

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

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Abstract. Deciduous broad-leaved woody plants such as *Quercus drymeja* Unger, *Quercus gigas* Goeppert emend. Walther & Zastawniak, '*Castanea*' *kubinyii* Kováts ex Ettingshausen sensu Knobloch & Z. Kvaček, and *Fagus silesiaca* Walther & Zastawniak (Fagaceae) are established for leaves imprints from the middle Miocene Ciocadia Valley deposits of Southern Carpathian Foredeep, Romania. Well preserved plant fossil assemblages are to be found in rhythmically banded marlstones of marine shallow-water origin. The fossil plant record provides further evidence for the existence of rich warm temperate forests (comparable to the present Mixed Mesophytic Forest biome) with numerous exotic or endemic taxa. Carefully descriptions and documented revisions are made for the Fagaceae family representatives in the Ciocadia Valley paleoflora and various taphonomic, palaeoecological and palaeobiological aspects are discussed.

Keywords: leaf architecture, insect-plant interactions, damage types (DTs), Fagaceae.

Rezumat. Noi contribuții la flora miocen medie de la Ciocadia (partea a treia). Plante fosile arborescente, cu frunze late, aparținând taxonilor *Quercus drymeja* Unger, *Quercus gigas* Goeppert emend. Walther & Zastawniak, „*Castanea*” *kubinyii* Kováts ex Ettingshausen sensu Knobloch & Z. Kvaček, și *Fagus silesiaca* Walther & Zastawniak (Fagaceae) sunt descrise pe baza amprentelor foliare descoperite în depozitele Miocenului mediu ce aflorază pe Valea Ciocadia, localizată în sudul Avandosei Carpaților Meridionali, România. Aceste asociații de plante fosile, excelent conservate, au fost găsite în roci carbonatice laminate, de tipul marnelor cenușii, acumulate în zona litorală a paleo-oceanului denumit Paratethysul Central. Punerea în evidență a acestor resturi de plante fosile oferă dovezi suplimentare referitoare la prezența în trecut pe teritoriul României a unor păduri temperate și calde (comparabile cu așa-numitul biom actual al pădurilor mixte mezofitice), cu numeroși taxoni exotici și/sau endemici. În acest articol au fost efectuate diagnoze precise și revizuirii documentate doar asupra reprezentanților familiei Fagaceae prezenți în paleoflora Văii Ciocadia și au fost discutate diverse aspecte legate de tafonomia, paleoecologia și paleobiologia acestora.

Cuvinte cheie: arhitectură foliară, interacțiuni mutuale plante-insecte, tipuri de distrugerii ale frunzelor, Fagaceae.

INTRODUCTION

This investigation was based on specimens from three genera, namely *Quercus*, '*Castanea*' and *Fagus* which co-occur in the Middle Miocene flora of Ciocadia. Now, new analyses of the gross morphological features of the plant remains show that the material previously described (by PARASCHIV & SEBE 2011) as *Quercus kubinyii* Kováts ex Ettingshausen must be re-assign to '*Castanea*' *kubinyii* Kováts ex Ettingshausen sensu Knobloch & Z. Kvaček. In the matter of *Fagus* remains there is no indication of more than one species of this genus.

MATERIAL AND METHODS

Besides their remarkable preservation as cleavage impression-compressions, the number of plant specimens from Ciocadia site is quite high and strongly suggestive of a very short transport (arguably of order of kilometres), although it can also be imagined that such a concentration has resulted of some eddy (turbionar) process. Leaves are preserved either parallel to the stratification or they lie at some angle to it (reworked hydrodynamically). Fine morphological features are often visible; cuticles are not preserved. For analytical observations and studies of the fossil plant 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. Systematic organization and taxonomic terminology in this article are based on the works of KUBITZKI (1993) and TAKHTAJAN (2009). Leaf remains were analysed morphologically according to the terminology proposed by HICKEY (1979) and WING et al., 1999.

RESULTS IN SYSTEMATIC PALEOBOTANY

Subinfradivision Angiospermae Brown & Doell ex Doell 1857 (=Magnoliophytina Cronquist, Takhtajan & Zimmermann 1966)

Class Dicotyledoneae de Candolle 1819 (=Magnoliopsida Brongniart 1843)

Subclass Hamamelididae Takhtajan 1967

Order Fagales Engler 1892

Family Fagaceae Dumortier 1829

Genus *Quercus* Linnaeus 1753

Quercus drymeja Unger

Text-fig. 1d

1847 *Quercus drymeja* Unger, Chloris protogea, p. 113-114, Pl. 32, Figs. 1-4.

2011 *Quercus drymeja* Unger; Z. Kvaček, Teodoridis & Roiron, p. 30-31, Pl. 6, Figs. 1-6; Pl. 11, Figs. 11-13; Pl. 17, Figs. 4-5.

Material. Complete slender lamina: BCI.0134.

