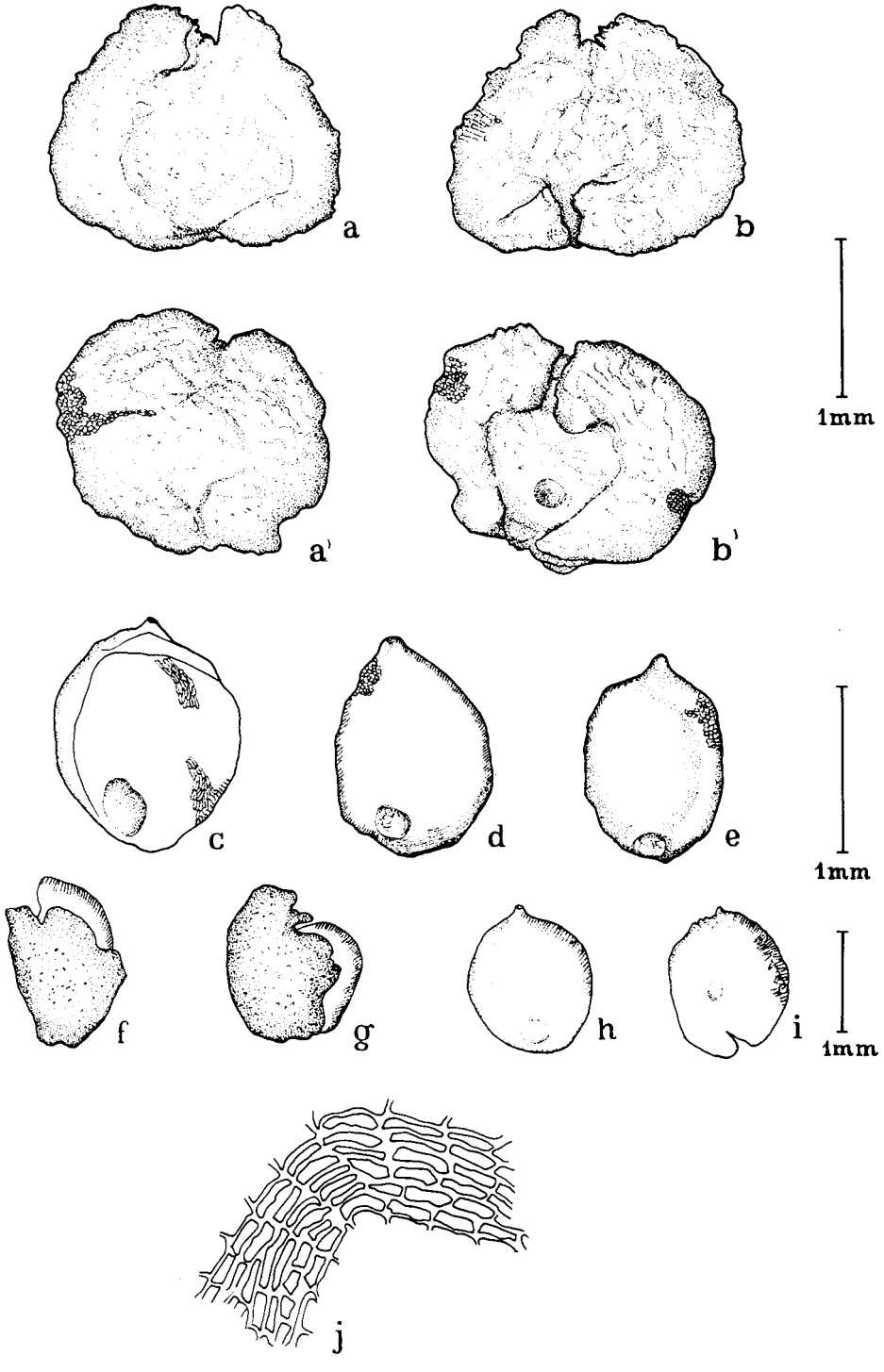
Material. Samples 2–9, 11–13; Nos. 121/88–93 KRAM-P: 35 seeds and tegmens and 7 fruitlets.

Description. Fruitlets 1.15–1.60 x 1.05–1.90 mm, (average 1.45 x 1.50 mm), partly damaged, only two entire (Fig. 2 a, a', b, b'). Fruitlets dorso-ventrally flattened, oval-cordate in shape. The fruitlet surface is somewhat wrinkled and reticulated. The fruitlets split along the ventral margin into two parts showing a single seed (Fig. 2b'). Seeds oval-ovate, somewhat pointed at the apical part and rounded at the base (Fig. 2c), of size 0.80–1.80 x 0.50–1.25 mm (average 1.18 x 0.92 mm). The seed testa is composed of two layers of epidermis cells. The outer layer contains equiaxial and quadrangle cells, the inner one has a thick, elongated and polygonal cells arranged in longitudinal rows (Fig. 2j). In a few specimens the testa is abraded exposing a lustrous brown tegmens which show imprints of the inner layer testal cells. The size ratio of fossil fruitlets and seeds is shown in Fig. 3.

The features of the fossil fruitlets and seeds are those of contemporary *Saururus* (Fig. 2 d, e). The fossil seeds differ from the modern ones by having bigger and more regular arranged transverse testal cells (Friis 1985).

Remarks. The genus was known in Europe from the Upper Eocene to the Pliocene (Friis 1985, Mai & Walther 1988). Carpological remains of that plant described from the Oligocene of West Siberia under the name *Carpolithus bilobatus* Nikitin (Dorofeev 1963, Nikitin 1965) were for the first time ascribed by Mai (1978) to the genus *Saururus*. In Poland the species was noted under the name *Heliotropium* sp. (Raniecka-Bobrowska 1959) and next it was reported as *Carpolithus* sp.cf. *Saururus bilobatus* (Nikit.) Mai from the Miocene of the the Nowy Sącz Basin (Łańcucka-Środoniowa 1979). The species was also present at Koniówka (Łańcucka-Środoniowa 1980f and in older part of the profile from Bełchatów (Stuchlik et al. 1990). Lipnica Mała is that site in Poland, in which the species *S. bilobatus* is abundatly represented. The genus *Saururus* from the endemic family *Saururaceae* of a distinct disjunctive distribution (Kornaś & Medwecka-Kornaś 1986) includes two modern species of bog plants: *S. chinensis* Hort. ex Loud. from eastern Asia (Japan, China, nothern Philipines) and *S. cernuus* L. from eastern North America (Hutchinson 1973, Mai & Walther 1978). They grow on the banks of rivers and in swamps. In Japan the genus *Saururus* grows in forest associations with *Fagus* and *Magnolia* in temperate cool climate zone (Numata 1974).

In North America, Cuba, Bermudy, Jamaica and Mexico the wood-duck *Aix sponsa* has been an important factor in dispersal mechanism of *Saururus*. In investigated stomachs of that duck one has found up to about 10000 seeds of *Saururus* (Ridley 1930).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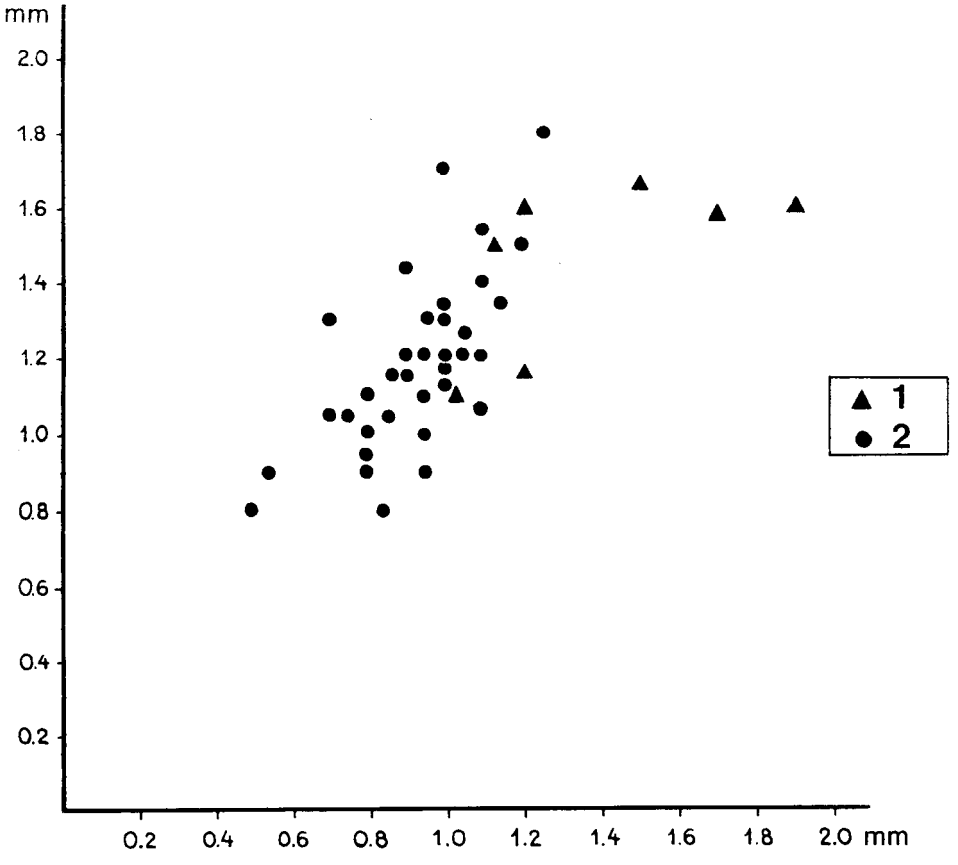

Fig. 3. Length and breadth of *S. bilobatus* (Nikitin) Mai: 1 – fruitlets, 2 – seeds and tegmens

Polygonaceae

Rumex sp. 1

Pl. 2 figs 6, 7

Material. Samples 5–8 and outcrop, Nos. 121/85, 86 KRAM-P: 18 fruits.

Description. Fruits 1.05–1.45 mm x 0.45–0.75 mm, trigonous, fusiform in shape, the base and apex wedgewise narrowed. Some specimens of asymmetric base. The greatest width in the middle or in 1/3 fruit length. Lateral edges thin and lustrous, middle edge flattened. The fruit surface is mat, slightly punctated, with delicate transverse wrinkles.

Remarks. Fruits from Lipnica Mała resemble those of *Rumex sp.* from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1979). With their size, shape and sculp-

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Fig. 2. Comparison of fossil *Saururus bilobatus* (Nikitin) Mai and extant *Saururus cernuus* L. *S. bilobatus*: a, a' – dorsal side of fruitlet, b, b' – ventral side of fruitlet, c – seed, f, g – tegmens with fruitlets remnants, h, i – tegmens, j – tegmen cells, x *ca* 80; *S. cernuus*: d, e – seeds

ture they correspond to the contemporary fruits of *Rumex ucrainicus* Fisch. and *R. maritimus* L.

The fruits of *Rumex* have frequently been reported from the Neogene of Europe and Asia, e.g. in the Miocene of Poland (Łańcucka-Środoniowa 1979) and Denmark (Friis 1985), but the most abundantly in the Pliocene floras (E. M. Reid 1920, Szafer 1954, Nikitin 1957, Mai & Walther 1988).

Rumex sp. 2

Pl. 2 fig. 8

Material. Sample 8, No 121/87 KRAM-P: 1 fruit.

Description. Fruit 1.95 x 0.78 mm, trigonous. Base somewhat asymmetric, wedgewise narrowed, apex pointed. Edges sharp and thin, lateral sides black and lustrous. The fruit surface covered with minute cells and delicate longitudinal strips.

Remarks. This fruit is bigger than the mentioned *Rumex* sp. 1, and differs from it by having more elongated shape and lustrous surface.

It is difficult to determine systematic position of the fossil *Rumex* due to possibilities of hybridization within the genus. The investigation on a cell structure of the fruits wall could provide useful information. In respect of its size, the fossil fruit resemble the modern one of *Rumex paluster* Sm., but in shape and the surface sculpture it corresponds to *R. aquaticus* L.

Fagaceaee

cf. Fagus sp.

Pl. 2 figs 9, 9a

Material. Sample 13, No 121/55 KRAM-P: cupule fragment.

Description. Fragment 4.70 x 2.80 mm, elongated, somewhat curved, walls thick and lignified. On the outer surface and in lower part small wrinkles conecting together into 3 distinct ribs with short broken processes are visible. The inner surface is lignified and delicately longitudinally striped.

Remarks. This remain has features of a cupula of the genus *Fagus* and probably represented its lower part.

Betulaceae

Alnus sp.

Pl. 2 figs 10–12

Material. Samples 4, 10, 12; No 121/12 KRAM-P: 3 nutlets.

Description. Winged nutlets 2.05 x 2.03 mm, 2.30 x 1.65 mm, 1.40 x 1.50 mm, broadly ovate and somewhat asymmetric in shape. On the apex of one nutlet a narrow remnants of two styles are visible. Other specimens have a short and thick styles. The base and the apex are rounded. The edges are thick, the surface at some points is longitudinally striped (Pl. 2, fig. 12). Wide wings are seen on two nutlets (Pl. 2, figs 10, 11).

Remarks. The remains undoubtedly belong to genus *Alnus*, but their specific determination is impossible. It seems they correspond with species *Alnus lapoi* Dorof. and *A. pliocenica* Dorof. (Dorofeev 1982, Pl. 148, figs 12–19, Pl. 149, figs 13–23).

Betula sp. 1

Pl. 2 fig. 13, Pl. 3 fig. 1

Material. Samples 5 and 9, No 121/15 KRAM-P: 2 nutlets.

Description. Nutlets 2.30 x 1.50 mm and 1.65 x 1.05 mm, inversely ovate. The apex rounded, with broad style, the base wedgewise narrowed. Dark and mat surface has small cells and delicate furrows. In the middle of the nutlets a small ovules are visible. Smaller nutlet without wings, the bigger one has uneven edges with minute shreds beeing likely wing traces (fig. 13).

Remarks. The remains are similar to *Betula omoloica* Dorof. and *B. tavdensis* Dorof. (Dorofeev 1982, Pl. 140, figs 1–14, Dorofeev 1967, Pl. 158, fig. 15) but differ in smaller size.

B. omoloica is the Oligocene-Miocene species from eastern Siberia, relative to West Siberian species *B. apoda* Nikit. and European *B. longisquamosa* Mäedl. *B. tavdensis* has been a charakteristic species for the Lower Oligocene of West Siberia and corresponds to *B. longisquamosa.*

The nutlets from Lipnica Mała differ from the contemporary birch fruits in smaller size.

Betula sp. 2

Pl. 3 figs 2, 3

Material. Samples 6 and 9, No 121/16 KRAM-P: 3 nutlet fragments.

