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MACROSCOPIC PLANT REMAINS FROM THE FRESHWATER MIOCENE OF THE NOWY SĄCZ BASIN (WEST CARPATHIANS, POLAND) *

Szczątki makroskopowe roślin z miocenu słodkowodnego Kotliny Sądeckiej (Karpaty Zachodnie, Polska)

ABSTRACT. The work contains the results of a study on the macroscopic plant remains from the freshwater deposits of the Miocene of the Nowy Sącz Basin referred to the younger Carpathian on the basis of geological and palynological investigations. The flora includes 111 taxa, of which 46 are extinct species. Thirty-nine taxa new to the Tertiary of Poland have been distinguished and 14 new fossil species described. The results of this study on the macroflora do not, in principle, contradict the stratigraphy accepted so far, although they contain some data suggesting that this flora is somewhat younger.

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* Praca wykonana w ramach planu PAN 26. 3. 2. c

INTRODUCTION

The Neogene deposits occurring in an area of c. 70 km² in the Nowy Sącz Basin have been investigated by many geologists during the last 90 years. They vary both in lithology (freshwater, brackish and marine deposits) and in stratigraphy.

The brackish deposits and the marine ones, overlying them, are referred to the transgression of the Tortonian Sea and assigned to the Lower Badenian (formerly Lower Tortonian). The freshwater deposits that fill the bottom of the Basin are somewhat older, since they have been regarded on the basis of geological and palynological data (Oszczypko & Stuchlik 1972) as the younger part of the Carpathian (formerly Upper Helvetian).

The freshwater deposits play a dominant role in the Nowy Sącz Basin and, as has been shown by deep-borings, are sometimes of considerable thickness. In 1972 Stuchlik carried out a spore-pollen analysis of samples from profile I at Nowy Sącz and from several outcrops and shallow borings (Biegonice, Dąbrówka Polska, Krzaki Gostwickie, Niskowa and Stadła). These samples contained also small macroscopic plant remains, chiefly those of fruits and seeds, the study of which is the objective of the present work.

I wish to express my warmest thanks to all that helped me during my investigations and then to Mrs. Z. Baranowska-Zarzycka for identifying mosses, Prof. S. Kapuściński for his help in determining coprolites of insects and numerous excrescences (zoocecidia), Assist. Prof. B. Gumińska for her remarks on the determination of fungi and, last not least, Prof. J. Raniecka-Bobrowska, Dr P. I. Dorofeev (Leningrad), Dr D. H. Mai (Berlin), Dr Z. Kvaček and Dr Č. Bůžek (Prague) for discussing some of my determinations. I am also indebted to Mr. A. Pachoński and Mrs. L. Łuczko for preparing photographs.

My heartfelt thanks go also to Assist. Prof. L. Stuchlik, from whom I received macroscopic remains derived from samples of borehole I at Nowy Sącz, Mgr M. Wąs for providing samples from borehole II, and my husband, Prof. A. Środoń, to whose advice and critical remarks this work owes very much.

I. GENERAL PART

GEOLOGY

Most of the macroscopic plant remains from the freshwater Miocene deposits in the Nowy Sącz Basin were derived from borehole I, located in the Pleistocene terrace of the River Dunajec at Nowy Sącz in 1963. It pierced a 5-metre stratum of Pleistocene clays and gravels and a 535-metre stratum of Miocene deposits. The geological profile of borehole I at Nowy Sącz is presented after Oszczypko & Stuchlik (1972). Two series of Miocene deposits can be distinguished in it: a clayey-sandy upper series (c. 400 m in thickness), which consists of marly shales, often divided by layers of sand and brown-coal sheds, and a lower series (140 m thick) of mudstones and sands, divided at a depth of 422 — 483 m by big blocks of flysch glauconitic sandstones and marlstones. In all these types of deposits there were varied amounts of fine plant detritus and varied numbers of lignitic fragments.

From borehole Nowy Sącz II, performed by the Geological-Engineering Enterprise in Cracow 200 m west of borehole Nowy Sącz I in 1956, I received samples from depths ranging from 2·5 to 71·0 m for palaeobotanical examination. They were obtained from the sandy-clayey layers of the so-called upper series with a shed of brown coal at a depth of 47·8—50·0 m. Nearly all samples used for study contained relatively much plant detritus and many lignitic fragments varying in size.

The samples from outcrops and shallow borings represented sandy-clayey deposits with brown coal intercalations and were also nearly all obtained from the upper series at 9 localities situated in the region of Nowy Sącz and Stary Sącz, i.e. at Biegonice, Dąbrówka Polska, Falkowa, Gołąbkowice, Gołkowice, Krzaki Gostwickie, Niskowa, Nowy Sącz-Błonie and Stadła. Moreover, a considerable number of these samples contained plant detritus and lignitic fragments.

Both freshwater Miocene series filling the bottom of the Nowy Sącz Basin are now referred to the younger part of the Carpathian. Only the deposits from Niskowa are somewhat younger and belong to the Badenian (cf. Oszczypko & Stuchlik 1972).

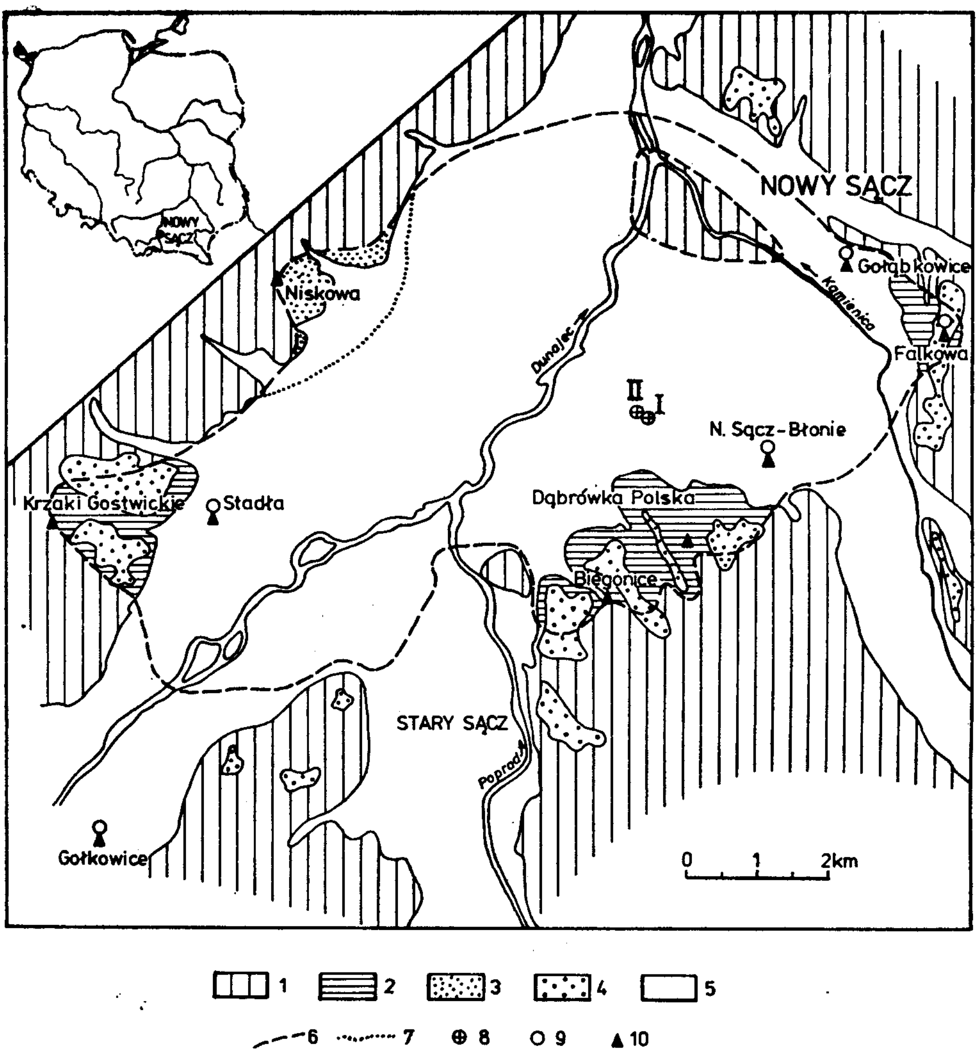

Fig. 1. Distribution of the Miocene deposits in Nowy Sącz Basin (after Oszczypko & Stuchlik 1972, slightly changed): 1 — Magura Nappe deposits; 2 — Miocene fresh-water deposits; 3 — Miocene brackish and marine deposits; 4 — Quaternary gravels of the uppermost terrace; 5 — Quaternary loams, sands and gravels of lower terraces; 6 — extent of the Miocene deposits; 7 — extent of brakish and marine deposits; 8 — boreholes Nowy Sącz I and Nowy Sącz II; 9 — shallow boreholes; 10 — sites of samples examined by palaeobotanical analysis

MATERIAL AND REMARKS ON METHOD

The deposit samples designed for examination of macroscopic plant remains contained in them were derived from boreholes I (NS. I: 365 samples) and II (NS. II: 40 samples) at Nowy Sącz and from different outcrops and shallow borings (40 samples).

Sample numbers	Depth in m	Lithology	Locality	Plant remains: Detritus	Plant remains: Lignite	Determined: No. of remains	Determined: No. of taxons	Name of taxons and number of specimens
1			BIEGONICE – outcrop	-	-	-	-	
2			"	+	+	-	-	
3			"	+	+	-	-	
4			"	-	-	-	-	
5			"	+	+	-	-	sclerots
6			DĄBRÓWKA POLSKA – outcrop	+	+	-	-	
7			" "	+	+	-	-	
8			" "	+	+	-	-	sclerots
9			" "	-	-	-	-	
10			FALKOWA – bore-hole	++	++	-	-	buds, roots, sclerots
11			"	++	++	-	-	buds, roots, sclerots
12			"	+	+	-	-	
13	5.5 - 8.0		GOŁĄBKOWICE – bore-hole	++	++	6	4	Epipremnum crist. (1), Lycopus (2), Selaginella (1), Trematosphaerites (2)
14	11.2-11.5		GOŁKOWICE – bore-hole	-	+	-	-	
15	11.5-12.2		"	-	+	-	-	
16			KRZAKI GOSTWICKIE – outcrop	-	+	-	-	
17			" "	-	+	-	-	
18			" "	-	+	-	-	
19			" "	-	-	-	-	
20			" "	-	-	-	-	
21			" "	+	+	-	-	
22			" "	-	-	-	-	
23			" "	+	+	-	-	
24			" "	+	+	-	-	
25			" "	+	+	-	-	sclerots
26			" "	-	-	-	-	
27			" "	+	++	-	-	
28			NISKOWA – outcrop	-	-	-	-	
29	18.0		" bore-pit	+	+	15	4	Actinidia fav. (1), Andromeda (11), Rubus latic. (2), Vaccinium (1), cocons, coprolites
30			"	+	++	-	-	
31			"	+	+	16	4	Cupressaceae gen. 3(1), Decodon (3), Glyptostrobus (1), Stratiotes (11), cocons, sclerots
32			"	-	++	-	-	
33	8.4 - 9.5		NOWY SĄCZ-BŁONIE – bore-hole	-	+	-	-	
34	9.5-10.5		" "	+	+	2	2	Glyptostrobus (1), Sparganium neglec. (1), buds, galls, sclerots
35	9.7-10.0		" "	+	-	-	-	
36	10.5-12.0		" "	-	+	-	-	
37	> 12.0		" "	+	+	-	-	sclerots
38	7.2 - 8.0		STADŁA – bore-hole	+	-	5	1	Trematosphaerites (5), sclerots
39	8.0 - 9.4		"	+	+	-	-	
40	9.4-10.0		"	-	+	-	-	
			Total	23	30	44		Total 13 taxons

Fig. 4. Macroscopic plant remains from outcrops and shallow boreholes in Nowy Sącz Basin: 1 — sand; 2 — clay; 3 — gravel; 4 — brown coal; 5 — plant remains; 6 — animal remains

The samples from profile NS. I were taken from its upper part (from 4 to 270 m) at regular one-metre intervals and below at larger and irregular intervals (1·2—2·5 m and even 3·0—5·8 m), as owing to compensation the core decreased in size. No samples were taken for palaeobotanical analysis from the complexes of flysh blocks occurring in the lower series (at depths of 437—457 m) and from the bottom part of this series (503—531 m and 535—540 m).

The samples that I received from profile NS. II had been taken at various, mostly one- or two-metre intervals, but occasionally they were spaced at much greater distances (4·0—6·5 m).

Nearly all samples, notably those from boreholes, contained plant remains, mostly strongly carbonized often also mineralized. These were generally wood pieces (lignites) and fine plant detritus (fruits, seeds, fragments of leaves, mosses, buds, roots, sclerotia and fructifications of fungi, zoocecidia, etc.). The whole vegetable material from each sample was examined under a low power binocular microscope, which made it possible to detect many very fine remains. Many of the remains were in a very bad state of preservation, which often prevented me from carrying out anatomical studies and in consequence unfavourably influenced taxonomic estimations. The amount of vegetable material varied from sample to sample and the number and size of lignites increased conspicuously in the horizons with brown coal inserts. Lignites have not been determined since the elaboration of usually very fine and ill-preserved specimens would call for separate studies.

The detailed results of study of the macroscopic remains from the Miocene deposits of the Nowy Sącz Basin are presented in three successive figures: Fig. 2 — Nowy Sącz I, Fig. 3 — Nowy Sącz II and Fig. 4 — outcrops and shallow borings. The documentary material from the borings made it possible to draw a detailed geological profile only for site NS. I. I had no such materials for profile NS. II at my disposal but, as this represents the top part of the upper series and is situated in the close neighbourhood of NS. I, I managed to correlate the particular layers.

An analysis of Figs. 2—4 permits us to trace the occurrence of identified taxa in the profiles and to find relationships between the abundance of plant detritus and the sort of deposits. It has been found that:

1. Vegetable material occurs in deposits of all sorts (brown coal, varicoloured sandy and marly clays, varigrained sands, breezes and shales) but it varies in amount.

2. There is a distinct relationship between the occurrence of plant material and the sort of deposit. The brown coal inserts generally provide quite a lot of lignites and detritus, but few identifiable remains, whereas most of the determined remains come from sandy clays.

3. No relationship has been observed between the amount of vegetable material obtained and the number of remains determined. Many samples with abundant plant detritus contained only few remains that could be determined.

4. There is also no relationship between the amount of vegetable material and the length of the section from which the sample has been obtained. The samples taken every one metre from borehole NS. I have sometimes several tens of determinable remains, whereas those from several-metre-long sections are very poor in this respect.

A quantitative comparison of the results of study concerning the occurrence of macroscopic plant remains is presented in Table 1. It shows that although vegetable material was present in nearly all samples from the deep-borings, the identifiable remains occurred in only a half of samples from profile NS. I and more than a half of samples from profile NS. II. The samples from this last site were besides richer as regards the number of specimens. The samples from the outcrops and shallow borings were the poorest and provided only 2·4% of the total of the specimens determined.

Table 1

Occurrence of macroscopic plant remains in the Miocene of the Nowy Sącz Basin. The number of specimens includes complete remains and their fragments

Locality	Samples			Plant material								
				Detritus indetermined		Lignites		Remains determined				
	Examined	Containing plant material	No plant material	Number of samples	%	Number of samples	%	Number of samples	%	Number of specimens	%	Indeterminatae
Nowy Sącz I	365	360	5	303	83·5	317	82·3	178	85·6	1276	69·8	28
Nowy Sącz II	40	38	2	37	10·2	38	9·9	25	12·0	508	27·8	±30
Outcrops and shallow boreholes	40	32	8	23	6·3	30	7·8	5	2·4	44	2·4	2
Total	445	430	15	363	100·0	385	100·0	208	100·0	1828	100·0	±60

LIST OF TAXA DETERMINED

The macroscopic plant remains found in the Miocene of the Nowy Sącz Basin belong to 111 taxa (Table 2). The accuracy of determination is various: 64 taxa (57·7%) have been determined to specific level, 30 (27·0%) to generic level, 10 (9·0%) to the level of family and 7 (6·3%) to that of higher systematic units.

Forty-nine families and 60 genera are represented in the material, among them only one extinct genus, whereas most of the 64 species distinguished are extinct (46 or 72%). In the flora examined 39 taxa are new to the Tertiary of Poland (35% of the taxa distinguished) and 14 new fossil species are described (cf. Table 2). The quantitative data concerning the occurrence of the above-mentioned groups of taxa in the samples from the deep-borings and outcrops are given in Table 3.

The survey shows a strikingly large number of taxa (including extinct species, the species described for the first time and those new to the Tertiary of Poland) found in a relatively small number of samples from profile NS. II.

Table 2

List of plant macrofossils determined from the Miocene deposits of the Nowy Sącz Basin
Abbreviations: a – anther; co – cone; fr – fruit; fruc – fructification; infl – inflorescence; l – leaf; msp – megaspore; r – root; s — seed

		Type of remains	Number of specimens	Nowy Sącz I	Nowy Sącz II	Outcrops and shallow borings	Extinct genera	Extinct species	New described species	Taxons new to the Tertiary of Poland	Taxons new to the Tertiary
	SCHIZOMYCETES										
1	*Actinomyces alni* Harz	r	3	+	+						
	FUNGI										
2	*Trematosphaerites lignitum* (Heer) Mesch.	fruc	59	+	+	+		+			
3	cf. *Hysterium* sp.	fruc	3	+							
4	*Microthyriaceae*	fruc	57	+	+						
5	*Pyrenomycetes* gen. 1	fruc	1		+						
6	*Pyrenomycetes* gen. 2	fruc	1		+						
7	*Pyrenomycetes* gen. 3	fruc	1		+						
8	*Pyrenomycetes* gen. 4	fruc	1		+						
9	*Polyporites* sp.	fruc	4		+						
	MUSCI										
10	*Neckera* cf. *complanata* (Hedw.) Hüb.	l	1	+							
11	*Anomodon* sp.	l	1	+							
12	*Amblystegium serpens* (Hedw.) B. S. G.	l	1	+						+	+
13	*Eurhynchium speciosum* (Brid.) Jur.	l	1	+						+	+
14	*Musci* gen.	l	3	+							
	LYCOPODINAE										
15	*Selaginella pliocenica* Dorof.	msp	19	+	+	+		+			
	CONIFERAE										
16	*Glyptostrobus europaeus* (Brongn.) Unger	l, s, co	792	+	+	+		+			
17	*Chamaecyparis* cf. *pisifera* (S. & Z.) Endl.	co	2	+							

18	*Cupressaceae* gen. 1	l	1	+							
19	*Cupressaceae* gen. 2	l	1	+							
20	*Cupressaceae* gen. 3	s	1			+					
21	*Pinaceae* gen. 1	l	1	+							
22	*Pinaceae* gen. 2	l	1	+							
	ANGIOSPERMAE — DICOTYLEDONES										
23	*Carpinus betulus* L.	fr	3	+	+						
24	*Betula* sp. 1 (sect. *Albae* Rgl.)	fr	2		+						
25	*Betula* sp. 2	fr	1		+						
26	*Alnus* sp.	fr, infl	11	+	+						
27	*Broussonetia pygmaea* Dorof.	fr	5	+	+			+			
28	*Eucommia* sp.	l	10	+							
29	*Boehmeria* cf. *sibirica* Dorof.	fr	14	+	+			+			
30	cf. *Pilea* sp.	fr	1		+						
31	*Polygonum aviculare* L. s. l.	fr	2	+							
32	*Polygonum* cf. *convolvulus* L.	fr	1	+							
33	*Rumex* sp. 1	fr	2	+	+						
34	*Rumex* sp. 2	fr	1	+							
35	*Phyllanthus* sp.	s	2	+	+						
36	*Cercidiphyllum crenatum* (Ung.) Brown	fr	6		+			+			
37	*Magnolia* cf. *cor* Ludwig	s	4	+	+			+			
38	*Ranunculus* cf. *reidi* Szafer	fr	2		+			+			
39	*Thalictrum* sp.	fr	1		+						
40	*Brasenia* sp.	s	1		+			+			
41	*Viola rimosa* Nikitin	s	1		+			+		+	
42	*Viola* sp. 1	s	16	+	+						
43	*Viola* sp. 2	s	1		+						
44	*Viola* sp. 3	s	7		+						
45	*Actinidia faveolata* C. & E. M. Reid	s	9	+	+	+		+			
46	*Actinidia argutaeformis* Dorof.	s	1	+				+		+	
47	*Hypericum* aff. *maculatum* Cr.	s	1	+						+	+
48	*Hypericum* cf. *tertiaerum* Nikitin	s	1		+			+		+	
49	*Hydrangea polonica* Łańc.-Środ.	s	4		+			+	+	+	+
50	*Rubus laticostatus* Kirchh.	fr	21	+	+	+		+			
51	*Rubus microspermus* C. & E. M. Reid	fr	45	+	+			+			
52	*Rubus semirotundatus* n. sp.	fr	9	+	+			+	+	+	+

Table 2. Continued

		Type of remains	Number of specimens	Nowy Sącz I	Nowy Sącz II	Outcrops and shallow borings	Extinct genera	Extinct secies	New described species	Taxons new to the Tertiary of Poland	Taxons new to the Tertiary
53	*Rubus* aff. *occidentalis* L.	fr	2	+	+						
54	*Potentilla pliocenica* E. M. Reid	fr	4	+	+			+			
55	*Potentilla* cf. *supina* L.	fr	1	+						+	
56	*Alchemilla* sp.	fr	1		+					+	+
57	*Decodon gibbosus* (E. M. Reid) Nikitin	s, fr	12	+	+	+		+			
58	*Microdiptera* cf. *parva* Chandl.	s	1	+			+	+		+	
59	*Phellodendron* sp.	s	1		+						
60	cf. *Acer* sp. div.	fr, s	2	+	+						
61	*Aralia rugosa* Dorof.	fr	3		+			+		+	
62	*Aralia* cf. *ucrainica* Dorof.	fr	4	+	+			+		+	
63	*Aralia tertiaria* Dorof.	fr	2	+				+		+	
64	*Aralia* sp.	fr	1		+						
65	*Schefflera dorofeevii* Łańc.-Środ.	fr	2	+				+	+	+	+
66	*Hydrocotyle* sp.	fr	1		+					+	+
67	*Primulaceae* gen.	s	1	+							
68	*Vaccinium minutulum* n. sp.	s	2		+	+		+	+	+	+
69	*Andromeda carpatica* n. sp.	s	164	+	+	+		+	+	+	+
70	cf. *Galium* sp.	fr	1	+						+	
71	*Gratiola tertiaria* Łańc.-Środ.	s	4		+			+	+	+	+
72	*Lycopus* cf. *antiquus* E. M. Reid	fr	16	+	+	+		+			
73	*Menyanthes* cf. *trifoliata* L.	s	1	+							
74	*Sambucus lucida* Dorof.	s	72	+	+			+		+	
75	*Patrinia palaeosibirica* Dorof.	fr	1	+				+		+	
76	*Campanula palaeopyramidalis* Łańc.-Środ.	s	3	+				+	+	+	+
77	*Campanula* sp.	s	1		+					+	+

	ANGIOSPERMAE — MONOCOTYLEDONES										
78	*Stratiotes kaltennordheimensis* (Zenk.) Keilh.	s	11			+		+			
79	*Potamogeton* aff. *polygonifolius* Pourr.	fr	2	+						+	+
80	*Potamogeton* sp. (subsect. *Colorati*)	fr	1	+							
81	*Najas marina* L.	s	1	+							
82	*Cyperus* sp. 1	fr	1		+						
83	*Cyperus* sp. 2	fr	2	+	+						
84	*Cyperus* sp. 3	fr	3	+							
85	*Acorellus distachyoformis* Łańc.-Środ.	fr	15	+	+			+	+	+	+
86	*Scirpus sylvaticus* L.	fr	35	+	+						
87	cf. *Trichophorum* sp.	fr	1	+							
88	*Cyperaceae* gen. 1 (cf. *Rhynchospora*)	fr	1	+						+	+
89	*Cyperaceae* gen. 2 (cf. *Eriophorum*)	fr	2		+					+	
90	*Carex* cf. *elongata* L.	fr	5	+	+					+	
91	*Carex elongatoides* n. sp.	fr	7	+	+			+	+	+	
92	*Carex* aff. *loliacea* L.	fr	9	+	+					+	+
93	*Carex* sp. 1 (sect. *Heleonastes*)	fr	2	+	+						
94	*Carex* sp. 2	fr	1	+							
95	*Carex globosaeformis* n. sp.	fr	2	+				+	+	+	+
96	*Carex strigosoides* n. sp.	fr	8	+	+			+	+	+	+
97	*Carex* cf. *acutiformis* Ehrh.	fr	2		+					+	
98	*Carex flavaeformis* n. sp.	fr	3	+				+	+	+	+
99	*Carex plicata* n. sp.	fr	72	+	+			+	+	+	+
100	*Carex pseudocyperoides* n. sp.	fr	21	+	+			+	+	+	+
101	*Gramineae* gen.	fr	3		+						
102	*Epipremnum crassum* C. & E. M. Reid	s	3	+				+		+	
103	*Epipremnum cristatum* Nikitin	s	2	+		+		+			
104	*Sparganium camenzianum* Kirchh.	fr	26	+				+			
105	*Sparganium haentzschelii* Kirchh.	fr	1	+				+			
106	*Sparganium neglectum* Beeby foss.	fr	13	+	+	+					
107	*Typha* cf. *elliptica* Negru	s	3		+			+			
108	*Typha* cf. *fusisperma* Negru	s	2		+			+			
109	*Typha* cf. *pliocenica* Dorof.	s	4	+	+			+		+	
110	*Carpolithus* sp.		116	+							
111	*Antherites* sp.	a	5		+						
	Total		1828	77	69	13	1	46	14	39	23

Table 3

Extinct taxa, newly described and new to the Tertiary of Poland, occurring in the Miocene of the Nowy Sącz Basin

Locality	Taxa distinguished (total — 111)	Taxa occurring only at given locality	Extinct species (total — 46)	Species newly described (total — 14)	Taxa new to the Tertiary of Poland (total — 39)	Number of samples examined
Nowy Sącz I	77	39	34	11	28	365
Nowy Sącz II	68	30	33	10	23	40
Outcrops and shallow boreholes	13	2	11	2	2	40

The macroscopic plant remains preserved in the freshwater Miocene deposits of the Nowy Sącz Basin indicate a great floristic differentiation of the vegetation of those times. The list of the plants determined (Table 2) contains members of the following systematic groups:

Cryptogamae — 9 families, 8 genera, 5 species
Gymnospermae — 3 families, 2 genera, 2 species
Angiospermae —
a) *Dicotyledones* — 29 families, 38 genera, 34 species
b) *Monocotyledones* — 8 families, 11 genera, 22 species.

Small and often inconspicuous herbs, and not trees or shrubs, predominate in the composition of the vegetation studied, in which they form 69·44 or nearly 70% of the taxa distinguished (Table 4).

CHARACTERISTICS OF FOSSIL FLORA

Plant communities

The occurrence of a large number of taxa represented by single specimens makes it difficult to reconstruct the picture of the Miocene vegetation of the study area. There are only a few species represented by considerable numbers of specimens and then in many samples, about which it may be stated that they played a major role in the plant communities of those times. These are, above all, *Glyptostrobus europaeus* (792 specimens) out of the trees, *Rubus* (77 specimens) out of the shrubs, *Andromeda carpatica* (164 specimens) out of the small shrubs, and the genera *Carex* (132 specimens) and *Sparganium* (40 specimens) out of the herbs.

An analysis of the full list of plants found in the Miocene of the Nowy Sącz Basin permits the reconstruction of a fairly clear picture of the Miocene vegetation of the study area (Table 5). It shows the dominance of plants associated with very moist habitats (marsh and peatbog plants, plants growing at riversides and by water reservoirs, and those of somewhat higher lying damp forests). There is also evidence of the existence of open water reservoirs in some periods (*Brasenia* in profile NS. II, *Stratiotes* in a sample from Niskowa, *Najas* and *Potamogeton* in profile NS. I). Relatively few plants are associated with dry habitats of the hills that surrounded the bottom of the Basin (14 taxa or c. 12 %).

Analysis of macroscopic plant remains supplements and enriches the picture of vegetation obtained on the basis of the results of palynological analyses (Oszczypko & Stuchlik 1972). The swampy forests that covered the bottom of the Nowy Sącz Basin for a long time, played an important part in the landscape and provided material for formation of brown coal beds, which varied in thickness. They were monotonous forests, composed nearly exclusively of trees of the genus *Glyptostrobus*. Their remains, consisting of leafed twigs, single leaves (needles), seeds and cone fragments, occur in various, often considerable numbers at depths ranging from 349 to 30 m of the upper series of the Miocene of the Basin. No macroscopic remains of the genus *Taxodium* have been found in any of the samples, which is a symptomatic fact, indicative of the lack of this tree in the close neighbourhood of the sedimentation reservoir.

The abundance of herbs characteristic of swamps and peatbogs proves the occurrence of plant communities of this type at the edges of swamp forests. Members of the family *Cyperaceae* (chiefly sedges — *Carex*) and species of the genera *Sparganium*, *Typha* and *Andromeda* prevailed in these communities.

The uplands surrounding the Nowy Sącz Basin were occupied by plant communities, varying in composition with environmental conditions (cf. Table 5). They were characterized by a low proportion of coniferous trees and shrubs, which (except for the genus *Glyptostrobus*) have been found present on the basis of only 6 poorly preserved specimens from all the samples examined. The results of analyses of the macroflora seem to indicate that the uplands, not very high, surrounding the Basin, were covered by deciduous and mixed forests with a small addition of coniferous trees and shrubs.

However, the palynological analysis shows a greater diversity of coniferous trees and, above all, a high proportion of pollen grains of *Pinus*, particularly *P. sylvestris* type (Oszczypko & Stuchlik 1972, Fig. 4 and Table 1), which often dominate over the group *Taxodiaceae-Cupressaceae*, so characteristic of Miocene diagrams. This high percentage of the genus *Pinus* is associated by these authors with the occurrence of pine forests, occupying dry upland habitats round the Basin. The entire absence of macroscopic remains of the genus *Pinus* from 445 samples collected at different localities in the Basin suggests that these pine forests were probably situated at a rather long distance from the sedimentation reservoir.

The flora of the Miocene of the Nowy Sącz Basin is relatively rich. It includes a total of 179 taxa, of which 68 have been distinguished in palynological studies and 111 on the basis of macroscopic remains presented in this paper. Only 8 taxa

Table 5

Plant communities represented in the Miocene flora of the Nowy Sącz Basin on the basis of macroscopic and pollen analyses

Aquatics	Swamps and peat-bogs	Riverside thickets	Mixed forests	Plants of dry and rocky habitats	Plants from unknown habitats	
Brasenia sp. Najas marina Potamogeton aff. polygonifolius Potamogeton sp. Stratiotes kaltennordheimensis	Acorellus distachyoformis Actinomyces alni Alnus sp. Andromeda carpatica Boehmeria cf. sibirica Carex cf. acutiformis C. cf. elongata C. elongatoides C. flavaeformis C. aff. loliacea C. pseudocyperoides Carex sp. 1 Carex sp. 2 Cyperaceae 1 (cf. Rhynchospora) Cyperaceae 2 (cf. Eriophorum) Cyperus sp. 1 Cyperus sp. 2 Cyperus sp. 3 Decodon gibbosus Epipremnum crassum E. cristatum Glyptostrobus europaeus Gratiola tertiaria Hydrocotyle sp. cf. Hysterium sp. Lycopus antiquus Menyanthes cf. trifoliata Microdiptera parva Musci gen. Scirpus sylvaticus Sparganium camenzianum	Acorellus distachyoformis Actinidia argutaeformis A. faveolata Actinomyces alni Alchemilla sp. Alnus sp. Amblystegium serpens Aralia rugosa A. cf. ucrainica Betula sp. 2 Boehmeria cf. sibirica Carex cf. acutiformis C. flavaeformis C. pseudocyperoides C. strigosoides Carex sp. 2 Cercidiphyllum crenatum Chamaecyparis cf. pisifera Cyperus sp. 1 Cyperus sp. 2 Cyperus sp. 3 Eurhynchium speciosum Hydrangea polonica Lycopus antiquus Magnolia cf. cor cf. Pilea sp. Polygonum aviculare Potentilla cf. supina Ranunculus cf. reidi Rubus Rumex sp. 1 Rumex sp. 2 Sambucus lucida Schefflera dorofeevii Scirpus sylvaticus	Acer sp. div. Actinomyces alni Alnus sp. Amblystegium serpens Anomodon sp. Aralia tertiaria Aralia sp. Betula sect. Albae Betula sp. 2 Broussonetia pygmaea Carex strigosoides Carpinus betulus Cercidiphyllum crenatum Chamaecyparis cf. pisifera Eucommia sp. Magnolia cf. cor Neckera complanata Phellodendron sp. Pinaceae gen. 1 (Abies, Tsuga) Rubus laticostatus R. semirotundatus Sambucus lucida Selaginella pliocenica Vaccinium minutulum Viola	Amblystegium serpens Campanula palaeopyramidalis Campanula sp. Carex globosaeformis Cupresaceae gen. 1 Cupressaceae gen. 2 Cupressaceae gen. 3 Hypericum aff. maculatum Patrinia palaeosibirica Pinaceae gen. 2 Polygonum cf. convolvulus Potentilla pliocenica Rubus aff. occidentalis Viola	Carex plicata Galium sp. Gramineae Hypericum cf. tertiaerum Microthyriaceae Phyllanthus sp. Polyporites sp. Primulaceae Pyrenomycetes gen. 1 Pyrenomycetes gen. 2 Pyrenomycetes gen. 3 Pyrenomycetes gen. 4 Trematosphaerites lignitum	Macroflora

	S. haentzschelii *S. neglectum* *Thalictrum* sp. cf. *Trichophorum* sp. *Typha* cf. *elliptica* *T.* cf. *fusisperma* *T.* cf. *pliocenica* *Viola*	*Sparganium camenzianum* *S. haentzschelii* *S. neglectum* *Viola*				
Total: 5 taxons	39 taxons	39 taxons	25 taxons	14 taxons	13 taxons	
Nympheaceae	*Alnus* *Cyperaceae* *Equisetum* *Ericaceae* *Glyptostrobus* *Nyssa* *Sphagnum* *Taxodiaceae-Cupressaceae* *Taxodium*	*Alnus* *Anthocerotaceae* *Araliaceae* *Betula* *Carya* *Celtis* *Cyrillaceae* *Cyperaceae* *Engelhardtia* *Myrica* *Platycarya* *Pterocarya* *Salix* *Ulmus* *Vitis*	*Abies* *Acer* *Alnus* *Betula* *Botrychium* *Carpinus* *Castanea* *Castanopsis* *Corylus* *Cryptomeria* *Cyatheaceae* *Dacrydium* *Engelhardtia* *Ericaceae* *Gleicheniaceae* *Hymenophyllaceae* *Ilex* *Lygodium* *Mohria* *Osmundaceae* *Picea* *Polypodiaceae* *Quercus* *Sciadopitys* *Selaginella* *Symplocaceae* *Tilia* *Tsuga*	*Botrychium* *Castanea* *Castanopsis* *Cupressus* *Ephedra* *Lycopodium* *Pinus* t. *haploxylon* *Pinus* t. *sylvestris* *Quercus* *Rhamnus* *Rhus*	*Campanulaceae* *Caryophyllaceae* *Chenopodiaceae* *Compositae* *Gramineae* *Labiatae* *Leguminosae* *Myrtaceae* *Ranunculaceae* *Rubiaceae* *Sapotaceae* *Umbelliferae*	Sporomorphs
Total: 1 taxon	9 taxons	15 taxons	28 taxons	11 taxons	12 taxons	

are common to both these groups: *Acer*, *Alnus*, *Betula*, *Carpinus*, *Cyperaceae*, *Glyptostrobus*, *Gramineae* and *Selaginella*. There is a distinct difference between the results obtained by two different methods of investigation. The palynological studies enriched the list of trees and shrubs considerably (42 taxa, of which only a few present also among 31 taxa distinguished on the basis of the macroflora), whereas the macroscopic study provided a long list of herbs, phanerogams (61 taxa — among them many species — against 11 families distinguished on the basis of sporomorphs). The palynological analysis revealed, among other things, the abundance of different ferns, and the macroscopic analysis the presence of mosses, fungi and various types of excrescences, indicating a variety of insects. The results of studies made by these two methods give a picture of luxuriant vegetation, diversified as regards its composition, which covered the Basin and the uplands surrounding it in the Miocene (cf. Tables 4 and 5).

Geographical elements

Better insight into the nature of the Miocene vegetation of the study area can be acquired by an analysis of the distribution and climatic requirements of the contemporary species more or less closely related to the fossil forms (Table 6). This was possible in the case of 73 taxa or 65·8% of the forms distinguished by the macroscopic analysis. The list given in the table contains also extinct species (11 taxa) whose modern counterparts are not known but whose climatic requirements it was possible to determine in approximation.

A striking fact shown by this list is the great geographical differentiation of the components of the flora and its distinct and close relationship with the vegetation of Eurasia. In particular, the vegetation of eastern and south-eastern Asia contains relatively many species to which the fossil remains can be compared.

The fossil flora of the Nowy Sącz Basin comprises numerous taxa, the modern counterparts of which are distributed widely in various regions of the world or show likeness to fairly many species living in various areas. These taxa can contribute only little to the considerations on the geographical elements of the flora. The fossil taxa for which we can find modern counterparts with a limited range form a good basis for analyses of this type. They show that 5 fossil taxa are related to the vegetation of the American mainland, 27 are connected with Eurasia (5 taxa with Europe and 16 with eastern and south-eastern Asia) and 1 taxon with Indo-Malaya (this last number would be probably higher if we were able to find counterparts for all extinct species).

The percentage occurrence of particular geographical elements of the fossil flora confirms the opinion expressed above that its bulk is made up of plants related to the vegetation of Eurasia. Their proportion is 81·8%, of which 15·1% falls to Europe and 48·5% to eastern and south-eastern Asia (cf. Table 6). These are naturally approximate values, which would probably undergo a change if we had a better knowledge of the vegetation of the subtropical and tropical zones.

Remarks on climate

An analysis of the climatic requirements of the modern species corresponding to the taxa from the Miocene of the Nowy Sącz Basin permits an approximate evaluation of the climate of those times. With the division into temperate, subtropical and tropical climates, suggestions with regard to climatic requirements have been acquired for 84 taxa from the Miocene of Nowy Sącz Basin. The data in Table 6 show that the most numerous plants are connected with the subtropical climate (57 taxa — 67·85%), out of which 27 plants are confined exclusively to the subtropical climate, 19 tolerate also the temperate climate and 9 the tropical. The group of plants of the temperate climate is also numerous (44 taxa — 52·38%) and consists of 26 plants associated exclusively with the temperate climate and 18 plants that occur in addition in the subtropics. The plants of the tropical climate form the smallest group (12 taxa — 14·28%), which contains two true tropical forms and 10 plants which occur also in the subtropics.

In the light of this analysis it may be assumed that in the Miocene, from which the flora described here is derived, the climate prevailing in the Nowy Sącz Basin was warm temperate to subtropical, with high rainfall.

COMPARISON WITH OTHER NEOGENE FLORAS OF POLAND

Only floras containing more or less numerous fruits and seeds have been taken into consideration — the Miocene floras from 14 localities and the Pliocene ones from only 4 localities (Table 7). In this table the taxa resembling each other but not identical are marked with the letter *x* and those not recorded hitherto from the given locality with the letter *o*. The comparison includes 69 taxa, since the remaining 42 ones do not occur in other Neogene floras of Poland or have been determined only in approximation, which makes any comparisons impossible.

Table 8

Stratigraphic distribution of taxa from the Nowy Sącz Basin against their occurrence in other Neogene floras of Poland

Taxa	Taxa from the Nowy Sącz Basin linked up to:	
	Miocene	Pliocene
Known only from the Miocene (25)	25	—
Known from the Miocene and Pliocene (29)	29	29
Known only from the Pliocene (6)	—	6
Known from the Miocene troughout the Pleistocene (6)	6	6
Total	60	41

Table 9

Stratigraphical ranges of some plants recorded in the Miocene deposits of Nowy Sącz Basin

	Name of plants	Cretaceous	Palaeocene	Eocene	Oligocene	Miocene	Pliocene	Pleistocene		Extinct
1	Glyptostrobus europaeus	—	—	—	—	**—**	—			+
2	Cercidiphyllum crenatum	- -	- -	—	—	**—**	—			+
3	Microdiptera cf. parva			—	—	—				+
4	Decodon gibbosus			—	—	—	- -			+
5	Viola rimosa				—	—				+
6	Brasenia sp. (aff. B. ucrainica, victoria)				—	—				+
7	Sambucus lucida				—	—				+
8	Stratiotes kaltennordheimensis				- -	**—**				+
9	Phyllanthus sp. (aff. Ph. triquetra, compassica)				—	—	—			+
10	Aralia rugosa				—	—	—			+
11	Epipremnum cristatum				—	—	—			+
12	Rubus microspermus				—	—	—			+
13	Lycopus cf. antiquus				—	—	- -			+
14	Actinidia argutaeformis				—	—	- -			+
15	Aralia tertiaria				—	—	- -			+
16	Actinidia faveolata				—	—	—	—		+
17	Eucommia sp.				- -	—	—	- -		
18	Epipremnum crassum				—	**—**				+
19	Broussonetia pygmaea				—	—	—			+
20	Typha pliocenica				—	—	—			+
21	Carpinus betulus				- -	—	—	—		
22	Sparganium camenzianum					—				+
23	Sparganium haentzschelii					—	- -			+
24	Hypericum aff. maculatum					- -				
25	Hypericum cf. tertiaerum					—	—			+
26	Patrinia palaeosibirica					—	—			+
27	Potentilla pliocenica					—	—			+
28	Trematosphaerites lignitum					—	—			+
29	Actinomyces alni					—	—	—		
30	Chamaecyparis cf. pisifera					—	—	—		
31	Magnolia cf. cor					—	—	—		+
32	Najas marina					—	—	—		
33	Menyanthes cf. trifoliata					- -	—	—		
34	Carex cf. acutiformis					- -	- -	—		
35	Typha cf. elliptica					—				+
36	Typha fusisperma					—				+
37	Selaginella pliocenica					—	—			+
38	Rubus laticostatus					—	—			+
39	Scirpus sylvaticus					—	—	—		+
40	Aralia ucrainica					—				+
41	Rubus semirotundatus					—				+
42	Schefflera dorofeevi					—				+
43	Vaccinium minutulum					—				+
44	Acorellus distachyoformis					—	—			+
45	Andromeda carpatica					—	—			+
46	Boehmeria sibirica					—	—			+
47	Neckera cf. complanata					—	—	—		
48	Polygonum aviculare s. l.					—	—	—		
49	Polygonum cf. convolvulus					—	—	—		
50	Sparganium neglectum					—	—	—		
51	Potentilla cf. supina						—			
52	Ranunculus cf. reidi						—			+
53	Rubus aff. occidentalis						—			
54	Carex elongatoides						- -			+
55	Carex cf. elongata						—	—		
56	Potamogeton aff. polygonifolius						—	—		
57	Amblystegium serpens							—		
58	Eurhynchium speciosum							—		
	Total	2	2	4	21	51	43	18		

The most taxa shared with the flora of the Nowy Sącz Basin occurred in the Miocene floras of Zatoka Gdowska (26 taxa), Czarny Dunajec (26 taxa) and Koniówka (27 taxa) and the Pliocene flora of Domański Wierch (24 taxa). The relatively large number of taxa that the Nowy Sącz Basin and the above-mentioned localities have in common (it may increase still more when the elaboration of the flora from Czarny Dunajec, Koniówka and Domański Wierch has been completed) is partly connected with the here adopted method of searching for fossils under a low power binocular microscope, which permits picking up very fine remains, often overlooked in the floras worked out earlier.

In comparisons of the Miocene flora from the Nowy Sącz Basin with other Neogene floras of Poland the number of common taxa is of no decisive importance, because it is dependent, among other things, on the sort of deposits, the nature of flora and even the methods used to obtain remains. On the other hand, it is important that most taxa, 60 in number, from the Nowy Sącz Basin are associated with Miocene floras of Poland and fewer (41) with Pliocene ones (Table 8).

A comparison of the biostratigraphic ranges of some components of the flora from the Nowy Sącz Basin in the scale of the whole world leads to the same conclusion (Table 9). Such comparisons were possible for 58 taxa. Their occurrence is in most cases associated with the Miocene (51 taxa), somewhat less frequently with the Pliocene (43 taxa). There are considerably fewer taxa known from floras older than the Miocene (21) and younger than the Pliocene (18). These data suggest the Miocene origin of the flora from the Nowy Sącz Basin.

There are 19 species (two of them do not grow in Europe at present) comparable with those living today or such as have survived from the late Tertiary up to now. The percentage ratio of the occurrence of the so-called indigeneous elements to that of the exotic elements, calculated on this basis, is 28·80:71·20%. The proportion of the exotic elements would probably be greater if all the components of the flora could be determined to specific level.

REMARKS ON THE AGE OF FLORA

In the light of the recently expressed opinions on the stratigraphy of the Miocene formations of the Nowy Sącz Basin, based on the results of geological and palynological studies (Oszczypko & Stuchlik 1972; Oszast & Stuchlik 1977), the deposits discussed here belong to two periods of the Miocene:

1. The brackish deposits (clays with brown coal) from Niskowa represent the Badenian (formerly termed the Lower Tortonian).

2. Freshwater deposits (clayey-sandy and mudstone-sandy) from boreholes NS. I and NS. II, outcrops and shallow borings date from the Carpathian (formerly termed the Upper Helvetian).

The macroscopic plant remains obtained from these deposits (Table 10) do not provide firm bases for distinguishing the two periods of the Miocene.

Table 10

Occurrence of macroscopic plant remains in two stages of the Miocene of the Nowy Sącz Basin

Stages of the Miocene	Nowy Sącz Basin	Depth	Number of samples examined	Remains determined		Number of taxa distinguished	Taxa		Remarks on vegetation
				Number	%		Common to two stages or two series	Occurring only in given stage or series	
				1828	100·0				
Badenian	Niskowa	outcrop, bore-pit	5	31	1·7	9	7	2	Four taxa known from floras older than the Miocene are present. Species occurring: *Rubus laticostatus* and *Sparganium neglectum*.
Karpatian	Upper series: Nowy Sącz I Nowy Sącz II Outcropsand shallow bore-holes	to 400 m	415	1660	90·8	101	12	89	18 taxa known from floras older than the Miocene are present. Species occurring: *Rubus laticostatus*, *microspermus*, *occidentalis*, *semirotundatus* and *Sparganium haentschelii*, *camenzianum*, *neglectum*. Single extinct genus — *Microdiptera*.
	Lower series: Nowy Sącz I	400 – 540 m	25	137	7·5	20	12	8	4 taxa known from floras older than the Miocene are present. Species occurring: *Rubus laticostatus*, *Sparganium camenzianum*. Genus *Glyptostrobus* lacking.

The amounts of the material examined were very unequal and for this reason it cannot be claimed that in the Badenian deposits from Niskowa (5 samples) there are fewer „older" taxa than in the Carpathian deposits from the remaining localities of the Nowy Sącz Basin (440 samples). It can only be stated on the basis of different species of the genera *Rubus* and *Sparganium* that the species occurring at Niskowa are chiefly those known from floras younger than the Miocene.

The two geologically distinguished series of deposits of the Carpathian, the so-called upper and lower series, do not contain any macrofloral indicators which might give evidence of the stratigraphic differentiation of these formations (Table 10). Taxa known from floras older than the Miocene occur in both series (their considerably smaller number in the lower series is partly explained by the small number of samples examined and the different type of deposits; the only extinct genus, *Microdiptera*, comes from the upper series). The results of macroscopic analysis are in this case consistent with those of the palynological analyses carried out by Stuchlik, according to whom, in palynological profile NS. I no important differences have been observed in floral composition between the samples from the bottom and those from the top.

Summarizing the results of macroscopic analyses, we may state that the Miocene flora of the Nowy Sącz Basin is characterized by:

the predominance of Arctic-Tertiary plants,

a low proportion of Lower Tertiary forms and extinct genera,

a close relationship with the Pliocene vegetation,

a high proportion of herbs, and

a considerable proportion of species comparable with those living at present.

In view of these features it would be more justified to assign the whole flora under study to the Badenian and not Carpathian. It should be added that the fossil flora preserved in the beds of salt at Wieliczka and referred to the Badenian contains many Lower Tertiary elements, e. g. *Mastixicarpum, Mastixia, Durania, Alangium, Engelhardtia, Symplocos* and *Toddalia.*

On the other hand, however, macroscopic remains alone do not make a sufficient basis for dating, since in our case they represent the local flora (chiefly marshy and littoral), have been obtained from samples small in volume, and the taxa that have not been determined to specific level or identified at all may be „older" forms. Moreover, the older age of the flora examined is suggested by the climatic data (Table 6), which show that this was the vegetation of a climate ranging from warm-temperate to subtropical, characteristic of the Carpathian (Oszast & Stuchlik 1977).