Description. Leaf simple, ovate lanceolate (spear-shaped), ?6.8 cm long and 1.8 cm wide (microphyll 2 to microphyll 3), with incomplete base and no petiole preserved, slightly asymmetrical; base angle acute, apex prolonged, acute to acuminate, leaf margin toothed, simply serrate, with regular or irregular acute, blunt to spiny teeth, distinct, rarely disposed, with zigzag feature, deep sinuses with shape rounded (Urticoid-Hamamelid Tooth Type, Z. KVAČEK et al., 2011); venation simple craspedodromous, with primary vein distinct, sinuate, strongly arcuated in the base (proximally) but also in the distal part, where the lamina become progressively narrowed; secondary veins thin, pinnate, alternate or opposite (in the apical part), arciform, 10-11 pairs, inserted at angles (from the base to the apex) of 50°-40°-30° towards the median vein, the secondary veins run out till the simple teeth of the margin; tertiary veins, when are visible, alternate percurrent, venation of the higher orders not obvious.

Remarks and discussions. In the upper third, the lamina it is slightly folded under itself (laminar contortion) due to the arrangement or reworking of leaves during or after emplacement at the sediment-water interface. The leaf described was infected by ovoid dark blister-like areas, < 3 mm maximum diameter, thoroughly carbonized and randomly disposed all over the lamina. This could represent the major foliar diseases of oak trees when they are attacked by fungal spores. Our specimen has several points of similarity to *Q. drymeja* diagnosed by UNGER (1847), namely the narrowly lanceolate lamina, the acuminate apex, the asymmetrical shape, the spiny teeth, the number and type of secondaries or the angle between these and midrib, which makes specific assignment to the discussed morphospecies more precise. *Quercus drymeja* is one of the most common Miocene sclerophyllous oaks of the Central Europe and Mediterranean area (BOZUKOV et al., 2011; KOVAR-EDER et al., 2004).

Thermophilous palaeotropical element which displays xeromorphic features, such as the serratures or teeth terminated by spines, *Q. drymeja* was adapted to warm and dry climate from coastal and low mountainous areas. The relatively dry habitats of the mountain slopes, with low species diversity, were occupied by xeromesophytic elements (or hemixerophytic, cf. NAKHUTSRISHVILI 2013), where *Q. drymeja* may flourish sufficiently distinct to rank as representative species.

The nearest living relative of *Q. drymeja* can be traced (GRANGEON, 1958; Z. KVAČEK et al., 2002) in the group of the extant *Quercus sartorii* Liebmann (from Mexico, native in tropical mesic forests of mountain slope, at 1000-2000 m), or *Quercus serrata* Murray, from deciduous forests situated below 2000 m in China, Japan and Korea. According to UNGER (1847) and PALAMAREV & TSENOV (2004), *Q. drymeja* has also affinities with *Q. lancifolia* Schlechtendal & Chamisso (endemic to the upper elevations, of 700-2400 m, in tropical forests located in the central and southern Mexico (Veracruz, Chiapas), Guatemala, Costa Rica, Panama, Honduras, and Nicaragua), *Q. xalapensis* Humboldt & Bonpland (from Mexico, native in tropical mesic forests at elevation of 1500 m above sea level), or *Q. libani* G. Olivier ('Black forests' of mountain areas from Lebanon and Syria, Asia Minor (eastern Turkey, and northern Iraq and Iran), a semi-shade deciduous or semi-evergreen shrub or tree).

Occurrence of *Q. drymeja* leaves in the fossil floras of Romania: Miocene-Slătioara, Vâlcea County (wrongly designated *Quercus kubinyii* (Kováts ex Ettingshausen) Czecczot, PARASCHIV 2006); Pannonian B-C Valea Neagră de Criș (Valea Crișului I & II), Bihor County (GIVULESCU 1962); Pannonian E-Delureni (Beznea), Bihor County (GIVULESCU 1983); Early Pontian-Cornîțel, Bihor County (GIVULESCU 1957); Early Pontian-Gheghie, Bihor County (GIVULESCU 1960); Late Pontian-Late Dacian (Early Pliocene) Cărbunești, Prahova County (denominated as *Quercus* aff. *Q. drymeja* Unger, GIVULESCU 2001).

Quercus gigas Goeppert emend. Walther & Zastawniak

Text-fig. 1a-c

1991 *Quercus gigas* Goeppert emend. Walther & Zastawniak, p. 160-169, Text-figs. 3-7; Pl. 4, Figs. 1-3; Pl. 5, 6, 7, Figs. 1-3; Pl. 8-10.

Material. Laminae incomplete: BCI.0127, BCI.0330, BCI.0250.

Description. Incomplete leaves and fragments, simple, slightly asymmetrical, oblong to obovate, ?10 (?11; ?5.5) cm long and ?2.7 (?4.7; ?4.2) cm wide (microphyll 2 to microphyll 3); without base preserved, and acute apex; leaf margin toothed, simple serrate, with mostly large and variable (coarse, hooked) wavy teeth, sometimes triangular, up to 4 mm high and 13 mm wide at the base, upcurved-flexuous (apical sides of teeth concave and basal sides convex), acute or acuminate-spinose (abruptly pointed to spine-tipped), deep sinuses with shape rounded (Urticoid-Hamamelid Tooth Type), apical angle of teeth acute to obtuse, regularly or irregularly spaced; venation simple craspedodromous, with primary vein straight, strong, up to 3 mm thick, tapering upward; secondary veins obvious, strongly pinnate (the secondary veins branch off at orderly intervals from the main central vein), at least 10 pairs, regularly-spaced, branching from midrib at intervals of 5-10 mm and at an divergence angle of 60° (median region), they are mostly opposite, passing through subopposite to alternate in the apical zone, running straight, slightly flexuous upwardly, but

