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THE FOSSIL FLORA OF THE MORILOR VALLEY, SOUTH-WESTERN DACIAN BASIN, ROMANIA

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Abstract. The article is based on a new discovered fossil flora, the flora of the Morilor Valley, located in the southern part of the Forecarpathian Basin (Central Paratethys area, southwest Romania). The plant remains are composed mainly by leaves and winged fruits imprints. The analysis of the fossil plant assemblages permitted a paleoenvironmental reconstruction which indicates humid mesophytic forests (of *Fagus*, *Quercus*, *Betula*, *Ulmus*, *Carpinus*), hydrophile (wetland) forests (of *Glyptostrobus*, *Alnus*, *Daphnogene*, *Salix*, *Populus*), small or extensive lake bodies populated by fresh-water plants (*Typha*, *Potamogeton*), herbaceous undercanopy layers (of Musci, Pteridophyta) and marine coastal environments (*Cystoseirites*). The age is very well determined after the molluscs and foraminifer assemblages as Sarmatian (Lower Serravallian).

Keywords: Morilor Valley, Romania, fossil flora, Sarmatian, taphonomy, paleoecology, paleoenvironmental reconstruction.

INTRODUCTION

The Middle Miocene flora of the Morilor Valley, situated in the NW of the city Drobeta Turnu-Severin, was unknown till now. We fill the gap of Sarmatian floras from Oltenia province with a new stratigraphic well documented one (Lower Volhynian).

The aim of this study is to present the results carried out in some new founded leaf-bearing outcrops from the Morilor Valley, South-Western Dacian Basin zone. The palaeobotanical studies are a part of a regional research project financed by NURC (The National University Research Council). The sampling in the Morilor Valley started on 17 May 2003 when it was discovered, for the first time, its remarkable richness in leaf and winged fruit remains.

GEOGRAPHY AND GEOLOGICAL SETTINGS

The Morilor Valley section is located about 13 km northwest of Drobeta Turnu-Severin (see the figures 1, 2), between Colibaşi village (altitude 191m, latitude (DMS): 44°43' N, longitude (DMS): 22°45' E) and Bobaița village (altitude 307m, latitude (DMS): 44° 46' N, longitude (DMS): 22°43' E). The Dacian Basin (or the Forecarpathian Basin) is a part of the Central Paratethys developed between the Carpathians, Balkans and the Dobrogean Promontory.

The area has been studied before by Marinescu (1959, 1968) in unpublished internal works of the Geological Survey of Romania.

Marinescu (in Papp et al., 1974, eds.) recognized and established the parastratotype and the boundary stratotypus Morilor Valley-Colibaşi (the Morilor Valley Formation) for the Sarmatian of Paratethys. This dating was based mainly on typical molluscs and microfaunas of the Upper Badenian and Sarmatian (sensu lato) deposits. The absolute age of the fossil flora is about 13-13.2 m.y.

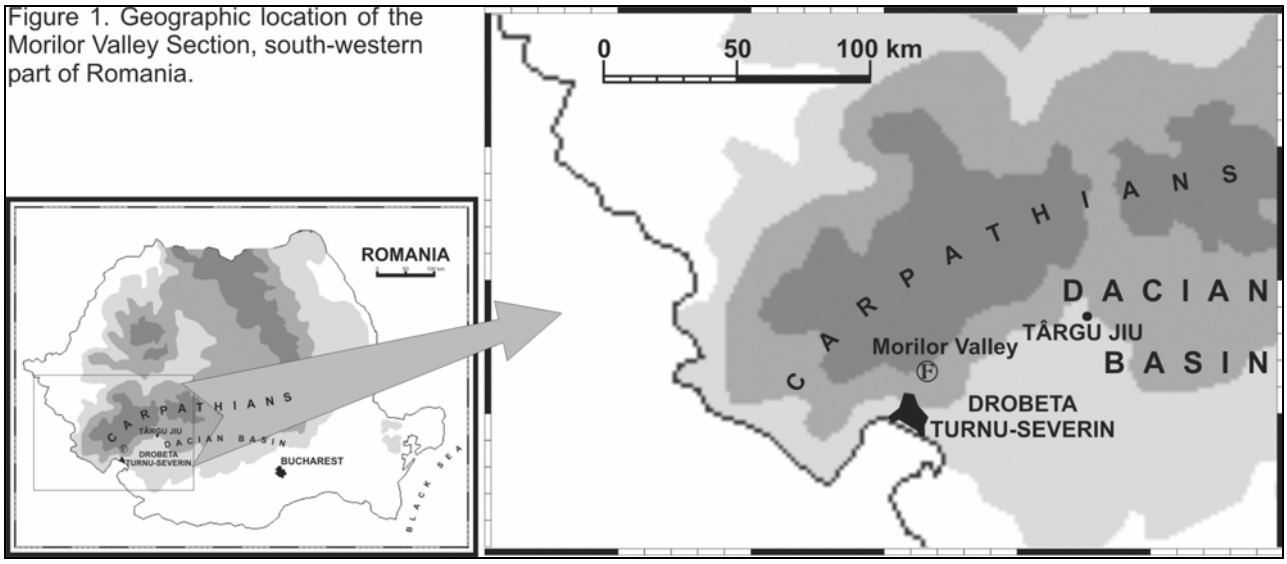

Figure 1. Geographic location of the Morilor Valley Section, south-western part of Romania.

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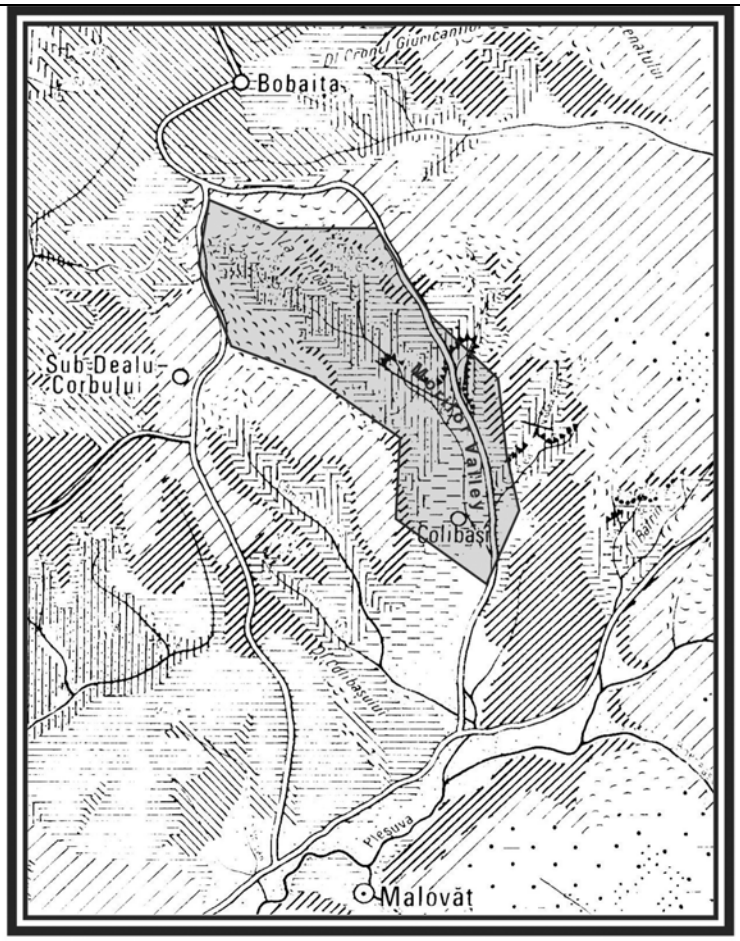


Figure 2. Geology of the Morilor Valley basin; the legend and the stratigraphic position of the regional deposits; after Marinescu (1978), Remane et al. (2000).

