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CLADOPHLEBIS MECSEKENSIS CZIER SP. NOV. AND *CLADOPHLEBIS BAUERI* CZIER SP. NOV. FROM THE LOWER JURASSIC OF THE CARPATHIAN-PANNONIAN REGION

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Abstract. *Cladophlebis mecsekensis* Czier sp. nov. and *Cladophlebis baueri* Czier sp. nov. are described from the lower Jurassic (Hettangian to lower Sinemurian) Mecsek Coal Formation, which occurs in southwest Hungary, at Vasas quarry. *C. mecsekensis* probably is thrice pinnate, possessing coalescent apical pinnulae, and separate basal pinnulae with lateral veins dichotomising near the midvein. *C. baueri* has triangular to rhomboidal pinnulae, of which the first catadromous one is half inserted to the pinna rachis, half to the rachis of previous order, and is twice wider than the other pinnulae are. *Cladophlebis* is new for the fossil flora of Hungary. However, this genus is already known from the Mesophytic of the Carpathian-Pannonian region, being well represented in the Jurassic flora of Romania by the species *denticulata, insignis, whitbiensis, nebbensis, haiburnensis, roesserti, browniana, williamsoni, obtusifolia, indica, virginiensis, acuta, raciborskii, vaccensis, naliokinii, rumana, serrulata, aldanensis, lenaensis, semakai, silvaeregis.*

Keywords. Macroflora, Mesophytic, Carpathian-Pannonian region.

Introduction

Studies accomplished on fossil plants are based mainly on the collections of state institutions like museums and universities. There are, however, some exceptions of this rule, and sometimes these exceptions are worthy to pay close attention to. Some particular collections for example, among many common pieces, may contain samples with scientific importance. It seems to be a good idea therefore, to investigate as many of these collections as possible. I took the opportunity to investigate in the last years such a collection, namely the Zsolt Bodorkós collection of minerals and fossils, kept at Szombathely, Saághy Street 4, Hungary.

The collection contains among others, fossil plants from the lower Jurassic (Hettangian – lower Sinemurian) of Mecsek Mountains, south-west Hungary.

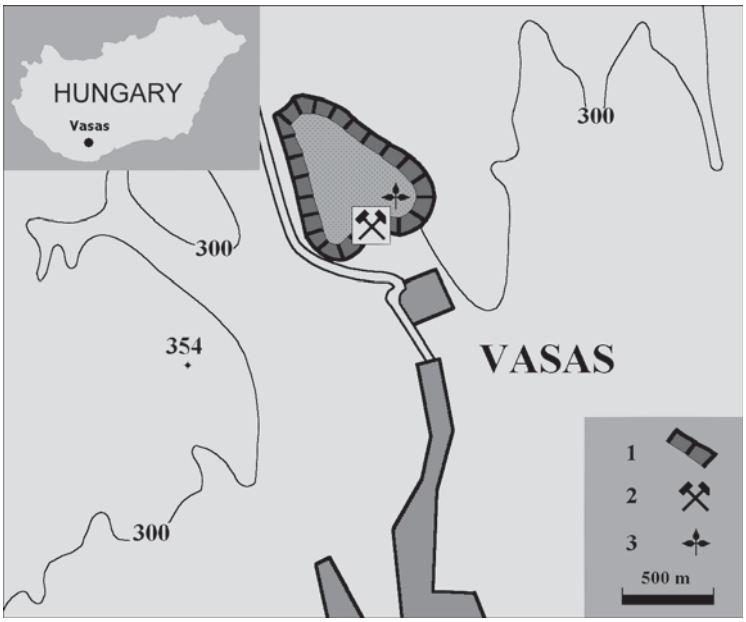

Figure 1. Geographical position of Vasas. 1. Limits of the quarry. 2. Petőfi-shaft. 3. Fossil plant site.

The plant fossils were collected from the Vasas quarry (Figure 1), by the keeper himself Zsolt Bodorkós, and by his field co-worker Norbert Bauer. The material originates from the surface of a grey to black argillaceous sandstone (Figure 2), which belongs to the sandstone member of the Mecsek Coal Formation. Data regarding this formation and its literature have been published by Nagy (1995), Némedi Varga and Nagy (1995), many details being given in the papers cited by them. I assigned in a previous paper (Czier 2004) the specimens to the following taxa:

Phlebopteris muensteri (Schenk) Hirmer & Hörhammer
Clathropteris meniscioides (Brongniart) Brongniart
Pachypteris rhomboidalis (Ettingshausen em. Gothan) Nathorst
Palissya sphenolepis (Braun) Brongniart
cf. *Taxodiophyllum scoticum* Van der Burgh & Van Konijnenburg-Van Cittert
Cladophlebis sp.

