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## **The Genus *Zamites* Brongniart 1828 emend. Harris 1969 (Bennettitales) in the fossil flora of Romania**

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**Abstract.** New Bennettitalean foliage originating from the Konservat-Lagerstätte Anina (Banat region, Romania, eastern Central-Europe) is presented. Although the cuticular analysis by Light- and Scanning Electron Microscopy reveals many details of the epidermal structure, the leaves described and figured herein are attributed just to cf. *Zamites* sp. 1, cf. *Zamites* sp. 2, and aff. *Zamites* sp., because the absence of the adaxial cuticle in the microscope preparations does not allow creating new species. The occurrences of these taxa are in the limits of the Hettangian *pro parte* – Sinemurian interval of the Steierdorf Formation, Valea Terezia Sandstone Member; all of them come from the *Clathropteris meniscioides* Biozone, the *Banatozamites chlamydostomus* Subzone. The Romanian *Zamites* material is completely revised. It is known from the Early Jurassic continental deposits of the Eastern Carpathians (Cristian) and Southern Carpathians (Crivi valley, Berzasca, Buschmann mine, Pietrele Albe, Dragosella, Cozla, Mehadia, Vezuroi mine, Crasna, Baia de Aramă, Anina, Doman, Vulcan, Holbav). No one formerly known species of *Zamites* is recognised in the Romanian fossil flora. Moreover, the usage of “cf.”, “aff.”, or even of “?” before the *Zamites* generic name is necessary.

**Keywords.** Bennettitales, Jurassic, cuticular analysis, Macroflora, Romania, *Zamites*.

## Introduction

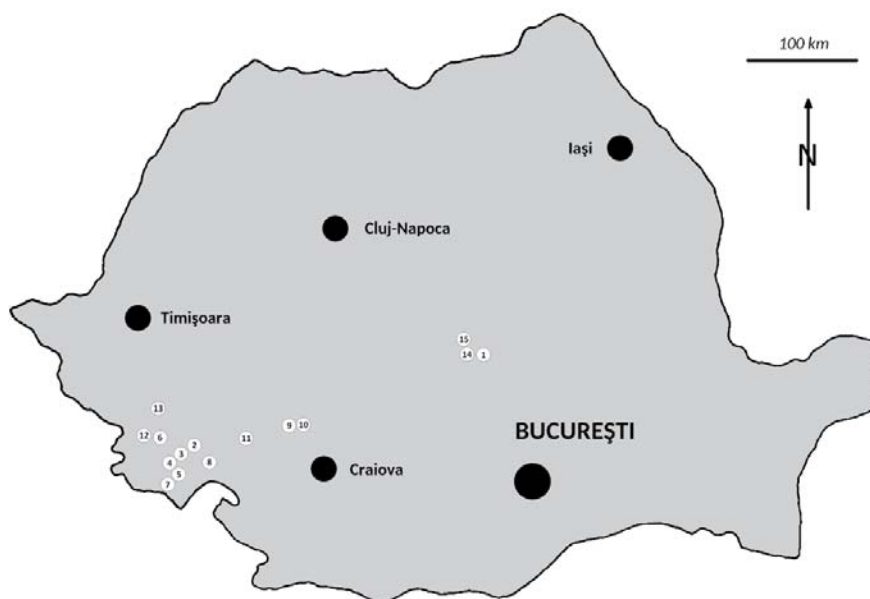
During the history of palaeobotany, the always trendy Bennettitalean genus *Zamites* Brongniart 1828, was and still is frequently cited as being present with a lot of species in all the regions of the Mesophytic world. The type species selected by Andrews (1955) is *Zamia gigas* Lindley and Hutton 1835, a species that Morris (1843) transferred later to *Zamites*. Enumeration of the vast international literature dealing with this genus is not subject of the present paper; just the still valid discussion of Seward (1917) and the emended generic diagnosis of Harris (1969) are mentioned on this occasion.

The Romanian literature abounds in *Zamites* citations. Many authors mention in a way or other data in this respect but the majority of those data are based on old papers that seldom contain a description or figuration, and those few that exist are incomplete. Only Andrae (1855), Thomas (1930), Langer (1947), Semaka (1962c, 1970), Mateescu (1964), Givulescu (1989, 1991, 1998), and Berg (1996) published descriptions and figurations of some specimens. However, all those are exclusively based on macro-morphological features or on incomplete cuticular characters if mentioned any. A complete revision of the Romanian material is necessary, not only because of this incompleteness, but also owing to the usually ignored emendation of the genus.