STRATIGRAPHIC CHART

QUATERNARY			
GELASIAN (1,75 m.a.)	ROMANIAN (2,58 m.a.)		
PIACENZIAN (3,4 m.a.)			
ZANCLEAN	DACIAN - GETIAN		
(5,3 m.a.)			
MESSINIAN	PONTIAN (7,3 m.a.)	Bosphorian	
		Portaferrian	
		Odessian	
TORTONIAN	MEOTIAN (undivided)		
	SARMATIAN	Chersonian	
		Basarabian	
(11 m.a.)		Volhynian	
SERRAVALIAN (14,3 m.a.)		(undivided)	
LANGHIAN	BADENIAN	Upper	
		Lower	

LEGEND

- a. Alluvial sediments; b. Alluvial cones; c. Land slides
- Terraces
- Sands, Clays, Coals
- Clays with coal
- Lazu sands
- Cocorova sands
- Marly clays, sands (Boereasca Formation)
- Marly clays, sands
- Marly clays; a. Level with Congeria panticapaea
- Sands, Clays, Sedimentary breccia
- Izvoru Barzii Gravels; fossiliferous limestones
- Marly clays with Ervilia (Morilor Valley Formation)
- a. Sands and gravels; fossiliferous limestones
- Gravels, Sands
- Marly clays with Spiratella
- Marly clays and Globigerina Tuffs

The Neogene evolution of the region is presented, in detail, by Marinescu (1978) where he summarize the lithostratigraphy of the sediments and provide the biostratigraphic subdivisions based on molluscs, foraminifers and ostracodes. The Upper Badenian deposits are predominantly represented by sediments of normal marine environments with frequent fresh water influxes. The Lower Sarmatian (Volhynian) deposits lies continuously above the Badenian deposits (see the figure 2, 3).

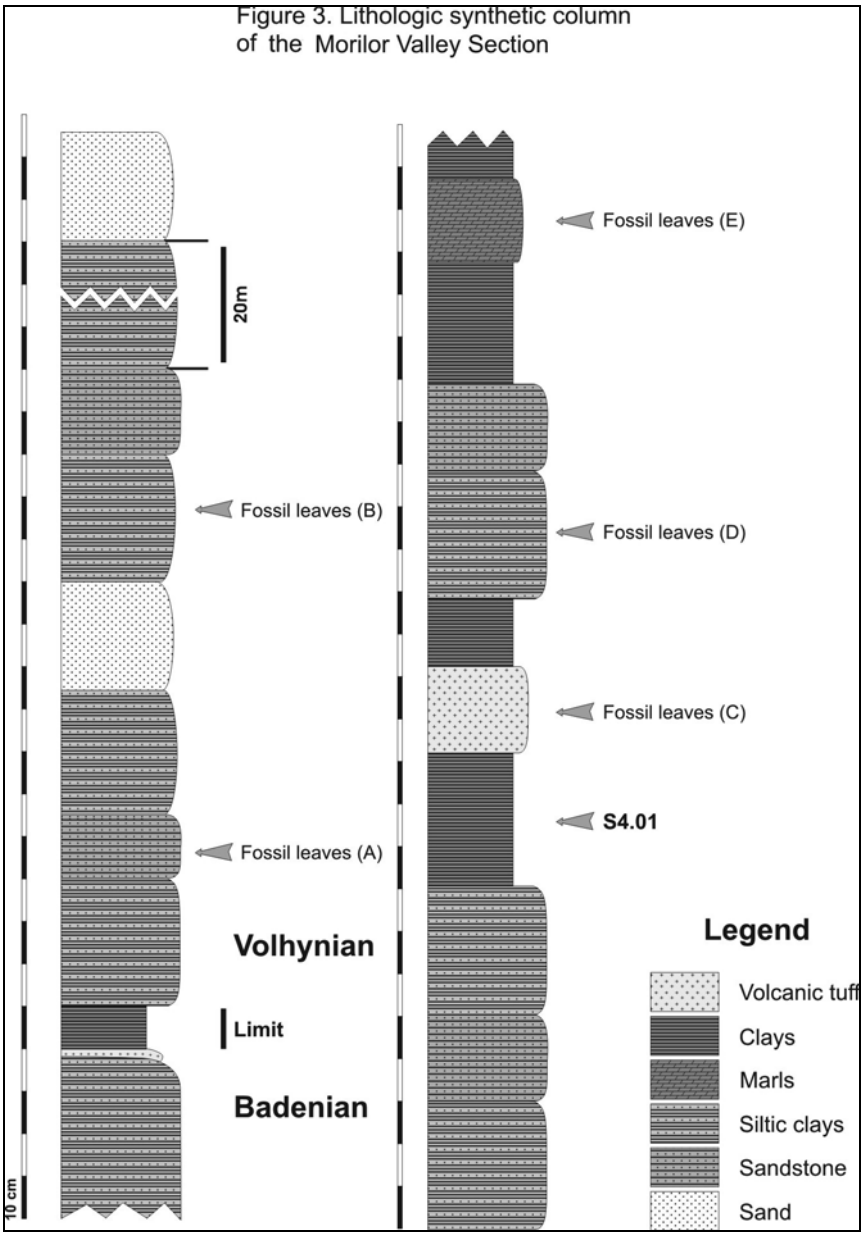
SEDIMENTOLOGY

The lithology of the Morilor Valley section proves the existence of coastal brackishwater-continental estuarine environments with shallow ponds or lakes. The sedimentary sequences reflect transitional stages from riverine conditions (gravels) to near-coast sands and offshore clays. These are tidal habitats, periodically covered by the sea. It is remarkable the cyclic change of the parameters of the sediment input (see the figure 3), from the alternation of fine-grained and coarse-grained sediments.

STRATIGRAPHY

Close to the Badenian-Sarmatian boundary the marine molluscs frequency become progressively lower, as a result of desalinization (Marinescu, 1978). The rich molluscs assemblages, in the lower part of the third outcrop (C, see the figure 3), are reflecting the Volhynian age (S4.01 reper sequence). The exuberant development of the Volhynian molluscs faunas reach the highest amplitude in the S4.01 lithological unit (Marinescu, 1978), where are

Figure 3. Lithologic synthetic column of the Morilor Valley Section



described species of *Modiolus*, *Ervilia*, *Mactra*, *Cardium*, *Gibbula*, *Calliostoma*, *Pirenella*, *Mohrensternia*, *Hydrobia*, *Dorsanum*, *Acteocina*. The foraminifers are represented (Gheorghian D. in Marinescu, 1974) by the species of *Spiroloculina*, *Nodobaculariella*, *Meandroloculina*, *Quinqueloculina*, *Triloculina*, *Dogielina*, *Articulina*, *Glabratella*, *Elphidium*, *Cibicides*, *Anomalinoides*, *Porosononion*, *Fissurina*. From the same site the ostracodes (Oltean R. in Marinescu, 1974) genera are: *Mutilus* (*Anvila*), *Haplocytheridea*, *Erpetocypris*, *Cythere*, *Cytheridea*, *Loxoconcha*, *Leptocythere*, *Paracythereis*, *Xestoleberis*.