The determination of the *Cladophlebis* specimens has shown that they do not belong to the known species. This is moreover the first record of this genus from the fossil flora of Hungary. This is why I gave in that paper only a general

description, and decided to restudy the specimens. Analysing in a detailed manner all the characters, my conclusion is that these specimens belong to new species.

Figure 2. The fossil plant site Vasas. Photo: Zsolt Bodorkós.

The description and figuration of these new species is the first aim of the present paper. My second goal is the summarisation of all the records of *Cladophlebis* from the Carpathian-Pannonian region.

Systematic palaeontology

CORMOPHYTA
PTERIDOPHYLLA[1]
Cladophlebis Brongniart 1849
Cladophlebis mecsekensis Czier sp. nov.
Plate 1, figure 1; Text-figures 3–4

Derivation of name. After Mecsek Mountains.

Holotype. Hand specimen no. 1 (Pl. 1, fig. 1; Text-figs. 3–4).

[1] *Cladophlebis* is a form-genus based exclusively on sterile leaves. The sterility may cause some taxonomical problems. This genus is usually attributed to the ferns, but in my opinion this is not correct, because some pteridosperms also have leaves of this morphology. Such leaves are assignable to pteridophyte or gymnospermatophyte taxa only if they are fertile, or if the material consists of fertile and sterile leaves that belong to the same plant specimen. However, if the material consists only of sterile leaves assigned to *Cladophlebis*, it should be not classified within the Pteridophyta or Gymnospermatophyta. The best thing that we can do, is to attribute *Cladophlebis* to Pteridophylla *sensu* Nathorst.

Repository. Private collection of Zsolt Bodorkós, at Szombathely, Hungary.

Type locality. Vasas quarry, near the mining locality Vasas, Hungary.

Lithostratigraphical unit. The sandstone member of the Mecsek Coal Formation.

Age. Hettangian – lower Sinemurian.

Diagnosis. At least bipinnate, imparipinnate frond, with smooth rachis. Pinnae alternate, pinna rachis smooth. Pinnulae separate in the basal two third of the leaf, increasingly coalescent in its apical third, becoming completely coalescent toward the apex. Separate pinnulae typically straight or slightly falcate, set closely and alternately, possessing entire margins and rounded-obtuse apex. Pinnulae possessing simple principal vein, straight, originating somewhat below the middle of the base, ending in the apex. Typical separate pinnula with 6–7 pairs of secondary lateral veins dichotomising once near their insertion at midvein, ending on the margins.

Supplementary description. The leaf is sterile. It is present on two portions of the rock's surface (Pl. 1, fig. 1; Text-fig. 3). One fragment is 8 x 4 cm, the other 2 x 1 cm. Their common main rachis (i. e. rachis of first order) is not preserved, but the same direction of the pinnae and of the pinnulae respectively, indicates that they very probably belong to the same frond. In this case, the frond is at least tripinnate. The rachis of secondary order is straight and narrows constantly towards the pinna apex (Text-fig. 4). Its length is 77 mm, the basal width 1.3 mm, and the apical width 0.4 mm. There is attached a single apical leaflet. The insertion interval and insertion angle of the pinnae rachises decrease distally, from 8.8 mm to 1.6 mm, and 77° to 55°. Their maximum measured length is 21 mm, width 0.8 mm. The pinnae are sparse; the pinnulae do not overlap one another. The pinnulae are attached by their whole base. The biggest separate pinnula is 11 mm long and 6 mm wide. The insertion angle of the principal vein is about 75° in basal pinnulae, but the angle decreases towards the pinnae and leaf apices, to about 45° in the last pinnulae. The insertion angle of the lateral veins also decreases, from 50° in the basal portion of pinnulae, even to 20° in their apical portion. The density of the venation is between 13–15 veins cm^{-1}.

Discussion. An important feature that differentiates *Cladophlebis mecsekensis* from other *Cladophlebis* leaves and sterile leaves of *Todites*, is the forking manner of the lateral veins. Other important characters are the disposition of the pinnulae, their margins, apex, the end of the midvein, the density of the venation.

The most important diagnostic character that allows one to differentiate *C. mecsekensis* from all the other species is the attachment of the pinnulae. This is an uncommon attachment, as the pinnae in the apical portion of *C. mecsekensis* look as they also would be pinnulae. I explain this strange situation by means of two trends.

