

Trapa kvacekii (Trapaceae), a remarkable new fossil species from the late Miocene of Greece

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ABSTRACT. *Trapa kvacekii* Wójcicki & D. Velitzelos (Trapaceae), a new fossil species from the late Miocene of Likudi near Ellassone (Thessalia, Greece) is described, illustrated and briefly discussed. It differs markedly from its congeners by fruit morphology, primarily by the characteristic fruit body oblong-triangular in outline, well-developed high ring at the base, and stout lower horns inserted 3/5 to 3/4 the distance from the base of the fruit.

KEY WORDS: *Trapa*, Trapaceae, new species, fruit morphology, late Miocene, Greece

INTRODUCTION

The late Miocene diatomites in Likudi near Ellassona (Thessalia, Greece) are known from rich and well-preserved leaf flora (Velitzelos & Gregor 1985, 1986, 1990, Knobloch & Velitzelos 1986, 1987, Mai 1995, Velitzelos et al. 2000). Their unique character is manifested by four new species of trees – *Quercus dubia* Knobloch & Velitzelos, *Q. likudensis* Knobloch & Velitzelos, *Ostrya likudensis* Knobloch & Velitzelos, and *Salix massalongii* Knobloch & Velitzelos, restricted to this locality (Knobloch & Velitzelos 1987) – and one legume *Gymnocladocarpum velitzelosii* Gregor of the subfamily Caesalpinioideae, probably ancestral to SE North American *Gymnocladus dioica* (L.) K. Koch (Gregor 1986).

Recent collections of the second author yielded new material from Likudi (Fig. 1), including several relatively well-preserved impressions of *Trapa* fruits of interesting morphology, which represent a new fossil species described here.

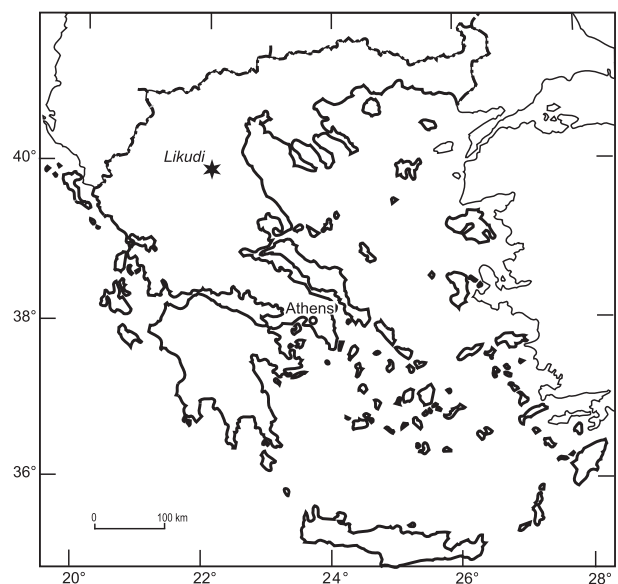


Fig. 1. Geographic location of the site of *Trapa kvacekii* Wójcicki & D. Velitzelos sp. nov. at Likudi near Ellassona, Greece

MATERIAL AND METHODS

Nine *Trapa* specimens exist as impressions in soft whitish or yellowish finely bedded diatomite, sometimes with remnants of oxidised and/or carbonised endocarp. They were collected from an erosion-exposed slope in a valley between Likudi and Kleisura, ca. 10 km NW of Ellassona (Fig. 1) marked on a schematic map provided by Velitzelos and Gregor (1986, Fig. 3) as "Likudi 5". *Trapa* fossils are reported from this place as *Trapa* sp. by Velitzelos and Gregor (1990), but they have not been described so far. The age of the locality is not precise, but according to Knobloch and Velitzelos (1987) it is late Miocene, younger than late Badenian (see also Kovar-Eder et al. 2006).

Most fruit impressions from Likudi are relatively well preserved (Figs 2, 3) and they bear characteristics that permit more precise interpretation of their morphology. Six of them are impressions of almost complete fruit compressions in the plane of the upper horns (Figs 2A–C, 3A–E, G). Two other fruits were positioned differently in the sediment, one in the plane of the lower horns (Fig. 3F) and the other obliquely in the plane of the upper horns (Figs 2D, 3H), enabling confirmation of the presence of well-developed lower horns, and their characterisation.