Description. The biggest fragment 1.50 x 1.15 mm, bottle-ovate in shape, thin, with broad style, at the base damaged. Surface smooth. Other two fragments are damaged, thin-walled, with fairly long remnants of two styles.

Remarks. Those bad preserved specimens made they impossible to give specific determination. They differ from *Betula* sp. 1 in shape, size, surface sculpture and wall thickeness.

Tubela sp.

Pl. 3 fig 4

Material. Sample 4, No 121/115 KRAM-P: 1 nutlet.

Description. Nutlet 2.05 mm long, broadly-oval, one side flat, the second somewhat convex. At narrowed apex the remnants of broad style and epicarp fragment are visible. The base wide, almost straight, somewhat concave. In the middle of nutlet a globular outline of ovoid. The surface is dark brownish, slightly lustrous, with small cells and delicate wrinkles.

Remarks. The artificial genus *Tubela* was established by Dorofeev (1982) for the fossil fruits combining characters of contemporary genera *Alnus* Gaertner, *Betula* L. and *Duschekia* Opiz.

The fruits of *Tubela* resemble fruits of the modern species of *Alnus* and some species of *Betula*, but differ in anatomical structure of the fruit wall. Dorofeev has distinguished 3 sections in the genus *Tubela*: *Tubela* Dorof., *Alnaria* Dorof. and *Itelmenia* Dorof. The fruits of the section *Tubela* distinctly differ from the majority of contemporary species of *Betula* which have narrow fruits with wide membraneous wings. They may be com-

pared with those modern East Asian species of *Betula* which have small and broad fruits with narrow, coriaceous wings and thick bracts with two indistinct lobes what is more characteristic for the genus *Alnus* (e.g. *Betula schmidti* Regel). The anatomical structure of fruit wall of the section *Tubela* Dorof. may be compared with those of some *Alnus* (Dorofeev 1982).

The fruits of the section *Alnaria* Dorof. closely resemble those of modern *Alnus*, although they have some features – especially in anatomical structure – of a few modern East Asian species of *Betula*.

The species of the section *Itelmenia* Dorof. combine the fruit features of contemporary species of *Alnus*, *Betula* and *Duschekia*.

In Dorofeev's opinion (op.cit.) all 3 sections or only section *Tubela* have gradually evolved from some archaic forms of *Betulaceae* in Cretaceous. Although some of the fossil species can actually belong to *Alnus* or *Betula* the establishment of the fossil genus *Tubela* is helpful in the presence transitional forms within *Betulaceae* and seems justified the difficulty in distinguishing the fruits of contemporary genus *Alnus* from those of a few East Asian species of *Betula*.

The remain described from Lipnica Mała undoubtedly belongs to the section *Alnaria* Dorof. and is similar to *Tubela kireevskiana* Dorof. (1982, Pl. 161, figs 1–15), *T. omskiana* Dorof. (1982, Pl. 160, figs 17–27) and *T. tymensis* Dorof. (1982, Pl. 159, figs 1–17).

Actinidiaceae

Actinidia faveolata C. & E. M. Reid

Pl. 3 figs 5–7

1915. *Actinidia faveolata* C. & E. M. Reid; p. 117, Pl. 13, figs 1–4

Material. Samples 6, 8, 9 and outcrop, Nos. 121/7–9 KRAM-P: 4 entire seeds and 3 seed fragments.

Description. Seeds dorso-ventrally flattened, the bigger is 3.05 x 2.30 mm, the smaller 1.85 x 1.35 and 1.90 x 1.50 mm, eliptical in shape. The apex rounded, the base somewhat narrowed and pointed at the micropyle. The testa surface has shallow, rarely circular, 4–6-lateral pits, each of diameter approximately 0.05–0.13 mm. There are 21 pits at the greatest width of seed what make diagnostic feature (Łańcucka-Środoniowa 1966).

Remarks. The species was known from the Upper Oligocene of West Siberia (Dorofeev 1963) through the Lower Miocene of Middle Europe (Bůžek & Holy 1964) up to the Upper Miocene and Pliocene of Europe (Reid C. & E. M. Reid 1907, Geissert 1972).

In Poland it has been known from a few Neogene floras: Krościenko and Mizerna (Szafer 1946–47, 1954), the Gdów Bay, the Nowy Sącz Basin and from Chyżne, Lipnica Wielka, Podczerwone, Czarny Dunajec and Domański Wierch (Łańcucka-Środoniowa 1966, 1979, 1980 a-g).

The extinct species is compared with the contemporary East Asian *Actinidia kolomikta* (Rupr.) Maxim. (Łańcucka-Środoniowa 1966).

Actinidia argutaeformis Dorofeev

Pl. 3 fig. 8

1955a. *Actinidia cf. arguta* Dorofeev; p. 133, Pl. 5, figs 9, 19
1960a *Actinidia argutaeformis* Dorofeev; p. 660, Pl. 1, figs 24–27

Material. Sample 7, No 121/6 KRAM-P: 1 seed.

Description. Seed dorso-ventrally flattened, of size 1.95 x 1.35 mm, ovate in shape. The apex rounded, the base slightly narrowed. At the base the hilum is adjacent to micropyle and marked by an elliptical, subbazal and oblique scar 0.25 mm long. The testa surface furnished with characteristic izodiametric, 5-lateral or almost circular pits of diameters 0.075–0.125 mm which decrease slightly towards the seed circumference. On the greatest width there are 16 pits.

Remarks. These fossils were described by Dorofeev from the Oligocene and Miocene of the Odessa region and West Siberia (1955 a, b, 1960a, 1963). Similar specimen was described from the Middle Miocene of Denmark as *Actinidia* sp. (Friis 1985). In Poland the species was reported from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1979).

The contemporary species *A. arguta* (S. & Z.) Planch. grows in East Asia which climbs high trees of mixed forests overgrowing wet places (Dorofeev 1963).

Actinidia sp.

Pl. 3 fig. 9

Material. Sample 6, No 121/10 KRAM-P: 1 seed.

Description. Seed 2.00 x 1.17 mm, elliptic in shape, inversely ovate, convex and somewhat narrowed at the base on which small scar can be seen. The testa surface is pitted, the pits are polygonal or 5–7 –lateral, of diameter 0.075–0.150 mm, with high and thin walls. There are about 20 pits at the greatest width.

Remarks. This specimen belongs to the genus *Actinidia*, but differs from the mentioned species in its shape, size and surface sculpture. This species corresponds with *Actinidia conspicuaeformis* Mai (Mai & Walther 1991, p. 83, Pl. 8, fig. 21).

Ericaceae

Andromeda carpatica Łańcucka-Środoniowa

Pl. 3 fig. 10

1979. *Andromeda carpatica* Łańcucka-Środoniowa; pp. 67–69, Pl. 11, figs 11a, 11b, Pl. 12, figs 1–6

Material. Samples 6 and 13, No 121/14 KRAM-P: 2 seeds.

Description. Seeds 1.30 x 0.93 and 1.40 x 1.20 mm, oval, with irregular folded surface. On ventral side an oblong, mat hilum situated asymmetric to seed axis can be seen. The testa is thick, with black and lustrous surface on which a minute, polygonal cells are seen.

Remarks. The species was distinguished from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1979) . It was also recorded from a few Neogene sites of southern Poland (Łańcucka-Środoniowa 1980a-g).

The contemporary genus includes 2 species of marshes and peatbogs: *Actinidia polifolia* L. (North America and Eurasia) and *A. glaucophylla* Link. (North America). There are a small evergreen bushes.

Violaceae

Viola sp.

Pl. 3 fig. 11

Material. Sample 5, No 121/116 KRAM-P: 1 seed.

Description. Seed 1.40 x 0.47 mm, the greatest width in 1/4 of the seed length. The base straight, the apex strongly pointed. The testa is thin, fragile, bright brown from the inner side and darker from the outer one. The surface testa is delicately longitudinal striped.

Remarks. These kind of seeds have not been found in the palaeobotanical publications. Comparising this specimen with the modern species of *Viola* it seems that it may be compared with the European species *Viola rothomagensis* Desf.

Euphorbiaceae

Euphorbia sp.

Pl. 3 fig. 12

Material, Samples 2, 3, 13, No 121/54 KRAM-P: 4 seed fragments.

Description. Seed fragments 1.30 x 1.00 – 1.70 x 1.90 mm, black, lustrous, strong convex. The testa surface almost smooth, with minute polygonal cells which are visible under bigger magnification. The remains are in bad state of preservation, without caruncule and raphae on ventral side what is characteristic feature for *Euphorbia* seeds. They represent probably the fragments of the dorsal side of seeds.

Remarks. With regard to the features of the testa surface the remains are similar to some of the contemporary species of *Euphorbia verrucosa* Lam., *E. spinosa* L., *E. stricta* L. The state of preservation of the remains makes impossible to carry the specific determination.

The genus *Euphorbia* has often been found in the Pliocene floras of Europe (C. Reid & E. M. Reid 1915, Szafer 1954, Nikitin 1957, 1976, Negru 1979, Mai & Walter 1988), rarely recorded from the Miocene (Dorofeev 1959).

Rosaceae

Potentilla pliocenica E. M. Reid

Pl. 3 fig. 13

1920. *Potentilla pliocenica* E. M. Reid; p. 127, Pl. 8, figs 31–34

Material. Samples 3 and 13, No 121/81 KRAM-P: 2 fruits.

Description. Fruits 0.95 x 0.70 and 0.80 x 0.60 mm, laterally flattened, ovate in shape, the base broadly rounded. The apex is narrowed and bent towards ventral side what makes asymmetry of fruit shape. Dorsal side semicircular, ventral side almost flat. The distinct character of this fossil is lack of irregular longitudinal grooves on their smooth and mat surface.

Remarks. The species was known from the Miocene and Pliocene of Europe and the Miocene of West Siberia (Dorofeev 1963, Mai 1965, 1967, Palamarev 1970, Friis 1985, Mai & Walther 1988). Dorofeev (1963) compared this species with a few contemporary East Asian species. In Poland the species was known from the Miocene (Łańcucka-Środoniowa 1979) and the Lower Pleistocene of Mizerna (Szafer 1954).

At present the genus *Potentilla* comprises about 300 species of herbs and small bushes distributed in the temperate North Hemisphere.

Potentilla supina L. fossilis

Pl. 3 fig. 14

1953. *Potentilla supina* L.: Nikitin & Dorofeev; p. 25, Pl. 3, fig. 9

Material. Samples 2, 5–8, 13, Nos. 121/78–80 KRAM-P: 38 fruits.

Description. Fruits 0.60–1.00 x 0.35–0.80 mm (average 0.86 x 0.59 mm), oval or semicircular in shape. The base and the apex broad and rounded, or the apex slightly narrowed. Dorsal side is convex, ventral side convex or straight. Some fruits almost globular. Most of them are flattened, thin-walled, split along ventral and dorsal sides. On the fruits surface delicate, longitudinal and uneven strips are seen, but some specimens are fairly smooth and mat.

Remarks. In Poland the species was described from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1979). It was also recorded in the Pliocene (Mai & Walther 1988), and in the Pleistocene of Europe and West Siberia (Korchagina 1958, Velichkevich 1973).

The contemporary species *Potentilla supina* L. grows in Eurasia reaching North Africa and India. It occurs in wet places, on the banks of rivers, lakes, ponds and marshy meadows almost excusively on lowlands at the attitudes not above 600 m a.s.l., avoiding a limestone soils (Mai & Walther 1988).

Rubus laticostatus Kirchheimer

Pl. 3 figs 15–18

1942. *Rubus laticostatus* Kirchheimer; pp. 438–440, Fig. 14

Material. Samples 5, 12 and outcrop, No 121/84 KRAM-P: 5 endocarps.

Description. Endocarps 1.40–1.95 x 1.33–1.50 mm, bilaterally compressed. The base broadly rounded, the apex bluntly narrowed, straight or somewhat curved towards ventral side. Dorsal side is convex, ventral one is almost straight or somewhat semicircular. On the endocarp surface are large, shallow and circular pits which vary in size and shape. The ridges that separate them are blunt and low.

Remarks. The species was frequently distributed in the Miocene and Pliocene of Europe (C. Reid & E. M. Reid 1915, Kirchheimer 1942, 1957, Mai 1964, Negru 1979, Łańcucka-Środoniowa 1979, Stuchlik et al. 1990, Mai & Walther 1991).

The contemporary relative species is *Rubus phoenicolasius* Maxim., growing in East Asian mountain forests (Negru 1986).

Aceraceae

cf. *Acer* sp.

Pl. 3 fig. 19

Material. Sample 5, No. 121/3 KRAM-P: fruit fragment.

Description. Fragment of endocarp, without wing, of size 3.50 x 2.70 mm, elliptical in shape, the base damaged, the apex narrowed, with traces of vascular bundle. A fragment of ventral raphae is visible. Endocarp walls are thin.

Remarks. Fruit size and shape could suggest the section *Platanoidea* Pax.

Rutaceae

Toddalia cf *maerkeri* Gregor

Pl. 3 figs 20, 20a, Pl. 4 figs 1–4; Fig. 4 A-G

1972. *Epipremnum crassum* C. et E. M. Reid: Müller; p. 77
1979. *Toddalia maerkeri* Gregor; pp. 322–323, figs 33, 34

Material. Sample 5, Nos. 121/111–112 KRAM-P: 5 seed halves.

Description. The biggest remain 3.97 mm long and 1.90 mm hight, boat-shaped and elongated. (Pl. 3 figs 20, 20a, Figs 4 A, B). The apex narrowed, the base broad, handle-shaped. The testa thick, (0.13–0.45 mm), lignified, smooth and almost mat. The testa surface has minute, circular cells. On the inner side of seed a deep, triangular hilum 2.40 x 0.90 mm is seen. At the narrowed apex is micropyle, at the base a curved vascular bundle over the chalaza making a raphae excrescence to the middle of dorsal side is visible. It represents one kind of raphae described by Gregor (1979, Fig. 6d). Inside seed locule a remain of a lustrous, bright-brownish tegmen of a minute cells can be seen. Four smaller remains (1.80–3.20 x 1.40–2.20 mm) are deformed and probably unripe (Fig. 4 C-G). Beyond a thick and smooth testa and a trace of locules there are no characters of the genus *Toddalia*.

Remarks. These types of seeds described Gregor (1979) from the Oligocene of Germany as *Toddalia maerkeri*, including into this species the specimens previously determined by Müller (1972) as *Epipremnum crassum*. In Gregor's opinion – the author's of the monograph on fossil *Toddalia* – *T. maerkeri* Gregor is closely related to *T. maii* Gregor and its relative contemporary species can be East Asian *T. asiatica* (L.) Lam. var. *gracilis* Gamble.

