NEW CONTRIBUTIONS TO THE CIOCADIA MIDDLE MIOCENE FLORA (PART TWO)

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Abstract. Further revisions and detailed determinations are made for the plant fossil assemblages discovered in the Middle Miocene deposits of Ciocadia village, South Carpathian Foredeep. Arcto-Tertiary geofloristic elements are certified, namely *Berberis* sp., *B. coloradensis*, *Ulmus pyramidalis*, *U. parschlugiana*, and *Zelkova zelkovifolia*. The macroremains of these species are thoroughly described, figured and comparative analysis are made taking into account all the analogous fossils reported in Romania. Taphonomic and palaeoecological considerations are assumed to clarify the sedimentation conditions and factors and the palaeoenvironmental significance of the fossil plant occurrence is given.

Keywords: taxonomy, plant megafossils, *Berberis coloradensis*, Ciocadia, Middle Miocene.

Rezumat. Noi contribuţii la flora miocen medie de la Ciocadia (partea a doua). Elemente din asociația de plante fosile descoperite în depozitele Miocenului mediu din aria localității Ciocadia (Avanfosa Carpaților Meridionali) sunt descrise detaliat și au fost supuse unor revizii. Provincia geofloristică Arctoterțiară (care domină astăzi continentul Nord-American, Asia de Est extratropicală și Europa) este reprezentată în flora fosilă de la Ciocadia prin *Berberis* sp., *B. coloradensis*, *Ulmus pyramidalis*, *U. parschlugiana* și *Zelkova zelkovifolia*. Fosilele macroscopice de plante sunt analizate paleontologic, fotografiate și discutate comparativ în relație cu celelalte descoperiri similare din România. De asemenea, au fost simulate condițiile tafonomice și paleoecologice în care s-a realizat conservarea materialului vegetal sub formă de fosile și sunt oferite informații despre mediul depozițional (de sedimentare) și configurația paleoreliefului din timpul miocenului.

Cuvinte cheie: taxonomie, plante fosile, *Berberis coloradensis*, Ciocadia, Miocenul mediu.

INTRODUCTION

Occurrences of Berberidaceae are rare in the area of the Paratethys Basin; instead Ulmaceae remains are recovered in numerous sites, as samaras and sometimes as foliage. Now we undertake detailed analysis of two peculiar specimens of *Berberis*, two distinct groups of fruits belonging to *Ulmus*, and there also is described, for the first time in the palaeoflora of Ciocadia, *Zelkova* foliage. Recent studies of some selected taxa of Ciocadia flora contributed to the revision (PARASCHIV, 2008a, b; PARASCHIV & SEBE, 2011) of the palaeofloristic assemblage. We focus on the rectification of the previous taxonomic data in order to attempt a more precise floristic correlation with other Romanian and European Miocene sites. The palaeofloristic assemblage of Ciocadia is of great stratigraphical importance because of independent dating of the fossiliferous deposit by small marine invertebrate remains belonging to the group of pteropods (particularly the shelled pteropod *Limacina*, see Pl. I, Fig. 11). These deposits correspond to the 'Spirialis Marls' (POPESCU, 1953; TUDOR, 1955; MARINESCU, 1969; HUICĂ, 1994; PARASCHIV, 2006) which consist in a bloom (associated with a red tide phenomenon) of fossil holoplanktonic gastropods with thin aragonitic shells, very fragile, and which is easily subject to dissolution. The depth of the water column may be approximated as a reflexion of the presence of upwelling currents which bring nutrient-rich bottom waters up into the photic zone. Such high level of nutrients would allow primary productivity to occur at an explosive rate (SCHOPF, 1980). Meanwhile, only an upwelling during Ciocadia's marls deposition, and a possible red tide could explain the mass occurrence of *Limacina* (=*Spiratella* (*Spirialis*) horizon). *Spiratella* horizon is characteristic to the Late Badenian (Kossovian) normal marine deposits in the Central Paratethys (IORGULESCU, 1952; BOHN-HAVAS et al., 2004). Pteropod taphocoenosis can be, also, generated by deposition of storm currents (VELCESCU, 1997). But the recognized large scale extension of *Spiratella* horizon may exclude a tempestitic hypothesis. These deposits are conformably overlain by marine, brackish water laminated grey marls (also rich in phytoclast assemblages), siltic clays, sand and gravel beds belonging to the Early Sarmatian (Volhynian) stage. This complete series of shallow water deposits (Late Badenian-Early Sarmatian) provides a local to regional record of the flora, mollusc, insect and fish fauna (PARASCHIV, 2006).