Apart from the presentation of new specimens that are kept at Budapest (Hungary) in the Palaeobotanical Collection of the Hungarian Natural History Museum (HNHM-BP), a scope of this research is the revision of the Romanian *Zamites* material. This is part of the author's project regarding the description and revision of the Jurassic macroflora and localities of the Carpathian-Pannonian area (Czier & Popescu 1988; Givulescu & Czier 1990; Czier 1989, 1990, 1991, 1992, 1993, 1994, 1995a, 1995b, 1995c, 1995d, 1996a, 1996b, 1997a, 1997b, 1997c, 1998a, 1998b, 1998c, 1999a, 1999b, 1999c, 2000a, 2000b, 2000c, 2000d, 2001, 2002, 2003a, 2003b, 2004, 2005, 2006, 2008, 2009, 2010, 2011, 2014, 2016a, 2016b, 2017). A planned goal to attain also is to determine the stratigraphic distribution of the specimens, in the context of the new scheme (Czier 2017) containing the litho- and biostratigraphical units of their origin.

## Geographic distribution

The study of the literature mentioning Romanian *Zamites* material, allows drawing a map of geographical distribution, which is a necessary first evidence for any research detailing this subject (Fig. 1).



**Figure 1.** Geographical map of Romania, indicating the fossiliferous localities with *Zamites* material. 1. Cristian; 2. Crivi valley; 3. Berzasca; 4. Buschmann mine; 5. Pietrele Albe; 6. Dragosella; 7. Cozla; 8. Mehadia; 9. Viezuroi mine; 10. Crasna; 11. Baia de Aramă; 12. Anina; 13. Doman; 14. Vulcan; 15. Holbav.

The Romanian *Zamites* material is known from the continental Early Jurassic deposits of the Eastern Carpathians (Cristian) and Southern Carpathians (Crivi valley, Berzasca, Buschmann mine, Pietrele Albe, Dragosella, Cozla, Mehadia, Viezuroi mine, Crasna, Baia de Aramă, Anina, Doman, Vulcan, Holbav).

### Geology and stratigraphy

The new material presented herein originates from Konservat-Lagerstätte Anina (Banat region, South-west Romania). The geology and stratigraphy of this locality already being extensively presented, and problems concerning the age intervals of the fossil flora occurrences, the lithostratigraphic and the biostratigraphic units also being clarified (Czier 1999a, 1999b, 2000a, 2016b, 2017), these data are not repeated here.

## Material and methods

A plant fossil specimen (HNHM-BP-602141) is preserved as compression of three fragments of a leaf, on a slab of fine-grained clastic sedimentary rock. The specimen was collected between the last decade of the 19<sup>th</sup> Century and before the end of the WW II.

A leaf compression of another plant fossil specimen (HNHM-BP-602231-1) is preserved on a face of another slab consisting from the same type of rock. A leaf impression of a third specimen (HNHM-BP-602231-2) is preserved on the other face of this slab. The slab containing these two specimens was collected in the second half of the 19<sup>th</sup> Century.

Although the specimens were collected from unknown sampling points around Anina, based on the label's information and the rock's aspect it is clear that the entire material comes from the Anina coal-bearing sequence of the Valea Terezia Sandstone Member of the Steierdorf Formation, from the *Banatozamites chlamydostomus* Subzone of the *Clathropteris meniscioides* Biozone, but the names of the collectors are unknown.

After macroscopical study, the material was analysed under light microscope (LM) and scanning electron microscope (SEM). Cuticles were prepared trying to use the method already described in details (Czier 2014, 2017). However, the adaxial cuticle of all specimens was so thin and delicate, that it has been lost during the preparation process, despite the maximal carefulness of the preparation by the author himself. Only the abaxial cuticle of the specimens was obtained in preparations, therefore this study is limited by the absence of the adaxial cuticle. Such circumstances rather commonly may appear when researchers prepare benettitalean cuticles of Anina specimens, and probably this is why Givulescu (1989, 1991, 1998) also was unable to describe and figure any adaxial cuticle of the material he had studied.