Five Volhynian-Basarabian plant-bearing outcrops were investigated (A, B, C, D and E, see the figure 3). In each one of these (Paraschiv, 2003), the plants are lying in different lithological contexts: A – grey sandstones of ca. 25 cm., B - siltic clays of ca. 30 cm., C – tuff layer of ca. 25 cm., D – black siltic clays of ca. 35 cm., E – laminated marls of ca. 20 cm.

PREVIOUS PALEOBOTANIC AND PALINOLOGIC RESEARCHES

The paleobotanical and palinological documentation is very scanty; from these deposits being described only a rest of a trunk of fossil ebony wood – *Diospyroxylon knolii* (Hofmann) Petrescu, founded in a sandy sequence, possibly from the Upper Badenian deposits (Iamandei & Iamandei, 1998).

Some palinological results are presented by Ştefana Roman (in Marinescu, 1974) from the lumachellic clays (S4.01 unit) situated under the tuff level (Lower Volhynian), and the paleofloristic spectrum is composed by: *Pinus silvestris* (22%), *Pinus haploxylon* (11%), *Taxodiaceae* (9,2%), *Quercus* (7%), *Ulmus* (4%), *Myrica* (4%), *Betula* (3%), *Tsuga* (3%), *Lygodium* (4%), and *Polypodiaceae* (3%). To the upper part of the Morilor Valley section (Lower Basarabian), Ştefana Roman (in Marinescu, 1974) made another pollen analysis with these results: *Pinus silvestris* (22-36,6%), *Pinus haploxylon* (9,6-10%), *Quercus* (7%), *Taxodiaceae* (6%), *Castanopsis* (4%), *Tsuga* (3-7%), *Cedrus* (2,8%), *Carya* (5,4%), *Ulmus* (5%), *Lygodium* (4,4%), *Triplanosporites* (2%), and *Polypodiaceae* (2%).

MATERIAL

The sedimentary sequence at the Morilor Valley is rich in plant-bearing sediments at various levels. The plant material is preserved as fine imprints on siltic clays, tuffs, marls and sandstones. Iron-aluminum-manganese oxides, due to the epidiagenesis processes, cover especially the leaves and winged seeds imprints from the siltic clays. Almost all the specimens (see the table 1) collected represent impressions (rare compressions), which are preserved without anatomical details. The fine-grained siltic clays reveal tiny details of venation (as in the case of *Antholithes*). The material is kept in the collections of the Laboratory of Paleontology, Faculty of Geology and Geophysics, University of Bucharest (Plants coll. file Nos. VMO/ME 1-2 – invent. VmMe. 0001-0355).

SYSTEMATICS

Phylum Phaeophyta
Family Cystoseiraceae Kuetzing
Cystoseirites Sternberg
Cystoseirites partschii Sternberg
Pl. I, Fig. 1

Fragmented pieces of parenchymatous thalli without the holdfast and with stipe that includes in the basal region small blades and branches. In the apical region of the thallus are presented floats or pneumatocysts and associated branches. Habitat: bushy seaweed, grow on rocky bottoms (rockpools) and pebble grounds in sublittoral (lower shore) areas, usually at 0.5-10 m depths. Material: VMO/ME 1: VmMe. 0007-0013; VMO/ME 2: VmMe. 0079-0081.

Algal mat indet.

Wide surfaces (25-40 cm^2) of brown algae mat are preserved as internal discontinuous planes on siltic clays. These are the indicators of the proximal shelf domain, the zone affected by the wave action (the immersion/emersion effect). Material: VMO/ME 2: VmMe. 0082-0092.

Phylum Bryophyta
Musci indet.

Small branches with scale-like alternate proto-leaves. Material: VMO/ME 1: VmMe. 0001-0006.

Phylum Pteridophyta
Family Schizaeaceae Kaulfuss
Lygodium Swartz
cf. *Lygodium kaulfussii* Heer, emend.
Gardner & Ettingshausen

Small leaves and fragments of fronds (sterile pinnae), with lobed and dissected leaves; triangular dispersed pinnae; obvious midrib and rare secondary veins. Material: VMO/ME 1: VmMe. 0015; VMO/ME 2: VmMe. 0325-0326.

Pteridophyta indet.

Three poorly preserved fragments of pinnate leaves (up to 25 mm length), pinnulae originating not directly from the rachis; with asymmetric base; apex obtuse to rounded; fine serrate to entire margin and

prominent midvein. Material: VMO/ME 1: VmMe. 0016-0018.

Phylum Gymnospermophyta
Family Cupressaceae Rich. ex Bartling
Tetraclinis Masters
Tetraclinis salicornioides (Unger) Z. Kvaček
Pl. I, Fig. 2, 3

Numerous fragments of flattened branches with scalelike leaves; young twig segments. The nearest living relative is *Tetraclinis articulata* (Vahl.) Masters from the north of Africa (Morocco, Algeria, Tunisia), SE Spain, Malta, living in hot, dry areas. Material: VMO/ME 1: VmMe. 0025-0038; VMO/ME 2: VmMe. 0221-0228.

Sequoia Endlicher
Sequoia abietina (Brongniart) Knobloch

Branched twigs, leaves with taxodioid and/or cupressoid needle shape; the needles are spirally inserted. Our specimens are almost identically with those represented by Kovar-Eder & Meller (2003), in Pl. I, Figs. 1-4, 13. The nearest living relative is *Sequoia sempervirens* (Lamb.) Endlicher, with hygrophyte affinities, which live along the Pacific coast of North America, beginning in SW Oregon, continuing in NW California (Sierra Nevada Mountains) and ending in the south of Monterey County, California; at elevations generally below 300 m, occasionally to 1000 m. Material: VMO/ME 2: VmMe. 0122-0124.

Glyptostrobus Endlicher
Glyptostrobus europaeus (Brongniart) Unger

Sterile twigs with helically disposed and appressed scale leaves. The nearest living relative is *Glyptostrobus pensilis* (Staunt.) K. Koch (= *Glyptostrobus heterophyllus* (Brongn.) Endlicher), which is a tree of hygrophyte conditions, grows as a dominant tree in lowland (flooded), riparian, damp or swampy forests and sometimes in pure stands. Today is living endemic in China in Guangzhou, Kwantung, Kwansi provinces and in Hainan Island. It was common in many provinces of Vietnam, but now it was founded only in some places of the Dac Lac province (Ea H' Leo and Krong Buk districts). The needles are absolutely identical with the modern species. Material: VMO/ME 2: VmMe. 0327-0331.