MATERIAL AND METHODS

For analytical observations and studies of the fossil remains a Carl Zeiss - Jena Technoval Stereo Microscope (Binocular) was used, followed by examination of the literature. The repository place for the studied specimens is the National Museum of Geology of the Geological Institute of Romania, Bucharest. The accepted morphological terminology used is mainly based on HICKEY (1979) and WING et al. (1999). Systematic organization and taxonomic terminology in this article are based on the works of KUBITZKI (1993) and TAKHTAJAN (2009).

SYSTEMATIC PALAEOBOTANY

Phylum *Magnoliophyta* CRONQUIST 1996
Class *Magnoliopsida* (*Dicotyledons*) BRONGNIART 1843
Order *Berberidales* DUMORTIER 1829
Family *Berberidaceae* JUSSIEU 1789
Genus *Berberis* LINNAEUS 1753
Berberis sp.
Pl. I, Figs. 1, 2.

Material: BCI.0322, BCI.0322a.

Description. Incomplete obovate leaf, coriaceous, slightly asymmetrical, with missing base and rounded apex; more than ?35 mm in length and 14 mm is the maximum width. The lower part of the lamina is long, attenuated to cuneate. Leaf margin serrate, with tiny spines teeth, or irregularly with crenulated aspect, conspicuously revolute. Midvein strong, raised adaxially, slightly curved; secondary veins of festooned brochidodromous type, conspicuous, diverging at an angle of 20° to 35° from base to apex, and looping with upper secondary veins; inter-secondary veins simple, straight or arched, fusing with secondary veins; tertiary veins reticulate and quaternary veins forming polygonal areoles. The leaf was severely damaged during diagenesis being transversely ripped apart in close range; nevertheless the still preserved leaf architecture maintains well defined characters that relate it to the genus *Berberis*. The most probable resemblance of our specimen is with fossil *Berberis berberidifolia* (HEER) PALAMAREV & PETKOVA (PALAMAREV & PETKOVA, 1987; KVAČEK et al., 2004).

Remarks. *Berberis* remains are cited from the Palaeocene to Pleistocene sediments of the Northern Hemisphere (PETRESCU & DRAGASTAN, 1981; LI et al., 2010). In Romania, it is described *Berberis* sp. from the **Cornești-Aghireș** (Cluj County, PETRESCU et al., 1997) Oligocene (Late Rupelian-Early Chattian) deposits, *Berberis* sp. from the **Coruș** (Cluj County, ȚICLEANU & GIVULESCU, 1978) Early Miocene deposits, *B. andreanszkyi* KVAČEK & ERDEI from the Early Sarmatian deposits of the **Morilor Valley** section (Mehedinți County, PARASCHIV 2006, 2008b), *Berberis* sp. from **Corni** (Neamț County, ȚICLEANU & MICU, 1979) in the Middle Miocene (Middle Sarmatian-Basarabian) deposits, *Berberis kymeana* (UNGER) KVAČEK & ERDEI from **Valea Neagră de Criș** (Valea Crișului, ante Valea Neagră, Bihor County) in the Early Pannonian deposits (GIVULESCU, 2002), *Berberis goinai* GIVULESCU, *Berberis inopinata* GIVULESCU, *Berberis* cf. *mougeoti* (HEER) GIVULESCU and *Berberis lanceolata* GIVULESCU are described from the **Chiuzbaia** palaeoflora (Maramureș County) in the Late Miocene deposits (Late Pontian = Pannonian s.l. G/H, GIVULESCU, 1990). *Berberis* of Cornești-Aghireș flora show a pinnately brochidodromous venation, and leaf margin irregularly toothed with tiny oblique teeth. There is no resemblance with any of Ciocadia specimens and it may be close to *B. lycium* Royle (see LI et al., 2010) of the section Asiaticae. ȚICLEANU & GIVULESCU (1978) believed to recognize another specimen of *Berberis* in Coruș beds. They only give few characters like 'oblong leaf impression (40 mm long, 9 mm wide) with cuneate base and a 2 mm long petiole, rounded apex and entire margin; venation distinct', unfortunately without a helpful illustration. The presence of *Berberis* in the Sarmatian sediments of Corni is suitable but the leaf fragment lack in details. This poorly preserved specimen shows a weak brochidodromous venation that can fit with a question mark to the Berberidaceae. Although the fossil record is relatively abundant (especially in the Central and North American Tertiary floras), LI et al. (2010) validate only seventeen true species of fossil *Berberis* preserved as leaves and omitted two other species described by GIVULESCU (1990) in Chiuzbaia palaeoflora, respectively *Berberis inopinata* and *Berberis lanceolata*. The extant *Berberis vulgaris* Linnaeus is the single species of *Berberis* which grow naturally in Romania, as shrubs and bushes in sunny and dry hills, on rocky substrates (SĂVULESCU et al., 1955; CIOCÂRLAN, 2009). It is native to continental Europe, except for the northwest, and is rare in the Mediterranean region.