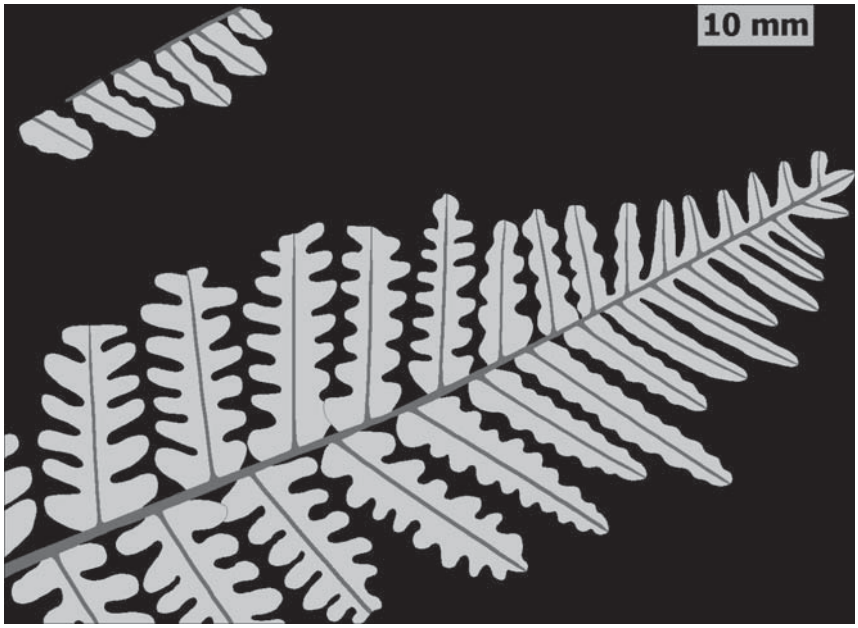

Figure 3. *Cladophlebis mecsekensis* sp. nov. Frond.

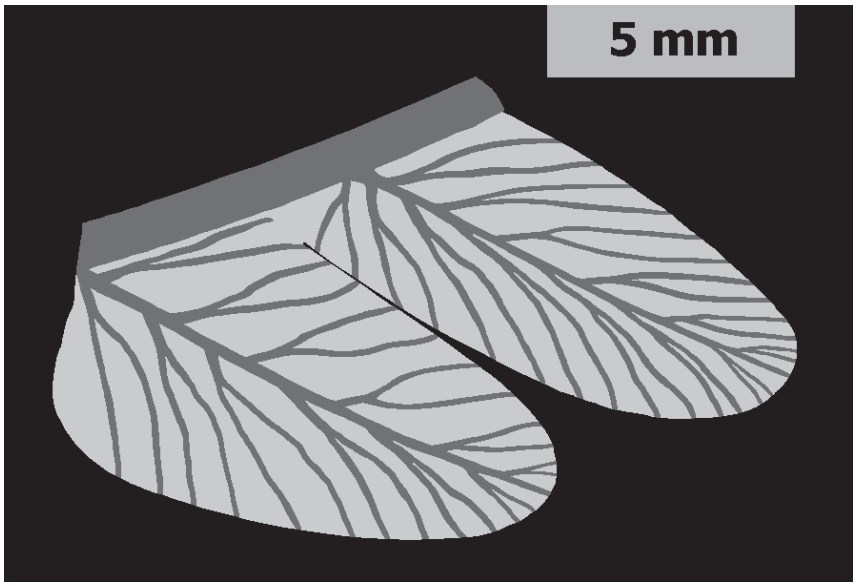

Figure 4. *Cladophlebis mecsekensis* sp. nov. Pinnulae.

Morphological trend. The apical pinnae look as they would be pinnulae because the pinnulae of these pinnae are completely coalescent. However, even if some pinnae are similar in appearance with the pinnulae, in fact, the pinnae are pinnae, and the pinnulae are pinnulae. Accepting this statement as being true, the morphology alone is not sufficient to clearly distinguish the pinnae from the pinnulae. As morphologically some pinnae may be easily confused with pinnulae, the practice of this theory is restricted. We are able to clearly distinguish pinnae from pinnulae in the basal two third of the leaf, but the distinction becomes arbitrary in the apical third, then impossible in the apex.

Evolutionary trend. Admitting that fern leaves growth mainly in the apices, the apical pinnule-like pinnae are nothing else but real pinnulae. Ontogenesis in this case is a program responsible for the genesis and growth of the apical pinnulae, their development into pinnule-like pinnae, and finally into large mature pinnae with separate pinnulae. Interpreting the growth in the light of phylogeny, the ancestors of *C. mecsekensis* probably were plants with similar habit, but with more simple leaves. Being in concordance with an evolutionary trend already established between an other group of ferns (Czier 1994), this approach may constitute both theoretical and practical base for further researches.