In the light of geological, palaeontological and palynological studies the flora of the Nowy Sącz Basin represents the Carpathian, and thus it would be the oldest and so far only link among the Neogene floras of southern Poland. The results of studies on the macroflora do not, in principle, contradict this opinion, although they contain elements suggesting a somewhat younger age of this flora.

SYSTEMATIC PART

SCHIZOMYCETES

Actinomyces alni Harz

Localities: NS. I: 133, 139
NS. II: 30

Material: 3 root fragments

Description. Small fragments (2 mm) of characteristically thickened roots, furnished with slight beak-shaped eminence at top.

Occurrence. Remains known mainly from the Pleistocene of Europe, but also found in the Pliocene (Krościenko — Szafer 1947) and Miocene localities (Stare Gliwice — Szafer 1961 and Zatoka Gdowska — Łańcucka-Środoniowa 1966).

FUNGI

Remains of fungi have frequently been found in the Miocene deposits of the Nowy Sącz Basin, both in samples from borings and those from outcrops. The most numerous remains are fine sclerotia and fructifications of parasitic fungi preserved on small fragments of leaf blades.

Sclerotia

Localities: NS. I: 32, 39, 44, 45, 54—56, 58, 60, 64, 66—69, 77, 91, 113, 139, 145, 171, 188, 193, 228, 247, 249, 266, 271, 280, 286, 287, 293, 301, 303, 332
NS. II: 15, 17—21, 23, 27—34, 38—40
Falkowa, Niskowa, Nowy Sącz-Błonie, Stadła

ASCOMYCETES

Family **Amphisphaeriaceae**

Trematosphaerites lignitum (Heer) Mesch.

Pl. I, figs. 1—4

Localities: NS. I: 30, 39, 42, 53, 56, 58, 61, 90, 278, 293, 347, 351
NS. II: 18, 31, 33, 37, 40
Gołąbkowice, Stadła

Material: Single perithecia set on 6 lignite pieces (NS. I: 42, 58 and NS. II: 33) and a large number of perithecia detached from their bases.

Description. Perithecia smooth, conical (sometimes laterally flattened), with small apertures at the top, which are traces left after the falling-out of the ostioles. The perithecium diameter is 0·4—0·8 mm at the base, in two specimens exceptionally 1·0—1·2 mm. All the perithecia being apically open or detached from the base, no spores are available.

Occurrence. Remains often recorded from the Tertiary of Europe, in Poland known from the Pliocene (Krościenko — Zabłocka in Szafer 1947, and Domański Wierch — Łańcucka-Środoniowa 1963) and Miocene (Wieliczka — Zabłocka 1931, Turów — Skirgiełło 1961, Jabłonka and Zatoka Gdowska — Łańcucka-Środoniowa 1963, 1966).

Family **Hysteriaceae**

cf. ***Hysterium*** sp.

Pl. I, figs. 5, 5a

Locality: NS. I: 233

Material: 3 fruit-bodies

Description. 3 elongate and narrow fruit-bodies (0·36—0·43 × 0·1—0·12 mm), opening along the longitudinal suture, have been preserved on the outer side of a leaflet of *Glyptostrobus europaeus*. They are somewhat indented equatorially and rounded at both ends. The fruit-bodies cling flatly to the surface of the leaf and have no additional sheath coalesced with the host tissue.

Comparison. Similarly built fruit-bodies occur in the family *Hysteriaceae* and are called hysterothecia. When sporeless, they cannot be determined more closely, because, in addition to the genus *Hysterium*, we may be concerned here with other genera, e.g. *Hysterographium* and *Gloniopsis*. This determination may cause doubt also because the present-day genera of the family *Hysteriaceae* live on branches and bark of trees (Dennis 1960), whereas the fruit-bodies under description are placed on a leaf of *Glyptostrobus europaeus*.

Fungi of the family *Hysteriaceae* have been known from the Tertiary for a long time and recorded under the name of *Hysterites* (Unger 1847; Goeppert

1855). The fruit-bodies of *H. labyrinthiformis*, described by Unger from the Miocene of Croatia (Unger 1847, Pl. I, fig. 1) occur on a large leaf, they are very long, narrow and distributed regularly densely beside each other. The determination calls for revision. The fruit-bodies of *H. serialis* Goepp., found at Sośnica on a leaf of *Salix varians* Goepp. (Goeppert 1855, Pl. I, figs. 1, 2) are also considerably larger than the specimens from Nowy Sącz. The drawing included shows that their length must have been about 1·0 mm.

Fruit-bodies similar to those from Nowy Sącz and somewhat larger (0·2—1·5 mm long) have been described from the Miocene of the Chomutov-Most-Teplice Basin as cf. *Hysterographium* sp. (Bůžek & Holý 1964). They occur on wood or bark. Recently, Friis (1976) has recorded a fruit-body of *Hysterographium* (?) sp. from the Miocene of Fasterholt in Denmark.

Occurrence. Genus new to the Tertiary. Fruit-bodies having a similar (but it is not known if identical) structure have been reported from the late Tertiary of Europe, in Poland from Sośnica (Goeppert 1855 sub *Hysterites serialis* Goepp.).

Family **Microthyriaceae**

Pl. II, figs. 1—5

Localities: NS. I: 42, 63—65, 276, 277, 279, 286, 300—302, 319
NS. II: 33

Material: Numerous fructifications on 57 small fragments of systematically indeterminate leaves and on many leaves of *Glyptostrobus europaeus* (Brongn.) Unger (not visible before maceration, not included in the list of samples).

Remarks. The material has not been worked out in detail, as there was not the faintest chance to obtain correct determinations because of its poorly seen anatomical structure. *Callimnothallus pertusus* Dilcher, described till lately as the alga *Phycopeltis microthyrioides* Kirchh. (cf. Dilcher 1965), probably occurs here among other species.

Occurrence. Fine fructifications of the fungi of the family *Microthyriaceae* are often mentioned from Tertiary floras. In Poland they have been found at Stare Gliwice (Szafer 1961), Zatoka Gdowska, Rypin and Chyżne (Łańcucka-Środoniowa 1966, and materials in prep.).

Pyrenomycetes gen. 1

Pl. I, fig. 6

Locality: NS. II: 31
Material: 1 lignitic fragment with traces of perithecia
Description. On the surface of a largely compressed piece of lignite (5·0 ×

5·0 mm) there are small pits, 0·25 × 0·4 mm in diameter, irregularly scattered or distributed close to each other, probably traces left after detached perithecia.

Pyrenomycetes gen. 2

Pl. I, figs. 7a, 7b

Locality: NS. II: 18

Locality: NS. II: 14

Material: 1 piece of lignite

Description. A piece of lignite, 1·9 × 1·4 × 0·3 mm, with 9 small perithecia, conical in shape and about 0·2 mm in diameter, situated close to each other, and a large number of pits left by the perithecia that had fallen out on one side, while on the other side there are only pits, and even these somewhat shallower. It was impossible to study the structure of spores, for all the perithecia preserved are opened at the top after the falling-out of the ostiole.

Pyrenomycetes gen. 3

Pl. I, fig. 8

Locality: NS. II: 33

Material: 1 piece of lignite

Description. This piece of lignite (2·0 × 3·5 mm) clearly shows a flat eminence of irregular shape, with sparsely scattered, very small, circular and oval pits, 0·1 mm in diameter, which are in all probability traces of detached perithecia.

Pyrenomycetes gen. 4

Pl. I, figs. 9a, 9b

Locality: NS. II: 22

Material: 1 fragment

Description. A small fragment of a fungus, 1·3 × 0·8 × 0·15 mm in dimensions. On one side it has 3 funnel-shaped pits, about 0·1 mm in diameter. Cracks radiate from each of them and form a characteristic ornamentation. On the opposite side there are 3 small appertures, corresponding to the pits of the upper side.

BASIDIOMYCETES

Family **Polyporaceae**

Polyporites sp.

Pl. I, figs. 10a, 10b

Locality: NS. II. 18
Material: 4 fragments of hymenophores
Description. One fragment, 4·0×2·0, and three other ones, 2·0×1·5 mm, their thickness being about 0·5 mm. Pores irregular, about 0·2—0·4 mm in diameter and with thick walls. Traces of tubes can be seen at the side.
Occurrence. This taxon is known from Miocene floras and so is the genus *Polyporus*, whose hymenophore it resembles.

MUSCI

Small pieces of leafed stems of mosses have been found in several samples (NS. I: 48, 63, 65, 275, 277, 294 and 319). The material is scanty and very fragmentary, the shape of particular leaves usually hard to define, but the cellular structure of some specimens is fairly well seen. Mrs. Z. Baranowska-Zarzycka has distinguished four different taxa in this material.

Family **Neckeraceae**

Neckera cf. ***complanata*** (Hedw.) Hüb.

Pl. II, fig. 6; Pl. III, fig. 2

Locality: NS. I: 294
Material: 1 stem
Description. The fairly well preserved apical piece of a stem, 3 mm long. The leaves are ovate - elongate, apically lengthened and unrounded, entire and without ribs.
Comparison. Now this species is widely distributed in Eurasia, North Africa and North America. It occurs on shady rocks and on trunks of deciduous trees.
Occurrence. Species known from the Pliocene and Pleistocene floras of Europe (Boureau 1967), reported also from the Miocene of Stare Gliwice (Szafran 1958). Remains of *Neckera* sp. have been obtained from the Tortonian of Zatoka Gdowska (Szafran 1964).

Family **Thuidiaceae**

Anomodon sp.

Pl. II, fig. 8; Pl. III, fig. 3

Locality: NS. I: 319
Material: 1 fragmentary stem

Description. A piece of a stem, 4 mm long, only with fragments of leaf bases, furnished with strong ribs. The cells of these basal parts of leaf blades are roundish-hexagonal and their lumina are largely verrucated (4—7 verrucae, round and cylindrically elongated).

Comparison. Lack of at least one whole leaf makes it hard to determine the specific level of this fragment. An important diagnostic character is the nature of verrucation of the cells in the base of leaf blades, suggesting the species *A. viticulosus* (Hedw.) Hook. et Tayl. (Watanabe 1972). The specific determination is made difficult not only for the fragmentary state of the specimen but also because the similarly abundant verrucation of cells in the basal portion of leaf blades occurs in such East-Asiatic species as *A. giraldii* C. Muell. and *A. minor* subsp. *integerrimus* (Mitt.) Iwatsuki (Watanabe 1972).

Today *A. viticulosus* grows in Europe (more rarely in the north, reaching to 69°N latitude) and Asia (Siberia, China, India, Vietnam, Korea and Japan) as well as in North Africa and North America. It occurs on shady rocks and old trees.

Occurrence. The species *A. viticulosus* is known from the Pliocene and Pleistocene of Europe (Boureau 1967), it has been found by Szafran in the Pliocene of Mizerna (Szafer 1954). The species that occurs in the Tortonian of Zatoka Gdowska is *A. longifolius* Bruch (Szafran 1964).

Family **Amblystegiaceae**

Amblystegium serpens (Hedw.) B.S.G.

Pl. II, fig. 9; Pl. III, fig. 1

Locality: NS. I: 65
Material: 1 stem

Description. A piece of a stem, 1·5 mm long, with fragments of very small leaves, which were probably 0·8—1·0 mm in length and c. 0·2 mm in width. The leaves lack their apical parts, but the ribs and smooth oval cells of the leaf blades are visible. One paraphyllum was also found.

Comparison. Species of wide distribution: Eurasia, North Africa, North and South America, New Zeland. It occurs on the bark of trees, especially on the lowest part of their trunks, and on stones and rocks.

Occurrence. Species recorded from the Pleistocene of Europe. It occurs in the Pliocene of Sośnica (Łańcucka-Środoniowa, in prep.). The species *A. varium* (Hedw.) Lindb. is known from the Pliocene flora of Krościenko (Szafran 1949).

Family **Brachytheciaceae**

Eurhynchium speciosum (Brid.) Jur.

Pl. II, fig. 7; Pl. III, fig. 4

Locality: NS. I: 275
Material: 1 stem fragment
Description. A stem fragment with two opposite leaves, of which one, relatively well preserved, measured 1·0×0·3 mm. The rib sticks out of the leaf blade in the form of a spine. The leaf blade has elongate-prosenchymatous cells and its margin is finely serrate.

Comparison. The arrangement of leaves on the stem indicates the species *E. speciosum* (Brid.) Jur., characterized now by fairly great variation, notably as regards the size and structure of leaves. E. g., the form *tenella* Podp., known from Brandenburg (Szafran 1961), has leaves that resemble those of our specimen in size. Today this species occurs on tree roots or stones, in alder-carrs and well-heads in central and south-western Europe and Iran.

Occurrence. Species recorded from the Pleistocene of Europe. *E. meridionale* (Schimp.) De Not. and *E. stokesii* (Tourn.) B. S. G. occur in the Pliocene of Krościenko, *E. pulchellum* Dix., *E. swartzii* (Turn.) Curn. and *Eurhynchium* sp. in the Tortonian of Zatoka Gdowska (Szafran 1949, 1964).

LYCOPODINAE

Family **Selaginellaceae**

Selaginella pliocenica Dorof.

Pl. II, figs. 10—13

Localities: NS. I: 35, 55, 183, 294, 307, 344, 345, 347, 358
NS. II: 17, 30, 31, 33, 34
Gołąbkowice
Material: 17 megaspores and 2 fragments
Description. Megaspores, 0·4—0·8 mm in diameter, globular, often flattened, with a characteristic network formed by projecting ridges on its surface. The meshes of this network differ in size (0·03—0·15 mm in diameter) and the height of the ridges is also various. The tetradic scar is well seen in most specimens.

Comparison. According to Dorofeev, similar megaspores occur in the North American species *S. apoda* (L.) Fern. and *S. densa* Rydb., growing in coniferous and mixed forests. A comparison to the species *S. apoda* may however be questioned on account of the presence of a distinct circular ridge in this species, dividing the surface occupied by the tetradic scar from the rest of the megaspore (Łańcucka-Środoniowa 1966).

Occurrence. This species is often encountered in the Upper Tertiary deposits of western Siberia and Europe and found in many Neogene floras of Poland (Łańcucka-Środoniowa 1966). The following localities should be added to those published so far: Czarny Dunajec, Koniówka, Chyżne, Lipnica Wielka, Rypin and Sośnica (Łańcucka-Środoniowa, in prep.).

CONIFERAE

Family **Taxodiaceae**

Glyptostrobus europaeus (Brongn.) Unger

Pl. IV, figs. 1—20; Pl. V, figs. 1—11a

Localities: NS. I: 30—32, 34—40, 44, 45, 51—53, 57, 58, 61, 62, 64, 65, 69, 71, 72, 75, 79, 81, 83, 87, 90, 93—98, 100, 102, 104—107, 110, 113, 114, 121—123, 126, 130, 133—136, 138—142, 148, 152, 172, 174, 177, 187, 218, 223, 227, 228, 233—237, 250, 252, 301—303, 318, 319
NS. II: 23, 26, 29—33, 40
Nowy Sącz-Błonie, Niskowa

Material: About 640 fragments of leafed twigs, 110 detached leaves, 28 seeds, 16 seed fragments and 3 fragmentary cones. A total of about 800 remains have been found, of which nearly 700 come from 77 samples from NS. I. Some samples contained several dozen remains of this kind each. These were samples taken at the following depths: 33—34 m (sample 30), 42—43 m (sample 39), 136—138 m (samples 133 and 134), 151—152 m (sample 148) and 315·2—316·3 m (sample 301).

Description. Leafed twigs, mostly small and fine, 2 mm wide, the longest of them, from sample NS. I 319, 8 mm long. Several thicker twigs, 3·0—5·0 mm in width, with large leaves clinging closely to them, have also been found.

The leaves on these twigs show great variation with regard to size and shape, depending on the place of their derivation. In addition to the ensiform leaves, clinging to the twigs and with relatively blunt tips, typical of the genus *Glyptostrobus*, there are also some narrow, slightly falcate leaves, diverging from the twigs, or triangular imbricate ones with pointed apices.

Seeds have been found in many samples of both profiles. Particularly well preserved specimens come from samples NS. I: 301 and NS. II: 23, 29 and 32.

Besides the normally developed seeds, there occur also some very narrow specimens, as if unripe, and besides the typical curved seeds, also some nearly straight ones. Seed dimensions: 3·8—6·6 × 1·3—3·0 mm.

Only three small fragments of cones have been preserved in samples NS. I: 45, 52 and 228. They are badly damaged basal parts of cones, with small, irregularly shaped scales. Dimensions of cone fragments: 2·6 × 4·4; 4·5 × 4·5 and 3·2 × 2·6 mm.

Comparison. Twigs with falcate or triangular leaves with acute tips often occur in the genus *Sequoia*, more rarely in *Glyptostrobus*. It cannot be decided on the basis of morphology in which genus such twigs belong. For this reason it was necessary to study the anatomical structure of the epidermis. The remains were macerated with HNO_3, which had to be preceded by many preliminary tests, because heavily carbonized and often mineralized leaves readily underwent utter disintegration.

A hundred and forty-nine leafed twigs, the morphological structure of which corresponded to that in the genus *Glyptostrobus* were examined anatomically. In all the fragments of epidermis obtained (58 preparations) the structure of stomata, guard cells and epidermal cells was characteristic of this genus. Then, 32 leafed twigs which on the basis of their morphology might be included in the genus *Glyptostrobus* or *Sequoia* were examined anatomically. All the fragments of epidermis which I managed to obtain (22 preparations) also bore characteristics of the genus *Glyptostrobus*.

This anatomical study has shown that one of the leafed twigs can be referred to the genus *Sequoia*. The same is indicated by the complete lack of seeds of *Sequoia* in the whole of material, against 44 seeds (or their fragments) and 3 fragmentary cones of the genus *Glyptostrobus*.

Occurrence. Species known from the Upper Cretaceous (Bajkovskaja 1956), characteristic of the Tertiary of Europe, particularly frequent in the Miocene. In Poland macroscopic remains of this genus are known, as yet, exclusively from Miocene floras.

Family **Cupressaceae**

Chamaecyparis cf. *pisifera* (S. & Z.) Endl.

Pl. VI, figs. 4a, 4b, 5a, 5b

Locality: NS. I: 30, 233

Material: 2 cone fragments

Description. The preserved fragments indicate that the cones were strikingly small, only about 5 mm in diameter. One of the specimens is the upper half of a cone, 5·5 × 4·0 mm, with several peltate scales, which cling closely to each other. Their upper portions are 5—6-sided, with mildly wavy margins and nearly smooth surface (radiate wrinkles are poorly marked), the umbo being

Table 11

Results of studies on the remains of the genus *Glyptostrobus* from borehole Nowy Sącz I

Samples	Seeds of *Glyptostrobus*	Leafed twigs of *Glyptostrobus* type			Leafed twigs similar to *Sequoia*		
		Number of twigs	Number of twigs examined anatomically	Number of preparations obtained	Number of twigs	Number of twigs examined anatomically	Number of preparations obtained
NS. I: 30	—	54	3	3	—	—	—
NS. I: 31	—	24	14	10	—	—	—
NS. I: 39	—	114	50	13	2	2	1
NS. I: 40	—	1	1	1	2	2	2
NS. I: 95	—	1	1	1	—	—	—
NS. I: 133	1	41	23	4	11	11	9
NS. I: 134	1	45	25	13	14	14	7
NS. I: 148	2	47	11	4	—	—	—
NS. I: 218	—	12	—	—	3	3	3
NS. I: 301	7	61	21	9	—	—	—
Total	11	400	149	58	32	32	22

shifted somewhat towards the apex of the cone. The cone axis and scales springing from it can be seen on the inner side of this specimen; the height of the scales does not exceed 2 mm and the diameter of their peltate part, in a lateral view, is about 3 mm. One seed (wingless), elongate, measuring $2{\cdot}0 \times 1{\cdot}0$ mm, somewhat broader in the lower part adjoining the axis and narrowing in the upper part, is preserved between two scales.

The other cone fragment, $2{\cdot}8 \times 2{\cdot}0$ mm, which is the basal part, shows two basal scales and 2 whorls of leaves with distinctly pointed tips.

Comparison. At present such small cones occur in the North American species *Ch. thyoides* (L.) B. S. P. and the East Asiatic ones *Ch. pisifera* (S. & Z.) Endl. and *Ch. obtusa* var. *formosana* (Hayata) Rehd., being somewhat larger in this last (Gaussen 1968). The morphology of the upper portion of peltate scales in the specimens from Nowy Sącz comes nearest to that of *Ch. pisifera* (S. & Z.) Endl., which grows on the banks of streams, at altitudes from 400 to 1000 m a.s.l. in Japan, reaching 50 m in height.

This species was first described by Miki (1938) from the Pliocene of Japan on the basis of cones and leafed twigs. Other remains, closely related to it, found in the Lower Miocene flora of Miyata on Honshu (Huzioka & Uemura 1973) have been reported under the name *Ch. miyataensis* Huzioka & Uemura, because they are also somewhat similar to *Ch. linguaefolia* (Lesq.) MacGinitie, described from the Tertiary of North America.

Ch. pisifera (S. & Z.) Endl. has not been recorded from the Tertiary of Europe (Gaussen 1968) except for the territory of Poland (Krościenko, Mizerna, Huba and Stare Gliwice — Szafer 1947, 1954, 1961) and the neighbouring regions (Zaleśce — Czeczottowa 1951). The cones from Krościenko, Mizerna and Huba are however somewhat bigger than those of *Ch. pisifera* (some of them are more than 7 mm in diameter), their scales are thicker, upper portions with sharp margins and a wrinkled surface, and the seeds are longer, up to 2·7 mm in length. Thus, they are not conformable, without reservations, to the very small and subtle cones of *Ch. pisifera* (S. & Z.) Endl.

The specimen of a young cone described from the Miocene of Stare Gliwice (Szafer 1961, Pl. 8, figs. 9, 10) is a large globular male inflorescence with imbricate thin scales. It cannot be referred to *Ch. pisifera*, the male inflorescence of which is much smaller and elongate. The fragments of leafed twigs are more similar to the genus *Thuja*, what however needs a closer study.

Occurrence. Species known from the Pliocene and Pleistocene of Japan, growing there probably as early as the Miocene. It has been recorded from the Miocene and Pliocene of Central Europe but the evidence calls for revision. This is also true of the Pliocene flora from Willershausen, which contains many leafed twigs of the family *Cupressaceae* undetermined more closely (Straus 1952). A cone and leafed twigs of *Ch.* cf. *pisifera* have been found in the Pliocene of Georgia (Čočieva 1975).

Cupressaceae gen. 1

Pl. VI, figs. 1a, 1b

Locality: NS. I: 46

Material: 1 twig

Description. A leafed twig fragment (3·7×1·6 mm), laterally flattened during fossilization. Three whorls of leaves (a middle and 2 lateral) are preserved on either flat side and one compressed leaf on either marginal side. Thus, this was not a dorsoventrally flattened twig with four leaves in a whorl, i. e. 2 facial and 2 marginal ones, but a cylindrical twig with a larger number of leaves arranged spirally and imbricately.

The leaves are fairly broad, especially their lower halves, and elongated at the top into a pointed tip, from which a distinct short rib extends downwards. They were relatively thick, with jagged margins. A side-branch, with several leaves preserved, goes off from the axil of a leaf, which deflects at nearly a right angle from the twig. Just beside, another side-branch went probably off at an angle of 45°; its structure is not clear, since it was compressed from above. It was only possible to observe the arrangement of leaves round the mark left after the break-off of the upper part of this branch or inflorescence.

Comparison. Cylindrical twigs with imbricate leaves are met with in some species of the genus *Juniperus* (subgenus *Sabina*) and then in both Asiatic and American species and European ones from the Mediterranean region. These twigs show a tendency to form many side-branches standing close to each other. Twigs of the North American species *J. occidentalis* Hook. of the section *Occidentales* are, among other species, very similar to the fossil specimen (Gaussen 1968).

However, the determinations of this twig cannot be based exclusively on its morphological structure, because many genera of the family *Cupressaceae* have similarly built leafy twigs. The cylindrical structure and the very regular arrangement of leaves occur not only in some species of the genus *Juniperus* but also in such genera as *Cupressus*, *Widringtonia*, *Diselma* or *Fitzroya* (cf. Gaussen 1970, pp. (7)—XVI). There is besides some resemblance to the twigs of the genus *Athrotaxis* of the family *Taxodiaceae*.

Anatomical examination was unsuccessful, since we failed to obtain a sufficiently clear picture of the anatomic structure of epidermis to permit generic determination.

Cupressaceae gen. 2

Pl. VI, fig. 2

Locality: NS. I: 39

Material: 1 top portion of twig (?)

Description. A fragment, cylindrical in shape, 4·0 × 2·2 × 0·6 mm, laterally flattened during fossilization. Leaves thick, relatively broad and convex in the middle portion, thinner and slightly fringed marginally, with blunt apex. They are set in whorls of 2, opposite each other, those of the last pair clinging closely to each other and forming the pointed top of the twig.

Comparison. The poor condition of the specimen, which disintegrates owing to its pyritization, and the impossibility to apply cuticular analysis made its determination very difficult. Twigs of similar structure occur in the species of *Cupressus* and *Juniperus*. A palynological analysis of the Miocene deposits of the Nowy Sącz Basin detected the presence of single pollen grains of *Cupressus* (Oszczypko & Stuchlik 1972).

The fragment described is also similar to male inflorescences, characteristic of different genera of the family *Cupressaceae*, like *Cupressus*, *Chamaecyparis*, *Juniperus* or *Cryptomeria*. However, the male inflorescences have much thinner scales, which overlap each other regularly, also in the apical portion.

Cupressaceae gen. 3

Pl. VI, figs. 3a, 3b

Locality: Niskowa

Material: 1 seed fragment

Description. A half of a flat seed, 2·2 × 2·4 mm; its width measured more or less halfway along the seed was about 2·5 mm and the length exceeded 3·5 mm. It was a bilaterally flatly winged seed, its wing being narrow (0·65 mm in width). Fine parallel striae can be seen on the surface of the better-preserved portion of the wing; its other portion, less regular in outline, is as if displaced from the peripheral part and bent in towards the inside of the seed, which brings about the distinct asymmetry of the seed.

Comparison. The fragment has the features of seeds belonging to some genera of the family *Cupressaceae*, e.g. *Cupressus* or *Chamaecyparis*. It cannot be referred to the genera *Sequoiă* or *Metasequoia*, because its seed: wing width ratio is to high.

Family **Pinaceae**

Pinaceae gen. 1

Pl. VI, figs. 6—7b

Locality: NS. I: 97
Material: 1 needle fragment

Description. A fragment of a flat needle, 2·9 × 1·2 mm, with its surface eroded considerably and uneven and the midrib marked in the form of an eminence. Small fragments of epidermis with stomata placed close to each other in rows parallel to the midrib were obtained for anatomical studies. The anatomical structure is poorly seen; the probable genera are *Tsuga* and *Abies* whose presence has been detected in palynological studies.

Pinaceae gen. 2

Pl. VI, figs. 8, 8a

Locality: NS. I: 300
Material: 1 needle fragment

Description. A fragment of the apical part of a needle, 1·2 mm long and 0·65 mm broad. Its tip is slightly narrowed and rounded, single rows of stomata arranged perpendicularly to the midrib lie on both its sides.

DICOTYLEDONES

Family **Betulaceae**

Carpinus betulus L.

Pl. VII, figs. 1—3b

Localities: NS. I: 39
NS. II: 23, 31
Material: 3 nuts

Description. One specimen, 4·5×3·3 mm, in shape typical of *C. betulus*, its base being broad and straight, the top blunt and the ribs distinctly marked. Another specimen, 4·95×3·25 mm, rounded in the lower part, has a very elongate top and ribs visible only in the basal part. In shape it resembles the genus *Ostrya*. The third specimen, 4·0×2·9 mm, has a rounded base, a pointedly elongated top and very poorly marked ribs. Its shape is similar to that of the nuts of *C. orientalis* Mill. and *C. turczaninowii* Hance.

Comparison. Although only one nut has its morphological structure typical of *C. betulus* L., all the three specimens have been included in this species on account of its great variation. As has been shown by Jentys-Szaferowa's (1960, 1961) studies, the nuts of this species are sometimes slender and resemble the genus *Ostrya* (material from the Miocene of Stare Gliwice and Pliocene of Domański Wierch) and sometimes are fine and delicate like the nuts of *C. orientalis* Mill. (material from the Miocene of Wieliczka).

The poor state of preservation of the two specimens from profile NS. II made it impossible to carry out anatomical studies.

Occurrence. In Poland nuts of *C. betulus* L. are known from the Miocene onwards: Wieliczka, Stare Gliwice (Jentys-Szaferowa 1961), Rypin, Zatoka Gdowska, Czarny Dunajec, Koniówka, Chyżne, Lipnica Mała, Lipnica Wielka (Łańcucka-Środoniowa 1957, 1966 and materials in prep.) and Gozdnica (Stachurska *et al.* 1971). Leaves of *C. grandis* Ung., corresponding with this species, occur in the Miocene of Chłapowo (Heer 1869), Silesia (Kräusel 1920), Chodzież (Zabłocki 1924), Dobrzyń (Kownas 1955) and Swoszowice (Iljinskaja 1964).

Betula sp. 1 (Sect. *Albae* Rgl.)

Pl. VII. fig. 4

Locality: NS. II: 30, 31

Material: 2 nutlets

Description. Nutlets, 2·0×1·0 and 1·9×1·25 mm, flat, elliptic, with a narrowed wedge-shaped base and elongated apical part. Edges uneven, there are even no traces of wings.

Comparison. The morphological structure refers them to the section *Albae* Rgl.

Occurrence. Nutlets of *Betula* sect. *Albae* Rgl. are known from Tertiary floras. In Poland they have been found in the Tortonian flora of Zatoka Gdowska (Łańcucka-Środoniowa 1966).

Betula sp. 2

Pl. VII, fig. 5

Locality: NS. II: 31

Material: 1 nutlet

Description. A nutlet, 1·6×1·15 mm, flat, roundly-ovate, narrowing in a wedge-like manner at the base with a thick and elongate top and with traces of hairs. The edges are even, the wings not preserved.

Comparison. Dorofeev (1969) recorded nutlets of similar shape and size from the Miocene of Mamontowa Góra on the Aldan River in eastern Siberia as *Betula* sp. 3. They belong to a separate species, which, according to Dorofeev, bears some characters in common with the species of both the section *Costatae* (Rgl.) Koehne and the sections *Fruticosae* Rgl. and *Nanae* Rgl.

Alnus sp.

Pl. VII, figs. 6—11

Localities: N.S. I: 42, 55, 107, 113, 135
NS. II: 30, 33

Material: 5 scale fragments, 5 fragments of male inflorescences and 1 female inflorescence (?)

Description. Fragments of the top parts of scales, measuring 2·1—3·0× 1·1—4·0 mm and rounded in outline. The upper surface is thickened and irregularly folded, the lower one with fine parallel ribs. A bract, irregular in shape, with a cordate base and rounded and revolute margins, can be seen in the fragments of male inflorescences (1·35×2·0 and 2·0×2·4 mm). Inner scales, much smaller than the bract, stick out from under it; in the best preserved specimen they are three in number, the fourth one being destroyed. These small scales have hollows underneath, in which stamina were set. This important morphological detail is best preserved in a detached inner scale from sample NS. II: 33 (Pl. VII, fig. 10). The fragment of a female inflorescence is conoid in shape and bears small scales regularly arranged on the spiral. The scales have sharply elongated tops, from which longitudinal swellings run towards the base.

Comparison. The fragments of scales and male inflorescences belong no doubt to the genus *Alnus*. The presence of this tree in the Neogene plant communities of the Nowy Sącz Basin is evidenced by the occurrence of dichotomic thickenings of roots containing bacteria *Actinomyces alni* Hartz and by the high proportion of pollen grains of *Alnus* in profile NS. I and in samples taken from the outcrops and shallow borings. Pollen grains of *Alnus* are present in nearly all samples of profile NS. I, their number reaching several dozen specimens in its lower portion and 76 specimens in sample 302 (Oszczypko & Stuchlik 1972).

Family **Moraceae**

Broussonetia pygmaea Dorof.

Pl. VII, figs. 12—15

Localities: NS. I: 293, 303
NS. II: 30

Material: 5 endocarps

Description. Endocarps, 1·15—1·4 × 1·05—1·2 mm, roundly ovate, flattened, with a characteristic process at the top. The process is turned towards the groove situated on the ventral side. The walls of the endocarps are thin, covered all over by very small and sparse tubercles.

Comparison. These remains agree unreservedly with the endocarp of *Broussonetia pygmea*, described by Dorofeev (1963a) from the Tertiary of West Siberia. This species is closely related to *B. kazinoki* S. & Z., a small tree growing now in the forests of China and Japan. The genus rarely recorded from the European Tertiary: endocarps of *B. rugosa* Chandl. from the Eocene of England (Chandler 1925—1926) and a leaf of cf. *Broussonetia* sp. from the Miocene of Switzerland (Rüffle 1963). Three living species of this genus, limited in their distribution to Southeast Asia (Japan, Korea, China and India), are trees of mountainous regions and thus they well tolerate the climatic conditions of Central Europe; e.g. the species *B. papyrifera* Vent. flowers and yields fruit successfully in the Botanical Gardens in Cracow.

Occurrence. Oligocene and Miocene of West Siberia, Miocene of East Siberia (Dorofeev 1963a, 1969a) and Miocene and Pliocene of southern Poland: Zatoka Gdowska, Domański Wierch (Łańcucka-Środoniowa 1966) and Czarny Dunajec, Koniówka-Podczerwone, Lipnica Wielka, Grywałd (Łańcucka-Środoniowa, in prep.).

Family **Eucommiaceae**

Eucommia sp.

Pl. VII, figs. 16—16c

Locality: NS. I: 355

Material: 10 leaf fragments

Description. Only very small fragments of leaf blades are preserved, the largest of them being a few millimetres in diameter. They are cracked into small, rectangular and polygonal pieces, joined by means of guttapercha threads, which have club-shaped thickenings at ends.

Occurrence. This is an East-Asiatic genus, common in the Tertiary of Europe, often found in the Neogene of southern and southeastern Poland: Mizerna, Stare Gliwice (Szafer 1952, 1961), Sośnica (Micek 1959), Zatoka Gdowska, Wieliczka, Zakrzów (Łańcucka-Środoniowa 1966).

Family **Urticaceae**

Boehmeria cf. ***sibirica*** Dorof.

Pl. VIII, figs. 1—4a

Localities: NS. I: 274, 278, 303, 347
NS. II: 18, 23, 30

Material: 14 nutlets

Description. Nutlets, 0·7—1·1×0·4—0·7 mm, broadly ovate or ovate-orbicular, almost flat or folded longitudinally (if preserved whole) or convex, especially in the lower part (if they are only halves of heavily fossilized nuts). Base rounded, slightly obliquely truncated, apex narrowed and sharply pointed. Small isodiametrical cells and sometimes also meshes of a seemingly superimposed regular network can be seen on the surface of the nutlets.

Comparison. The remains described correspond with fruits of the genus *Boehmeria*, which is now represented by about 45 species (herbs, shrubs and small trees) growing in East Asia and North America, in areas of tropical and temperate climates. Nikitin (1957) described fruits of *B.* cf. *cylindrica* Willd. from the Pliocene of the Voronež region, emphasizing their great likeness to this North American species. The fossil species *B. sibirica* Dorof. is also closely related to *B. cylindrica* Willd. (Dorofeev 1963a) and sometimes even regarded as its Tertiary counterpart (Palamarev 1970).

The remains from Nowy Sącz are somewhat smaller than the fruits of *B. sibirica* Dorof. and, in addition, they have no characteristic wings preserved on them.

Occurrence. The species has been described from the Miocene of West Siberia and found in the Miocene and Pliocene of Europe. In Poland it is known from Konin (Raniecka-Bobrowska 1959, sub *Urticaceae* gen. 1, to which fact Dorofeev drew attention in 1963) and has also been found at Chyżne in Orawa and at Sośnica (Łańcucka-Środoniowa, in prep.).

cf. ***Pilea*** sp.

Pl. VIII, fig. 5

Locality: NS. II: 31

Material: 1 fruit

Description. Fruit, 1·05×0·7 mm, ovate-cuneate, rounded at the base, narrowing in a wedge-like manner at the top, somewhat asymmetrical and biconvex. The lower portion of the fruit is worn and broken, its walls are rather thick. On the external surface there are thick longitudinal wrinkles, irregular in shape, and roundly polygonal cells are visible between them.

Comparison. In morphological structure the specimen described much resembles the fruits of the genus *Pilea*, which today includes about 200 Asiatic and American species of herbs. In Tertiary times the fossil species *P. cantalensis* (Reid) Dorof. related to East-Asiatic *P. mongolica* Wedd. and North American *P. pumila* Gray, was widely distributed in Europe and West Siberia (Reid 1923; Dorofeev 1963a). Similar fruits have been described from the Miocene of Konin by Raniecka-Bobrowska (1959) under the name *P.* cf. *mongolica* Wedd.

The fruit from Nowy Sącz agrees with *P. cantalensis* (Reid) Dorof. in size and shape, but this determination may be called in question, for the specimen studied lacks its basal portion, the morphological structure of which is of great importance in determining fruits of the genus *Pilea*.

Occurrence. This genus, known from the Miocene and Pliocene of Eurasia, has been recorded from the Miocene of Konin (Raniecka-Bobrowska 1959).

Family **Polygonaceae**

Polygonum aviculare L. s. l.

Pl. VIII, fig. 11

Locality: NS. I: 237

Material: 2 fruit fragments

Description. The preserved fragments, 1·9×1·0 and 1·75×1·1 mm, are apical portions of fruits and have a characteristic external sculpture. Small tubercles form elongate wrinkles, which run parallel to the long axis of the fruit.

Comparison. However fragmentary, these remains may certainly be included in the polymorphous species *P. aviculare* L., now widely distributed in areas of temperate and subtropical climates all over the world.

Occurrence. Species known from the younger Tertiary of Europe and West and East Siberia. Reported from the Pliocene of Krościenko and Miocene of Stare Gliwice (Szafer 1947, 1961), it also occurs in the Miocene of Rypin and Pliocene of Domański Wierch (Łańcucka-Środoniowa, in prep.).

Polygonum cf. ***convolvulus*** L.

Locality: NS. I: 31

Material: 1 fruit fragment

Description. A small fragment, 1·4×0·95 mm, including parts of two side walls and the blunt edge formed by them. The external surface is dull, with densely distributed small tubercles.

Comparison. This fragment resembles fruits of some species of the genus *Polygonum*, notably those of *P. convolvulus* L., which, separated lately into a distinct genus, *Bilderdykia convolvulus* (L.) Dumort., is widespread in Eurasia and North America, growing in areas of a temperate climate.

Occurrence. Fruits of this species are known from the late Tertiary of Europe and West Siberia. Localities in Poland: Krościenko, Mizerna (Szafer 1947, 1954), Rypin (Łańcucka-Środoniowa, in prep.). A leaf similar to those of *P. convolvulus* L. and *P. dumetorum* L. has been found in the Miocene of Transcarpathia (Ilinskaja 1959).

Rumex sp. 1

Pl. VIII, fig. 7

Localities: NS. I: 349
NS. II: 23

Material: 1 fruit and 1 fragment

Description. Fruits, 1·05 × 0·5 and 0·8 × 0·45 mm, trigonous, all the side walls are nearly the same width, narrowed wedgewise at both ends, and at the top furnished with a short and pointed mucro. The fruit is broadest in the middle of its length. The lateral edges are sharp, shining conspicuously in places. The external surface is glassy, punctated, with traces of fine transverse wrinkles.

Comparison. In morphological structure the remains correspond to the fruits of the genus *Rumex*, notably those of such species as *R. ucrainicus* Fisch. and *R. maritimus* L. Today both these species, closely related to each other, grow in wet areas and on river-banks and lake-shores, *R. ucrainicus* Fisch. being restricted in its range to Poland, Romania and the European territories of the U.S.S.R.

Occurrence. Both above-mentioned species have been reported from the Pleistocene of Europe, including the European part of the U.S.S.R., and *R. maritimus* L., in addition, from the Pliocene.

Rumex sp. 2

Pl. VIII, figs. 8a, 8b

Locality: NS. I: 348

Material: 1 fruit

Description. Fruit, 1·35 × 0·6 mm, trigonous, with its side-walls subequal in width (one of them is bent in noticeably), rounded at base and narrowed wedgewise at top. The side edges are very sharp and shining, the walls are thin and the external surface is finely punctated.

Comparison. Most species of the genus *Rumex* have trigonous fruits, broadly fusiform or pyriform in shape (Marek 1954). However, there are also species which have relatively narrow fruits, e.g. *R. palustris* Sm., but the fruits of this last are larger and relatively broader than the specimen from Nowy Sącz.

Family **Euphorbiaceae**

Phyllanthus sp.

Pl. VIII, figs. 6, 6a

Localities: NS. I: 236
NS. II: 30

Material: 2 seeds

Description. Seeds, 1·2—1·4×0·9—1·0 mm, three-sided. The convex dorsal wall passes onto the ventral side, which is composed of two side-walls, flat or bent in, joined by a blunt longitudinal rib. The round aperture of the micropyle is situated in the upper part of this rib. One specimen has its thick testa preserved, but the external sculpture is blurred. The other specimen (NS. I: 236) consists only of the external layer of the testa. On its surface there occur fine longitudinal ridges, which extend at rather great distances from each other, and tubercles, irregular in shape, are set on them.

Comparison. The structure of the seeds indicates their affiliation in the genus *Phyllanthus*, which now numbers about 750 species of trees and shrubs, distributed mostly in tropical and subtropical regions of Asia, America and Africa. Dorofeev (1963a) included the seeds, similar in size, found in the Tertiary of West Siberia, in two fossil species, *P. triquetra* (Nikitin) Dorof. and *P. compassica* Dorof. The bad state of preservation of both specimens from Nowy Sącz makes it impossible to determine them more closely.

Occurrence. Genus known from the Oligocene and Miocene of West Siberia (Dorofeev 1963a) and from the Miocene and Pliocene of Poland: Zatoka Gdowska, Konin, Domański Wierch and Sośnica (Łańcucka-Środoniowa 1966).

Family **Cercidiphyllaceae**

Cercidiphyllum crenatum (Ung.) Brown

Pl. VIII, figs. 9a — 10

Locality: NS. II: 33

Material: half of a fruit and 5 fragments

Description. Lower part of fruit, 7·4 mm in length and 4·1 mm in breadth, strongly compressed and at base narrowed wedgewise. Its external surface is dull and smooth, fine longitudinal wrinkles occur only in the basal region. A longitudinal crack is visible on one side of the fruit, and a vascular bundle, also longitudinal, on the other. There is also a fragment of the upper part of a fruit, 3·0×2·0 mm, distinctly convex on one side, passing into a short bent mucro. On its inner surface there is a relatively thick longitudinal ridge, along which the fruit splits into halves and there are also some fine parallel transverse striae.

Comparison. These remains are similar in structure to the fruits of the genus *Cercidiphyllum*, the only modern species of which *C. japonicum* S. & Z grows in the mountains of Japan and central China, where on stream banks and slopes it sometimes reaches to 1800 m a.s.l.

Fossil leaves of this genus were described under various generic names (the list of synonyms is very long, cf. Tralau 1963), although their similarity to the leaves of *C. japonicum* S. & Z. has attracted attention since long ago. Studies carried out by Brown on abundant fossil materials in 1935—1939 explained this problem, especially when the simultaneous occurrence of leaves, fruits and seeds of this genus had been found in many American floras. The fruits, fossil remains of which have been known for a long time, were described, among other names, as *Widdringtonia helvetica* Heer and the small winged seeds as *Embothrium microspermum* Heer and *E. leptospermum* Ett. In the latest years fruits and sometimes also seeds have been found beside the leaves of *Cercidiphyllum* in the Tertiary of Europe (Koch 1963; Mai 1963; Bůžek and Holý 1964; Ilinskaja 1968).

Occurrence. The genus known from the period ranging from the Cretaceous throughout the Pliocene and represented, according to Brown, by five different species. The species *C. crenatum* (Ung.) Brown, related to contemporary *C. japonicum* S. & Z., was widely distributed in the Oligocene and Miocene of Eurasia. This tree had particularly favourable conditions for development in the Miocene. The morphological structure of its leaves was marked by great variation, which became the cause of the separation of two new fossil species, *C. andreánszky* Kovács and *C. novemnervium* Andreánszky. In Ilinskaja's (1968) opinion, these are merely forms of *C. crenatum* (Ung.) Brown, which grew in the territory of Romania (Givulescu 1964, 1974), Moravia (Knobloch 1966) and Transcarpathia (Ilinskaja 1968) as late as the Pliocene.

So far chiefly leaves of *C. crenatum* (Ung.) Brown have been recorded from the Tertiary of Poland. They were found in the Miocene of Silesia, i.e. at Pieruszów, Smogorzówek near Wołów, Turów (cf. Hummel 1970, 1971) and probably at Swoszowice[1]. Menzel (1910) found its fruits in the Miocene of Koronowo and described them as cf. *Widdringtonia helvetica* Heer. Fruits occur also in the Neogene of southern Poland, namely, on Domański Wierch and at Chyżne in Orawa, where more than 100 pods or their fragments have been found (Łańcucka-Środoniowa, in prep.).

Family **Magnoliaceae**

Magnolia cf. ***cor*** Ludwig

Pl. VIII, figs. 13, 14

Localities: NS. I: 55
NS. II: 31
Material: 2 halves and 2 fragments of seeds

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[1] A short note about additionally collected samples of the fossil flora of Swoszowice, published by Stur in 1873, mentions the species *Grewia crenata* Ung., now commonly regarded as synonymous with *Cercidiphyllum crenatum* (Ung.) Brown. Unfortunately, while working out the Tortonian flora of Swoszowice, Ilinskaja had not Stur's original specimens at her disposal (cf. Ilinskaja 1964).

Description. Two seed halves found in sample NS. I: 55 probably come from one and the same specimen, as indicated by their identical measurements (5·4 mm in length and 8·3 mm in breadth) and the same reniform shape. The characteristic feature of this seed is its considerable breadth against the small length and a large and shallow apical hollow. The seed surface is smooth and dull and the testa is thick.

Comparison. Seeds of the genus *Magnolia*, characterized by their considerable breadth and relatively small length, are known from the older Tertiary of England, from which E. M. Reid and Chandler distinguished as many as 7 fossil species. Three of them are marked by very large seeds, exceeding 10 and even 15 mm in breadth. The seeds of the remaining four species are less than 10 mm wide (cf. Mai 1975).

Sometimes seeds of this shape occur also in Neogene floras. They have been described under various names, i.e. as *M. cor* Ludwig (related to *M. kobus* DC., now living in Japan), *M. hoffmanni* Ludwig (large seeds of the *M. cor* Ludwig type), *M. kobus* DC. foss. (species corresponding to the contemporary one, from which, according to the Reids', it cannot be discriminated) and lastly *M. ultima* Kirchh. (species similar to several East-Asiatic ones, notably to *M. kobus* DC.). We may be concerned here with one and the same species, widespread in the late Tertiary.

This is the opinion held by Mai (1975), who included the seeds described as *M. hoffmanni* Ludwig or *M. kobus* DC. foss. and the specimens from Tegelen recorded as *M. ultima* Kirchh. (Kirchheimer 1957) in the species *M. cor* Ludwig. According to Mai, the seeds described by Kirchheimer (1949) from the Pliocene of Soufflenheim as *M. ultima* n. sp. are really distinctly broader than long; to be sure, they resemble the contemporary seeds of *M. kobus* DC., but differ somewhat in shape from the specimens generally recognized as *M. cor* Ludwig. The distinctness of this fossil species must however be documented by more numerous fossil material, for Kirchheimer distinguished it on the basis of 2 specimens only.

The specimen from Nowy Sącz well agrees with the holotype *M. ultima* Kirchh. from the Pliocene of Soufflenheim (Kirchheimer 1949, 1957), but it is also similar to some seeds of *M. cor* Ludwig from the Pliocene of Krościenko and to many seeds from the Pliocene of Mizerna (Szafer 1947, 1954). Seeds identical in structure or perhaps even still broader occur in the Neogene deposits of Domański Wierch and Koniówka (Łańcucka-Środoniowa, in prep.). An investigation of the abundant fossil materials from these two localities will make it possible to decide whether the short and very broad seeds should be separated as a distinct fossil species.

Occurrence. Species known from the Miocene, Pliocene and from Pleistocene of Eurazia. Localities in Poland: Krościenko, Mizerna (Szafer 1947, 1954), Domański Wierch and Koniówka (Łańcucka-Środoniowa 1963 and in prep.). The seeds described as *M. kobus* DC. foss. from Wieliczka (Zabłocki 1930) belong to the species *M. lusatica* Kirchh. (cf. Mai 1975). The seeds of *M. cor.* Ludwig and *M.* sp. (*M. kobus* DC.) recorded by Kräusel (1920) from the Miocene of Silesia (Kgl. Neudorf — Nowa Wieś Królewska, Naumburg a. O. — Nowogrodziec [2] and Poppelwitz — Popowice, late Niemcza District [3] also belong, according to Mai, to other species.

Family **Ranunculaceae**

Ranunculus cf. ***reidi*** Szafer

Pl. VIII, figs. 15, 16

Locality: NS. II 31, 33

Material: 2 fruits

Description. Fruits, 1·5 × 1·2 and 1·6 × 1·4 mm, flat, ovate-oval or asymmetrically oval, with a very inconspicuous beak. Fine, isodiametrical, subcircular cells and, besides, sparse wart-like protuberances can be seen on the surface of these fruits.