Berberis coloradensis AXELROD 1987
Pl. I, Fig. 3.

Mahonia hakeaeformis BECKER; BECKER, 1969, p. 90, Pl. XXVI, Fig. 4.
Berberis coloradensis AXELROD; AXELROD, 1987, p. 110, Pl. XXII, Figs. 1, 2, 3, 6, 7.

Material: BCI.0181.

Description. Small leaf almost complete, simple, narrowly elliptic, with the base quasi-symmetric, cuneate, basal angle acute, apex absent; the length is of about 20 mm and width of ?6 mm; midrib firm, thin in the most part of the lamina and thickened in the base, where it becomes slightly swollen and divergent (near the node around which the leaf can flex); petiole absent; basal acrodromous venation with two lateral secondary veins rising at low angles forming elongated and asymmetric loops, of characteristic festooned brochidodromous type; other secondaries originate at angles of 70°-80° extending straight to form brochidodromous loops that are elongated parallel to midrib joining to it; tertiary veins seems to be randomly reticulate; margin sparsely dentate, with one prominent, spiny tooth near the middle of blade and tiny apiculate teeth irregularly placed.

Remarks. This form is represented by one poorly preserved specimen; however the distinctive acrodromous venation, the festooned brochidodromy of the secondaries, rare spinose teeth or the missing petiole justified the type suite of the designated species. *Berberis coloradensis* was compared by AXELROD (1987) to the extant *B. candidula* SCHNEIDER which is endemic to China (where it lives at the altitude of 1200-3000 m in Hubei and Sichuan). Our specimen resembles much with the *Mahonia hakeaeformis* hypotypes figured by BECKER (1969) in figure 4 of the plate XXVI. Anyway, this leaf is dissimilar to the other presented in the same group, by its small dimensions and marginal architecture. *B. coloradensis* is one of the most primitive forms (plesiomorphy) and makes problematic any assignment of this species to any extant section of the genus (SCHORN & WOLFE, 1989). HABLY et al. (2000) disagree with that and suggest that *B. coloradensis* and one of the four *Berberis* new species identified in Mexico (RAMÍREZ & CEVALLOS-FERRIZ, 2000), *B. lozanofolia*, represent foliage of barberries related to the extant South American section *Actinacanthae*. This very intriguing fossil record is for the first time described in the Tertiary of Europe and rise questionable problems about phytogeography of *Berberis*. When did it migrate from Eastern Asia (see GÜNER & DENK, 2012) and what kind of route did it follow? What is the relation between the occurrences of *B. coloradensis* from the Late Oligocene Creede flora (North America), *B. lozanofolia* RAMÍREZ & CEVALLOS-FERRIZ from the Oligocene of Puebla (Mexico), and our Middle Miocene specimen as closely related species? Moreover, it cannot be explained the morphologically conservative character of the taxa during the Oligocene epoch and up to the Middle Miocene. *B. coloradensis* in Ciocadia fossil assemblage may now be considered endemic until there are made further discoveries.

Order Urticales DUMORTIER 1829
Family Ulmaceae MIRBEL 1815 nom. cons.
Genus *Ulmus* LINNAEUS 1753
Ulmus pyramidalis GOEPPERT 1855
Pl. I, Figs. 4, 5, 6, 7, 8, 9, 10.

Ulmus pyramidalis GOEPPERT, GOEPPERT, 1855, p. 29, Pl. XIII, Figs. 10, 11, 12; Pl. XIV, Figs. 18, 19, 20.
Ulmus Braunii HEER, HEER, 1859, p. 181, Pl. CLI, Fig. 29, 31.
Ulmus braunii HEER, BARBU, 1936, p. 379, Text-Fig. 18.
Ulmus pyramidalis GOEPPERT, BŮŽEK, 1971, p. 56-57, Pl. XIX, Figs. 3-18.

