

PALAEOFLORESTIC STUDY OF VOLHYNIAN FROM PÎRTEȘTII DE SUS

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Abstract

A new fossil plant assemblage was collected from a quarry located within the Pîrteștii de Sus locality (Suceava county). Plant remains, mainly a good preserved leaves were fossilized in a litoral-neritic facies. The age of this deposits is Upper Volhynian. The palaeoflora includes 8 species of angiosperms, belonging to 7 families. Was observed a predominance of remains a *Typha* and *Phragmites*, showing a lacustrine and the swampy biotope. Another part of the vegetation comes from a riverside forest spread along a hydrographical path.

Key words: palaeoflora, Upper Volhynian, systematic description, Pîrteștii de Sus.

Geological setting

The outcrop where the foliar impressions from the present paper were yielded is located within the Pîrteștii de Sus locality, on the right side of Soloneț Stream (Figure 1).

In this area, the sedimentary deposits are referred as Volhynian (Ionesi B., 1968), with a litoral-neritic facies near the limit with the Subcarpathian Nappe.

The lithological succession of the Volhynian deposits was described by Ionesi B. (1968) in a profile analyzed between Soloneț – Vîrful Dealului railway station – Ilișești (400-540 m height). The deposits represent about 140-150 m thick and include sands with argillaceous and sandstone intercalations, at the basis, followed by fossiliferous calcareous sandstones and clays with gypsum at the upper part of the profile (Figure 2).

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Our studied outcrop stands between 400-420 m height, its upper part being affected by a quarry exploitation process. Lithologically, at the base of the outcrop there were identified yellowish sands with clay intercalations (Figure 3), sandstone intercalations with fossiliferous leaf impressions, at the upper side of the profile.

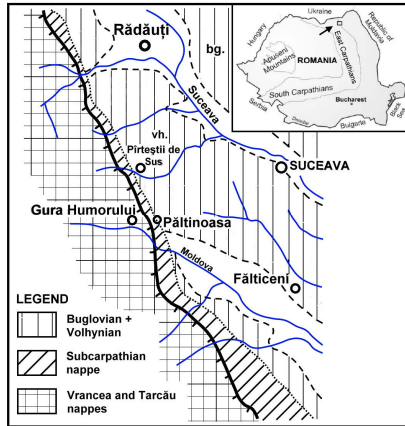


Fig. 1 Geological map of the studied area (after Ionesi et al., 2005).

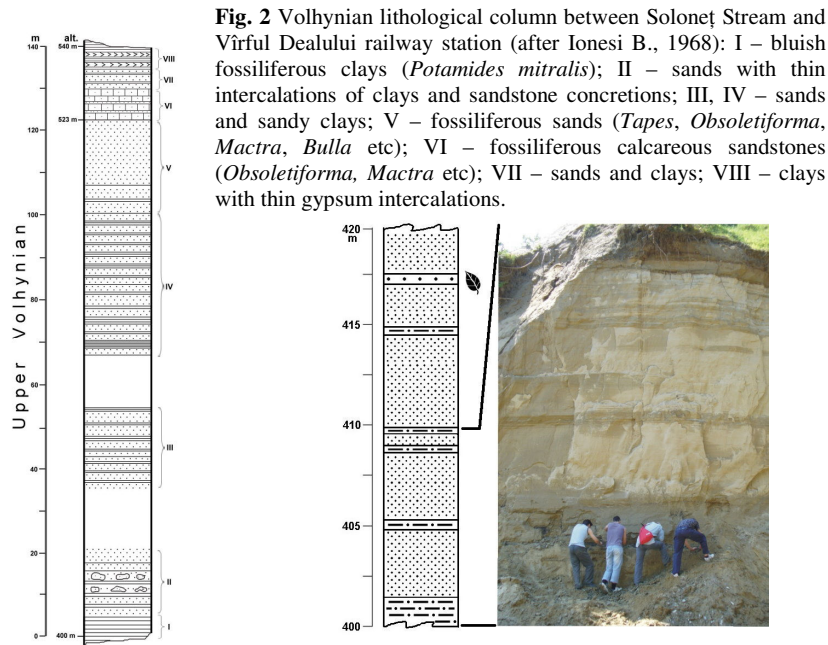


Fig. 2 Volhynian lithological column between Soloneț Stream and Vîrful Dealului railway station (after Ionesi B., 1968): I – bluish fossiliferous clays (*Potamides mitralis*); II – sands with thin intercalations of clays and sandstone concretions; III, IV – sands and sandy clays; V – fossiliferous sands (*Tapes*, *Obsoletiforma*, *Macra*, *Bulla* etc); VI – fossiliferous calcareous sandstones (*Obsoletiforma*, *Macra* etc); VII – sands and clays; VIII – clays with thin gypsum intercalations.