## Nomenclature, taxonomy, and revision principles

The emended diagnosis that Harris (1969, p. 5) gives for the genus *Zamites* stipulates: „Leaf simply pinnate, pinnae attached to upper side of rachis; pinnae lanceolate; base of pinna symmetrically contracted and attached by a small area in middle of basal margin; apex of pinna acute; veins diverging from pinna base, dichotomising but not anastomosing; ending in pinna margins and apex. Cuticle developed, stomata syndetocheilic with one subsidiary cell beside each guard

cell; confined to under surface; epidermal cell walls sinuous.” Therefore, before attributing any specimen to *Zamites*, we should not forget that diagnostic features of this Bennettitalean genus include both morphologic and epidermal characters. Without denying the importance of the macromorphological characters of the leaf, the epidermal characters of the lamina are among the most important diagnostic features. However, the diagnostic epidermal characters can be proved only when both the adaxial cuticle and the abaxial cuticle are preserved and both are present in the microscope preparations, furthermore if both cuticles are described and figured. No sure generic determination is possible when any of these evidences is missing. Determinations of specimens assigned as sure to *Zamites* are susceptible to revision whenever the diagnostic characters are unproved. In such cases the generic attribution is unsure, and evidently, no specific assignment is possible.

The revision method (Czier 2011) used herein already was applied on *Ptilophyllum*, which is another Bennettitalean genus that frequently is cited in the Romanian literature. The essence of the method applied here consists in revisions as “cf. *Zamites* sp.” (hand specimen and one cuticle: description + figuration; the other cuticle not described and/or not figured), “aff. *Zamites* sp.” (only macroscopic or only microscopic description and/or figuration), and “? *Zamites* sp.” (no description, no figuration). In this context, the Romanian *Zamites* material is revised below, and the specimens described and figured in this paper are determined as cf. *Zamites* sp. 1 (macroscopic and abaxial cuticle description and figuration), cf. *Zamites* sp. 2 (macroscopic and abaxial cuticle description and figuration), and aff. *Zamites* sp. (macroscopic description and figuration, no cuticle preserved).

Even if the excellent preservation of a cuticle studied in LM- and SEM microscopy suggests new species, no new species should be created when the other cuticle is unknown. The absence of the adaxial cuticle makes both the LM slides and SEM micrographs useless for specific determination, despite the excellent preservation of the abaxial cuticle.

*Remark:* The used nomenclature and the discussions below are in the style of a previous paper (Czier 2010). The segments improperly are called “pinnae” in the generic diagnosis of *Zamites*, because the meaning of “pinnae” is that of the leaf, when leaves appear as simply pinnate. In addition, the classification of the stomatal apparati follows the recommendations of Sincock and Watson (1988) for plant fossils (cyclocytic instead of haplocheilic, paracytic instead of syndetocheilic).

### Systematic palaeontology

This section comprises the Romanian *Zamites* record and revision. Only the basic references are included in the lists of synonymies. Citations and refigurations, like those from the works of Schimper (1870), Stur (1872), Schréter (1912), Krasser (1921), Thomas (1930), Langer (1947), Oncescu (1951), Semaka (1954), Givulescu (1998) are omitted from the lists, to not increase them excessively, so to make them less complicated. However, previous nomenclatural revisions are considered, and finally, new revisions are done where necessary.

Class Cycadopsida Brongniart, 1843

Order Bennettitales Engler, 1892

Family Williamoniaceae (Carruthers, 1870) Nathorst, 1913

Genus *Zamites* Brongniart, 1828 emend. Harris, 1969

cf. ***Zamites*** sp. 1 Czier

(Figs. 2A, 3A–D, 4A–D, 5A–D)

*Locality*: Anina (coordinates 45°05'30"N 21°51'12"E), Caraş-Severin County, Banat region, Romania.