Material: BCI.0184, BCI.0269, BCI.0302, BCI.0313, BCI.0328, BCI.0562c, BCI.0615.

Description. One-seeded (dry) fruits, with the pericarp modified into a narrow winglike structure (samara), membranous, adapted for airborne dispersal, ovate to elliptic and orbicular in shape, typically of ?7.5-11.5 mm long and 4-5 mm wide. The base of the samara is concave, slightly asymmetric, stalked (1-4 mm long). The pedicels can often possess pieces of slightly thicker bracteoles (stipe) non-adherent to the base. Samaras conspicuously notched at the tip (beak-like tip or stigmatic cleft), and rarely with persistent lobed perianth, funnel-shaped pair of styles and bifurcate stigma. Seed (endocarp) compressed, distinct (of dark colour), elliptic to oval, 4 mm long and 1.5 mm wide, centrally or slightly toward base disposed on the samara; seed apex not reaching notch. Wings with strong axial vein laterally deflected from the stipe and connected to the seed, and radiant fine venation when visible.

Remarks. Leaves, fruits and pollen assignable to the Ulmaceae can be traced back to the Late Cretaceous, in North America, Europe, and Asia. Foliage and fruits of *Ulmus pyramidalis* are frequently cited in Europe from the Late Oligocene to the Pliocene time. Occurrence in the fossil floras of Romania: **Valea Jiului** (Zsil-Tales, Petroşani, Hunedoara County, Oligocene, leaves), **Valea Almaşului** (Sălaj County, Oligocene, leaves), **Surduc** (Sălaj County, Late Oligocene, Chattian, leaves), **Muereasca de Sus** (Vâlcea County, Late Oligocene-Early Miocene, fruits), **Coruş** (Cluj County, Early Miocene=Late Egerian, Aquitanian, fruits and leaves), **Tihău** (Sălaj County, Early Miocene, Eggenburgian, Burdigalian, leaves), **Slătioara** (Vâlcea County, Miocene, fruits), **Valea Glâmboaca** (Vâlcea County, Badenian, fruits), **Căstău** (Orăştie, Hunedoara County, Early Badenian, fruits), **Pârlagele** (Mehedinţi County, Late Badenian, leaves), **Porceni** (Gorj County, Sarmatian, leaves), **Râmeşti** (Vâlcea County, Sarmatian, leaves), **Feleac** (Cluj County, Sarmatian, fruits), **Comăneşti** (Bacău County, Sarmatian, leaves), **Oaş** (Satu-Mare County, Early Sarmatian, leaves), **Daia** (Sibiu County, Early Sarmatian, Volhynian, leaves), **Săcădate** (Sibiu County, Early Sarmatian, Volhynian, leaves), **Morilor Valley** (Mehedinţi County, Early Sarmatian, Volhynian-Early Basarabian, leaves and fruits), **Cavnic** (Maramureş County, Early Sarmatian, Volhynian-Early Basarabian, leaves), **Săcădate** (Sibiu County, Early Sarmatian, Volhynian-Early Basarabian, leaves), **Corni** (Neamţ County, Middle Sarmatian, Basarabian, leaves), **Buneşti** (Fălciu, Suceava County, Middle Sarmatian, leaves and woods, *Ulmoxylon kersonianum* STAROSTIN & TRELEA), **Tănăseşti-Râmeşti** (Vâlcea County, Late Sarmatian, Basarabian-Chersonian, leaves), **Hârşova** (Vaslui County, Late Sarmatian, leaves), **Păun** (Iaşi County, Late Sarmatian, Chersonian, leaves), **Valea Neagră de Criş** (Valea Crişului I & II, Bihor County, Pannonian B-C, leaves, GIVULESCU, 1997), **Beznea** (Delureni, Bihor County, Pannonian E, fruits), **Ibana Valley** (Mânzaţi, Vaslui County, Maeotian, leaves), **Turţ** (Satu Mare County, Pontian, leaves), **Băiţa** (Maramureş County, Pontian, leaves), **Micluşoara** (Covasna County, Pontian, leaves), **Borsec** (Harghita County, Pontian, leaves), **Odeşti** (Maramureş County, Early Pontian, leaves), **Sărmăşag** (Chieşd, Sălaj County, Early Pontian, leaves), **Crivina** (Mehedinţi County, Early Pontian, leaves), **Batoţi** (Mehedinţi County, Early Pontian, leaves), **Cornitel** (Bihor County, Early Pontian, leaves, fruits), **Vişag** (Valea Nochi Mică, Timiş County, Middle