Comparison. The published literature of the fossil ferns contains hundreds of descriptions referring to *Cladophlebis*-like leaves, but only few numbers of specimens have been described as possessing coalescent pinnulae. All those specimens belong to species that differ in many characters from *C. mecsekensis*.

- *Cladophlebis haiburnensis* (Lindley & Hutton 1836) Brongniart 1849. Semaka (1956) described some specimens with coalescent pinnulae, but the coalescence is very short, of only 1–2 mm. The pinnulae are lanceolate, in many cases falcate, and have rather irregular venation. The midvein usually is forked, and ends without reaching the pinnula apex. The lateral veins are thrice or even four times forked.
- *Cladophlebis insignis* (Lindley & Hutton 1834) Raciborski 1894. Humml (1969) has thoroughly studied this species. According to his remarks, the main rachis and the pinna rachises have specific ribs. The pinnulae are lanceolate, coalescent only on a short portion, possessing obtuse or slightly acute apices.
- *Cladophlebis semakai* Czier 1995. The pinna rachis is two-ribbed, and the pinnulae are of an asymmetrical, short-triangular form. The midvein of typical pinnula arises at an angle of about 80°. The lateral veins are mostly opposite and dichotomise twice.
- *Cladophlebis silvaeregis* Czier 1995. The main rachis is finely striated, and the pinna rachises are oppositely attached. The pinnulae are falcate and have rounded apex. The lateral veins bifurcate twice, ending on the margins with a density of 10–12 veins cm^{-1}. The first catadromous pinnula is shorter than the others, tongue-shaped to elliptic, mainly attached to the rachis of previous order. The midvein of this pinnula always arises from this rachis.

Cladophlebis baueri Czier sp. nov.
Plate 1, figure 2; Text-figure 5

Derivation of name. In honour of the collector Norbert Bauer.

Holotype. Hand specimen no. 2 (Pl. 1, fig. 2; Text-fig. 5).

Repository. Private collection of Zsolt Bodorkós, at Szombathely, Hungary.

Type locality. Vasas quarry, near the mining locality Vasas, Hungary.

Lithostratigraphical unit. The sandstone member of the Mecsek Coal Formation.

Age. Hettangian – lower Sinemurian.

Diagnosis. At least bipinnate frond, with two-ribbed rachis possessing a central furrow and fine longitudinal striations. Pinnae opposite, pinna rachis two-ribbed and striated. Pinnulae separate, alternate, triangular, with margins entire and straight at the base, apex subacute to obtuse. Pinnulae possessing simple midvein ending in apex, 3–4 pairs of opposite lateral veins dichotomising once, ending on the margins. First catadromous pinnula half inserted to the pinna rachis, half to the rachis of previous order, typically rhomboidal and up to twice wider than the other pinnulae.
Supplementary description. The leaf is sterile. It is present on a portion of 8 x 6 cm, where the pinnae and pinnulae present catadromous arrangement (Pl. 1, fig. 2). It has a straight rachis, which has 14 longitudinal striations, and is preserved on a length of 77 mm and a width of 9.8 mm. The pinna rachises possess 4–5 longitudinal striations. They are inserted at intervals of about 18 mm. While the insertion interval is rather constant, the insertion angle decreases distally, from 35° to 28°. The measured length and width of these rachises are maximum 37 mm and 1.6 mm. The pinnae are set closely; the pinnule apices often overlap one another. The pinnulae are attached by the whole breadth of their base (Text-fig. 5). The common pinnulae are only slightly longer as they wide are. Their mean length is 5.5 mm, but their mean breadth 5 mm. The insertion angle of the midvein is about 90°. The midvein of the common pinnula is slightly curved in an acroscopic direction, but the midvein of the first catadromous pinnula is curved in a basiscopic direction. The insertion angle of the lateral veins decreases from the pinnula base towards its apex. The extreme values of this angle are between 50°–80° in the basal portion of pinnulae, and between 30°–50° in their apical portion. The lateral veins dichotomise at various distances from the midvein. The density of the venation is between 4–6 veins cm^{-1}.
Discussion. The shape and venation of the common pinnulae are important specifics of *Cladophlebis baueri*. However, the most important diagnostic characters are

those referring to the specialised first catadromous pinnula, namely its attachment, shape, and relative dimensions. No data are known regarding the causes from which this pinnula became so differentiated, or the scopes that such an evolution deserves. It might be an adaptation for a better retain of water near the stalk, but this is just a hypothesis.