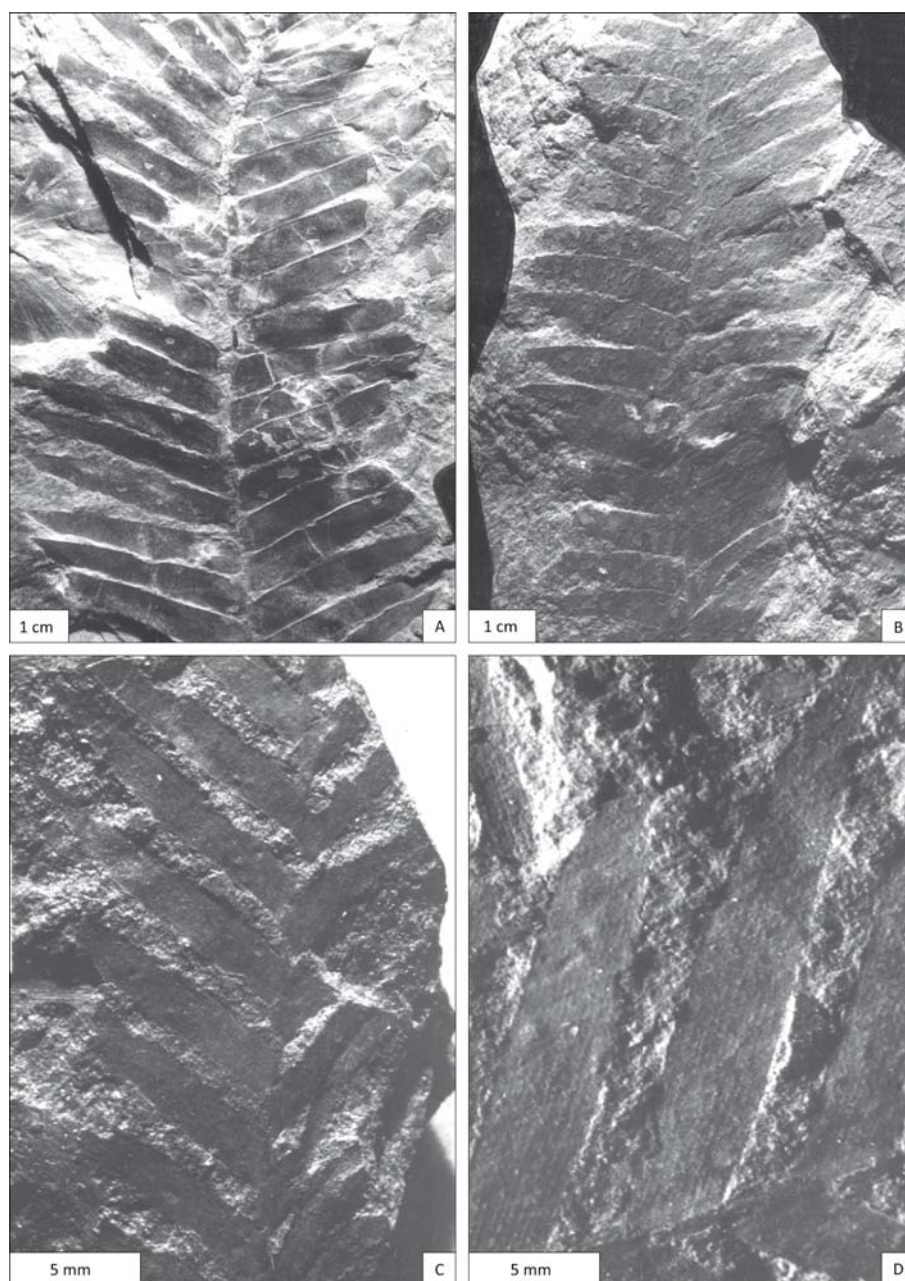
*Lithostratigraphic units*: Steierdorf Formation, Valea Terezia Sandstone Member.

*Biostratigraphic units*: *Clathropteris meniscioides* Biozone, *Banatozamites chlamydostomus* Subzone.

*Age*: Hettangian *pro parte* – Sinemurian.