Pontian=Portaferrian, leaves), **Chiuzbaia** (Maramureș County, Late Pontian, leaves), **Cărbunești** (Prahova County, Late Pontian-Early Dacian, leaves), **Jilț** (Jilț Sud open-pit coal mine, Gorj County, Early Pliocene, Dacian, leaves), **Bâcleș** (Dolj County, Late Pliocene, Middle Romanian, leaves), **Biborțeni** (Covasna County, Late Pliocene, leaves), and **Bodoș** (Covasna County, Late Pliocene-Pleistocene, leaves). There are signalled about 45 extant species of *Ulmus* (most speciose genus of the family) occurring widespread in the temperate and boreal regions of the Northern Hemisphere and extending into tropical America and Malesia (MANCHESTER, 1989). The centre of distribution seems to be central and northern Asia (KUBITZKI, 1993). According to CIOCÂRLAN (2009), in Romania there grow naturally only four *Ulmus* species: *U. laevis* PALLAS (syn. *U. effusa* WILLDENOW), *U. glabra* HUDSON (syn. *U. montana* STOKES; *U. scabra* MILLER), *U. procera* SALISBURY and *U. minor* MILLER (syn. *U. foliacea* GILIBERT ex C. K. SCHNEIDER; *U. campestris* auct non LINNAEUS; *U. carpinifolia* GLEDITSCH). Their ecology demonstrate high adaptation ability (BORLEA, 2004) concerning the soil humidity, preferring drained soils of typical forest steppe sites, but also can grow disseminated in easily flooded areas along river banks or in some meadows. *U. pyramidalis* GOEPPERT is commonly compared (BŮŽEK, 1971) with the modern *U. americana* LINNAEUS and *U. alata* MICHAUX, which are constituents of the riparian forests in the eastern and south-eastern USA. Apparently, the winged fruits from Ciocadia site match better with *U. americana* (section *Blepharocarpus* DUMORTIER) and probable not with *U. alata* of the section *Chaetoptelea* (LIEBMANN) C. SCHNEIDER. Currently, *U. pyramidalis* is considered a meso-hygrophyte member of intrazonal communities outside zonal communities, inhabiting as extrazonal element in gallery forests along high flood area of rivers, or sometimes in swampy conditions.

Ulmus parschlugiana KOVAR-EDER & KVAČEK 2004
Pl. I, Fig. 11.

Ulmus braunii HEER, BARBU, 1954, p. 41-42, Pl. VIII, Fig. 5.
Ulmus parschlugiana KOVAR-EDER & KVAČEK 2004; KOVAR-EDER, KVAČEK & STRÖBITZER-HERMANN, 2004, p. 67-68, Pl. VI, Figs. 23-26.

Material: BCI.0294.

Description. Larger single-seeded samaras, broadly oval, long stalked (stalk of 6 mm long). Endocarp distinct (of dark colour), with wing 10.5-15 mm long and 6.5-12 mm wide, elliptic to obovate in outline (4.5 mm long and 2.5 mm wide), styles persistent, 4 mm long. The seed body is typically oriented toward the base of samara and is surrounded by a broad membranous wing. Wings entire, very slightly undulate, usually do not have any distal stigmatic notch, or sometimes have a hint of a notch. The samara is flattened, where the seed is located, but not on the samara edges. Wing venation is clearly seen, composed of an axial vein laterally deflected from the stipe and connected to the seed, a surrounding strong marginal vein, and radiant reticulate fine venation from the seed, reticulate. Fruits are shortly stipitate, with stipe around 2 mm long.