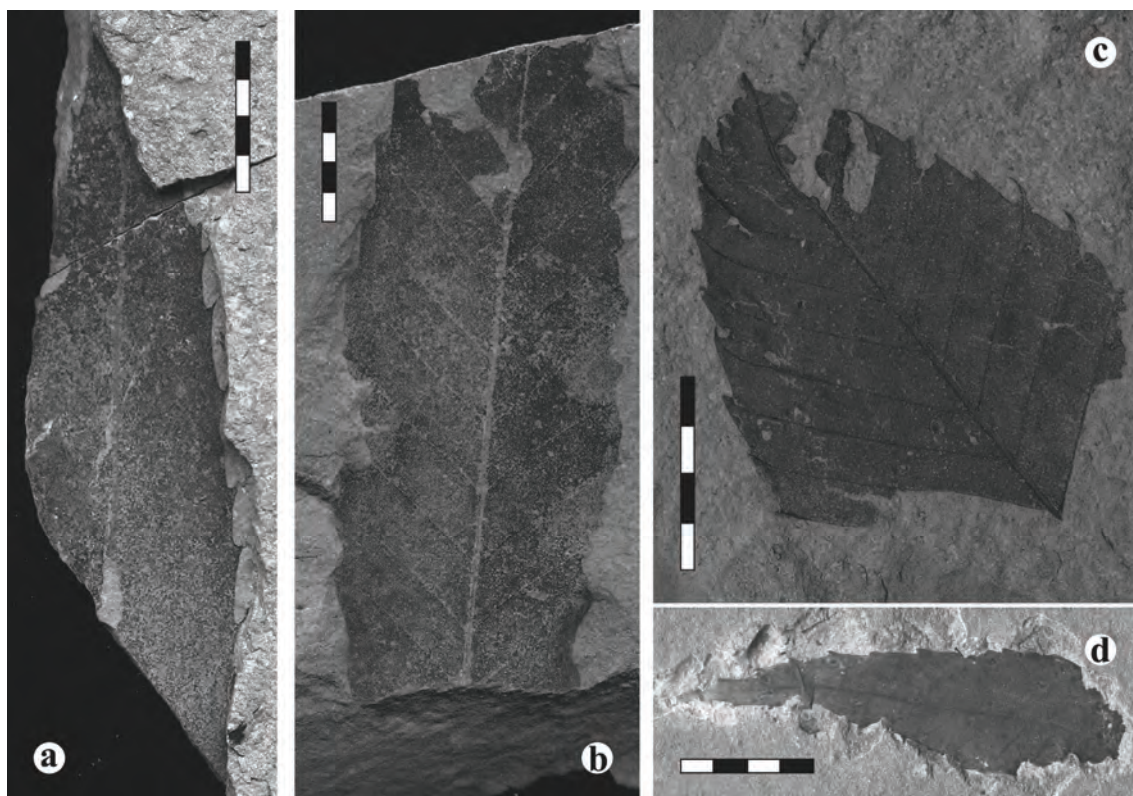
reversing its arching distally and crossing into long bristle-pointed teeth; tertiary veins when are visible, percurrent, more or less perpendicular to the secondaries.

Remarks and discussions. Although *Quercus gigas* presents an expanded diagnosis, WALTHER & ZASTAWNIAK (1991) strengthen the belief in the validity of this fossil species. The fossil oak leaves outlined great morphological variation, and in the *Q. gigas* type is now included *Q. kubinyii* Kovats pro parte, *Q. pontica miocenica* Kubát, *Q. czechotitiae* Hummel, and *Castanea atavia* Unger (WALTHER & ZASTAWNIAK, 1991). According to the same authors, *Q. gigas* may be related with the today living species of the monophyletic Group (Section or Subgenus) *Cerris* (Spach) Oersted, common in significant areas of Europe, Asia, and North Africa. *Q. gigas* is considered an important arctotertiary element of the Middle-Late Miocene floras in Europe (SONG et al., 2000; Z. KVAČEK et al., 2011). It was a representative broad-leaved deciduous element of warm-temperate mixed mesophytic forests (part of the zonal vegetation or climax vegetation of *Quercus* zone) from drier areas, in the middle altitude mountains to foothills. As noted by Z. KVAČEK et al. (2006), *Q. gigas* may occur partly on intrazonal (azonal) formations, probably riparian mixed forests, with *Ulmus* spp., *Acer* spp., *Cedrelospermum* spp., *Juglans* sp. and *Fraxinus macroptera*. This paleocommunity of sub-mountain to mountain forested wetlands was able to support dynamic groundwater near to surface, or short-term flooded sites, but never waterlogged.

The earliest verified macrofossils of *Quercus* are discovered in the Warman clay pit (Middle Eocene Claiborne Group), from western Tennessee, U.S.A., as staminate inflorescences (catkins) of *Q. oligocenensis* Daghljan & Crepet (WANG et al., 2013). Confirmed presence of fossil staminate flowers and pollen, belonging to either *Quercus* Group *Quercus* or *Lobatae*, is documented by CREPET (1989) from the Upper Eocene Baltic Amber (Prussian Formation). DENK et al. (2012) describes dispersed pollen belonging to *Quercus* Group *Ilex* from the Lower Oligocene (Rupelian) of Cospuden (Saxony, Germany) that may be the earliest unequivocal record of *Quercus* Group *Ilex* in Europe.