To stabilise the morphology of the *Trapa* fruit impressions and to prevent degradation and removal of organic matter, the samples were coated with arti-

ficial resin (Poraloid dissolved in acetone) after preparation of the specimens. Photographic documentation was made with a standard Nikon Coolpix 995 digital camera. The contrast was enhanced by low-angle light.

The material described here is housed in the palaeobotanical collection of the Department of Historical Geology and Palaeontology, Athens University, Athens (DHGPA; eight specimens), and one specimen, kindly donated by the second author, is stored in the Palaeobotanical Museum of the W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków (KRAM-P). Comparative fossil plant material was studied by the first author in the palaeobotanical collections of Barcelona (Departament d'Estratigrafia, Paleontologia i Geociències Marines, Universitat de Barcelona), Beijing (Institute of Botany, Chinese Academy of Sciences), Berlin (Museum für Naturkunde), Brno (The Moravian Museum), Bucharest (Department of Geology and Palaeontology, University of Bucharest), Budapest (Hungarian Natural History Museum and Geological Institute of Hungary), Cottbus (Museum der Natur und Umwelt), Dresden (Staatliche Sammlungen, Museum für Mineralogie und Geologie), Frankfurt (Palaeobotanical Section of the Forschungsinstitut Senckenberg), Kraków (W. Szafer Institute of Botany, Polish Academy of Sciences), London (Palaeontological Collection of the British Museum – Natural History), Munich (Bayer-

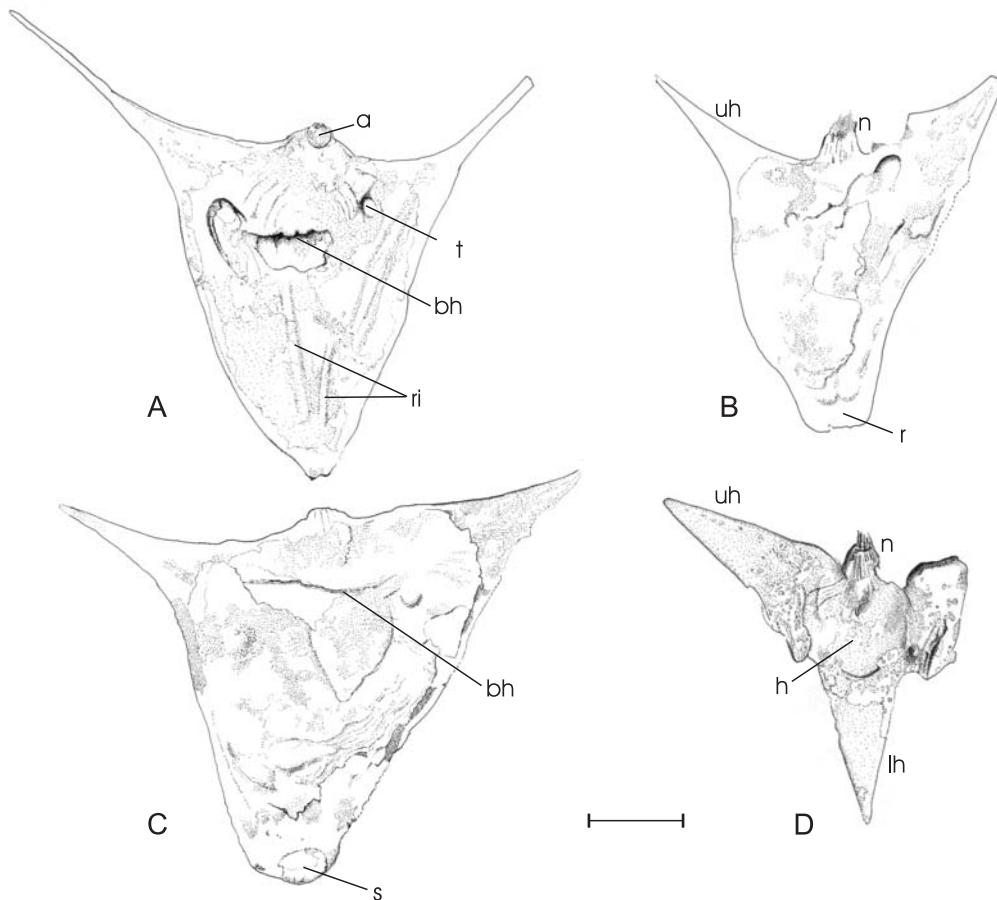


Fig. 2. *Trapa kvacekii* Wójcicki & D. Velitzelos sp. nov. from Likudi near Ellassona. **A** – No. DHGPA L/Tr/1 (= Fig. 3A), **B** – DHGPA L/Tr/5 (= Fig. 3D), **C** – DHGPA L/Tr/2 (= Fig. 3B), **D** – DHGPA L/Tr/9 (= Fig. 3H); **A** – holotype, **B**, **C** – paratype. **a** – apical aperture, **bh** – base of lower horn, **h** – head, **lh** – lower horn, **n** – neck, **r** – ring, **ri** – ribs, **s** – scar, **t** – trace of tubercle, **uh** – upper horn; scale bar 1 cm