Comparison. Fruits of *Ranunculus* with a characteristic tuberculate surface were decribed from the Pliocene of Europe at first as the Mediterranean species *R. lateriflorus* DC. and *R. nodiflorus* L. (Reid 1915, 1920). In Szafer's (1947) opinion, *R. lateriflorus* DC. did not occur in Europe in the Pliocene yet, but its primitive form, the fossil species *R. reidi* Szafer, with somewhat larger and relatively broader fruits.

The problem of relation and affinity between *R. reidi* Szafer and the present-day species needs further studies. The fruits of *R. lateriflorus* DC. differ not only in size but, what is more important, in shape (much narrower, with a broad base) and the situation of the beak (often almost symmetrical). Further, fruits of other Mediterranean species of the section *Flammula*, related to *R. lateriflorus* DC., like *R. nodiflorus* L., *R. pedunculatus* Lange *R. fontanus* C. Presl. and *R. ophioglossifolius* Vill., should also be taken into account.

According to Dorofeev (Dorofeev, in Iskopaemye cvetkovye rastenija SSSR, 1974), fruits similar to those of *R. reidi* Szafer occur also *in R. chius* DC., *R. trachycarpus* Fisch. & C. A. Mey and other species.

Occurrence. Species known from the Pliocene of Europe, in Poland from Krościenko, Grywałd, Mizerna and Huba (Szafer 1947, 1954).

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[2] Mai (1975) uses the appelation Novogrod Bobrzański.

[3] Mai (1975) refers to this locality as Jordanów bei Niemcza.

Thalictrum sp.

(Pl. VIII, fig. 17a, 17b)

Locality: NS. II: 31
Material: 1 fruit
Description. Fruit, 1·3×0·8 mm, ovate, tapering at both ends, with a small pointed beak preserved at one end. Eight longitudinal sharp-edged ribs extend on the fruit surface.

Comparison. Although the fruit is cracked and, at one end, damaged, it well shows the characters of the genus *Thalictrum*. One can see a likeness between this specimen and several contemporary species, but it is comparable only with the smallets and not quite ripe fruits, among other Eurasian species, of *T. simplex* L. and *T. flavum* L. (both known from Pliocene floras).

Occurrence. A similar fruit has been reported as *Thalictrum* sp. from the Tortonian of Zatoka Gdowska (Łańcucka-Środoniowa 1966). It is similar to unripe of *T. flavum* L. Several species of this genus have been described from the Pliocene and Miocene floras of Eurasia.

Family **Nymphaeaceae**

Brasenia sp.

Pl. VIII, fig. 12

Locality: NS. II: 9
Material: 1 seed fragment
Description. Only a fragment (1·8×1·7 mm) of a seed, which was 1·7mm broad and probably about 2·2 mm long, has been preserved. This is an apical portion of the seed with a small, relatively high, conical opercle. The line of detachment of the opercle from the remaining part of the seed is invisible. Testa thick, composed of two layers. Outer layer built of high palisade cells with markedly thickened walls. The height of these rectangular cells is 0·13 mm and then not very great as for the genus *Brasenia*. The inner layer consists of several rows of oval-round cells with uniformly thick walls. The seed surface is shining like pitch, smooth, with occasional single tubercles. On the surface of the apical portion of the seed rows of cells go radially away from the opercle. The anatomical characteristics of the seed structure have been established on the basis of observations made with the help of a low power binocular microscope, because the specimen would have been destroyed while being sectioned for anatomical studies.

Comparison. It may be assumed that the preserved fragment is a part of a small ellipsoid seed, with relatively low palisade cells of the testa. It is however difficult to determine it to specific level in view of the systematics of the genus

Brasenia very markedly developed recently on the basis of seeds derived from the Tertiary (Dorofeev in: Iskopaemye cvetkovye rastenija SSSR, 1974).

The specimen from Nowy Sącz might be included, for its small size, in the species *B. victoria* (Casp.) Weberb., often recorded from the European Tertiary. Seeds of this species are considered to be marked, in addition to small dimensions, by their relatively thick testa (Kirchheimer 1936), whereas in our specimen the testa is rather thin.

Small seeds with low palisade cells and, in consequence, the relatively thin testa have been described by Dorofeev (1970a) under the name *B. ucrainica* Dorof. from the Oligocene of the Ukraine. The specimen from Nowy Sącz has much resemblance to these seeds, from which it differs merely in having traces of tubercles in its apical part, whereas seeds of *B. ucrainica* Dorof. are mostly smooth and only rarely slightly tuberculate at the base. Dorofeev emphasizes that both species mentioned are similar and together with *B. turgaica* Dorof. (from the Oligocene of Kazachstan) belong to one systematic group.

Occurrence. According to Dorofeev (1970a), *B. ucrainica* Dorof. and *B. victoria* (Casp.) Weberb. differ a little in stratigraphic position: the former occurs from the Middle Oligocene to the Lower Miocene and the latter in the Lower and Middle Miocene. In Poland this last species has been found in the Miocene of Kruszyna in Silesia (Kraüsel 1920) and Rypin (Łańcucka-Środoniowa 1957).

Family **Violaceae**

Viola rimosa Nikitin

Pl. IX, figs. 1a, 1b

Locality: NS. II: 36

Material: 1 seed

Description. Seed, 1·75×0·9 mm, ovate in shape, flattened at base, with convex round chalaza and elongated into distinct beak at top. Testa thick, splitting into several narrow parts from top to base. Surface rough, covered with elongate polygonal cells arranged in longitudinal rows. The longer walls of these cells are sharp and higher than the transverse walls, which gives the impression that the whole seed surface is delicately ribbed. The inner surface of the testa is marked by fine transverse striations, for the elongate thin-walled cells lie square to the length of the seed (feature characteristic of the genus *Viola*).

Comparison. The fossil specimen corresponds to the species *Viola rimosa* Nikitin, described from the Tertiary of Russia and in its structure of testa differing distinctly from all the present-day species of this genus. According to Dorofeev (1963a), it may even constitute another genus of the family *Violaceae*.

Occurrence. In western Siberia this species is known chiefly from the Oligocene, in the Miocene it occurs very rarely (Nikitin 1965; Dorofeev 1963a). It has also been found in the Miocene of Mamontowa Góra in eastern

Siberia (Dorofeev 1969a). So far it has not been reported from the Tertiary of Europe, recently recorded from the Middle Miocene of Fasterholt in Denmark (E. M. Friis, oral communication).

Viola sp. 1

Pl. IX, figs. 2—4

Localities: NS. I: 299
NS. II: 30, 31, 32

Material: 6 seeds and 10 seed fragments

Description. Seeds, 1·3—2·1×0·7 —1·3 mm, ovate, truncate at base and furnished with large round chalaza, pointed at top and easily cracking into several parts. Testa thin, finely punctated on outer surface. Seeds very delicate and brittle.

Comparison. The taxonomic distinction of species of the genus *Viola* in the Tertiary material is very difficult because the structure of seeds in different present-day species and their numerous hybrids is very similar. In the reference material that I had at my disposal similarly built seeds occurred in more than ten species belonging to different sections and varying in geographical distribution. The fossil specimens show much resemblance to the seeds of such species as *V. canina* L., *V. elatior* Fries, *V. papilionacea* Pursh., *V. riviniana* Reichb., *V. rupestris* F. W. Schm. and *V. sylvestris* Lam.

Similar seeds have been described from the Pliocene of the Netherlands (Reid 1915, Pl. 13, fig. 27) as *Viola* sp. 3 (cf. *V. rupestris*) and from the Miocene of West Siberia (Dorofeev 1963a, Pl. 40, figs. 47—50) as *Viola* sp. 4 and *Viola* sp. 2. Lately van der Burgh (1978) described similar seeds as *Viola* cf. *rupestris* F. Schm. from Fortuna-Garsdorf (Germany) Pliocene flora.

Seeds derived from Tertiary floras in Poland, namely, from Krościenko [4], Grywałd and Stare Gliwice, are similar in shape and size, but their testa is considerably thicker and the sculpture of the outer surface more distinct (longitudinal rows of relatively large isodiametric cells).

Viola sp. 2

Pl. IX, fig. 5

Locality: NS. II: 29

Material: 1 seed

Description. Seed, 2·5×1·2 mm, elliptical in shape, truncated at base, with relatively large round chalaza, at top elongated into long beak and cracked.

[4] The remains described from the Pliocene of Krościenko as fruits of *Circaea lutetianoides* n. sp. (Szafer 1947, Pl. X, figs. 14, 15) bear characteristics of the seeds of *Viola* (large round chalaza, longitudinal raphe on the incurvation side of the apical part, which at the same time is the place where the elaiosome was), and are identical with the remains recorded from this flora as *Viola* cf. *uliginosa* Bess.

Fine longitudinal wrinkles can be seen on the outer surface of the fairly thick testa, especially at the top. Delicate transverse striations, typical of the genus *Viola*, are visible on the inner surface.

Comparison. Relatively large and narrow seeds, strongly elongated in the apical part, occur in various modern species which also vary in geographical distribution. The seed under study is supposed to bear the most resemblance in size, shape and outer sculpture to the seeds of *V. cornuta* Hall. (south-eastern Europe).

Viola sp. 3

Pl. IX, figs. 6—8

Locality: NS. II: 31

Material: 2 seeds and 5 fragments

Description. Seeds, 1·2—1·3 × 0·8—0·9 mm, broadly ovate and as if inflated (broadest halfway along), truncated at base, with short and sharply ending apex. Chalaza fairly large, visible in two specimens. Testa thin, with external sculpture blurred.

Comparison. Seeds similar in shape but somewhat larger in size can be found among contemporary species, e.g. those of *V. chinensis* [5], 1·5 mm in length and 1·2 mm in width. Dorofeev (1963a) described similar seeds from the Miocene of West Siberia as *Viola* sp. 7. According to him, they show semblance to the seeds of *V. uliginosa* Schrad., but are shorter, more inflated and thin-walled. Thus, comparing them to this modern species does not seem well-founded.

Family **Actinidiaceae**

Actinidia faveolata C. & E. M. Reid

Pl. IX, figs. 11, 12

Localities: NS. I: 85, 151, (273, 320)
NS. II: (18, 30, 31)
(Niskowa)

Material: 9 seed fragments

Description. Only small fragments of testa, characteristically pitted, resembling a honeycomb, are preserved. The largest two of them (1·8 × 1·5 mm and 1·8 × 0·9 mm) are parts of seeds, above 2 mm wide and above 3 mm long. The other fragments are much smaller.

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[5] In the reference material derived from the collection of fruits and seeds of the Institute of Botany, Polish Academy of Sciences, the author's name is missing. Probably we are concerned here with the East-Asiatic species *V. mandshurica* W. Bckr. (= *V. chinensis* W. Bckr. = *V. chinensis* G. Don = *V. patrinii* Ging. var. *chinensis* Maxim.).

Comparison. These two larger fragments of testa from samples NS. I: 85 and 151 may be included in the named species authoratively on account of the large size of seeds from which they derive and the large number of pits distributed across the seed at its greatest width (cf. Łańcucka-Środoniowa 1966). The remaining, very small fragments may belong to the same species, but this cannot be proved for certain unless the number of pits at the greatest width is known.

Occurrence. Species described from the Pliocene of the Netherlands (Reid 1915), often reported from the Upper Tertiary of Europe and even from the lowest Pleistocene of the Netherlands (Tegelen-Reid 1915, cf. also Tralau 1963, p. 57). Known also from the Oligocene and Miocene of West Siberia (Dorofeev 1963a). In Poland it has been found in the Pliocene of Krościenko, Mizerna (Szafer 1947, 1954) and Domański Wierch (Łańcucka-Środoniowa, in prep.) and in the Miocene of Zatoka Gdowska (Łańcucka-Środoniowa 1966).

Actinidia argutaeformis Dorof.

Pl. IX, fig. 13

Locality: NS. I: 53

Material: 1 seed

Description. A seed, 1·5×1·05 mm, obovate and biconvex. Top rounded, base somewhat tapering, with an asymmetrically situated short rim. Testa relatively thick (the seed splits on the circumference and is filled with clay), pitted, with about 16 pits across at the greatest width of seed. The pits are circular, more rarely polygonal, their walls largely thickened and smoothened, almost rounded. The pit diameter decreases slightly towards the seed circumference, but the differences are not as distinct as in the previous species.

Comparison. Dorofeev described similar seeds first as *Actinidia* cf. *arguta* (S. & Z.) Planch. and later as the fossil species *A. argutaeformis* Dorof. (Dorofeev 1963a, Pl. 39 /19—26), related to *A. arguta* (S. & Z.) Planch. The seeds of this East Asiatic species are somewhat larger than the fossil ones, being 2·0—2·2 mm long and 1·2—1·6 mm wide. *A. arguta* (S. & Z.) Planch. is a climber which climbs high trees of mixed forests overgrowing the banks of streams and descending to seashores. It grows in Primorsk, Japan, Korea, southern islands of the Kuril Is. and north-eastern China.

Occurrence. According to Dorofeev (1963a), seeds of *A. argutaeformis* Dorof. have been found in the Miocene and Oligocene deposits of West Siberia and in the Miocene of the Odessa region. So far this species has not been reported from the Tertiary of Poland. Some specimens of *Actinidia* sp. from the Pliocene of Krościenko and Mizerna may belong to it.

Family **Guttiferae**

Hypericum aff. ***maculatum*** Cr.

Pl. X, fig. 12

Locality: NS. I: 349

Material: 1 seed

Description. A seed, 1·15×0·45 mm, cylindrical, with a slightly bent axis. Apex and base pointedly elongate; fairly deep and subsquare cells arranged in parallel longitudinal rows visible on the surface of the seed. There are 15 rows of these cells on either side of the seed compressed during fossilization. The vertical walls of these cells are more conspicuously thickened and form longitudinal striae on the surface of the seed. Testa thick, black in colour.

Comparison. Raniecka-Bobrowska (1959, Pl. 20, figs. 12—15) described similar seeds, with distinct longitudinal striae, from the Miocene of Konin as *Hypericum* sp. 2, relatively most closely related to *H. elatum* Ait. from the Canary Is. However, the specimens from Konin are less elongated than those from Nowy Sącz and besides, as this authoress writes, „the network meshes arranged in fairly regular longitudinal rows on its surface are somewhat elongated transversely".

The species *H.* cf. *balearicum* L. recorded from the Lower Sarmatian of Moldavia (Negru 1972, Pl. 26, figs. 1—9) is, to be sure, marked by distinct longitudinal striae, but its seeds are larger, relatively broader and have fewer longitudinal rows of cells, only 8—11 on either side of the seed flattened during fossilization.

Resemblance can also be found between the specimen from Nowy Sącz and the seeds of *H.* cf. *septestum* Nikitin from the Miocene of Kirevskoje in West Siberia (Dorofeev 1963a, Pl. 40, figs. 21—23). These last seeds differ in details of their morphological structure from the typical seeds of *H. septestum* Nikitin and, in Dorofeev's opinion, may belong to a separate species. The seeds from Kirevskoje, 1·5—1·6 mm in length, are still larger than the specimen from Nowy Sącz.

An additional difficulty encountered in determining the seeds of fossil *Hypericum* is connected with the mode of their fossilization. Their external structure may be various in dependence on the fact whether their epidermis has been preserved (it has generally smaller, often equilateral cells arranged in a large number of parallel longitudinal rows) or whether it is missing and the middle layer of the testa, built of considerably larger and thick-walled cells in many species, is exposed. Comparing the fossil seeds to those of modern species demands circumspection, even if their shapes and sizes are very much alike.

The specimen from Nowy Sącz well corresponds with the seeds of *H. maculatum* Cr. (= *H. quadrangulum* L. p.p.) as regards these two characters. This similarity includes also their external structure, assuming that the fossil specimen has its epidermis preserved. This is probable, because it is possible to trace the place where the subtle filiform raphe extended.

Occurrence. Seeds of this genus are reported from the Pliocene and Miocene of Eurasia and the Oligocene of West Siberia. The seeds most closely resembling the specimen from Nowy Sącz come from Miocene deposits.

Hypericum cf. *tertiaerum* Nikitin

Pl. X, fig. 11

Locality: NS. II: 31

Material: 1 seed

Description. Seed, 0·9×0·55 mm, largely flattened, elliptic, tapering at both ends, in places almost transparent, yellow-brown in colour. Testa thin, with large hexagonal thick-walled cells marked on its surface in 6—7 longitudinal rows. These cells are equilateral or somewhat elongated perpendicularly to the seed length, their primary hexagonal form being discernible on one side and deformed and subrectangular owing to compression on the other. Strongly thickened cell walls make the seed surface look spiny.

Comparison. Seeds similar in shape and size occur in the species *H. tertiaerum* Nikitin, first described from the Pliocene of Voronež (Nikitin 1957). Their surface is however smooth, with many rows of relatively small cells. From the same flora Nikitin described *Hypericum* sp. 3?, with seeds similar to those of *H. tertiaerum* in shape and size but having a different „spiny" structure. According to Nikitin, they are seeds of *H. tertiaerum* with the epidermis worn out. The specimen from Nowy Sącz shows the same characters as the seeds of *Hypericum* sp. 3? from the Pliocene of the Voronež region.

Occurrence. Species known from the Miocene and Pliocene of Europe and the Miocene of West and East Siberia (Dorofeev 1963a; Nikitin V. P. 1976).

Family **Saxifragaceae**

Hydrangea polonica Łańc.-Środ.

Pl. IX, figs. 14—16a

Locality: NS. II: 23, 30

Material: 4 seeds

Description. Small seeds, 0·5—0·75×0·27—0·42 mm, bilaterally flattened, fusiform, narrowing wedgewise at both ends. They have a short beak apically and pass into an elongate and membranous stalk in the lower part. The surface is longitudinally ribbed, 4—5 protruding ridges running on either side, and the seeds split along these ridges in the apical part. The neighbouring ridges are sometimes connected by delicate oblique walls. The seeds are transparent, strongly shining and light- or dark-brown in colour.

Comparison. The genus *Hydrangea*, now comprising more than 20 species growing in East Asia, North America and tropical regions of Southeast Asia and Central and South America, has small seeds of a similar so characteristic structure. These are mostly shrubs, sometimes climbers, rarely trees, growing most readily on fertile humus and alluvial soils.

Some specimens from Nowy Sącz are comparable to the seeds of the North American species *H. quercifolia* Bart., others to those of the Chinese species *H. sargentiana* Rehd., now defined as *H. aspera* D. Don. ssp. *sargentiana* (Rehd.) McClintock. The differences in morphological structure between the seeds of the two modern species are however small and it is also difficult to establish them in the case of the fossil seeds from Nowy Sącz, which for this reason have been included in one species (Łańcucka-Środoniowa 1975).

Occurrence. Genus known from the Tertiary of Eurasia and North America (also South America — cf. Andrews 1970) only on the basis of impressions of leaves and sterile flowers, which have not, as yet, been found in the Tertiary of Poland. Seeds described for the first time from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1975).

Family **Rosaceae**

Rubus laticostatus Kirchh.

Pl. IX, figs. 17, 18

Localities: NS. I: 43, 56, 75, 164, 188, 254, 280, 349
NS. II: 18, 30, 31
Niskowa

Material: 12 complete endocarps, 9 damaged ones or their fragments.

Description. Endocarps, 1·4—2·0×1·05—1·4 mm, obliquely ovate, laterally flattened. The ventral side is straight or slightly convex and the dorsal side rounded, the apex bluntly narrowed and the base widely rounded. Pits in the surface of the endocarps vary in shape and size (often not very large and subcircular) and the ridges that separate them are relatively wide and blunt.

Comparison. These remains correspond with the endocarps of *Rubus laticostatus* Kirchh., the species described from the Tertiary of Germany by Kirchheimer (1942). In his opinion, similarly built but considerably larger endocarps occur, out of the modern species, in *R. fruticosus* L.

Negru (1972) sees the greatest similarity to the endocarps of *R. phoenicolasius* Maxim., a high shrub of the forests of Japan, Korea and northern China. Many modern species show a great resemblance in the morphological structure of endocarps, which fact is still more complicated by the frequent occurrence of hybrids. For this reason the unquestionable inclusion of Tertiary endocarps in one of the very numerous modern species is little probable.

Occurrence. Species known from the Miocene and Pliocene floras of Europe. It includes endocarps of *R. caesius* L. from the Pliocene of Krościenko and *Rubus* sp. from the Miocene of Nowogrodziec (Naumburg a. Q.) in Silesia (cf. Kirchheimer 1942, 1957; Łańcucka-Środoniowa 1966; Negru 1972). In Gregor's (1975) opinion, the endocarps of *Rubus* sp. 1 and *R.* sp. 2 from the Miocene of Rypin and *R.* cf. *idaeus* L., *R.* sp. 1 and *R.* sp. 2 from the Miocene of Konin also belong to the same species. Most of the endocarps from the Miocene of Stare Gliwice, described as *R. caesius* L. s. l., *R. idaeus* L. s. l. and *R. saxatilis* L. s.l. should be numbered in this species.

Rubus microspermus C. & E. M. Reid

Pl. IX, figs. 19—25

Localities: NS. I: 122, 258, 266, 270, 287, 294, 295, 298, 308, 312, 320
NS. II: 18, 27—31, 33, 36, 39
Material: 36 endocarps and 9 fragments

Description. The most commonly encountered endocarps are very small, little exceeding 1 mm in length, 0·95—2·0 × 0·5— 1·15 mm. The shape of endocarps is rather variable, but the narrow and elongate specimens with the ventral side straight, the dorsal side convex and the apex elongated, prevail. Pits in the surface of the endocarps are rather large, elongated, irregular and angular, while the ridges between them are thin and sharp.

Comparison. These remains well agree with the species *R. microspermus* described from the Oligocene of Bovey Tracey by the Reids in 1910.

Occurrence. Species recorded (not often) from the Oligocene and Miocene of Europe. According to Palamarev (1970), it still occurred in the Pliocene of Bulgaria. In Poland known from the Tortonian of Zatoka Gdowska (Łańcucka-Środoniowa 1966).

Rubus semirotundatus n. sp.

Pl. X, figs. 1—4

Localities: NS. I: 270, 276
NS. II: 30, 33, 40
Material: 9 endocarps

Description. Most endocarps, 1·3—2·0 × 1·1—1·45 mm, semicircular, others obliquely ovate, biconvex and thick. Ventral side more or less convex, dorsal side strongly vaulted and rounded. Apex blunt, with a small and pointed eminence, which is shifted to the ventral side. Pits in surface large and deep, somewhat elongate in the apical and basal parts and equilateral (often hexagonal) in the middle of both side-walls. The ridges between the pits are thin and sharp, often perfectly straight. Except for the apical part, pitting does not reach the margins of the two-sidedly flattened endocarps, which, in consequence, have a broad, flat and smooth ledge on the circumference, unencroached on by the pit walls. This arrangement of pits suggests that the endocarps were distinctly flattened nearly all over their circumference before fossilization and then in their natural state.

Comparison. The endocarps described differ in morphological structure from the species so far distinguished in Tertiary floras. To be sure, *Rubus* (cf. *R. villosus* Ait.) described from the Pliocene of Pont de Gail (Reid 1923) has a conspicuous and broad ledge on the dorsal side, but in other characters of morphological structure it does not correspond with the specimens from Nowy Sącz.

These specimens may be compared, judging by the contemporary material I had at my disposal, with the endocarps of such species as *R. rudis* Weihe & Nees (north-west and central Europe), *R. radula* Weihe (west Europe, south Scandinavia, Hungary) or *R. laciniatus* Willd. (cultivated in Europe and America, of unknown origin — cf. Flora Europaea II). The endocarps of these species are larger than the fossil ones, but they are similar in shape, in large sharp-edged pits and in the characteristic flat ledge on the dorsal side.

The likeness of the endocarps from the Miocene of Nowy Sącz to those of different modern species (their number is perhaps still greater) impels me to describe a new fossil species; its name is connected with the semicircular shape of the endocarps.

Occurrence. Species new to the Tertiary, found also in the Neogene of Czarny Dunajec and Koniówka (Łańcucka-Środoniowa, in prep.).

Rubus aff. *occidentalis* L.

Pl. X, fig. 5

Localities: NS. I: 268
NS. II: 18

Material: 2 endocarps

Description. Endocarps, 1·6×1·25 mm and 1·85×1·25 mm, obliquely ovate, laterally flattened, their base being rounded and slightly asymmetrical and the top tapering in a cuneiform manner. Ventral side somewhat convex or nearly flat, dorsal side fairly strongly convex. Pits in surface fine, ridges separating them narrow.

Comparison. In view of their shape and size these remains might be included in *R. laticostatus* Kirchh., often recorded from Neogene floras. This is however contravened by the difference in the ridges which separate the pits and which in *R. laticostatus* are wide and blunt.

The remains described show a great similarity to the North American species *R. occidentalis* L. and are almost identical in all details of their morphological structure with its variety from Japan (*R. occidentalis* L. var. *japonicus* Migali).

Occurrence. Species reported from the Pliocene of Europe, described for the first time from the Pliocene of Pont-de-Gail (Reid 1923, Pl. X, fig. 22). The only specimen found in this flora has a very acute top and is nearly semilunar in shape, which however is not typical of this species. The endocarps of *R.* cf. *occidentalis* L., distinguished in the Pliocene flora of Krościenko (Szafer 1947), are more elongate and narrower than those in the modern species.

Potentilla pliocenica E. M. Reid

Pl. X, figs. 6—8

Localities: NS. I: 278
NS. II: 30, 31

Material: 4 fruits

Description. Fruits, 1·05—1·2×0·7—0·9 mm, obliquely ovate, apex somewhat narrowed and bent towards the ventral side, base broader and rounded. Ventral side flat or slightly convex, dorsal side semicircular. Fruits flattened and thin-walled, surface dull and smooth, with small isodiametrical cells marked on it.

Comparison. The distinctive character of this fossil species, first described from the Pliocene of Castle Eden by E. M. Reid (1920a), is, according to this authoress, its lack of irregular longitudinal grooves typical of most species of the genus *Potentilla*. E. M. Reid did not compare this fossil species with the recent ones. Dorofeev (1963a) sees its similarity to different East Asiatic species like *P. nudicaulis* Willd., *P. sericea* L., *P. dealbata* Bge., *P. multifida* L. or *P. verticillaris* Steph.

Occurrence. Species known from the Miocene and Pliocene of Europe and the Miocene of West Siberia. It also includes fruits described as *Comarum palustre* L. from Mizerna IV (cf. Dorofeev 1963a, p. 204), i. e. from the formations referred by Szafer (1954) to the Lower Pleistocene.

Potentilla cf. *supina* L.

Pl. X, fig. 9

Locality: NS. I 30

Material: 1 fruit

Description. Fruit, 0·8×0·6 mm, roundly oval, base broad, top somewhat narrowed and rounded, ventral side slightly convex. The specimen is heavily compressed; a trace of a delicate longitudinal groove, running parallel to the dorsal side, can be seen on its smooth external surface.

Comparison. The specimen described may be compared with the fruits of several European species, e. g. *P. supina* L., *P. norvegica* L. and *P. argentea* L., but it is *P. supina* L. that it resembles most in size and shape. To be sure, the bilaterally flattened fruits of this species have three (and not one) delicate longitudinal grooves, running parallel to the dorsal side of fruit, on either lateral surface, but with the mode of fossilization observed in the flora examined they had hardly any chance to be preserved.

P. supina L. is a plant of damp sandy places, notably alluvial ones, distributed in lowland regions and in lower parts of mountains.

Occurrence. The fossil form of this species was first distinguished by D. Mai in the Pliocene flora of Nordhausen (oral communication). E. M. Reid (1920a) described similar fruits from the Pliocene of Castle Eden as *P. argentea* L. The specimen figured by E. M. Reid (Pl. VIII, fig. 30) however lacks distinctive features of this species and in its shape rather comes near *P. supina* L.

Alchemilla sp.

Pl. X, fig. 10

Locality: NS. II: 36
Material: 1 fruit

Description. Fruit, 1·2×0·95 mm, asymmetrical, laterally compressed, base broadly rounded, apex narrowing, wedge-shaped. Dorsal side semicircular, ventral side slightly convex and in its lower part furnished with a large attachment prominence. The outlines of tetra- and polygonal cells can be seen on the surface; they are arranged in fairly regular rows, which gives the impression of a longitudinal striation, especially distinct in the apical part of the fruit.

Comparison. The morphological structure of the specimen described agrees with that of fruits of the genus *Alchemilla*. Unfortunately, only one specimen has been found and not very well preserved at that, cracked over a considerable distance on one side, which might cause some deformation, i.e. a greater convexity of the dorsal part. It would be difficult to describe a new species on this basis and still more difficult to carry out comparisons with recent species whose fruits show a very similar structure.

Occurrence. This genus has not, as yet, been recorded from the Tertiary and relatively rarely from Pleistocene floras. In Poland its fruits have been collected in the Pleistocene deposits of the Western Carpathians (Sobolewska & Środoń 1961; Środoń 1968).

Family **Lythraceae**

Decodon gibbosus (E. M. Reid) Nikitin

Pl. X, figs. 13—15a

Localities: NS. I: 280
NS. II: 30, 31, 40
Niskowa
Material: 9 seeds, 2 fragments of seeds, 1 capsule

Description. Seeds, 0·55—1·25×0·95—1·6 mm, irregular in shape, semicircular or more elongate, laterally flattened. Dorsal side markedly convex, ventral side flat and whole occupied by germination valve, which is often collapsed and damaged or has entirely fallen off. In two specimens it is however well preserved and shows its triangular shape and longitudinal striations on the surface. Broad funnel-shaped hilum close to valve. Seed walls thick, their surface smooth and dull, in some specimens intensely shining and characteristically pitted outer layer is preserved; pits relatively large, elongate and shallow.

Table 12

Measurements of seeds of *Decodon gibbosus* (E. M. Reid) Nikitin from the Miocene of the Nowy Sącz Basin

Locality	NS. I: 280		NS. II: 30	NS. II: 31	NS. II: 40			Niskowa	
Specimen No.	1	2	3	4	5	6	7	8	9
Length of seed	0·92	0·85	0·92	0·55	0·92	0·80	1·00	1·15	1·25
Breadth of seed	1·20	1·38	1·13	0.95	1.10	1.45	1.20	1.25	1.60

A small capsule is also preserved, it measures 1·5×1·25 mm, and shows 3 ripe seeds, which cling closely to each other, 1 abortive seed and a stalk fragment.

Comparison. The species was first described under the name *Diclidocarya gibbosa* (E. M. Reid 1920b, Pl. IV, figs. 23 and 25) from the Pliocene of Pont-de-Gail, next included in the genus *Decodon* (Nikitin 1929). The seeds from the Miocene of the Nowy Sącz Basin have characteristic features of this species, above all, a very irregular shape, a considerable thickening of the dorsal part and the position of the valve on the ventral side.

Occurrence. Species known from the Tertiary of Europe (from Oligocene to Pliocene), the Oligocene and Miocene of West Siberia and the Miocene of East Siberia (Dorofeev 1963a, 1969a). According to Dorofeev, it is an ancient species that had already appeared towards the end of the Eocene.

In Poland it occurs in the Miocene of Konin, from where it has been reported by Raniecka-Bobrowska (1957, Pl. VII, figs. 7—11) as *D. globosus* (Reid) Nikitin (cf. Dorofeev 1963a, p. 234). It has also been found in other Neogene floras, e. g. at Koniówka, Lipnica Mała and Sośnica (Łańcucka-Środoniowa, in prep.).

Microdiptera cf. *parva* Chandl.

Pl. X, figs. 16a, 16b

Locality: NS. I: 240
Material: 1 seed

Description. Seed, 1·9×0·9 mm, elongated, trapezoidal in shape. Top slightly rounded and acute in the middle part, base rounded with an indent on either side. The dorsal side has a protruding rib in the lower part and an oval germination valve in the upper part. The valve had completely come off, uncovering the seed cavity. The ventral side has a broad raphe in the form of an elongate cylinder. A projecting thickening, resembling thick wings, with the surface finely longitudinally striated, extends on either side of the raphe. Such striations can also be seen on the flanks of the dorsal side. Testa thick, external surface dull. Unfortunately, this specimen was lost after determination.

Comparison. Two closely related extict genera *Diclidocarya* and *Microdiptera* are similar in morphological structure to the specimen under study. Most characters refer it to the genus *Microdiptera*, first described from the Oligocene of England (Chandler 1957).

Seeds of *M. parva* Chandler (l. c., Pl. 15, figs. 133—149) are generally marked by their considerable breadth, which often exceeds the length. Slender specimens also happen but they are rare (l. c., figs. 146 and 147). This species was encountered in the Oligocene flora of Haselbach (Mai & Walther 1978) and in the Miocene of Hartau (Mai 1964, Pl. 14, fig. 36) and Kleinleipisch (Mai, in prep.). The Miocene seeds from Kleinleipisch are much slenderer than the specimens from the Eocene and Oligocene of England. By courtesy of Dr. D. Mai I had many seeds from that locality at my disposal and thus I was able to investigate their size and shape variation and to find the fairly frequent occurrence of seeds of small breadth sometimes nearly oblong, without a distinct widening above the germination valve. In shape and size the specimen from Nowy Sącz much resembles many Kleinleipisch seeds, which it exceeds in length by 0·1 mm only.

The seeds of *M. elongata* (Dorof.) Dorof., described from the Tertiary of West Siberia initially as *Diclidocarya elongata* n. sp. (Dorofeev 1963a, 1968), are distinctly smaller, 1·0—1·3 mm long, most often trigonous, although specimens oblong in outline also happen (l. c., Pl. 40, fig. 32).

The seeds of *Diclidocarya uralensis* Dorof. from the Miocene of the Ural Mts. (Dorofeev 1970b, Text-fig. 12, Pl. 15, figs. 1—5) might also agree with the specimen from Nowy Sącz in their elongate and trapezoid shape, but their lateral wings are not so thick.

The thickness of lateral wings is the character by which the genera *Diclidocarya* (thin wings) and *Microdiptera* (conspicuously thickened wings) are distinguished. However, this distinction is not always easy. In Dorofeev's (1970b) opinion, the differences between the seeds of *Diclidocarya* and *Microdiptera* are slight and discrimination of these genera may encounter difficulties, notably in Lower and Middle Miocene floras, in which intermediate forms occur.

Occurrence. Species known from the Upper Eocene throughout the Middle Miocene of West and Central Europe and new to the Tertiary of Poland. It belongs to the oldest elements of the flora studied.

Family **Rutaceae**

Phellodendron sp.

Pl. X, fig. 17

Locality: NS. II: 31
Material: 1 seed fragment

Description. Fragment of a seed, 1·9×1·3 mm, including upper part of the convex dorsal side. Testa 0·1 mm thick. Surface shining, black, with large quadrangular pits arranged in longitudinal parallel rows. The size of these pits is various, but they are markedly smaller in the dorsal region of the seed. The longitudinal walls of the pits are unequal in thickness but distinctly higher than the transverse walls, which produces a picture of more or less sharp longitudinal ribs.

Comparison. On the basis of such a small fragment it was impossible to determine it to specific level, since the sculpture of the testa surface remains as the only diagnostic feature and neither in recent species nor in fossil ones does it show any great differences; it depends also on the part of seed from which it comes.

The genus *Phellodendron* includes about 13 species. They are trees of damp mountainous forests (500—1000 m a.s.l.) in East Asia from Sachalin to Formosa. The seeds of recent species show great variation and are not easy to distinguish. The species described on the basis of seeds from the Tertiary of Eurasia, were compared, above all, to *Ph. amurense* Rupr. (grows on the Amur, in Manchuria and Korea) and *Ph. japonicum* Maxim. (grows in Japan).

Occurrence. Seeds of *Phellodendron* are known from the Miocene, Pliocene and Pleistocene of Eurasia [6]. *Ph. amurense* Rupr. foss. and *Ph. japonicum* Maxim. foss. have been described from the Pliocene of Krościenko and Mizerna (Szafer 1947, 1954). Seeds of this genus have also been found in the Pliocene of Domański Wierch and in the Miocene of Wieliczka, Koniówka and Łabędy in Silesia (Łańcucka-Środoniowa 1963 and in prep.).

Family **Aceraceae**

cf. ***Acer*** sp. div.

Pl. X, figs. 18—19b

Localities: NS. I: 272
NS. II: 32
Material: 1 fruit (wingless) and 1 seed

[6] The seeds of *Ph. costatum* Chandler, occurring in the Eocene and Oligocene of England (Chandler 1925, 1961), do not agree with the genus *Phellodendron* in their morphological structure (cf. Tralau 1963, p. 49). The species *Ph. europaeum* n. s.p., described by Menzel from Herzogenrath near Aachen in 1913 (flora referred previously to the Oligocene, now to the Middle Miocene), cannot be acknowledged either, since the structure of the seeds is not known (cf. Kirchheimer 1957; Tralau 1963).

Description. Fruit (NS. II: 32), 3·1×2·3 mm, elliptical in shape, markedly flattened. A part of its circumference is formed by a straight section, which was probably the place of accretion with the other fruit. On the side surfaces there are delicate wrinkles, running along the line of circumference, and more distinct ones, extending from the place of accretion towards the long axis of fruit.

The other specimen (NS. I: 272), 3·3×3·0 mm, subcircular, also markedly flattened. Its side surfaces show elongate cells, which, lying close to each other, give the impression of shining black threads. On these surfaces there are, besides, delicate wrinkles, which run radially from the accretion line towards the circumference.

Comparison. The state of preservation of these remains is such that we cannot even be sure that the generic determination is reliable. The first of the specimens described resembles the fruit of *Acer* sp. 2 (sect. *Spicata* Pax) from the Tortonian of Zatoka Gdowska (Łańcucka-Środoniowa 1966) in shape but is smaller. Out of the modern species, East-Asiatic *A. ukurunduense* Trautv. Mey. has small fruits similar in structure.

The other specimen bears a great resemblance to the seeds of some species of the genus *Acer*.

Family **Araliaceae**

Aralia rugosa Dorof.

Pl. XI, figs. 1, 2

Locality: NS. II: 30, 31

Material: 2 endocarps and 1 fragment

Description. Endocarps, 2·35×1·35 mm and 1·8×1·3 mm, more or less elongate, flattened, with relatively thick walls. Surface with fairly large pits of irregular shape. The partitions which separate these pits vary in thickness and they look like thick wrinkles which run in fairly regular longitudinal rows on the dorsal side. In addition, a very fine transverse striation, characteristic of the genus *Aralia*, can be seen on the surface of the endocarps studied, especially on their ventral side.

Comparison. Dorofeev (1963a, p. 245, Pl. 43, figs. 13—16) described endocarps similar in morphological structure, with a characteristically pittedly wrinkled surface, from the Oligocene of Dunaevski Jar in West Siberia as *A. rugosa* sp. nov. According to him, these endocarps are built typically of the genus *Aralia* and from all the species described so far they differ in their pittedly rugose surface. He did not find similarly built endocarps in species living at present.

Occurrence. This species occurs chiefly in the Oligocene, rarely in the Miocene of West Siberia, and in the Miocene of East Siberia (Dorofeev 1963a, 1969a). In Dorofeev's opinion, it grew in West Europe from the Miocene throughout the Pliocene (cf. Biostratigrafija..., 1962, p. 411). It has been found in the Pliocene of Domański Wierch and probably occurs also in the Miocene of Czarny Dunajec and Koniówka (Łańcucka-Środoniowa, in prep.).

Aralia cf. *ucrainica* Dorof.

Pl. XI, figs. 3, 4

Localities: NS. I: 110
NS. II: 15, 16

Material: 3 endocarps and 1 fragment

Description. Endocarps, 1·25—1·4 × 0·9—1·1 mm, ovate in shape, laterally, flattened, thin-walled. Outer surface finely transversely striated and, in addition delicately longitudinally wrinkled at the semicircular dorsal side. A round micropylar aperture occurs at the top of the almost straight ventral side.

Comparison. These remains most resemble the endocarps of *A. ucrainica* Dorof., described from the Miocene of Odessa (Dorofeev 1955, Pl. 6, figs. 5—7), but only one specimen has an acute apical part, characteristic of this species. We might also see some resemblance to *A. depressa* Dorof., but the endocarps of this species, distinguished in the Miocene of West Siberia, are larger and more elongate (cf. Biostratigrafija... 1962, p. 411; Dorofeev 1963a, p. 247, Pl. 43, figs. 18—21).

Occurrence. The species *A. ucrainica* Dorof. has been found in the Upper Miocene of the Ukraine and this was, so far, its only fossil locality.

Aralia tertiaria Dorof.

Pl. XI, figs. 5a, 5b

Locality: NS. I: 4, 349

Material: 1 endocarp and 1 fragment

Description. The dimensions of the endocarp and fragment are, respectively, 2·6 × 1·5 and 2·1 × 1·3 mm. The whole specimen is elongate, somewhat broader in the upper half. The ventral side is straight with a small micropylar aperture by the top and the dorsal side is convex, truncated at the base and at the top. They are compressed and thick-walled endocarps, with distinct sculpture — fine transverse striations, short longitudinal wrinkles and a characteristic crest, extending parallel all along the dorsal side.

Comparison. These remains correspond to the endocarps of *A. tertiaria* Dorof., first described from the Tertiary of West Siberia (Dorofeev 1963a) and similar to several modern species, notably to East-Asiatic *A. continentalis* Kitag., which grows in the forests of north-eastern China and Korea.

Occurrence. Species known from the Oligocene and Lower Miocene of West Siberia and from the Miocene and Pliocene of West Europe (cf. Dorofeev in Biostratigrafija... 1962, p. 411). Reported also from the Miocene of East Siberia (Nikitin V. P. 1976), has not as yet been distinguished in the Tertiary of Poland.

Aralia sp.

Pl. XI, fig. 6

Locality: NS. II: 29
Material: 1 endocarp
Description. Only a part of an endocarp, measuring $2{\cdot}6 \times 1{\cdot}1$ mm, with a slightly convex ventral side, rounded top and obliquely truncated base. The whole endocarp may have been 2·7 mm in length and relatively narrow. The endocarp walls are thin, subtle and almost transparent. The finely transversely striated lateral surfaces show, in addition, small elongate pits, which are particularly distinct close to the dorsal side.

Comparison. This specimen may be compared with several modern species, both East-Asiatic (*A. cordata* Thunb., *A. cachemirica* Decne) and North-American (*A. racemosa* L., *A. californica* Wats.). Endocarps of this type, resembling the above-mentioned modern species, were found many a time in the Tertiary flora of Eurasia and described under their names.

Occurrence. Endocarps of this type are known from the Miocene and Pliocene of Europe and the Oligocene and Miocene of West Siberia.

Schefflera dorofeevii Łańc.-Środ.

Pl. XI, figs. 7a, 7b, 8a, 8b

Locality: NS. I: 300, 302
Material: 2 endocarps
Description. Endocarps, $3{\cdot}55 \times 1{\cdot}75$ and $3{\cdot}7 \times 1{\cdot}8$ mm, elongate, straight ventrally, convex dorsally, rounded at base, narrowing wedgewise at top and with a distinct micropylar aperture on the ventral side. They are markedly flattened and conspicuously thinwalled. Lateral surfaces dull and smooth, delicate longitudinal wrinkles being marked in some places, especially near the dorsal side.

Comparison. Similarly built endocarps occur in the genus *Schefflera*, many species of which (300—400 species according to data from 1942) grow in tropical and subtropical areas throughout the world. These are rather low trees and shrubs with digitate leaves, composed mostly of 5 elongate leaflets with long petiolules.

This genus has been known in the fossil state on the basis of its characteristically built leaves since long ago, but for a long time they were described under other generic names (cf. Łańcucka-Środoniowa 1975). The fossil species, recently distinguished on the basis of leaves, come from the Oligocene of Hungary (Rasky 1959) and the Pliocene of the Caucasus (Kolakovskij 1964).

Endocarps of this genus have not yet been described from fossil floras. It is very hard to determine the relation of the specimens from the Miocene of Nowy

Sącz to the contemporary species because of the scantity of comparative material. The most similar are the endocarps of *S. venulosa* var. *erythrostachys* from the Botanical Garden at Coimbra (Portugal). Describing the leaves of *S. integrifolia* n. sp. from the Pliocene of Kodor in the Caucasus, Kolakovskij (1964) drew attention to a similarity to the Chino-Indian species *S. venulosa* (With. & Arn) Harms.

Occurrence. Species described for the first time from the Miocene of Nowy Sącz, Chyżne and Lipnica Wielka in Orawa (Łańcucka-Środoniowa 1975).

Family **Umbelliferae**

Hydrocotyle sp.

Pl. XI, figs. 9a, 9b

Locality: NS. II: 32

Material: 1 schizocarp

Description. Fruit, 0·85 × 0·55 mm, bilaterally flattened, dorsally rounded, especially at top and at bottom. The almost straight ventral side shows a concave surface of adhesion of two schizocarps, of which one had undergone a destruction. An arcuate narrow rib extends on each lateral wall, being preserved whole only on one wall. The surface of the flat lateral walls is shining but uneven, as if tuberculous.

Comparison. The morphological structure of the fruit described refers it to the genus *Hydrocotyle*, whose flat schizocarps have a narrow and arcuate rib on their lateral walls.

The genus *Hydrocotyle* numbers about 60 species, spread in marshy and wet areas chiefly in the tropical and subtropical zones of the Old and New World. Nowadays two species occur in Europe, i.e. *H. vulgaris* L. (western, central and southern Europe) and *H. ranunculoides* L. (southern Italy, Sicily, Caucasus, coast of the Caspian Sea, Iran, Ethiopia, Madagascar, North America, Chile).

The specimen from the Miocene of Nowy Sącz is very small (0·85 mm in length) and it is by no means comparable to the fruits of *H. vulgaris* L., the length of which is about 2 mm, or those of *H. ranunculoides* L., which reach 3 mm in length. Some East-Asiatic species, e. g. *H. wilfordi* Maxim. (Japan) and *H. japonica* Zoll. (= *H. sundaica* Blume — Malaya), have very small fruits, about 1 mm long. Not quite ripe fruits of these species are more or less equal in size to the specimen from Nowy Sącz. It is impossible to go on determining it beyond generic level if one is short of complete reference material (there may be much more such small-fruited species). Neither does the bad state of preservation of this specimen permits the distinction of a new fossil species.

Occurrence. Taxon new to the Tertiary. Two species of this genus (*Hydrocotyle vulgaris* L. and *H. ranunculoides* L.) are known from the Pleistocene of Europe.

Family **Primulaceae**

Primulaceae gen.

Pl. XI, figs. 9a, 9b

Locality: NS. I: 347
Material: 1 seed
Description. Seed, 0·85×0·6 mm, flattened dorsoventrally, irregular in shape, pentagonal in outline. The dorsal side is slightly corrugated and the ventral side gives the impression of having been originally roof-shaped but owing to compression it is also irregularly folded and the centrally situated elongate hilum is very poorly seen. The seed is grey-brown in colour, its thin testa has angular margins formed by a row of high semitransparent cells. Rows of fairly large polygonal cells can also be seen on the surface of the ventral and dorsal sides of the seed.

Comparison. The morphologic structural characters refer the specimen described above to the family *Primulaceae*, but the bad condition of preservation makes its generic determination difficult. Similarly built seeds can be found in such genera as *Lysimachia*, *Androsace* and *Glaux*. Some Tertiary remains have already been compared with these genera (cf. Raniecka-Bobrowska 1957; Dorofeev 1962, 1963a; Łańcucka-Środoniowa 1966).

Occurrence. The genus *Lysimachia* has been found in the Miocene of Konin (Raniecka-Bobrowska 1957) and the seed of cf. *Primulaceae* gen. from the Miocene of Zatoka Gdowska resembles that of *Androsace* (Łańcucka-Środoniowa 1966).

Family **Ericaceae**

Vaccinium minutulum n. sp.

Pl. XI, figs. 12a, 12b, 13

Localities: NS. II: 26
Niskowa
Material: 2 seeds
Description. Seeds, 0·87×0·45 mm, irregularly cuneate in shape, with a kind of broad rib on the arched dorsal side. Apical part narrowed, obliquely truncated, with relatively large round hilum. Basal part wedge-like and rounded. Seeds somewhat shining, brown-black in colour, their surface showing elongate cells with thick and high walls, which are wavy in places. In the basal part these cells are slightly shorter.

Comparison. Similar seeds occur in the family *Ericaceae* in the genera *Vaccinium*, *Chamaedaphne*, *Chiogenes* and *Gaultheria*. The character of the cells in the external surface of our seeds relates them without reservation only to the genus *Vaccinium*. As regards the features of their morphological structure, they also agree most closely with the seeds of this last genus only that their dimensions are smaller than those of the ripe seeds of various modern species, being equal in size to their unripe seeds, which often occur in fruits.

Today the genus *Vaccinium* contains more than 100 species, distributed from Arctic regions to mountains of the Tropics in the Northern Hemisphere. They are mostly small shrubs with deciduous or evergreen leaves. Leaves of many fossil species have been described from the Tertiary of Eurasia and North America since long ago, but many determinations were called in question and the respective remains were subsequently placed in quite different families. Some seeds have also been found in Tertiary floras recently and sometimes included in new fossil species, like *V. pliocenicum* Dorof. or *V. sibiricum* Dorof. (Dorofeev 1960a, b).