Cupressospermum Mai

Very small winged nuts (seeds), rhombic in shape, of ca. 1.5-1.7 mm x 0.3-0.5 mm in diameter; distinct rounded pairs of wings; our specimens are the same with those represented by Rüffle (1963). Material: VMO/ME 1: VmMe. 0014; VMO/ME 2: VmMe. 0093-0112.

Family Pinaceae Lindley
Pinus Linnaeus
Pinus pinnulae binae

Two-needled fascicle, needles are finely longitudinally striated. Material: VMO/ME 1: VmMe. 0019-0024.

Pinus sp.1 seeds
Pl. IV, Fig. 1

Dispersed winged seeds that do not seem to be identifiable at the species level. The general feature is pseudorhombic. Material: VMO/ME 1: VmMe. 0039-0044; VMO/ME 2: VmMe. 0113-0118.

Pinus sp.2 seeds
Pl. IV, Fig. 2

Disperse winged seeds with general elliptic shape and oval nuts. Material: VMO/ME 1: VmMe. 0045-0047.

Picea A. Dietrich
Picea sp. seeds
Pl. IV, Fig. 3

Disperse winged seeds with elongated to rounded features. The wing surrounds partially the seed. Material: VMO/ME 1: VmMe. 0048-0050.

Phylum Angiospermophyta
Family Lauraceae Juss.
Daphnogene Unger
Daphnogene polymorpha (Al. Braun) Ettingshausen
Pl. I, Fig. 5

Cinnamomoid leaves; broader forms typical of the Miocene populations. Our specimens are close to the figured material of Givulescu (1996). Material: VMO/ME 1: VmMe. 0051-0052; VMO/ME 2: VmMe. 0119.

Laurophyllum Goeppert
Laurophyllum sp.1
Pl. I, Fig. 4

Obovate leaves with entire margin, long petiolated, midrib straight and strong evidenced; secondary veins not obvious. The general features are indicating laurel-like leaves. Material: VMO/ME 2: VmMe. 0120-0121.

Laurophyllum sp.2
Pl. I, Fig. 6

Lanceolate entire margin leaves, falcated, long

petiolated, with cuneate base and sharp apex; midrib strong and the general feature showing laurel-like characters. Material: VMO/ME 1: VmMe. 0053-0054.

Family Ulmaceae Mirb.
Ulmus Linnaeus
Ulmus parschlugiana Kovar-Eder & Z. Kvaček
Pl. IV, Fig. 4, 5

Elm samaras in bundles, stalked, some specimens with persistent perianth, winged, broadly oval, with an elliptic endocarp surrounded in the centre by moderate wide wings. Our specimens are similar to those figured by Kovar-Eder et al., (in press) from Parschlug. Fruits similar to *U. parschlugiana* are produced by the extant *Ulmus americana* L. (Manchester, 1989). Material: VMO/ME 2: VmMe. 0332-0336.

Ulmus sp. seeds
Pl. III, Fig. 6

Samaras bigger in size, winged, broadly oval, with an elliptic endocarp; short petiolated. Material: VMO/ME 1: VmMe. 0055; VMO/ME 2: VmMe. 0125-0127.

Family Fagaceae Dum.
Fagus Linnaeus
cf. *Fagus silesiaca* Walther & Zastawniak

Fragments of slightly asymmetrical leaves, elliptic, without apex, basis cuneate; leaf margin serrate, with rare teeth; semicraspedodromous venation, primary vein straight. Our specimens are quite similar to those from Walther & Zastawniak (1991). Material: VMO/ME 2: VmMe. 0337-0339.

Quercus Linnaeus
Quercus kubinyii Kováts ex Ettingshausen
Pl. II, Fig. 2

Leaves lanceolate, without the base, margin dentate, with strong acuminate teeth (rounded sinuses between teeth), apex acuminate; strong midrib, straight, to the apex slightly curved; venation is craspedodromous, secondaries symmetric disposed, opposite, running to the margin where emerge as specific aculeated teeth. Material: VMO/ME 1: VmMe. 0056-0062.

Family Betulaceae S.F. Gray
Betula Linnaeus
Betula longisquamosa Mädler

Tiny winged seeds (2.9-3.8 x 2.0-2.3 mm - the measures of the seed-nut), the width of the wing is 1.25-1.85 mm; the wings are distinct in the impression. Our specimens are similar to those presented by Zastawniak & Walther (1998). Material: VMO/ME 1: VmMe. 0077-0078; VMO/ME 2: VmMe. 0340-0344.

Betula pseudoluminifera Givulescu
Pl. II, Fig. 3

Large ovate leaves, asymmetrical, base inequilateral rounded, attenuate apex, the margin is complex serrate, with teeth oblique curved upward; midrib strong, sinuously-straight, secondaries simple craspedodromous, asymmetric disposed, opposite or alternate; tertiary venation oblique, forming parallel polygons. Our specimens are very close to those represented by Givulescu (1990) from Chiuzbaia. Material: VMO/ME 2: VmMe. 0128-0139.

Alnus Miller
Alnus sp.
Pl. II, Fig. 4

Fragmentary leaves with oval to ovate lamina, without petiole preserved, rounded base, apex not preserved; leaf margin irregularly or double serrate, with variable teeth; straight midvein, strong, secondaries simple, craspedodromous (7-10 in number, on each side), mostly alternate (but at the base opposite), arising from the midvein at wide intervals; tertiaries forked percurrent, oblique in relation with the midvein. Material: VMO/ME 1: VmMe. 0070-0076; VMO/ME 2: VmMe. 0229.

Carpinus Linnaeus
Carpinus betulus Linnaeus fossilis Engelhardt & Kinkelin
Pl. IV, Fig. 7

Involucres generally with 3, rare 2 lobes, up to 3 cm long and 1.1-2 cm broad, with rare peduncle preserved (up to 4 mm long); the central lobe is much longer than the lateral lobes, with entire margin; lateral lobes are asymmetric; apices of all lobes attenuate to acute; a single nut, or a visible scar in the place of its detachment at the base of the involucres. Material: VMO/ME 1: VmMe. 0068; VMO/ME 2: VmMe. 0140-0141.

Family Juglandaceae A. Rich. ex Kunth
Engelhardia Leschenault ex Blume, Bijdr
Engelhardia orsbergensis (Wessel & Weber) Jähnichen, Mai & Walther
Pl. III, Fig. 1

Wide distributed in the Tertiary deposits of the Europe, these leaves remains are characteristic for the Sarmatian floras of Romania (see Givulescu, 1997). Material: VMO/ME 1: VmMe. 0063; VMO/ME 2: VmMe. 0230-233.

Engelhardia macroptera (Brongniart) Unger
Pl. III, Fig. 2; Pl. IV, Fig. 6

The involucres of this species are rare at the Morilor Valley section. They are not different from the forms illustrated by Manchester (1987) and share triveined lobes of the involucrum and bear an coalified compression of the fruit. The fruits, like in many other occurrences from Europe, are associated with the leaflets and with the compound leaves of the genus. Material: VMO/ME 1: VmMe. 0064-0066.