ische Staatssammlung für Paläontologie und Geologie in Munich), Nanjing (Institute of Geology and Palaeontology, Chinese Academy of Sciences), Stockholm (Swedish Museum of Natural History), St. Petersburg (Komarov Botanical Institute, Russian Academy of Sciences), Turin (Museo di Geologia e Paleontologia of

the Turin University) and Vienna (Geological-Palaeontological Department of the Natural History Museum). Extant plant material was studied in or obtained on loan from the following herbaria: B, BM, BP, CAL, FI, KRAM, KW, LE, LY, MW, MHA, P, PE, PR, PRC, S, W, WU, Z (acronyms follow Holmgren et al. 1990).

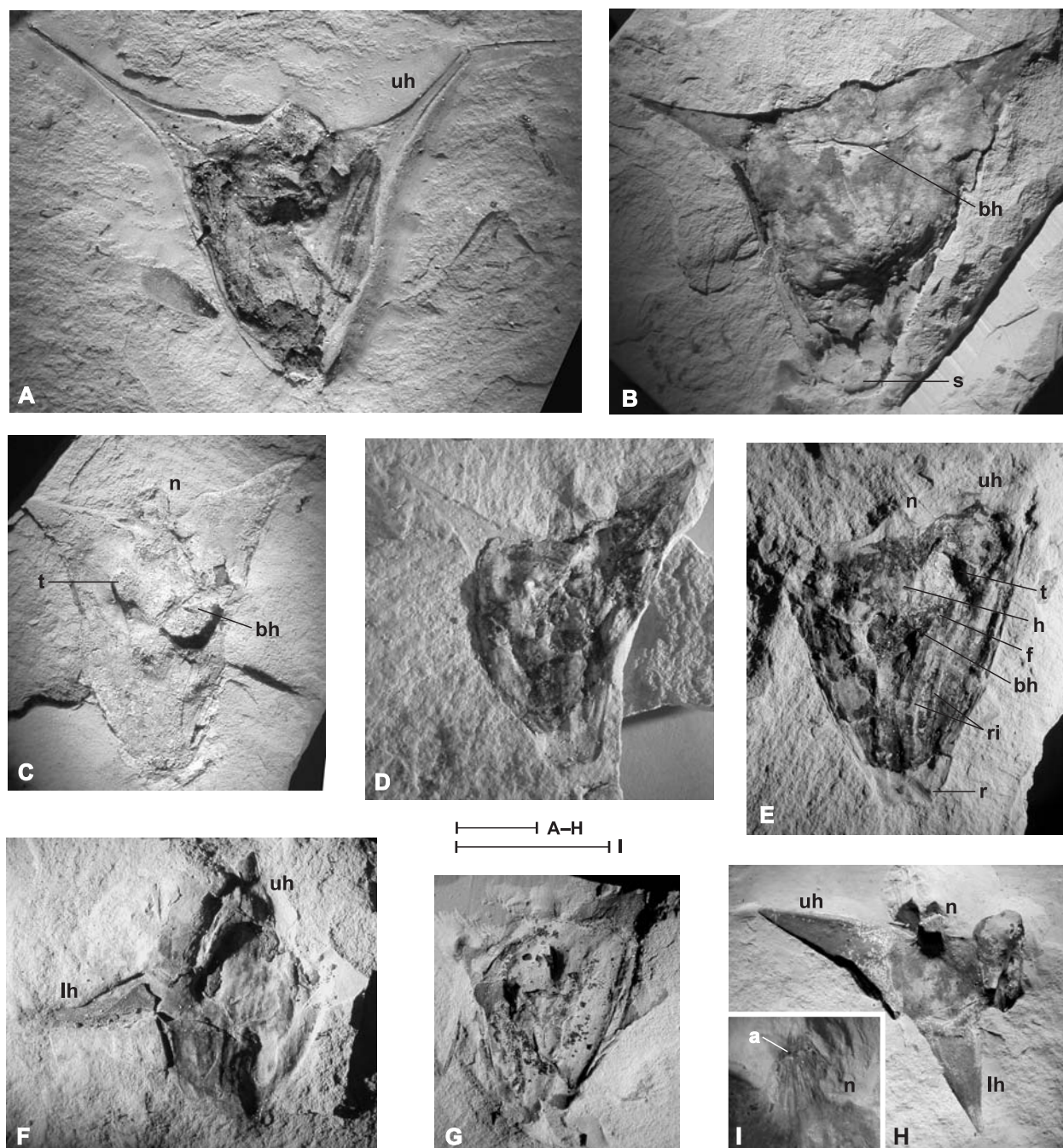


Fig. 3. *Trapa kvacekii* Wójcicki & D. Velitzelos sp. nov. from Likudi near Ellassona. **A** – No. DHGPA L/Tr/1 (= Fig. 2A), **B** – DHGPA L/Tr/2 (= Fig. 2B), **C** – KRAM-P 249, **D** – DHGPA L/Tr/5 (= Fig. 2B), **E** – DHGPA L/Tr/6, **F** – DHGPA L/Tr/7, **G** – DHGPA L/Tr/8, **H** – DHGPA L/Tr/9 (= Fig. 2D), **I** – neck of **H** with visible upward-pointing hairs closing apical aperture; **A** – holotype, **B**, **C**, **D** – paratypes. **a** – apical aperture, **bh** – base of lower horn, **f** – frame, **h** – head, **lh** – lower horn, **n** – neck, **r** – ring, **ri** – ribs, **s** – scar, **t** – trace of tubercle, **uh** – upper horn; scale bars 1 cm

SYSTEMATICS

Trapaceae Doum. *nom. cons.*

Trapa kvacekii Wójcicki
& D. Velitzelos **sp. nov.**

Figs 2A–D, 3A–I

Holotype (designated here). Coll. file No. DHGPA L/Tr/1 (Figs 2A & 3A).

Paratypes. Coll. file Nos DHGPA L/Tr/2 (Figs 2C & 3B), L/Tr/5 (Figs 2B & 3D); KRAM-P 249 (Fig. 3C).

Further material. Coll. file Nos DHGPA L/Tr/3, L/Tr/6 (Fig. 3E), L/Tr/7 (Fig. 3F), L/Tr/8 (Fig. 3G), L/Tr/9 (Figs 2D & 3H).

Type locality. Erosion exposed slope in a valley between Likudi and Kleisura near Elassona, Thessalia, Greece ("Likudi 5" according to Velitzelos & Gregor 1986).