Remarks. These kinds of endocarps with large wings are considered more evoluate because they may have improved the efficiency of fruit dispersal (DENK & DILLHOFF, 2005). The diversity of forms in the *Ulmus* fossils (leaves or samaras) is high in the Tertiary deposits of Europe, and is generally accepted the opinion of a greater specific differentiation in this genus. Large, broadly oval similar samaras are described in Romania from the **Morilor Valley** (Mehedinți County, Early Sarmatian, PARASCHIV, 2004), **Porceni** (Gorj County, Sarmatian, BARBU, 1954), and **Valea Neagră de Criș** (Valea Crișului I & II, Bihor County, Pannonian B-C, GIVULESCU, 1997). Because in Ciocadia palaeoflora *Ulmus* leaves have not been yet described we cannot assign the fruits to the correspondent foliage. KOVAR-EDER et al. (2004) merged similar fruits of *U. parschlugiana* with the only one elm species which is foliage producer at Parschlug, *U. plurinervia* UNGER. *U. parschlugiana* is described from Parschlug (Styria, Austria) in deposits of Karpatian/Early Badenian age, based on the palaeofloristic composition. Fruits with broader wings and close morphology are dispersed by extant elm species like *U. americana* LINNAEUS, *U. minor* MILLER (an European polymorphic species), or the European elm with the widest natural range *U. glabra* HUDSON.

Genus *Zelkova* SPACH 1841
Zelkova zelkovifolia (UNGER 1843) BŮŽEK & KOTLABA in KOTLABA, 1963
Pl. I, Fig. 12.

Zelkova (*Planera*) *ungeri* KOVATS, BARBU, 1932, p. 13-14, Text-Fig. 9.
Planera ungeri KOVATS, BARBU, 1934, p. 126-127, Text-Fig. 31.
Planera protokeaki SAPORTA, BARBU, 1934, p. 127, Text-Fig. 32.
Planera (*Zelkova*) *Ungeri* KOVATS, BARBU, 1942, p. 130, Fig. 15.

Material: BCI.0129.

Description. Young branches with leaves having inconspicuously pedicelate axillary fruits in anatomical connection. Leaves simple, slightly asymmetric, oblong ovate to elliptic, 25-31 mm long and 10-13 mm wide, alternate on the shoot, with symmetric or slightly asymmetrical base, rounded, apex shortly acute, slightly bent sideways,

gradually narrowed, and coarse simple-serrated to crenulated margins (with "*Zelkova*-like teeth" or "wavy-toothed"), regularly spaced. Apical side of teeth short, acuminate, basal side convex, angular shape of the sinus, and the tooth apex is simple. Petioles are strong, 1.5-3 mm long. Venation simple craspedodromous, with midrib strong, straight, distally bent. Secondary veins conspicuous, parallel, alternate, originating at 45-70°, seven to nine pairs of veins, distally curved upward, and innervating characteristically the apices of teeth (their apical branches terminate in tooth apex forming an angle of about 40° with primary vein). Tertiary veins and venation of higher order are not obvious. The fruits are dry, nut-like drupe, not winged, subglobose to carinate (after compression are obvious bilobed), with stigmas beak-shaped, oblique attached to the leaf insertion on the shoot, approximately 3 mm in diameter.