Fig. 3 Lithological column of the profile from Pîrtești de Sus.

The fauna from the studied stratigraphical interval is poor; in one outcrop laying at about 1 km SE is cited a thin intercalation with *Potamides mitralis* Eichwald 1830 (Ionesi B., 1968). The faunistic assemblage, identified within the upper deposits of those which outcrop on the Soloneț Stream, allowed, for the same author, to assimilate these deposits to those between Burdujeni calcareous sandstones and Arghira II level. This assemblage includes numerous exemplars of *Tapes tricuspis* Eichwald 1830, *Mactra eichwaldi* Laskarew 1914, *Plicatiforma plicata* Eichwald 1853 etc., identified in the profiles from Ilișești and Vîrful Dealului. The absence of the *Ervilia* genre, abundant in Lower Volhynian, shows that these sediments belong to the upper part of Volhynian (Ionesi B., 1968).

Grasu et al. (2002) consider the deposits between Soloneț Stream and the Șomuzul Mare springs belonging to the foredeep zone, placing this sector in the distal area of the alluvial cone from Ciungi.

Systematic description

The palaeofloristic material yielded from the Pîrteștii de Sus quarry generally includes foliar impressions preserved in a friable sandstone layer. Their preserving state is quite good, some of them being almost entire.

The examination of this palaeoflora allowed us to identify and describe 8 species of Angiosperms, belonging to 7 families. The list of the fossil taxa is presented in Table 1.

Tab. 1 Palaeofloristic assemblage identified in the Pîrteștii de Sus profile.

Curr. nr.	Taxon	Number of exemplars	Palaeoclimate
Angiospermatophyta. Monocotyledonatae			
1	<i>Typha latissima</i> Braun 1851	10	Arcto-Tertiary
2	<i>Phragmites oeningensis</i> Braun	2	Arcto-Tertiary
Dicotyledonatae			
3	<i>Carpinus grandis</i> Unger 1850	1	Arcto-Tertiary
4	<i>Populus populina</i> (Brongniart 1822) Knobloch 1964	1	Arcto-Tertiary
5	<i>Salix varians</i> Goepfert 1855	1	Arcto-Tertiary
6	<i>Zelkova zelkovaefolia</i> (Unger 1843) Buzek & Kotlaba 1963	1	Arcto-Tertiary
7	<i>Platanus platanifolia</i> (Ettingshausen 1851) Knobloch 1964	1	palaeotropical
8	<i>Cassia lignitum</i> Unger	1	?

Phyllum: Angiospermatophyta
Class: Monocotyledonatae
Family: Typhaceae

***Typha latissima* Braun 1851**
Plate I, Figures 1 - 3

1855 *Typha latissima* Braun – Heer, p. 98, Plates XLIII, XLIV.
1957 *Typha latissima* Braun – Givulescu, p. 24, Plate I, Figures 22, 23.
2000 *Typha latissima* Braun – Bozukov, p. 29, Plate V, Figures 2, 6.

The foliar impressions ascribed to this species are the most numerous from the yielded material (10 exemplars). Some of these have a thicker longitudinal midvein, on the one side and another, being visible parallel and equidistant secondary veins. The width of the laminae varies between 8-23 mm. The presence of 3 well-preserved exemplars of larger size proves their short transport.

In the Sarmatian stage from Moldavian Platform, this species was also cited in Bursuc – Moldavian Republic (Ștefăruță, 1997). Palynologically, the presence of *Typha* genus was also outlined in Upper Volhynian from Hărmănești (Țabără, 2006).

Family: Gramineae

***Phragmites oeningensis* Braun**
Plate I, Figures 4 - 6

1855 *Phragmites oeningensis* – Heer, p. 64, Plate XXIV, Figures 1, 2.

There were identified only 2 stalk impressions which belong to this species. The exemplars are 14-16 mm width and about 40 mm length, both with a junction node between the two stalk segments. From the area of these nodes, there are noticed several fine longitudinal striations.