The genus *Toddalia* was distributed in the European Tertiary from the Eocene to Pliocene, the most frequently in the Miocene. In nearly all browncoal Tertiary deposits, clay pits and in many fissure-fillings one can find hard, black, lustrous and boat-shaped seeds with rutaceous characteristics. The specimens from Lipnica Mała also came from lignite layer filled with grey-brown clays.

In Poland the seeds of *Toddalia* are known from a few Miocene floras: Wieliczka (*T. latisiliquata* (Ludwig) Gregor, *T. maii* Gregor, *T. naviculaeformis* (E. M. Reid) Gregor – Gregor 1978, Łańcucka-Środoniowa 1984); Turów (*T. maii* Gregor, *T. turoviensis* Czeczott & Skirgiełło – Czeczott & Skirgiełło 1980) and Stara Wieś (*T. maii* Gregor – Łańcucka-Środoniowa 1981).

The recent monotypic genus includes plants growing as lianas or shrubs which are distributed in areas with subtropical to tropical conditions not below 14°C mean annual temperature (Gregor 1979).

Loranthaceae gen.

Pl. 4 figs 5–5b

Material. Samples 5, 8, 9 and outcrop, Nos. 121/72, 72a, 73 KRAM-P: 13 stem fragments.

Description. The biggest fragment of stem 4.00 x 3.80 mm, other smaller. The surface seems as if "granular" due to large cells, tetragonal and arranged in rows paralell to the longer axis. The walls thick, straight, yellow-brownish and strongly cutinized.

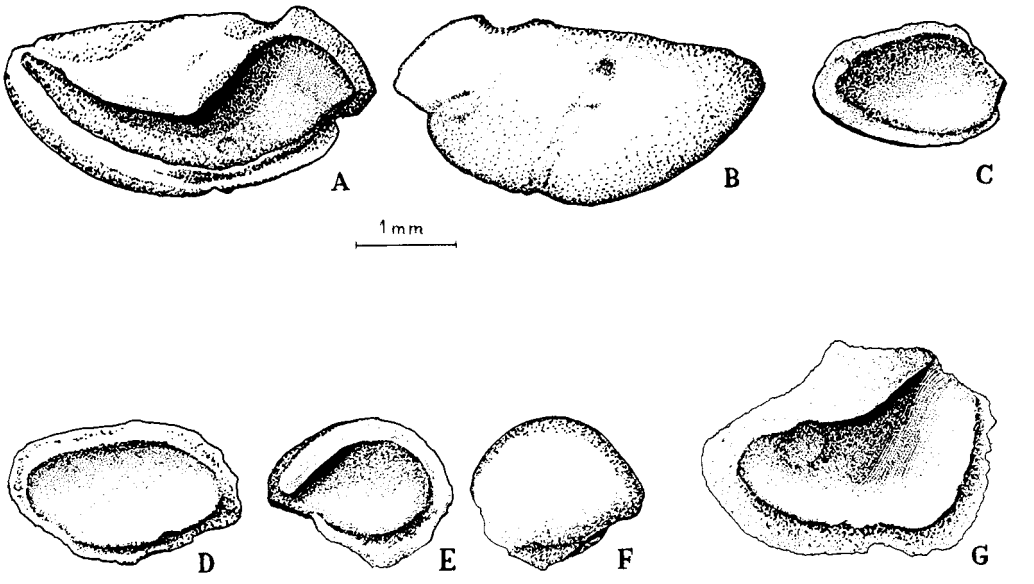

Fig. 4. *Toddalia* cf. *maerkeri* Gregor. A – F: half of a ripe (A, B) and immature seeds (C-F) from outer and inner sides, G – seed with remnant of tegmen.

Stomata which are single among epidermal cells occur transversely to the longer axis of stem.

Remarks. The structure of epidermis and paracytic stomata are common in the family *Loranthaceae* and present in the genera as *Arceuthobium*, *Loranthus*, *Viscum* (Juchniewicz 1975).

Loranthaceae were known in fossil state from the Eocene to Pliocene in European floras (Jähnichen 1965, Mai 1965, Givulescu 1970) as well as South American ones (Gothan & Weyland 1964). In the Tertiary of Poland one found the leaves, epiderms, stems and fruits of *Viscum* (Kräusel 1920, Stachurska et al. 1971, Juchniewicz 1975) and leaves of *Viscophyllum pliocaenicum* (Engl.) Mädler (Wąs 1956). For the first time the shoots, flowers and fruits of the genus *Arceuthobium* described Łańcucka-Środoniowa from the Upper Miocene flora of Gozdnica (Łańcucka-Środoniowa 1980, Dyjor et al. 1992).

Vitaceae

Ampelopsis malvaeformis (Schlotheim) Mai

Pl. 5 figs 1, 1a

1822. *Carpolithus malvaeformis* Schlotheimm; pp. 98–99, Pl. 21, figs 9a-c
1957. *Ampelopsis ludwigii* (A. Br): Dorofeev; pp. 644–645, Pl. 1, figs 1, 2
1982. *Ampelopsis malvaeformis* Mai: Mai & Gregor; pp. 418–419, Pl. 21, figs 1–3

Material. Sample 5, No 121/13 KRAM-P: 1 entire and half of seed.

Description. Seed 2.80 x 3.00 mm, flattened and blunt. On the outer side a convex and large chalaza from which run shallow wrinkles is seen. The half seed 4.30 x 2.70 mm, the base wedgewise narrowed, the apex cordate rounded. On the dorsal side of seed an

elongated chalaza narrowed into furrow is visible. Radial wrinkles run off from chalaza.

Remarks. The species occurs frequently in the Tertiary floras particularly in the Miocene and Pliocene (Szafer 1946–47, 1961, Czeczott & Skirgiełło 1959, Łańcucka-Środoniowa 1966, Mai & Walther 1988).

The contemporary genus *Ampelopsis* includes about 24 species in temperate and subtropical areas of Asia and North America.

Cornaceae

cf. *Swida* sp.

Pl. 5 figs 2, 2a

Material. Sample 7, No 121/110 KRAM-P: half of endocarp.

Description. Endocarp about 3.0 mm in diameter, damaged, broadly ovate in shape, the base straight, the apex somewhat narrowed. The testa surface is smooth, mat, dark brown. From the base to 1/4 length of endocarp a delicate trace of vascular bundles are seen.

Remarks. The remain has a features of stony endocarps of *Cornaceae*, but it is thin-walled and has no traces of a median depression and septum. A thin-walled, smooth and nearly globular endocarps occur in genus *Swida*, which formerly was ascribed to the subspecies in the genus *Cornus* (Poyarkova 1951, Mai & Walther 1988).

The endocarps of *Cornaceae* have frequently been found in the Neogene floras of Europe and West Siberia (Szafer 1946–47, 1954, 1961, Łańcucka-Środoniowa 1957, 1983, Raniecka-Bobrowska 1959, Dorofeev 1963, Negru 1986, Friis 1985, Mai & Walther 1988).

The recent genus *Swida* is represented by about 40 species of small trees or shrubs distributed mainly in South-Eastern Asia and North America which are predominately grow in wet forests and on the river banks (Mai & Walther 1988).

Valerianaceae

Patrinia palaeosibirica Dorofeev

Pl. 5 fig. 3

1962. *Patrinia palaeosibirica* Dorofeev; p. 800, Pl. 4, figs 39–42

Material. Sample 5, No 121/77 KRAM-P: 1 fruit.

Description. Fruit 2.15 x 1.20 mm, inversely ovate in shape, at the base narrowed and somewhat acute, at the apex rounded. A trace of small, oval attachement is seen at the base. Dorsal face of the fruit is convex, in the middle of fruit a distinct, vascular bundle runs from the base to its top. Two bundles paralell to the first one, running from the apex and not reaching the base are seen. A trace of wings is under the apex and at the base. Ventral face is flattened and furnished with a furrow. The fruit margins are edged. The fruit surface is brown and mat.

Remarks. The fruits of genus *Patrinia* have been known from the Miocene of West Siberia (Nikitin 1948, Kolesnikova 1961). The fossil species *Patrinia sibirica* was distinguished by Dorofeev (1962) from the Pliocene of Bashkiria. In Poland the species was described from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1979)

and noted from a few Neogene sites of West Carpathians (Domański Wierch, Chyżne, Koniówka, Czarny Dunajec – Łańcucka-Środoniowa 1980 a-g).

The fossil species *Patrinia palaeosibirica* Dorof. resemble the recent *P. sibirica* (L.) Juss. It is a perennial which grows on rocks and sandy slopes in Bashkiria, Siberia, Mongolia and North-Western China. The contemporary genus *Patrinia* includes about 20 species growing predominately in East Asia.

Angiospermae – Monocotyledones

Hydrocharitaceae

Stratiotes sp.

Pl. 5 fig. 4

Material. Sample 4, No 121/109 KRAM-P: 1 fragment of leaf margin tooth.

Description. Remain 0.75 mm long consists of triangular fragment of parenchymatic tissue of leaf margin with single tooth. It is 0.36 x 0.15 mm, lustrous, brown, somewhat curved, with broad base, the top strongly narrowed. The cells at the tooth base are fairly long and big.

Remarks. These types of margin teeth occur on the leaves of *Stratiotes*. The remain corresponds to the specimens from the Pliocene of the Kłodzko Basin (Jahn et al. 1984, Pl. 18, figs 11–13) and the Lower Oligocene of Bembridge Marls, Hamstead Ledge, Isle of Wight (Collinson 1983, Fig. 23).

Cyperaceae

Acorellus distachyoformis Łańcucka-Środoniowa

Pl. 5 fig. 5

1977. *Acorellus distachyoformis* Łańcucka-Środoniowa; p. 40, Pl. 5, figs 1–9

Material. Samples 4, 9 and outcrop, Nos. 121/4, 5 KRAM-P: 5 fruits.

Description. Fruits bilaterally flattened, 1.40–1.75 x 1.05–1.20 mm (average 1.57 x 1.10 mm), romboid-elliptic in shape, of narrowed and truncated basal part. The apex somewhat rounded, furnished with small and short beak. Fruit surface with small, 4–6-sided cells arranged in longitudinal rows.

Remarks. For the first time the genus *Acorellus* was distinguished in the fossil state from the freshwater Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1977, 1979). The genus is also present in the Miocene of Czarny Dunajec, Koniówka and Domański Wierch (Łańcucka-Środoniowa 1980 a-g) and in the Pliocene of Thuringia (Mai & Walther 1988)

The fossil fruits are very similar to the recent fruits of the Mediterranean species *Acorellus distachyus* (All. Palla), which also grows in southern Europe, Asia, India and North America (Łańcucka-Środoniowa 1977, 1979).

Scirpus sylvaticus L. fossilis

Pl. 5 figs 6, 7

1908. *Scirpus silvaticus* L. fossilis: Schröder & Stoller; p. 26

Material. Samples 4, 12 and outcrop, Nos. 121/94, 95 KRAM-P: 3 fruits.

Description. Fruits 0.87–0.92 x 0.65 – 0.73 mm, trigonous, one of lateral walls broader than two others, edges blunt. Fruits inversely broadly ovate, the base wedgewise narrowed, the apex slightly rounded with small beak. The fruit surface is brown, with a minute isodiametric cells arranged in longitudinal rows.
Remarks. The fruits of *Scirpus sylvaticus* L. fossilis have been known from the Middle Miocene (Łańcucka-Środoniowa 1966, 1979) and Pliocene of Central Europe and Asia (Dorofeev 1956, 1960b, Jahn et al. 1984, Mai & Walther 1988).

The contemporary species occurs in Eurasia in wet habitats.

Cyperus aff. *glomeratus* L.
Pl. 5 figs 8, 9

Material. Outcrop, No 121/41 KRAM-P: 2 fruits.
Description. Fruits 1.70 x 0.46 and 1.60 x 0.45 mm, trigonous, with narrow elliptical lateral walls, the base wedgewise narrowed, beak short. The fruit surface is dark and mat with minute cells which are somewhat elongated towards the fruit axis.
Remarks. The specimen is similar to the fruit of *Cyperus glomeratus* L. which has been known from the fossil floras of the Miocene to Pleistocene (Łańcucka-Środoniowa 1979). One can compare mentioned remain with similar, but damaged, fruit of *Cyperus* sp. 1 from the Miocene of the Nowy Sącz Basin (op. cit.) The recent species grows in Eurasia.

Cyperus sp.
Pl. 5 fig. 10

Material. Samples 4, 5, 11, Nos. 121/42, 42a KRAM-P: 3 fruits.
Description. Fruits 1.40–2.00 x 0.60–0.80 mm, compressed, elongated in shape, the greatest width in about 1/4 of the fruit length, edges blunt. The beak is distinct, 0.20–0.30 mm, the stipe is small and short. The surface is mat, finely punctated.
Remarks. The specimens slightly resemble the fruits of *Cyperus* sp. 2 i sp. 3 described from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1979).

Carex – lenticular shaped nutlets

Carex ungeri Mai
Pl. 5 figs 11–16

1963. *Carex elongata* L.: Mai, Majewski & Unger; Pl. 2, fig. 18
1988. *Carex ungeri* Mai: Mai & Walther; p. 87, Pl. 12, figs 18, 19

Material. Samples 4, 5 and outcrop, Nos. 121/26, 30 KRAM-P: 1 utricle and 6 nutlets.
Description. Nutlets 1.50–1.90 x 0.80–0.90 mm, elongated elliptic in shape, bilaterally flattened, at the base narrowed into short stipe, at the apex rounded with short, narrow style. The walls are thin, on the surface are small isodiametric cells in longitudinal rows. Minute papillae can be seen. The utricle 2.05 x 1.00 mm, elliptic elongated, at the base damaged, strongly flattened and thin. Its both sides furnished with 10 irregular, thin and paralell longitudinal nerves.
Remarks. The specimens closely corresponds with the nutlets described by Mai as

Carex ungeri (Mai & Walther 1988). In Poland noted from the flora of Gozdnica (as *Carex ungeri* Mai, Łańcucka et al. 1992). The nutlets from the Miocene of the Gdów Bay (Łańcucka-Środoniowa 1966, *Carex* sp. 3, Fig. 21, 4) and the Nowy Sącz Basin (*Carex elongata* L. foss., Łańcucka-Środoniowa 1979) have probably belonged to this species.

The recent North-American species *Carex hudsonii* A. Benn. closely resemble the fossil one (Mai & Walther 1988).

Carex loliacea L. fossilis

Pl. 5 figs 17–19

1977. *Carex loliacea* L. fossilis: Fuhrmann et al.; pp. 717–743

Material. Samples 6 and 11, Nos. 121/24, 25 KRAM-P: 3 utricles.

Description. Utricles 1.95–2.25 x 0.85–1.20 mm, bilaterally flattened, elliptic, wedgewise narrowed at both ends, at the basal part somewhat damaged. Edges smooth, the surface covered with regular, even, paralell and fairly thick longitudinal ribs in number 10–12 on each utricle side.