The remains from the Miocene of the Nowy Sącz Basin show a great resemblance to the unripe seeds of *V. myrtillus* L., but they may also be compared with those of other species, e.g. *V. vitis idaea* L., *V. caespitosum* Michx. (North America) and *V. hirtum* Thunb. (Japan).

Occurrence. Taxon new to the Tertiary. Genus known from Oligocene, Miocene and Pliocene floras of Eurasia. In North America found in the Eocene flora of Nevada (leaves of *V. scioensis* Sanborn — Axelrod 1966) and in the Palaeocene of Alaska (leaves of *V. homerensis* Wolfe — Wolfe 1966).

Andromeda carpatica n. sp.

Pl. XI, figs. 11a, 11b; Pl. XII, figs. 1—6

Localities: NS. I: 18, 30, 31, 39, 40, 57, 61, 69, 85, 88, 90, 91, 102, 110, 111, 168, 178, 188, 260, 261, 263, 264, 274, 275, 290, 314, 316—318, 321, 323, 329, 330, 332—334, 341, 350
NS. II: 7, 12, 14, 17, 18, 23, 26, 28, 30—32, 36
Niskowa

Material: 19 seeds and above 140 fragments

Description. Seeds, 1·15—1·65 (2·0) × 1·2—1·3 mm, oval, obliquely ovate or subcircular (if pressed from above), biconvex, often flattened, with irregular folds on both lateral surfaces. The hilum is rather large, oval or oblong, often protruding, sometimes in a small depression, at the top of the seed or shifted somewhat on to the ventral side. Testa thick, its surface smooth, shining, covered with small polygonal cells, closely adjoining each other. Seeds glossy and black, hilum dull, brown in colour.

Comparison. The above-mentioned seeds belong, in addition to leafed twigs and single needles of *Glyptostrobus*, to the most frequent remains in both boreholes at Nowy Sącz. Thus, they constitute an important component of the fossil flora and their accurate identification is of importance to the reconstruction of the vegetation. Such determination however presents much difficulty, mainly because the fossil material contains as if two types of seeds and intermediate forms.

1. Smaller seeds (up to 1·65 mm long), with thicker testa and very smooth and intensely shining surface. They are usually preserved whole and often have their lateral surfaces irregularly folded. They have been found in samples NS. I: 18, 91, 260, 263, 264, 323, 341 and NS. II: 7, 17, 18, 23, 26, 28, 30 and 32.
2. Somewhat larger seeds (up to 2·0 mm long), with thinner testa, and smooth, shining or dull surface. They are very rarely preserved whole (only 1 almost whole specimen), usually broken (but without deep folds), there being only small fragments in many samples. They come from 33 remaining samples and 7 samples in which the first type of seeds also occurred (NS. I: 264; NS. II: 7, 17, 26, 28, 30 and 32).

Both these types of seeds have identical outer and inner sculptures of testa and a similar and so characteristic hilum. There are, in addition, intermediate forms, which are hard to include in any of these types. For this reason the whole, relatively abundant fossil material has been numbered in one species, characterized by relatively great variation in the thickness of testa.

These remains share characters with the seeds of the genus *Andromeda* and in view of their great dimensions might be compared with the seeds of the species *A. brunnea* Dorof., described from the Oligocene of Krasnyj Jar in West Siberia (Dorofeev 1963a). The external sculpture of this species is identical with that of the contemporary *A. polifolia* L. and Pliocene *A. polifolia* L. var. *pliocenica* Nikitin (Nikitin 1957), because particular polygonal cells are divided by thin transverse walls. If there is one wall, it runs along a cell diameter, and in the case of two walls they cross and divide the cell into four parts. Transverse walls of this type do not occur in cells on the surface of the seeds from the Nowy Sącz Basin and this is why they cannot be included in *A. brunnea* Dorof.

However, such a picture of the external structure of seeds may not always occur in the genus *Andromeda*. In the seeds of the contemporary *A. polifolia* L. there happen specimens, in which no additional walls dividing the polygonal cells of testa can be seen. In the description of *A. nigra* Dorof., the species distinguished from the Oligocene of Krasnyj Jar (Dorofeev 1963a), there is no mention of this sort of structure, the cells being described as „small, round-polygonal, sometimes elongate". Also the surface of the seeds of *Andromeda* sp. 1 and *Andromeda* sp. 2 from the Tertiary of East Siberia (Dorofeev 1972) is almost smooth, with small round cells.

The genus *Andromeda* earlier embraced a large number of species, which on the basis of later studies have been included in many other genera, like *Cassiope*, *Chamaedaphne*, *Enkianthus*, *Leucothoë*, *Lyonia*, *Pieris*, *Xolisma* and *Zenobia*. Now only two species have remained in the genus *Andromeda*, i.e. *A. polifolia* L. (Eurasia — down to Korea and Japan in the south, North America) and *A. glaucophylla* Link. (North America), but to this last form some taxonomists assign only the rank of subspecies. These are small shrubs with evergreen leaves and small oval seeds. They grow in marshy places and peatbogs.

This genus has been described on the basis of impressions of its leaves and capsules from many Tertiary floras of Eurasia and North America since long ago.

At revisions a great number of its fossil species have been included in the genera *Leucothoë*, *Pieris* or *Cassiope*. As the morphological structure of leaves and capsules is very similar in different genera of the family *Ericaceae*, the seeds preserved sometimes in capsules may make a reliable diagnostic basis. Thus, e.g. the seeds obtained from the capsules of *Leucothoë narbonnensis* (Saporta) Mai from Wiese near Kamenz indicate clearly that these remains cannot be referred to the genus *Andromeda* (Mai 1960, Pl. 6, figs. 5—16).

In Poland the genus *Andromeda* has been recorded from the Miocene floras of Chłapowo, Wieliczka and Stare Gliwice. Out of the six species described by Heer on the basis of leaves (also capsules are associated with one of them) in 1869, only the leaf of *A. revoluta* A. Br. resembles the leaves of *A. polifolia* L. (cf. Schenk & Schimper 1890), whereas the remains of *A. narbonnensis* Sap. and *A. protogaea* Ung. belong to the genus *Leucothoë* (cf. Mai 1960). In this flora all the specimens included in the genus *Andromeda* call for a revision. Some fruits or seeds of this genus have been found probably by J. Zabłocki at Wieliczka (cf. Kostyniuk 1959), but these materials have not been published and no detailed data about them are available. The remains reported from the Miocene of Stare Gliwice as capsules of *A. protogaea* Ung. (Szafer 1961, Pl. 21, figs. 24, 25) have a different structure and cannot be related to the family *Ericaceae.*

Occurrence. Taxon new to the Tertiary. It has also been found in other Neogene floras of Poland, namely, those of Domański Wierch, Koniówka and Czarny Dunajec (Łańcucka-Środoniowa, in prep.).

Family **Rubiaceae**

cf. *Galium* sp.

Pl. XII, figs. 16a, 16b

Locality: NS. I: 301

Material: 1 fruit

Description. Fruit, 1·9×1·6 mm, ovate, dorso-ventrally compressed and with surface irregularly folded in fossilization. Originally it was a globular-ovate fruit with a large and deep depression on the ventral side. An elongate flat scar of attachment of another fruit is visible in the middle of this depression of our specimen. The external surface is dull and smooth, only in two places there are very delicate striae, which run radially from the periphery towards the central depression.

Comparison. Globular-ovate fruits with a large depression in the middle occur in the genera *Asperula*, *Galium* and *Rubia*. The fruit described most resembles a single schizocarp of the genus *Galium*, but unfortunately this cannot be confirmed by anatomical methods.

Fruits of *Galium* sp. were reported from the Pliocene of Europe (Ludwig 1857; Reid 1915), but these determinations roused reservations of some authors

(Kirchheimer 1957). Two joined globular fruits, described from the Tertiary of Greenland under the name *Galium antiquum* Heer, also need an anatomical examination, although they well agree in morphological structure with the genus *Galium* (cf. Schenk & Schimper 1890, p. 765).

Occurrence. Fruits of this genus, known, above all, from Pleistocene floras, are also recorded from the Tertiary of Europe and Greenland.

Family **Scrophulariaceae**

Gratiola tertiaria Łańc.-Środ.

Pl. XII, figs. 7—9

Locality: NS. II: 30, 31

Material: 3 seeds and 1 fragment

Description. Seeds, 0·65×0·35 and 0·63×0·3 mm, elongated, slightly asymmetrical, with obliquely truncated base and narrowing top. On the surface of the seeds there is a thick reticulation composed of protruding sharp-edged ridges. There are 6—7 meshes of this reticulum per diameter of lateral surface (the seeds had been compressed laterally in fossilization). Testa thin and brittle, surface finely punctated, yellow-brown in colour.

Comparison. The similarity to the seeds of *Gratiola officinalis* L. is striking, but the Miocene specimens cannot be relatedto this species because we lack reference material of seeds of other present-day species. The genus *Gratiola* numbers more than 50 species today. They grow chiefly in North America and south — east Asia (cf. Łańcucka-Środoniowa 1977). The only European species *G. officinalis* L. grows at the waterside and in wet meadows. Seeds of this species have been found in Holocene deposits of the Ural Mts. (cf. Kac *et al.* 1965).

Occurrence. This genus has not hitherto been recorded from Tertiary or Pleistocene deposits. The species first described from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1977).

Family **Labiatae**

Lycopus cf. *antiquus* E. M. Reid

Pl. XII, figs. 10—12

Localities: NS. I: 55, 349
NS. II: 31
Gołąbkowice

Material: 10 fruits and 6 fragments

Description. Fruits, 1·0—1·35×0·5—0·63 mm, ovate-cuneate, broadened, rounded or flattened in the apical part and markedly narrowed in the basal.

The dorsal side is almost flat, at the base of the roof -shaped ventral side there is a large scar of attachment which passes into an elongate depression. The walls of fruit are thin, brittle and dark-brown. The external surface is smooth and covered by small polygonal cells. On the ventral side of two specimens there are small pale-yellow semi-translucent globules, lying tightly side by side, which are resin glands. Marks left behind by these glands can also be seen in two other specimens.

Comparison. These remains are fruits of *Lycopus*, deprived of their characteristic spongy collar. Its small remainder is preserved only on one specimen (sample NS. II: 31) and even here in the basal portion, where the collar is relatively thinnest. In their dimensions and elongate shape these remains correspond to the fruits of *L. antiquus* E. M. Reid, described from the Pliocene of Pont-de--Gail (Reid 1920b), which have a very well developped spongy collar with tower ends sticking out beyond the base of the fruit. In modern species the collar is the same length as the fruit.

In view of the absence of the spongy collar from the specimens from the Nowy Sącz Basin the determination of their specific affiliation is only probable. According to E. M. Reid (1920b), the fruits of *L. antiquus* Reid more resemble those of the Japanese or American species or forms than the European ones. Now the genus *Lycopus* contains 7 species, which occur in areas of a temperate climate in Eurasia and North America. They are herbs growing at the riverside and in marshy and wet areas.

Occurrence. Pliocene and Miocene of Europe, Oligocene and chiefly Miocene of West Siberia. The remains reported from the Miocene of Stare Gliwice as *Labiatae* (Szafer 1961, Pl. 22, figs. 8, 9) have been inaccurately included by Negru (1972, p. 154) in the genus *Lycopus*, from which they are differentiated by some details of their morphological structure. However, this genus actually occurred in the flora of Stare Gliwice, for in Szafer's undetermined material there is one fruit of *L.* cf. *antiquus* E. M. Reid (without its spongy collar, det. M. Łańcucka-Środoniowa). Also the fruit mentioned from the Tortonian of Zatoka Gdowska as *Labiatae* gen. (Łańcucka-Środoniowa 1966, Fig. 19/4) probably belongs to this genus.

Family **Menyanthaceae**

Menyanthes cf. *trifoliata* L.

Pl. XII, fig. 17

Locality: NS. I: 301

Material: 1 seed

Description. Seed, 2·7×1·95 mm, oval in outline, markedly flattened, slightly concave in one place of its circumference. There is a crack running from this place for a long distance along the circumference line. Surface smooth, shining, with distinctly marked elongate cells of testa extending towards the long axis of seed.

Comparison. There is no doubt that this specimen belongs to the genus *Menyanthes*. Its size agree with the most frequently occurring dimensions of the seeds of *M*. cf. *trifoliata* L., known from the Miocene (Truchanowiczówna 1964, 1967). There being only one specimen preserved, no anatomical examination has been carried out. This determination has been confirmed by Dr J. Truchanowiczówna, who examined seeds from several Miocene localities of Poland and Germany using the biometrical method.

Occurrence. Species known in Europe from the Miocene onwards, found also in the Miocene of West Siberia (Nikitin V. P. 1976). In Poland it has been recorded from the Miocene of Chyżne, Koniówka (Truchanowiczówna 1967), Gozdnica (Stachurska *et al.* 1971) and from the Pliocene of Domański Wierch (Łańcucka-Środoniowa 1965).

Family **Caprifoliaceae**

Sambucus lucida Dorof.

Pl. XII, figs. 18—22

Localities: NS. I: 180, 186, 278, 285, 337, 344, 351
NS. II: 16, 18, 23, 27, 31

Material: 23 seeds and 49 fragments

Description. The largest number of specimens come from samples NS. I: 351 (16 whole seeds and 23 fragments) and NS. I: 344 (4 whole seeds and 16 fragments), there being only single specimens from the remaining samples. Seeds, measuring 1·6—2·85×0·95—1·7 mm, are mostly oblong-ovate, sometimes more elongated or shorter, ovate. Some specimens seem to be narrower than they actually are because they are laterally compressed. Apex bluntly pointed, base lightly rounded, sometimes almost flat if the basal portion is bent up on to the ventral side. Seeds black, intensely shining, with wrinkled surface. Wrinkles, extending across seeds, formed of relatively high wart-like eminences, varying in size and shape, round or, more often, elongate. Some dozen such transverse wrinkles occur over the long axis of the seed.

Comparison. To be sure, the seeds described show a great diversity of shape, but the extreme forms may be easily linked together by means of a series of transitional forms, all of them have a similar structure of surface and for this reason may be included in one species. They correspond most closely to the species *S. lucida* Dorof., described by Dorofeev (1963a, Pl. 48, figs. 1—14) from the Tertiary of West Siberia. In his opinion, the seeds of the fossil species exhibit a still greater diversity of shape than those of modern species. They resemble such modern species as *S. ebulus* L., *S. chinensis* Lindl. and *S. nigra* L. In addition to these three species mentioned by Dorofeev, other ones may be named, such as share many characters with the fossil specimens, e.g. the Chinese species *S. williamsi* Hance or North American *S. glauca* Nutt (= *S. coerulea* Raf.) and *S. pubens* Michx.

Occurrence. According to Dorofeev (1963a), this species occurred in the Oligocene and Miocene of Eurasia and another fossil species, *S. pulchella* Reid, in the Miocene and Pliocene. In Dorofeev's opinion, the seeds of *S. pulchella* Reid from the brown coals of Lusatia, described by Kirchheimer in 1942, and the seeds from the Miocene of Rypin (Łańcucka-Środoniowa 1957) are very much like those of *S. lucida* Dorof. [7]

Family **Valerianaceae**

Patrinia palaeosibirica Dorof.

Pl. XIII, figs. 1a—1c

Locality: NS. I: 303

Material: 1 fruit

Description. Fruit, 2·0 × 1·0 mm, regularly oval in shape, acute at the base, somewhat rounded at the top. It is markedly flattened but, as can be seen, was slightly convex on the dorsal side and concave on the ventral. Across the middle of the dorsal side a thin vascular bundle runs from the top of the fruit to its base, whereas the remains of an elongate thin-walled part of the fruit, brown in colour, which has burst and been destroyed, are seen on the ventral side. The fruit surface is smooth and dull, with fine punctation formed by polygonal cells.

Comparison. The fruits of the genus *Patrinia* have such a characteristic structure that they can be identified even on the basis of a heavily damaged specimen. Marked by their better state of preservation, the fruits found in the Pliocene of Domański Wierch and in the Miocene of Chyżne, Koniówka and Czarny Dunajec (Łańcucka-Środoniowa, in prep.) were very helpful with identification of the specimen from Nowy Sącz.

Fruits of the genus *Patrinia* were first described by Nikitin (1948) from the Tertiary deposits at the riverside of the Ob (West Siberia), later they were recorded by Kolesnikova (1961, Pl. 1, fig. 20) from a sample obtained from the same locality. In 1962 Dorofeev described the fossil species *P. palaeosibirica* Dorof. from the Pliocene of Baškiria, with fruits similar to those of *P. sibirica*

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[7] Recently Dorofeev (1977) described a new fossil species, *S. pusilla* Dorof. from the Pliocene of the Baškiria A. S. S. R., in which he included the smallest specimens of *S. lucida* Dorof. In the material from the Nowy Sącz Basin there are two such small seeds, which might possibly be numbered in the species *S. pusilla* Dorof. Their dimensions are as follows: 1·62 × 1·25 (NS. I: 180) and 1·67 × 1·13 mm (NS. I: 344).

(L.) Juss., the species which now grows on rocks and sandy slopes in Baškiria, Siberia, Mongolia and north-western China. In Dorofeev's opinion the fruits from the Tertiary of West Siberia belong to *P. palaeosibirica* (Dorofeev 1962, p. 800). The specimen from the Nowy Sącz Basin lies within the range of variation of *P. palaeosibirica* Dorof., the fruits of which are 2—3 mm in length and 1·0—1·9 mm in breadth. No remains of their wings, characteristic of the genus *Patrinia*, which sometimes occur on fossil specimens in the form of thick nerves converging at the base of the peduncle, are preserved on this specimen.

Now the genus *Patrinia* numbers about 20 species, occurring in East Asia (China, Japan, Formosa, East India, Himalaya Mts., Manchuria and Siberia).

Occurrence. *P. palaeosibirica* has been found in the Miocene of West Siberia and in the Pliocene of Baškiria. The fruits of the modern species *P. sibirica* (L.) Juss. were recorded by Nikitin from the Pleistocene of West Siberia in 1940, later found also in the Pleistocene of the lower Kama and Jenisej (cf. Kac *et al.* 1965). This taxon is new to the Tertiary of Poland.

Family **Campanulaceae**

Campanula palaeopyramidalis Łańc.-Środ.

Pl. XII, figs. 13—14a

Locality: NS. I: 278

Material: 3 seeds

Description. Seeds, 1·25—1·5 × 0·5—0·7 mm, longitudinally cylindrical, with rounded base and truncated top, dully grey, irregularly longitudinally folded, with relatively thick and brittle testa. Testa surface of big polygonal cells, which form a characteristic network with large angular meshes, varying in shape (elongate to nearly equilateral at the base) and not arranged in regular longitudinal rows.

Comparison. The fossil seeds are very similar in size, shape and surface structure to those of *Campanula pyramidalis* L. The fossil seeds have a deep longitudinal incurvation and seem to have been somewhat broader than the modern ones and, in addition, the large cells on their surface have somewhat lower walls. These differences may be partly explained by the effect of deformation and damage in fossilization.

C. pyramidalis L. grows in the Mediterranean (Lombardy, Istria, Kraina, Croatia and Dalmatia), mostly on rocks and saxicolous grassland. The structure of seeds occurring in this species is very rarely met with in the other (about 250) species of the genus *Campanula*.

Occurrence. This taxon was first described from the Miocene of the Nowy Sącz Basin (Łańcucka-Środoniowa 1977).

Campanula sp.

Pl. XII, fig. 15

Locality: NS. II: 30

Material: 1 seed

Description. Seed, 0·85×0·4 mm, oblong-oval, markedly flattened. Base rounded, apical portion somewhat narrowed and truncated, with a visible depression. The seed surface is delicately longitudinally ribbed (which is well seen under high magnification), with silky lustre.

Comparison. Seeds of similar structure occur in such genera as *Campanula*, *Adenophora*, *Phyteuma*, *Jassione* and *Wahlenbergia*. The remain described corresponds closely to the seeds of the genus *Campanula*, numerous species of which may be divided into two main groups. The seeds of the first group are lenticularly flattened and distinctly membraned on the circumference. In the second group the seeds are less flattened and rather cylindrical, bearing no membrane on the circumference or only its slight trace. Many species of the second group have seeds similar to the specimen from the Nowy Sącz Basin. Here belong such European species as, e.g. *C. rotundifolia* L. (also in Siberia and North America), *C. persicifolia* L. (also in Siberia and Armenia), *C. patula* L. (Europe except Arctic regions) and those associated with mountainous areas, i.e. *C. kladniana* Schur., *C. linifolia* Scop., *C. pulla* L., *C. rhomboidalis* L., *C. scheuchzeri* Vill., *C. abietina* Griseb., *C. erinus*., *C. lanata* Friv., *C. montana* Del., and *C. pyrenaica*. Out of the species of Asia Minor, represented in the reference collection of the Institute of Botany, Polish Academy of Sciences, *C. peregrina* and *C. phyctidocalyx* Boiss. & Noé have similar seeds.

The genus *Campanula* includes about 250 species, which occupy areas of temperate and subtropical climates, chiefly of the Old World. A large number of species are associated with the mountains of Europe and Asia Minor and with the Mediterranean region (Hegi VI/1).

Occurrence. Seeds of *Campanula* sp. (including *C. rotundifolia* L.) are known from the Pleistocene of Europe and West Siberia.

MONOCOTYLEDONES

Family **Hydrocharitaceae**

Stratiotes kaltennordheimensis (Zenker) Keilhack

Pl. XIII, figs. 2a, 2b

Locality: Niskowa

Material: 2 seeds, 2 halves of seeds and 7 fragments

Description. Seeds, 6·7—7·8×3·1—3·6 mm, very typical in their form so that there is no doubt as to their identity. The canal left after the vascular bundle or the so-called raphe penetrates into the hollow at the very apex of the seed. The external surface of the very thick testa is finely pitted and covered with rows of elongate tubercles; the internal surface of the testa is shining and delicately longitudinally striated (cf. Łańcucka-Środoniowa 1957).

Comparison. The morphological structure of the seeds refers them to the Tertiary species *Stratiotes kaltennordheimensis* (Zenker) Keilhack, whose role in the evolution of the monotypic genus *Stratiotes* is widely known (Chandler 1923).

Occurrence. Known in Europe since the Upper Oligocene (Chandler 1923) and still sometimes occurring in the Upper Miocene, this species is characteristic, above all, of the Lower Miocene. Dorofeev (1963a) recorded seeds of this type under the name *S.* cf. *kaltennordheimensis* (Zenker) Keilhack from the Oligocene of West Siberia. In Poland this species is known from the Upper Miocene floras of Dobrzyń (Kownas 1955), Rypin (Łańcucka-Środoniowa 1957) and Konin (Raniecka-Bobrowska 1959).

Family **Potamogetonaceae**

Potamogeton aff. ***polygonifolius*** Pourr.

Pl. XIII, figs. 4a, 4b

Locality: NS. I: 83, 303

Material: 1 endocarp and 1 fragment

Description. Endocarp, 1·55 × 1·25 mm, nearly round in outline, markedly flattened. Ventral side convex, bent in the lower portion, ending in a poorly preserved beak at the top. Dorsal side rounded, with apically acute lid, the end of which does not reach the beak. There is a low keel on the lid, with two tiny processes preserved in the basal part. At the centre of the flat lateral walls there is a large and deep depression. Surface smooth, dull, with very fine elongate cells arranged concentrically round the central depression.

Comparison. Small endocarps of similar morphological structure were described by Dorofeev (1963a, 1966a) from the Oligocene and Miocene of West Siberia as the fossil species *P. semirotundatus* Dorof., *P. minimus* Dorof. (a little like *P. polygonifolius* Pourr. and *P. heterophyllus* Schreb.) and *P. kipianiae* Dorof. (most resembling *P. polygonifolius* Pourr.). Negru (1972), too, recorded similar endocarps from the Upper Miocene of Moldavia as *Potamogeton* sp. and *P. tyraspolitanus* Negru (related to but not identical with *P. kipianiae* Dorof.). In Dorofeev's (1966a) opinion, *P. kipianiae* Dorof. must be treated as a distinct fossil species, since its endocarps differ from those of *P. polygonifolius* Pourr., among other things, in the somewhat different shape of its beak, lid and central depression.

The specimen from the Nowy Sącz Basin shows a fairly great similarity to *P. kipianiae* Dorof. and *P. tyraspolitanus* Negru, but it cannot be placed in either of these species. It is more rounded and broader in the upper part than the endocarp of *P. kipianiae* Dorof. figured in Dorofeev's work (1966a, p. 1484, Pl. I, fig. 17), is slenderer in the basal portion and has its lateral walls flat and not convex as those of *P. tyraspolitanus* Negru. In shape, size and other characters of morphological structure this specimen corresponds most closely to the species *P. polygonifolius* Pourr. (Aalto 1970). This species, belonging to the subsection *Colorati* (Graebn.) Hagestr., is associated with the mild oceanic climate of the Baltic region; it also grows in southern Scandinavia.

Occurrence. *P. polygonifolius* Pourr. is known from Pleistocene floras of Eurasia, also reported from the Pliocene of Belorussia (Dorofeev 1967). Numerous specimens of this species were determined in the Pliocene flora of Domański Wierch by Dr. M. Aalto during her stay in Cracow (oral communication). Some allied fossil species are known from Miocene floras.

Potamogeton sp., Subsect. *Colorati* (Graebn.) Hagestr.

Pl. XIII, fig. 5

Locality: NS. I: 341

Material: 1 endocarp

Description. Endocarp, 1·55×1·3 mm, with markedly flat lateral walls, in which there is a large central depression. Ventral side convex, slightly incurved in the lower part, dorsal side regularly rounded. Lid broad, with low and sharp keel. In the basal part of the lid there are two lateral cylindrical thickenings and the top of the lid does not reach the beak, a trace of which is visible in the upper part of the endocarp (the distance between the top of the lid and the beak is smaller than in the previous species). The surface of the endocarp is smooth and dull, with small elongate cells, arranged concentrically round the central depression.

Comparison. This specimen is very similar to the endocarp described from the Miocene of Zatoka Gdowska under the name *P.* cf. *heinkei* Mai (Łańcucka-Środoniowa 1966, Pl. VI, fig. 17). However, having re-examined the material, I have arrived at the conclusion that the lid of this endocarp is heavily damaged (only a small fragment of the basal part is preserved) and that it is impossible to reconstruct its true appearance. For this reason the referring of this endocarp to the species *P. heinkei* Mai, which is said to have extremely narrow lid, devoid of any keel, does not seem to me justified. The destruction of lid in the specimen from Zatoka Gdowska also made its identification with the specimen from the Nowy Sącz Basin impossible despite the similarity of other morphological characters.

Negru (1972, Pl. VI, fig. 14) described two small endocarps similar in structure from the Upper Sarmatian of Moldavia as *Potamogeton* sp., emphasizing their specific distinctness, although they somewhat resemble the present-day *P. coloratus*. The lateral walls of the endocarps of *Potamogeton* sp. from Moldavia (l. c. p. 73, fig. 11) and *P. coloratus* Hornem. (Aalto 1970, p. 34, fig. 74a) are slightly oval in outline and not round as those of the endocarps from the Miocene of the Nowy Sącz Basin or Zatoka Gdowska. It cannot be determined without detailed studies if such differences in shape lie within the range of variation of *P. coloratus* Hornem. The endocarps of *P. kunovicensis* sp. n. described by Knobloch (1977) from the Pliocene of Czechoslovakia also resemble this species. *P. coloratus* Hornem. is a relatively thermophilous species (European subaltlantic plants acc. to Hultén 1950), occurring in western Europe, southern Scandinavia and north-eastern Africa. In the fossil state it is known from the early Pleistocene of Eurasia and the Pliocene of Belorussia and Baškiria (Dorofeev 1967, 1977).

The specimen from the Miocene of the Nowy Sącz Basin belongs to the subsection *Colorati* (Graebn.) Hagestr. and is closely related to one of its species, i. e. *P. coloratus* Hornem.

Occurrence. Allied species are known from the Miocene of Poland and Moldavia. Endocarps identical with the specimen from the Nowy Sącz Basin occur in the Pliocene of Domański Wierch.

Family **Najadaceae**

Najas marina L.

Pl. XIII, figs. 3a, 3b

Locality: NS. I: 106

Material: 1 half of seed

Description. Seed, 6·0×2·0 mm, navicular in shape, with rounded base and slightly narrowing apex. Testa very thick, its outer surface covered by round-polygonal thick-walled cells, arranged in a disorderly manner. In the photograph (Pl. XIII fig. 3a) these cells are best seen on the left-hand side, in the middle part of the seed, whereas over a considerable area they are overlaid with larger polygonal cells of epidermis with very delicate walls, their outlines being visible in this photograph as large light blotches. Fairly regularly arranged polygonal cells, giving the impression of oblique striae, can be seen on the intensely shining inner side of the seed testa.

Comparison. The specimen described has all the morphological characters of the seed of *Najas marina* L., now widely spread in areas of temperate and subtropical climates all over the world (Eurasia, both Americas, north Africa and Australia).

Occurrence. Species often occurring in Pleistocene deposits of Eurasia, more rarely in the Pliocene, e.g. in the Pliocene of Poland (Mizerna — Szafer 1954). Is has also been recorded from Miocene floras, namely, from the Rostov region (Dorofeev 1959, p. 166) or Isakovka on the Irtyš in West Siberia (Dorofeev 1963a).

Family **Cyperaceae**

Cyperus sp. 1

Pl. XIII, fig. 9

Locality: NS. II: 30
Material: 1 fruit

Description. Fruit, 1·05×0·45 mm, but as it is damaged at the base, its length was presumably 1·15—1·2 mm. Fruit elongate, almost oblong, with short and straight beak, trigonous, one of the three walls being bent inwards so much that now the fruit is quite flat. The outer surface is finely punctated and there are small isodiametrical cells visible on it.

Comparison. The specimen described resembles the fruits of some species of the genus *Cyperus*, such as, e.g. *C. longus* L. and *C. glomeratus* L., growing in Eurasia today. It is however heavily damaged and specific determination is impossible.

Occurrence. Fruits of *C.* cf. *glomeratus* L. were reported from the Miocene of the Rostov region (Dorofeev 1959) and the Pliocene of Matanov Sad on the Don and Belorussia (Dorofeev 1966b, 1967). This species has many a time been distinguished in the Pleistocene floras of the European territories of the U.S.S.R. and West Siberia (cf. Kac *et al.* 1965). It has also been found in the Pleistocene of Poland (Drozdowski & Tobolski 1972). Fruits of *C.* cf. *longus* L. have been recorded from the Pliocene flora of Matanov Sad on the Don (Dorofeev 1966b).

Cyperus sp. 2

Pl. XIII, fig. 10

Localities: NS. I: 173
NS. II: 23
Material: 2 fruits

Description. Fruits, 1·3×0·9 mm, trigonous. Lateral walls of nearly equal, relatively large breadth (broadest slightly above the middle), markedly concave. Tops of fruits rounded and devoid of beak, base narrowed wedgewise, stipe indistinct and thick. Angle lines narrow, well-seen, notably in the apical part. Isodiametrical cells, poorly marked on the outer surface of the fruits are smaller and less regularly arranged than those in the nutlets of *Carex*.

Comparison. Fruits of some species of the genus *Cyperus* are characterized by a similar structure. Out of the reference materials, I had at my disposal, the fruits of *C. compressus* L., a cosmopolitan species of the Tropics, very much resemble these specimens.

Cyperus sp. 3

Pl. XIII, figs. 11, 12

Locality: NS. I: 278, 301

Material: 2 fruits and 1 fragment

Description. Fruits, 1·2×0·5 and 1·3×0·5 mm, trigonous, with narrowly elliptical lateral walls, tapering at both ends. Walls thin, subtle, concave, their outer surface formed of small isodiametrical cells. Beak conical, with broad base, stipe short and thin, widened at the base. Edges sharp, passing on to the beak.

Comparison. The morphological details correspond to those of the fruits of the genus *Cyperus*, especially the Eurasian species *C. fuscus* L., only that the specimens described above are somewhat longer (by 0·2 mm) and seem slimmer, particularly in their upper part. The sharp fruit edges, the extensions of which run on the conical beak, this being triangularly pyramidal in consequence, are well seen on the fossil specimens. This is a very distinctive character of *C. fuscus* L. (Berggren 1969, p. 12), to which the specimens from the Nowy Sącz Basin are closely related.

Today *C. fuscus* L. occurs commonly on the banks of rivers and on lake-shores, as well as in wet places in lowlands and at lower altitudes in mountains. It belongs to the few species of *Cyperus* that are associated with the temperate zone, whereas most species of this genus demand a warm and humid climate.

Occurrence. Fruits of *C. fuscus* L. are known from the Pleistocene of Europe (Kac *et al.* 1965; Gibbard & Pettit 1978) and the Pliocene of Matanov Sad on the Don and Belorussia (Dorofeev 1966b, 1967).

Acorellus distachyoformis Łańc.-Środ.

Pl. XIII, figs. 6—8

Localities: NS. I: 134, 286, 291, 301, 303, 348
NS. II: 18, 33

Material: 9 fruits and 6 fragments

Description. Fruits, 1·3—1·8×0·8—0·95 mm, bilaterally compressed; one of the sides must have been somewhat convex originally and has been folded longitudinally in fossilization. The transverse section through these fruits has the outline of a unilaterally convex lens. Fruits elliptic-rhomboid in shape with truncated top and similarly truncated slightly narrowed basal part. The greatest breadth is usually below and only sometimes at the middle of the length of the fruit. In the small apical depression there is a very delicate, short and narrow beak, this being often destroyed. The external surface shows longitudinal rows of small, thin-walled 4 — 6-sided cells.

Comparison. The morphological structure and notably the small and very delicate beak, distinctly separated from the pericarp, indicate that these fruits belong to the genus *Acorellus*, closely allied with *Cyperus* (cf. Łańcucka-Środoniowa 1977). This genus contains 7 species at present, of which three occur in southern Europe. They are plants of wet places, growing on the sandy banks of rivers, salt lake-shores and marshes.

The elongate shape of the fossil fruits makes them very similar to the fruits of *A. distachyus* (All.) Palla (= *Cyperus distachyos* All.). The dimensions of the fossil fruits and those of the modern species mentioned are also equal, but there happen large fossil specimens, reaching 1·8 mm in length, whereas the longest fruits of *A. distachyus* (All.) Palla, judging from the reference materials from Turkmenia, do not exceed 1·6 mm in length.

A. distachyus (All.) Palla is a Mediterranean species, which grows in southern Europe, northern Africa, Asia Minor, Central Asia, Iran and India (Shishkin 1935).

Occurrence. In the fossil state this genus was distinguished for the first time in 1977 (Łańcucka-Środoniowa 1977). It is new to the Tertiary and in Poland has also been found in the Miocene of Czarny Dunajec and Koniówka and in the Pliocene of Domański Wierch.

Scirpus sylvaticus L.

Pl. XIII, figs. 13—15

Localities: NS. I: 271
NS. II: 18, 23

Material: 25 fruits and 10 fragments

Description. Fruits, 0·85—1·1 × 0·6—0·75 mm, obovoid or elliptic in outline, trigonous, one of the lateral walls broader, two remaining ones somewhat narrower. Base narrowing wedgewise and bluntly truncated, apical part usually rounded, with a conical and blunt beak. Edges three, blunt. External surface finely punctated, sometimes with very subtle longitudinal wrinkles running for nearly the whole length of the fruit on its lateral walls.

Comparison. The above description of remains quite agrees with the fruits of *Scirpus sylvaticus* L. and there is no doubt as to this determination, although no bristles have been preserved on the fossil specimens. The Japanese species *S. fuirenoides* Maxim. has similar fruits, but they are somewhat larger, elliptic in outline and have a long beak. Although at first sight the fruits of *Cyperus fuscus* L. also resemble the fossil fruits, their edges are much sharper, beak thinner and shape slightly different, because the greatest breadth of each of the three lateral walls is most often in the middle of their length.

Today *Scirpus sylvaticus* L. grows in places adjacent to water reservoirs, in wet meadows and damp thickets in Europe (except the Arctic and southernmost regions), Asia Minor and Central Asia. One of the varieties of this species occurs in East Asia and another in North America.

Occurrence. This species, is known from the Pliocene (lower Kama River and Belorussia — Dorofeev 1956, 1967b), occurs probably also in the Tortonian of Zatoka Gdowska, the Pliocene of Sośnica (Łańcucka-Środoniowa 1966 and materials in preparations) and the Tertiary of East Siberia (Dorofeev 1972).

cf. *Trichophorum* sp.

Pl. XIII, fig. 16

Locality: NS. I: 319

Material: 1 upper part of a fruit

Description. The fragment preserved is 1·5 mm in length and 1·1 mm in breadth. Fruit trigonous, with one lateral wall far broader than the other two and with distinct sharp edges. The mildly rounded apical part passes into a robust, broad and fairly long (0·25 mm) beak. The external surface dull, very finely punctated, with traces of thin-walled isodiametrical cells seen in some places.

Comparison. The morphological structure corresponds to that of the fruits of the genus *Trichophorum*, especially of the species *T. caespitosum* (L.) Hartm. (= *Scirpus caespitosus* L. = *Trichophorum austriacum* Palla = *T. germanicum* Palla). This is a plant of raised bogs and springs, growing over considerable areas of the North Hemisphere (Eurasia, North America, north-western Africa).

The determination of this genus may however be questioned, as it is based only on the upper portion of a fruit.

Occurrence. The fruit of *Trichophorum* sp. has been recorded from the Miocene of Gozdnica in Silesia (Stachurska *et al.* 1971).

Cyperaceae gen. 1 (cf. *Rhynchospora* sp.)

Pl. XIII, fig. 17

Locality: NS. I: 277

Material: 1 fruit

Description. Fruit, 1·2×0·7 mm, obovoid in outline, markedly flattened, thin-walled, almost transparent and brown in colour. Base narrowed and truncated, with traces of longitudinal rugosities on the stipe which is 0·45 mm long. The upper part of the fruit is damaged, only on one side there is a fragment of transparent tissue, grown together with the fruit apex and differing in structure from the body of fruit. The external surface of the fruit is covered with small isodiametrical cells, arranged in parallel longitudinal rows.

Comparison. This specimen shows a great similarity to the fruits of the genus *Rhynchospora*, but unfortunately its broad, bilaterally flattened beak, distinctly separated from the rest of the fruit and characteristic of this genus, has not been preserved on it (cf. Kowal 1958). The small fragment of transparent tissue, visible on the fossil fruit, is probably a part of such a beak. The fossil specimen is comparable to the fruits of *R. alba* (L.) Vohl., only that these last are relatively broader than it is.

This genus includes about 250 species, distributed chiefly in subtropical and tropical regions. In central Europe there occur two species and a third one in the Caucasus Mts. (Hegi 1966, Vol. II/1).

R. alba (L.) Vohl. grows in Europe (absent from the northern and southern areas), in the Caucasus Mts., Turkestan, Siberia, Korea, Japan and North America. It grows in raised and transition bogs, wet meadows and mid-forest swamps.

Occurrence. This genus has not hitherto been distinguished in the Tertiary.

Cyperaceae gen. 2 (cf. *Eriophorum* sp.)

Pl. XIII, fig. 18

Locality: NS. II: 32, 39

Material: 1 fruit and 1 fragment (?)

Description. Fruit, 2·15×0·85 mm, trigonous, with a longitudinal elliptic outline, markedly thin-walled and delicate. Slightly rounded and furnished with a relatively narrow and not very long beak at the top and gradually narrowing at the base. External surface finely punctated, cells small and thin-walled, arranged in long longitudinal rows. The other specimen is a small fragment of the upper part of a fruit, with its beak preserved.

Comparison. The remains described share many features with the fruits of the genus *Eriophorum*, especially such species as *E. angustifolium* Honck., *E. chamissonis* C. A. M. f. *rufescens* Lindb. or *E. russeolum* Fries (cf. Kowal 1958; Kac *et al.* 1965; Flora USSR, III). However, they differ from *E. angustifolium* Honck. in smaller dimensions and their less slender shape, and from the remaining species in their lack of bristles or their traces. Similarly shaped small fruits can also be found in the species *E. brachyantherum* Trautv. and, closely related to it, *E. callitrix* Cham. (cf. Flora USSR, III).

The genus *Eriophorum* numbers 15 species, now widely distributed in the temperate zone of the northern hemisphere and partly also in the Arctic. Some species (e. g. *E. angustifolium* Honck.) occur, in addition, in southern Africa, Cuba and Jamaica and are characterized by great variation. All the species of *Eriophorum* are plants of marshes, wet meadows and peatbogs.

Occurrence. Fruits of *E. angustifolium* Honck. and *E. latifolium* Hoppe have been reported from the Pliocene of Germany (Mai *et al.* 1963; Mai 1965; van der Burgh 1978), *E.* cf. *gracile* Koch from the Pliocene of Bulgaria (Palamarev 1970).

Carex L.

Carex cf. *elongata* L.

Pl. XIV, figs. 1—3

Localities: NS. I: 268, 300
NS. II: 30, 33

Material: 2 nutlets and 3 utricles

Description. Nutlets, 2·0×0·98 and 2·1×1·1 mm, bilaterally flattened, elongate elliptic in outline, at the base narrowed into a short stipe at the top rounded and furnished with a short beak. The walls of nutlets are thin, the external surface weakly shining, with minute papillae, which however are not well seen all over the walls. Utricles, 2·0—2·2×1·0—1·2 mm, apically damaged, thin, bilaterally compressed. There are 7—8 delicate and not very regular longitudinal ridges on each of the lateral walls.

Comparison. Similarly built nutlets occur in many species of the genus *Carex*, but the remains described most resemble the nutlets and utricles of *C. elongata* L. Now this species grows in alder carrs and bogs in Europe, Caucasus Mts., south Siberia and central Asia.

Occurrence. Fruits of this species are known from the Pleistocene of Eurasia (Kräusel 1937; Kac *et al.* 1965) and also from the Pliocene of Europe (Dorofeev 1962; Mai *et al.* 1963; Mai 1965). The specimens of *C.* cf. *elongata* L., described by Mai from the Pliocene of Kranichfeld, have, as he has emphasized, a longer beak than have present-day fruits.

Carex elongatoides n. sp.

Pl. XIV, figs. 4—6

Localities: NS. I: 268, 269, 280, 303
NS. II: 33

Material: 7 nutlets

Description. Nutlets, 1·7—1·9×0·7—0·85 mm, elongate, bilaterally flattened, with narrow elliptic walls, broadest at the middle of the length or somewhat below it. One lateral wall flat, the other one must have been more convex, because in most specimens there is a longitudinal fold on one side of it; this fold sometimes extends only over a half of the nutlets length. The lateral walls sometimes show, in addition to isodiametrical cells, also very subtle parallel striation. Base relatively broad, evenly truncated, stipe indistinct, beak robust, conical, 0·15—0·2 mm long. Remains of the utricle, with parallel nerves running relatively close to each other, are preserved on an exceptionally large specimen (2·17×0·9 mm, beak 0·35 mm long).

Comparison. Out of the Eurasian species, the remains under discussion fairly much resemble the nutlets of *C. elongata* L. (but these are uniformly flattened on both sides, the beak is straight and short, the venation of utricles looser and less regular), *C. bohemica* Schreb. = *C. cyperoides* Murr. (but these nutlets are smaller and relatively narrower, the beak long and narrow) or *C. leporina* L. (whose nutlets are however less slender, the beak long and narrow, the venation regular and looser, particularly so on one side).

Similarly built nutlets can be found in different North American species also, e. g. *C. elachycarpa* Fern., *C. proposita* Macken., *C. tracyi* Macken., *C. sco-*

paria Schkuhr. and *C. straminea* Willd. (Mackenzie 1940, Pl. 103, 128, 148, 160 and 184). The degree of this resemblance cannot however be established without suitable reference materials.

Occurrence. Species new to the Tertiary. In this species we may possible place the fruits of *C.* cf. *elongata* L. from the Pliocene flora of Kranichfeld (Mai 1965, Pl. V, figs. 2—4), which have a long sturdy conical beak and dense and parallel venation of utricles.

Carex aff. *loliacea* L.

Pl. XIV, figs. 7—9

Localities: NS. I: 267, 269, 271, 301, 319
NS. II: 33

Material: 1 nutlet, 6 utricles and 2 fragments

Description. Utricles, 2·5—3·0×1·0—1·6 mm, bilaterally compressed, elliptic in outline, narrowed wedgewise at both ends. Lower part, slightly broader and rounded, generally burst. The utricles have quite smooth edges and, besides, they are characterized by a large number of longitudinal ribs, which are regularly parallel and all of more or less the same considerable thickness. On either side of the bilaterally flattened utricle there are sometimes more than 10 such ribs, which gives it a very characteristic appearance. On two specimens the outline of the nutlet enclosed in the utricle can be traced: it is elliptic, rounded at the top and furnished with a delicate elongated beak.

In addition to utricle fragments, a nutlet, 1·6×0·9 mm, has been found in sample NS. I: 269. It is bilaterally flattened, elliptic, rounded at the top, with traces of a delicate beak, relatively broad and rounded at the base and without a distinct stipe. Walls thin and delicate, external surface somewhat shining, slightly tuberculate.

Comparison. Utricles of similar shape and size occur in many Eurasian and North American species of the genus *Carex*, but usually have markedly fewer longitudinal ribs. The fossil remains most resemble the utricles of *C. loliacea* L. (Kulczyński 1930, Pl. 300; Berggren 1969, Pl. 13, fig. 3). The nutlet found in sample NS. I: 269 and the outlines of nutlets inside the utricles show a great similarity to this species. Today *C. loliacea* L. occurs in Eurasia and North America, reaching northern Korea and Japan in the south. It grows (unfrequently) in peatbogs, on stream banks and notably in marshy alderwoods, in the association *Carici elongatae-Alnetum* (Hegi 1968, Vol. II/1/2).

Two other species with similarly built utricles can be found in a monograph (Mackenzie 1940, Pl. 83 and 84) of 533 North American members of the genus *Carex*, namely, *C. trisperma* Dewey and *C. tenuiflora* Wahlenb. However, in herbarial materials the utricles of both these species have a considerably smaller number of longitudinal ribs. The atlas published by Berggren (1969 Pl. 12, fig. 4) gives good photographs for *C. tenuiflora* Wahlenb. (this species grows also in Eurasia). In Mackenzie's work the utricles of *C. loliacea* L. (Pl. 85) have too few ribs marked on their surface.

Occurrence. Species recorded from the Pleistocene deposits of Mahlis near Leipzig (Furmann *et al.* 1977).

Carex sp. 1 (Sect. *Heleonastes* Kunth)

Pl. XIV, fig. 10

Localities: NS. I: 348
NS. II: 32 (?)

Material: 1 nutlet and 1 utricle

Description. Nutlet, 1·4×1·0 mm, bilaterally flattened, elliptic, rounded at the top. Beak damaged, its base is fairly large but its length is unknown. Neither is it known what the basal portion of the nutlet was like and whether it had a short stipe, because this part is also broken off. The external surface is shining, the presence of papillae probable, but their demonstration by maceration might cause the destruction of the specimen.

Utricle, 1·55×1·1 mm (heavily damaged, it was presumably larger), also bilaterally flattened and elliptic in outline, wedgewise narrowed at the top, rounded at the base. About 7 subtle longitudinal ribs run on both lateral walls, there are also elongate thinwalled cells (larger than in the nuts of *Carex*), arranged in longitudinal rows.

The remains described may be numbered in one taxon only with great uncertainty, because of their bad state of preservation and provenance from two different boreholes.

Comparison. Nutlets of similar structure occur in many species of sedges, especially in the section *Heleonastes* Kunth (cf. Berggren 1969), and it would not be easy to determine the species even with well preserved remains. Their comparison with *C. canescens* L. and *C. disperma* Dew. (= *C. tenella* Schkuhr.) comes off relatively best.

The first of these species occurs in swamps and grounds adjacent to water reservoirs in Eurasia, North and South America, Australia, Tasmania and New Guinea, the other grows in swamps of Eurasia (reaching northern Korea and Japan in the south) and North America.

Occurrence. Fruits of *C. canescens* L. are known from the Pleistocene and Holocene of Eurasia (Kac *et al.* 1965).

Carex sp. 2 (Sect. *Stellulatae* Kunth, Sect. *Paniculatae* Carey, Sect. *Dioicae* Tuck.)

Pl. XIV, fig. 11

Locality: NS. I: 278

Material: 1 nutlet

Description. Nutlet, 1·35×1·0 mm, bilaterally flattened, rhombovate in outline, slightly rounded at the top and furnished with a short beak; base broadly cuneate with rather small and broad stipe. The greatest breadth of the lateral walls occurs low, at one-third of the length from the base of the nutlet. The surface is somewhat lustrous, with traces of subtle papillae.

Comparison. Flat small nutlets, characteristically rhombovate in outline, occur in many Eurasian species of the genus *Carex*, chiefly in those belonging to the section *Stellulatae* Kunth, *Paniculatae* Carey and *Dioicae* Tuck. (cf. Berggren 1969). The fossil nutlet rather much resembles for instance nutlets of *C. echinata* Murr (= *C. stellulata* Good.) only that it is slightly smaller. According to Nilsson and Hjelmqvist (1967), the length of nutlet of this species is 1·4—2·1 mm and, according to Berggren (1969) 1·5—1·9 mm. This sedge often grows in wet meadows, peatbogs, on stream-banks and in damp mid-forest clearings. This is a species spread widely in Europe, Asia Minor, East Asia (up to Japan, Korea and China), North America, Australia, New Zealand and northern Africa (Marocco).