In Moldavian Platform, it was cited in Volhynian and Basarabian, in Moldavian Republic (Ștefăruță, 1997), in Volhynian from Fălticeni area (Țibuleac, 1998) and in Basarabian from Comănești Basin (Givulescu, 1968). *Phragmites oeningensis* was identified in many deposits of Miocene fossil plants, sedimented in a marine-brackish environment or in a fresh water one.

The present equivalent of this fossil species is considered to be *Phragmites communis*, spread within Europe, Asia, America and Australia (Givulescu, 1957).

Class: Dicotyledonatae
Family: Betulaceae

Carpinus grandis Unger 1850
Plate I, Figures 7 - 9

- 1856 *Carpinus grandis* Unger – Heer, p. 40, Plate LXXI, Figures 19 b, c, d, e; Plate LXXII, Figures 2-24, Plate LXXIII, Figures 2-4.
1934 *Carpinus grandis* Unger – Barbu, p. 122, Figures 22-24.
1966 *Carpinus grandis* Unger – Macarovici and Paghida, p. 69, Plate II, Figure 2; Plate III, Figures 5, 6.
1990 *Carpinus grandis* Unger – Givulescu, p. 66, Plate 28, Figures 7, 8; Plate 36, Figure 2.

The identified lamina has an elliptic form, with an acute apex and a rounded base. The margin of the foliar impression is not visible in order to have its description. It has a pinnate vein organization, with a primary vein slightly curved which grows thinner from the basis to the top. The secondary nervures are alternate, parallel one to each other, with an approximate 45° emergency angle. There are 17 pairs of secondary nervures.

Biometry: Length – 86 mm; Width – 35 mm; L/W – 2,45.

The described species was often cited for Sarmatian and Meotian in Moldavian Platform: Hîrsova and Bunești (Barbu, 1934), Șcheia (David, 1922), Leucușești (Țibuleac, 1998), Comănești Basin (Givulescu, 1968), Păun (Macarovici and Paghida, 1966), Bursuc, Naslavcea, Bravicea, Ghidighici (Ștefărtă, 1997).

The presence of *Carpinus* genre was also palynologically outlined all along the Basarabian period from Moldavian Platform (Țabără, 2006).

The present equivalent of the fossil species is considered to be *Carpinus betulus* L., one tree from the deciduous forests widespread in Central and South Europe (Givulescu, 1990). It grows in the wet valleys, between 100-500 m altitude, mixed with *Quercus* and other deciduous plants.

Family: Salicaceae

Populus populina (Brongniart 1822) Knobloch 1964
Plate II, Figures 1, 2

- 1856 *Populus populina* Braun – Heer, p. 11, Plate LIII, Figures 1, 7; Plate LIV, Figure 5.
1934 *Populus latior* Braun – Barbu, p. 7, Figure 6.
1957 *Populus latior* Braun – Givulescu, p. 25, Plate III, Figure 1.
1990 *Populus populina* Knobloch – Givulescu, p. 143, Plate 18, Figure 13; Plate 31, Figure 7.

The form of the lamina is ovate, with the maximal width situated in the lower third and the ratio L(ength)/W(idth) = 1,13. The apex is acute and the base shape is rounded and entire. It has an actinodromous vein organization, with a primary vein slightly sinuous, which grows thinner from the basis towards the apex. The secondary veins have a 45° emergency angle, being slightly curved and with ramifications at their terminal part.

Biometry: L – 43 mm; W – 38 mm.

Knobloch (1964; *fide* Givulescu, 1990) considers the correct nomination of *Populus latior* species, described by Braun and Heer from Oeningen, is *Populus populina*. *Populus latior* was cited by Barbu (1934) in Chersonian from Hirsova, by Macarovici and Paghida (1966) in Chersonian from Păun and in Basarabian from Nisporeni (Ștefăriță, 1997). *Populus populina* is described, also by Ștefăriță (1997), in Basarabian from Bravicea and Ghidighici and in Meotian from Seimen.

The present equivalent of this fossil species is considered to be *Populus canadensis* Moench. widespread from Canada to South of North America (Givulescu, 1957).

***Salix varians* Goepfert 1855**

Plate II, Figure 3

1856 *Salix varians* Goepfert – Heer, p. 26, Plate LXV, Figures 1-3, 6-16.

1934 *Salix varians* Goepfert – Barbu, p. 110, Figure 5.

1966 *Salix varians* Goepfert – Macarovici and Paghida, p. 67, Plate II, Figure 5.

1978 *Salix varians* Goepfert – Țicleanu and Micu, p. 403, Figure 6.