Nowadays the genus *Quercus* is widely distributed across the Northern Hemisphere with about 500 species in Europe, North Africa, Asia and North America (NIXON, 1989).

Occurrence of *Q. gigas* leaves in the fossil floras of Romania: Early Sarmatian (Volhynian-Early Basarabian) **Daia** (Thalheim), Sibiu County (wrongly assumed as *Castanea kubinyii* Kováts ex Ettingshausen, GIVULESCU 1975); Early Sarmatian-**Tâmpa**, Hunedoara County (described as *Castanea palaeopumilla* Andrae, BARBU 1932); Early Sarmatian-**Borod** (Valea Mâșca, drilling cores), Bihor County (wrongly assumed as *Castanea gigas* (Goepfert) Ilinskaya, GIVULESCU 1991); Pannonian-**Șoimi**, Bihor County (unfigured specimen, incorrectly attributed to *Quercus pontica miocenica* Kubát, GIVULESCU 1969); Pontian-**Borsec**, Harghita County (wrongly designated as *Quercus etymodrys* Unger, BARBU 1932); Late Pontian (= Pannonian s.l. G/H) **Chiuzbaia**, Maramureș County (wrongly attributed to *Castanea* sp., GIVULESCU 1984).



Text-fig. 1a-c - *Quercus gigas* Goepfert emend. Walther & Zastawniak. Scale bars, 20 mm.

Text-fig. 1d - *Quercus drymeja* Unger. Scale bar, 20 mm.

Genus (?) *Castanea* Miller 1759

'*Castanea*' *kubinyii* Kováts ex Ettingshausen sensu Knobloch & Z. Kvaček
Text-fig. 2a-d

1976 *Castanea kubinyii* Kováts ex Ettingshausen; Knobloch & Z. Kvaček, p. 35-38, Text-figs. 13, 14; Pl. 16, Figs. 7-9; Pl. 18, Figs. 1, 4-10; Pl. 23, Figs. 4, 6, 8-11; Pl. 31, Fig. 7.

Material. Laminae incomplete but also entire leaves: BCI.0301, BCI.0301a (counterpart), BCI.0305, BCI.0343.

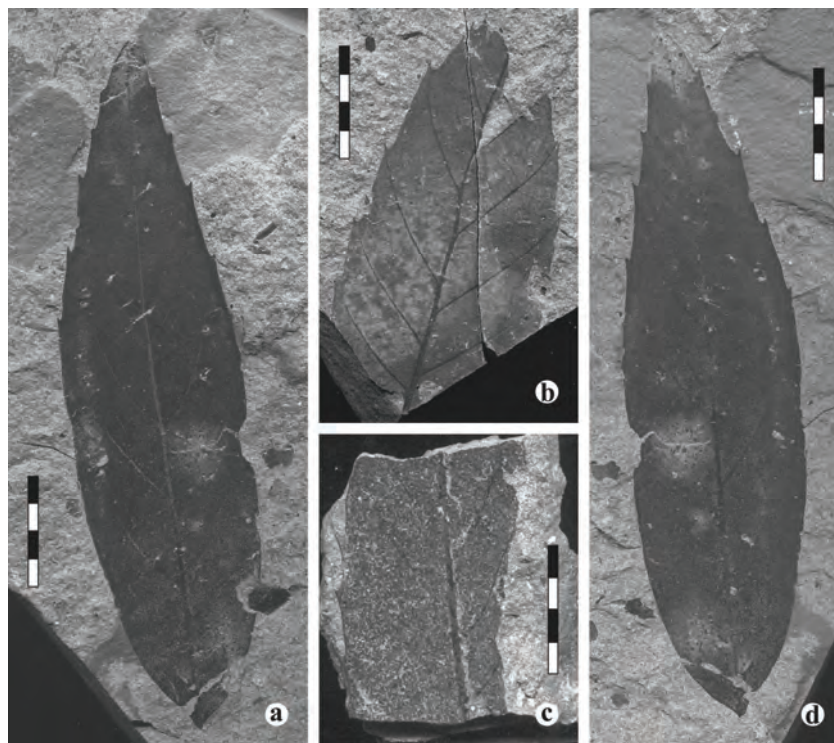
Description. Leaves entire or fragments, simple, symmetrical, with ovate-elliptic shape, 12.5 (?7.3; ?4.3) cm long and 3.4 (3.7; ?2.7) cm wide (microphyll 2 to microphyll 3); no petiole attached; base and apex angle acute, leaf base slightly asymmetrical, nearly rounded, partially decurrent; leaf margins toothed (dentate), simply serrated with each serration bearing a bristle tip (reaching up to 0.3 cm long), teeth moderate size or large (Text-fig. 2c), rarely spaced, narrow and point forward, apical sides of teeth deeply concave, basal sides concave to convex or acuminate (Text-fig. 2b), sinuses rounded (Urticoid-Hamamelid Tooth Type), tooth apex simple to spinose; in the first half (basal) the lamina margin is entire, more or less sinuous; venation simple craspedodromous, with the amendment that at the leaf base first pairs of secondary veins (suprabasal lateral veins) are interconnected into loops, primary vein strong (of moderate thickness or thick), straight, and obvious sinuate to the apex where it tapers gradually, secondary veins, 10-11 pairs, relatively thick, arise pinnate from the main vein at an angle of about 30°-40°, mainly alternate, few subopposite, slightly recurved, their course is arched and terminate upward in tooth apex passing into a bristle; tertiary veins ramified, reticulate or percurrent, convex or sinuous, forming an angle of 110-140° (commonly 120°) with primary vein, higher-orders of venation, when is observable, orthogonal reticulate, areoles well developed.