Type horizon. Yellowish diatomite.

Age. Late Miocene.

Derivation of the name. Named after the eminent Czech palaeobotanist Professor Zlatko Kvaček in recognition of his contribution to Tertiary palaeobotany.

Diagnosis and description. Large fruits, oblong-triangular in outline, with two pairs of solid horns; fruit 31–41 mm high (including neck), width of fruit at upper horns 40–55 mm; fruit about 1.3 times as wide as high; fruit head pronounced, 8–10 mm long, its upper end situated below the line joining the bases of the upper horns, bearing a well-developed neck usually somewhat narrowing towards the apex; neck 3–4 mm long and 3.5–5.0 mm broad, slightly protruding beyond the line joining the bases of the upper horns, corona lacking; apical aperture with a ring of upward-pointing hairs; surface of fruit head and neck finely ribbed; upper horns triangular in outline, (14) 16–22 mm long, at least slightly raised at the base, gradually attenuating into straight, elongate, thin, spine-like tips, ascending (50°–65°), with a smooth surface except for poorly marked, at least 6 mm long, retrorsely barbed spines (harpoons); presence of mat areas excluded; lower horns narrowly triangular in outline, up to 14 mm long, and about 8 mm wide at the base, at least slightly retrorse, straight or with gently upward-pointing apical

part, inserted usually 3/5 to 3/4 the distance from the base of the fruit; the frame of the fruit well developed; on the fruit frame between the bases of the upper and lower horns, solid, probably conical (truncate?) tubercles developed, traces of their bases up to 4 mm in diameter; lower part of the fruit body obtriangular in outline, truncate at the base, its surface (on one side only) covered with five protruding longitudinal ribs; fruit base with a smooth ring, up to 3 mm high; basal scar probably up to 3 mm in diameter.