In Mackenzie's (1940) work on North American sedges we can find some dozen species that have small nutlets, 1·25—1·5 mm long, identical in structure with the fossil specimen, whereas nutlets similar in shape but somewhat larger in size characterize very many North American species. Nutlets of *C. hookerana* Dewey (Mackenzie 1940, Pl. 39), *C. cusickii* Macken. (Pl. 69) and *C. laricina* Macken. (Pl. 118) show a particular similarity.

Carex globosaeformis n. sp.

Pl. XIV, figs. 12a—12c

Locality: NS. I: 272, 276
Material: 2 nutlets

Description. A nutlet, 1·6×1·2 mm, trigonous, with an indistinct stipe, short beak and strongly convex lateral walls. These walls are broadly obovoid, even roundish in the apical part. The nutlet was originally nearly round in cross-section, now it is compressed, but the course of its three narrow longitudinal edges can be traced on it. Remains of the utricle are preserved in the lower part of the lateral walls of the nutlet and its surface shows longitudinal rows of isodiametrical cells. The other nutlet, 1·55×1·0 mm, is also heavily compressed, with strongly convex lateral walls.

Comparison. Similarly built nutlets occur, though infrequently, in European sedges — here we may mention such species as *C. pilulifera* L. and *C. ericetorum* Poll. In the first of them the isodiametrical cells of the epidermis bear distinct papillae, situated centrally, one in each cell. No such papillae can be seen in the fossil specimen. The nutlets of *C. ericetorum* Poll. are not so markedly rounded in the upper portion as is the fossil specimen. Their external surface is smooth, with no papillae.

A similar structure of nutlets appears in more than ten North American species. Some of them, however, have somewhat larger nutlets, measuring 1·75—2·5 mm in length. *C. globosa* Boott. (Mackenzie 1940, Pl. 225) belongs to them, its nutlets are especially similar to the fossil specimen, as they have a distinct beak, but their dimensions are somewhat larger (2·0×1·75 mm). The Miocene specimen resembles all the species of another group, which have smaller nutlets, 1·5—1·7 mm long, namely, *C. pensylvanica* Lamarck, *C. deflexa* Hornem., *C. brevipes* Bott., *C. microrhyncha* Macken. and *C. umbellata* Schkuhr. (cf. Mackenzie 1940, Pl. 223, 227, 228, 233 and 234).

The new fossil species described is marked by the similarity of the morphological structure of its nutlets to that in many modern species of wide geographical distribution. Its name is associated with the oval-globular shape of the nutlet.

Occurrence. I have not found a description of similar remains in the available palaeobotanic literature. *C. pilulifera* L. was given as doubtful from the late glacial of Ireland by Mitchell in 1953 (Godwin 1975).

Carex strigosoides n. sp.

Pl. XIV, figs. 26—28

Localities: NS. I: 271, 294
NS. II: 31, 32

Material: 4 nutlets and 2 fragments, 2 utricles

Description. Nutlets, 1·6—1·75×0·7—0·8 mm, trigonous, with oblong, more or less equilateral, flat or even slightly concave walls. Beak straight, relatively long (0·2 mm), stipe distinct, rather thick, 0·2—0·3 mm in length. The angle lines between the lateral walls are well-defined and fairly sharp. The nutlet walls are strong and thick, their external surface is covered with relatively large, isodiametrical cells, arranged in longitudinal rows. No traces of papillae are visible on the surface of these cells. The utricles, 2·7×0·85 and 2·8×1·1 mm (apical part damaged), were about 3 mm long; they are rather distinctly and densely veined, the nerves being thin and running irregularly.

Comparison. Nutlets of the same structure rarely occur in Eurasian and North American species. The fossil remains relatively most resemble *C. strigosa* Huds., but the nutlets of this last are somewhat smaller (1·4—1·6 ×0·8—0·9 mm, acc. to Nilsson & Hjelmqvist 1967), set on a thin stipe, and their external walls bear small acute papillae. No papillae are discernible on the fossil specimens and the stipes are relatively thick. Trigonous, elongate and oblong nutlets appear in some North American species, e.g. *C. collinsii* Nutt. (Mackenzie 1940, Pl. 488) or *C. squarrosa* L. (l. c., Pl. 508), but they are considerably larger, 2·5—3·0 mm long. The same is true of the nutlets of the Eurasian species *C. secalina* Wahlb.

Two utricles, corresponding in morphological structure to those of *C. strigosa* Huds. have been found beside two well-preserved nutlets in sample N.S. II: 31. Thus the fruits described here may be regarded as belonging to a species closely related to *C. strigosa* Huds.

C. strigosa Huds. grows in damp deciduous forests of north-western and central Europe (Mediterranean-Atlantic species), Asia Minor and southwest Asia.

Occurrence. Nutlets of *C.* cf. *strigosa* Huds. have been found in the Pleistocene floras of Germany (Kräusel 1937, Pl. 1, figs. 41 and 48); fruits of this sedge have also been recorded from the Pleistocene and Holocene of Great Britain (Godwin 1975).

Carex cf. *acutiformis* Ehrh.

Pl. XIV, figs. 13a, 13b

Locality: NS. II: 33

Material: 1 fruit and 1 nutlet fragment

Description. Nutlet, 2·0×1·15 mm, trigonous, ovate-elliptic in outline, with lateral walls arched and broadest in the middle. Beak straight and thick, 0·2 mm long. Walls thick, edges sharp, external surface with relatively large, distinct, isodiametrical cells furnished with pointed papillae. The nutlet is inserted in a utricle, the upper part of which is destroyed. Its walls were comparatively thick and its shape most probably ovate-elliptic; it was flat on one side and convex on the other. The external side of the utricle shows large isodiametrical cells and distinct longitudinal nerves, which run upwards from the base and gradually disappear.

Comparison. Palamarev (1970) described similar nutlets from the Pliocene and Miocene of Bulgaria as *Carex* sp. IV, comparing them with the nutlets of *C. acutiformis* Ehrh., *C. nutans* Host. and *C. limosa* L. The specimen from the Miocene of the Nowy Sącz Basin best corresponds to *C. acutiformis* Ehrh.

Today *C. acutiformis* Ehrh. (= *C. paludosa* Good.) grows in the territory of Eurasia and North America, occurring in marshy places, wet meadows and areas neighbouring upon waters.

Occurrence. Species reported from Eurasian Pleistocene floras. Similar nutlets have also been found in Pliocene and Miocene floras (Mai 1965; Palamarev 1970).

Carex flavaeformis n. sp.

Pl. XIV, figs. 18, 19

Locality: NS. I: 268

Material: 3 nutlets

Description. Nutlets, 1·45—1·7×0·9—1·05 mm, trigonous, with lateral walls cuneate-obovate, straight beak, 0·1 mm long, and fairly distinct stipe, about 0·2 mm in length. Edges sharp — particularly in the specimen illustrated in Pl. XIV, fig. 19 — nutlet surface covered with fine pointed papillae. The morphological features described can be investigated on two larger specimens, the third one being damaged, without its beak and with a less distinct stipe.

Comparison. This type of fruits is frequent in Eurasio-North American sedges, chiefly *C. flava* L., *C. lepidocarpa* Tausch, *C. oederi* Retz. or *C. tumidicarpa* Ands. (= *C. demissa* Horn.). At least 10 species with nutlets similar in shape and size can also be found among the North American sedges. One specimen, the best preserved one, seems more similar to *C. flava* L. (edge lines narrow), the other one to *C. lepidocarpa* Tausch (somewhat greater dimensions, angle lines indistinct). Nevertheless, it is very hard to refer the remains described to one of the species living now.

Occurrence. *C. flava* L. was recorded from the Pleistocene and Holocene of Europe and *C. lepidocarpa* Tausch. and *C. oederi* Retz. from the Holocene.

Carex plicata n. sp.

Pl. XIV, figs. 20—25

Localities: NS. I: 57, 180, 193
NS. II: 18, 23, 30, 31, 39

Material: 52 nutlets, 16 nutlet fragments, 1 utricle, 3 utricle fragments

Description. Small nutlets, 1·0—1·5×0·47—0·7 mm, trigonous, broadest halfway along the length, narrowing considerably at both ends. Beak straight or curved, narrow, not very long, pointed; stipe also short and narrow. Lateral walls thick but very concave, with rather large transverse depressions in their surfaces, resulting in the uneven undulation of the lateral surfaces and circumferential line of the nutlet. About 40 nutlets and some utricles, these last however in the poor state of preservation, distorted and broken, come from sample NS. II: 31. Presumably the utricles were very small (1·0—2·0 mm long) and narrow (0·6—0·75 mm broad), with delicate longitudinal nerves, which ran parallel and fairly close to each other.

Comparison. I have not found any descriptions of similar fruits of *Carex* in palaeobotanical literature. Neither have I succeeded in finding any fruits identical in structure among contemporary species, although many of them have small trigonous nutlets. The nutlets of the Mexican species *C. conspecta* Macken., North American *C. williamsi* Britt. and North American-Eurasian *C. capillaris* L. (Mackenzie 1940, Pls. 346—348) show a fairly great similarity to the fossil specimens. In the last of these species the nutlets are somewhat broader and less pointed at both ends, have a less distinct stipe, a robuster and always straight beak and an uneven external surface, which is without conspicuous transverse folds but only finely pitted. The three above-mentioned species have, in addition, utricles varying in structure, different from the fossil specimens derived from the same sample that provided the nutlets.

The name of the newly described fossil species is connected with the transverse undulation of the external surface of nutlets, which gives them a very characteristic appearance, different from that of other species.

Occurrence. Remains not described from fossil floras hitherto.

Carex pseudocyperoides n. sp.

Pl. XIV, figs. 14—17

Localities: NS. I: 57, 271, 291, 300, 311, 346, 348
NS. II: 18, 23, 29 (?), 32

Material: 17 nutlets and 4 fragments

Description. Nutlets, 1·5—1·7 (1·95)×0·8—0·95 mm, trigonous, with elliptic lateral walls, which narrow rather markedly and to the same degree at both ends. The lateral walls have 2 axes of symmetry each, since their greatest breadth occurs exactly in the middle of the length of nutlet. Beak thin, long, bent at the base, readily breaking off, well preserved on one specimen only. Stipe not very distinct, short, straight or somewhat bent. Lateral walls thin, markedly concave, often semitransparent owing to fossilization. Edges sharp, external surface with fine papillae.

Comparison. Nutlets of similar structure can be found in some Eurasian and North American species, but they usually differ from the remains described mainly in size, thickness of walls and appearance of the beak, which is more often than not thicker, straight and short. The fossil remains best compare with the nutlets of *C. pseudocyperus* L., for which Nilsson and Hjelmqvist (1967) give the dimensions 1·5—1·7×0·8—1·0 mm, which range of variation Berggren (1969) widens a little (1·5—1·8×0·9—1·2 mm). The fossil specimens except one, which is very long, lie within this range of variation.

Now *C. pseudocyperus* L. occurs in Eurasia (reaching Japan in the south), growing in wet places, fens and in the neighbourhood of water reservoirs.

Occurrence. Species new to the Tertiary. The allied contemporary species *C. pseudocyperus* L. is known on the basis of fruits from the Pleistocene and Pliocene of Europe (Bass 1932; Kräusel 1937; Szafer 1947; Nikitin 1957). Nutlets resembling those of *C. pseudocyperus* L. have been recorded from the Pliocene of Baškiria as *Carex* sp. 5 (Dorofeev 1977).

Gramineae gen.

Locality: NS. II: 39

Material: 1 caryopsis, 2 fragments

Description. Caryopsis, 1·25×0·65 mm, much compressed, with one end rounded and the other acute. The acute end has a comparatively large hollow, which held the embryo. The walls of the pericarp are thin and cracked, delicate longitudinal striation can be seen on the external surface.

Comparison. A similar length ratio of embryo to whole caryopsis (the hollow for the embryo is 0·57 mm long or its length reaches nearly half the length of caryopsis) occurs in a small number of genera of the family *Gramineae*. The genus *Sieglingia* has this type of caryopsides. However, the only species I found available, *S. decumbens* (L.) Lam. has larger caryopsides.

In the genus *Molinia* the embryo is also relatively large, but its length equals only one-third of the length of caryopsis.

Occurrence. A similar caryopsis has been found in the Tortonian flora of Zatoka Gdowska (Łańcucka-Środoniowa 1966, Fig. 23/2), but neither is its determination to generic level possible.

Family **Araceae**

Epipremnum crassum C. & E. M. Reid

Pl. XV, figs. 1, 2

Locality: NS. I: 42, 133

Material: 2 seeds, 1 fragment

Description. Seeds, 2·5 × 2·9 and 1·7 × 3·3 mm, reniform, laterally compressed. One end narrowed, with a micropylar depression, the other end, broader and rounded, with a chalaza. Ventral side distinctly bent in, dorsal side markedly convex and smooth. Testa thick, with smooth surface. Fine wrinkles, parallel to the external margin can be seen on one specimen. There are small oval pits, arranged in two rows, also parallel to the external margin.

Comparison. Seeds of this type, fairly often found in the Tertiary floras of Eurasia, were first described by Ludwig as *Cytisus reniculus* Ludw. of the family *Papilionaceae* in 1857. Similarly built seeds have been described by the Reids (1915) as *Epipremnum crassum* C. & E. M. Reid of the family *Araceae*. German authors called both these determinations in question (Menzel 1913; Kirchheimer 1957). The name *Carpolithus reniculus* (Ludwig) Menzel should be used until the systematic position of these seeds has been established definitively. Such is Mai's (1973) view, according to whom, the anatomical structure of Ludwig's original specimens from the Pliocene of Wetterau does not correspond to the family *Araceae*, but suggests the genus *Thalia* of the family *Marantaceae*.

In the present work I keep using the generic name *Epipremnum*, because the names given for many other fossil species have persisted in palaeobotanical literature (*E. ornatum* Reid & Chandler, *E. cristatum* Nikitin, *E. cristatum* var. *turgaicum* Dorof., *E. rugosum* Dorof., *E. visimense* Dorof. and *E. uralense* Dorof.) and this genus whole needs a critical study.

Madison and Tiffney (1976) have recently dealt with this problem. They studied the morphological structure of seeds of the recent genera belonging to the tribe *Monstereae* of the family *Araceae*. Several species of each of the genera *Stenospermation*, *Rhaphidophora*, *Epipremnum*, *Rhodospatha*, *Scindapsus*, *Monstera* and *Amydrium* were examined.

Basing their opinions only on illustrations and descriptions of the fossil remains, these authors were unable to carry out a formal taxonomic revision of the determinations so far published and confined themselves to suggesting to which modern genera the fossil species of the genus *Epipremnum* can be referred. In the tribe *Monstereae* they are inclined to number only the seeds with a smooth dorsal side, described as *E. crassum* C. & E. M. Reid, *E. ornatum* Reid & Chandler, *E. uralense* Dorof. and *E.* sp. (Reid 1915, Pl. IV/13, 14). The possible genera are *Epipremnum* and *Scindapsus*. The genus *Rhaphidophora*, suggested by Chandler (1963) for *E. ornatum* C. & E. M. Reid cannot be taken into account because of the completely different morphological structure of its seeds.

According to the above-mentioned authors, Ludwig's specimens from Wetterau, described as *Cytisus reniculus* Ludw., later defined as *Carpolithus reniculus* (Ludw.) Menzel, *C. reniformis* Fritsch, lastly as *Epipremnum? reniculum* (Ludw.) Kirchh. cannot be included in the *Monstereae*. The morphological structure of these specimens, to be sure, suggests the genus *Epipremnum* but, if Mai's (1964) interpretation is sound and the micropyle and hilum are situated at the opposite ends of the seed, these seeds, in Madison and Tiffney's (1976) opinion, by no means can belong to the *Monstereae*. Besides, they have a thick testa with isodiametrical (in transverse section) sclereids (Kirchheimer 1957; Mai 1973), whereas in a similar section through modern *E. pinnatum* Engl. the testa is thin and the sclereids elongated (Kirchheimer 1957).

It should however be kept in mind that the seeds described as *Epipremnum crassum* C. & E. M. Reid have also thick and hard testa — as emphasized by the authors — thicker and more compact than that of the modern species *E. pinnatum* Engl. (Reid 1915). According to Reid and Chandler (1926), the seeds of *E. ornatum* Reid & Chandler also have thicker testa than have the modern species *E. pinnatum* Engl., *E. mirabile* Schott. and *E. giganteum* Schott.

Further studies are necessary to explain the systematic position of the seeds of *Carpolithus* (?*Epipremnum*) *reniculus* (Ludw.) Menzel and their relation to *E. crassum* C. & E. M. Reid. These studies should cover, above all, the anatomic structure of the fossil taxa mentioned and, if possible, of all modern species of the genera *Epipremnum* and *Scindapsus*.

The genus *Epipremnum* comprises about 15 species (frequently lianas), growing from Indo-Malaya to the Samoa and Marshall Is. The only species of the temperate zone is *E. pinnatum* Engl., the remaining ones are tropical. The genus *Scindapsus* numbers about 25 species (mostly lianas), now growing from India and Sikkim to the Solomon Is. and in South America (1 species). Madison and Tiffney (1976) emphasize that the living *Monstereae* are, above all, tropical and for this reason we can hardly expect the presence of plants of the tribe *Monstereae* in the fossil floras marked by distinct features characteristic of a temperate climate.

Occurrence. Species known from the Oligocene to the Pliocene in Eurasia, chiefly from the Miocene of West and East Siberia (Dorofeev 1963a, 1969a), new to the Tertiary of Poland. It has also been found in the Miocene of Lipnica Mała and Koniówka (Łańcucka-Środoniowa, in prep.).

Epipremnum cristatum Nikitin

Pl. XV, figs. 3a—4b

Localities: NS. I: 277
Gołąbkowice

Material: 2 seeds

Description. Seeds, 1·85×3·65 and 1·7×2·9 mm, thick, curved and laterally flattened. The micropyle lies at the narrower end, the chalaza at the broader one. The internal (ventral) side of the seeds is bent in and has a longitudinal trough-shaped depression. On the convex dorsal side there are fairly large processes with broad bases, running in three parallel rows. These processes are comparatively well preserved (though we do not know if they are whole) on the specimen from sample NS. I: 277, whereas the specimen from Gołąbkowice has only their broad bases, arranged in three parallel rows. The lateral walls of both seeds have small round and oval pits in their surface. The testa of these seeds is thick and lignified and its external surface shows the cellular structure in the form of rows of elongate cells.

Comparison. Similarly built seeds bearing characteristic processes on the dorsal side were first described by Nikitin under the name *Epipremnum cristatum*. Dorofeev obtained seeds of this type from many Tertiary floras of the U.S.S.R. and his rich collections show various deviations from the typical seeds of *E. cristatum* Nikit. as regards shape, size and, above all, the nature of processes. In addition to *E. cristatum* Nikit., Dorofeev (1963a, 1963c, 1970b) distinguished several other allied species: *E. cristatum* Nikit. var. *turgaicum* Dorof., *E. rugosum* Dorof. and *E. visimense* Dorof.

The specimens from the Miocene of the Nowy Sącz Basin differ from the seeds of *E. cristatum* Nikit. in some details of their morphological structure, i.e. they are somewhat slenderer and less curved. In this respect they would rather correspond to the species *E. borysthenicum*, distinguished by Dorofeev in the Oligocene material from Belorussia (oral communication). In this species the processes on the dorsal side are however poorly developed, whereas in the material from the Nowy Sącz Basin they are distinct and comparatively large. For this reason the inclusion of the remains described in *E. cristatum* Nikit. seems just, the more so, since in the material from Lagernovyj Sad near Tomsk, from where this fossil species has been described, there are also specimens which are little curved (Nikitin 1965, Pl. VII, fig. 12).

In his description of *E. cristatum* Nikit. and *E. rugosum* Dorof. from the Tertiary of West Siberia and *E. visimense* Dorof. from the Oligocene of the Ural Mts. Dorofeev emphasizes that the generic name is tentative and the genus *Cyrtosperma* with spiky seeds is here possible.

Madison and Tiffney (1976) numbered species *E. cristatum* Nikit., *E. rugosum* Dorof. and *E. visimense* Dorof. in the subfamily *Lasioideae*, several genera of which, e.g. *Dracontium*, *Dracontioides* and *Cyrtosperma*, have seeds furnished with parallel rows of spiky processes on the dorsal side. In their opinion, correct generic determination will not be possible until the seeds of the modern species of the subfamily *Lasioideae* have been closely examined. These are chiefly tropical plants, but some genera reach up to Japan in the north.

Occurrence. Species known from the Oligocene and Miocene of West Siberia and the Miocene of Europe. Palamarev (1970) records it from the Pliocene of Bulgaria. In Poland it has been found in the Miocene of Stare Gliwice (Szafer 1961).

Family **Sparganiaceae**

Sparganium haentzschelii Kirchh.

Pl. XV, figs. 11a, 11b

Locality: NS. I: 276

Material: 1 endocarp

Description. Endocarp, 3·3×2·5 mm, narrowing wedgewise at both ends, broadest in the upper part. It bears a stiff and sharp process at the top and close to the base of the process is the circular micropyle. There are 7 high and sharp longitudinal ridges and large roundish pits between them on the surface of the endocarp. The wall of the endocarp is thick and lignified.

Comparison. The specimen well agrees with the species *Sparganium haentzschelii*, described by Kirchheimer (1941) from the Miocene flora of Wiese in Lower Lusatia, only that it is somewhat less elongate than the specimens from Wiese and Klettwitz, figured in the description of this species. The endocarps of *S. haentzschelii* Kirchh. however show great variation in shape; this is well illustrated by the comparative material from Wiese, in which there are also some less elongate specimens.

Occurrence. Species known from several Miocene floras of Europe, first of all from Germany (Kirchheimer 1941, 1957; Mai 1964, 1967), in Poland from Stare Gliwice (Szafer 1961). From Fortuna-Garsdorf (Germany) Pliocene flora van der Burgh (1978) described one endocarp of *S.* cf. *haentzschelii* Kirchh.

Sparganium camenzianum Kirchh.

Pl. XV, figs. 12a—16

Locality: NS. I: 195, 196, 348, 350

Material: 4 complete endocarps, 16 halves, 6 fragments

Description. Endocarps, 1·2—1·6 × 0·87—1·2 mm, bottle-shaped, broadest above one-half of the length, narrowed wedgewise or rounded at the bottom, much narrowed and with a large micropylar opening at the top. The external surface is smooth, with poorly marked longitudinal edges. There is one locule inside the endocarp. The walls are very thick and lignified.

Comparison. These remains correspond closely to the species *S. camenzianum*, described by Kirchheimer (1941) from the Miocene of Wiese. The specimens from this locality reach 3·1 mm in length and 1·9 mm in breadth; the remain from the Nowy Sącz Basin are smaller, but they lie within the range of variation of this species.

Occurrence. Species known from the Miocene floras in Germany (Kirchheimer 1941, 1957; Mai 1964, 1967), Denmark (Friis 1975), in Poland from the Miocene of Stare Gliwice (Szafer 1961) and Zatoka Gdowska (Łańcucka-Środoniowa 1966).

Sparganium neglectum Beeby foss.

Pl. XV, figs. 5—10

Localities: NS. I: 4, 10, 26, 77, 85, 97, 102, 104, 109, 240
NS. II: 36
Nowy Sącz - Błonie

Material: 10 endocarps, 3 fragments

Description. Endocarps, 2·8—3·75 × 1·5—2·2 mm, unilocular, elongate, ovate-oval or pyriform in outline, often asymmetrical. Base slightly narrowed, truncated or rounded, top narrowed, short or somewhat elongated, with a large micropylar opening. Walls thick and lignified, with longitudinal ridges, on top of which a groove runs as the trace of thin vascular bundle. Some specimens have relatively high and thick ridges, the ends of which descend below the base (e. g. the specimen in Pl. XV, fig. 5), in other ones the ridges are low, thin and poorly marked (Pl. XV, fig. 10).

Comparison. Similarly built endocarps have been described from fossil floras for a long time as *Sparganium ramosum* Huds., for such was originally taxonomic position of this polymorphic species, including 3 subspecies (or varieties), which later were distinguished as three closely related species: *S. ramosum* L., *S. neglectum* Beeby and *S. microcarpum* (Neuman) Čelak. These species differ, among other things, in the structure of whole fruits (Hess, Landolt & Hirzel 1967) and also in that of endocarps themselves (Dorofeev 1963b), well persisting in the fossil state.

On account of their relatively small size the specimens from the Nowy Sącz Basin are comparable with the species *S. neglectum* Beeby and *S. microcarpum* (Neuman) Čelak. According to Dorofeev (1963b) the first of these species has endocarps measuring 1·8—3·8 × 1·4—2·4 mm, ovate-oval in outline, with a short and thick apex, relatively high and thick ridges, the ends of which descend below the usually truncated base. Five endocarps derived from samples NS. I: 4, 26, 77, 85 and 102 correspond to this species. The high and thick ridges are best preserved in the specimen from sample NS. I: 4 (Pl. XV, fig. 5). On the other hand, *S. microcarpum* (Neuman) Čelak. has asymmetrical endocarps, 2·3—3·6 × 1·0—2·0 mm, pyriform or oval-cylindrical in shape, with a fairly long tubular apex and rounded base. The ridges are low and thin, walls lignified, but slightly thinner than in the previous species. The specimen from the sample from Błonie (Pl. XV, fig. 10) best coincides with this description; besides, 4 endocarps from samples NS. I: 10 and 240; NS. II: 36 can be compared with this species. These endocarps however have distinct and fairly high longitudinal ridges, so it may well be that they belong to *S. neglectum* Beeby. The scanty fossil material from the Nowy Sącz Basin does not provide sufficient bases for distinguishing two taxonomic units, particularly in the presence of great variation of endocarps of the modern species. The specimens from the Nowy Sącz Basin lie within the range of variation of *S. neglectum* Beeby. The results of biometrical studies made by Knobloch and Mai (1975) on Neogene and Pleistocene materials from Europe prove a wide range of variation of this species, which can be well exemplified by the variety of shape and size of the specimens from Nové Ústie (l. c., Pl. II).

S. neglectum Beeby is a West European species, reaching to England and southern Sweden in the north, to the upper Dnepr and Volga in the east, to northern Africa, the Caucasus Mts. and Asia Minor in the south. It grows in muddy places and close to water reservoirs.

Occurrence. Species recorded from the Pleistocene of Europe, but occurring here as early as the Pliocene and even Miocene (cf. Knobloch & Mai 1975). Localities in Poland, according to Knobloch and Mai: Krościenko, Mizerna and Huba (Szafer 1947, 1954, sub *S. ramosum* Huds. and *S. ramosum* Huds. s. l.) and Konin (Raniecka-Bobrowska 1959, sub *S. ramosum* Huds. s. l., cf. *S. ovale* Reid).

Note. At inspection of the fossil fruits of the genus *Sparganium* in Museum of Palaeobotany, Polish Academy of Sciences, it appeared that the specimen described as *S. noduliferum* Reid from the Pliocene of Krościenko (Szafer 1947, Pl. 15, figs. 36, 37) lacks features of the endocarp of this genus. It is a fruit, 6·0 × 4·5 mm in diameter, distinctly pentagonal in outline, its very narrow apex has a small aperture, there being another round aperture of a relatively great diameter at the base. It is a fruit of *Tilia platyphyllos* Scop.

Family **Typhaceae**

Typha cf. *fusisperma* Negru

Pl. XV, figs. 17, 18

Locality: NS. II: 29, 31

Material: 2 tegmina

Description. Tegmina, 0·92—1·2×0·3—0·35 mm, elongate and fusiform, much compressed, broadest at one-half of the length, narrowing gradually towards the top into a long neck. The top is slightly narrower than a half of the greatest breadth of the tegmen, the micropylar lid narrow, straight or a little convex, the style short and thin. Base narrowed wedgewise, with nipple-shaped ending (hilum). Walls thin, almost translucent, dark yellow or brown in colour. Surface shining, often damaged in fossilization (waved and densely pitted), only in few places the outlines (impressions) of small square cells of epidermis can be seen under high-power magnification.

Comparison. The determination of the seeds of *Typha*, of which only tegmina, i.e. the inner membranous layers of the seed coat, are most often preserved in the fossil state, presents much difficulty, seeing that the differences in morphological structure between the seeds of modern species are small (cf. Łańcucka-Środoniowa 1966) and the number of species described from the Tertiary of Eurasia very great (1 species described by Reid and Chandler in 1926, about 25 species by Dorofeev and 2 species by Negru in 1972). Correct determination is particularly hard if one has at one's disposal a small number of poorly-preserved specimens.

The specimens from the Miocene of Nowy Sącz correspond relatively most closely to the species *T. fusisperma* Negru, described from the Lower Sarmatian of Moldavia (Negru 1972, Pl. 6, figs. 8—13, Text-fig. 6 — see especially two smaller specimens on the righthand side of the drawing). In Negru's opinion, the specimen given from the Miocene of Stare Gliwice as *Typha* sp. (Szafer 1961, Pl. 25, fig. 6) and three specimens from the Tortonian of Zatoka Gdowska as *T. elongata* Dorof. (Łańcucka-Środoniowa 1966, Pl. 7, figs. 14—16) belong to this species. *T. fusisperma* Negru resembles modern *T. angustifolia* L., with which species *T. elongata* Dorof, described from the Oligocene of Kazachstan (Dorofeev 1963c), is also comparable.

How much doubt arises in course of determination of the fossil seeds of *Typha* can be seen from different statements concerning the same taxa from the Tortonian of Zatoka Gdowska made by Dorofeev and Negru. Dorofeev (1969b, p. 6) included the specimen presented in Pl. 7, fig. 14 of this work in the species *T. miocenica* Dorof. and the specimen in fig. 16 in *T. poltavica* Dorof. (both species described from the Middle Miocene of Lochvica in the Poltava region, U.S.S.R.). Negru (1972) numbered the same specimens from Zatoka Gdowska in *T. fusisperma* Negru.

Occurrence. Species described from the Lower Sarmatian of Moldavia. It occured in the Miocene of southern Poland (Zatoka Gdowska, Stare Gliwice) and probably also in the Miocene of northern Poland (Dobrzyń, Rypin, Chłapowo — Łańcucka-Środoniowa 1958 and unpubl. materials).

Typha cf. *elliptica* Negru

Pl. XV, figs. 19, 20

Locality: NS. II: 31, 33

Material: 2 tegmina, 1 fragment

Description. Tegmina, 0·82×0·3 and 0·97×0·35 mm, and a fragment of the largest specimen, which was 0·45 mm in breadth. They are cigar-shaped or elongate-elliptical, uniformly broadened, with the axis slightly bent. The top is not narrower than half the greatest breadth of the tegmen. The micropylar lid is fairly broad, slightly sunk, the style short and thick, preserved only on one specimen. The walls of the tegmina vary in thickness; in the larger specimen, derived from sample NS. II: 33, they are comparatively thick, brown in colour and with an almost dull surface. The other specimen has thinner walls, lighter in colour and their surface is more shining. The outlines of rectangular cells, arranged in longitudinal rows, are very weakly marked on the surface of both specimens.

Comparison. The tegmina described best agree with the species *T. elliptica* Negru from the Lower Sarmatian of Moldavia (Negru 1972, Pl. 6, figs. 3—7). This is particularly true of the larger specimen from sample NS. II: 33, in which the shape resembling a cigar is very distinct, although this is not well seen in its photograph (Pl. XV, fig. 19) owing to the folding and incurvation of the tegmen wall on the left side. On account of its uniformly broadened shape the specimen from sample NS. II: 31 (Pl. XV, fig. 20) might as well belong to the species *T. poltavica* Dorof. from the Miocene of Lochvica in the Poltava region. However, I cannot bring myself to distinguish still another species in the flora under study, on the basis of a single poorly-preserved specimen, the more so, since Negru also mentions a uniformly broadened elliptical shape in his diagnosis of *T. elliptica.*

According to Negru, the tegmina of *T. elliptica* differ clearly from the modern species, and as regards the fossil ones, some resemblance can be seen to the seeds of *T. maxima* Dorof., described from the Oligocene of Kazachstan (Dorofeev 1963c, Pl. I, figs. 35—38).

In *T. elliptica,* Negru also included the specimens recorded from the Neogene of southern Poland, namely, *Typha* sp. from Stare Gliwice (Szafer 1961, Pl. 25, fig. 7) and *T.* aff. *maxima* from Zatoka Gdowska (Łańcucka-Środoniowa 1966, Pl. 7, figs. 17, 18). In Dorofeev's opinion, the specimen from Zatoka Gdowska, presented in fig. 17, corresponds to *T. tertiaria* Dorof., described from the Middle Miocene of Lochvica (Dorofeev 1969b).

Occurrence. The species, described from the Lower Sarmatian of Moldavia, occurred in the Miocene of southern Poland (Zatoka Gdowska, Stare Gliwice) and probably in the Miocene of nothern Poland (Dobrzyń, Rypin, Chłapowo — Łańcucka-Środoniowa 1958 and unpubl. materials).

Typha cf. *pliocenica* Dorof.

Pl. XV, figs. 21—24

Localities: NS. I: 39, 254
NS. II: 20, 21

Material: 4 seeds

Description. Seeds, 0·67—0·75 × 0·30—0·35 mm, elongate, broadest at one-half of the length of the seed or somewhat below, narrowing wedgewise at the base and at the top, where they pass into a short neck. One of the specimens (Pl. XV, fig. 24) has its apical part deformed by an additional lateral compression, owing to which it gives the impression of being considerably narrower than it is in reality. The micropyle-covering lid has not been preserved at the top of any specimen and the cavities of these seeds are open. The seeds are dark, nearly black in colour. Two specimens show the well-preserved second or middle layer of the seed coat, built of small rectangular cells, oriented transversely to the length of the seed and arranged in some dozen longitudinal rows (counted on each side of the slightly bilaterally flattened seed). The walls of these cells are high and thickened, which is particularly well seen in the specimen from sample NS. I: 39 (Pl. XV, fig. 21). The external layer of testa, overlying the middle layer and composed of somewhat larger rectangular or 5—6-sided, but always elongate, cells arranged in more than ten longitudinal rows, counted on one side of the seed, is preserved on the remaining two seeds. It is best seen in the specimen from sample NS. II: 20 (Pl. XV, fig. 22).

Comparison. In 1960 Dorofeev described similarly built but a little larger seeds (0·8—1·1 × 0·2—0·4 mm) from the Pliocene of Baškiria under the name *T. pliocenica* Dorof. He besides distinguished several other species of *Typha* on the basis of seeds preserved whole and not only on the basis of tegmina, which are most commonly met with. The seeds of these species are however considerably larger and narrow (*T. lipetzkiana* Dorof. and *T. sibirica* Dorof.) or broader but still larger than the specimens from the Miocene of Nowy Sącz (*T. besczeulina* Dorof.).

According to Dorofeev (1960a), there is, to be sure, some resemblance between the seeds of *T. pliocenica* Dorof. and those of *T. latifolia* L., but the seeds of this last species, now widespread in Eurasia and North America, are somewhat longer, less inflated at one-half of the length, more regular in shape and their testa is somewhat thinner.

Occurrence. Species known from the Pliocene in Europe and as early as the Miocene and even Upper Oligocene in West Siberia („beščeulskaja svita" —

Dorofeev 1963a, pp. 7, 90). It has also been found in the Miocene of East Siberia (Nikitin V. P. 1976) and the Pliocene of Krościenko (Łaćnucka-Środoniowa, unpubl. materials).

Carpolithus sp.

Pl. XVI, figs. 1—7

Locality: NS. I: 54, 55, 57, 58, 72, 113, 163, 188, 190, 271, 280, 303, 309, 319, 334, 346

Material: 115 remains

Description. Remains, 0·8—1·9×0·8—1·5 mm (oftenest 1·4×1·1 mm), oval or oval-round in outline, markedly flattened bilaterally. Their original convexity is suggested by irregular folds, which frequently occur on both lateral surfaces. The walls are thin, often translucent and brown, their external surface being dull and smooth, with poorly seen cells, which are small, polygonal and lying close to each other. Some specimens bear a small process or semitranslucent longitudinal protrusion which causes the unevenness of the usually smooth marginal line. The specimens described are characterized by great variation in size and shape. Their irregular and little complicated morphological structure is a little similar to the cocoons of insects.

Comparison. I failed to determine these remains. They are most probably related to the family *Moraceae*, but such families as *Urticaceae*, *Ulmaceae* and *Piperaceae* cannot be excluded, either. D. Mai and E. Knobloch (oral communication) found similar remains in Neogene deposits.

Antherites sp.

Pl. XVI, figs. 8, 9

Locality: NS. II: 33

Material: 1 specimen and 4 fragments

Description. Anther, 1·0×0·72 mm in diameter; two longitudinally splitting lobes are visible but no trace of the connective. It is dark brown in colour, the surface shows the distinct frothy texture of the anther. Four fragments preserved in the same sample derive from anthers of still smaller size (one measurable specimen is 0·72 mm long and 0·65 mm broad) and distinctly rounded in shape.

Comparison. Single anthers, similar in shape and size, have been found in the Tortonian flora of Zatoka Gdowska and described in detail (Łańcucka-Środoniowa 1966, Pl. VII, fig. 20 and Text-fig. 25 /8—10). Generic determination would demand long studies.

Occurrence. These delicate remains are found in Tertiary deposits of various age, when, after having been washed on a finely meshed sieve, fossil material is examined under a low power binocular microscope.

UNDETERMINED REMAINS

Buds

Pl. XVI, figs. 10—26

Localities: NS. I: 22, 32, 34, 39, 42—44, 50—52, 54—56, 58, 60—62, 102, 105, 106, 134, 138, 147, 148, 188, 266—271, 275, 276, 280, 286, 287, 291, 300—303, 319, 334, 341, 348
NS. II: 18, 29, 30—33, 36—39
Nowy Sącz - Błonie

Material: 169 buds and 45 bud scales

Description. A large number of buds varying in size and shape occur in the deposits under study. The smallest of them do not exceed 1·0 mm in diameter and the largest specimen is 8·2 × 4·4 mm. The shape of buds is various, nevertheless several distinct groups can be distinguished.

1. Globular buds, usually unflattened or only slightly flattened, with a large number of covering scales, 1·0—4·0 mm in diameter, averaging 2·0 mm (Pl. XVI, figs. 10—12).

2. Buds, elliptical in outline, flattened, with a smooth and shining surface, finely striated, especially in the basal portion. Dimensions: 4·2—6·0 × 2·6—4·5 mm (Pl. XVI, figs. 13—15).

3. Buds, triangular and equilateral in outline, flattened, with a large number of imbricate scales. Their length ranges between 1·0 and 2·7 mm (Pl. XVI, figs. 16—20).

4. Buds, triangular in outline, with two sides equal, elongate, flattened, bearing a large number of imbricate scales, 2·0—5·0 mm in length (Pl. XVI, figs. 21, 22).

5. Buds, triangular in outline, with two sides equal, elongate, flattened, with a smooth and shining surface, sometimes finely longitudinally wrinkled. The length ranges within the limits of 1·8—5·0 mm (Pl. XVI, figs. 23—25b).

6. Bud, elliptically elongate in outline, flattened, with rounded apex (also somewhat damaged); its elongate scales are visible only in the upper portion of the bud. It is the largest of the buds found, measuring 8·2 × 4·4 mm (Pl. XVI, fig. 26).

Rootlets — type 1 (ensiform)

Localities: NS. I: 39, 43, 64, 65, 94, 122, 193, 268, 275, 280, 281, 298—303, 306, 307, 309—314, 316—319, 323, 328, 334
NS. II: 15, 23, 28, 30, 33, 38, 40

Material: about 100 specimens

Description. Fragments of ensiform rootlets of small thickness (0·25—1·0 mm in diameter). Remains strongly flattened, semitranslucent, yellow-brown, mostly with a fairly well seen cellular structure. Some specimens show their stele, darker in coloration.

Comparison. These remains have not been studied closely, since the state of preservation of tissues is not sufficiently good for this purpose.

Rootlets — type 2 (segmented)

Pl. XVII, figs. 1—10

Localities: NS. I: 30—32, 35, 39, 55, 57, 58, 134, 227, 228, 233, 236, 237, 249, 250, 261, 268, 272, 276, 278—281, 286, 287, 297—301, 303, 305, 307, 317, 319, 334, 348
NS. II: 18, 20, 21, 23, 28—33, 37—40
Falkowa

Material: about 550 specimens.

Description. Remains, very small, segmented. Particular segments measuring 0·4—1·13 × 0·25—0·45 mm, flat, semitranslucent, light or dark brown, oval or elongate oval in outline. An ensiform longitudinal zone extends through its middle; it is dark brown in colour and occupies about one-fifth of the breadth of the segment. Most specimens are single segments, there being only exceptional ones composed of two joined segments (Pl. XVII, figs. 3, 4, 7). Some specimens are not translucent but almost black and finely longitudinally striated, little flattened, with well marked segments, which reach 2·0 × 0·75 mm in diameter.

Comparison. Determination of these remains presents much difficulty in spite of their fairly distinctly defined morphological structure. Anatomical details are not clear enough in the material from the Nowy Sącz Basin to permit us to exclude their affinity with lower plants. This became possible in consequence of an examination of numerous remains of this type, much better preserved, found in many Pliocene samples from Domański Wierch (Łańcucka-Środoniowa, in prep.). Their anatomical structure proves the affinity with higher (vascular) plants, since they are cylindrical in shape and have vessels (spirals are seen in microscopic sections) in the central zone, which forms an axis common to all segments. In the material from Domański Wierch there are numerous specimens consisting of many segments resembling a string of beads.

Such a structure is characteristic of small rootlets of higher plants as I was in a position to find while examining the washed material from Tertiary deposits under a low power binocular microscope (Sośnica, Krzaki Gostwickie in the Nowy Sącz Basin). Similarly segmented rootlets of undetermined recent plants occurred in it as contamination.

Occurrence. These fine remains may be found in Tertiary deposits of various age, whenever after having been washed on a finely meshed sieve, fossil material is examined under a low power binocular microscope.

Coprolites of butterfly caterpillars — type 1

Pl. XVII, figs. 12—13a

Locality: NS. I: 58, 134, 147, 148, 172
Material: 5 specimens

Description. Somewhat elongate cylindrical remains, 1·0—2·0 mm in diameter, longitudinally deeply grooved, resembling six-toothed wheel in cross-section. The convex surfaces between the grooves are shining, black and irregularly wrinkled. The internal structure is amorphous.

Comparison. Similarly built remains were described as *Carpolithes* sp. or as fruits of the *Araliaceae*, particularly those of the genus *Aralia*. They have turned out to be coprolites of butterfly caterpillars (Łańcucka-Środoniowa 1964).

Occurrence. Recorded from floras of various age, from Eocene to Pliocene. Tertiary localities of Poland: Krościenko, Mizerna and Stare Gliwice (Szafer 1947, 1954, 1961 — specimens described as fruits of *Aralia* sp., *Araliaceae* or *Aralia* aff. *chinensis* L.).

Coprolites of butterfly caterpillars — type 2

Pl. XVII, figs. 14—16a

Localities: NS. I: 43, 268
NS, II: 30, 31, 33
Material: 7 specimens

Description. Small, more or less elongate cylindrical remains, 0·65—0·95 mm in diameter. Some specimens are very short, as if truncated and are hardly 0·5 and 0·7 mm long, whereas the longest specimen is 1·32 mm. The external surface is usually black and shining, uneven, finely transversely folded and the structure is amorphous in cross-section.

Comparison. So far these remains have not been described from the Tertiary, but on the basis of their characteristic morphological features they may be regarded with certainty as coprolites of caterpillars of a lepidopterous species. Prof. S. Kapuściński has approved this determination.

Coprolites of insects

Pl. XVII, figs. 17—21

Localities: NS. I: 58, 77
NS. II: 23, 26, 30, 31
Biegonice
Material: 10 specimens

Description. Small, black, elongate cylinders, measuring 0·55—1·25 × 0·3—0·5 mm (specimens very much flattened are 0·6 and 0·7 mm broad). External surface smooth, amorphous.

Comparison. In Prof. S. Kapuściński's opinion, coprolites of this type come from larvae of the *Symphyta* (*Hymenoptera*).

A large number of similar remains, equal in size to or somewhat larger than the specimens from Nowy Sącz have been found in the Miocene flora of Wieliczka (unstudied materials in the Museum of Palaeobotany, Institute of Botany, Polish Academy of Sciences, in Cracow). Their amorphous structure is seen in cross-sections.

Cocoons of insects

Localities: NS. II: 17, 20, 30, 32, 33
Niskowa
Material: 6 specimens

Description. Remains, round or oval in outline, 0·5 mm and 2·3—3·8 mm in diameter, lustrous, semitranslucent. Yellow-brown in colour, structure amorphous.

HOMOPTERA, COCCIDOIDEA

Family **Coccidae**

Pl. XVII, figs. 22a, 22b

Locality: NS. II: 30
Material: 1 specimen

Description. Specimen, 2·0 × 1·9 mm, subcircular in outline but unevenly fringed, quite flat on one side, convex with deep and irregular folds on the other. Outlines of spongy tissue, brown in colour, visible on the flat side. The surface of the convex side is smooth, leathery and intensely lustrous, dark brown in colour.

Comparison. This is a covering scale of a female body, the interior of which is filled with ova. The body of female insects of the family *Coccidae* is undifferentiated, shield-shaped or globular, without thoracic legs. The insects attach themselves to different parts of plants by means of their mouth-parts (Kapuściński 1973). This determination has been approved by Prof. S. Kapuściński.

Zoocecidia (plant-galls)

Pl. XVIII, figs. 1—15b; Pl. XIX, figs. 1—6b

Localities: NS. I: 39, 42, 43, 46, 58, 134, 138, 227, 267, 276, 280, 301—303, 342, 348
NS. II: 11, 30, 31, 33, 36, 37
Nowy Sącz - Błonie

Material: 33 specimens

Description. With respect to their various morphological structure the zoocecidia found in the Miocene flora of the Nowy Sącz Basin may be divided into a number of groups. Only for some of the types it was possible to determine in approximation (without carrying out special studies) by what group of animals they had been caused.

I am indebted to Prof. S. Kapuściński for his imparting much information to me and discussing the whole of fossil material.

Type 1 (Pl. XVIII, figs. 1, 2)

Globular zoocecidia, 1·7—3·0 mm in diameter, with thick walls and lustrous smooth surfaces. The larger specimen is torn open and shows an empty spherical chamber with smooth walls inside. It is placed on a small twig. Samples: NS. I: 42, Błonie.

Type 2 (Pl. XVIII, figs. 3a—3c)

Globular zoocecidium, 1·3 mm in diameter, somewhat flattened from above, with relatively thin walls. On the slightly folded external surface there are fairly large polygonal plots and a small fragment of the leaf blade on which this zoocecidium is placed has been preserved. Sample NS. I: 39.

Very similarly built zoocecidia, brought about by the arachnid *Eriophyes laevis* Nalepa occur on the leaves of *Alnus glutinosa* (L.) Gaertn. Prof. S. Kapuściński has approved this determination, at the same time emphasizing that similarly shaped zoocecidia are also present on the leaves of *A. incana* (L.) Mnch. and are caused by *Eriophyes laevis* f. *alni incanae* Nalepa. These arachnids belong to the mites (*Acarina*) of the superfamily *Eriophyoidea.*

Type 3 (Pl. XVIII, fig. 7)

Zoocecidium, 2·2 × 1·5 mm, ovate-elliptical in outline, primarily cylindrical, secondarily flattened bilaterally, with uneven, rough surface. The apical part is rounded and at the base there is an arcuate depression, which may be regarded as the scar of attachment of the zoocecidium to the vein of the leaf. Sample NS. I: 280.

Type 4 (Pl. XVIII, figs. 4a—6)

Zoocecidia, 1·25×1·0—1·1 mm, globular or ovate-globular. In the laterally compressed specimen the attachment scar is on the circumference and in the specimen flattened from above the small attachment scar (0·3 mm in diameter) is well seen and situated centrally in the lower part of the zoocecidium. The external surface is covered by large, bulging, wart-like tubercles, which lie close to each other, being less distinct round the attachment scar. Samples NS. I: 42 and NS. II: 36. Larger specimens identical in form occur in the Neogene deposits of Czarny Dunajec (2·0×1·4 mm).

These zoocecidia are also similar to the perithecia of the fungus *Bertia moriformis* of the family *Coronophoraceae* (*Ascomycetes*), which however adhere to the host twig over a considerable area and the scars left after their removal would be much larger than those in the fossil specimens (cf. Dennis 1960). Prof. S. Kapuściński has approved the inclusion of these remains among zoocecidia, since similar ones occur on oaks, although they do not bear so large tubercles on their surfaces. They would therefore be forms exotic to our modern ones, probably associated with other oak species.