Remarks and discussions. The displayed leaf margins and the venation patterns are diagnostic to several fagacean fossil species such as *Castanea atavia* Unger, *C. gigas* (Goeppert) Ilinskaya, *C. kubinyii* Kováts ex Ettingshausen, *Quercus kubinyii* (Kováts ex Ettingshausen) Czecczot, and *Q. gigas* Goeppert emend. Walther & Zastawniak. Because such specimens are very similar in size, shape, and in general appearance, with both *Quercus* and *Castanea* (see WOROBIEC, 2003; Z. KVAČEK et al., 2011), it is still unclear whether the leaves of '*Castanea*' *kubinyii* belong to oak or chestnut. Although '*Castanea*' *kubinyii* was a conspicuous thermophilous element in many Middle-Late Neogene floras in Europe (Paratethys area), the details of the epidermal structure are not distinct enough (see Z. KVAČEK et al., 2002). Only a fortunate co-occurrence of fruits (nuts or/and cupules) together with this kind of foliage may help to clarify this problem. We assume, with some reserves, the denomination '*Castanea*' *kubinyii* for our specimens, giving credit to GIVULESCU (1990) who established that the comparison with *Quercus* is not morphologically or environmentally satisfactory. Moreover, the arctotertiary genus *Castanea* is unambiguously present in the Middle Miocene deposits of Romania, based on the rich fossil pollen record (*Tricolporopollenites cingulum* (Potonié) Thomson & Pflug, cf. PETRESCU, 2003).

Fossils of *Castanea* have been found throughout the Tertiary in the Northern Hemisphere beginning with the Palaeocene and until Late Pliocene (LANG et al., 2007). *Castanea* was a co-dominant element in the *Quercus-Carpinus-Castanea* association (MAI, 1995) of the upland warm-temperate mesophytic forests which correspond to deciduous broad-leaved forests (KOVAR-EDER et al., 2008).

GIVULESCU (1990) compared this fossil species to the extant species *Castanea sativa* Miller (*C. vesca* Gaertner), usually referred to as the European, Spanish or Sweet Chestnut, which is a large, deciduous tree, resistant to a very short dry season (limited by climate conditions) and distributed across the Mediterranean region, from the Caspian Sea to the Atlantic Ocean. The genus *Castanea* comprises three sections (*Castanea*-with three nuts per cupule, *Balanocastanon*-with one nut per cupule, and *Hypocastanon*-with a single nut per cupule) and seven species: *C. mollissima* Blume, *C. seguinii* Dode, *C. crenata* Siebold & Zuccharini, *C. dentata* (Marshall) Borkhausen, *C. sativa* Miller, *C. pumila* Miller, and *C. henryi* (Skan) Rehder & Wilson (DANE et al., 2003).

Occurrence of '*Castanea*' *kubinyii* leaves in the fossil floras of Romania: Miocene-Slătioara, Vâlcea County (wrongly assumed as *Castanea palaeovesca* Paolucci, BARBU 1942); Early Sarmatian (Volhynian-Early Bessarabian) **Cavnic**, Maramureş County (unfigured specimens, wrongly attributed to *Castanea atavia* Unger, GIVULESCU 1971b); Early Sarmatian-**Borod**, Bihor County (GIVULESCU 1944); Early Sarmatian-**Luncşoara**, Bihor County (GIVULESCU 1951); Sarmatian-**Porceni**, Gorj County (wrongly assumed as *Castanea palaeovesca* Paolucci, BARBU 1954); Sarmatian (Basarabian-Chersonian)-**Râmeşti** (Tănăşeşti-Râmeşti), Vâlcea County (wrongly assumed as *Castanea palaeovesca* Paolucci, BARBU 1954); Pannonian B-C **Valea Neagră de Criş** (Valea Crişului I & II), Bihor County (GIVULESCU 1956); Pannonian E-**Delureni** (Beznea), Bihor County (GIVULESCU 1983); Early Pontian-**Cornitel**, Bihor County (GIVULESCU 1957); Early Pontian-**Gheghie**, Bihor County (wrongly assumed as *Quercus kubinyii* (Kováts) Czecczot, GIVULESCU 1960); Pontian-**Borsec**, Harghita County (reported as *Castanea palaeovesca* Paolucci, BARBU 1932); Late Pontian (= Pannonian s.l. G/H) **Chiuzbaia**, Maramureş County (wrongly attributed to *Castanea* cf. *sativa* Miller, GIVULESCU 1964); Late Pontian-Late Dacian (Early Pliocene) **Cărbuneşti**, Prahova County (denominated as *Castanea* sp., GIVULESCU 2001).



Text-fig. 2a-d - '*Castanea*' *kubinyii* Kováts ex Ettingshausen sensu Knobloch & Z. Kvaček. Scale bars, 20 mm.

Genus *Fagus* Linnaeus 1753

Fagus silesiaca Walther & Zastawniak

Text-fig. 3a-c

1991 *Fagus silesiaca* Walther & Zastawniak, p. 156-160, Text-fig. 1; Pl. 1, Figs. 1-6; Pl. 2, Fig. 1.