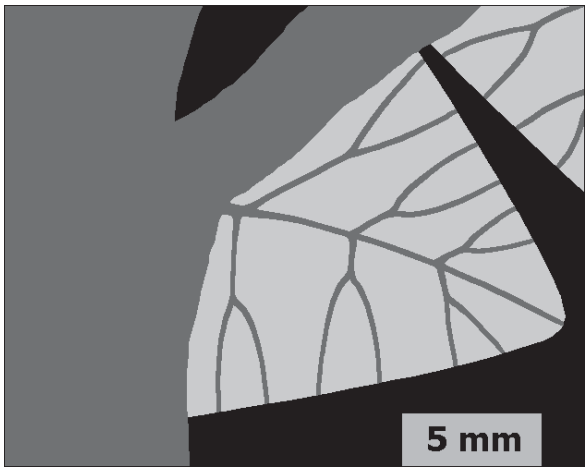

Figure 5. *Cladophlebis baueri* sp. nov. Catadromous pinnula.

Comparison. There are few specimens of the *Cladophlebis – Todites* group, described as possessing specialised first catadromous pinnula. This comparison is restricted therefore to very few species. All these species differ from *C. baueri* in many characters, so they are clearly distinguishable.

- *Cladophlebis triangularis* Oishi 1940. The main rachis is very slender. The pinnae are set alternately, the pinnae rachises are short, attached at an angle of 45°. The pinnulae have mainly simple lateral veins, and waved margins. The first anadromous pinnula sometimes is specialised.
- *Todites acutinervis* Kilpper 1964. The sterile specimens possess smooth rachises, narrow pinnulae. The principal vein does not end in the pinnula apex. The lateral veins arise at very acute angle, of only 5°–20°, dichotomising twice or even thrice.
- *Cladophlebis lobulata* Samylina 1976. The frond has slender main rachis, and the pinnae are alternately disposed at 50°–60°. Pinnulae are twice longer as wide they are. They possess asymmetrical acute apex, and 5–7 pairs of lateral veins simple near the apices. The first catadromous pinnula bears lobes; the lobes possess specific venation.
- *Cladophlebis mungyeongensis* Kimura & Kim 1988. The main rachis is very slender, the pinnae rachises alternate, attached in most cases at right angle. The pinnulae have finely dentate margins, usually acute apex. Each lateral vein ends in a marginal dent.

- *Cladophlebis silvaeregis* Czier 1995. The pinnae are attached at angle of about 60°. Pinna rachises are smooth. Common pinnulae are falcate, with rounded apex, lateral veins dichotomising twice. The density of the venation is 10–12 veins cm^{-1}. The first catadromous pinnula typically is shorter than the others are and tongue-shaped to elliptic.
- *Cladophlebis mecsekensis* Czier. As described in the present paper, the leaf probably is thrice pinnate. All the rachises are smooth, and the pinnae are set alternately. Certain pinnulae are more or less coalescent, in a specific manner. The pinnulae are straight or slightly falcate, possessing rounded-obtuse apex. The principal vein originates somewhat below the middle of the pinnula base. There are 6–7 pairs of lateral veins, dichotomising once near the midvein.

Chronology and chorology

Despite of the taxonomical problems already mentioned, *Cladophlebis* is a very important, characteristic genus of the Mesophytic. Many data of relevant fossil plant catalogues (Jongmans and Dijkstra 1959, 1967, 1968; Andrews 1970; Dijkstra and Van Amerom 1981; Boersma and Broekmeyer 1980, 1982) denote a world-wide spreading of this genus, numerous occurrences being known from almost all the stages of the Triassic, Jurassic, and the Cretaceous. The Carpathian-Pannonian occurrences prove that it was present in the flora of this region only during the early Jurassic times.

Figure 6 points out the geographical positions of the localities in the Carpathian-Pannonian region where *Cladophlebis* occurrences are known. All these localities are represented on the map, excepting an unknown locality that is not localisable. The chronological and chorological distributions of the localities are rather unequal:

- Hettangian *pro parte*: one locality (Biger) in the Southern Carpathians;
- Hettangian – Sinemurian: five localities (Viezuroi valley, Porcului valley, Stancesti, Anina, Doman) in the Southern Carpathians, and one locality not localised (unknown locality);
- Hettangian – lower Sinemurian: one locality (Vasas) in the Mecsek Mountains;
- Lower Hettangian *pro parte* – lower Sinemurian *pro parte*: three localities (Dumbrava, Banlaca, Recea) in the Apuseni Mountains;
- Hettangian *pro parte* – Sinemurian: seven localities (Pregheda, Pietrele Albe, Cozla, Baia de Arama, Anina, Cioclovina, Vulcan) in the Southern Carpathians;
- Hettangian *pro parte* – Sinemurian *pro parte*: one locality (Dragosella Mica) in the Southern Carpathians;
- Sinemurian *pro parte*: one locality (Crasna) in the Southern Carpathians.