A single foliar impression of this species was identified. Its basal section is missing. The lamina is ovate-lanceolate with a primary vein slightly curved. The apex is long, acute. The secondary veins are curved towards the margin of the leaf, but they do not touch it. The tertiary veins, almost perpendicular disposed on the secondary ones, as well as the small teeth from the margin of the lamina, do not appear on the yielded exemplar.

Biometry: L – 55 mm; W – 23 mm.

From Sarmatian of Moldavian Platform, this species is cited in Lapoș (Barbu, 1934), Corni (Țicleanu and Micu, 1978), Păun (Macarovici and Paghida, 1966), Bravicea, Ghidighici and Seimen (Ștefăriță, 1997).

The pollen species *Salixipollenites densibaculatus* and *S. helveticus* were mentioned in Basarabian and Chersonian from Moldavian Platform (Țabără, 2006).

Family: Ulmaceae

Zelkova zelkovaefolia (Unger 1834) Buzek & Kotlaba 1963
Plate II, Figures 6, 7

- 1856 *Planera ungeri* Etting. – Heer, p. 60, Plate LXXX, Figure 11.
1934 *Planera ungeri* Kov. – Barbu, p. 126, Figure 31.
1957 *Zelkova ungeri* Kov. – Givulescu, p. 45, Plate XVII, Figure 5.
1978 *Zelkova zelkovaefolia* (Ung.) Buzek & Kotlaba – Țicleanu and Micu, p. 406,
Figures 18, 19.
1990 *Zelkova zelkovaefolia* (Ung.) Buzek & Kotlaba – Givulescu, p. 99, Plate 30,
Figures 6-8.

The yielded lamina fragment has an acute apex, a serrate margin with wide teeth, oblique oriented to the apex. The external margin of the teeth is slightly curved. The vein organization is pinnate-craspedodromous, with a straight primary vein and 3 pairs of secondary veins, slightly arched, which ends within the lamina teeth.

This taxon was cited in Sarmatian from Corni (Țicleanu and Micu, 1978), Păun (Macarovici and Paghida, 1966), Bursuc, Lipcani, Naslavcea, Bravicea (Ștefârță, 1997), and in Meotian from Bunești (Barbu, 1934).

Pollen species such as *Zelkovaepollenites thiergarti* and *Z. potoniéi* were cited in Basarabian from Moldavian Platform (Țabără, 2006).

The fossil species resembles with *Zelkova crenata* Spach., a 15-20 m height tree which lives nowadays in the riverside forests from Caucasus and North Persia, between 300-1500 m altitude (Givulescu, 1957, 1990).

Family: Platanaceae

Platanus platanifolia (Ettingshausen 1851) Knobloch 1964
Plate II, Figures 8, 9

- 1856 *Platanus aceroides* Goep. – Heer, p. 71, Plate LXXXVII; Plate LXXXVIII,
Figures 5-15.
1957 *Platanus aceroides* Goep. – Givulescu, p. 60, Plate IX, Figures 4, 5; Plate X,
Figure 1.
1966 *Platanus aceroides* Goep. – Macarovici and Paghida, p. 70, Plate II, Figure 1;
Plate III, Figures 9, 10.
1990 *Platanus platanifolia* (Etting.) Knobloch – Givulescu, p. 54, Plate 31, Figure 6.

The yielded material is preserved as a double impression, visible only at the lower side of the leaf. The vein organization represents a basal actinodromous type, with a

straight primary vein, from which come out other two lateral primary veins right from the base of the leaf. These lateral veins branch from the median one with a 42° angle. The secondary veins which come from the lateral primary veins are slightly curved and parallel one to another. The margin of the leaf was not preserved by fossilization.

This species is known in the old palaeobotanical literature as *Platanus aceroides* Goepf., nomination updated by Knobloch (1964, *fide* Givulescu, 1990).

In Sarmatian from Moldavian Platform, *Platanus aceroides* was cited in Chersonian from Păun (Macarovici and Paghida, 1966), and *Platanus platanifolia* in Basarabian from Ghidighici and Bravicea (Ștefărtă, 1997).

Platanus occidentalis L. is considered the present equivalent of the fossil taxon, a tree spread in the United States in the region of the western mesophytic forest and in the southern region of the valley of Mississippi River. It grows in large alluvial valleys, in association with *Populus*, *Quercus*, *Ulmus*, *Carya*, *Acer* etc.

Family: Fabaceae

Cassia lignitum Unger

Plate II, Figures 4, 5

1859 *Cassia lignitum* Ung. – Heer, p. 121, Plate CXXXVIII, Figures 22-28.