Remarks. The species was known from the Pleistocene of Mahlis near Leipzig (Fuhrmann et al. 1977), in Poland it was noted from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1979).

The recent species belonging to the section *Heleonastes* Kunth occurs in Eurasia in marshy alderwoods.

Carex sp. div.

Pl. 5 figs 20–22

Material. Samples 5 and 6, No 121/21 KRAM-P: 5 utricles.

Description. Utricles thin, bilaterally flattened, 1.70–2.00 x 0.90–1.30 mm, oval-elliptic to nerly globular in shape. The surface nervation is irregular and differs from 7–13 ribs on each side of utricle.

Remarks. The utricles may belong to different species but their specific determination was impossible.

Carex – trigonous nutlets

Carex globosaeformis Łańcucka-Środoniowa

Pl. 6 fig. 1

1979. *Carex globosaeformis* Łańcucka-Środoniowa; Pl. 14, figs 12a, 12b

Material. Sample 11, No 121/18 KRAM-P: 1 nutlet.

Description. Nutlet 1.30 x 1.03 mm, oval-globular, trigonous, with elliptic lateral walls and apex. The stalk is short and broad, the style is short (0.05 mm), the edges are blunt. The surface is somewhat lustrous and delicate pitted, without papillae.

Remarks. The nutlets of the same type occured in the freshwater Miocene deposits of the Nowy Sącz Basin (Łańcucka-Środoniowa 1979). In its morphology the specimens most resemble the North-American species *Carex globosa* Bott, but also are similar to other species of that region.

Carex pseudocyperoides Łańcucka-Środoniowa

Pl. 6 figs 2–7

1979. *Carex pseudocyperoides* Łańcucka-Środoniowa; p. 91, Pl. 14, figs 14–17

Material. Samples 10, 12 and outcrop, Nos. 121/27–29 KRAM-P: 7 nutlets.

Description. Nutlets 1.40–1.50 x 0.75–0.80 mm, trigonous, elongated, with elliptic rounded lateral walls and narrowed on the both ends. The stalk is short and straight, the style is thin, of various length. The surface is pitted with a small cells and papillae.

Remarks. The species has been described from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1979). Its relative and contemporary species *Carex pseudocyperus* L. growing in wet habitats in Eurasia and Atlantic part of North America has been known from the Pliocene and the Pleistocene of Europe and West Siberia (Keilhack 1906, Weber 1919, Baas 1932, Szafer 1947, Nikitin 1957, Mania & Mai 1969, Dorofeev 1977, Fuhrmann 1977, Mai & Walther 1988).

Carex acutiformis Ehrhardt fossilis

Pl. 6 fig. 8

1899. *Carex acutiformis* Ehrhardt: C. Reid

Material. Sample 4, No 121/17 KRAM-P: 1 nutlet.

Description. Nutlet 1.76 x 1.10 mm, trigonous, broadly ovate-elliptic in shape, of arched lateral walls. The greatest width in the middle of the nutlet length. The base has a broad and short stalk. The apex has a short, narrow style, about 0.20 mm long. The walls are thick, the surface has izodiametric cells furnished with minute papillae.

Remarks. The species was present in the Pliocene and Miocene of Bulgaria (Palamarev 1970), the Miocene of Poland (Łańcucka-Środoniowa 1979), the Pliocene of Thuringia and several Eurasian Pleistocene floras (Mai & Walther 1988).

The recent *Carex acutiformis* Ehrh. grows in marshy areas, wet meadows and banks of water reservoirs in Eurasia and North America.

Carex cf. *pilulifera* L. fossilis

Pl. 6 figs 9–12

1953. *Carex pilulifera* L.: Mitchell; p. 225

Material. Sample 11 and outcrop, Nos. 121/19, 20 KRAM-P: 8 nutlets.

Description. Nutlets 1.50–1.70 x 0.90–1.10 mm, trigonous, inversely ovate, extended in the upper part. The base is straight and narrowed. The remnants of styles are fairly thick and straight. The walls elliptic, the surface is tiny pitted, without papillae.

Remarks. In the fossil state the species was known from the Pliocene (Mai & Walther 1988) and Pleistocene of Europe (Mitchell 1953).

The recent species which belongs to the section *Montanae* Fr. grows on acid sandy and forest soils in the Atlantic part of Europe and North Asia.

Carex sp. 1

Pl. 6 figs 13, 14

Material. Sample 6, Nos 121/22, 121/36 KRAM-P: 2 nutlets.

Description. Nutlets trigonous 1.10 x 0.80 i 1.10 x 1.00 mm, broadly ovate in

shape. The lateral walls are semicircular, the middle edge is narrow. The style and stalk are almost of the same size, 0.10 mm. On the nutlets surface a minute, isodiametric and papillatae cells can be seen.
Remarks. In their shape and size the nutlets are similar to *Carex globosaeformis* Łańc.-Środ., but differs from them in having papillae and more ovate shape. Similar built nutlets have a few contemporary European sedges, e.g. *Carex pallescens* L. which, however, has the bigger and narrower nutlets.

Carex sp. 2
Pl. 6 figs 15–19

Material. Samples 5, 6, 8 and outcrop, Nos. 121/32–35 KRAM-P: 7 nutlets.
Description. Nutlets 1.85–2.05 x 1.05–1.30 mm, trigonous, oval-elliptic, at the base narrowed and split along edges into 2–3 parts. At the apex narrowed and furnished with a small style or without it. The surface is dark, lustrous and somewhat coriaceous, with fairly large izodiametric cells. The greatest width is in the middle of the nutlet length.
Remarks. The nutlets without specific determination.

Carex sp. 3
Pl. 6 fig. 20

Material. Samples 5, 11 and outcrop, No 121/23 KRAM-P: 3 nutlets.
Description. Nutlets 1.20–1.80 x 0.50–1.00 mm, elliptic elongated, trigonous, of a thick, mat testa. The base wedgewise narrowed, the apex rounded and furnished with a short, thick style.
Remarks. The author failed their specific determination.

Cyperaceae gen.
Pl. 6 fig. 21

Material. Sample 4, No 121/40 KRAM-P: nutlet fragment.
Description. Fragment of elongated, trigonous fruit of 0.80 mm wide. Its basal part damaged, the apex wedgewise narrowed into style of 0.15 mm long. The surface is brown, minute pitted and lustrous.
Remarks. The fruits of similar morphology one can find in the genera *Scirpus* and *Eriophorum*.

Arecaceae
Epipremnites reniculus (Ludwig) Mai
Pl. 6 figs 22–25, Pl. 7 figs 1–3

1857. *Cytisus reniculus* Ludwig; p. 101, Pl. 20, fig. 21
1885. *Carpolithus reniformis* v. Fritsch; p. 437, Pl. 26, fig. 26
1913. *Carpolithus reniculus* Menzel; p. 19, Pl. 1. fig. 37
1915. *Epipremnum crassum* C. et E. M. Reid; p. 71, Pl. 4, figs 1–9
1935. *Epipremnum* ? *reniculum* Kirchheimer; pp. 79–80; Pl. 11, figs 31a-i
1988. *Epipremnum reniculum* (Ludwig) Kirchheimer: Mai & Walther; p. 94, Pl. 14, fig. 3
1989. *Epipremnites reniculus* (Ludwig) Mai; p. 40, Pl. 8, figs 21, 22

Material. Samples 3, 5, 6, 8, 11, 12 and outcrop, Nos. 121/47–52 KRAM-P: 54 seeds.

Description. Seeds 1.60–2.25 x 1.90–3.55 mm (average 2.08 x 2.98 mm), laterally flattened, reniform in shape, strongly curved to almost globular. The dorsal side is convex. On one narrowed end is a great and oval micropylar depression, on the second one is chalaza. The testa is black and thick, some specimens has fairly smooth testa, but most specimens have sculptured testa consisting of small, oval pits or minute furrows.
Remarks. In Mai's opinion (Mai & Walther 1988) this species may be distinguished from the others one of *Epipremnum* because of several distinct morphological features . It has been known from the Upper Oligocene of West Siberia (Dorofeev 1963), through the Miocene and Pliocene of Europe (Mai 1973) up to the Older Pleistocene of Bashkiria. (Goretzkiy 1979). In Poland they were reported from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1979) and Bełchatów (Stuchlik et al. 1990).

The taxonomy of the fossil species of *Epipremnum* Schott and the whole subfamily *Monsteroidae* should be revised on what have already gave attention some authors (Łańcucka-Środoniowa 1979, Dorofeev 1988). The Madison and Tiffney (1976) investigations pointed to the close relation of fossil seeds with the recent genus *Raphidophora* due to some anatomical characteristics. But similar structure of the testa is not excluded in the genus *Thalia* (*Marantaceae*) (Mai & Walther 1988).

Urospathites cristatus Gregor et Bogner

Pl. 7 figs 4–6

1965. *Epipremnum cristatum* Nikitin; p. 64, Pl. 7, figs 10–14
1984. *Urosphatites cristatus* (Nikitin) comb. nov.: Gregor & Bogner; pp. 12–22, Pl. 11, figs 7–8

Material. Samples 2, 7 and outcrop, Nos. 121/44–46 KRAM-P: 31 entire seeds and 6 seed fragments.
Description. Seeds 1.15–2.05 x 2.30–3.55 mm (average 1.60 x 2.77 mm), laterally compressed, curved, reniform, boat-shaped, some almost hooklet in shape. The testa black, thick, the micropylar end even or somewhat narrowed, taller or equal to the chalazal end. On the strongly convex dorsal side a well developed comblike structure consisting of 2–3 rows of processes can be seen. The processes are somewhat flattened or conical and they have a distinct, longitudinal stripes on its surface. On the lateral walls of seeds are analogous combs but not always so great and well developed and than some bumps of rollers are observed. The surface of lateral walls and some points between the processes have a small, oval and rounded pits. Some specimens have only small bumps and pits. The testa surface has the rows of elongate cells.
Remarks. The polymorphic species which was differentiated and broadly distributed in the Oligocene of West Siberia, Kazakhstan, Ural and Europe and Miocene of Europe (Bůžek & Holy 1964, Nikitin 1965, Łańcucka-Środoniowa 1979, Dorofeev 1988). In Poland it was reported from the Miocene of Stare Gliwice (Szafer 1961) and the Nowy Sącz Basin (Łańcucka-Środoniowa 1979).

Sparganiaceae

Sparganium camenzianum Kirchheimer

Pl. 7 figs 7–11

1941. *Sparganium camenzianum* Kirchheimer; pp. 225–226, Pl. 18, figs a-c

Material. Samples 2, 5, 6, 7 and outcrop, Nos. 121/98–102 KRAM-P: 121 endocarps.
Description. Endocarps 1.10–1.85 x 0.70–1.35 mm (average 1.45 x 1.01 mm), broadly elliptical, fusiform or elongated. The base rounded or wedgewise narrowed. Their broadest part above the middle of the endocarp length. The apex narrowed into a short neck with a subcircular germination aperture. The most specimens are one-loculed, a few are probably two-loculed. A lustrous and bright-brown tegmens are visible in some splitting endocarps. The endocarp walls are thick and lignified. The surface is smooth or furnished with poorly marked longitudinal ridges and a minute pits which looks like spongy sculpture.
Remarks. In Dorofeev's opinion (1979) the endocarps described as *Sparganium camenzianum* Kirchh. have represented the groups of related species which are poorly differentiated. The morphology of endocarps bear the features ocurring in the recent species of subgenus *Xanthosparganium* Holmb. However the presence of two locules and irregular surface sculpture can relate this group to the contemporary species of subgenus *Sparganium* L. Dorofeev (op. cit.) assumed that *S. camenzianum* was the extinct group of species that have had some features of both contemporary subgenera.

S. camenzianum represents the characteristic species from the Miocene floras of Europe and Asia (Kirchheimer 1941, 1957, Mai 1964, 1967, Dorofeev 1979). In Poland it occured in the Miocene of Stare Gliwice (Szafer 1961), the Gdów Bay, the Nowy Sącz Basin and Stara Wieś (Łańcucka-Środoniowa 1966, 1979, 1981).

Sparganium haentzschelii Kirchheimer

Pl. 7 figs 12, 13

1941. *Sparganium haentzschelii* Kirchheimer; pp. 221–225, Pl. 15, 16, 17

Material. Samples 2, 11 and outcrop, Nos. 121/104, 105 KRAM-P: 5 endocarps.
Description. Thick-walled and lignified endocarps 2.75–4.05 x 1.65–2.30 mm (measured in entire). Endocarps of very characteristic surface with a few longitudinal, high and sharp ridges and large, roundish pits between them. The base wedgewise narrowed, blunt or pointed. On the apex is a long, stiff and sharp style, 0.35–0.60 mm long. At the base of style is an oval or triangular germination aperture.
Remarks. The species is known from the Miocene and Pliocene floras of Europe (Kirchheimer 1957, Mai 1964, 1967, Van der Burgh 1978), and in Poland from Turów (Czeczott & Skirgiełło 1980), Stare Gliwice (Szafer 1961), the Nowy Sącz Basin (Łańcucka-Środoniowa 1979) and Ruszów (Baranowska-Zarzycka 1988).

Sparganium neglectum Beeby fossilis

Pl. 7 fig. 14

1909. *Sparganium ramosum* Huds.: Hartz; p. 191, Pl. 9, fig 15
1988. *Sparganium neglectum* Beeby fossilis: Mai & Walther; p. 95, Pl. 14, figs 9, 10

Material. Outcrop, No 121/106 KRAM-P: 1 endocarp.
Description. Endocarp 2.55 x 1.40 mm, elongated, slightly curved, asymmetric in shape. The base rounded with very short stalk. The endocarp narrows apically into a short neck with oblique apex which is furnished with a large, circular germination aperture. On the outer surface a few wide, blunt uneven ridges extending from the

base to apex can be seen. A deep pits are between them. The endocarp walls are fairly thick.

Remarks. The endocarp is considerably smaller than the contemporary one of European species *Sparganium neglectum* Beeby. In palaeobotanical publications it was often described under the name *S. ramosum* Huds. fossilis, the polymorphic and comprehensive species which was divided again (Dorofeev 1963, 1979, Negru 1979, 1982). In Europe it is been known from the Miocene (Knobloch & Mai 1975, Łańcucka-Środoniowa 1979) and interglacial floras (Keilhack 1906, Stöller 1926, Nötzold 1959).

Sparganium cf. *crassum* Nikitin

Pl. 7 fig. 15

1957. *Sparganium crassum* Nikitin; p. 96, Pl. 1, figs 42, 43

Material. Outcrop, No 121/103 KRĄM-P: 1 endocarp.

Description. Endocarp 2.10 x 2.00 mm, almost globular, extended, the base rounded. The apex narrows into a short and wide neck with an oval germination aperture. On the surface are a distinct blunt ridges, somewhat exceeding the apex; irregular, small rollers and oval, shallow pits are among them.