Family Fabaceae
(Papilionaceae, Leguminosae) Lindl.
Leguminosites Bowerbank emend. Schimper
Leguminosites parschlugianus (Unger) Kovar-Eder & Z. Kvaček
Pl. III, Fig. 3

Pods rather large in size (10 mm wide and less than 40 mm long), flattened, slightly curved, with one (occasionally two) seeds; the margin is distinctly contracted, close to the seeds; seeds have max. 9 mm in diameter. We assign these fruits to the actual genera *Robinia* or *Acacia*. Material: VMO/ME 1: VmMe. 0067, 0069.

Family Sapindaceae Juss.
Sapindus Linnaeus
Sapindus falcifolius (Al. Braun) Al. Braun

Fragments of leaflets shortly petiolated, inequilateral, lanceolate to oblong-lanceolate, falcate; base cuneate, frequent asymmetrical; apex acuminate, margin entire; midrib strong, curved; numerous secondary veins, irregularly spaced, curved upwards. Almost identical with the specimens figured by Bůžek (1971). Material: VMO/ME 2: VmMe. 0345-0348.

Family Aceraceae Juss.
Acer Linnaeus
Acer sp.1
Pl. IV, Fig. 8

Winged fruits preserved as impressions. The classification at species level is often problematic. Based on the differences of the nutlet in shape and size, on the course of veins in the wings, and on the distance where the nutlet is enclosed by the wing, on the ventral side, 2 different formal groups are distinguished within the material from the Morilor Valley section. The *Acer* sp.1 have the nutlet roundish (4 mm long, 3.2 mm wide, the wing is 19 mm long and 5.5 mm wide), the dorsal side is slightly convex, the ventral side is convex; the end of the wing is rounded. Our specimens have similitudes with the actual living *Acer platanoides* L. Material: VMO/ME 2: VmMe. 0142-0144, 0234.

Acer sp.2
Pl. IV, Fig. 9

Winged fruits with the nutlet quadrate-subtriangular (5.2 mm long, 3 mm wide, the wing is 20 mm long and 6 mm wide), the dorsal side is straight, the ventral side is convex; the veins run upright towards the ventral side, several times dichotomously ramified, interconnected by several cross-anastomoses. We cannot compare this specimen with any other from Gregor's (1986) work. Material: VMO/ME 2: VmMe. 0135, 0345-0347.

Family Salicaceae Mirbel
Salix Linnaeus
Salix sp.

Fragmented leaves, with the margin regularly, simply serrate (tiny teeth); the venation is brochidodromous; midrib strong and slightly curved, secondaries forming wide curves, at the margin they form loops; loops of higher venation orders send fine veins towards the bases of the teeth, from where these run along the apical sides of the teeth towards the teeth apices; tertiary veins forked percurrent, oblique. Material: VMO/ME 2: VmMe. 0235-0236.

Populus Linnaeus
Populus sp. female catkins
Pl. III, Fig. 4

Fossil female aments, tiny petiolated, elongate shape, with numerous small capsules (1 mm). Material: VMO/ME 2: VmMe. 0136-0137.

Family Sterculiaceae Vent.
Byttneriophyllum Knobloch & Kvaček, ex Givulescu
Byttneriophyllum tiliaefolium (Al. Braun) Knobloch & Kvaček

Fragmentary asymmetric leaves, obovate to rounded, cordate base and entire margined. The venation type is acrodomous. Material: VMO/ME 2: VmMe. 0145, 0227-0229.

Family Ebenaceae Gurke
Diospyros Linnaeus
Diospyros brachysepala Al. Braun sensu Hantke

Fragmented leaves, oval to ovate; apex rounded or short-acute; the venation is brochidodromous; midrib very strong, straight; secondary veins alternate, irregularly branched, curved upward, looping with the tertiary veins in a series of loops; texture apparently coriaceous. Material: VMO/ME 2: VmMe. 0348-355.

Angiosperms incertae sedis

Dicotylophyllum Saporta
Dicotylophyllum sp.
Pl. II, Fig. 1

One well preserved leaf without base, very large in size, lanceolate nearly oval, entire margined with "drip tip" apex. The midrib is very strong, straight, the secondary veins are camptodrome, very numerous, regularly and dense spaced, originating approximately at angles of 90˚ and in the upper part of the leaf at 60˚ to 80˚, mostly alternate, curved distally and connected mutually in the marginal region in loops. Also these veins run at first almost straight and then widely curved towards the leaf margin, in front of which they fuse forming an intramarginal vein. The intersecondary veins are ending frequently in anastomoses. The tertiary and higher-order venations form an irregular network with a rather large polygonal areola (reticulate like); the lamina is thick but without cuticle preserved. The generic and specific determination of this entire-margined leaf is difficult and we include artificially these specimens in the species group *Dicotylophyllum* Saporta. It is possible that the concerned species to be an extinct type without any direct relationship with the recent species. Material: VMO/ME 2: VmMe. 0146-0147.

Antholithes Brongniart
Antholithes sp.
Pl. III, Fig. 5

Isolated inflorescence, actinomorphic, quadromeric; four non-free tips petals very narrow ovoidal, subrhomboidal shape, rounded at the apex. Corolla shortly sympetalous. No visible pedicle is present. Material: VMO/ME 2: VmMe. 0330-0331.

Seminae sp.
Pl. III, Fig. 7

Winged seeds with long hairy petiol and elliptic tiny nut surrounded by a radiar perianth. Material: VMO/ME 2: VmMe. 0332, 0367-0369.

Family Potamogetonaceae
Potamogeton Linnaeus
Potamogeton sp.
Pl. III, Fig. 8

Elliptic leaves without apex, entire margined, with obtuse base. The venation is paralelodrom type, with secondary arcuated veins. The tertiary veins show reticulate features. Material: VMO/ME 2: VmMe. 0271-0271, 0289.

Family Typhaceae

Typha Linnaeus
Typha latissima Al. Braun
Pl. III, Fig. 9

Fragmentary flattened leaves, linear, entire margined, with the venation of paralelodrom type. Material: VMO/ME 2: VmMe. 0290, 0297.

***Table* 1** The floristic spectrum of the Morilor Valley section

Taxa	Family
Cystoseirites partschii	Cystoseiraceae
Algal mat indet.	Phaeophytae
Musci indet.	Bryatae
cf. *Lygodium kaulfusii*	Schizaeaceae
Pteridophyta indet.	Pteridophytae
Tetraclinis salicornioides	Cupressaceae
Sequoia abietina	Cupressaceae
Glyptostrobus europaeus	Cupressaceae
Cupressospermum sp.	Cupressaceae
Pinus pinnulae binae	Pinaceae
Pinus sp.1	Pinaceae
Pinus sp.2	Pinaceae
Picea sp.	Pinaceae
Daphnogene polymorpha	Lauraceae
Laurophyllum sp.1	Lauraceae
Laurophyllum sp.2	Lauraceae
Ulmus parschlugiana	Ulmaceae
Ulmus sp.	Ulmaceae
cf. *Fagus silesiaca*	Fagaceae
Quercus kubinyii	Fagaceae
Betula longisquamosa	Betulaceae
Betula pseudoluminifera	Betulaceae
Alnus sp.	Betulaceae
Carpinus betulus	Betulaceae
Engelhardia orsbergensis	Juglandaceae
Engelhardia macroptera	Juglandaceae
Leguminosites arschlugianus	Fabaceae
Sapindus falcifolius	Sapindaceae
Acer sp.1	Aceraceae
Acer sp.2	Aceraceae
Salix sp.	Salicaceae
Populus sp.	Salicaceae
Byttneriophyllum tiliaefolium	Sterculiaceae
Diospyros brachysepala	Ebenaceae
Dicotylophyllum sp.	Dicotyledonatae
Antholithes sp.	Dicotyledonatae
Seminae sp.	Dicotyledonatae
Potamogeton sp.	Potamogetonaceae
Typha latissima	Typhaceae