Material. Laminae incomplete but also entire leaves: BCI.0547, BCI.0545, BCI.0548, BCI.0566 (counterpart).

Description. Leaves entire or fragments, simple, slightly asymmetrical, elliptic to oblong-ovate, 8.4 (?5) cm long and 3 (2.5; 3.4) cm wide (microphyll 2 to microphyll 3); relatively short (2 mm) or absent petiole, stout, slightly bent sideways; apex acute or attenuate, triangular, base cuneate to rounded, partially decurrent (with the laminar tissue from half of the base extending proximally along the petiole at a gradually decreasing angle), slightly undulate; leaf margin toothed, serrate, with small teeth, regularly or irregularly spaced, shape variable, often concave-flexuous, simple to acuminate, sometimes spinose, occasionally blunt, apically oriented, with sinus shape rounded, region of the base entire; venation pinnate, simple craspedodromous, rarely semicraspedodromous, with primary vein straight, strong, gradually narrowed, slightly sinuous in the upper part of the lamina (adaxial), 8-13 pair of secondary veins, straight or subparallel, near leaf margin slightly upwardly curved, repeatedly curved abaxial and concave downwards, distributed at intervals of 0.8-1.2 cm, moderately thick, alternately disposed on the midrib, with the two lowermost pairs opposite; the angles with the primary vein varies between 40° and 60° (increasing in the median part of the lamina, very rare up to 70°), each secondary vein enters basally in a single, sharp tooth; intersecondary veins not clear; the tertiary venation when is preserved, very thin, percurrent, mostly opposite, rarely alternate, simple or forked, forming an orthogonal reticulum, they are consistently obtuse to the midrib, with a proximally increasing vein angle; higher order of venation, when is visible, forming a network with well-developed quadrangular areoles.

Some highly distinctive insect damage types (DTs) are to be found on the fossil leaves of *Fagus* from Ciocadia. The appearance can be attributed to the good preservation of impression-type of plant material. First, (see Text-fig.3c) there are irregular to circular perforations, 1 to 3 mm in diameter, undiagnostic, which are classified as hole feeding (DT02, LABANDEIRA et al., 2007), which is the standard bite marks, occurring on primary and secondary veins; second, an incipient excision that is incised on the interveinal tissue, toward the primary vein (see Text-fig.3b), of margin feeding type (DT15, LABANDEIRA et al., 2007), the sides of the leaf are eaten, common in orthopterans and weevils; and third, piercing and sucking punctures (see Text-fig.3c), undiagnostic, circular, < 2 mm in diameter (DT47, LABANDEIRA et al., 2007), with central dome distinct, thick, dense, and thoroughly carbonized, surrounded by a brim of reaction tissue, caused by sucking insects which pierce the leaf blade to suck out the nutrients, and the pierce marks are left behind.

Remarks and discussions. After the process of examination of previously described foliage of fossil *Fagus* from Romania and Europe it became apparent that the taxonomy of middle Tertiary species of this genus is still unclear or in open nomenclature. Apparently, many authors have erected new species on characteristics of little systematic value (e.g. the morphology of shade leaves vs. sun leaves, when polymorphism is common not only in the fossil record, but also in the today living species of *Fagus*); some ignored the initial descriptions of the name bearing specimens, or have assigned material of widely differing morphology to the same species. Revision of some historical types usually lowers diversity of morphospecies once synonyms (or erroneously assigned fossils) have been recognized.

The fossil beech leaves described above differ from the leaves of the Lower Pliocene *Fagus kraeuselii* Z. Kvaček & Walther (= *F. haidingeri* Kováts sensu DENK 2004 pro parte) in having a greater number of secondary veins (8-13 pairs), from the Middle Oligocene-Early Miocene *Fagus saxonica* Z. Kvaček & Walther (WALTHER 1994), in having fewer secondary veins (*F. saxonica* has 12-16), and from the Middle Miocene *Fagus friedrichii* Grímsson & Denk, because they display less densely spaced secondary and tertiary veins, and from the Late Miocene *Fagus gussonii* Massalongo emend. Knobloch & Velitzelos in generally smaller leaves (GRÍMSSON & DENK, 2005). On the other hand, the above-noted venation features of *Fagus* do not always provide a sufficient tool for distinction of infrageneric species. *F. silesiaca* is very similar with *Fagus menzelii* Z. Kvaček & Walther (possible junior synonym from the Middle Miocene, see Z. KVAČEK & WALTHER, 1991), and may be the same taxon, based on the morphological resemblance and epidermal structure (WOROBIEC, 2003; WOROBIEC et al., 2012).

No cupules or bud scales of *Fagus silesiaca* were described until now from the Ciocadia site and the only form-species *Fagus deucalionis* Unger emend. Denk & Meller is described based on the cupule-nut complex from the Late Oligocene to Early Miocene of Central Europe (DENK & MELLER, 2001).

F. silesiaca occurs frequently in fossil floras from the Late Miocene to the Early Pliocene of Central Europe (WALTHER, 1994). KOVAR-EDER et al., 2004 consider that the beech maximum of Europe is starting with the latest Early Miocene. Now we extend its early colonisation to the Middle Miocene (Late Badenian-Early Sarmatian). Anyway, such a short range during the Neogene turns our *Fagus* morphospecies to be of great value in biostratigraphy and in establishing correlations. Because such leaf remains have traditionally been assigned in Romania to various species of *Fagus*, yet a reliable assignment can be made to *F. silesiaca*, grace to its distinct characters.