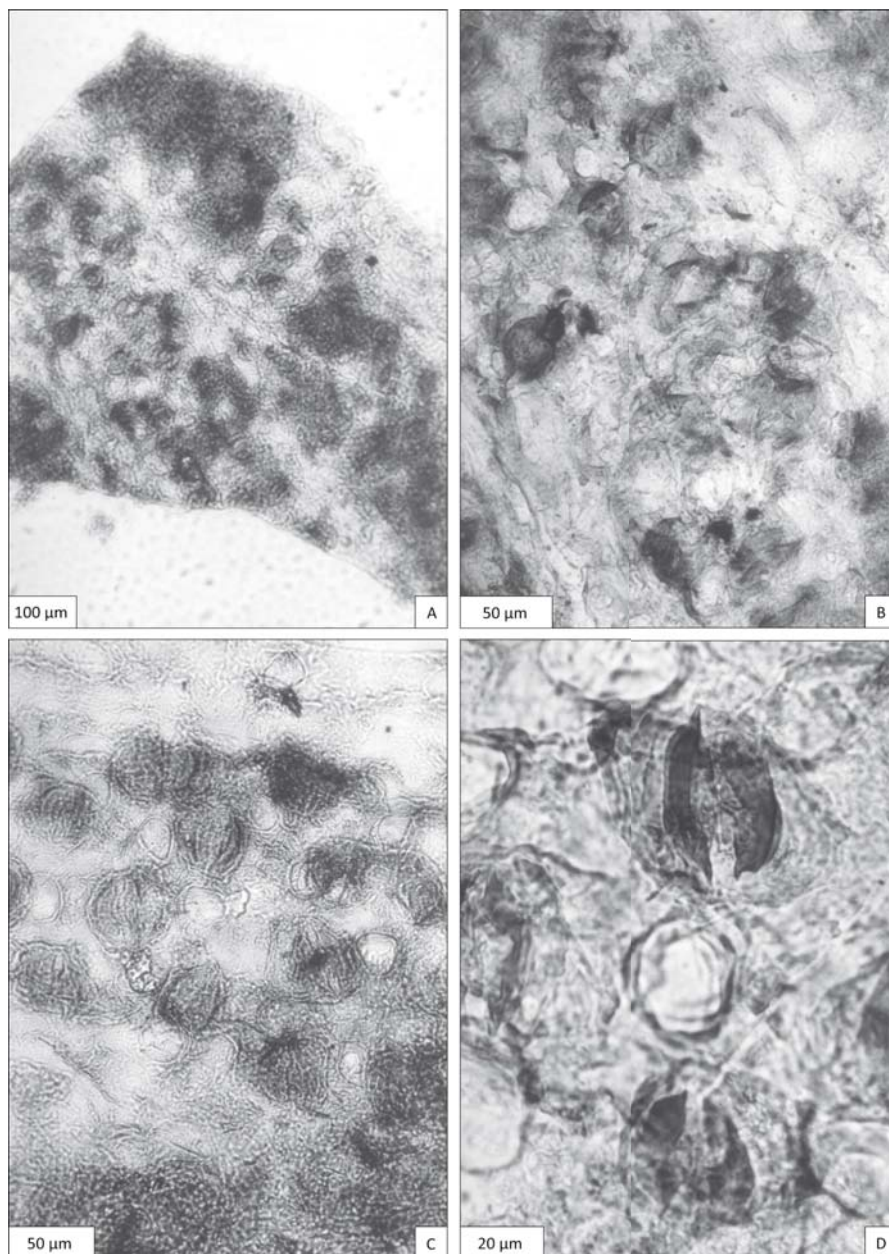
*Material*: Hand specimen HNHM-BP-602141; Slides HNHM-BP-LM-ZC-11 and HNHM-BP-SEM-ZC-2.

*Description and measurements*: Medial-distal fragment of a pinnate leaf (Fig. 2A). Judging after the 75 mm maximal width measured in the middle of the fragment, its length of 144 mm, and the general aspect, the entire leaf initially was medium-sized and linear-lanceolate. The rachis is slightly curved, 3–5 mm wide, preserved on the whole length of the fragment. On its adaxial face there are attached alternately disposed segments at an angle of about 70°; they are closely set in the proximal part of the leaf, to slightly distant in its distal part. Segments are lanceolate, up to 40 mm long and 6 mm wide. They have symmetrically contracted slightly rounded base, being attached to rachis by a small callosity of insertion; in the rest the surface of lamina is flat. The margins of segments are entire, tapering gradually to an acute or even acuminate apex. The venation consists of about 18 crowded, hardly ever dichotomised, almost parallel veins that diverge from the segment base and end in the margins and in the apex. Veins density is 30 per cm.