Remarks. The species was described from the Pliocene flora of the Woronesh vicinity (Nikitin 1957) and Dworets in Belarus (Velichkevich 1990). In Nikitin's opinion (op. cit.) the species *S. crassum* Nikit. could be a transitory taxon between an older Miocene-Pliocene species *S. noduliferum* C. & E. M. Reid and a younger, Pleistocene *S. emersum* Rehm.

Sparganium cf. *crassum* Nikitin is a new species for the Tertiary of Poland.

Sparganium cf. *tanaiticum* Dorof.

Pl. 7 fig. 16

1979. *Sparganium* cf. *tanaiticum* Dorofeev; pp. 67–68, Pl. 8, figs 11–19, Fig. 11/1–11

Material. Sample 2, No 121/107 KRAM-P: 1 endocarp.

Description. Endocarp 2.60 x 1.50 mm, elongated, its broadest part in about 1/3 of the length. The base wedgewise narrowed into a stalk 0.50 mm long. The apex neck-shaped, with a germination aperture. On the surface are two ridges somewhat exceeding the apex and not reaching the base. The surface is covered with a tiny rollers, at some points a thin vascular bundles are seen.

Remarks. Similar built endocarps from the Sarmatian of Ukraine were described under the name *S. tanaiticum* Dorof. (Dorofeev 1979). This is a new species for the Tertiary of Poland.

Sparganium sp.

Pl. 7 fig. 17

Material. Sample 4, No 121/108 KRAM-P: 1 endocarp.

Description. Endocarp 0.98 x 0.50 mm, somewhat asymmetric in shape. The base is wedgewise narrowed and truncated. The apex is strongly narrowed with a small germination aperture. The surface is delicate pitted with a minute blunt bumps and poorly marked ridges. The walls not too thick.

Remarks. The specimen from Lipnica Mała belongs to the group of small- fruits-species of the genus *Sparganium* L. Specific determination is difficult to define because this group of contemporary species called for taxonomic revision. The endocarp is nearly similar to *Sparganium nanum* Dorof., but it is smaller and has narrower and funnel apex and truncated base. It is also slightly similar to *Sparganium coboideum* Negru (Mai & Walther 1988). The small-fruits –fossil species of *Sparganium* L. are similar to a lot of contemporary European-Siberian and North American species of that genus (Dorofeev 1979).

Indeterminatae

Carpolithus sp. 1

Pl. 7 figs 18–20

Material. Samples 5, 6, 8, Nos. 121/117–119 KRAM-P: 59 remains.
Description. Remains 1.05–2.20 x 0.75–1.70 mm (average 1.60 x 1.30 mm), vary in shape and size, elliptic to circular in shape. The edges are smooth or have a tiny processes. The remains are thin-walled, brown and strongly compressed. Their external surface is mat and smooth and their original convexity is suggested by some irregular folds which occur in surfaces.
Remarks. These types of remains described Łańcucka-Środoniowa (1979) from the Miocene of the Nowy Sącz Basin. The author suggested their resemblance to the coccons of insect but not excluded their relation with the seeds of families *Moraceae, Ulmaceae* and *Piperaceae.*

Carpolithus sp. 2

Pl. 7 fig. 21

Material. Sample 13, No 121/120 KRAM-P: 1 remain.
Description. Remain 1.20 x 0.48 mm, bilaterally flattened, elongated, asymmetric curved, with its broader part in the middle. The base strongly narrowed, with a small attachment scar. The apex also narrowed, somewhat curved, the edges uneven. On one lateral wall are two longitudinal ridges, a small depression linked with anastomosae furnished with tiny papillae are between them. The surface has minute polygonal cells. Other side of remain has poorly marked furrows.
Remarks. The author has failed to determine this remain.

RESULTS

A total of 1675 plant macrofossils were determined (Table 1). All the samples, besides, contained a high proportion of indeterminable detritus consisting of small fragments of leaves, rootlets, twigs, scales, buds, cocoons and coprolites of insects, and zoocecidia. Small fragments of lignites were indeterminable because of their state of preservation.

The most numerous and most frequently occurring in these sediments are the remains

Table 1. List of plant macrofossils determined from the Middle Miocene deposit of Lipnica Mała
Abbreviations: c – cupula, ep – epiderma, f – fragment, fr – fruit, fruc – fructification, l – leaf, msp – megaspore, s – seed, u –utricle

Taxon	Type of remains	Number of specimens
Fungi		
Amphisphaeriaceae		
Trematosphaerites lignitum (Heer) Beck	fruc	6
Sphaeriaceae		
Rosellinites congregatus (Beck) Mesch.	fruc	5
Pteridophyta		
Selaginellaceae		
Selaginella pliocenica Dorof.	msp	13
Coniferae		
Taxodiaceae		
Glyptostrobus brevisiliquata (Ludwig) Mai	s	105
Glyptostrobus europaea (Brongn.) Unger	l, e	1061
Cupressospermum chamaecyparoides Mai	s	f
Angiospermae – Dicotyledones		
Magnoliaceae		
Magnolia cor Ludwig	s	1
Saururaceae		
Saururus bilobatus (Nikitin) Mai	fr	7
	s	35
Polygonaceae		
Rumex sp. 1	fr	18
Rumex sp. 2	fr	1
Fagaceae		
cf. *Fagus* sp.	c	f
Betulaceae		
Alnus sp.	fr	3
Betula sp. 1	fr	2
Betula sp. 2	fr	3
Tubela sp.	fr	1
Actinidiaceae		
Actinidia faveolata E. M. Reid	s	4
Actinidia argutaeformis Dorof.	s	1
Actinidia sp.	s	1
Ericaceae		
Andromeda carpatica Łańc.-Środ.	s	2
Violaceae		
Viola sp.	s	1
Euphorbiaceae		
Euphorbia sp.	s	f
Rosaceae		
Potentilla pliocenica E. M. Reid	fr	2
Potentilla supina L. fossilis	fr	38
Rubus laticostatus Kirchh.	fr	5
Aceraceae		
cf. *Acer* sp.	fr	f
Rutaceae		
Toddalia cf. *maerkeri* Gregor	s	5
Loranthaceae gen.	ep	13

Table. 1. Continued

Taxon	Type of remains	Number of specimens
Vitaceae		
Ampelopsis malvaeformis (Schlotheim) Mai	s	2
Cornaceae		
cf. *Swida* sp.	s	1
Valerianaceae		
Patrinia palaeosibirica Dorof.	fr	1
Angiospermae – Monocotyledones		
Hydrocharitaceae		
Stratiotes sp.	l	1
Cyperaceae		
Acorellus distachyoformis Łańc.-Środ.	fr	5
Scirpus sylvaticus L. fossilis	fr	3
Cyperus aff. glomeratus L. fossilis	fr	1
Cyperus sp.	fr	3
Carex ungeri Mai	fr	7
Carex loliacea L. fossilis	u	3
Carex sp. div.	u	5
Carex globosaeformis Łańc.-Środ.	fr	1
Carex pseudocyperoides Łańc.-Środ.	fr	7
Carex acutiformis Ehrh. fossilis	fr	1
Carex cf. *pilulifera* L. fossilis	fr	8
Carex sp. 1	fr	2
Carex sp. 2	fr	7
Carex sp. 3	fr	3
Cyperaceae gen.	fr	f
Arecaceae		
Epipremnites reniculus (Ludwig) Mai	s	54
Urospathites cristatus Nikitin	s	37
Sparganiaceae		
Sparganium camenzianum Kirchh.	fr	121
Sparganium haentzschelii Kirchh.	fr	5
Sparganium neglectum Beeby fossilis	fr	1
Sparganium cf. *crassum* Nikitin	fr	1
Sparganium cf. *tanaiticum* Dorof.	fr	1
Sparganium sp.	fr	1
Indeterminatae		
Carpolithus sp. 1		59
Carpolithus sp. 2		1
Total		1675

of *Glyptostrobus europaea* and *G. brevisiliquata, Epipremnites reniculus, Saururus bilobatus, Sparganium camenzianum, Potentilla supina* and the species of the genus *Carex.*

Particular taxa appeared recurrently throughout the profile, the remains of *Glyptostrobus* and herbaceous plants being dominant. Samples 5 and 6 from a depth of 4.8–5.3 m were particularly rich in remains, whereas the overlying layers of grey clays and sandy-clayey sediments with gravel from a depth of 4.0–4.17 m and the lignite horizon from the lower layer of the profile, 6.25–6.32 m, were poorer (Table 2).

Table 2. The profile of Neogene deposit of Lipnica Mała with the numbers of macroscopic and palynological samples (vis. Tran Dinh Nghia 1974, Fig. 3) and occurence of determined plant remains. 1 – gravels, 2 – sand, 3 – brown clays, 4 – grey clays, 5 – grey and brown clays with plant remains, 6 – lignites

Depth in m	Lithology	Thickness of macroscopic samples	No of macroscopic sample	Nos. of palynological samples	Taxa and number of specimens
4.0		4.00–4.15	1	1–4	*Trematosphaerites lignitum* (1)
		4.15–4.35	2	5–8	*Trematosphaerites lignitum* (2), *Selaginella pliocenica* (13), *Saururus bilobatus* (1), *Euphorbia* sp. (2), *Potentilla supina* (4), *Urospathites cristatus* (1), *Sparganium camenzianum* (2), *Sparganium haentzschelii* (1), *Sparganium* cf. *tanaiticum* (1)
4.5		4.35–4.60	3	9–13	*Magnolia cor* (fr.), *Saururus bilobatus* (2), *Euphorbia* sp. (1), *Potentilla pliocenica* (1), *Epipremnites reniculus* (4)
		4.60–4.80	4	14–17	*Saururus bilobatus* (2), *Alnus* sp. (1), *Tubela* sp. (1), *Stratiotes* sp. (fr.), *Acorellus distachyoformis* (2), *Scirpus sylvaticus* (1), *Cyperus* sp. (1), *Carex ungeri* (1), *Carex acutiformis* (1), *Cyperaceae* gen. (1), *Sparganium* sp. (1)
5.0		4.80–5.05	5	18–22	*Glyptostrobus brevisiliquata* (37), *Glyptostrobus europaea* (206), *Magnolia cor* (fr.), *Saururus bilobatus* (24), *Rumex* sp. 1 (7), *Betula* sp. 1 (1), *Viola* sp. (1), *Potentilla supina* (11), *Rubus laticostatus* (3), cf. *Acer* sp. (1), *Toddalia* cf. *maerkeri* (5), *Loranthaceae* gen. (2), *Ampelopsis malvaeformis* (2), *Patrinia palaeosibirica* (1), *Cyperus* sp. (1), *Carex ungeri* (1), *Carex* sp. div. (1), *Carex* sp. 2 (2), *Carex* sp. 3 (1), *Epipremnites reniculus* (3), *Sparganium camenzianum* (4), *Carpolithus* sp. 1 (55)
		5.05–5.30	6	23–27	*Glyptostrobus brevisiliquata* (40), *Glyptostrobus europaea* (35), *Saururus bilobatus* (7), *Rumex* sp. 1 (1), *Betula* sp. 2 (fr.), *Actinidia faveolata* (2), *Actinidia* sp. (1), *Andromeda carpatica* (1), *Potentilla supina* (3), *Carex loliacea* (2), *Carex* sp. div. (2), *Carex* sp. 1 (2), *Carex* sp. 2 (3), *Epipremnites reniculus* (7), *Sparganium camenzianum* (18), *Carpolithus* sp. 1 (2)
5.5		5.30–5.55	7	28–32	*Glyptostrobus brevisiliquata* (15), *Glyptostrobus europaea* (147), *Saururus bilobatus* (1), *Rumex* sp. 1 (4), *Actinidia argutaeformis* (1), *Potentilla supina* (6), cf. *Swida* sp. (1), *Urospathites cristatus* (2), *Sparganium camenzianum* (89)
		5.55–5.80	8	33–37	*Rosellinites congregatus* (1), *Glyptostrobus europaea* (37), *Cupressospermum chamaecyparoides* (fr.), *Saururus bilobatus* (1), *Rumex* sp. 1 (1), *Rumex* sp. 2 (1), *Actinidia faveolata* (fr.), *Potentilla supina* (2), *Loranthaceae* gen. (2), *Carex* sp. 2 (1), *Epipremnites reniculus* (2), *Sparganium camenzianum* (1), *Carpolithus* sp. 1 (1)
6.0		5.80–6.05	9	38–42	*Glyptostrobus brevisiliquata* (4), *Saururus bilobatus* (1), *Betula* sp. 1 (1), *Betula* sp. 2 (fr.), *Actinidia faveolata* (fr.), *Loranthaceae* gen. (6), *Acorellus distachyoformis* (1)
		6.05–6.20	10	43–45	*Glyptostrobus brevisiliquata* (3), *Alnus sp.* (1), *Carex pseudocyperoides* (2)
		6.20–6.35	11	46–48	*Glyptostrobus europaea* (185), *Saururus bilobatus* (1), *Cyperus* sp. (1), *Carex loliacea* (1), *Carex globosaeformis* (1), *Carex* cf. *pilulifera* (7), *Carex* sp. 3 (1), *Epipremnites reniculus* (2), *Sparganium haentzschelii* (1)
6.5		6.35–6.55	12	49–52	*Glyptostrobus europaea* (128), *Saururus bilobatus* (1), *Alnus* sp. (1), *Rubus laticostatus* (1), *Scirpus sylvaticus* (1), *Carex pseudocyperoides* (1), *Epipremnites reniculus* (1), *Carpolithus* sp. 1 (1)
		6.55–6.75	13	53–56	*Trematosphaerites lignitum* (3), *Rosellinites congregatus* (1), *Saururus bilobatus* (2), cf. *Fagus* sp. (fr.), *Andromeda carpatica* (1), *Euphorbia* sp. (fr.), *Potentilla pliocenica* (1), *Potentilla supina* (12), *Carpolithus* sp. 2 (1)
7.0		6.75–7.15	–	57–63	1. 2. 3. 4. 5. 6.

Fifty-six taxa of fossil plants have been distinguished, 33 of them being identifed down to specific level, 19 to generic level and 2 to family. The numbers of families in particular units of higher order were: Fungi – 3, Coniferae – 1, Dicotyledones – 16, Monocotyledones- 4. Altogether 31 genera and 24 families have been distinguished. Three new species for the Tertiary of Poland were determined: *Toddalia* cf. *maerkeri* Gregor, *Sparganium* cf. *crassum* Nikitin, *Sparganium* cf. *tanaiticum* Dorof., and an artificial genus, *Tubela* Dorof. has been singled out.