TAPHONOMY AND PALEOECOLOGY

The fine-grained sediment made the conservation of the leaf remains possible after a rapid sedimentation process. Certain parts of the plants and animals that were living near the sedimentation basin (brackish sea, lagoon or lake) drifted into the water and fossilized. All of these paleoenvironments are documented in the Morilor Valley section. The fine venation of the plant imprints from the siltic clays was generally well conserved. The water was eutrophic during the deposition of the siltic clays from

the second plant-bearing outcrop (B, see the figure 3), as we consider after the presence of the fresh-water plants *Typha* and *Potamogeton* or, after the presence of single bedding planes covered exclusively by algal mats. Besides water, wind has probably played an essential role in transporting the plant materials into the lake sediments, because the diversity of winged seeds and fruits is rather high: *Cupressospermum* sp., *Pinus* sp. div., *Ulmus* sp., *Carpinus* sp., *Engelhardia macroptera*, *Acer* sp. div. Flower remains such as *Antholithes* sp., flying seeds like Seminae sp., or insect wings still preserved in pairs, support this view. The high frequency and diversity of winged seeds and fruits indicate the parautochthonous deposition of the plant remains.

Small bioherms (isolated bound stone structures) of red algae (*Lithothamnium* sp.) associated with bryozoans, and rare sessile bivalves (*Ostrea* sp. and *Chlamis elegans* Andrz.) documented the marine shallow-water sedimentation domain. More open waters are interpreted after the presence of the numerous unidentified fish remains (impressions) on gray marls, silty clays and oil-shale (dysodil) laminas. Fish remains (otolithes) are reported by Josefina Stancu (in Marinescu, 1974): *Gobius triangularis* Weiller, *Gobius tenuis* Weiller, *Clupea testis* Koken, *Dentix latior* Schubert, *Gadus minusculoides* Schubert, *Gadus insectus* Weiller, *Myctophum debile* Koken, and ?*Macrurus rumanus* Weiller.

The wood fragments (of different shape and heights) drifted on the shore domain are very frequent in the siltic clays as a result of the high velocities surface currents. Wood fragments drifted into the sea are called drifter buoys, which float with the currents and fall to the bottom of the sea when the current competence is decreasing or when it's becoming too heavy. These surface marine currents are produced by the continental fresh waters flowing into the more dense marine (brackish) waters.

PALEOENVIRONMENTAL RECONSTRUCTION

The environment where we suspect that was deposited the most important quantity of vegetal materials is a paleoestuary (an estuary is the part of a river where it meets the sea). Typically, the estuarine waters are slow and sluggish and often very silty and fertile. There is the habitat where we placed the brown algae *Cystoseirites partschii*. Depths of maximum 50 meters are documented by the presence of fossil algae Phaeophyceae and Rhodophyceae (*Lithothamnium* sp.), and associated bryozoans. The salinity is variable depending on the tide, the amount of freshwater entering from rivers or as rain, and the rate of evaporation. The salinity of the Volhynian depositional environments is assumed to be mostly around 23-18 $^{o}/_{oo}$ after the analysis of ecological demands of the molluscs and ostracods (Marinescu, 1978).

The Morilor Valley paleoecoregion contains remarkable overlapped forest habitats, from which some have disappeared today. The mesophytic forests of the ancient Morilor Valley, populated by species of *Fagus*, *Quercus*, *Betula*, *Ulmus*, *Carpinus*, *Engelhardia*, *Daphnogene*, *Laurophyllum*, *Leguminosites*, support drier substrates and composed small patches of humid mesophytic habitats. Oligotypic wetland forests composed mainly by *Glyptostrobus europaeus*, *Alnus* sp., *Ulmus* parschlugiana, *Daphnogene polymorpha*, *Salix* sp., *Populus* sp., *Byttneriophyllum tiliaefolium*, were developing along the shores of the lake. Pine stands were dispersed or mixed with oaks. A multistructural herbaceous layer (Musci, Pteridophyta) could have been existed under the deciduous canopy (of *Acer*, *Betula*, *Fagus*, *Quercus*), and rarely or nonexisted beneath the dense evergreen shrubs (like *Daphnogene*, *Laurophyllum*). A few aquatic plants, *Potamogeton*, *Typha*, demonstrate extensive shallow water habitats in the area. The zonal paleovegetation turned to be dominated by deciduous trees, in the upper part of the section (Paraschiv, 2003), including also a few exotic taxa, which allow to identify, in the "Mixed Mesophytic Forests" of eastern Asia and eastern North America, the best modern vegetation analogue.

During the Volhynian and Basarabian (after Ivanov et al., 2002) the mean annual temperature (MAT) was between 15.6 and 17.2 ºC (the paleoclimate reconstructions resulting from the application of the coexistence approach method (CAM) to some palynofloras from Northwest Bulgaria). Also, after the same work, the temperature of the coldest month (TCM) is ranging between 5 and 7 ºC, the summer temperatures (ST) mainly within 24.6-27.8 ºC and the mean annual precipitation (MAP) ranging between 1187-1322 mm and 1076-1322 mm.

DISCUSSIONS

For the same interval of time (Lower Sarmatian), the fossil flora of the Morilor Valley do not fit with the general amount in paleotropical (Mediterranean) elements of the Bursuc flora, from the Moldavian Republic (Ştefârță, 1997, 2000). It is interesting to take into account the total absence of the Lauraceae family in the flora of the Bursuc, and the great number of cinnamomoide leaves from the Morilor Valley section (e.g. *Daphnogene*, *Laurophyllum* sp. div.). Also, two important forest components from the flora of the Morilor Valley, *Tetraclinis salicornioides* and *Engelhardia orsbergensis* (*macroptera*), are missing from the fossil forests of the Bursuc area.

CONCLUSIONS

Five horizons (A, B, C, D, and E), rich in fossil plants, were studied from a Middle Miocene section (the Morilor Valley), southwest of the Dacian Basin.

According to the earlier molluscs and microfauna findings, in the Morilor Valley section, the stratigraphic position of these deposits is determined as Middle Miocene (Sarmatian). The studied paleobotanical assemblages build up a first sight of the flora and vegetation from the habitats of the western border of the Dacian Basin. The regional paleovegetation was represented by forest communities where evergreen and summergreen plants grew together, like in the today living Laurisilvae forests of the central China ("Evergreen Broad-Leaved Forests") and the "Mixed Mesophytic Forests" of the Northern Hemisphere (eastern North America, eastern and central China).