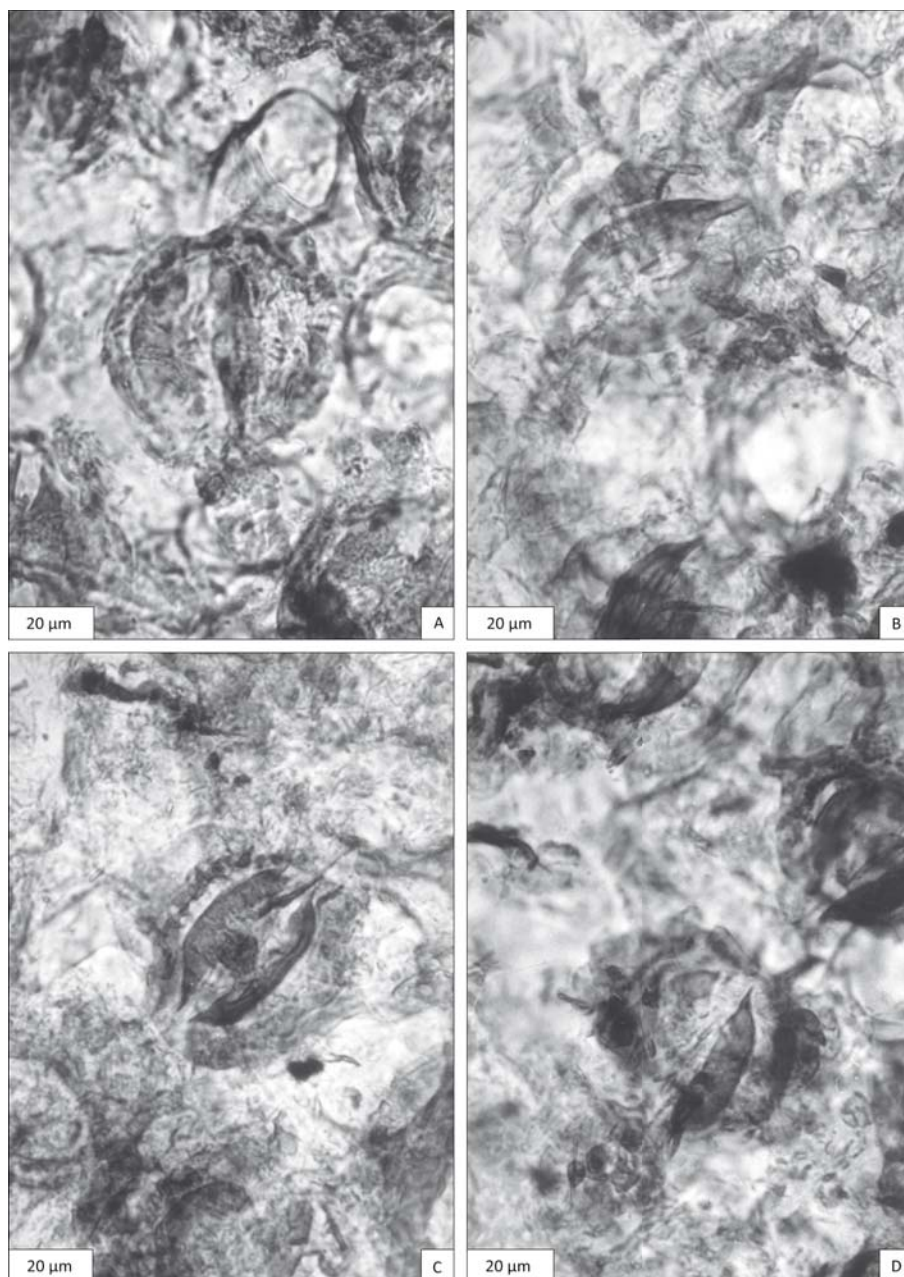
**Figure 2.** *Zamites* foliage. From Anina, Romania, Valea Terezia Sandstone Member, Steierdorf Formation, *Banatozamites chlamydostomus* Subzone of the *Clathropteris meniscioides* Biozone, Hettangian *pro parte* – Sinemurian. (A) cf. *Zamites* sp. 1 Czier. Leaf fragment (HNHM-BP-602141); (B) cf. *Zamites* sp. 2 Czier. Leaf fragment (HNHM-BP-602231-1); (C) aff. *Zamites* sp. Czier. Leaf fragment (HNHM-BP-602231-2); (D) aff. *Zamites* sp. Czier. Shape, attachment, and venation of a segment (HNHM-BP-602231-2).