An analysis of macrofossils allowed us to increase the list of floral taxa obtained from the Lipnica Mała sediments on the basis of the studies of sporomorphs (Tran Dinh Nghia 1974, Oszast & Stuchlik 1977). In the fossil flora of that site the authors distinguished altogether 67 genera, 23 families and 6 species of plants. The plant macrofossils examined confirmed the occurence of seven common genera (*Glyptostrobus, Cupressus, Betula, Alnus, Fagus, Acer* and *Sparganium*) and 13 common families (*Selaginellaceae, Taxodiaceae, Betulaceae, Fagaceae, Loranthaceaee, Polygonaceae, Rosaceae, Rutaceae, Aceraceae, Vitaceae, Ericaceae, Cyperaceae* and *Sparganiaceae*). On analysing the macrofossils it was possible to distinguish such genera within the common families as *Saururus, Rumex, Andromeda, Potentilla, Rubus, Toddalia, Ampelopsis, Swida, Patrinia, Stratiotes, Acorellus, Scirpus, Cyperus,* and *Carex.*

In the aggregate, 24 new taxa have been added to the floral list from Lipnica Mała and so about 21% of all the forms determined from that site.

GENERAL REMARKS

FLORA

The following groups of plants can be distinguished in the flora from Lipnica Mała with regard to their biotopic requirements:

– trees of wet and periodically inundated habitats on the bottom of the Basin: *Glyptostrobus, Alnus*

– trees of higher-lying, drier habitats: *Acer, Fagus, Magnolia*

– shrubs of wet habitats: *Andromeda, Swida*

– shrubs of drier habitats: *Rubus*

– lianas: *Actinidia, Ampelopsis, Epipremnites, Toddalia*

– herbaceous plants: *Selaginella, Euphorbia, Rumex, Potentilla, Patrinia, Viola*

– water-and-marsh herbaceous plants, on swamps, areas with periodically stagnant water and peatbogs: *Acorellus, Carex, Cyperus, Saururus, Scirpus, Sparganium, Stratiotes*

As regards its quantitative composition, the flora from Lipnica Mała is characterized by the predominance of remains of *Glyptostrobus* and various herbs growing in swamp forest and wet biotopes. This supports Łańcucka-Środoniowa's (1965) opinion that: "...the *Glyptostrobus* flora is characteristic of Orawian clays and distinctly associated with the environment of wet forests and swamps (...)".

A similar picture of flora can be observed in the palynological profile from Lipnica Mała studied by Tran Dinh Nghia (1974, Fig 3), who reffered it to the first phase distin-

guished by him in the development of vegetation in the Upper Miocene of Orawa and characterized by the dominance of swamp forests composed chiefly of *Taxodium*, *Glyptostrobus* and *Taxodiacaee-Cupressaceae* group, the proportion of which reached up to 95% in the profile. The contribution of forest communities of another type is small both in the palynological profile and in the fruit-seed flora. Only the presence of mixed deciduous forest is distinctly marked; in the pollen flora it is evidenced by fairly numerous sporomorphs of such trees as *Acer, Carpinus, Carya, Celtis, Cornus, Corylus, Engelhardtia, Fagus, Fraxinus, Juglans, Nyssa, Ostrya, Platycarya, Pterocarya, Rhus, Staphylea, Tilia* and *Ulmus* and, among macroscopic remains, the genera *Acer, Fagus* and *Magnolia*. This indicates that macrofossils represent a local flora whereas pollen spectra show the type of vegetation surrounding the area.

There is decidedly no evidence of the presence of an open water body; only one marginal fragment of a leaf of *Stratiotes* and sporomorphs of *Nymphaeaceae* have been found. These data quite agree with the geological study on the basis of which it was found that the morphological, tectonic and sedimentational conditions in Orawa had not favoured the origin of rather a large, long-lasting water reservoir in which sedimentation leading to the formation of a big coal bed would have been possible (Watycha 1976). In Orawa brown coal occurs only in discontinuous beds or lenses up to 2 m thick. Coal from the Neogene sediments of the Basin is one of few examples of brown coal in Poland and in the world containing large amounts of cutinite, which is a remnant of epithelia of arborescent vegetation (Kołcon & Wagner 1991). On the basis of close petrological studies of coal (Kołcon & Wagner op. cit.) two rare varieties have been found in the coal from Lipnica Mała: liptobioliths-detrital (stratified and containing many carbonified leaves and needles of coniferous trees) and xylitic coal (brittle xylites forming a horizon of "upright trunks" composed of stumps preserved in the position of growth and numerous slivers). Lithotypes of coal from Orawa mirror the conditions of sedimentation, the nature of plant communities and confirm the spectrum of plants obtained on the basis of palaeobotanical studies. Liptobioliths coal originated in the deeper parts of the water body, detrital coal on its periferies, in the sedge-grass and shrub belt, and xylitic coal in swamp forest.

ELEMENTS IN THE FOSSIL FLORA

In the flora from Lipnica Mała the arctotertiary element is dominant (83%), the proportion of the palaeotropical element being small (7%) and represented by the genera *Magnolia* and *Toddalia*, artificial *Epipremnites* and *Urospathites*. The following phytogeographical elements have been distinguished:

1. Panholarctic-European (*Acer, Alnus, Betula, Fagus, Swida, Acorellus, Sparganium, Stratiotes*),
2. East Asiatic-North American (*Glyptostrobus, Andromeda, Actinidia, Ampelopsis, Patrinia, Saururus*),
3. Tropical and subtropical (*Magnolia, Toddalia, Cyperus*),
4. Cosmopolitan (*Rubus, Potentilla, Rumex, Scirpus, Viola*).

The equilibrium of the proportions of particular elements with a small preponderance of the panholarctic-European element is noteworthy.

AGE OF THE FLORA

The flora-bearing deposits from Lipnica Mała were initially referred to the Upper Miocene (Tran Dinh Nghia 1974, Oszast & Stuchlik 1977). On the basis of geological (Watycha 1976) and palaeontological (Woźny 1976) studies the Orawa Beds, with a fauna of terrestial snails, were ascribed to the Middle Miocene.

In the middle part of the coal bed at Lipnica Wielka there occurs a thin tuffogenic (tonstein) layer, which made it possible more closely to determine the stratigraphic position of the Orawa Beds (Kołcon & Wagner 1991). It was preliminary correlated with an extensive tuffogenic horizon (Bochnia horizon), included in the lower part of the Upper Badenian (Alexandrowicz & Pawlikowski 1980, Matl & Wagner 1985, 1987). The Orawa Beds from Lipnica Wielka may therefore correspond to the Chodenice layers from the sub-Carpathian Foredeep. On the other hand, the profile of the Orawa Beds from Lipnica Mała is undoubtedly older, which is evidenced by the stronger tectonic committment of formations and their location on the older formation outcrop side. According to Kołcon and Wagner (1991), they may represent the upper part of the Carpatian and the lower part of the Badenian, corresponding to the Skawina layers from the western part of the sub-Carpathian Foredeep. This opinion is supported by the results of the studies of brown coal (Kołcon & Wagner 1991), the palynological spectrum of the profile from Lipnica Mała and analysis of the fruit-and-seed flora.

Both the palynological spectra of the profile and the floral composition of the samples with macrofossils indicate the domination of little diversified swamp forest composed of *Taxodiaceae* and *Nyssa* and the distinct presence of infraforest marshes and peatbogs with *Cyperaceae, Sparganiaceae, Ericaceae*, ferns and other herbaceous plants. The distribution of particular taxa in the profile (Table 2) and the course of the curves in Tran Dinh Nghia's (1974, Fig. 3) pollen diagram illustrate relatively uniform vegetation throughout the sedimentation time and give no grounds to distinguish any phases and to differentiate the age. The floristic picture is typical of the vegetation of the Carpatian-Badenian boundary and of the Badenian all over southern Poland, which is most fully documented by the flora of the same age from the Nowy Sącz Basin (cf. Łańcucka-Środoniowa 1979).

ACKNOWLEDGEMENTS

The present study was carried out under the direction of Prof. M. Łańcucka-Środoniowa to whom I owe my warmest thanks for introducing me with the Tertiary fruit-seed floras and for her much help, discussion and essential advice during the course of the work. I wish to thank Prof. L. Stuchlik for material, helpful information and for reading and improving English text. I am greatly indebted to Assist. Prof. E. Zastawniak who read the Polish text and gave valuable criticism and help in preparation of the manuscript and figures. I also thank to A. Pachoński, Dr K. Skawińska-Wieser and M. Sc. J. Wieser for their valuable assistance in making photographs and drawings.

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STRESZCZENIE

Szczątki makroskopowe roślin pochodzą z 13 prób osadu neogeńskiego (warstw orawskich) w Kotlinie Orawsko-Nowotarskiej uzyskanego z profilu geologicznego o głębokości 7,15 m. Próby obejmują łącznie 2,75 m. W stropie dominują utwory piaszczysto-żwirowe, poniżej ilaste i ilasto-lignitowe, w spągu ilasto-piaszczyste.

W całym profilu na głębokości 6,75–4,0 m stwierdzono obecność detrytusu roślinnego zawierającego obok owoców i nasion liczne nieoznaczalne fragmenty roślin i lignitów.

Wyróżniono 56 taksonów, z których 25 należy do gatunków wymarłych. Oznaczono 3 gatunki roślin zarodnikowych, 3 Gymnospermae, 11 Dicotyledones i 16 Monocotyledones. Ogółem wyróżniono 25 rodzin, 31 rodzajów i 33 gatunki.

Dominującym ekosystemem lądowym był las bagienny, monotonny florystycznie, złożony głównie z drzew *Glyptostrobus* oraz śródleśne torfowiska i zarastające mokradła, na których rosły liczne *Cyperaceae* (*Carex, Cyperus, Scirpus, Acorellus*), *Sparganium, Saururus* i inne rośliny zielne. Lasy mieszane z udziałem *Magnolia, Fagus, Acer* porastały wyżej wzniesione obrzeża Kotliny.

Poszczególne elementy fitogeograficzne są równomiernie reprezentowane w całej florze kopalnej. Na podstawie badań geologicznych (Watycha 1976), paleontologicznych (Woźny 1976) i petrologicznych węgla brunatnego (Kołcon & Wagner 1991) neogeńskie warstwy orawskie z Lipnicy Małej zaliczono do środkowego miocenu, sugerując piętro karpatian/badenian. Badania flory owocowo-nasiennej w pełni potwierdzają środkowomioceński wiek osadów.

PLATES

Plate 1

Trematosphaerites lignitum (Heer) Beck

1. Perithecium, KRAM-P No 121/113, × 26

Rosellinites congregatus (Beck) Meschinelli

2. Perithecia, KRAM-P No 121/83, × 10

Selaginella pliocenica Dorofeev

3, 4. Megaspores, KRAM-P No 121/97, × 31

Glyptostrobus brevisiliquata (Ludwig) Mai

5–7. Seeds, KRAM-P No 121/57, × 8, × 10, × 9

Glyptostrobus europaea (Brongniart) Unger

8–12. Twigs, KRAM-P No 121/56, × 10, × 6

13. Fragment of leaf surface, KRAM-P No 121/71, × 200

13a. – stomata, × 400

Cupressospermum chamaecyparoides Mai

14. Seed fragment, KRAM-P No 121/43, × 12.5

1–12, 14 Photo by A. Pachoński
13, 13a Photo by K. Skawińska-Wieser

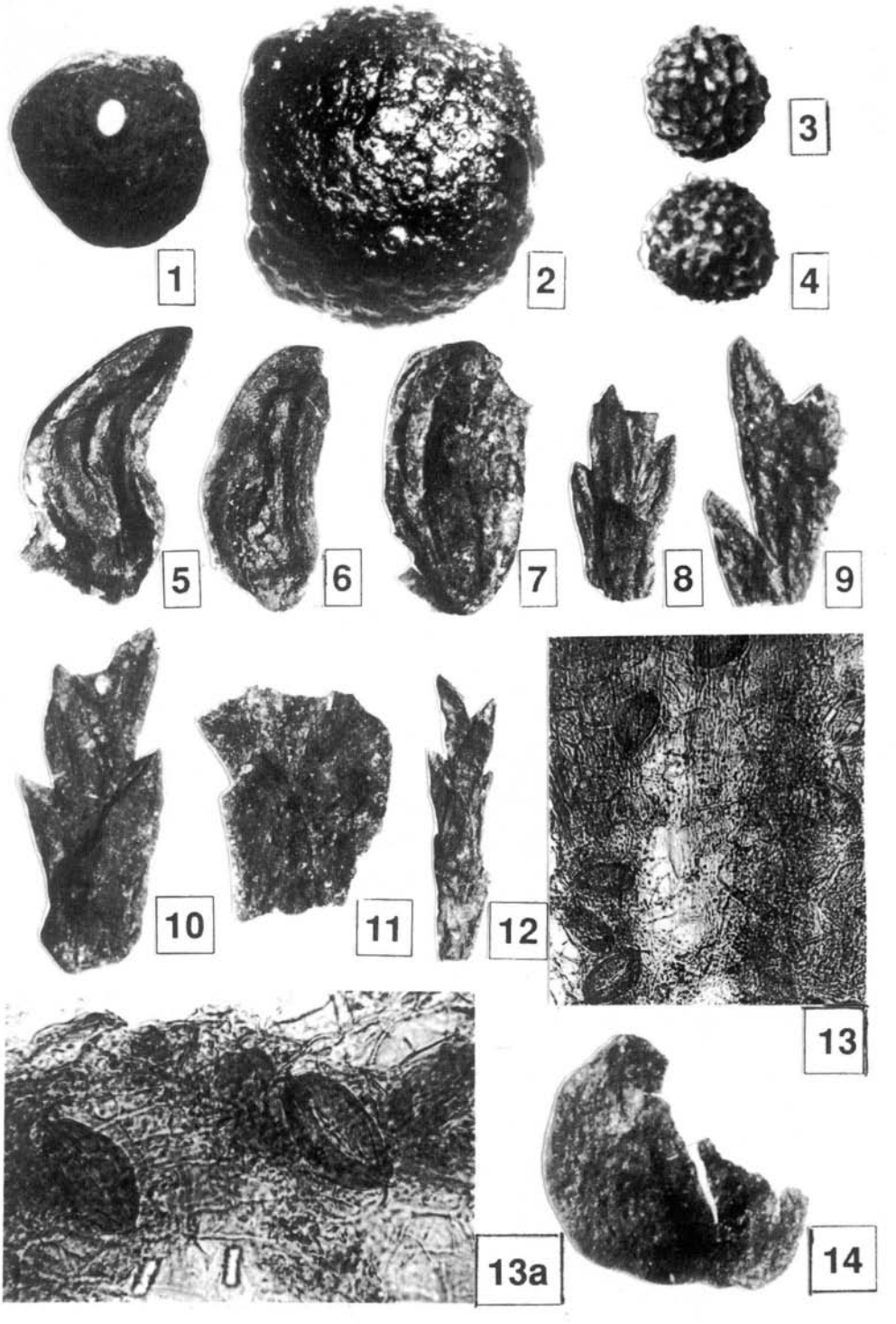
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Plate 2

Magnolia cor Ludwig

1, 1a. Half of seed from both sides, KRAM-P No 121/75, × 6.5

Saururus bilobatus (Nikitin) Mai

2. Dorsal side of fruitlet, KRAM-P No 121/88, × 21.5

3. Seed with remnant of fruitlet – ventral side, KRAM-P No 121/88, × 23

4, 5. Seeds, KRAM-P No 121/88, × 24

Rumex sp. 1

6, 7. Seeds, KRAM-P No 121/85, × 20

Rumex sp. 2

8. Seed, KRAM-P No 121/87, × 16

cf. *Fagus* sp.