Lanceolate lamina, with acute apex and a slightly asymmetrical normal acute base. The margin is very slightly wavy. It has a pinnate camptodromous vein organization: the primary vein is straight, and the secondary ones are alternated, being curved and forming arches at the margin of the lamina.

Biometry: L – 35 mm; W – 13 mm; L/W – 2.7

This species is for the first time cited in Sarmatian from Moldavian Platform. Until now, only *Cassia ambigua* was mentioned from Hîrsova and Nisporeni (Barbu, 1934), Păun (Macarovici and Paghida, 1966) and Nisporeni (Ștefărtă, 1997).

The two species, *Cassia lignitum* and *C. ambigua*, resemble quite a lot, only that *C. lignitum* is larger.

Palaeofloristical and biostratigraphical considerations

In the present paper there were described 8 taxa, among them one (*Cassia lignitum*) is presented for the first time in Sarmatian from Moldavian Platform.

The palaeoflora from Pîrteștii de Sus could be considered a poor taxa one. The specific vegetal rests are mainly allohtone, brought by running waters, by wind, and mixed within the deposits of the sedimentary basin.

A prime palaeobiotope which could be guessed, considering this fossil flora, is the lacustrine and the swampy one, on its edge growing an abundant *Typha* vegetation.

Phragmites was included in the same biotope, but on a quantitatively secondary place. Another part of the vegetation comes from a riverside forest spread along a hydrographical path, where could be found taxa such as *Populus*, *Salix*, *Zelkova*, *Platanus*. Such palaeobiocenosis were also recognized by Givulescu (1999), based on the taxonomic list given by Ștefăruță (1997) from Bursuc: riverside forest, more or less flooded, with *Salix*, *Populus*, *Zelkova*, *Ulmus*, *Carya*; marsh forest with *Taxodium*, *Gleditsia lyelliana*, *Osmunda*; different types of mesophytic forest, including heights with *Quercus moldavica*, *Q. pseudorobur*, *Sorbus*, *Castanea*, *Tilia* etc. From Upper Volhynian of Fălticeni-Boroaia Formation there is cited a rich hydrophyllic vegetation, typical for a wide lake (*Typha*, *Phragmites*, *Potamogeton*) and swamp (*Glyptostrobus europaeus*) (Țibuleac, 1998, 2001). It completes with a dryer zone vegetation with *Pinus*, *Carpinus*, *Fagus*.

From a palaeoclimatic point of view, the prevalence of Arcto-tertiary elements stands up, *Platanus* is the only taxon with palaeotropical affinities. Based on the palaeofloristic researches for Volhynian from Moldavian Republic, Ștefăruță (1999) supposes a climate similar to the present one from the western region of Mediterranean Sea, with a 15° mean annual temperature and about 1000 mm precipitations. Considering the climate betrayed by the same Volhynian palaeoflora from Bursuc, Givulescu (1999) considers that it was a warm-temperate climate with a drier period (34.56% entire leaves from the total number of identified taxa).

The biostratigraphical analysis of the identified palaeoflora shows that almost all taxa have been previously cited in Sarmatian from Moldavian Platform (Table 2).

Tab. 2 Correlation of palaeoflora from Pîrteștii de Sus with other areas from Moldavian Platform: • Volhynian; ▲ Basarabian; ■ Chersonian.

Identified taxa in the present paper	Ștefăruță (1997)	Țibuleac (1998)	Țicleanu and Micu (1978)	Givulescu (1968)	Barbu (1934)	Macarovici and Paghida (1966)
<i>Typha latissima</i>	• Bursuc	•				
<i>Phragmites oeningensis</i>	• Naslavcea • Bursuc	•		▲		
<i>Carpinus grandis</i>	• Naslavcea • Bursuc	•		▲		■
<i>Populus populina</i>	▲ Nisporeni ▲ Bravicea ▲ Ghidighici					■

<i>Salix varians</i>	▲ Ghidighici Bravicea		▲	▲		■
<i>Zelkova zelkovaefolia</i>	• Naslavcea Bursuc Lipcani		▲			■
<i>Platanus platanifolia</i>	▲ Bravicea Ghidighici					■
<i>Cassia lignitum</i>	-	-	-	-	-	-

As we observe, 4 taxa (*Typha*, *Phragmites*, *Carpinus* and *Zelkova*) were previously cited for Lower Sarmatian from Bursuc, Naslavcea and Lipcani (Ștefăreț, 1997), and 3 among them from Fălticeni-Boroaia Formation (Țibuleac, 1998). From the palaeoflora identified in Pîrtești de Sus, we noticed the absence of *Glyptostrobus europaeus* and *Taxodium*, trees that represented the vegetal biomass which allowed the forming of the main coal levels which belong to Fălticeni-Boroaia Formation.