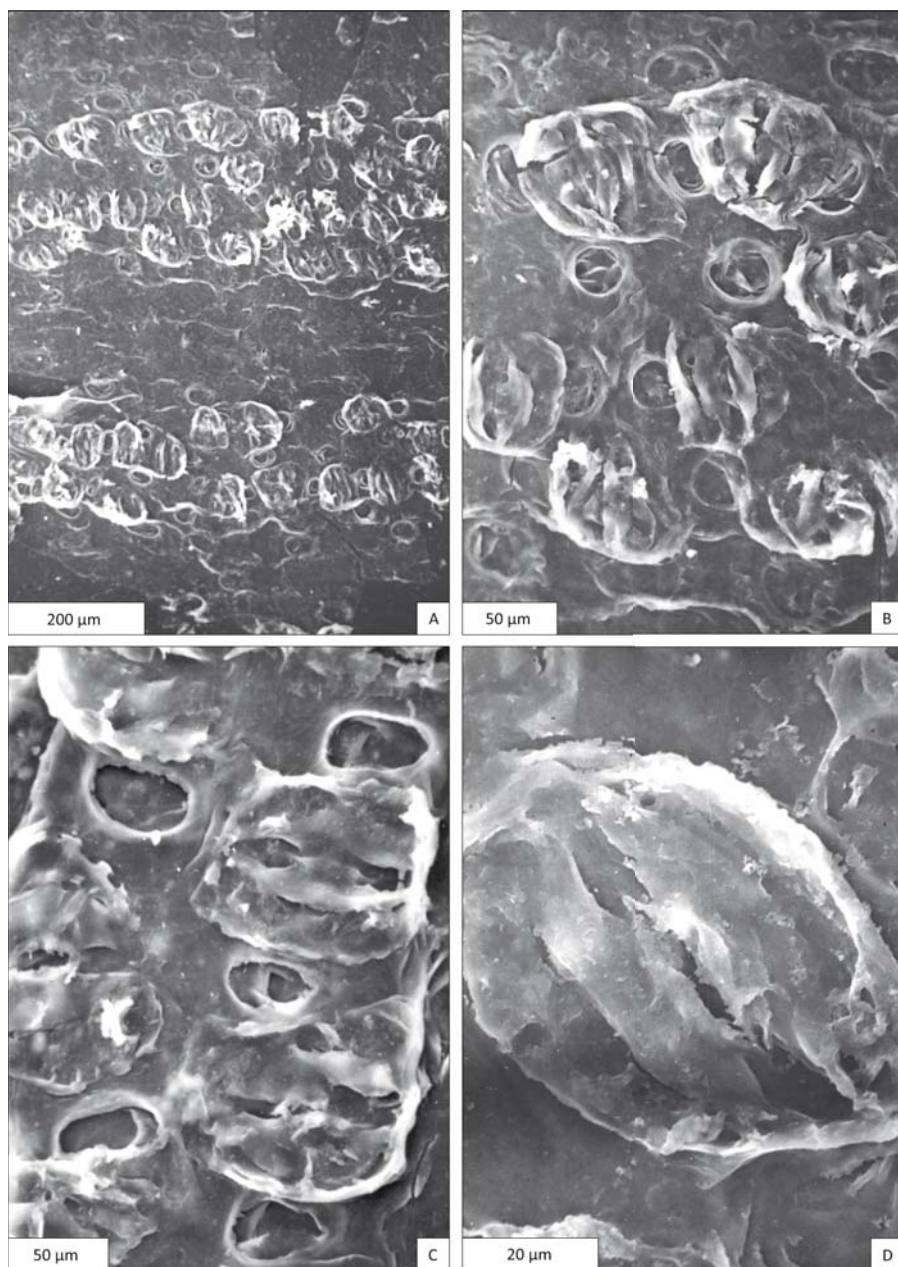


**Figure 3.** cf. *Zamites* sp. 1 Czier. Abaxial cuticle (HNHM-BP-LM-ZC-11). From Anina, Romania, Valea Terezia Sandstone Member, Steierdorf Formation, *Banatozamites chlamydostomus* Subzone of the *Clathropteris meniscioides* Biozone, Hettangian *pro parte* – Sinemurian. (A) Stomatal and non-stomatal bands; (B) Stomatal band showing stomata with regular transverse orientation, between two bands of ordinary epidermal cells; (C) Heavily papillate cuticle, showing a stomatal band between two non-stomatal bands. Stomata transversely oriented to the veins, typically disposed in four rows; (D) Portion of a stomatal band, showing large developed papilla between each pair of stomata.





**Figure 4.** cf. *Zamites* sp. 1 Czier. Abaxial cuticle (HNHM-BP-LM-ZC-11). From Anina, Romania, Valea Terezia Sandstone Member, Steierdorf Formation, *Banatozamites chlamydostomus* Subzone of the *Clathropteris meniscioides* Biozone, Hettangian *pro parte* – Sinemurian. (A) Stomatal apparatus and epidermal cells; (B) Stomata and epidermal cells; (C) Stomata and papillate epidermal cells; (D) Stomata and epidermal cells with large developed papillae.