9, 9a. Cupule fragment from both sides, KRAM-P No 121/55, × 9

Alnus sp.

10–12. Fruits, KRAM-P No 121/12, × 20, × 23.5, × 17

Betula sp. 1

13. Fruit, KRAM-P No 121/15, × 17

Photo by A. Pachoński

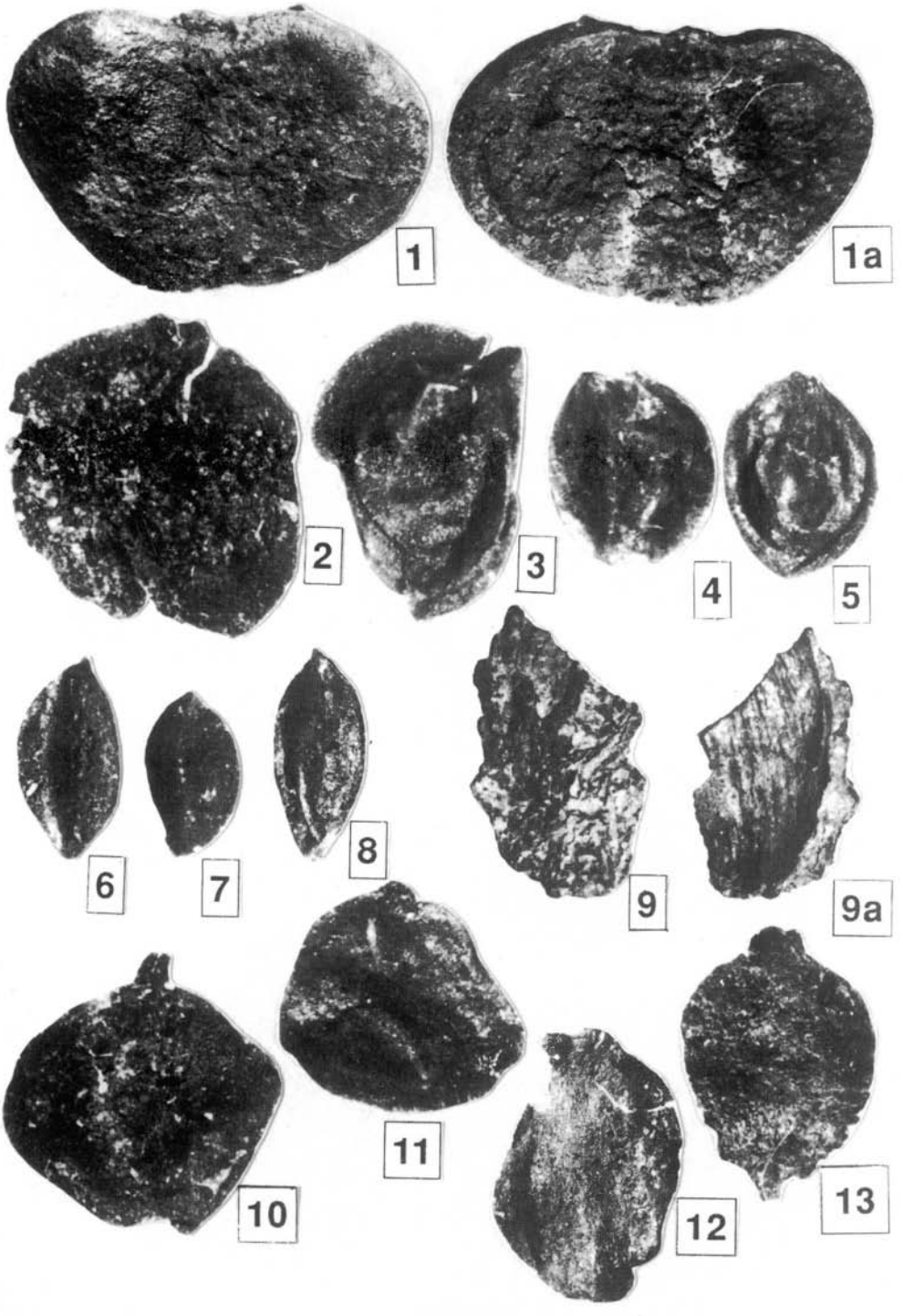

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Plate 3

Betula sp. 1

1. Fruit, KRAM-P No 121/15, × 21

Betula sp. 2

2, 3. Fruits, KRAM-P No 121/16, × 20, × 15

Tubela sp.

4. Fruit, KRAM-P No 121/115, × 19.5

Actinidia faveolata C. & E. M. Reid

5–7. Seeds, KRAM-P No 121/7, 121/8, × 15

Actinidia argutaeformis Dorofeev

8. Seed, KRAM-P No 121/6, × 16

Actinidia sp.

9. Seed, KRAM-P No 121/10, × 14

Andromeda carpatica Łańcucka-Środoniowa

10. Seed, KRAM-P No 121/14, × 23

Viola sp.

11. Seed, KRAM-P No 121/116, × 22

Euphorbia sp.

12. Seed fragment, KRAM-P No 121/54, × 19

Potentilla pliocenica E. M. Reid

13. Fruit, KRAM-P No 121/81, × 29

Potentilla supina Linné fossilis

14. Fruit, KRAM-P No 121/80, × 32

Rubus laticostatus Kirchheimer

15–18. Endocarps, KRAM-P No 121/84, × 18, × 25, × 19, × 24

cf. Acer sp.

19. Seed fragment, KRAM-P No 121/3, × 12

Toddalia cf. *maerekeri* Gregor

20, 20a. Half of seed from both sides, KRAM-P No 121/112, × 12

Photo by A. Pachoński

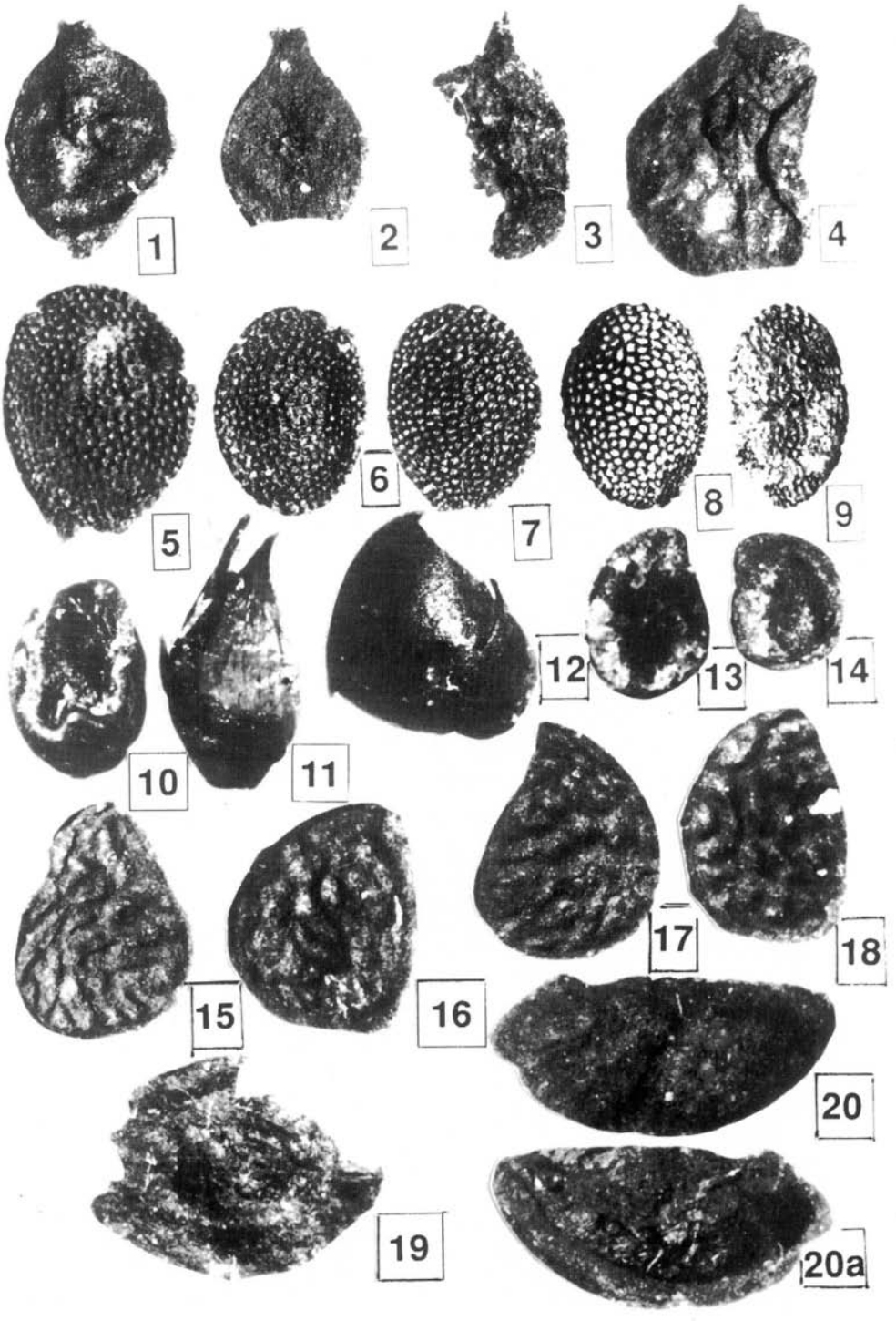
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Plate 4

Toddalia cf. *maerkeri* Gregor

1–4. Half of seeds from inner side, KRAM-P No 121/111, × 13, × 11, × 9, × 9

Loranthaceae gen.

5. Stem fragment, KRAM-P No 121/72, × 9

5a. – the same, × 200

5b. – the same, × 400

1–5 Photo by A. Pachoński
5a, 5b Photo by K. Skawińska-Wieser

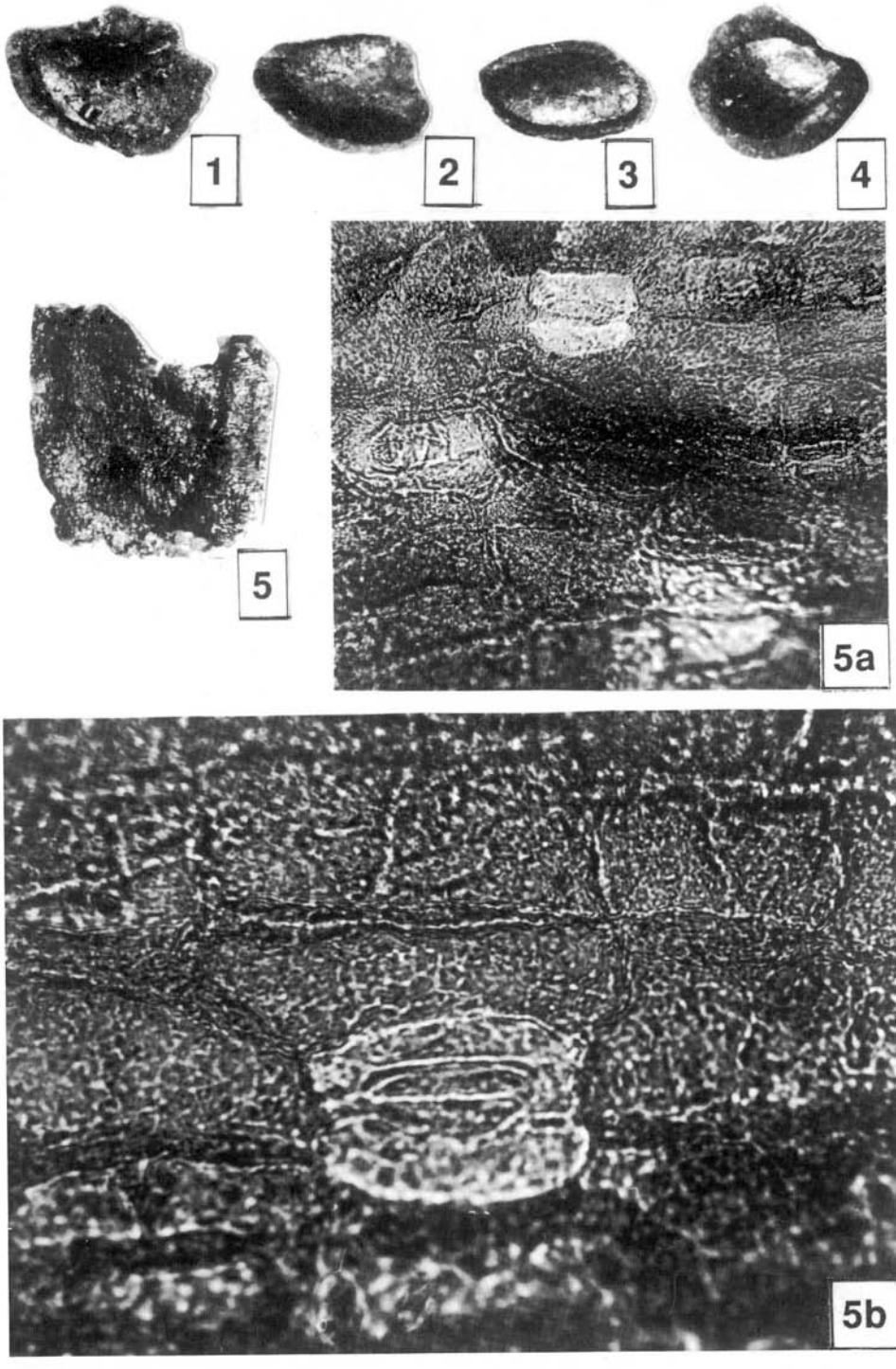
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Plate 5

Ampelopsis malvaeformis (Schlotheim) Mai

1, 1a. Half of seed from both sides, KRAM-P No 121/13, × 8

cf. *Swida* sp.

2, 2a. Fruit fragment from both sides, KRAM-P No 121/110, × 13.5

Patrinia palaeosibirica Dorofeev

3. Fruit, KRAM-P 121/77, × 20

Stratiotes sp.