According to Prof. S. Kapuściński, 2 somewhat larger ovate-globular zoocecidia (2·3×1·35 and 1·4×1·1 mm), with a small attachment area and a fragment of the leaf blade in one case, may also be numbered in this type. On the surface they have tubercles, irregular in shape, rather low and situated at wide intervals (Pl. XVIII, fig. 6). Samples NS. II: 31 and 33.

Type 5 (Pl. XVIII, figs. 8—9b)

Zoocecidia, 1·2—1·4×0·6—0·9 mm, ovate-globular, with a relatively large attachment scar, on the outside covered by fine tubercles, which lie close to each other and give the impression of a rough surface. In the lower portion, round the attachment, the tubercles are less distinct. The walls of the zoocecidia are thick and brittle, they crack readily along the line of circumference when being pressed. Sample NS. II: 11. Some specimens of the same shape but somewhat larger (2·0×1·5 mm) have been found in the Neogene flora of Koniówka.

In Prof. S. Kapuściński's opinion, these zoocecidia resemble some galls occurring on oaks.

Type 6 (Pl. XVIII, figs. 10a, 10b)

Remains, 0·6 and 1·1 in diameter, round in outline, with an irregularly jagged circumference. They are groupings of wart-like processes, lying close to each other on fragments of leaf blades. The texture of these excrescences is delicate, as if spongy, and their external surface shows distinct and fairly large isodiametrical cells, similar to the cells which can be seen in the fragments of leaves. Samples NS. I: 43 and 138.

According to Prof. S. Kapuściński, zoocecidia of a similar type are induced, e. g. on the leaves of *Populus tremula* L., by some arachnids of the superfamily *Eriophyoidea*. The punctures made by these arachnids stimulate particular cells of the leaf blade to produce large wart-like processes.

Type 7 (Pl. XVIII, figs. 11—13b)

Zoocecidia, 0·87—1·15 (1·65)×0·52—0·73 (0·9) mm, cylindrical, somewhat narrowed and rounded at one end, and at the other furnished with a large opening, which occupies the nearly whole breadth of the zoocecidium and makes it possible to investigate its thick walls. The external surface is finely longitudinally striated and, besides, fragments of the epidermis composed of large cells with thick, straight and as if glassy walls, are preserved on some specimens. These specimens, except one, the largest, have no attachment scar and are open in the basal part. There are specimens which strikingly resemble the seeds of certain species of *Salix* (cf. Dombrovskaja *et al.* 1959, Pl. 94, figs. 1—4). These last, however, have a delicate and thin testa (at the state of preservation found in the whole flora under study their remains would be almost translucent) with small and thin-walled cells. Samples NS. I: 46, 58, 134, 276, 302 and NS. II: 33 and 37.

Prof. S. Kapuściński has approved this determination. In his opinion, the zoocecidia of this type are brought about by arachnids of the superfamily *Eriophyoidea* and may vary in dimensions, being more or less regularly bag-like in shape.

Type 8 (Pl. XVIII, figs. 14a, 14b)

Zoocecidia, 1·0×2·5 mm, bilaterally flattened, elongate-elliptical in outline, grown to the substratum nearly all over their base and coming off from it at both rounded ends. This gives them the characteristic appearance of ears or flaps, grown together with a small twig, pedicle, petiole or, which is most probable in view of the distinctly jagged margins, vein of a leaf blade. On the external surface of the „ear" and vein there are similar rows of small isodiametrical cells. Sample NS. II: 30.

Prof. S. Kapuściński recognized these specimens as remains of one of the many types of zoocecidia occurring on oaks. When the gall proper, ovate-globular in shape, has fallen off, in some specimens its basal part remains and it looks like ears (flaps). The name proposed: *Cynipidocecidium* I, because the galls of this type are induced on oaks by hymenopterans of the family *Cynipidae*. Particularly similar are the zoocecidia on the veins of oak leaves, caused by punctures made by female *Andricus ostrea* (Hartig).

Type 9 (Pl. XVIII, figs. 15a, 15b)

Zoocecidia, 2·25×2·25 and 2·25×2·20 mm, strongly flattened from above but originally globular or at least convex on one side. The attachment in the form of a distinct small stalk (0·3×0·3 mm) is preserved in one specimen. The external surface is very uneven, with folds and irregular ridges, which, resembling creased flounces, extend parallel to the circumference. Samples NS. I: 348 and NS. II: 31.

Prof. S. Kapuściński has proposed the name *Cynipidocecidium* II, finding these remains similar to the galls provoked by female hymenopterans belonging to *Neuroterus quercusbaccarum* (L.).

Type 10 (Pl. XIX, figs. 1a—2)

Zoocecidia, 3·0—3·7 × 3·6—4·2 mm, subglobular, their broad base grown to the substratum. Walls thin, easily cracking in the apical region. External surface smooth, dull, showing small isodiametrical cells, which lie close to each other. On the surface, above all, in the basal part, there are, in addition, some tuberculous structures, 0·3—0·5 mm in diameter, with well-seen central depressions and concentrically arranged layers of tissue, undulated irregularly at the periphery. Samples NS. I: 301 and 303.

Prof. S. Kapuściński confirmed that these are zoocecidia and at that similar ones to the zoocecidia induced by bisexual forms of *Neuroterus quercusbaccarum* (L.) on the blades of oak leaves. The tuberculous structures on their surface would be remnants of the leaf veins with which the zoocecidia was grown together. Name proposed: *Cynipidocecidium* III.

Type 11 (Pl. XIX, figs. 3—4b)

Remains, 4·2—4·9 × 3·4—4·6 mm, subglobular, grown by their probably fairly broad base to the substratum, which however is not well seen in any of the three specimens. Walls very thin, liable to crack, surface dull, completely smooth, with well marked small isodiametrical cells, which lie close to each other. Samples NS. I: 267 and 276.

According to Prof. S. Kapuściński, these remains, too, resemble the zoocecidia induced by bisexual forms of *Neuroterus quercusbaccarum* (L.) on oak leaves, i.e. they should be included in type 10 and come within the name *Cynipidocecidium* III.

However, it is hard to decide in favour of this opinion without carrying out close studies of the galls which occur on different species of *Quercus* today, because the remains described differ much from the zoocecidia of type 10. They have considerably thinner walls, very smooth and void of tuberculous thickenings on the surface. In connection with their regular shape and smoothness of the surface they make the impression of cocoons.

Type 12 (Pl. XIX, figs. 5—6b)

Zoocecidia, 5·4 × 3·5 and 3·4 × 2·8 mm, ovoid in shape, with marks of their broad attachment along the long axis. Walls thick, lignified, surface dull and rough, composed of more or less elongated cells, which are thin-walled and not very regular. Besides, on the surface these zoocecidia bear two irregular tuberculous thickenings each, which may be regarded as the traces of their attachment to the veins of the leaf blade. Sample NS. II: 33.

Prof. S. Kapuściński thinks that they are zoocecidia related to the galls induced on oaks by female hymenopterans belonging to the species *Cynips longiventris* Hartig. Name proposed: *Cynipidocecidium* IV.

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STRESZCZENIE

SZCZĄTKI MAKROSKOPOWE ROŚLIN Z MIOCENU SŁODKOWODNEGO KOTLINY SĄDECKIEJ (KARPATY ZACHODNIE, POLSKA)

Zbadany materiał makroskopowy roślin pochodzi z 445 prób osadów miocenu, uzyskanych z dwóch profili (do 535 m głębokości) oraz z wierceń i odkrywek powierzchniowych. W stropie dominują utwory ilasto-piaszczyste, poniżej mułowcowo-piaszczyste z blokami fliszu. We wszystkich typach osadu stwierdzono mniejszą lub większą ilość detrytusu roślinnego oraz ułamki lignitów.

Wyróżniono 111 taksonów roślin zarodnikowych, nagozalążkowych i okrytozalążkowych, w tym 14 nowo opisanych i 39 dotychczas nie notowanych z trzeciorzędu Polski. Wśród szczątków makroskopowych dominują nie drzewa i krzewy, ale rośliny zielne, liczące niemal 70% całości wyróżnionych taksonów.

Panującym typem roślinności były mało urozmaicone lasy bagienne, zbudowane niemal wyłącznie z przedstawicieli rodzaju *Glyptostrobus*, oraz śródleśne mokradła, jeziorka i torfowiska opanowane głównie przez rośliny z rodziny *Cyperaceae*, oraz z rodzajów *Sparganium*, *Typha*, *Andromeda*, *Stratiotes* i.i. Wyżej wzniesione obrzeża Kotliny zajmowały lasy liściaste z nieznaczną domieszką drzew i krzewów szpilkowych. Na uwagę zasługują liczne szczątki makroskopowe, rzadko dotychczas opisywane z osadów trzeciorzędowych, takie jak pączki, koprolity gąsienic motyli i owadów, oraz wyrośla (zoocecidia).

Analiza geograficzna listy oznaczonej flory dowodzi dominowania w jej składzie elementu euroazjatyckiego z wysokim udziałem elementu wschodnio- i południowoazjatyckiego.

Panujący był klimat umiarkowanie ciepły do subtropikalnego z dużymi opadami.

Osady, z których pochodzi opisana flora, zostały zaliczone do środkowomioceńskiego piętra karpatian na podstawie wyników badań geologicznych i palinologicznych (Oszczypko & Stuchlik 1972). Wyniki badań nad szczątkami makroskopowymi roślin tej ocenie nie przeczą, jakkolwiek zawierają one przesłanki sugerujące dla tej flory wiek nieco młodszy (piętro badenian). Przemawia za tym przewaga roślin arktyczno-trzeciorzędowych, nikły udział rodzajów wymarłych, brak taksonów starotrzeciorzędowych oraz wyraźny związek z roślinnością pliocenu południowej Polski.

PLATES

TABLICE

Plate I

1, 2. *Trematosphaerites lignitum* (Heer) Mesch., perithecia on lignite pieces — NS. II: 33, ×10 and NS. I: 58, ×22

3, 4. *Trematosphaerites lignitum* (Heer) Mesch., perithecia detached from their bases — NS. I: 347, ×31 and NS. II: 30, ×13

5, 5a. cf. *Hysterium* sp., fruit-bodies preserved on the leaf of *Glyptostrobus europaeus* — NS. I: 233, ×13, 26

6. *Pyrenomycetes* gen. 1, fragment of lignite with traces of perithecia — NS. II: 31, ×9

7a, 7b. *Pyrenomycetes* gen. 2, fragment of lignite with traces of perithecia, from two sides — NS. II: 14, ×29

8. *Pyrenomycetes* gen. 3, fragment of lignite with traces of perithecia — NS. II: 33, ×14

9a, 9b. *Pyrenomycetes* gen. 4, fragment of lignite with traces of perithecia, from two sides — NS. II: 22, ×35

10a, 10b. *Polyporites* sp., fragment of hymenophore from two sides — NS. II: 18, ×21

Plate I

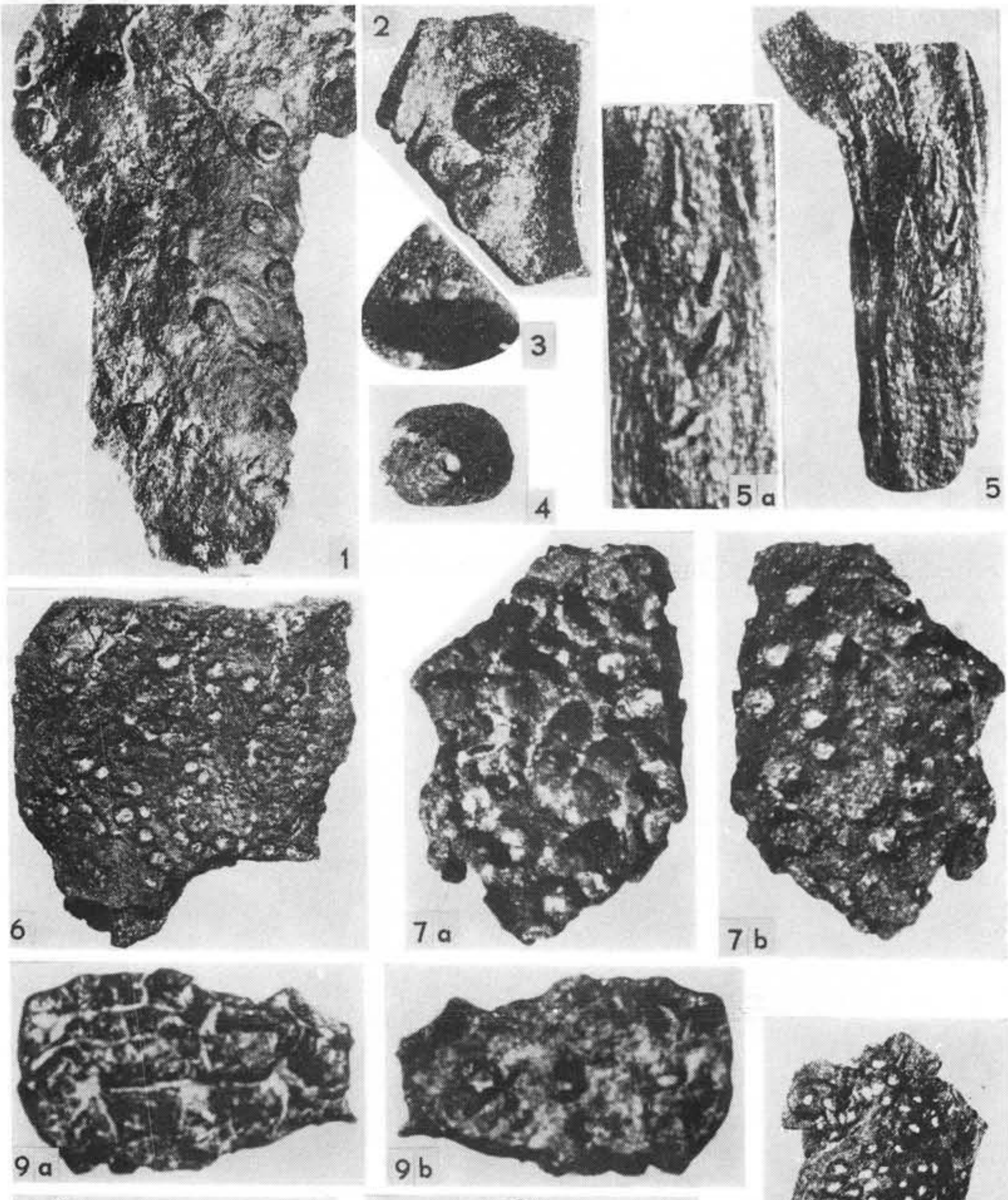

Plate II

1. *Microthyriaceae*, fructifications on the fragment of leaf — NS. I: 279, ×21

2—2b. *Microthyiaceae*, fructifications on the fragments of leaf; probably *Calimnothallus pertusus* Dilcher — NS. II: 33, ×40, 100, 330

3—5. *Microthyriaceae*, fructifications on the fragments of leaf — NS. I: 300, ×11; NS. I: 276, ×19 and NS. I: 63, ×51

6. *Neckera* cf. *complanata* (Hedw.) Hüb., stem fragment — NS. I: 294, ×18

7. *Eurhynchium speciosum* Milde, stem fragment — NS. I: 275, ×42

8. *Anomodon* sp., stem with fragments of leaf bases — NS. I: 319, ×15

9. *Amblystegium serpens* (Hedw.) B.S.G., stem fragment — NS. I: 65, ×33

10—12b. *Selaginella pliocenica* Dorof., megaspores

10. Sample NS. II: 31, ×52

11. Sample NS. I: 344, ×41

12a, 12b. Sample NS. I: 347, ×41

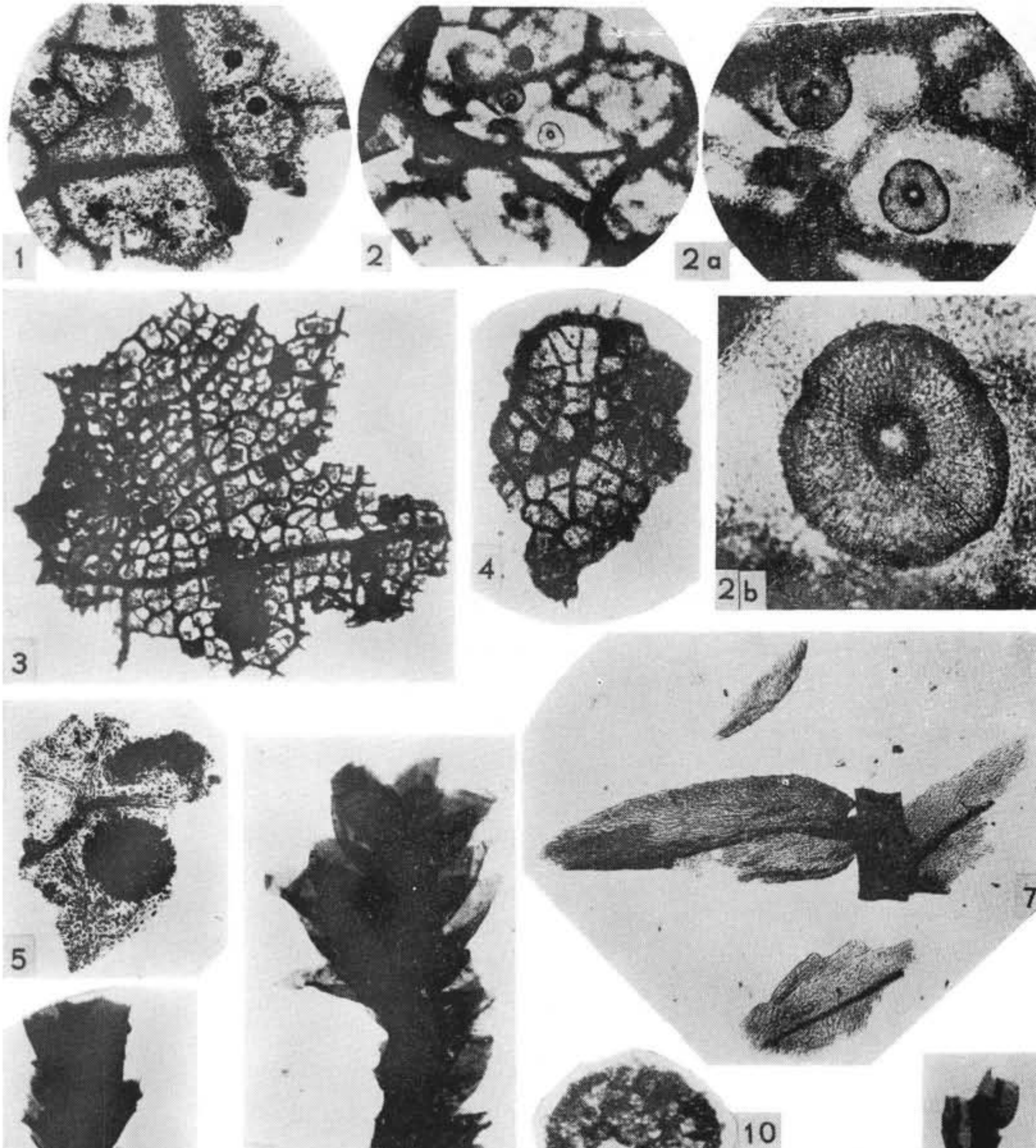
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Plate III

1. *Amblystegium serpens* (Hedw.) B.S.G., leaf base — NS. I: 65, ×ca. 390
2. *Neckera* cf. *complanata* (Hedw.) Hüb., apical part of leaf — NS. I: 294, ×240
3. *Anomodon* sp., fragment of leaf base — NS. I: 319, ×ca. 350
4. *Eurhynchium speciosum* Milde, basal part of leaf — NS. I: 275, ×240

Plate III

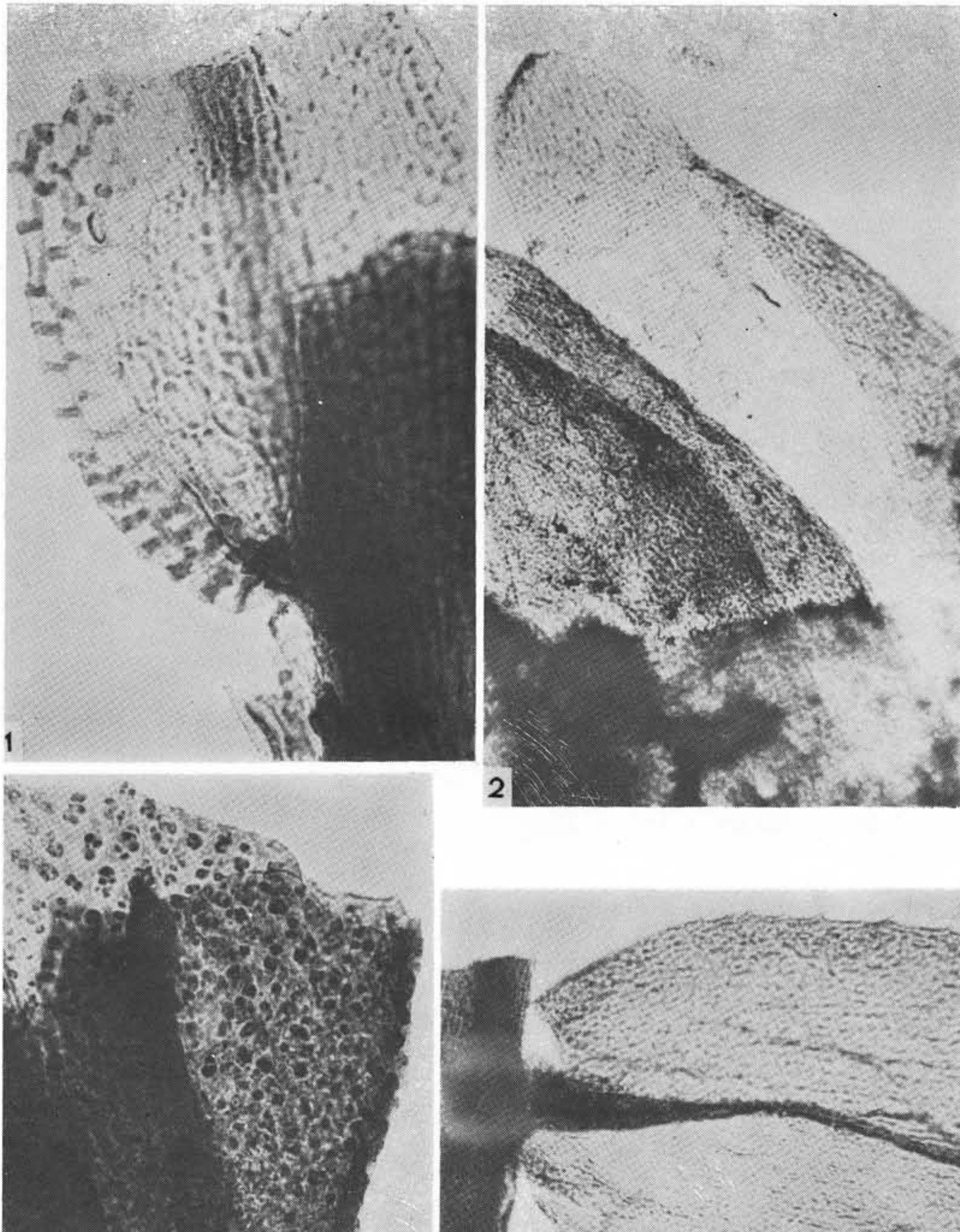

Plate IV

1—7. *Glyptostrobus europaeus* (Brongn.) Unger, fragments of leafed twigs
   1, 2, 6. Sample NS. I: 39, × 8, 6, 11.
   3. Sample NS. I: 121, × 12
   4. Sample NS. I: 141, × 12
   5. Sample NS. I: 319, × 10
   7. Sample NS. I: 301, × 11

8—15. *Glyptostrobus europaeus* (Brongn.) Unger, fragments of leafed twigs examined anatomically
   8. Sample NS. I: 134, × ca. 10
   9. Sample NS. I: 301, × 12
   10—13. Sample NS. I: 133, × 14, 16. ca. 15, ca. 11
   14. Sample NS. I: 40, × 17
   15. Sample NS. I: 122, × 11

16—20. *Glyptostrobus europaeus* (Brongn.) Unger, seeds
   16, 18, 20. Sample NS. I: 301, × 8
   17. Sample NS. II: 23, × 8
   19. Sample NS. II: 29, × 8

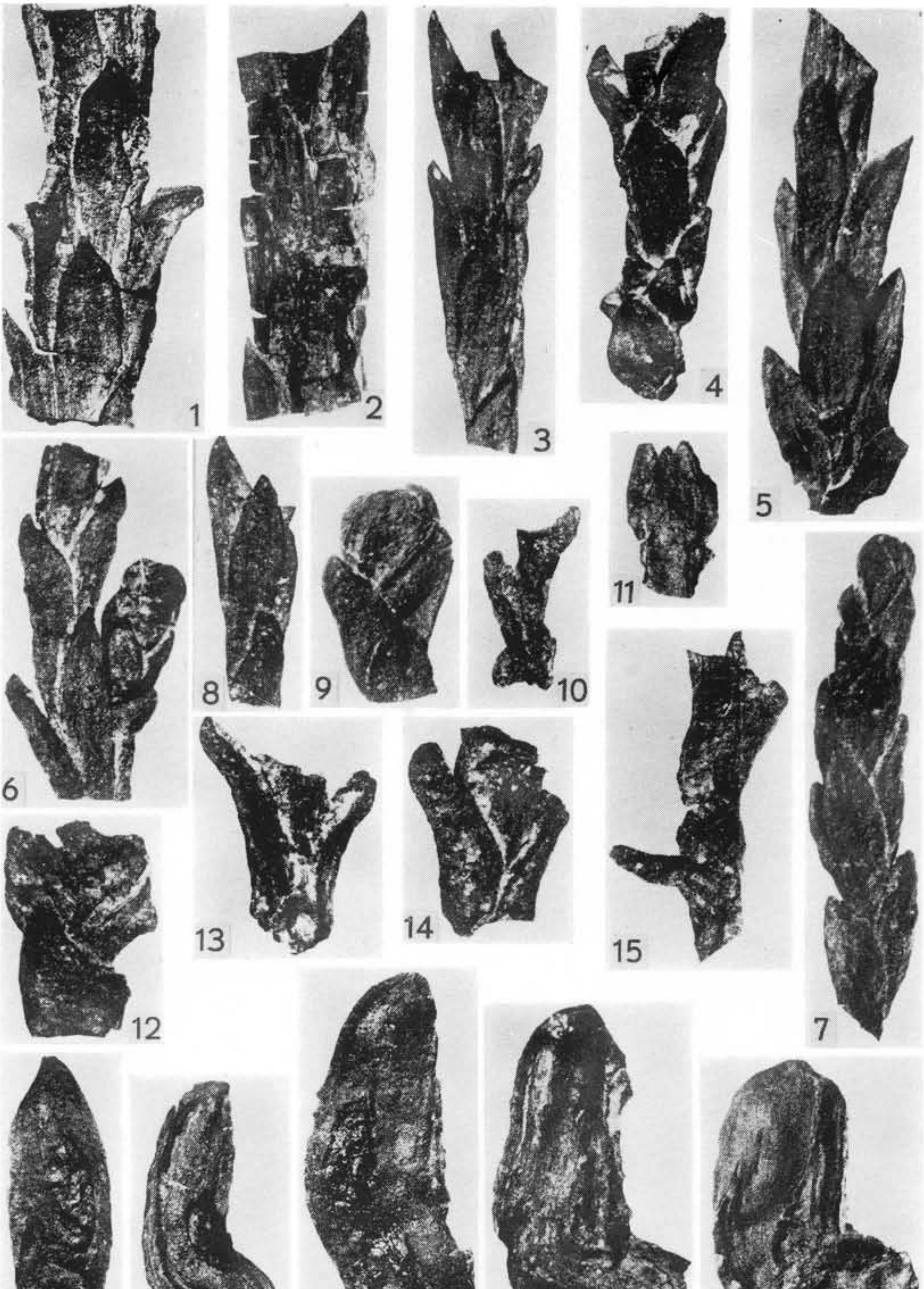
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Plate V

1, 1a. *Glyptostrobus europaeus* (Brongn.) Unger, leaf examined anatomically — NS. I: 133, ×18, 140

2—7. *Glyptostrobus europaeus* (Brongn.) Unger, fragments of leafed twigs examined anatomically

2, 5, 7. Sample NS. I: 134, ×19, 19, 22

3. Sample NS. I: 133, ×18

4. Sample NS. I: 39, ×19

6. Sample NS. I: 218, ×19

7a—11a. *Glyptostrobus europaeus* (Brongn.) Unger, fragments of epidermis obtained from the leaves similar to the genus *Sequoia*

7a. Sample NS. I: 134, ×140

8, 8a. Sample NS. I: 31, ×50, 140

9, 11, 11a. Sample NS. I: 30, ×140, 140, 400

10. Sample NS. I: 133, ×50

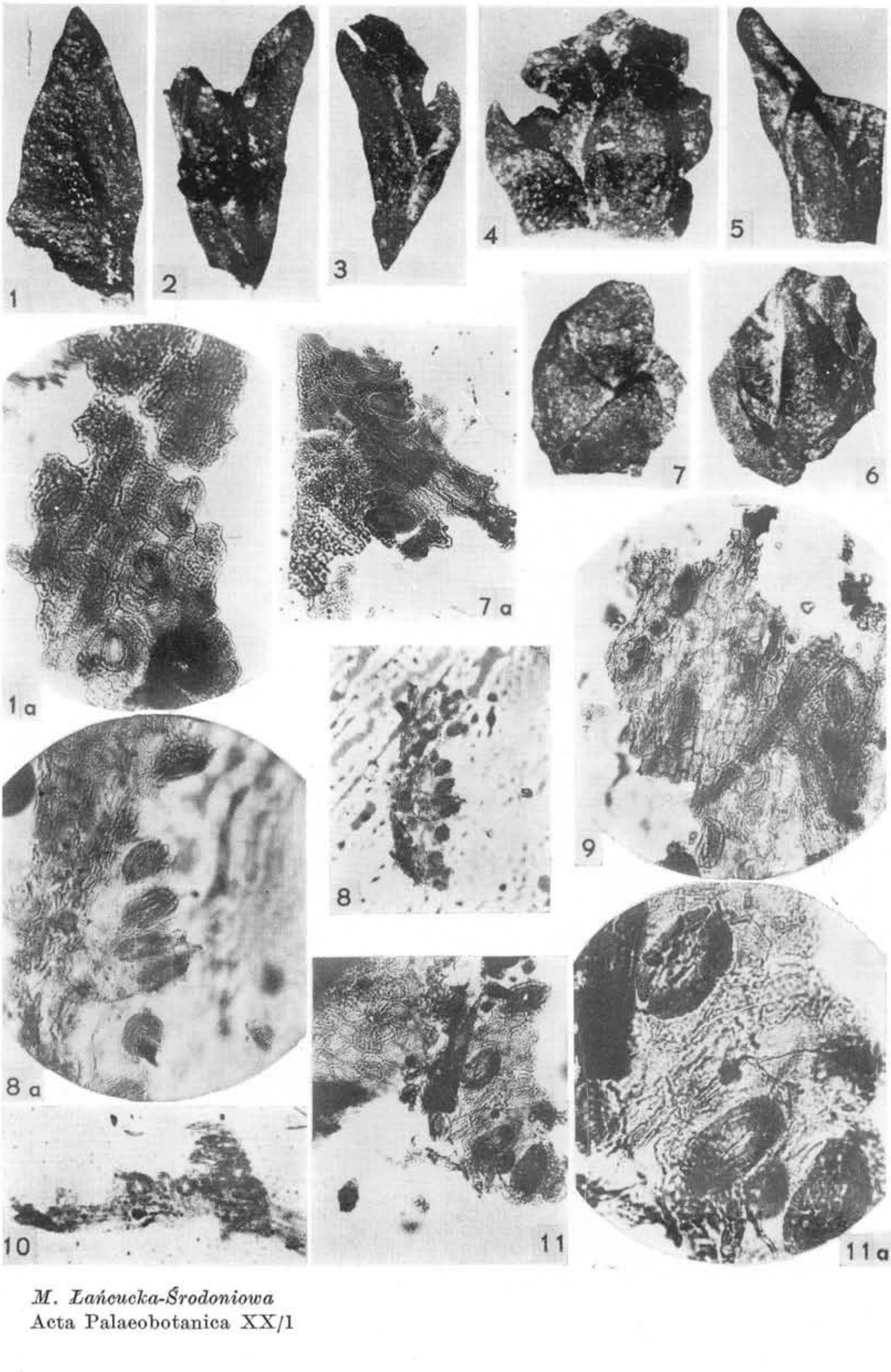
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Plate VI

1a, 1b. *Cupressaceae* gen. 1, fragment of leafed twig from two sides — NS. I: 46, ×13
2. *Cupressaceae* gen. 2, male inflorescence? — NS. I: 39, ×9
3a—3b. *Cupressaceae* gen. 3, seed fragment from two sides — Niskowa, ×11
4a—5b. *Chamaecyparis* cf. *pisifera* (S. & Z.) Endl.
4a—4c. Upper part of a cone from two sides — NS. I: 233, ×8, 6
5a, 5b. Basal part of a cone from two sides — NS. I: 30, ×14
6—7b. *Pinaceae* gen. 1 — NS. I: 97
6. Needle fragment, ×15
7—7b. Fragment of epidermis of this needle, ×44, 130, 480
8, 8a. *Pinaceae* gen. 2, needle fragment — NS. I: 300, ×22, 44

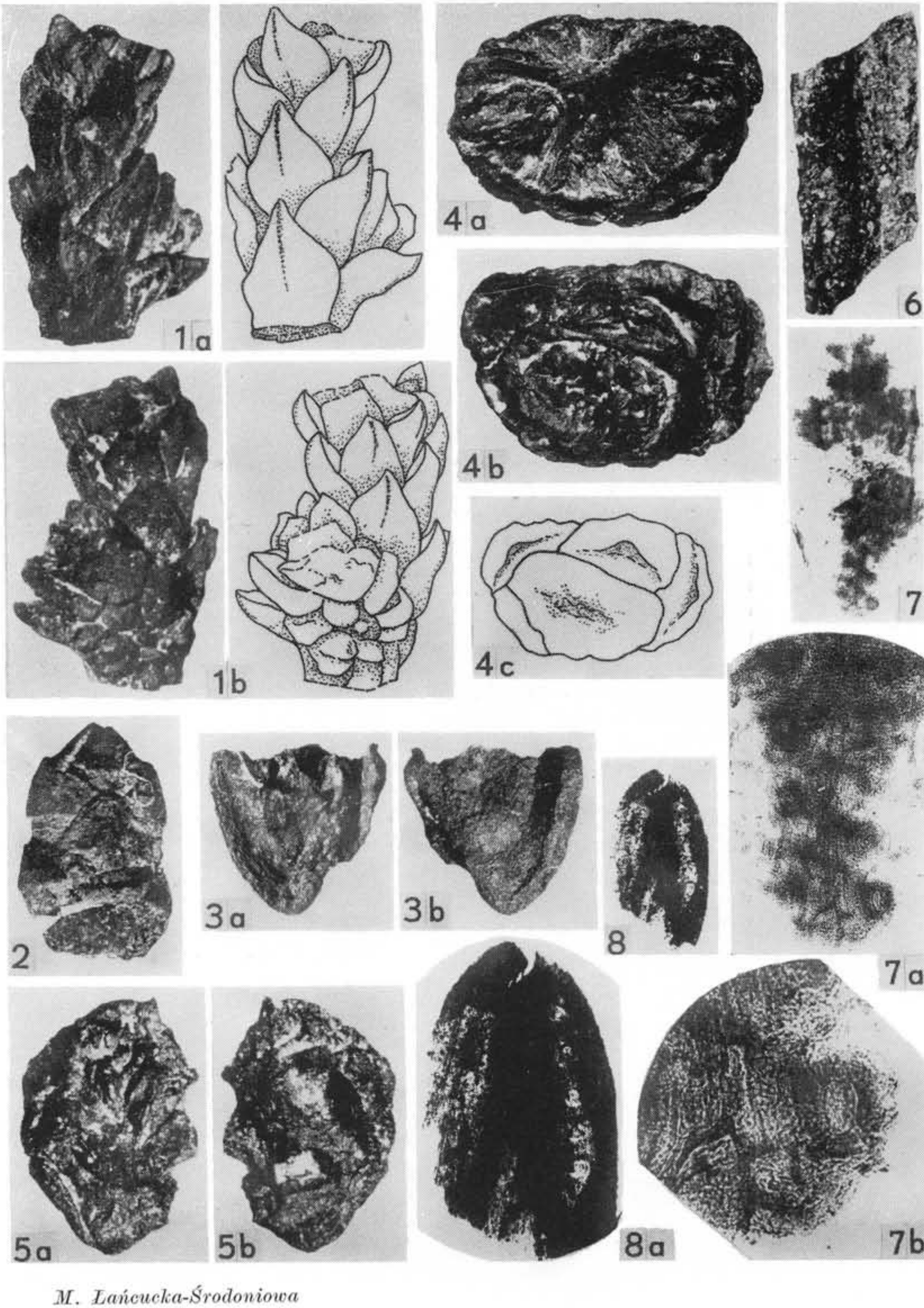
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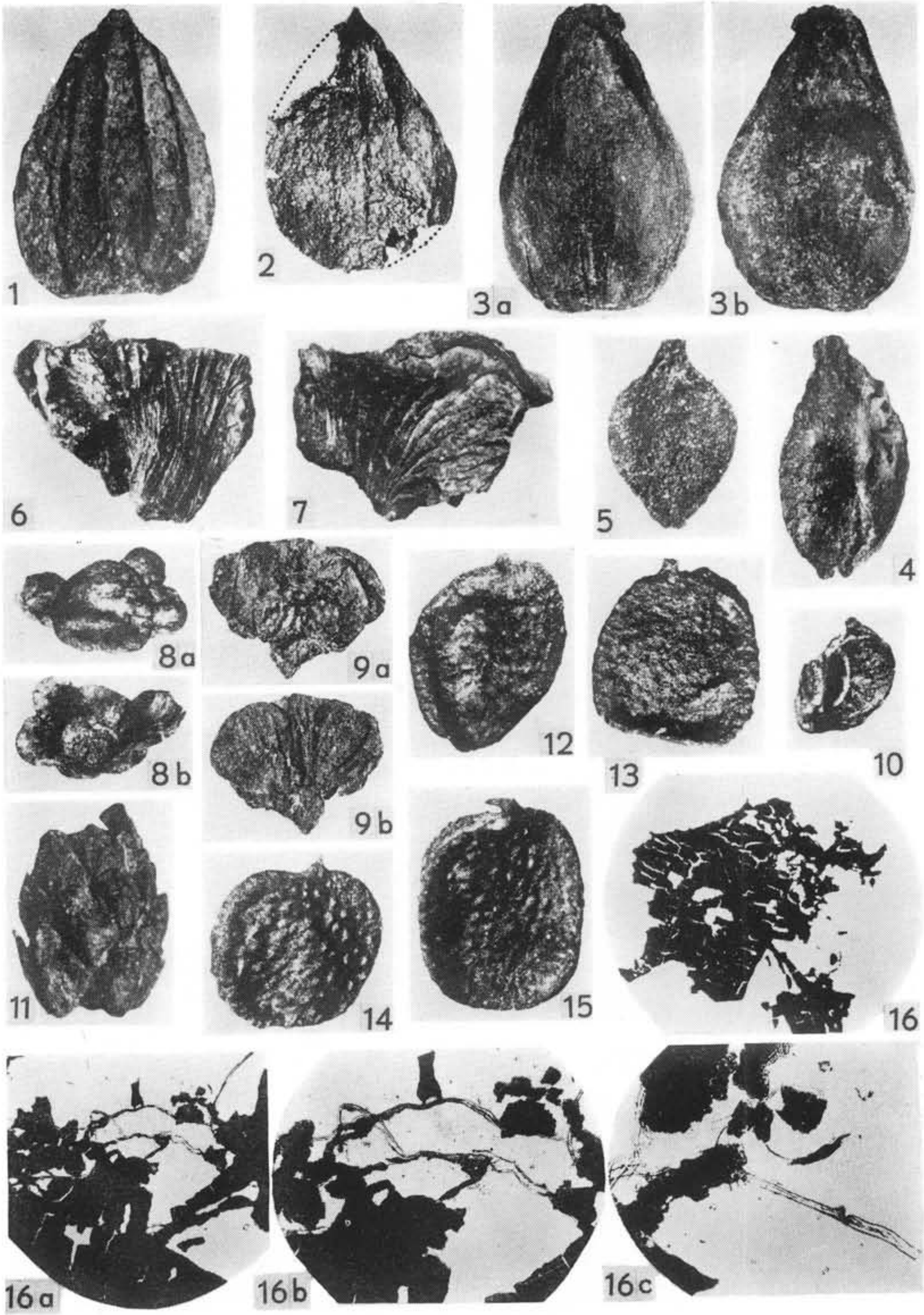
Plate VII

1, 2. *Carpinus betulus* L., nuts — NS. I: 39, ×10 and NS. II: 31, ×10
3a, 3b. cf. *Carpinus betulus* L., nut from two sides — NS. II: 23, ×9
4. *Betula* sp. 1 (Sect. *Albae* Rgl.), nutlet — NS. II: 30, ×18
5. *Betula* sp. 2, nutlet — NS. II: 31, ×18
6—11. *Alnus* sp.
6, 7. Fragments of the top part of scales — NS. I: 42, ×9, 15
8a, 8b. Fragment of male inflorescence from two sides — NS. I: 135, ×10
9a, 9b. The same — NS. I: 42, ×10
10. Fragment of male inflorescence with trace of stamina — NS. II: 33, ×17
11. Female inflorescence? — NS. I: 55, ×18
12—15. *Broussonetia pygmaea* Dorof., endocarps
12, 13, 15. Sample NS. II: 30, ×22, 23, 22
14. Sample NS. I: 293, ×20
16—16c. *Eucommia* sp.
16. Leaf fragment — NS. I: 355, ×11
16a—16c. Part of this leaf with fibres of guttapercha, ×29, 37, 106



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Acta Palaeobotanica XX/1

Plate VIII

1—4a. *Boehmeria* cf. *sibirica* Dorof., nutlets
1. Sample NS. II: 18, ×34
2—4. Sample NS. I: 274, ×32, 32, 36
4a. External surface of nutlet, ×70
5. cf. *Pilea* sp., fruit — NS. II: 31, ×32
6, 6a. *Phyllanthus* sp., seed and its reconstruction — NS. I: 236, ×24, 22
7. *Rumex* sp. 1, fruit — NS. II: 23, ×22
8a, 8b. *Rumex* sp. 2, fruit from two sides — NS. I: 348, ×22
9a—10. *Cercidiphyllum crenatum* (Ung.) Brown — NS. II: 33
9a, 9b. Lower part of fruit from two sides, ×7
10. Fragment of the upper part of fruit, ×11
11. *Polygonum aviculare* L. s. l., fruit fragment — NS. I: 237, ×23
12. *Brasenia* sp., seed fragment — NS. II: 9, ×19
13, 14. *Magnolia* cf. *cor* Ludwig, seed halves — NS. I: 55, ×7
15, 16. *Ranunculus* cf. *reidi* Szafer, fruits — NS. II: 33, ×21 and NS. II: 31, ×21
17a, 17b. *Thalictrum* sp., fruit from two sides — NS. II: 31, ×22

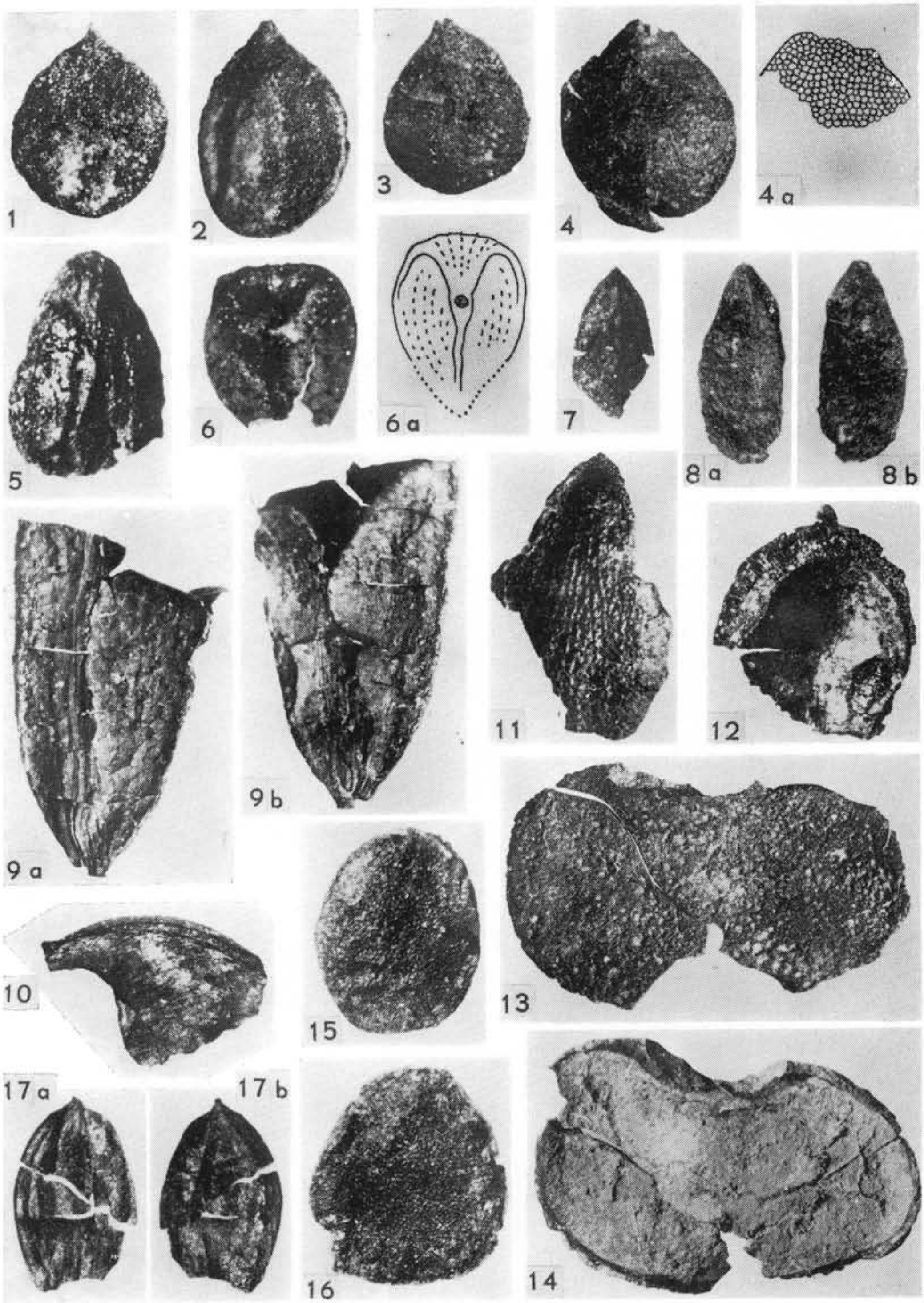
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Plate IX

1a, 1b. *Viola rimosa* Nikitin, seed from two sides — NS. II: 36, ×23
2—4. *Viola* sp. 1, seeds
2, 4. Sample NS. II: 32, ×20, 22
3. Sample NS. I: 299, ×22
5. *Viola* sp. 2, seed — NS. II: 29, ×18
6—8. *Viola* sp. 3, seeds — NS. II: 31, ×21, 22, 21
9, 10. *Viola* sp., seeds — NS. II: 31, ×25, 23
11, 12. *Actinidia faveolata* C. & E. M. Reid, seed fragments — NS. I: 151, ×24 and NS. I: 85, ×24
13. *Actinidia argutaeformis* Dorof., seed — NS. I: 53, ×23
14—16a. *Hydrangea polonica* Łańc.-Środ., seeds
14. Sample NS. II: 23, ×48
15, 16. Sample NS. II: 30, ×48, 50
16a. Reconstruction of the seed represented on fig. 16
17, 18. *Rubus laticostatus* Kirchh., endocarps — NS. II: 31, ×21 and NS. I: 43, ×22
19—25. *Rubus microspermus* C. & E. M. Reid, endocarps
19, 21, 22, 24. Sample NS. II: 31, ×28, 26, 27, 27
20, 23. Sample NS. II: 18 ×25, 24
25. Sample NS. I: 308 ×22