Remarks. The specimen, which is a young (current-season) fertile shoot with conspicuously zig-zag architecture, preserves three fruits, solitary, in the axils of upper leaves. This is a rare case with leaves that occur together with fruits in natural state, because *Zelkova* usually grew at some distance from the sedimentary basins (DENK & DILLHOFF 2005). Leaf fossils attributed to *Zelkova* are particularly common in Eurasia from the Eocene-Oligocene to the Plio-Pleistocene. This taxon is not very uniform as regards the general morphology of leaves (continuous transition *Ulmus-Zelkova*, comprising also common-size leaves, see BŮŽEK, 1971) but, in our case, the co-occurrence with characteristic fruits excludes any confusion. *Z. zelkovifolia* is widespread in the Tertiary floras of Romania: **Valea Almaşului** (Sălaj County, Oligocene, leaves and fossil woods, *Zelkovoxylon dacicum* PETRESCU), **Slătioara** (Vâlcea County, Miocene), **Coruş** (Cluj County, Early Miocene=Late Egerian, Aquitanian), **Tihău** (Sălaj County, Early Miocene), **Pătârlagele** (Buzău County, Late Badenian), **Baia Sprie** (Maramureş County, Sarmatian), **Racşa** (Satu-Mare County, Early Sarmatian), **Deva** (Hunedoara County, Early Sarmatian, Early Volhynian), **Morilor Valley** (Mehedinți County, Early Sarmatian), **Târnpa** (Hunedoara County, Early Sarmatian, as a fertile branch with three leaves and two fruits attached axillary), **Oaş** (Satu-Mare County, Early Sarmatian), **Pârteştii de Sus** (Suceava County, Early Sarmatian, Volhynian), **Corni** (Neamţ County, Middle Sarmatian), **Buneşti** (Fălciu, Suceava County, Middle Sarmatian), **Tănăseşti-Râmeşti** (Vâlcea County, Late Sarmatian), **Păun** (Iaşi County, Late Sarmatian), **Valea Neagră de Criş** (Valea Crişului I & II, Bihor County, Pannonian B-C, leaves with fruits), **Vadu Crişului** (Bihor County, Early Pannonian), **Beznea** (Delureni, Bihor County, Pannonian E), **Tirol** (Caraş-Severin County, Pannonian G), **Ibana Valley** (Mânzați, Vaslui County, Maeotian), **Sinersig** (Timiș County, Pontian), **Micluşoara** (Covasna County, Pontian), **Herculian** (Covasna County, Pontian), **Hărman** (Braşov County, Pontian), **Borsec** (Harghita County, Pontian), **Batoți** (Mehedinți County, Early Pontian), **Corniţel** (Bihor County, Early Pontian), **Vişag** (Valea Nochi Mică, Timiș County, Middle Pontian=Portaferrian), **Chiuzbaia** (Maramureş County, Late Pontian), **Cerna** (open-pit coal mine, Vâlcea County, Early Pliocene, Dacian), **Baraolt** ("Grădina cu mei", Covasna County, Late Pliocene, Early Villafranchian), **Biborțeni** (Bibartfalva, Covasna County, Late Pliocene), **Dobogeni** (Covasna County, Late Pliocene-Pleistocene), and **Bodoş** (Covasna County, Late Pliocene-Pleistocene). There are six extant species of *Zelkova*, two Mediterranean: *Z. abelicea*, originating from Crete and *Z. sicula* from south-eastern Sicily (NAKAGAWA et al., 1998), one Caucasian (Turkey, Georgia, Armenia, Azerbaijan, Iran) *Z. carpinifolia* (KVAVADZE & CONNOR, 2005), and three east Asian: the Chinese species *Z. schneideriana* and *Z. sinica* and the Japanese *Z. serrata* (DENK & GRIMM, 2005). *Z. zelkovifolia* can be compared with the recent species *Z. carpinifolia* (PALLAS) K. KOCH (=*Z. crenata* SPACH) from relic deciduous and mesophytic forests formations of Colchis (Caucasus, Kaçkar, and Alborz mountains). This mesophilous tree flourishes on moist well-drained soils and warm conditions, and do not show resilience to frost or tolerance to water logging or swampy conditions. *Z. zelkovifolia* is included in the (Warm-) temperate Broad leaved Deciduous Forest as a zonal vegetation formation (KVAČEK et al., 2006). It represents the so called "edaphic vegetation" because it probably lived on more humid soils along shallow streams that entered the sea, but also it was an important component of the mesophytic open woodlands.

RESULTS AND DISCUSSIONS

Taxa like *Berberis coloradensis*, *Ulmus pyramidalis* and *U. parschlugiana* show a combination of long stratigraphical ranges and wide geographic range, and presumably can demonstrate a considerable tolerance to changing environmental factors (TANAI & WOLFE, 1977). This study demonstrates that the occurrence of *Ulmus* fruits in the fossil assemblages is scarce and that its leaves are best preserved in sediments. Only 9 fossil floras from the total of 44 with *U. pyramidalis* remains are documented by fruits (and leaves). There is a large amount of *Ulmus* samaras in the Ciocadia palaeoflora and this can be explained by a characteristic dominance of this taxon. Because *Zelkova* twigs are poorly dispersed over long distances, the presence in the Ciocadia assemblage likely indicates its local origin and a significant participation together with *Ulmus* in palaeoforests.

CONCLUSIONS

This is the second part of a series of contributions, which will clarify the floristic and vegetation aspects of the Middle Miocene flora of Ciocadia (Oltenia Province). In this paper we describe well-preserved fossils of leaves attached to fruits belonging to *Zelkova*, leaves assignable to two different species of *Berberis*, and isolated fruits of *Ulmus*. We also provide the necessary data about the general occurrence in Romania of mentioned taxa and thus contribute to a better understanding of the evolution in Berberidaceae and Ulmaceae.