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PLATES

PLATE I

Figure 1 - *Cystoseirites partschii* Sternberg, fragmented thallus
Figure 2, 3 - *Tetraclinis salicornioides* (Unger) Z. Kvaček, branches with leaves
Figure 4 - *Laurophyllum* sp.1, leaves
Figure 5 - *Daphnogene polymorpha* (Al. Braun) Ettingshausen, leaves
Figure 6 - *Laurophyllum* sp.2, leaves

PLATE II

Figure 1 - *Dicotylophyllum* sp., leaves
Figure 2 - *Quercus kubinyii* Kováts ex Ettingshausen, leaves
Figure 3 - *Betula pseudoluminifera* Givulescu, leaves
Figure 4 – *Alnus* sp., leaves

PLATE III

Figure 1 - *Engelhardia orsbergensis* (Wessel & Weber) Jähnichen, Mai & Walther, leaves
Figure 2 - *Engelhardia macroptera* (Brongniart) Unger, winged fruits
Figure 3 - *Leguminosites parschlugianus* (Unger) Kovar-Eder & Z. Kvaček, pods
Figure 4 - *Populus* sp., female catkins
Figure 5 - *Antholithes* sp., flowers
Figure 6 - *Ulmus* sp., seeds
Figure 7 - *Seminae* sp., seeds
Figure 8 - *Potamogeton* sp., leaves
Figure 9 - *Typha latissima* Al. Braun, leaves

PLATE IV

Figure 1 - *Pinus* sp.1, seeds
Figure 2 - *Pinus* sp.2, seeds
Figure 3 – *Picea* sp., seeds
Figure 4, 5 - *Ulmus parschlugiana* Kovar-Eder & Z. Kvaček, seeds
Figure 6 - *Engelhardia macroptera* (Brongniart) Unger, winged fruits
Figure 7 - *Carpinus betulus* Linnaeus fossilis Engelhardt & Kinkelin, seeds
Figure 8 - *Acer* sp.1, winged fruits
Figure 9 - *Acer* sp.2, winged fruits

Fig. 1

Fig. 2

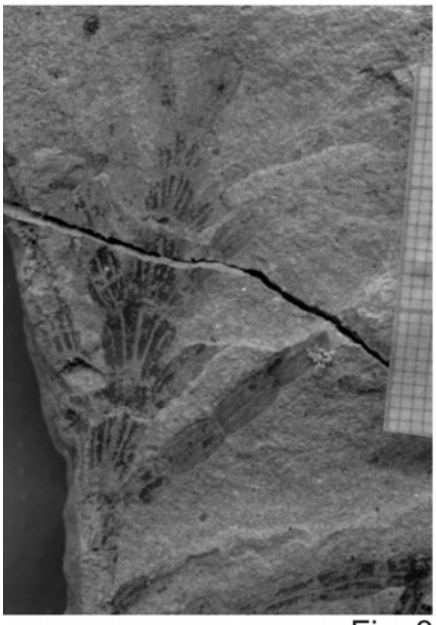
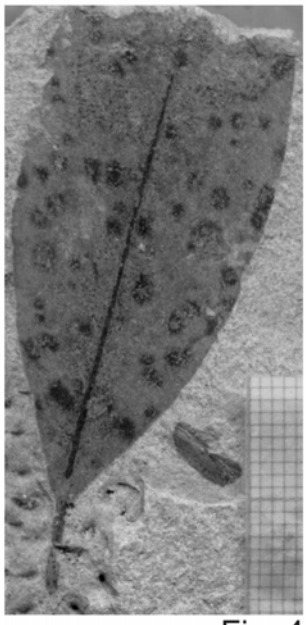


Fig. 3



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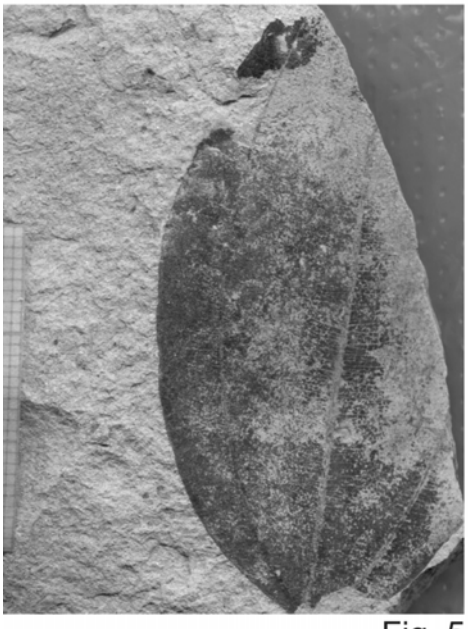

Fig. 5

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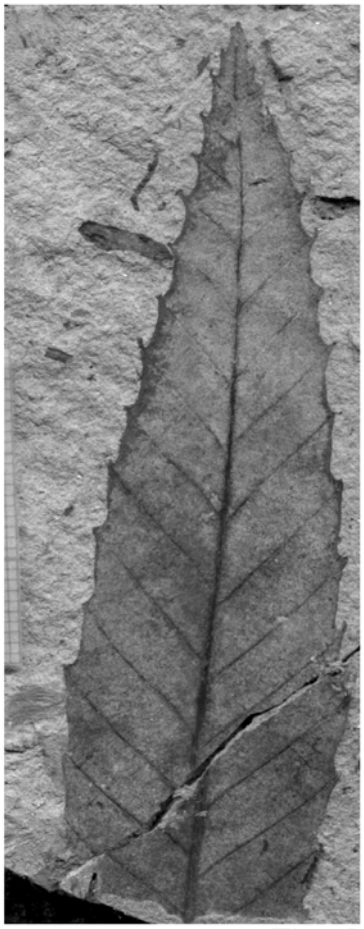

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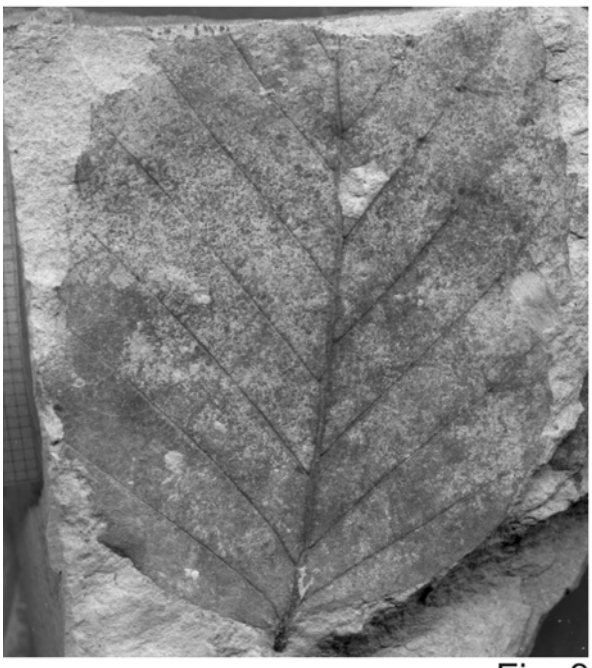