Table 1 summarises the taxa to which the Carpathian-Pannonian *Cladophlebis* specimens belong. There are just some minor changes in the nomenclature, which do not alter the determinations of the cited authors.

Table no. 1. *Cladophlebis* records within the Carpathian-Pannonian region.

Taxa	Localities	References
Cladophlebis denticulata (Brongniart) Nathorst	Anina, Vulcan, Recea	Andrae (1855), Štur (1871), Roth (1906), Krasser (1921), Semaka (1956, 1958), Mateescu (1964), Givulescu and Farcaşiu (1989), Czier (1993), Popa (1997)
Cladophlebis insignis (Lindley & Hutton) Raciborski	Anina	Humml (1963, 1969)
Cladophlebis whitbiensis (Brongniart) Brongniart	Anina	Andrae (1855), Humml (1969)
Cladophlebis nebbensis (Brongniart) Nathorst	Pietrele Albe, Anina, Recea	Semaka (1970), Czier (1993, 2000), Popa (1997)
Cladophlebis cf. *nebbensis* (Brongniart) Nathorst	Anina	Popa (1997)
Cladophlebis haiburnensis (Lindley & Hutton) Brongniart em. Harris	Pregheda, Biger, Pietrele Albe, Porcului valley, Crasna, Baia de Arama, Anina, Romania (unknown locality)	Semaka (1958, 1962, 1970), Oarcea and Semaka (1962), Drăghici and Semaka (1962), Humml (1963), Zberea *et al*. (1966), Semaka *et al*. (1972), Preda *et al*. (1985), Popa (1997)
Cladophlebis aff. *haiburnensis* (Lindley & Hutton) Brongniart em. Harris	Baia de Arama	Drăghici and Semaka (1962)
Cladophlebis haiburnensis (Lindley & Hutton) Brongniart em. Harris fvar. *densinervis* Fakhr	Anina	Popa (1997)
Cladophlebis haiburnensis (Lindley & Hutton) Brongniart em. Harris fvar. *ingens* (Harris) Kilpper	Anina	Popa (1997)
Cladophlebis roesserti (Presl in Sternberg) Saporta	Anina	Štur (1865), Humml (1969)
Cladophlebis browniana (Dunker) Seward	Pietrele Albe, Anina, Vulcan	Semaka (1956, 1961), Oarcea and Semaka (1962)
Cladophlebis williamsoni Brongniart	Porcului valley, Anina	Oarcea and Semaka (1962), Semaka *et al.* (1972)
Cladophlebis obtusifolia (Andrae) Schimper in Ward	Anina	Andrae (1855), Humml (1963)

Table no. 1. continued

Cladophlebis indica (Oldham & Morris) Sahni & Rao	Anina, Recea	Czier and Popescu (1988), Czier (1994, 2000)
Cladophlebis virginiensis Fontaine em. Berry	Anina, Recea	Czier (1994, 2000)
Cladophlebis acuta Fontaine	Recea	Czier (1994)
Cladophlebis raciborskii Zeiller	Cioclovina	Laufer (1925)
Cladophlebis cf. *vaccensis* Ward	Anina	Semaka (1958, 1962)
Cladophlebis naliokini Thomas	Vulcan	Mateescu (1964)
Cladophlebis ingens Harris	Dragosella Mica	Semaka (1970)
Cladophlebis rumana Semaka	Biger, Pietrele Albe, Crasna, Anina, Doman, Vulcan, Dumbrava	Semaka (1956, 1961, 1964, 1969), Oarcea and Semaka (1962), Zberea *et al.* (1966)
Cladophlebis serrulata Samylina	Stancesti, Crasna	Semaka *et al.* (1972)
Cladophlebis aldanensis Vakhrameev	Stancesti, Crasna	Semaka *et al.* (1972)
Cladophlebis lenaensis Vakhrameev	Stancesti	Semaka *et al.* (1972)
Cladophlebis semakai Czier	Banlaca	Czier (1995)
Cladophlebis silvaeregis Czier	Banlaca	Czier (1995)
Cladophlebis mecsekensis Czier	Vasas	Czier (this paper)
Cladophlebis baueri Czier	Vasas	Czier (this paper)
Cladophlebis sp. A	Anina	Czier (2000)
Cladophlebis sp. B	Recea	Givulescu and Czier (1990)
Cladophlebis sp. C	Recea	Czier (1993)
Cladophlebis sp. D	Recea	Czier (1993)
Cladophlebis sp. E	Recea	Czier (1993)
Cladophlebis sp.	Dragosella Mica, Pietrele Albe, Cozla, Viezuroi valley, Porcului valley, Stancesti, Baia de Arama, Anina, Doman, Vulcan, Dumbrava, Banlaca, Romania (unknown locality)	Semaka (1956, 1958, 1963, 1969, 1970), Drăghici and Semaka (1962), Humml (1963), Semaka *et al.* (1972), Popa (1994)
cf. *Cladophlebis* sp.	Recea	Czier (1993)