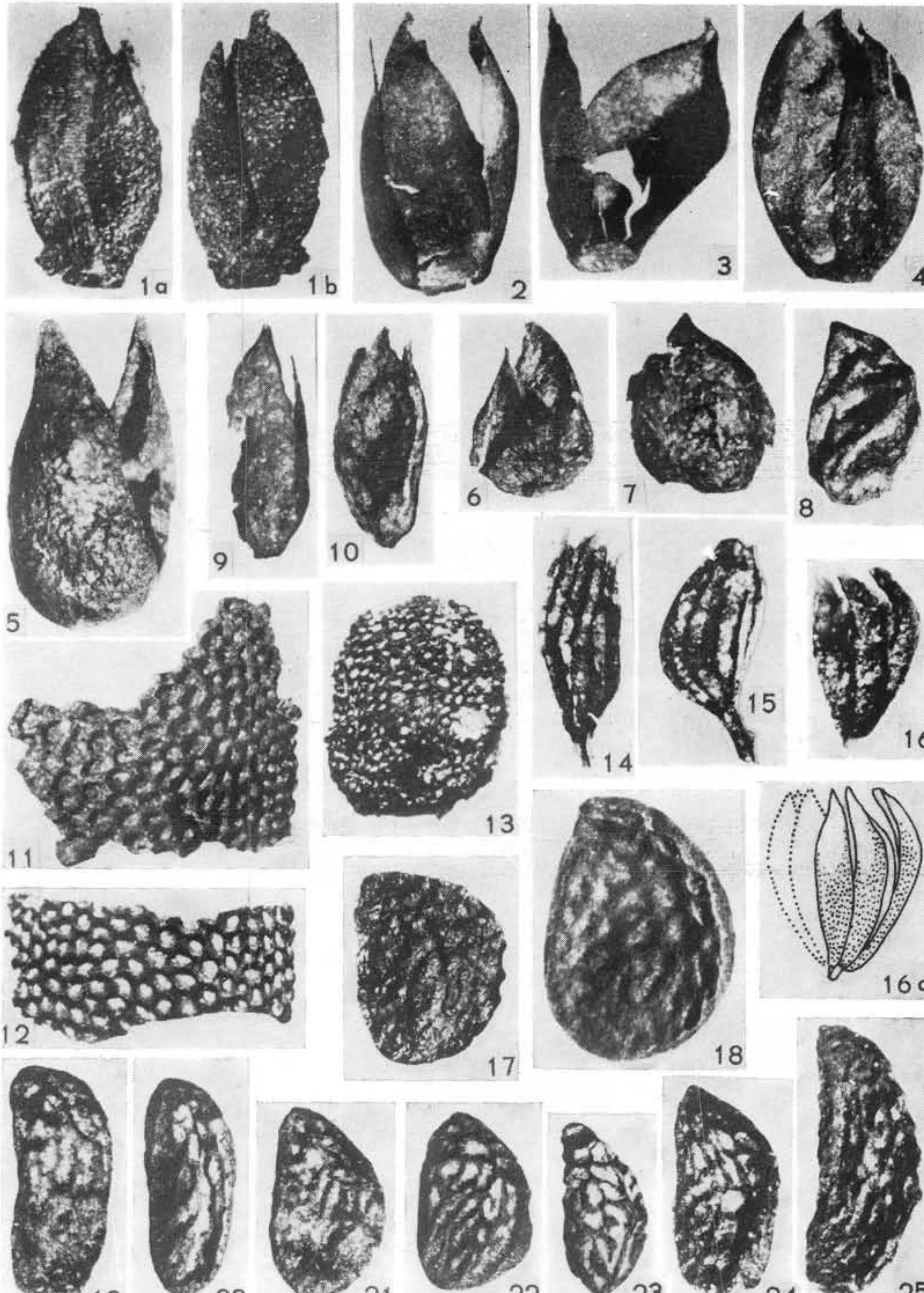

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Plate X

1—4. *Rubus semirotundatus* n. sp., endocarps
1, 2, 4. Sample NS. II: 33, ×22
3. Sample NS. I: 276, ×21
5. *Rubus* aff. *occidentalis* L., endocarp — NS. II: 18, ×22
6—8. *Potentilla pliocenica* E. M. Reid, fruits
6, 8. Sample NS. I: 278, ×25, 24
7. Sample NS. II: 30, ×26
9. *Potentilla* cf. *supina* L., fruit — NS. I: 30, ×28
10. *Alchemilla* sp., fruit — NS. II: 36, ×24
11. *Hypericum* cf. *tertiaerum* Nikit., seed — NS. II: 31, ×28
12. *Hypericum* aff. *maculatum* Cr., seed — NS. I: 349, ×27
13—15a. *Decodon gibbosus* (E. M. Reid) Nikit., seeds — Niskowa
13. Specimen ×20
14, 15. Specimens ×19; 15a ×14
16a, 16b. *Microdiptera* cf. *parva* Chandl., seed from two sides — NS. I: 240, ×22
17. *Phellodendron* sp., seed fragment — NS. II: 31, ×22
18. *Acer* sp., fruit — NS. II: 32, ×14
19a, 19b. *Acer* sp., seed from two sides — NS. I: 272, ×13

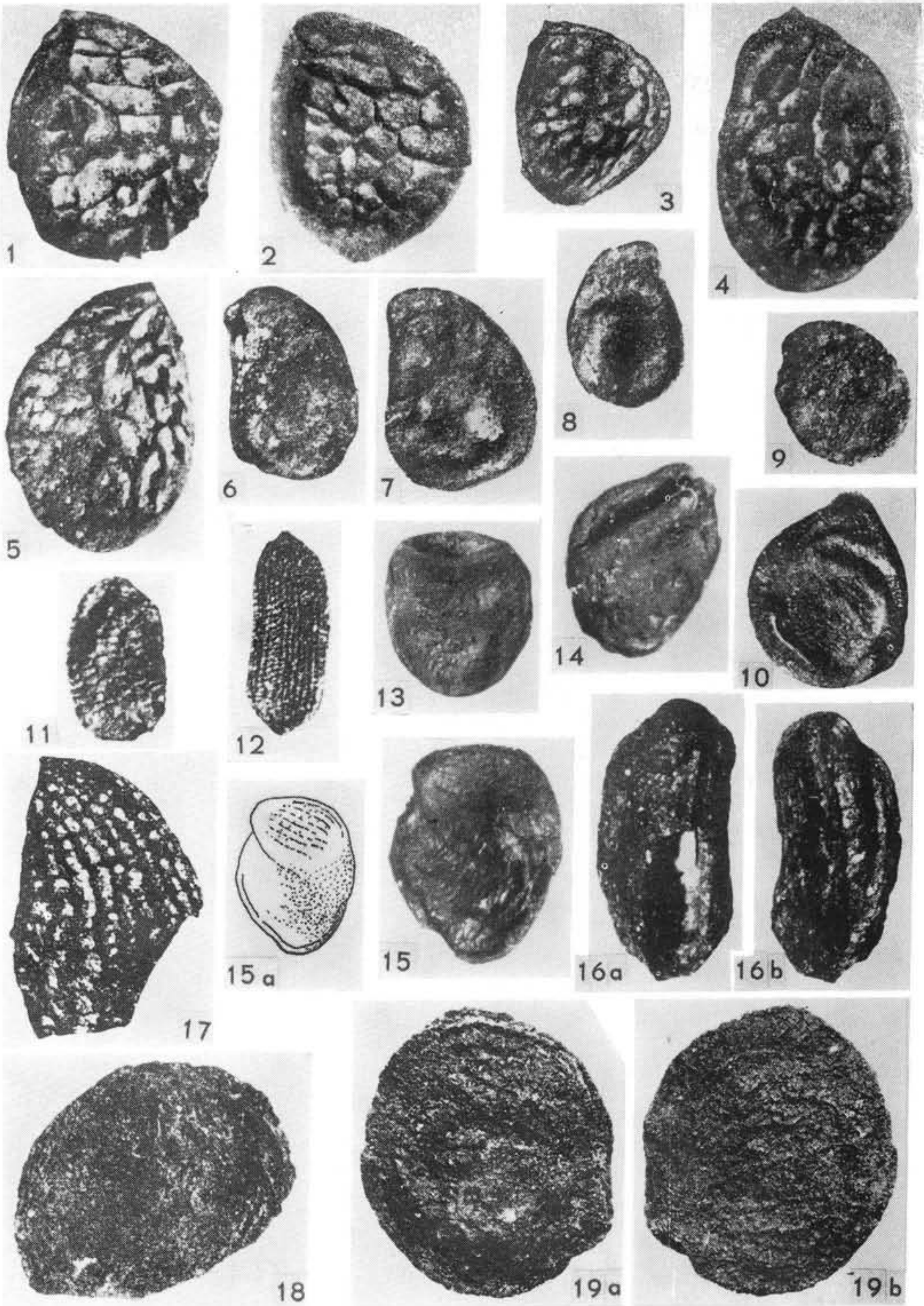
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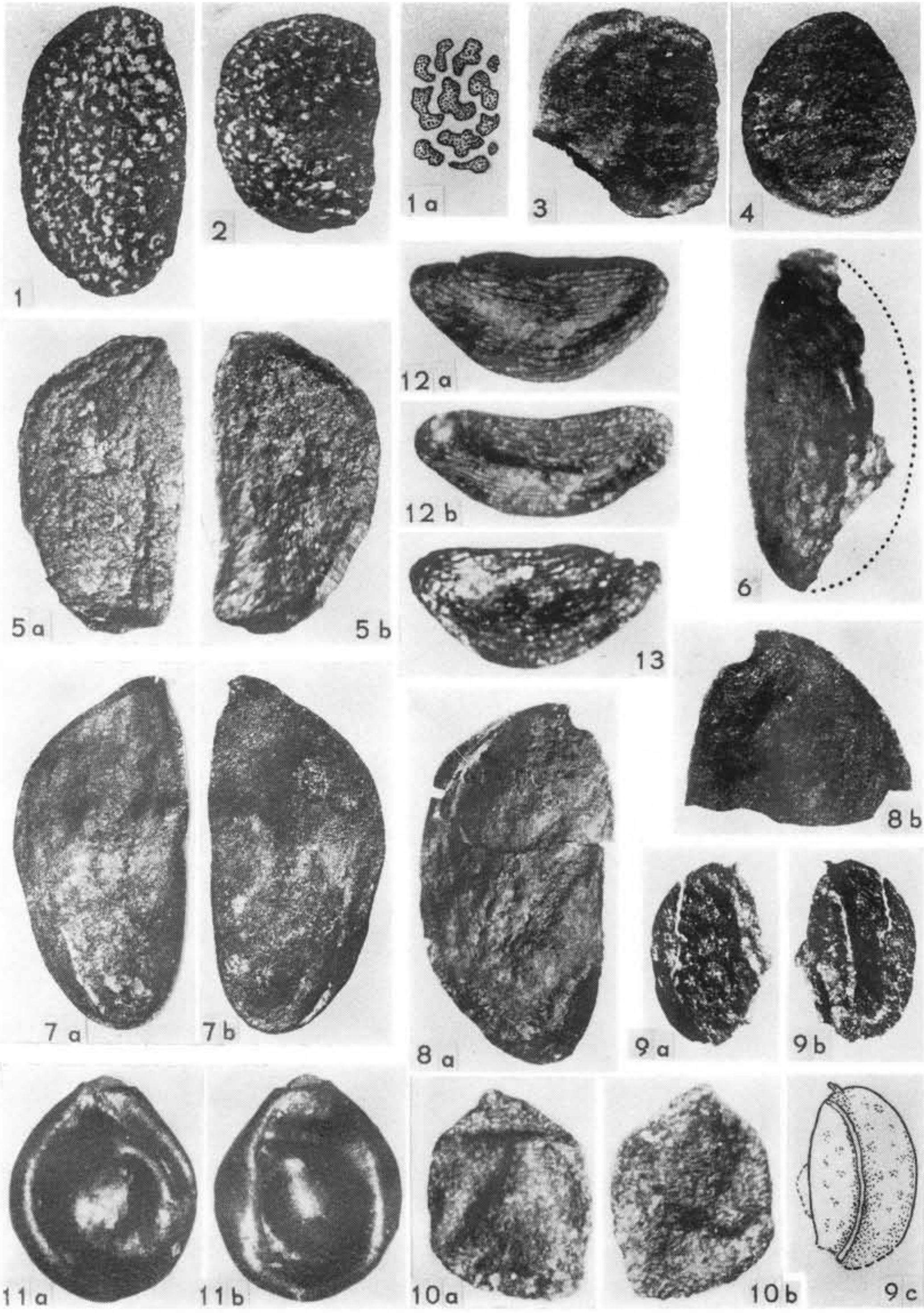
Plate XI

1, 2. *Aralia rugosa* Dorof., endocarps — NS. II: 30, × 18 and NS. II: 31, × 18
1a. External surface of endocarp
3, 4. *Aralia* cf. *ucrainica* Dorof., endocarps — NS. II: 15, × 25 and NS. I: 110, × 25
5a, 5b. *Aralia tertiaria* Dorof., endocarp from two sides — NS. I: 349, × 16
6. *Aralia* sp., fragment of endocarp — NS. II: 29, × 20
7—8b. *Schefflera dorofeevii* Łańc.—Środ., endocarps
7a, 7b. Sample NS. I: 302, × 14
8a, 8b. Sample NS. I: 300, × 15, 19
9a—9c. *Hydrocotyle* sp., fruit from two sides — NS. II: 32, × 33
10a, 10b. *Primulaceae* gen., seed from two sides — NS. I: 18, × 38
11a, 11b. *Andromeda carpatica* n. sp., seed from two sides — NS. I: 18, × 21
12a—13. *Vaccinium minutulum* n. sp., seeds
12a, 12b. Sample NS. II: 26, × 44; specimen in different positions
13. Sample: Niskowa, × 43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10 b
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Plate XII

1—6. *Andromeda carpatica* n. sp., seeds
1. Sample NS. II: 32, ×23
2, 3. Sample NS. II: 30, ×22, 24
4, 6. Sample NS. II: 7, ×20, 19
5. Sample NS. I: 274, ×20

7—9. *Gratiola tertiaria* Łańc.-Środ., seeds — NS. II: 31, ×49, 51, 52

10—12. *Lycopus* cf. *antiquus* E. M. Reid, fruits
10, 11. Sample: Gołąbkowice, ×30
12. Sample NS. II: 31, ×27

13—14a. *Campanula palaeopyramidalis* Łańc.-Środ., seeds — NS. I: 278, ×26, 52

15. *Campanula* sp., seed — NS. II: 30, ×36

16a, 16b. cf. *Galium* sp., fruit from two sides — NS. I: 301, ×17

17. *Menyanthes* cf. *trifoliata* L., seed — NS. I: 301, ×17

18—22. *Sambucus lucida* Dorof., seeds
18, 19, 21, 22. Sample NS. I: 351, ×17, 17, 18, 17
20. Sample NS. I: 186, ×20

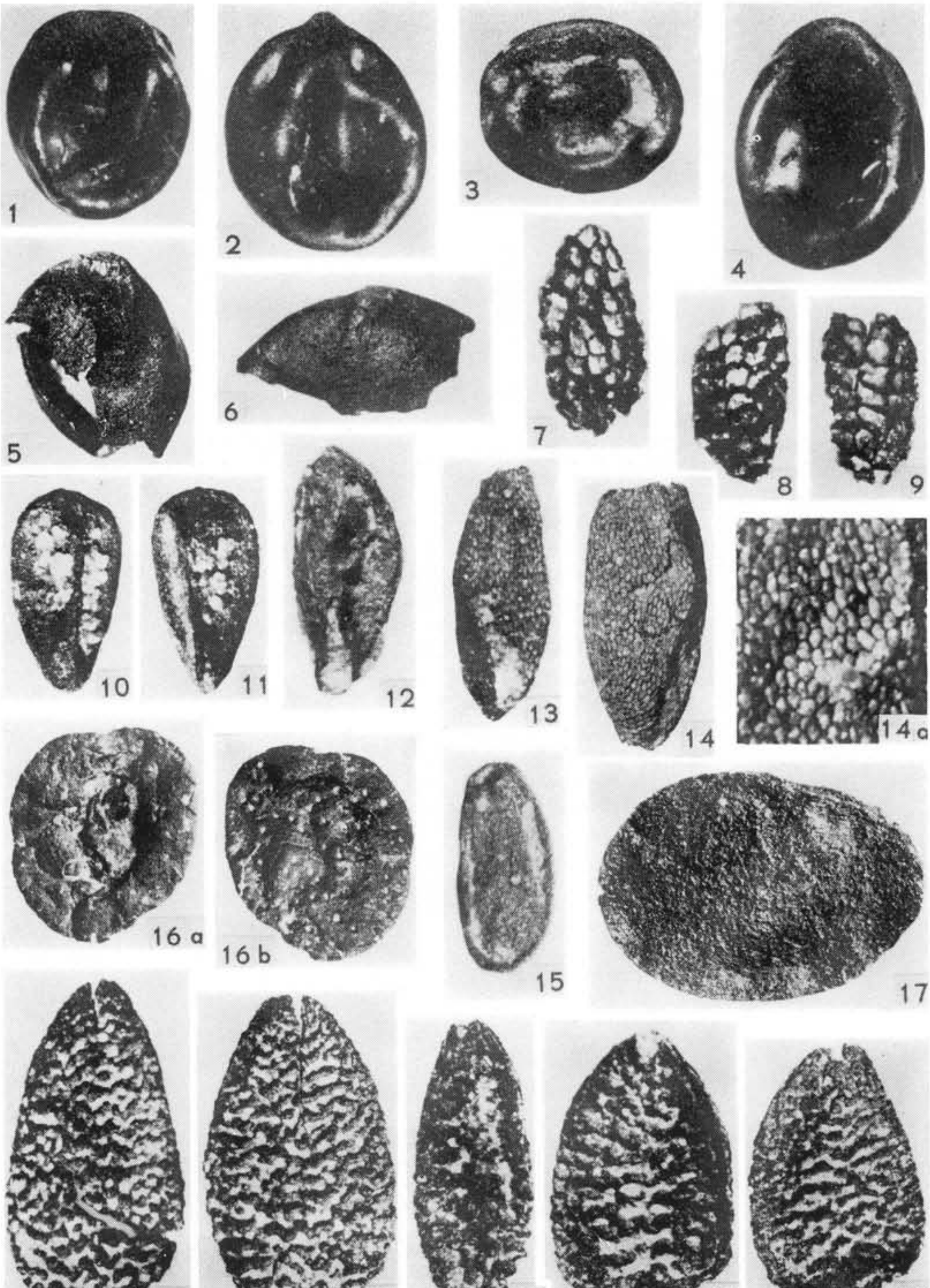
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Plate XIII

1a—1c. *Patrinia palaeosibirica* Dorof., fruit from two sides — NS. I: 303, ×22, 14
2a, 2b. *Stratiotes kaltennordheimensis* (Zenker) Keilhack, seed from internal and external sides — Niskowa, ×9
3a, 3b. *Najas marina* L., seed from external and internal sides — NS. I: 106, ×9
4a, 4b. *Potamogeton* aff. *polygonifolius* Pourr., endocarp from two sides — NS. I: 303, ×19
5. *Potamogeton* sp., endocarp — NS. I: 341, ×20
6—8. *Acorellus distachyoformis* Łańc.-Środ., fruits — NS. I: 348, ×25; NS. I: 286, ×25 and NS. II: 33, ×18
9. *Cyperus* sp. 1, fragment of fruit — NS. II: 30, ×30
10. *Cyperus* sp. 2, fruit — NS. I: 173, ×27
11, 12. *Cyperus* sp. 3, fruits — NS. I: 278, ×31
13—15. *Scirpus sylvaticus* L., fruits — NS. II: 18, ×28, 26, 26
16. cf. *Trichophorum* sp., upper part of fruit — NS. I: 319, ×17
17. *Cyperaceae* gen. 1 (cf. *Rhynchospora* sp.), fruit — NS. I: 277, ×23
18. *Cyperaceae* gen. 2 (cf. *Eriophorum* sp.), fruit — NS. II: 32, ×23

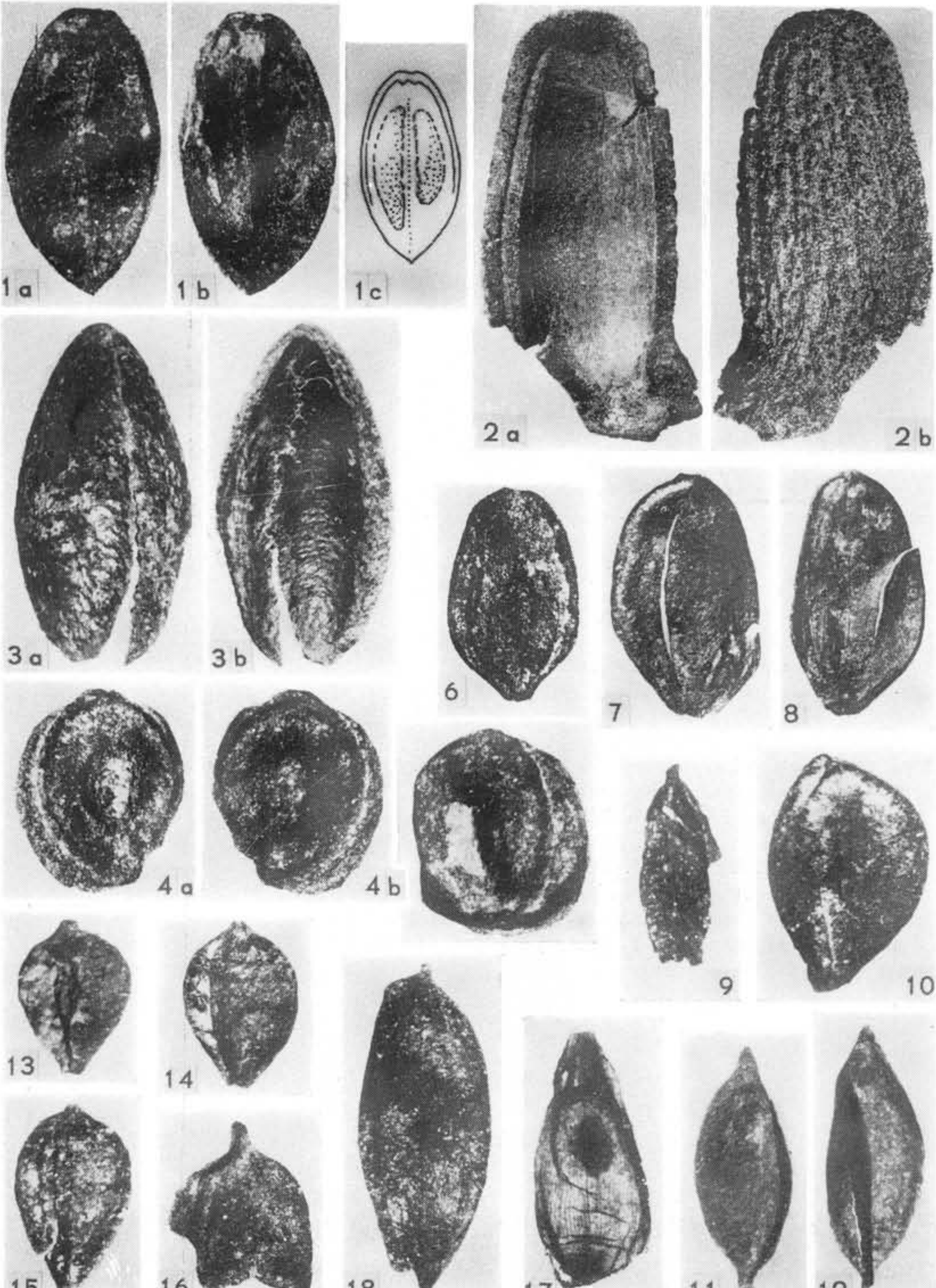
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Plate XIV

1—3. *Carex* cf. *elongata* L., nutlets and utricle
1, 3. Sample NS. I: 268, ×18, 19
2. Sample NS. I: 300, ×18
4—6. *Carex elongatoides* n. sp., nutlets — NS. I: 280, ×21; NS. I: 269, ×18 and NS. I: 268, ×23
7—9. *Carex* aff. *loliacea* L., utricles with nutlets
7, 9. Sample NS. II: 33, ×16
8. Sample NS. I: 319, ×16
10. *Carex* sp. 1, nutlet — NS. I: 348, ×18
11. *Carex* sp. 2, nutlet — NS. I: 278, ×18
12a—12c. *Carex globosaeformis* n. sp. — NS. I: 276
12a, 12b. Nutlet from two sides, ×22
12c. Reconstruction, ×13
13a, 13b. *Carex* cf. *acutiformis* Ehrh., fruit from two sides — NS. II: 33, ×18
14—17. *Carex pseudocyperoides* n. sp., nutlets
14. Sample NS. II: 32, ×19
15. Sample NS. I: 348, ×21
16, 17. Sample NS. II: 23, ×19, 20
18, 19. *Carex flavaeformis* n. sp., nutlets — NS. I: 268, ×21, 20
20—25. *Carex plicata* n. sp., nutlets — NS. II: 31, ×18
26—28. *Carex strigosoides* n. sp., nutlets and utricle — NS. II: 31, ×18, 20, 18

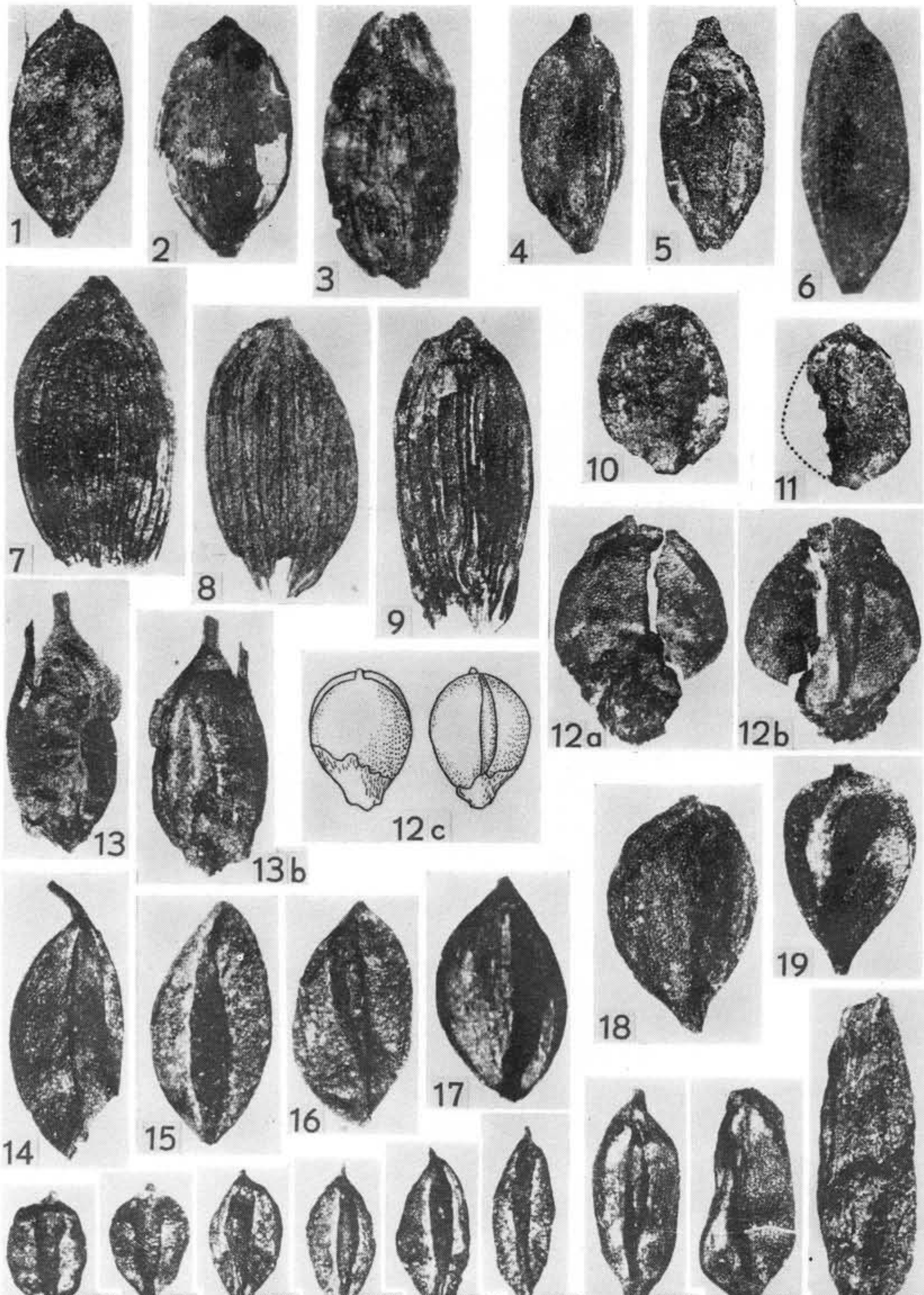
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Plate XV

1, 2. *Epipremnum crassum* C. & E. M. Reid, seeds — NS. I: 133, ×12

3a—4b. *Epipremnum cristatum* Nikit., seeds

3a, 3b. Sample NS. I: 287, ×14

4a, 4b. Sample: Gołąbkowice, ×19

5—10. *Sparganium neglectum* Beeby foss., endocarps

5. Sample NS. I: 4, ×12
6. Sample NS. I: 102, ×12
7. Sample NS. I: 109, ×12
8. Sample NS. I: 240, ×12
9. Sample NS. I: 10, ×12
10. Sample: Błonie, ×12

11a, 11b. *Sparganium haentzschelii* Kirchh., endocarp from two sides — NS. I: 276, ×13

12a—16. *Sparganium camenzianum* Kirchh., endocarps — NS. I: 348, ×17, 15, 16, 16, 15

17, 18. *Typha* cf. *fusisperma* Negru, tegmina — NS. II: 31, ×32 and NS. II: 29, ×32

19, 20. *Typha* cf. *elliptica* Negru, tegmina — NS. II: 33, ×35 and NS. II: 31, ×34

21—24. *Typha pliocenica* Dorof., seeds

21. Sample NS. I: 39, ×35
22. Sample NS. II: 20, ×33
23. Sample NS. II: 21, ×35
24. Sample NS. I: 254/256, ×38

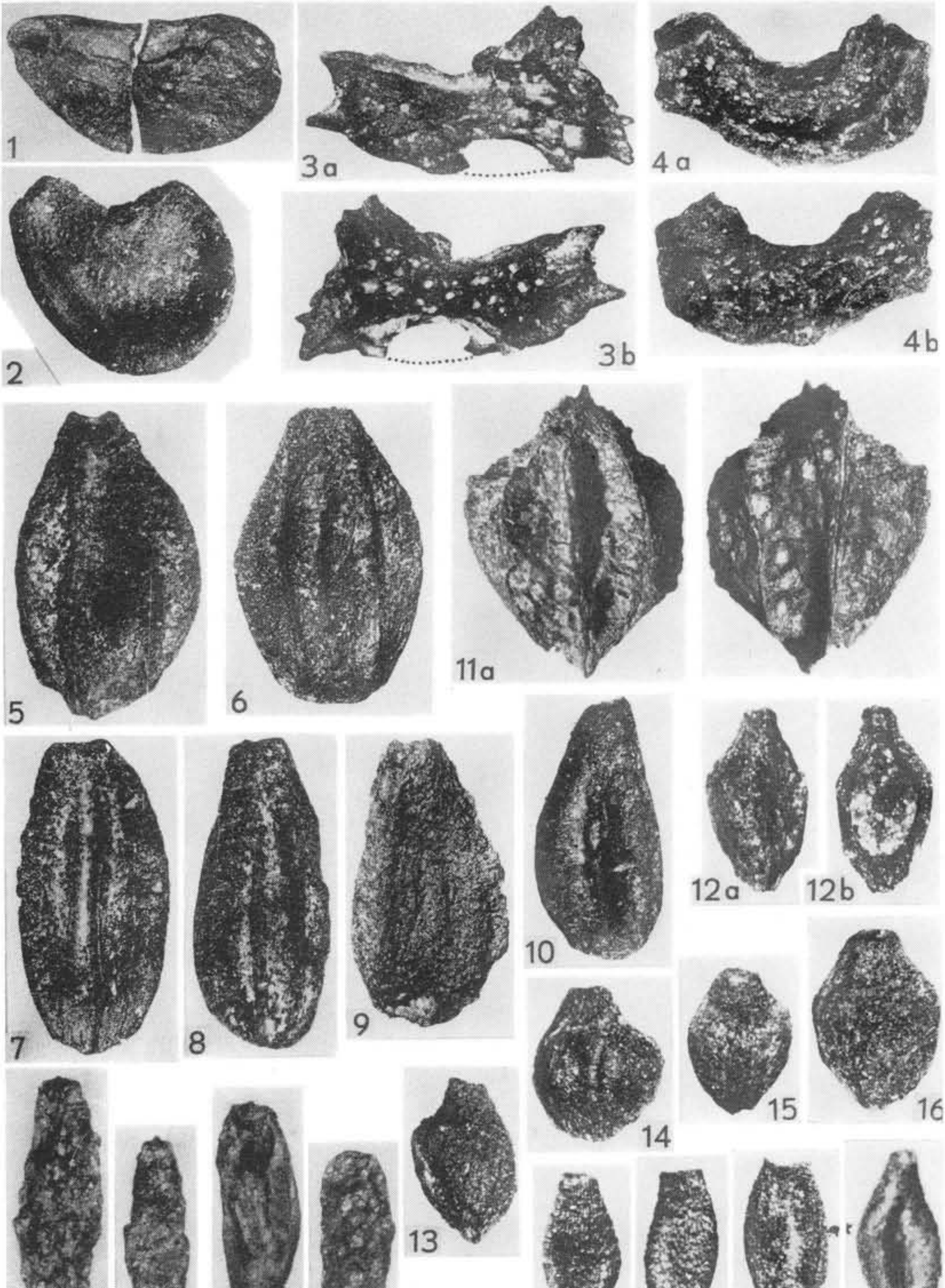
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Plate XVI

1—7. *Carpolithus* sp.
1—3, 6, 7. Sample NS. I: 54, ×24, 22, 32, 17, 16
4. Sample NS. I: 348, × 18
5a, 5b. Sample NS. I: 55, ×18; specimen from two sides
8, 9. *Antherites* sp. — NS. II: 33, ×21, 28
10—12. Buds, type 1 — NS. I: 268, ×10
13—15. Buds, type 2 — NS. II: 31, ×6
16—20. Buds, type 3
16, 17, 19, 20. Sample NS. II: 33, ×10
18. Sample NS. I: 268, ×13
21, 22. Buds, type 4 — NS. II: 33, ×9
23—25b. Buds, type 5
23, 25a, 25b. Sample NS. II: 31, ×11 and ×8; specimen from two sides
24a, 24b. Sample NS. II: 30, ×14; specimen from two sides
26. Buds, type 6 — NS. I: 268, ×6

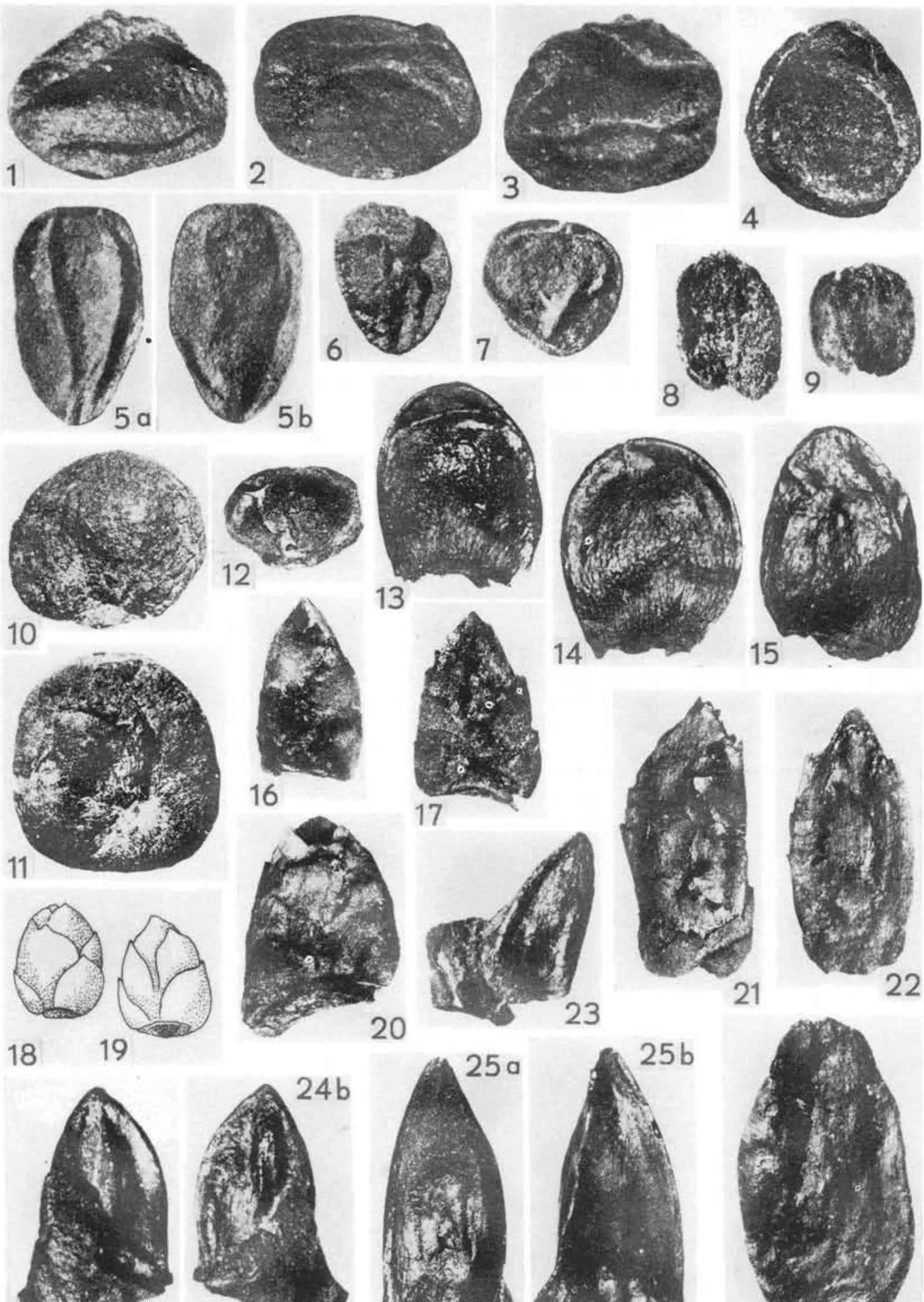
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Plate XVII

1—11. Rootlets, type 2 (segmented)
1, 7. Sample NS. I: 227, ×17
2—4, 8—10. Sample NS. I: 39, × 26—28
5. Sample NS. I: 236, ×19
6. Sample NS. I: 233, ×22
11. Sample: Domański Wierch (Pliocene), ×25
12—13a. Coprolites of butterfly caterpillars, type 1
12, 12a. Sample NS. I: 134, ×19, 12
13, 13a. Sample NS. I: 58, ×20; specimen in different positions
14—16a. Coprolites of butterfly caterpillars, type 2
14, 15, 15a. Sample NS. II: 30, ×26, 31, 28
16, 16a. Sample NS. I: 42, ×46, 36
17—21. Coprolites of insects, type 3
17. Sample NS. I: 74, ×22
18. Sample NS. II: 26, ×25
19, 20. Sample NS. II: 30, ×25, 22
21. Sample NS. II: 23, ×22
22a, 22b. *Coccidae*, female body from two sides — NS. II: 30, ×16

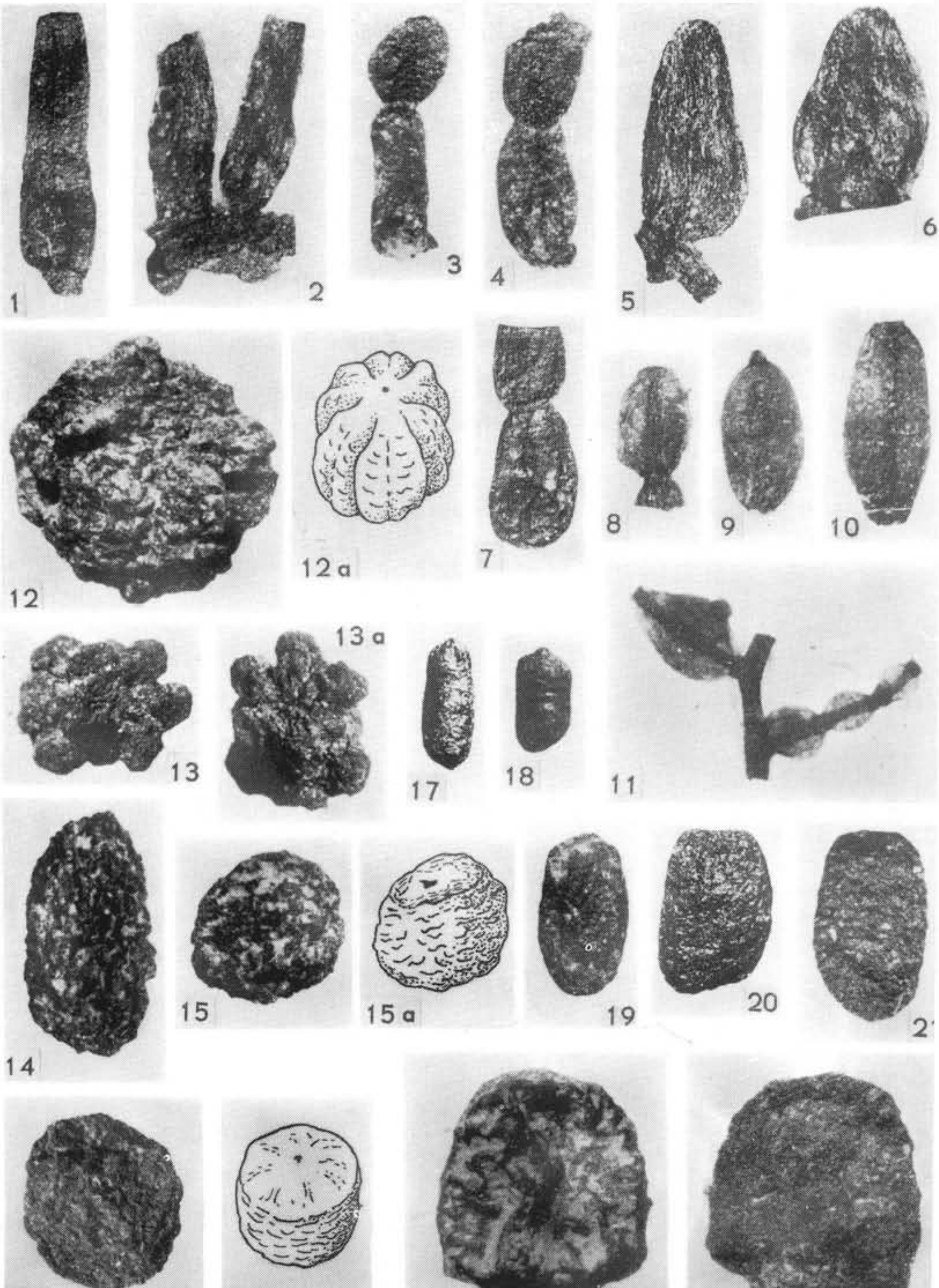


Plate XVIII

1, 2. Zoocecidium, type 1
 1. Sample: Blonie, ×10; specimen seen from the apex
 2. Sample NS. I: 42, ×17; specimen seen from the base

3a—3c. Zoocecidium, type 2 — NS. I: 39
 3a, 3b. Specimen from two sides, ×23
 3c. Scheme of the structure of the same specimen, ×15

4a—6. Zoocecidium, type 4
 4a, 4b. Sample NS. I: 36, ×22; specimen from two sides
 5. Sample NS. I: 42, ×25
 6. Sample NS. II: 31, ×17

7. Zoocecidium, type 3 — NS. I: 280, ×16

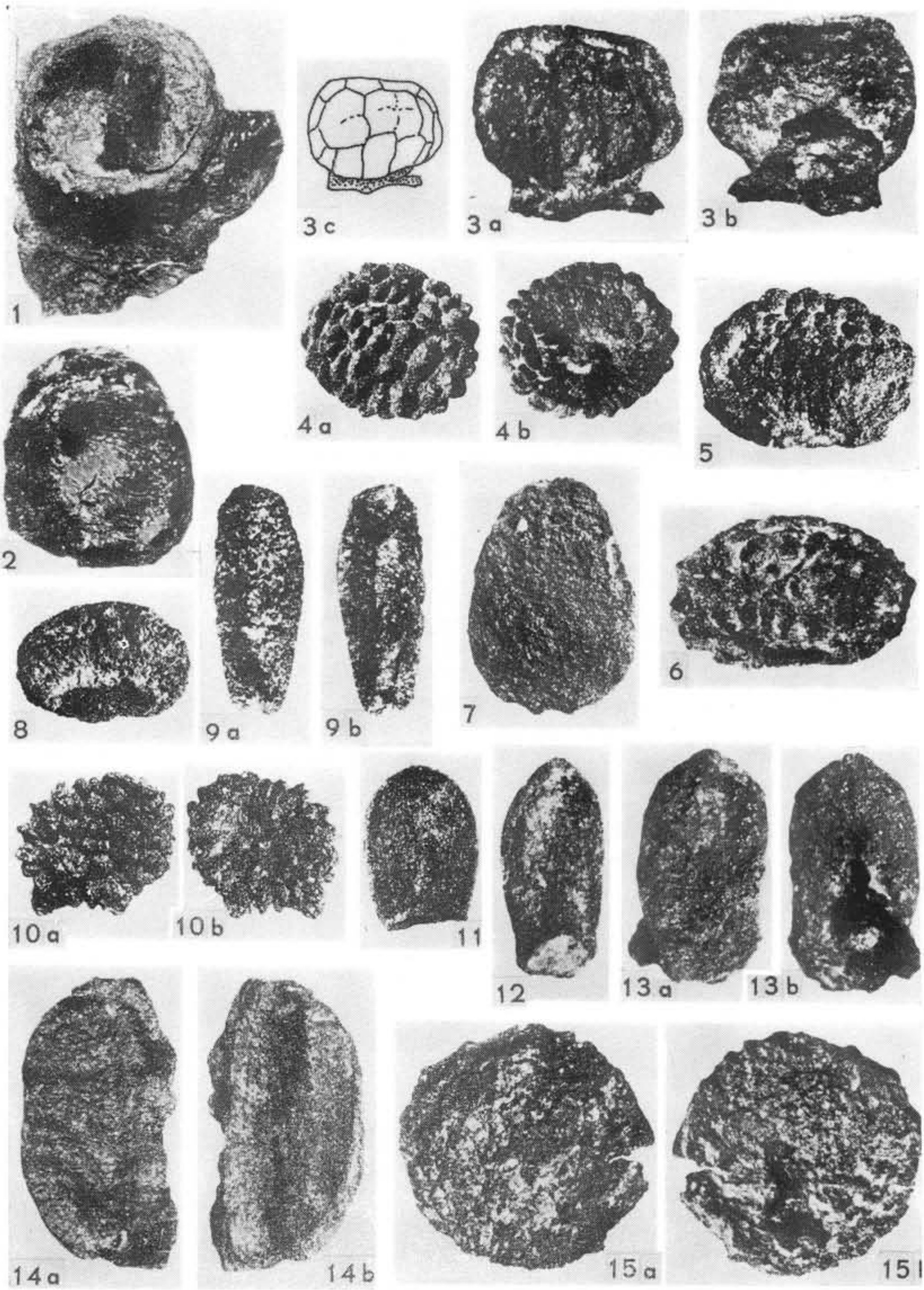
8—9b. Zoocecidium, type 5 — NS. II: 11
 8. Specimen seen from the lateral side, ×22
 9a, 9b. Another specimen seen from the apex and from the base, ×25

10a, 10b. Zoocecidium, type 6, specimen seen from the apex and from the base — NS. I: 43, ×23

11—13b. Zoocecidium, type 7
 11. Sample NS. II: 33, ×29
 12. Sample NS. I: 276, ×29
 13a, 13b. Sample NS. I: 37, ×25; specimen from two sides

14a, 14b. Zoocecidium, type 8, specimen from two sides — NS. II: 30, ×16

15a, 15b. Zoocecidium, type 9, specimen from two sides — NS. I: 348, ×17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14 a
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15 b

Plate XIX

1a—2. Zoocecidium, type 10 — NS. I: 303
  1a, 1b. Specimen from two sides, ×8
  2. Another specimen, ×8
3—4b. Zoocecidium, type 11 — NS. I: 276
  4a, 4b. Specimen from two sides, ×8
  3. Another specimen, ×8
5—6b. Zoocecidium, type 12 — NS. II: 33
  6a, 6b. Specimen from two sides, ×7
  5. Another specimen, ×9

Indeterminatae

7a, 7b. *Carpolithus* sp., cf. *Saururus bilobatus* (Nikitin) Mai, fruit from two sides — Sample: Gołąbkowice, ×18
8, 8a. Fragment of epidermis — NS. II: 30, ×40, ca. 280
9, 10. *Carpolithus* sp., cf. *Urticaceae* (*Debregeasia* sp.?), fruits — NS. II: 30, ×40
11. *Carpolithus* sp., cf. *Rosaceae*, fruit — NS. I: 207, ×11
12. cf. *Platanus* sp., fragment of male inflorescence — NS. I: 218, ×13
13. *Carpolithus* sp., cf. *Rutaceae*, seed — NS. II: 30, ×9
14a, 14b. *Carpolithus* sp., cf. *Araliaceae* (*Echinopanax* sp?), fragment of fruit with endocarps (e), seen from two sides — NS. II: 39, ×6
15—16b. *Carpolithus* sp., fruits — NS. II: 33
  16a, 16b. Specimen from two sides, ×43
  15. Another specimen, ×41