The main synonyms of *F. silesiaca* are *Fagus attenuata* Goeppert, *Fagus haidingeri* Kováts sensu Knobloch (WOROBIEC, 2003), *Fagus pliocaenica* Saporta, *Fagus pristina* Saporta (BARRÓN & DIÉGUEZ, 1994).

Fagus silesiaca certainly inhabited wider areas and most probably belonged to zonal vegetation, of mesophytic deciduous or mixed broad-leaved evergreen forest formation (Z. KVAČEK et al., 2006). This tree was one of the arctotertiary dominant elements from the Ciocadia paleoflora. It populated moist, rich soils of uplands, or well-drained lowlands, and it sometimes formed either dense patches or larger and maybe pure stands (after the great number of leaf remains) due to vegetative propagation from stumps and trunks of young trees. By the presence of subtropical elements, like *Tetraclinis salicornioides*, *Cunninghamia*, *Glyptostrobus europaeus*, *Laurophyllum* etc. (PARASCHIV & SEBE, 2011), these forests certainly developed in a warmer climate than the present-day beech forests.

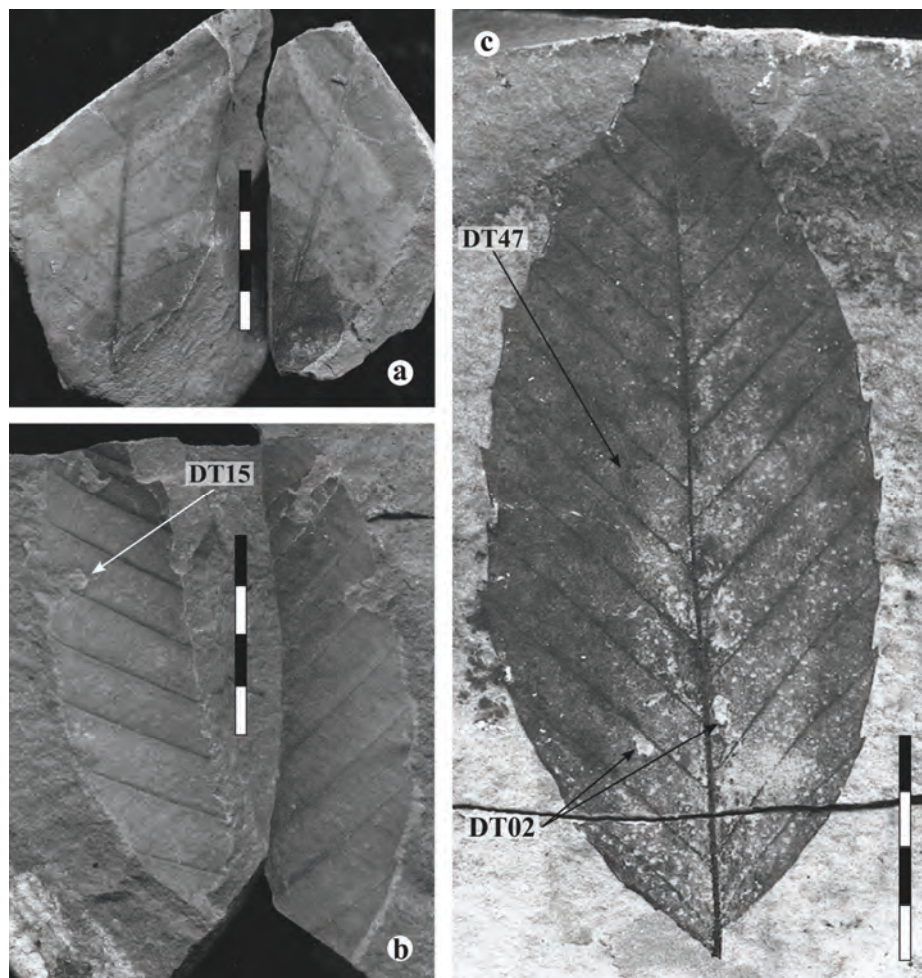
F. silesiaca is compared with the modern species *F. longipetiolata* Seemen (PALAMAREV & IVANOV, 2003), native to China and Vietnam, where it grows on broad-leaved evergreen and mixed mesophytic forests on mountain slopes, *F. hayatae* Palibin ex Hayata (WOROBIEC, 2003), which flourish in the mixed mesophytic forests of Central China, and *F. grandifolia* Ehrhart (PALAMAREV & MAI, 1998), whose area covers almost the entire eastern half of the U.S.A. from Labrador Peninsula to the north of Florida Peninsula, where it lives as a dominant species in mixed deciduous forests (Northern and Central Hardwood, and Southeastern Forest Region).