The fossil plant site Vasas in the European lower Jurassic

During the Triassic and Jurassic periods, a series of islands bordered the Southern margin of the European carbonate platform. Mecsek was one of these islands, and Vasas was part of Mecsek. The strata, which contain the fossil plant remains, belong to the Mecsek-Villány structural unit. According to Kovács *et al.* (1987), Gawlick *et al.* (1999), Márton (2000), Vörös (2001), this unit belongs to the Tisza Superunit, as part of the North Tethyan, European margin.

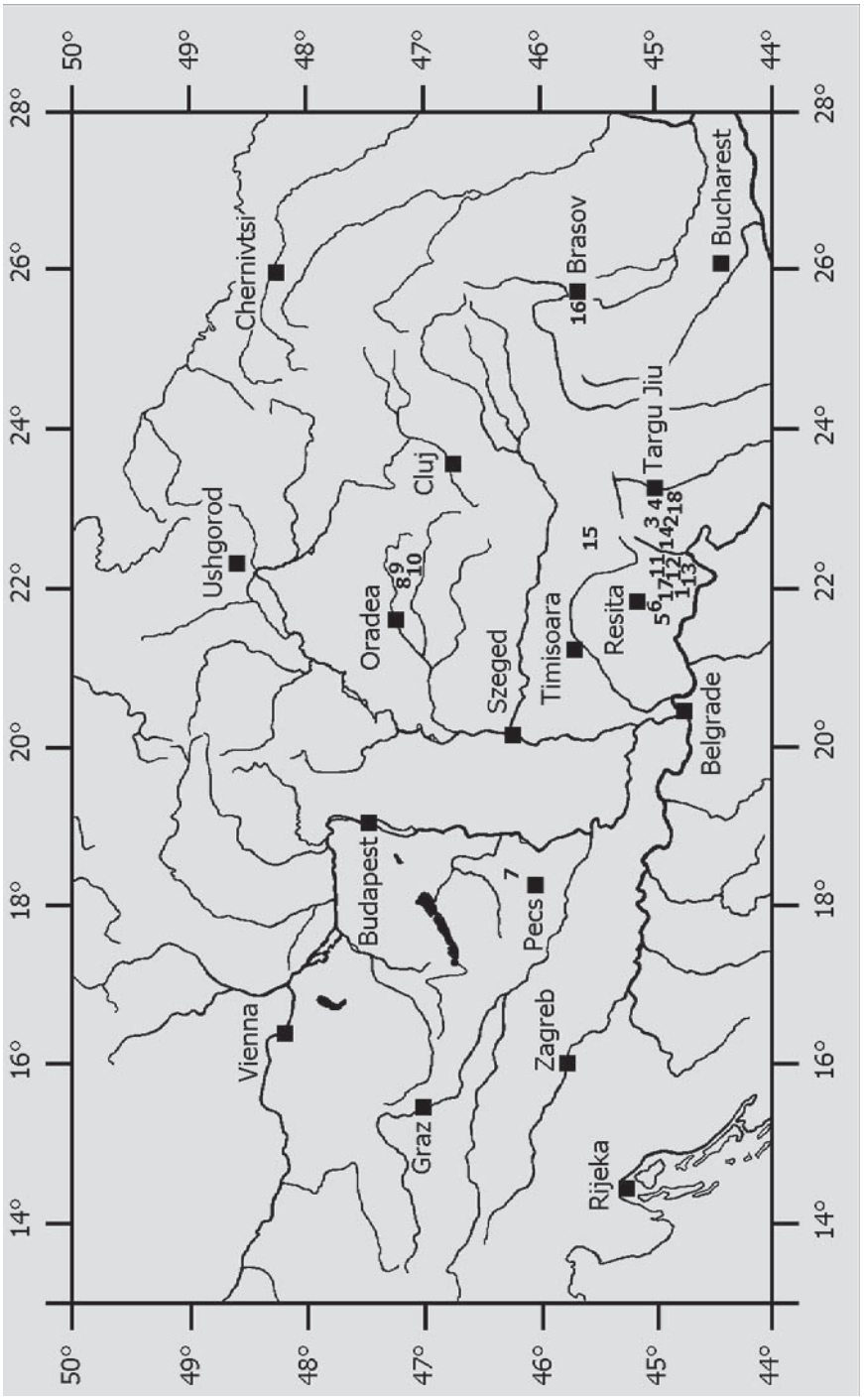

Figure 6. Chorological map of the Carpathian-Pannonian region, showing the *Cladophlebis* localities. 1. Biger. 2. Viezuroi valley. 3. Porcului valley. 4. Stancesti. 5. Anina. 6. Doman. 7. Vasas. 8. Dumbrava. 9. Banlaca. 10. Recea. 11. Pregheda. 12. Pietrele Albe. 13. Cozla. 14. Baia de Arama. 15. Cioclovina. 16. Vulcan. 17. Dragosella Mica. 18. Crasna.