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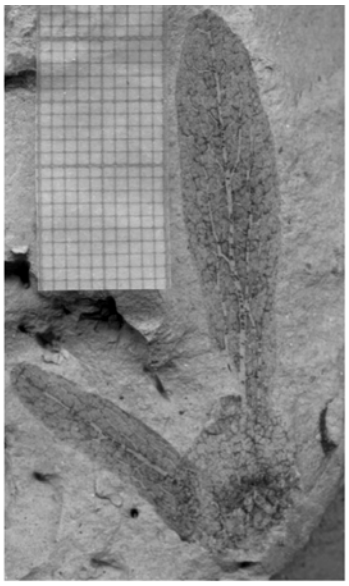

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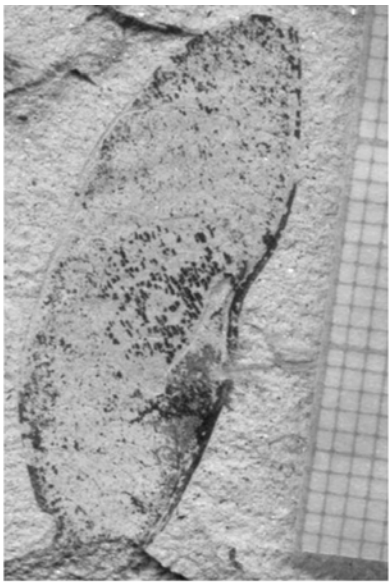

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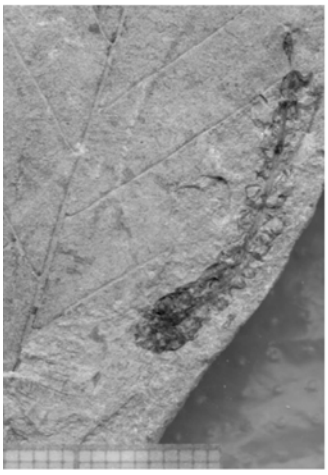

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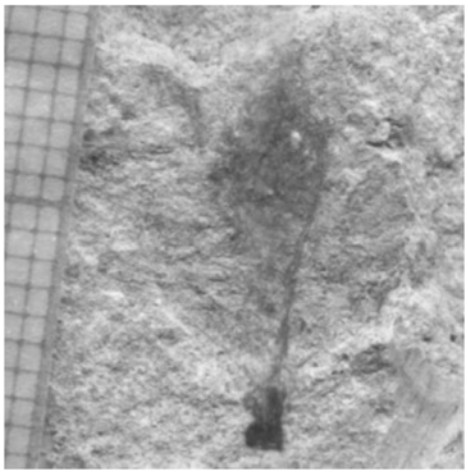

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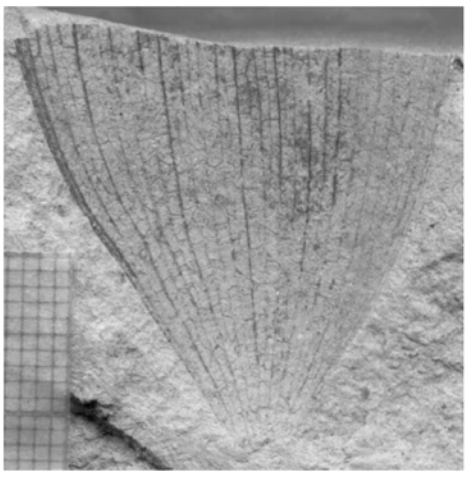

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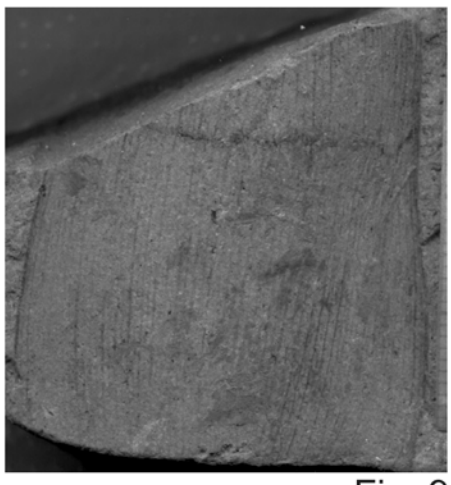

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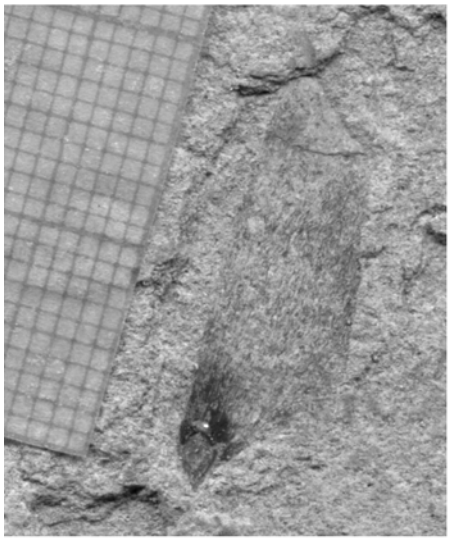

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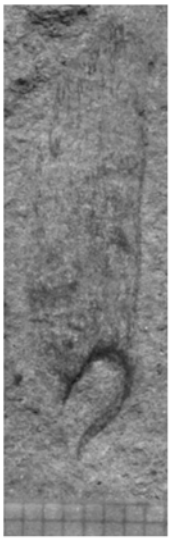

Fig. 2

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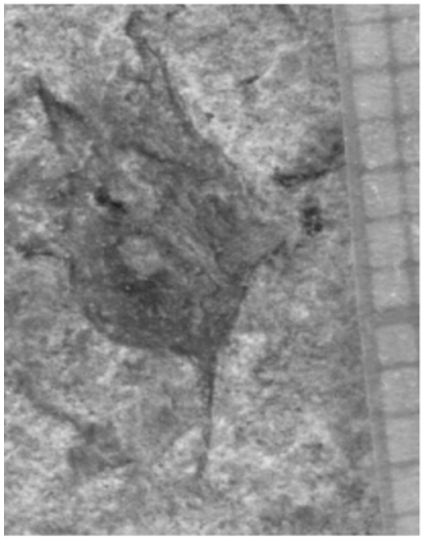

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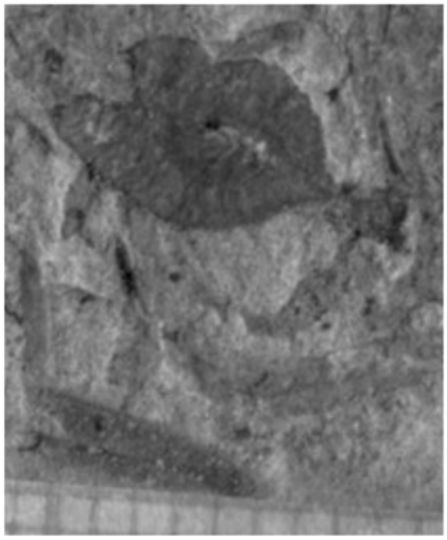

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