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Plate I

- 1, 3. *Typha latissima* Braun
2. *Typha latissima* Braun
- 4, 5. *Phragmites oeningensis* Braun
6. *Phragmites oeningensis* Braun
- 7, 8, 9. *Carpinus grandis* Unger

scale in mm.

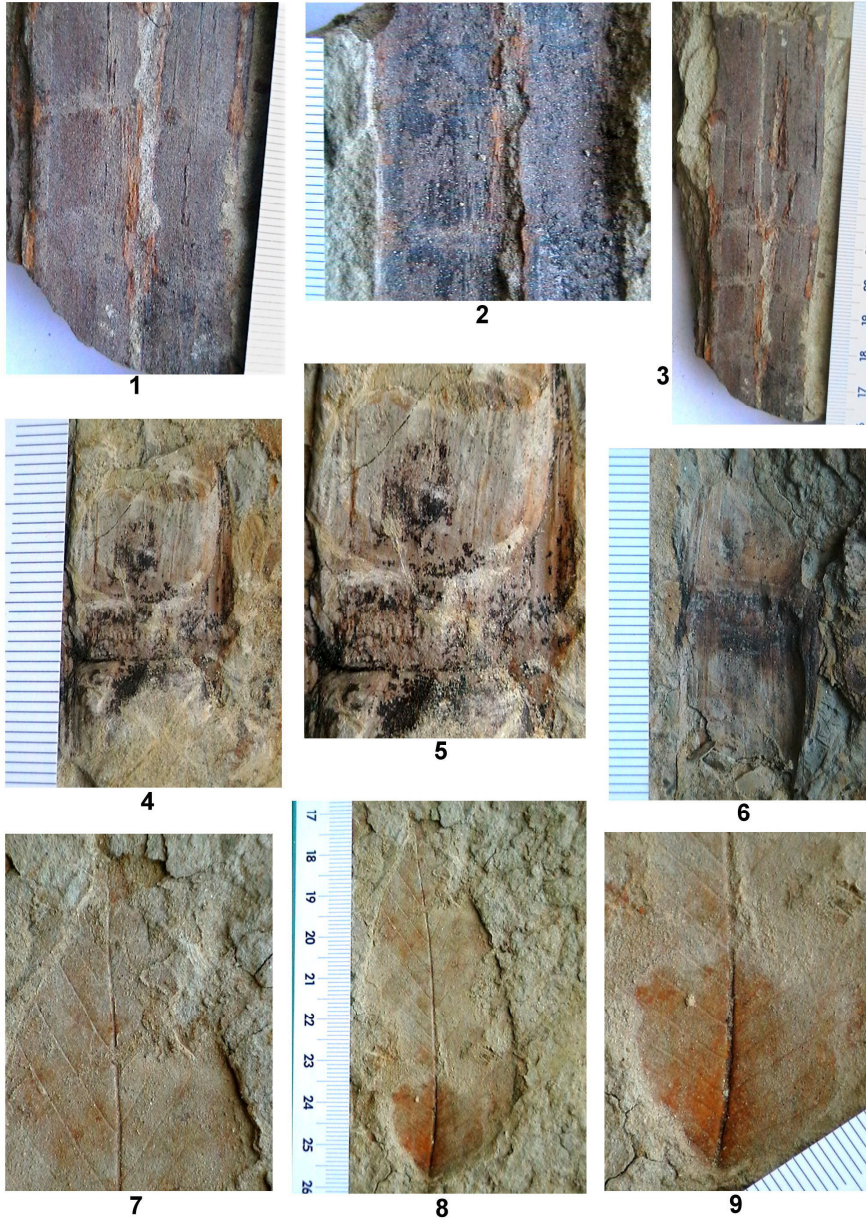


Plate II

- 1, 2. *Populus populina* (Brongniart) Knobloch
3. *Salix varians* Goepfert
- 4, 5. *Cassia lignitum* Unger
- 6, 7. *Zelkova zelkovaefolia* (Unger) Buzek & Kotlaba
- 8, 9. *Platanus platanifolia* (Ettingshausen) Knobloch

scale in mm.