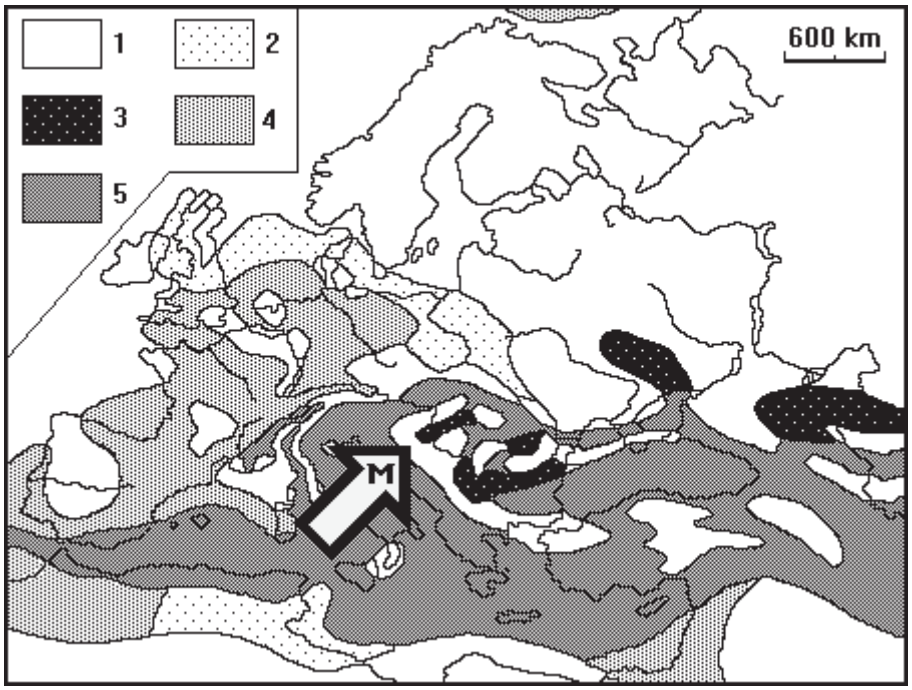

Figure 7. Position of Mecsek island in the European lower Jurassic. 1. Dry land. 2. Epicontinental lagoon. 3. Coal-generating epicontinental lagoon. 4. Epicontinental sea. 5. Deep sea. M = Mecsek. Cartography based on data published by Saulea (1967), Czier (2000).

In the early Jurassic, rich vegetation of ferns and conifers covered the island of Mecsek. Wind and storm, rain and rivers, transported the vegetal remains in the epicontinental lagoon near the beach (Text-fig. 7). The lagoon generated a succession of detrital rocks and coals. The extensive mining of the coal stream has open in the mining area many fossil plant sites. The site at Vasas quarry presents the best opportunities to study the Jurassic plant-bearing field from Hungary. The aspect of the field resembles much with the facies known in Austria at Gresten, and is almost identical with what is seen in Romania, in the Bihor structural unit at Suncuius. The type sequence at Gresten is lack of the Triassic carbonate basement (Lachkar *et al.* 1984), while the Jurassic strata at Vasas and Suncuius lay on limestone. These two localities resemble closely not only in their facial development, but also regarding their fossil flora.

A palaeophytogeographical comparison (Czier 2004) has shown that many elements of the Vasas and Suncuius associations belong to the same species of *Equisetites, Phlebopteris, Dictyophyllum, Clathropteris, Nilsonia, Ginkgo*, and *Taxodiophyllum*. This is palaeogeographically explainable, by the near positions of

the Mecsek-Villány and Bihor units, which both belong to the same megatectonic superunit. The new species of *Cladophlebis*, i.e. *C. silvaeregis* and *C. semakai* in the Suncuius flora, *C. mecsekensis* and *C. baueri* in the Vasas flora, are endemic elements that argue for the presence of the island habitat.

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Plate I. 1. *Cladophlebis mecsekensis* sp. nov. Holotype. 2. *Cladophlebis baueri* sp. nov. Holotype.