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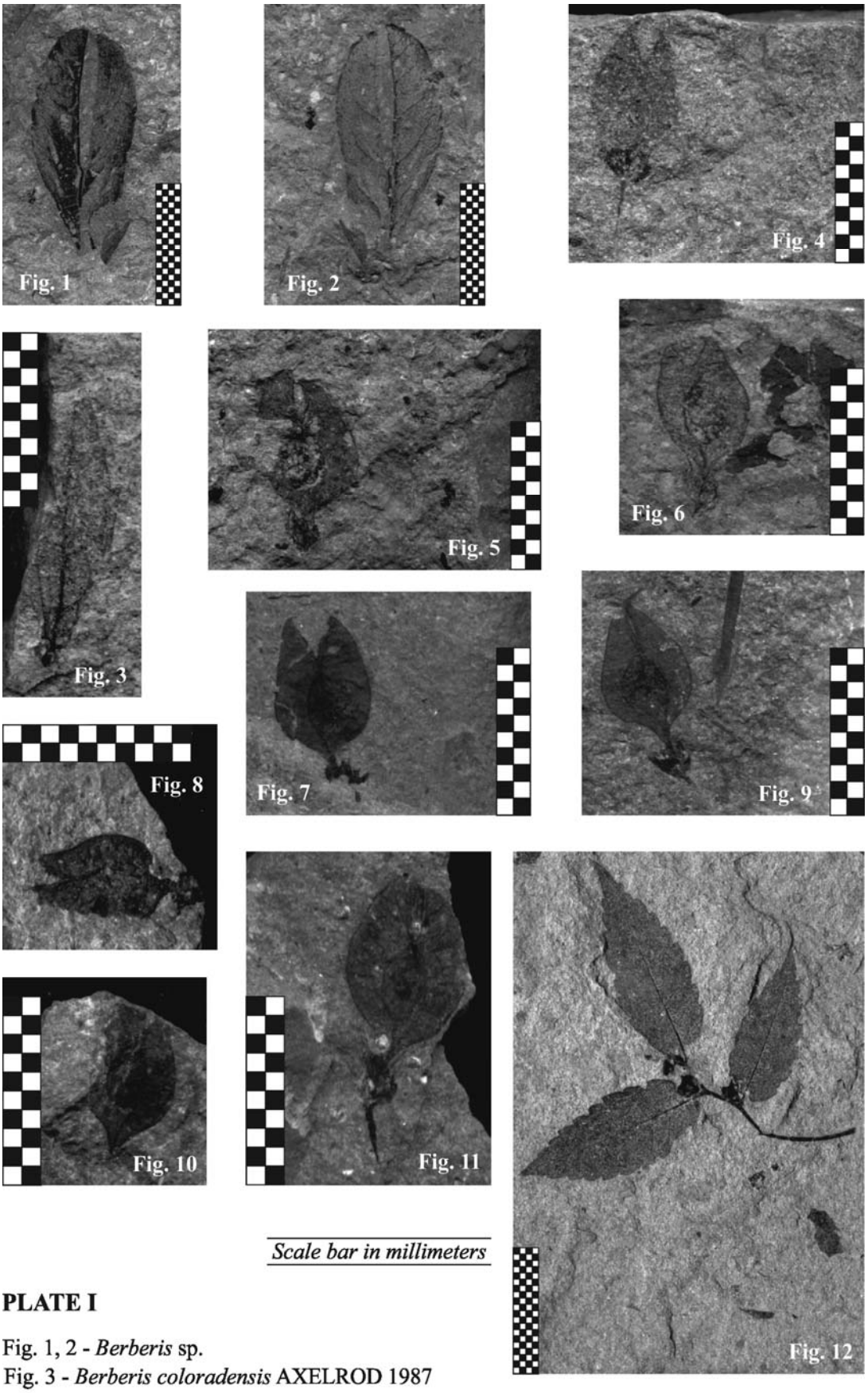

Scale bar in millimeters

PLATE I

Fig. 1, 2 - *Berberis* sp.
Fig. 3 - *Berberis coloradensis* AXELROD 1987
Fig. 4-10 - *Ulmus pyramidalis* GOEPPERT 1855
Fig. 11 - *Ulmus parschlugiana* KOVAR-EDER & Z. KVAČEK 2004
Fig. 12 - *Zelkova zelkovifolia* (UNGER 1843) BŮŽEK & KOTLABA in KOTLABA 1963