4. Leaf margin tooth, KRAM-P No 121/109, × 53

Acorellus distachyoformis Łańcucka-Środoniowa

5. Fruit, KRAM-P No 121/4, × 27

Scirpus sylvaticus Linné fossilis

6, 7. Fruits, KRAM-P No 121/94, × 21

Cyperus aff. glomeratus Linné

8, 9. Fruits, KRAM-P No 121/41, × 17

Cyperus sp.

10. Fruit, KRAM-P No 121/42, × 16

Carex ungeri Mai

11. Utricle, KRAM-P No 121/26, × 19

12–16. Nutlets, KRAM-P No 121/26, 121/30, 121/31, × 16, × 17, × 16, × 15, × 15

Carex loliacea Linné fossilis

17–19. Utricles, KRAM-P No 121/24, 121/25, × 18, × 18, × 21

Carex sp. div.

20–22. Utricles, KRAM-P No 121/21, × 19, × 20, × 22

Photo by A. Pachoński

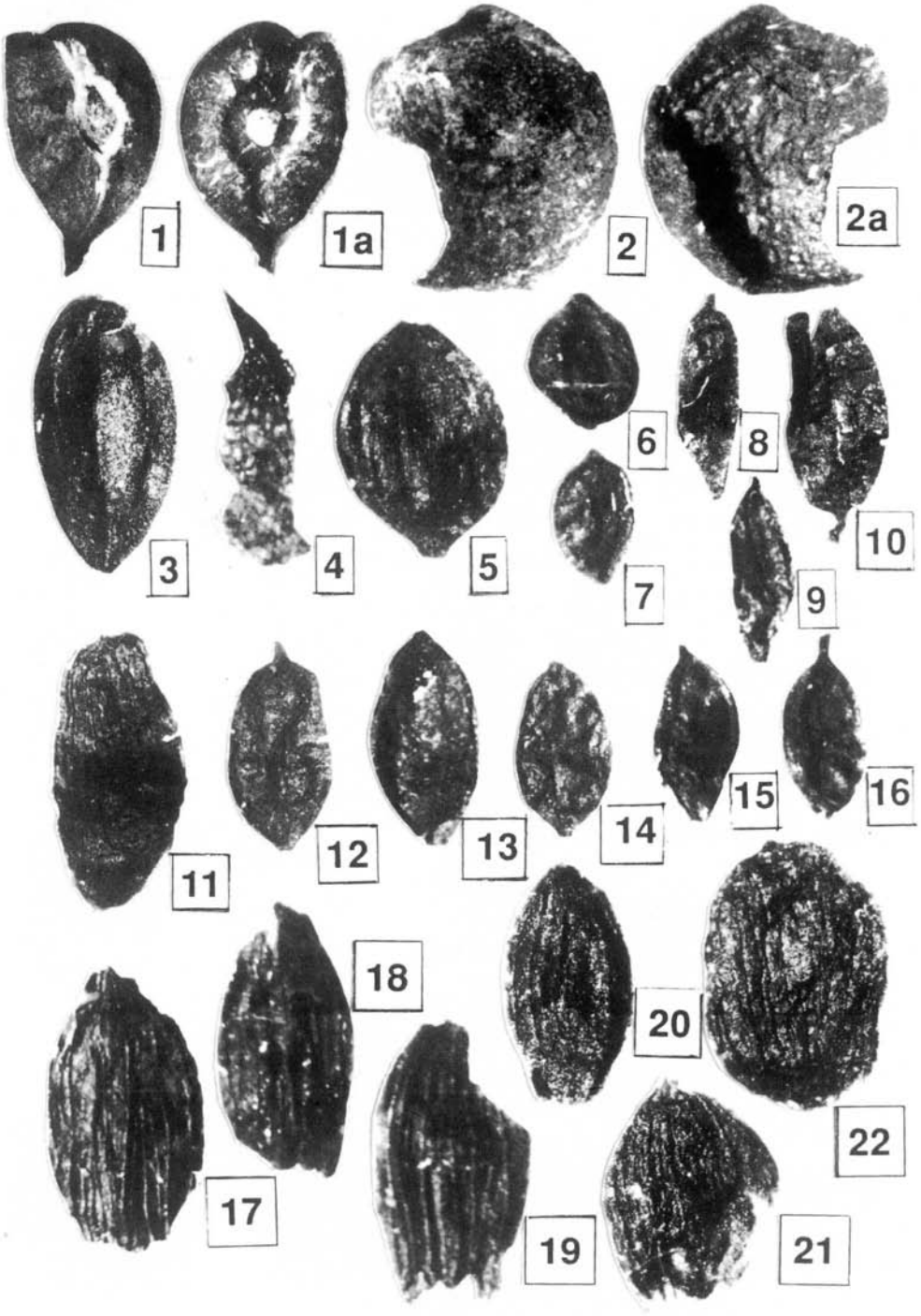

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Plate 6

Carex globosaeformis Łańcucka-Środoniowa

1. Nutlet, KRAM-P No 121/18, × 19

Carex pseudocyperoides Łańcucka-Środoniowa

2–7. Nutlets, KRAM-P No 121/27 – 121/29, 2–5: × 23, 6 & 7: × 20

Carex acutiformis Ehrhardt fossilis

8. Nutlet, KRAM-P No 121/17, × 22

Carex cf. *pilulifera* Linné fossilis

9–12. Nutlets, KRAM-P No 121/20, × 19, × 20, × 22, × 22

Carex sp. 1

13, 14. Nutlets, KRAM-P No 121/22, 121/23, × 21.5, × 23

Carex sp. 2

15–19. Nutlets, KRAM-P No 121/32–121/35, × 19.5, × 19.5, × 17.5, × 18.5, × 19.5

Carex sp. 3

20. Nutlet, KRAM-P No 121/23, × 15

Cyperaceae gen.

21. Fruit, KRAM-P No 121/40, × 21

Epipremnites reniculus (Kirchheimer) Mai

22–25. Seeds, KRAM-P No 121/48, 121/49, × 10

Photo by A. Pachoński

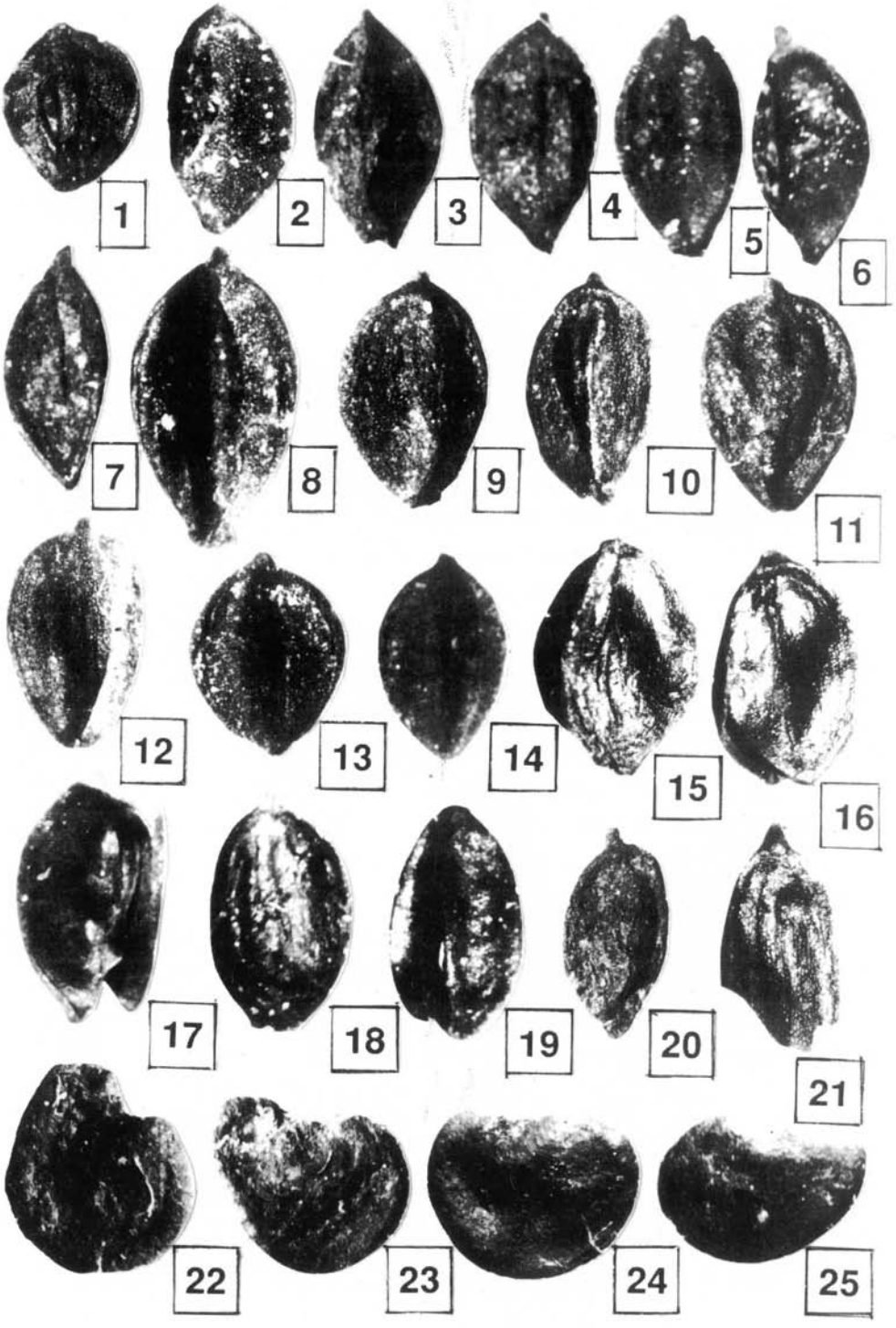
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Plate 7

Epipremnites reniculus (Kirchheimer) Mai

1–3. Seeds, KRAM-P No 121/42, 121/49, × 10, × 12, × 15

Urospathites cristatus Gregor & Bogner

4–6. Seeds, KRAM-P No 121/44, × 15, × 17, × 20

Sparganium camenzianum Kirchheimer

7–11. Endocarps, KRAM-P No 121/100, 7, 8 & 11: × 20, 9 & 10: × 20.5

Sparganium haentzschelii Kirchheimer

12, 13. Endocarps, KRAM-P No 121/104, × 11, × 10

Sparganium neglectum Beeby fossilis

14. Endocarp, KRAM-P No 121/106, × 16

Sparganium cf. crassum Nikitin

15. Endocarp, KRAM-P No 121/103, × 16

Sparganium cf. *tanaiticum* Dorofeev

16. Endocarp, KRAM-P No 121/107, × 13

Sparganium sp.

17. Endocarp, KRAM-P No 121/108, × 26

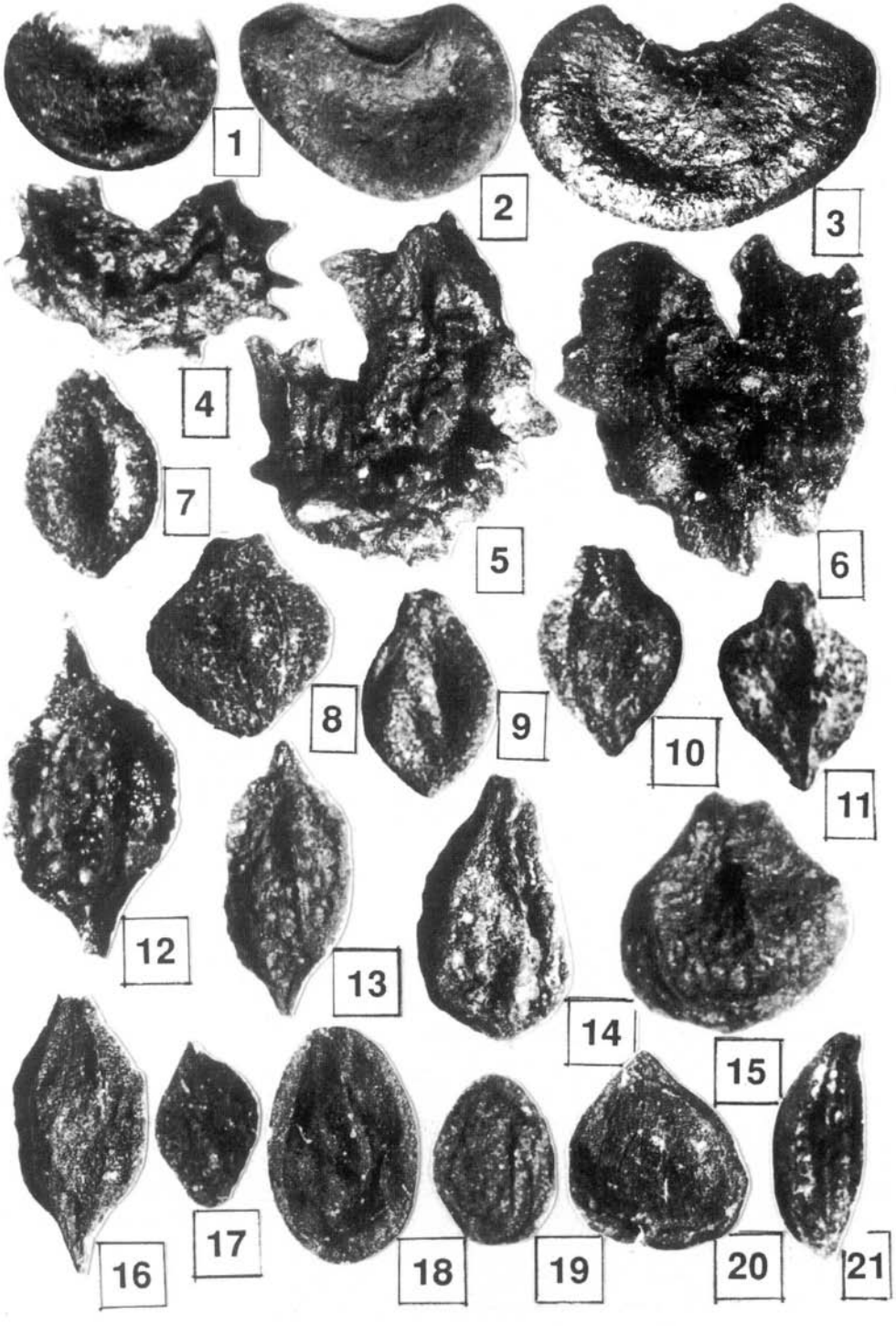
Carpolithus sp. 1

18–20. Fossil remains, KRAM-P No 121/117, × 18, × 19, × 15

Carpolithus sp. 2

21. Fossil remain, KRAM-P No 121/120, × 27

Photo by A. Pachoński



M. Lesiak
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