DISCUSSION

Trapa kvacekii is a new well-defined fossil species of the late Miocene of Europe with a unique combination of characters never reported previously (see Wójcicki 2002, Wójcicki & Zastawniak 2003 and Kovar-Eder et al. 2005 for references). It is characterized by having fruits with the fruit body oblong-triangular in outline, solid, relatively long lower horns inserted 3/5 to 3/4 the distance from its base and a well developed high ring at the base (Figs 2, 3). In addition, *Trapa kvacekii* possesses the largest fruit body of all Tertiary fossil *Trapa* described so far. The fruits from Likudi seem not to vary much, and the variation observed is probably due to fossilisation and the position of the fruit in the sediment (Fig. 3).

From the Balkan Peninsula there are several late Neogene localities with fossil *Trapa* remains reported. One is the Kreka Basin near Tuzla in Bosnia of the late Miocene. On the basis of single specimens, Janković and Pantić (1953; see also Janković 1958) described four separate fossil species from this locality: *Trapa bosniaca* Janković & Pantić, *T. tuzlensis* Janković & Pantić, *T. pontica* Janković & Pantić, and *T. praemuzzanensis* Janković & Pantić. From the protologues and figures it is evident that *T. bosniaca* and *T. tuzlensis* differ in fruit shape and size from the species newly described from Likudi. Unlike *T. kvacekii*, their fruits are broadly rounded at the base, with a pair of relatively short upward-pointing upper horns and reduced lower horns inserted probably 1/3 the distance from the base of the fruit. It is possible that *T. bosniaca* and *T. tuzlensis* represent the same fossil species. The original descriptions of

the other two species, *T. pontica* and *T. prae-muzzanensis*, are based on poorly preserved, incomplete specimens showing some similarity to *T. silesiaca* Goeppert emend. Wójcicki & Zastawniak, widely distributed in Europe in the late Miocene (Wójcicki & Zastawniak 2002, Kovar-Eder et al. 2005). The identity of the fruits from Kreka remains unsolved, requiring detailed reinvestigation of the original material.

Other localities with *Trapa* remains from the Balkan region are of Pliocene age, reported from south-western Romania (Dacic Basin) by Givulescu and Țicleanu (1986) and Țicleanu (1995, 2003). The characteristic morphology of *Trapa* fruits from these localities (e.g., stalked and/or abruptly elongated fruit base) suggests that they are evidently of separate evolutionary lineage (Wójcicki & Țicleanu, in preparation).

The fruits of *T. kvacekii* show some similarity to those from the Pliocene of Arboschio (Villafranca d'Asti, Italy), originally classified by Pavia (1970: tab. 4, fig. 1) as *T. natans* L., but they differ in some aspects. Like *T. kvacekii*, the specimens from Arboschio are obtriangular and somewhat elongate in outline, with solid lower horns, relatively big tubercles on the fruit frame between the bases of the upper and lower horns, and a well-developed smooth basal ring up to 2 mm high. The difference of the specimens from Italy is best marked by their smaller size (about 25 mm high and 32 mm wide at upper horns), the position of the lower horns (inserted approximately in the centre of the fruit body), and the presence of a corona on the neck, a character unknown in representatives of the *Trapa* genus described from the Miocene.

There are at least a few unnamed modern morphotypes scattered in the southern part of Europe, placed in the still poorly recognized *T. natans* complex, with a visibly elongated fruit body obtriangular in outline, relatively stout lower horns located above the centre of the fruit, bearing at least small tubercles on the fruit frame between the lower and upper horns, and a smooth basal ring (Wójcicki, personal observation). Despite the obvious morphological differences, such a combination of characters suggests their similarity to *T. kvacekii*, and leads us to suspect that the newly described species may have given rise to some extant morphotypes, but convergence cannot be ruled out.

Similarly to some other fossil *Trapa* species of the Miocene of Europe (Kovar-Eder et al. 2005), *T. kvacekii* was probably endemic to the late Miocene of Thessalia; it highlights the unique character of its flora.