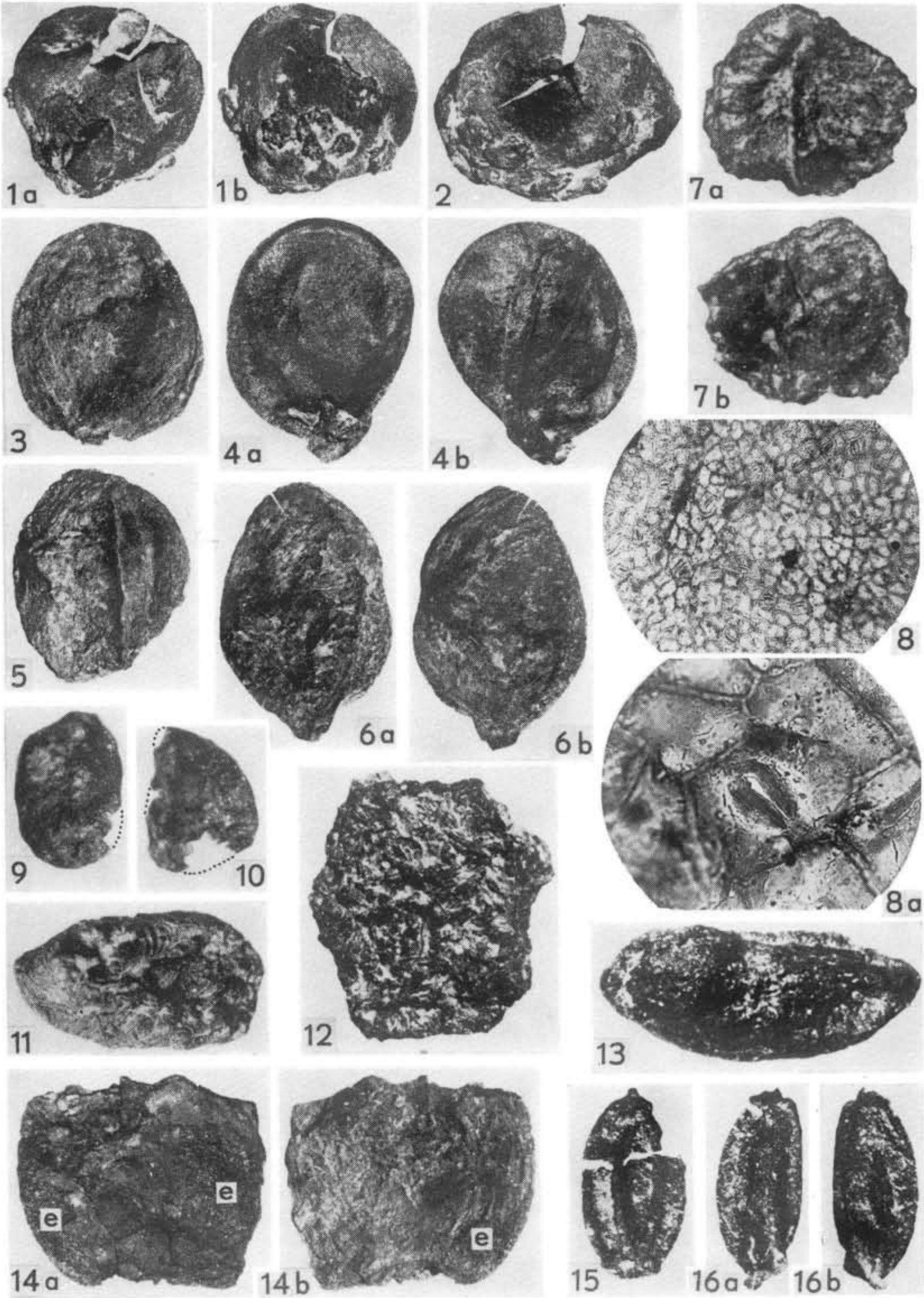
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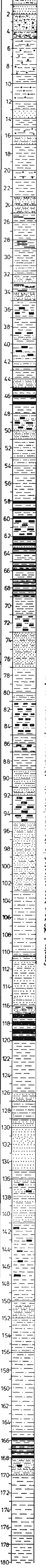
Fig. 2 Macroscopic plant remains of the borehole Nowy Sącz I (1st part)

NOWY SĄCZ I



Stratigraphy: QUATERNARY (samples 1); MIOCENE: Higher series — sandy clay (samples 2–176)

Sample thickness in m: Samples 1–259 have been collected in the same intervals; thickness of sample was 1 m

Sample numbers	Depth in m	Plant remains: Detritus	Lignite	Determined: No. of remains	No. of taxons	Name of taxons and number of specimens
1	4.0 — 5.0	+	+	—	—	
2	5.0 — 6.0	—	++	—	—	
3	6.0 — 7.0	—	++	—	—	
4	7.0 — 8.0	+	++	2	2	Aralia tertiaria (1), Sparganium neglectum (1)
5	8.0 — 9.0	+	+	—	—	
6	9.0 — 10.0	+	+	—	—	
7	10.0 — 11.0	++	+	—	—	
8	11.0 — 12.0	+	+	—	—	
9	12.0 — 13.0	+	+	—	—	
10	13.0 — 14.0	+	—	1	1	Sparganium neglectum (1)
11	14.0 — 15.0	+	+	—	—	
12	15.0 — 16.0	+	+	—	—	
13	16.0 — 17.0	+	+	—	—	
14	17.0 — 18.0	+	+	—	—	
15	18.0 — 19.0	+	+	—	—	
16	19.0 — 20.0	++	+	—	—	
17	20.0 — 21.0	+	+	—	—	
18	21.0 — 22.0	++	+	2	2	Actinidia faveolata (1), Andromeda (1)
19	22.0 — 23.0	+	+	—	—	
20	23.0 — 24.0	+	+	—	—	
21	24.0 — 25.0	+	+	—	—	
22	25.0 — 26.0	++	++	—	—	buds
23	26.0 — 27.0	+	+	—	—	
24	27.0 — 28.0	+	+	—	—	
25	28.0 — 29.0	+	+	—	—	
26	29.0 — 30.0	+	+	1	1	Sparganium neglectum (1)
27	30.0 — 31.0	++	+	—	—	
28	31.0 — 32.0	—	+	—	—	
29	32.0 — 33.0	—	+	—	—	
30	33.0 — 34.0	+	++	60	6	Andromeda (2), Betula sp. 1 (1), Chamaecyparis (1), Glyptostrobus (54), Potentilla supina (1), Trematosphaerites (1), roots
31	34.0 — 35.0	+	++	27	4	Andromeda (1), Betula sp. 1 (1) Glyptostrobus (24), Polygonum convolvulus (1), roots
32	35.0 — 36.0	+	+	9	1	Glyptostrobus (9), buds, roots, sclerots
33	36.0 — 37.0	++	+	—	—	
34	37.0 — 38.0	++	+	19	1	Glyptostrobus (19), buds
35	38.0 — 39.0	+	+	2	2	Glyptostrobus (1), Selaginella (1), roots
36	39.0 — 40.0	++	+	2	1	Glyptostrobus (2)
37	40.0 — 41.0	+	++	1	1	Glyptostrobus (1)
38	41.0 — 42.0	+	++	4	1	Glyptostrobus (4)
39	42.0 — 43.0	++	++	121	6	Andromeda (1), Carpinus (1), Cupressaceae gen. 2 (1), Glyptostrobus (116), Trematosphaerites (1), Typha pliocenica (1), buds, galls, roots, sclerots
40	43.0 — 44.0	+	+	4	2	Andromeda (1) Glyptostrobus (3)
41	44.0 — 45.0	+	+	—	—	
42	45.0 — 46.0	+	+	7	4	Alnus (4), Epipremnum crassum (1), Microthyriaceae (1), Trematosphaerites (1), buds
43	46.0 — 47.0	+	+	1	1	Rubus laticostatus (1), buds, coprolites, galls, roots
44	47.0 — 48.0	++	—	2	1	Glyptostrobus (2), buds, sclerots
45	48.0 — 49.0	+	+	2	1	Glyptostrobus (2) sclerots
46	49.0 — 50.0	+	+	1	1	Cupressaceae gen. 1 (1), galls
47	50.0 — 51.0	—	—	—	—	
48	51.0 — 52.0	++	+	1	1	Musci (1)
49	52.0 — 53.0	—	—	—	—	
50	53.0 — 54.0	+	+	—	—	buds
51	54.0 — 55.0	+	+	1	1	Glyptostrobus (1), buds
52	55.0 — 56.0	+	+	3	1	Glyptostrobus (3), buds
53	56.0 — 57.0	+	—	7	3	Actinidia argutaeformis (1), Glyptostrobus (5), Trematosphaerites (1)
54	57.0 — 58.0	+	+	55	1	Carpolithus sp. (55), buds, sclerots
55	58.0 — 59.0	++	+	45	5	Alnus (1), Carpolithus sp. (40), Lycopus (1), Magnolia (2), Selaginella (1), buds, roots, sclerots
56	59.0 — 60.0	++	++	3	2	Rubus laticostatus (1), Trematosphaerites (2), buds, roots, sclerots
57	60.0 — 61.0	+	++	12	5	Andromeda (5), Carex plicata (3), Carex pseudocyperoides (1), Carpolithus sp. (1), Glyptostrobus (2), roots
58	61.0 — 62.0	+	+	21	3	Carpolithus sp. (1), Glyptostrobus (15), Trematosphaerites (5), buds, coprolites, galls, roots, sclerots
59	62.0 — 63.0	+	+	—	—	
60	63.0 — 64.0	+	++	—	—	buds, sclerots
61	64.0 — 65.0	+	+	6	3	Andromeda (2), Glyptostrobus (3), Trematosphaerites (1), buds
62	65.0 — 66.0	++	++	1	1	Glyptostrobus (1), buds
63	66.0 — 67.0	++	+	7	2	Microthyriaceae (6), Musci (1)
64	67.0 — 68.0	++	+	8	2	Glyptostrobus (7), Microthyriaceae (1), roots, sclerots
65	68.0 — 69.0	++	++	5	3	Amblystegium (1), Glyptostrobus (1), Microthyriaceae (3), roots
66	69.0 — 70.0	+	+	—	—	sclerots
67	70.0 — 71.0	+	+	—	—	sclerots
68	71.0 — 72.0	+	+	—	—	sclerots
69	72.0 — 73.0	++	+	2	2	Andromeda (1), Glyptostrobus (1), sclerots
70	73.0 — 74.0	+	+	—	—	roots
71	74.0 — 75.0	+	+	1	1	Glyptostrobus (1)
72	75.0 — 76.0	+	—	2	2	Carpolithus sp. (1), Glyptostrobus (1)
73	76.0 — 77.0	+	+	—	—	
74	77.0 — 78.0	—	+	—	—	
75	78.0 — 79.0	+	+	7	2	Glyptostrobus (6), Rubus laticostatus (1)
76	79.0 — 80.0	+	+	—	—	
77	80.0 — 81.0	+	+	1	1	Sparganium neglectum (1), coprolites, sclerots
78	81.0 — 82.0	+	+	—	—	
79	82.0 — 83.0	+	+	1	1	Glyptostrobus (1)
80	83.0 — 84.0	+	++	—	—	
81	84.0 — 85.0	++	++	3	1	Glyptostrobus (3)
82	85.0 — 86.0	++	++	—	—	
83	86.0 — 87.0	+	+	9	2	Glyptostrobus (8), Potamogeton polygonifolius (1)
84	87.0 — 88.0	+	+	—	—	
85	88.0 — 89.0	+	+	3	3	Actinidia faveolata (1), Andromeda (1), Sparganium neglectum (1)
86	89.0 — 90.0	—	+	—	—	
87	90.0 — 91.0	+	+	1	1	Glyptostrobus (1)
88	91.0 — 92.0	+	+	1	1	Andromeda (1)
89	92.0 — 93.0	—	+	—	—	
90	93.0 — 94.0	+	++	5	3	Andromeda (1), Glyptostrobus (3), Trematosphaerites (1)
91	94.0 — 95.0	+	++	3	1	Andromeda (3), sclerots
92	95.0 — 96.0	+	+	—	—	
93	96.0 — 97.0	+	+	2	1	Glyptostrobus (2)
94	97.0 — 98.0	+	+	2	1	Glyptostrobus (2), roots
95	98.0 — 99.0	+	—	1	1	Glyptostrobus (1)
96	99.0 — 100.0	+	—	1	1	Glyptostrobus (1)
97	100.0 — 101.0	+	+	4	3	Glyptostrobus (2), Pinaceae gen. 1 (1), Sparganium neglectum (1)
98	101.0 — 102.0	+	—	1	1	Glyptostrobus (1)
99	102.0 — 103.0	+	+	—	—	
100	103.0 — 104.0	+	+	10	1	Glyptostrobus (10)
101	104.0 — 105.0	+	+	—	—	
102	105.0 — 106.0	+	+	13	3	Andromeda (1), Glyptostrobus (10), Sparganium neglectum (2), buds
103	106.0 — 107.0	+	+	—	—	
104	107.0 — 108.0	+	+	5	2	Glyptostrobus (4), Sparganium neglectum (1)
105	108.0 — 109.0	+	+	1	1	Glyptostrobus (1), buds
106	109.0 — 110.0	+	+	2	2	Glyptostrobus (1), Najas (1), buds
107	110.0 — 111.0	+	+	4	2	Alnus (1), Glyptostrobus (3)
108	111.0 — 112.0	—	+	—	—	
109	112.0 — 113.0	+	+	1	1	Sparganium neglectum (1)
110	113.0 — 114.0	—	+	5	3	Andromeda (1), Aralia ucrainica (1), Glyptostrobus (3)
111	114.0 — 115.0	+	+	1	1	Andromeda (1)
112	115.0 — 116.0	—	+	—	—	
113	116.0 — 117.0	+	++	9	3	Alnus (1), Carpolithus sp. (1), Glyptostrobus (7), sclerots
114	117.0 — 118.0	+	+	3	1	Glyptostrobus (3)
115	118.0 — 119.0	+	+	—	—	
116	119.0 — 120.0	—	+	—	—	
117	120.0 — 121.0	+	—	—	—	
118	121.0 — 122.0	+	—	—	—	
119	122.0 — 123.0	+	—	—	—	
120	123.0 — 124.0	—	+	—	—	
121	124.0 — 125.0	+	+	2	1	Glyptostrobus (2)
122	125.0 — 126.0	+	+	11	2	Glyptostrobus (10), Rubus microspermus (1), roots
123	126.0 — 127.0	+	+	2	1	Glyptostrobus (2)
124	127.0 — 128.0	—	+	—	—	
125	128.0 — 129.0	+	+	—	—	
126	129.0 — 130.0	—	+	1	1	Glyptostrobus (1)
127	130.0 — 131.0	—	+	—	—	
128	131.0 — 132.0	+	+	—	—	
129	132.0 — 133.0	+	+	—	—	
130	133.0 — 134.0	+	+	1	1	Glyptostrobus (1)
131	134.0 — 135.0	+	—	—	—	
132	135.0 — 136.0	+	+	—	—	
133	136.0 — 137.0	+	+	56	3	Actinomyces (1), Epipremnum crassum (2), Glyptostrobus (53)
134	137.0 — 138.0	+	+	62	2	Acorellus (2), Glyptostrobus (60), buds, coprolites, galls, roots
135	138.0 — 139.0	+	+	10	2	Alnus (1), Glyptostrobus (9)
136	139.0 — 140.0	+	+	4	1	Glyptostrobus (4)
137	140.0 — 141.0	—	+	—	—	
138	141.0 — 142.0	++	++	16	1	Glyptostrobus (16), buds, galls
139	142.0 — 143.0	++	++	12	2	Actinomyces (1), Glyptostrobus (11), sclerots
140	143.0 — 144.0	+	+	3	1	Glyptostrobus (3)
141	144.0 — 145.0	+	++	5	1	Glyptostrobus (5)
142	145.0 — 146.0	+	+	3	1	Glyptostrobus (3)
143	146.0 — 147.0	+	+	—	—	
144	147.0 — 148.0	+	+	—	—	
145	148.0 — 149.0	+	+	—	—	sclerots
146	149.0 — 150.0	+	+	—	—	
147	150.0 — 151.0	+	+	—	—	buds, coprolites
148	151.0 — 152.0	+	+	49	1	Glyptostrobus (49), coprolites
149	152.0 — 153.0	+	—	—	—	
150	153.0 — 154.0	+	—	—	—	
151	154.0 — 155.0	+	+	1	1	Actinidia faveolata (1)
152	155.0 — 156.0	+	+	1	1	Glyptostrobus (1)
153	156.0 — 157.0	—	+	—	—	
154	157.0 — 158.0	—	+	—	—	
155	158.0 — 159.0	—	+	—	—	
156	159.0 — 160.0	—	+	—	—	
157	160.0 — 161.0	+	+	—	—	
158	161.0 — 162.0	+	+	—	—	
159	162.0 — 163.0	+	+	—	—	
160	163.0 — 164.0	+	+	—	—	
161	164.0 — 165.0	+	+	—	—	
162	165.0 — 166.0	+	+	—	—	
163	166.0 — 167.0	+	++	1	1	Carpolithus sp. (1), sclerots
164	167.0 — 168.0	+	+	1	1	Rubus laticostatus (1)
165	168.0 — 169.0	—	+	—	—	
166	169.0 — 170.0	—	+	—	—	
167	170.0 — 171.0	—	+	—	—	
168	171.0 — 172.0	+	+	2	1	Andromeda (2)
169	172.0 — 173.0	+	+	—	—	roots
170	173.0 — 174.0	—	+	—	—	
171	174.0 — 175.0	+	+	—	—	
172	175.0 — 176.0	+	+	1	1	Glyptostrobus (1), coprolites
173	176.0 — 177.0	+	+	1	1	Cyperus sp. 2 (1)
174	177.0 — 178.0	+	+	6	1	Glyptostrobus (6)
175	178.0 — 179.0	+	+	—	—	
176	179.0 — 180.0	+	+	—	—	

Fig. 2 (2nd part)

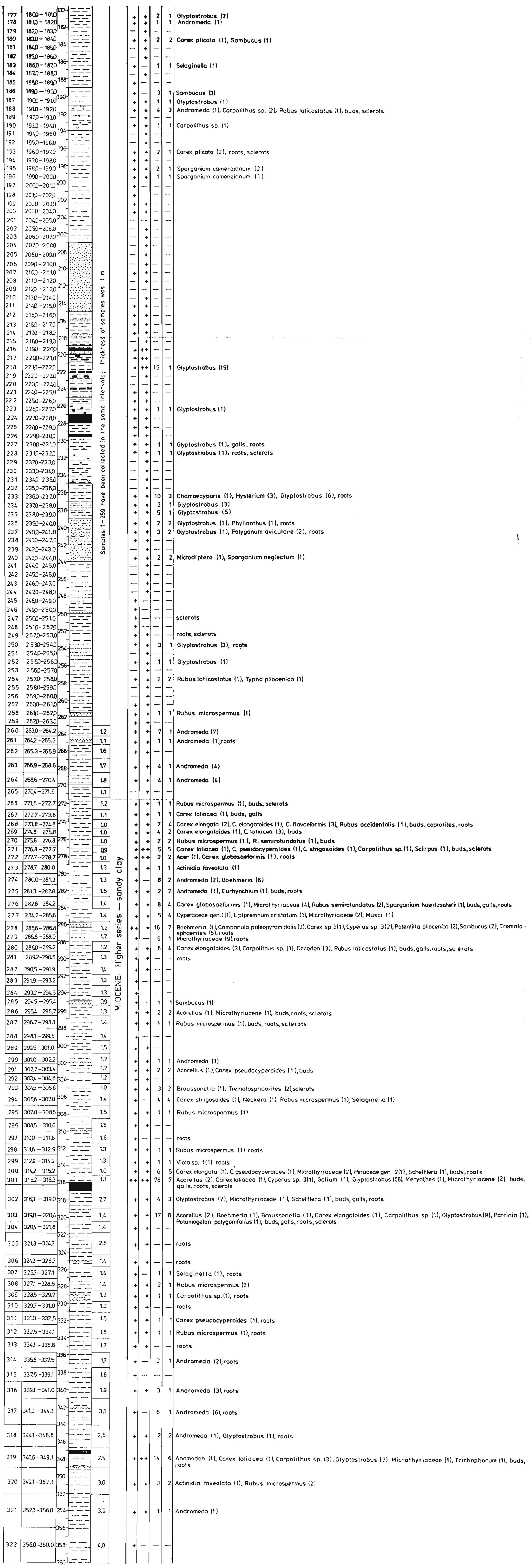
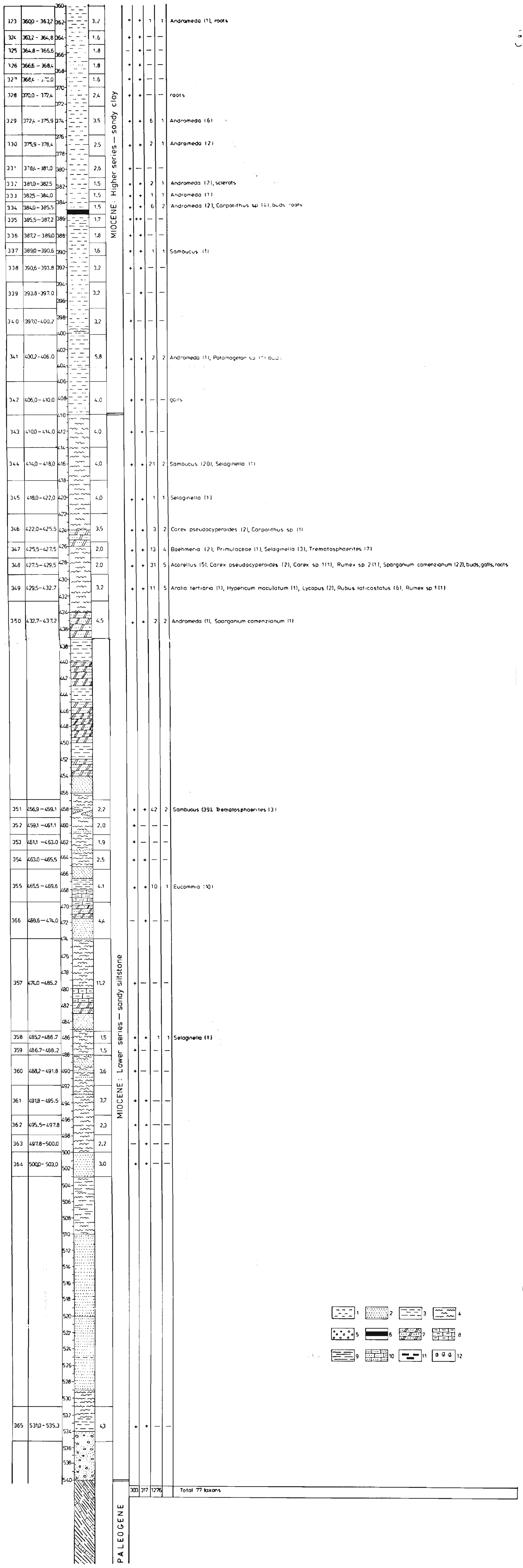


Fig. 2 (3rd part)



Explanations: 1 — loam; 2 — sand; 3 — clay; 4 — siltstone; 5 — gravel; 6 — brown coal; 7 — glauconite sandstone; 8 — marl; 9 — clay shale; 10 — muscovite sandstone; 11 — plant remains; 12 — animal remains

Sample numbers	Depth in m	Lithology	Sample thickness in m	Stratigraphy	Plant remains: Detritus	Plant remains: Lignite	Determined: No. of remains	Determined: No. of taxons	Name of taxons and number of specimens
1	2.5 – 3.5		1.0	QUATERNARY	–	–	–	–	
2	3.5 – 4.2		0.7		–	–	–	–	
3	4.2 – 5.4		1.2		–	+	–	–	
4	5.4 – 6.0		0.6	MIOCENE: Higher series - sandy clay	+	+	–	–	
5	6.0 – 7.0		1.0		+	+	–	–	
6	7.0 – 8.0		1.0		+	+	–	–	
7	8.0 – 9.0		1.0		+	+	15	1	Andromeda (15)
8	9.0 – 10.0		1.0		+	+	–	–	
9	10.0 – 11.0		1.0		+	+	1	1	Brasenia (1)
10	11.1 – 12.1		1.0		+	+	–	–	
11	12.1 – 13.1		1.0		+	+	–	–	galls
12	13.1 – 14.1		1.0		+	+	2	1	Andromeda (2)
13	14.1 – 15.1		1.0		+	+	–	–	roots
14	15.2 – (16.2)		(1.0)		+	+	3	2	Andromeda (2), Pyrenomycetes gen. 2 (1)
15	(16.2) – 17.4		(1.2)		+	+	1	1	Aralia ucrainica (1), roots, sclerots
16	(17.4) – 20.4		(3.0)		+	+	1	1	Sambucus (1)
17	20.4 – 22.1		1.7		+	+	20	2	Andromeda (19), Selaginella (1), cocons, sclerots
18	22.1 – 23.0		0.9		++	+	28	13	Acorellus (1), Actinidia faveolata (1), Andromeda (1), Boehmeria (1), Carex plicata (1), Carex pseudocyperoides (1), Polyporites (4), Rubus laticostatus (3), Rubus microspermus (2), Rubus occidentalis (1), Sambucus (1), Scirpus (10), Trematosphaerites (1), buds, roots, sclerots
19	23.0 – 24.0		1.0		+	+	–	–	sclerots
20	24.0 – 24.9		0.9		+	+	1	1	Typha pliocenica (1), cocons, roots, sclerots
21	24.9 – 26.5		1.6		+	+	1	1	Typha pliocenica (1), roots, sclerots
22	26.5 – (28.0)		(1.5)		+	+	1	1	Pyrenomycetes gen. 4 (1)
23	(28.0) – 30.0		(2.0)		++	+	76	11	Andromeda (1), Boehmeria (2), Carex plicata (5), Carex pseudocyperoides (4), Carpinus (1), Cyperus sp. 2 (1), Glyptostrobus (34), Hydrangea (2), Rumex sp. 1 (1), Sambucus (1), Scirpus (24), coprolites, galls, roots, sclerots
24	30.0 – (31.5)		(1.5)		+	+	–	–	
25	(31.5) – (33.0)		(1.5)		+	+	–	–	
26	(33.0) – 34.5		(1.5)		+	+	10	3	Andromeda (5), Glyptostrobus (4), Vaccinium (1), roots
27	34.5 – 36.5		2.0		+	+	2	2	Rubus microspermus (1), Sambucus (1), sclerots
28	36.5 – (38.0)		(1.5)		+	+	10	2	Andromeda (9), Rubus microspermus (1), roots, sclerots
29	(38.0) – (40.0)		(2.0)		+	+	15	6	Aralia sp. (1), Carex pseudocyperoides (3), Glyptostrobus (5), Rubus microspermus (4), Typha fusisperma (1), Viola sp. 2 (1), buds, roots, sclerots
30	(40.0) – 42.0		(2.0)		++	++	45	23	Actinidia faveolata (1), Actinomyces (1), Alnus (2), Andromeda (2), Aralia rugosa (1), Betula sp. 1 (1), Boehmeria (2), Broussonetia (3), Campanula sp. (1), Carex elong. (1), Carex plicata (3), Cyperus sp. 1 (1), Decodon (1), Glyptostrobus (11), Gratiola (1), Hydrangea (2), Phyllanthus (1), Potentilla pliocenica (1), Rubus laticostatus (1), Rubus microspermus (3), Rubus semirotundatus (1), Selaginella (1), Viola sp. 1 (3), buds, cocons, coprolites, galls, roots, sclerots
31	42.0 – 44.0		2.0		++	++	150	30	Actinidia faveolata (2) Andromeda (1), Aralia rugosa (2), Aralia ucrainica (2), Betula sp. 1 (1), Betula sp. 2 (1), Carex plicata (57), Carex strigosoides (5), Carpinus (1), Decodon (1), Glyptostrobus (3), Gratiola (3), Hypericum tertiaerum (1), Lycopus (11), Magnolia (2), Pilea (1), Phellodendron (1), Potentilla pliocenica (1), Pyrenomycetes gen. 1 (1), Ranunculus (1), Rubus laticostatus (2), Rubus microspermus (18), Sambucus (1), Selaginella (3), Thalictrum (1), Trematosphaerites, (15) Typha elliptica (2), Typha fusisperma (1), Viola sp. 1 (2), Viola sp. 3 (7), buds, coprolites, galls, roots, sclerots
32	44.0 – 47.8		3.8		+	+	43	9	Acer (1), Andromeda (14), Carex pseudocyperoides (5), Carex strigosoides (1), Carex sp. 1 (1), Cyperaceae gen. 2 (1), Glyptostrobus (9), Hydrocotyle (1), Viola sp. 1 (10), buds, roots, sclerots
33	47.8 – 50.0		2.2		+	+	60	17	Acorellus (1), Alnus (1), Antherites (5), Carex acutiformis (2), Carex elong. (1), Carex elongat. (1), Carex loliacea (2), Cercidiphyllum (6), Glyptostrobus (5), Microthyriaceae (24), Pyrenomycetes gen. 3 (1), Ranunculus (1), Rubus microspermus (1), Rubus semirotundatus (4), Selaginella (1), Trematosphaerites (3), Typha elliptica (1), buds, cocons, coprolites, galls, roots, sclerots
34	50.0 – 52.0		2.0		+	+	1	1	Selaginella (1), sclerots
35	52.0 – 56.0		4.0		+	+	–	–	
36	56.0 – 58.5		2.5		+	+	7	5	Alchemilla (1), Andromeda (3), Rubus microspermus (1), Sparganium neglectum (1), Viola rimosa (1), buds, galls
37	58.5 – 65.0		6.5		+	+	1	1	Trematosphaerites (1), buds, galls, roots
38	65.0 – 66.0		1.0		+	+	–	–	buds, roots, sclerots
39	(66.0) – 71.0		(5.0)		+	+	6	4	Carex plicata (1), Cyperaceae gen. 2 (1), Gramineae (3), Rubus microspermus (1), buds, roots, sclerots
40	71.0 –				+	+	8	4	Decodon (4), Glyptostrobus (1), Rubus semirotundatus (1), Trematosphaerites (2), roots, sclerots
				Total	37	38	508		Total – 68 taxons

Fig. 3. Macroscopic plant remains of the bore-hole Nowy Sącz II: 1 — loam; 2 — sand; 3 — clay; 4 — gravel; 5 — brown coal; 6 — plant remains

Participation of trees, shrubs and herbaceous plants in the Miocene flora of the Nowy Sącz Basin (100 % for macroflora equals 108, for sporomorphs 68, and for the total 176 taxons)

Table 4

Trees and shrubs		Small shrubs		Herbaceous plants			
				Phanerogams		Cryptogams	
Macroflora	Sporomorphs	Macroflora	Sporomorphs	Macroflora	Sporomorphs	Macroflora	Sporomorphs
cf. Acer sp.	Abies	Andromeda carpatica	Ericaceae	Acorellus distachyoformis	Campanulaceae	Ablystegium serpens	Anthocerotaceae
Actinidia faveolata	Acer	Vaccinium minutulum	Leguminosae	Alchemilla sp.	Caryophyllaceae	Anomodon sp.	Botrychium
A. argutaeformis	Alnus			Boehmeria cf. sibirica	Chenopodiaceae	Eurhynchium speciosum	Cyatheaceae
Alnus sp.	Araliaceae			Brasenia sp.	Compositae	cf. Hysterium sp.	Equisetum
Aralia rugosa	Betula			Campanula palaeopyramidalis	Cyperaceae	Microthyriaceae	Gleicheniaceae
A. tertiaria	Carpinus			Campanula sp.	Gramineae	Musci gen.	Hymenophyllaceae
A. cf. ucrainica	Carya			Carex cf. acutiformis	Labiatae	Neckera cf. complanata	Lycopodium
Aralia sp.	Castanea			C. cf. elongata	Nymphaeaceae	Polyporites sp.	Lygodium
Betula sp. 1 (sect.Albae)	Castanea-Castanopsis			C. elongatoides	Ranunculaceae	Pyrenomycetes gen. 1	Mohria
Betula sp. 2	Celtis			C. flavaeformis	Rubiaceae	Pyrenomycetes gen. 2	Osmundaceae
Broussonetia pygmaea	Corylus			C. globosaeformis	Umbelliferae	Pyrenomycetes gen. 3	Polypodiaceae
Carpinus betulus	Cryptomeria			C. aff. loliacea		Pyrenomycetes gen. 4	Selaginella
Cercidiphyllum crenatum	Cupressus			C. plicata		Selaginella pliocenica	Sphagnum
Chamaecyparis cf. pisifera	Cyrillaceae			C. pseudocyperoides		Trematosphaerites lignitum	
Cupressaceae gen. 1	Dacrydium			C. strigosoides			
Cupressaceae gen. 2	Engelhardtia			Carex sp. 1 (sect.Heleonastes)			
Cupressaceae gen. 3	Ephedra			Carex sp. 2			
Eucommia sp.	Fagus			Cyperaceae gen. 1 (cf.Rhynchospora)			
Glyptostrobus europaeus	Glyptostrobus			Cyperaceae gen. 2 (cf.Eriophorum)			
Hydrangea polonica	Ilex			Cyperus sp. 1			
Magnolia cf. cor	Juglans			Cyperus sp. 2			
Phellodendron sp.	Myrica			Cyperus sp. 3			
Phyllanthus sp.	Myrtaceae			Decodon gibbosus			
Pinaceae gen. 1	Nyssa			Epipremnum crassum			
Pinaceae gen. 2	Picea			E. cristatum			
Sambucus lucida	Pinus t. haploxylon			cf. Galium			
Schefflera dorofeevi	P. t. sylvestris			Gramineae			
Rubus laticostatus	Platycarya			Gratiola tertiaria			
R. microspermus	Pterocarya			Hydrocotyle sp.			
R. aff. occidentalis	Quercus			Hypericum aff. maculatum			
R. semirotundatus	Rhamnus			H. cf. tertiaerum			
	Rhus			Lycopus cf. antiquus			
	Salix			Menyanthes cf. trifoliata			
	Sapotaceae			Microdiptera cf. parva			
	Sciadopitys			Najas marina			
	Symplocaceae			Patrinia palaeosibirica			
	Taxodiaceae-Cupressaceae			cf. Pilea sp.			
	Taxodium			Polygonum aviculare s.l.			
	Tilia			P. cf. convolvulus			
	Tsuga			Potamogeton aff. polygonifolius			
	Ulmus			Potamogeton sp.			
	Vitis			Potentilla pliocenica			
				P. cf. supina			
				Primulaceae			
				Ranunculus cf. reidi			
				Rumex sp. 1			
				Rumex sp. 2			
				Scirpus sylvaticus			
				Sparganium camenzianum			
				S. haentzschelii			
				S. neglectum			
				Stratiotes kaltennordheimensis			
				Thalictrum sp.			
				cf. Trichophorum			
				Typha cf. elliptica			
				T. cf. fusisperma			
				T. cf. pliocenica			
				Viola rimosa			
				Viola sp. 1			
				Viola sp. 2			
				Viola sp. 3			
31 taxons - 28.71 %	42 taxons - 61.76 %	2 taxons - 1.85 %	2 taxons - -2.94 %	61 taxons - 56.48 %	11 taxons - - 16.18 %	14 taxons - 12.96 %	13 taxons - - 19.12 %
Total: 73 taxons - 41.48 %		Total: 4 taxons - 2.27 %		Total: 72 taxons - 40.91 %		Total: 27 taxons - 15.34 %	

Table 6.

Distribution and climatic demands of present-day species compared with taxons recorded in Miocene deposits of Nowy Sącz Basin

Taxons in brackets are those for which the degree of relationship is not univocally defined. Extinct taxons marked by cross-mark

No.		Macroflora of the Nowy Sącz Basin	America	Europe	Eurasia	Asia Minor	Asia E. and SE.	Africa	New Zealand and Australia	Indo-Malaya	Climate: tropical	Climate: subtropical	Climate: temperate
1		Neckera cf. complanata	N. complanata		N. complanata			N. complanata					
2		Anomodon sp.	(A. viticulosus)		(A. viticulosus)		(A. viticulosus, giraldii, minor)	(A. viticulosus)					
3		Amblystegium serpens	A. serpens		A. serpens			A. serpens	A. serpens				
4		Eurhynchium speciosum		E. speciosum		E. speciosum							
5	+	Selaginella pliocenica	(S.apoda, densa)										
6	+	Glyptostrobus europaeus					G. pensilis						
7		Chamaecyparis cf.pisifera					Ch. pisifera						
8		Carpinus betulus			C. betulus								
9	+	Broussonetia pygmaea					B. kazinoki						
10		Eucommia sp.					E. ulmoides						
11	+	Boehmeria cf. sibirica	B. cylindrica										
12		cf. Pilea sp.	(P. pumila)				(P. mongolica)						
13		Polygonum aviculare s.l.	P. aviculare		P. aviculare	P. aviculare	P. aviculare	P. aviculare					
14		Polygonum cf. convolvulus	P. convolvulus		P. convolvulus								
15		Rumex sp. 1			(R. maritimus, ucrainicus)								
16	+	Phyllanthus sp.	(Ph. sp. div.)				(Ph. sp. div.)	(Ph. sp. div.)					
17	+	Cercidiphyllum crenatum					C. japonicum						
18	+	Magnolia cf. cor					M. kobus						
19	+	Ranunculus cf. reidi		(R. lateriflorus et al.)									
20		Thalictrum sp.			(Th. flavum, simplex)								
21	+	Brasenia sp.	(B. purpurea)				(B. purpurea)	(B. purpurea)	(B. purpurea)				
22	+	Viola rimosa											
23		Viola sp. 2		(V. cornuta)									
24		Viola sp. 3					(V. chinensis)						
25	+	Actinidia faveolata					A. kolomiota						
26	+	Actinidia argutaeformis					A. arguta						
27		Hypericum aff. maculatum			H. maculatum								
28	+	Hypericum cf. tertiaerum											
29	+	Hydrangea polonica	(H. quercifolia)				(H. sargentiana)						
30	+	Rubus laticostatus					(R. phoenicolasius)						
31	+	Rubus microspermus											
32	+	Rubus semirotundatus		(R. rudis, radula)									
33		Rubus aff. occidentalis	R. occidentalis				R. occidentalis var. japonica						
34	+	Potentilla pliocenica					(P. sp. div.)						
35	+	Potentilla cf. supina		P. supina									
36	+	Decodon gibbosus	(D. verticillatus)										
37	+	Microdiptera parva											
38		Phellodendron sp.					(Ph. amurense, japonicum)						
39		Acer sp. div.					(A. ukurunduense)						
40	+	Aralia rugosa											
41	+	Aralia cf. ucrainica											
42	+	Aralia tertiaria					(A. continentalis)						
43		Aralia sp.	(A. racemosa, californica)				(A. cordata, cachemirica)						
44	+	Schefflera dorofeevi					(Sch. venulosa)						
45	+	Hydrocotyle sp.					(H. wilfordi, japonica)						
46	+	Vaccinium minutulum	(V. caespitosum)	(V. myrtillus, vitis-idaea)			(V. hirtum)						
47	+	Andromeda carpatica											
48	+	Gratiola tertiaria			(G. officinalis)								
49	+	Lycopus cf. antiquus	(L. sp.)				(L. sp.)						
50		Menyanthes cf. trifoliata	M. trifoliata		M. trifoliata								
51	+	Sambucus lucida	(S. glauca, pubens)		(S. ebulus)		(S. chinensis, williamsi)						
52	+	Patrinia palaeosibirica			P. sibirica		P. sibirica						
53	+	Campanula palaeopyramidalis		C. pyramidalis									
54		Campanula sp.	(C. rotundifolia)	(C. sp. div.)	(C. rotundifolia)	(C. sp. div.)							
55	+	Stratiotes kaltennordheimensis											
56		Potamogeton aff. polygonifolius		P. polygonifolius				P. polygonifolius					
57		Potamogeton sp. (subsect. Colorati)		(P. coloratus)				(P. coloratus)					
58		Najas marina	N. marina		N. marina			N. marina	N. marina				
59		Cyperus sp. 1		(C. longus)	(C. glomeratus)	(C. longus, glomeratus)	(C. longus)	(C. longus)	(C. longus)	(C. longus)			
60		Cyperus sp. 2	(C. compressus)				(C. compressus)	(C. compressus)	(C. compressus)				
61		Cyperus sp. 3			(C. fuscus)								
62	+	Acorellus distachyoformis		A. distachyus		A. distachyus	A. distachyus	A. distachyus					
63		Scirpus sylvaticus	S. sylvaticus		S. sylvaticus	S. sylvaticus	S. sylvaticus						
64		cf. Trichophorum sp.	(T. caespitosum)		(T. caespitosum)			(T. caespitosum)					
65		Cyperaceae gen.1 (cf.Rhynchospora)	(R. alba)		(R. alba)	(R. alba)	(R. alba)						
66		Carex cf. elongata			C. elongata	C. elongata							
67	+	Carex elongatoides	(C. sp. div.)		(C. elongata, bohemica, leporina)	(C. elongata, bohemica)	(C. bohemica, leporina)	(C. leporina)					
68		Carex aff. loliacea	C. loliacea		C. loliacea		C. loliacea						
69		Carex sp. 1 sect. Heleonastes	(C. canescens, disperma)		(C. canescens, disperma)		(C. disperma)		(C. canescens)	(C. canescens)			
70		Carex sp. 2	(C. echinata, sp. div.)		(C. echinata)	(C. echinata)	(C. echinata)	(C. echinata)	(C. echinata)				
71	+	Carex globosaeformis	(C. sp. div.)										
72	+	Carex strigosoides	(C. collinsii, squarrosa)		C. strigosa	C. strigosa	C. strigosa						
73		Carex cf. acutiformis	C. acutiformis		C. acutiformis								
74	+	Carex flavaeformis	(C. flava, lepidocarpa et al.)		(C. flava, lepidocarpa et al.)			(C. flava)					
75	+	Carex plicata	(C. conspecta, williamsi)										
76	+	Carex pseudocyperoides	C. pseudocyperus		C. pseudocyperus		C. pseudocyperus		C. pseudocyperus ?				
77	+	Epipremnum crassum								E. sp. div.			
78	+	Epipremnum cristatum					(Cyrtosperma)			(Cyrtosperma)			
79	+	Sparganium haentzschelii											
80	+	Sparganium camenzianum											
81		Sparganium neglectum			S. neglectum	S. neglectum		S. neglectum					
82	+	Typha cf. fusisperma	(T. angustifolia)		(T. angustifolia)								
83	+	Typha cf. elliptica											
84	+	Typha cf. pliocenica	(T. latifolia)		(T. latifolia)								
		Number of determined taxons having their present-day equivalents exclusively on the given territory	5	5	6	-	16	-	-	1	12	57	44

Nowy Sącz Basin macroflora compared with other Neogene floras from Poland

x = related taxons, o = unpublished taxons

Plant macrofossils determined from the Miocene deposits of the Nowy Sącz Basin	MIOCENE														PLIOCENE			
	Turów	Chłapowo	Zatoka Gdowska (Gdów Bay)	Wieliczka	Czarny Dunajec	Koniówka	Konin	Rypin	Dobrzyń	Stare Gliwice	Chyżne	Lipnica Mała and Lipnica Wielka	Miocene of Silesia (Kräusel 1920)	Gozdnica	Sośnica	Krościenko	Domański Wierch	Mizerna
SCHIZOMYCETES																		
Actinomyces alni Harz			+		o	o				+						+	o	
FUNGI																		
Trematosphaerites lignitum (Heer) Mesch.	+		+	+	o	o					o	o				+	+	o
cf. Hysterium sp.															x			
Microthyriaceae			+					o		+	o							
Pyrenomycetes gen. 1																		
Pyrenomycetes gen. 2			x															
Pyrenomycetes gen. 3																		
Pyrenomycetes gen. 4																		
Polyporites sp.			+		o	o		o									+	
MUSCI																		
Neckera cf. complanata (Hedw.) Hub.			x							+								
Anomodon sp.																		x
Amblystegium serpens (Hedw.) B.S.G.															o			
Eurhynchium speciosum (Brid.) Jur.																		
LYCOPODINAE																		
Selaginella pliocenica			+		o	o		o			o	o			o	+	+	o
CONIFERAE																		
Glyptostrobus europaeus (Brongn.) Unger	+	+	+	+	o	o	+	+	x	+	+	+	+					
Chamaecyparis cf. pisifera (S.& Z.) Endl.										+						+		+
Cupressaceae gen. 1																		
Cupressaceae gen. 2										?								
Cupressaceae gen. 3											x	x						
Pinaceae gen. 1 (Tsuga vel Abies)																		
Pinaceae gen. 2																		
ANGIOSPERMAE - DICOTYLEDONES																		
Carpinus betulus L.		+	+	+	o	o		+	x	+	+	o	+	+	+	+	+	+
Betula sp. 1 (sect. Albae Rgl.)			+															
Betula sp. 2																		
Alnus sp.		x																
Broussonetia pygmaea Dorof.			+		o	o						o				o	+	
Eucommia sp.			+	+		?				+					+			+
Boehmeria cf. sibirica Dorof.							+				o				o			
cf. Pilea sp.					o	o	x									o	o	
Polygonum aviculare L.s.l.								o		+						o	+	
Polygonum cf. convolvulus L.								o									+	+
Rumex sp. 1																		
Rumex sp. 2																		
Phyllanthus sp.			+		o	o	x								o		x	
Ceroidiphyllum crenatum (Ung.) Brown	+				o						o		+				o	
Magnolia cf. cor Ludwig						o										+	o	+
Ranunculus cf. reidi Szafer																+		+
Thalictrum sp.			+							x				x		x		x
Brasenia sp.				x				x					x					
Viola rimosa Nikitin																		
Viola sp. 1										x						x		
Viola sp. 2																		
Viola sp. 3																		
Actinidia faveolata C.& E.M. Reid			+	x	o	o					o	o				+	+	+
Actinidia argutaeformis Dorof.																		
Hypericum aff. maculatum Cr.							x											
Hypericum cf. tertiaerum Nikitin					o									o	o			
Hydrangea polonica Łańc.-Środ.																		
Rubus laticostatus Kirchh.							+	+		+			+			+		
Rubus microspermus C.& E.M. Reid			+			o												
Rubus semirotundatus n. sp.					o	o												
Rubus aff. occidentalis L.																		
Potentilla pliocenica E.M. Reid					o	o												+
Potentilla cf. supina L.					o													
Alchemilla sp.																		
Decodon gibbosus (E.M. Reid) Nikitin						o	+					o			o			
Microdiptera cf. parva Chandl.																		
Phellodendron sp.				x		o										x	x	x
cf. Acer sp. div.			x															
Aralia rugosa Dorof.					?	o											o	
Aralia cf. ucrainica Dorof.																		
Aralia tertiaria Dorof.																		
Aralia sp.																	o	+
Schefflera dorofeevi Łańc.-Środ.											+	+						
Hydrocotyle sp.																		
Primulaceae			x				x											
Vaccinium minutulum n. sp.														o				
Andromeda carpatica n. sp.					o	o											o	
cf. Galium sp.					o													
Gratiola tertiaria Łańc.-Środ.																		
Lycopus cf. antiquus E.M. Reid			+		o	o		o		+	o				o		+	
Menyanthes cf. trifoliata L.						+					+			+			+	
Sambucus lucida Dorof.								+										
Patrinia palaeosibirica Dorof.					o	o					o						o	
Campanula palaeopyramidalis Łańc.-Środ.																		
Campanula sp.																		
ANGIOSPERMAE - MONOCOTYLEDONES																		
Stratiotes kaltennordheimensis (Zenk.) Keilh.		+					+	+	+									
Potamogeton aff. polygonifolius Pour																	o	
Potamogeton sp. (subsect. Colorati)			x														o	
Najas marina L.																+		+
Cyperus sp. 1			x															
Cyperus sp. 2																		
Cyperus sp. 3																		
Acorellus distachyoformis Łańc.-Środ.					o	o									o		o	
Scirpus sylvaticus L.			+		o	o									o			
cf. Trichophorum sp.														x				
Cyperaceae gen. 1 (cf. Rhynchospora)																		
Cyperaceae gen. 2 (cf. Eriophorum)																		
Carex cf. elongata L.																		
Carex elongatoides n. sp.																		
Carex aff. loliacea L.																		
Carex sp. 1 (sect. Heleonastes)																		
Carex sp. 2																		
Carex globosaeformis n. sp.																		
Carex strigosoides n. sp.																		
Carex cf. acutiformis Ehrh.																		
Carex flavaeformis n. sp.																		
Carex plicata n. sp.																		
Carex pseudocyperoides n. sp.																		
Gramineae gen.			x			x		o						o				
Epipremnum crassum C.& E.M. Reid						o						o						
Epipremnum cristatum Nikitin										+								
Sparganium camenzianum Kirchh.			+		o					+								
Sparganium haentzschelii Kirchh.					o					+								
Sparganium neglectum Beeby foss.		x			o	o	+	+	x						o	+	+	+
Typha cf. fusisperma Negru		o	+					?	?	+								
Typha cf. elliptica Negru		o	+					?	?	+								
Typha cf. pliocenica Dorof.																o		
Carpolithus sp.																		
Antherites sp.		+			o		+							o	o			
Total	3	8	26	7	26	27	11	16	6	18	13	10	5	8	14	18	24	16