Fagus is a small genus (10 or 13 species) of broad-leaved deciduous trees (disjunctly distributed in temperate areas of the Northern Hemisphere-Holarctic ecozone) with two accepted subgenera, based on phylogenetic studies, *Engleriana* Shen with the species *F. engleriana* Seemen in Diels (incl. *F. multinervis* Nakai) of China and South Korea, *F. japonica* Maximovich from Japan and *F. okamotoi* Shen (Japan), and *Fagus* Shen, with the species *F. longipetiolata* Seemen (China), *F. brevipetiolata* Hu (China), *F. bijiensis* C. F. Wei & Y. T. Chang (limited to Western China), *F. tientaiensis* T. N. Liou (limited to Eastern China), *F. lucida* Rehder & E. H. Wilson in Sargent (China), *F. chienii* Cheng (limited to Western China), *F. hayatae* Palibin in Hayata (incl. *F. pashanica* C. C. Yang) from China mainland and Taiwan, *F. crenata* Blume (Japan), *F. sylvatica* Linnaeus (incl. *F. orientalis* Lipsky, and *F. moesiaca* (K. Malý) Czechtz, from Europe and southwestern Asia), and *F. grandifolia* Ehrhart (incl. *F. mexicana* Martinez or *F. ferruginea* Aiton) of Eastern North America and Mexico (cf. DENK et al., 2005). *Fagus* grows abundantly in undisturbed forest habitats of *Fagus* Zone (phytogeographical unit disposed on different altitudinal gradients from 1200-1300 meters up to 1500-1700 meters).

The oldest fossil occurrence of this genus based on both fruits and leaves, is provided by *Fagus langevinii* Manchester & Dillhoff from the Middle Eocene of McAbee, British Columbia, and Republic, Washington (MANCHESTER & DILLHOFF, 2004), which outperform the previous record of *Fagus pacifica* Chaney from the Early Oligocene Bridge Creek flora of Oregon (MEYER & MANCHESTER, 1997).

Occurrence of *F. silesiaca* leaves in the fossil floras of Romania: Miocene-Slătioara, Vâlcea County (wrongly assumed as *Fagus* aff. *ferruginea* Aiton, BARBU 1942); Sarmatian-Porcenii, Gorj County (wrongly assumed as *Fagus* aff. *ferruginea* Aiton, BARBU 1954); Early Sarmatian-Morilor Valley, Mehedinți County (PARASCHIV 2004, conferred); Late Miocene (Maeotian)-Negoești, Dolj County (wrongly presumed as *Fagus sylvatica* Linnaeus

fossilis Laurent & Marty, BARBU 1954); Pannonian B-C **Valea Neagră de Criș** (Valea Crișului I & II), Bihor County (incorrectly assumed as *Fagus attenuata* Goepfert or *Fagus sylvatica* Linnaeus *fossilis* Laurent & Marty, GIVULESCU 1956); Pannonian E-**Delureni** (Beznea), Bihor County (wrongly ascribed to *Fagus attenuata* Goepfert, GIVULESCU 1983); Pannonian-**Guşterița**, Sibiu County (unfigured specimen, incorrectly attributed to *Fagus attenuata* Goepfert, GIVULESCU 1969); Early Pontian-**Cornițel**, Bihor County (incorrectly determined as *Fagus attenuata* Goepfert or *Fagus feroniae* Unger, GIVULESCU 1957); Early Pontian (Odessian) **Batoți**, Mehedinți County (PETRESCU et al., 2002, not figured or described; ȚICLEANU et al., 2002, incorrectly categorized, in both works, as *Fagus pliocaenica* Saporta); Pontian-**Borsec**, Harghita County (reported as *Fagus* aff. *ferruginea* Aiton, BARBU 1932); Pontian-**Crăguiești**, Mehedinți County (DIACONU 2007, not figured or described); Late Pontian (= Pannonian s.l. G/H) **Chiuzbaia**, Maramureș County (wrongly ascribed to *Fagus attenuata* Goepfert, GIVULESCU 1964); Late Dacian (Early Pliocene) **Dedovița**, Mehedinți County (GIVULESCU 2001); Late Pliocene-**Biborțeni**, Covasna County, (incorrectly determined as *Fagus* cf. *grandifolia* Ehrhart or *Fagus* sp. aff. *sylvatica* Linnaeus, GIVULESCU 1971a).



Text-fig. 3a-c - *Fagus silesiaca* Walther & Zastawniak. Scale bars, 20 mm.

CONCLUSIONS

As a generality, a high floral diversity (as in the Middle Miocene floras of Romania) associated with high insect-feeding activity, indicate a 'healthy' plant-insect system (WAPPLER et al., 2009). The local palaeogeography and equable climate (oceanic influenced) enabled different fossil taxa to extend far outside their 'normal' ranges of distribution as we know today from the nearest living species. This can be sustained by the fact that deciduous fossil species (of *Fagus*, '*Castanea*', *Quercus*, *Carpinus*, *Betula*, *Ulmus*) grow together alongside evergreen taxa (*Laurophyllum*, *Daphnogene*, *Engelhardia*, *Ziziphus*) or taxonomically isolated and seemingly relict forms (as *Berberis* or *Cedrelospermum*). Their abundance in the fossil record and their representation by heavy organs such as foliage is interpreted as indicating that they lived on adjacent slopes near sites of deposition. An altitudinal differentiation of the vegetation in the Ciocadia area already existed in the Middle Miocene as suggested by the presence of *Tetraclinis salicornioides*, *Glyptostrobus europaeus*, *Ulmus pyramidalis*, *Carpinus* spp., *Quercus gigas*, *Fagus silesiaca*, *Platanus* sp., *Pinus* spp., *Picea* sp., *Cunninghamia* sp., etc. (see ȚICLEANU, 1984; PARASCHIV & SEBE, 2011; PARASCHIV, 2013).

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