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REFERENCES

- GIVULESCU R. & ȚICLEANU N. 1986. Fossile *Trapa*-Früchte aus Rumänien. Dări de Seam ale Sedințelor, 3. Paleontologie [1983, 1984], 70–71(3): 187–193.
- GREGOR H.-J. 1986. *Gymnocladocarpum velitzelosii* nov. gen. et spec. aus den obermiozänen Diatomiten von Likudi (Griechenland). Documenta Naturae, 29: 41–43.
- HOLMGREN P.K., HOLMGREN N.H. & BARNETT L.C. 1990. Index herbariorum. Part 1. The herbaria of the World. Regnum Veg., 120: 1–693.
- JANKOVIĆ M. 1958. Oekologie, Verbreitung, Systematik und Geschichte der Gattung *Trapa* L. in Jugoslawien. Societe Serbe de Biologie, Editions Speciales, 2: 1–143.
- JANKOVIĆ M. & PANTIĆ N. 1953. Fossilarten der Gattung *Trapa* L. in Nord-Ost-Bosnien. Ann. Geol. Penins. Balkan., 21: 133–142.
- NOBLOCH E. & VELITZELOS E. 1986. Die obermiozäne Flora von Likudi bei Ellassona/Thessalien, Griechenland. Documenta Naturae, 29: 5–20.
- NOBLOCH E. & VELITZELOS E. 1987. New leaf floras in the Neogene of Greece. Věst. Ústř. Úst. Geol., 62(3): 157–164.
- KOVAR-EDER J., WÓJCICKI J.J. & ZETTER R. 2005. Trapaceae from the late Miocene of Austria

- and the European context. *Acta Palaeobot.*, 45(2): 165–186.
- KOVAR-EDER J., KVAČEK Z., MARTINETTO E. & ROIRON P. 2006. Late Miocene to Early Pliocene vegetation of southern Europe (7–4Ma) as reflected in the megafossil plant record. *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 238(1–4): 321–339.
- MAI D.H. 1995. *Tertiäre Vegetationsgeschichte Europas*. Gustav Fischer Verlag, Jena, Stuttgart, New York.
- PAVIA G. 1970. Rest di anancus arvernensis e flora ad affinità plioceniche nel Villafranchiano inferiore della Cava Arboschio (Villafranca d'Asti). *Mem. Soc. Geol. Ital.*, 9: 157–176.
- ȚICLEANU N. 1995. Macroflora et végétation daciennes du Bassin Dacique: 473–528. In: Marinescu F. & Papaianopol I. (eds) *Chronostratigraphie und Neostatotypen. Neogen der Zentrale Paratethys*. Bd. 9. Dacien. Akademie, București.
- ȚICLEANU N. 2003. La flore du Romanien: 442–467. In: Papaianopol I., Marinescu F., Krstić N. & Macaleț R. (eds) *Chronostratigraphie und Neostatotypen. Neogen der Zentrale Paratethys*. Pliozän Pl₂, Bd. 10. Romanien. Editura Academiei Române, București.
- VELITZELOS E. & GREGOR H.-J. 1985. Neue paläofloristische Befunde im Neogen Griechenlands. *Documenta Naturae*, 25: 1–4.
- VELITZELOS E. & GREGOR H.-J. 1986. Geologische Daten zu den fossilführenden Fundstellen Lava, Prossilion und Likudi (Griechenland) nebst Bemerkungen zu deren Frucht- und Samenflora. *Documenta Naturae*, 29: 34–40.
- VELITZELOS E. & GREGOR H.-J. 1990. Some aspects of the Neogene floral history in Greece. *Rev. Palaeobot. Palynol.*, 62: 291–307.
- VELITZELOS D., KVAČEK Z. & VELITZELOS E. 2000. Palaeoecological and climatological significance of conifer synusia occurring in the Tertiary of Greece. In: *The Sixth Conference of International Organization of Palaeobotany (IOPC-VI), Quinhuangdao*. Abstract: 137–138.
- WÓJCICKI J. J. 2002. *Trapa assamica* (Trapaceae), a remarkable new extant species from the Indian subcontinent. *Polish Bot. J.*, 47(1): 5–9.
- WÓJCICKI J.J. & ZASTAWNIAK E. 2002. Late Miocene *Trapa* L. (Trapaceae) of Sośnica (SW Poland) revisited. *Acta Palaeobot.*, 42(1): 29–38.
- WÓJCICKI J.J. & ZASTAWNIAK E. 2003. Rodzina Trapaceae w trzeciorzędzie Europy – wstępne wyniki badań (summary: The Trapaceae family in the Tertiary of Europe – preliminary results). *Botanical Guidebooks*, 26: 153–185.