**Figure 5.** cf. *Zamites* sp. 1 Czier. Abaxial cuticle (HNHM-BP-SEM-ZC-2). From Anina, Romania, Valea Terezia Sandstone Member, Steierdorf Formation, *Banatozamites chlamydostomus* Subzone of the *Clathropteris meniscioides* Biozone, Hettangian *pro parte* – Sinemurian. (A) Stomatal and non-stomatal bands; (B) Stomatal band showing epidermal cells and rows of stomata with regular transverse orientation; (C) Stomata surrounded by epidermal cells with large developed papillae; (D) Paracytic stomatal apparatus, showing details of guard cells, subsidiary cells, and stomatal aperture.

No adaxial cuticle is preserved in the obtained preparations, but only some abaxial cuticle fragments that, however, are well developed. These indicate an abaxial epidermis that was composed by 150  $\mu\text{m}$  wide costal fields (non-stomatal bands corresponding to the veins), and 200–260  $\mu\text{m}$  wide intercostal fields (stomatal bands corresponding to the regions between the veins) (Figs. 3A, 5A). The costal fields are composed by more or less conspicuous rows of epidermal cells rectangular to irregular in shape, of 40–100 / 30–50  $\mu\text{m}$ , oriented with the longest side along the vein courses. These cells show slightly to medium sinuous walls; the sinuosities are relatively large, though not exceeding 10  $\mu\text{m}$  in length (wave length) and 12  $\mu\text{m}$  in width (amplitude). The intercostal fields consist of typically four rows (occasionally 2 or 3 rows) of stomata transversely oriented to the veins, and epidermal cells the most often polygonal or irregular in shape (Figs. 3B, 3C, 5B), shorter than the cells of the costal fields. The stomatal apparatus is of paracytic ('syndetocheilic') type (Figs. 5C–D). Stomata are elliptical, sunken, with two rather elongated guard cells. Each of the guard cells is 45–50  $\mu\text{m}$  long and 12–18  $\mu\text{m}$  wide (typically of 48/16  $\mu\text{m}$ ), showing simple thickenings at the margins and pointed ends, as well large polar spaces. The two subsidiary cells are semicircular, of about 30  $\mu\text{m}$  wide, having smooth walls. The stomatal aperture is large, with maximal diameter of 28  $\mu\text{m}$ . It is bordered by an ovale space in the centre of the stoma, ending at its terminations in a sharp point. Densely scattered stomata, of 50–100 per sq. mm reported to the costal and intercostal fields together, but in the stomatal bands alone even twice as much. Stomatic index of about 15 %. The epidermal cells both in the stomatal and in the non-stomatal bands present large developed papillae bases. These latter usually are circular, sometimes triangular or hexagonal, each of about 20  $\mu\text{m}$  in diameter. In the stomatal bands they typically are disposed one between each neighboured pairs of stomata (Figs. 3D, 4A–D).

*Discussion:* Based on the macro-morphology, and on the paracytic stomatal apparatus that according to Florin (1933) is essential character of Bennettitales, the material undoubtedly belongs to this order. The characters of the specimen suggest that it is a *Zamites*; however, the lack of the adaxial cuticle does not allow a sure statement regarding the lamina, so the amphistomatic character cannot be excluded, and the hypostomatic character stipulated in the generic diagnosis cannot be firmly confirmed. Therefore, the absence of the adaxial cuticle does not allow sure assignment to this genus. At the same time, no specific assignment is done, because specific determination has sense only when the generic attribution is perfectly reliable. Consequently, the material is attributed to *Zamites* with "cf".

*Remark:* The lack of the adaxial cuticle does not allow pronouncing if the lamina is hypostomatic or amphistomatic, therefore, the generic assignment in such cases is unsure, and the specimens are not proper for specific determination. This situation, when the adaxial cuticle is unknown, noted here for *Zamites*, is analogue with that of *Ptilophyllum*, which became well known from the Romanian literature. *Ptilophyllum acifolium*, *P. curvatum*, *P. grandis*, and *P. romanicum* are good examples of incompletely documented species, which were revised by the author (Czier 2011) as cf. *Ptilophyllum* sp.

cf. ***Zamites*** sp. 2 Czier  
(Figs. 2B, 6A–D, 7A–D)

*Locality:* Anina (coordinates 45°05'30"N 21°51'12"E), Caraş-Severin County, Banat region, Romania.

*Lithostratigraphic units:* Steierdorf Formation, Valea Terezia Sandstone Member.

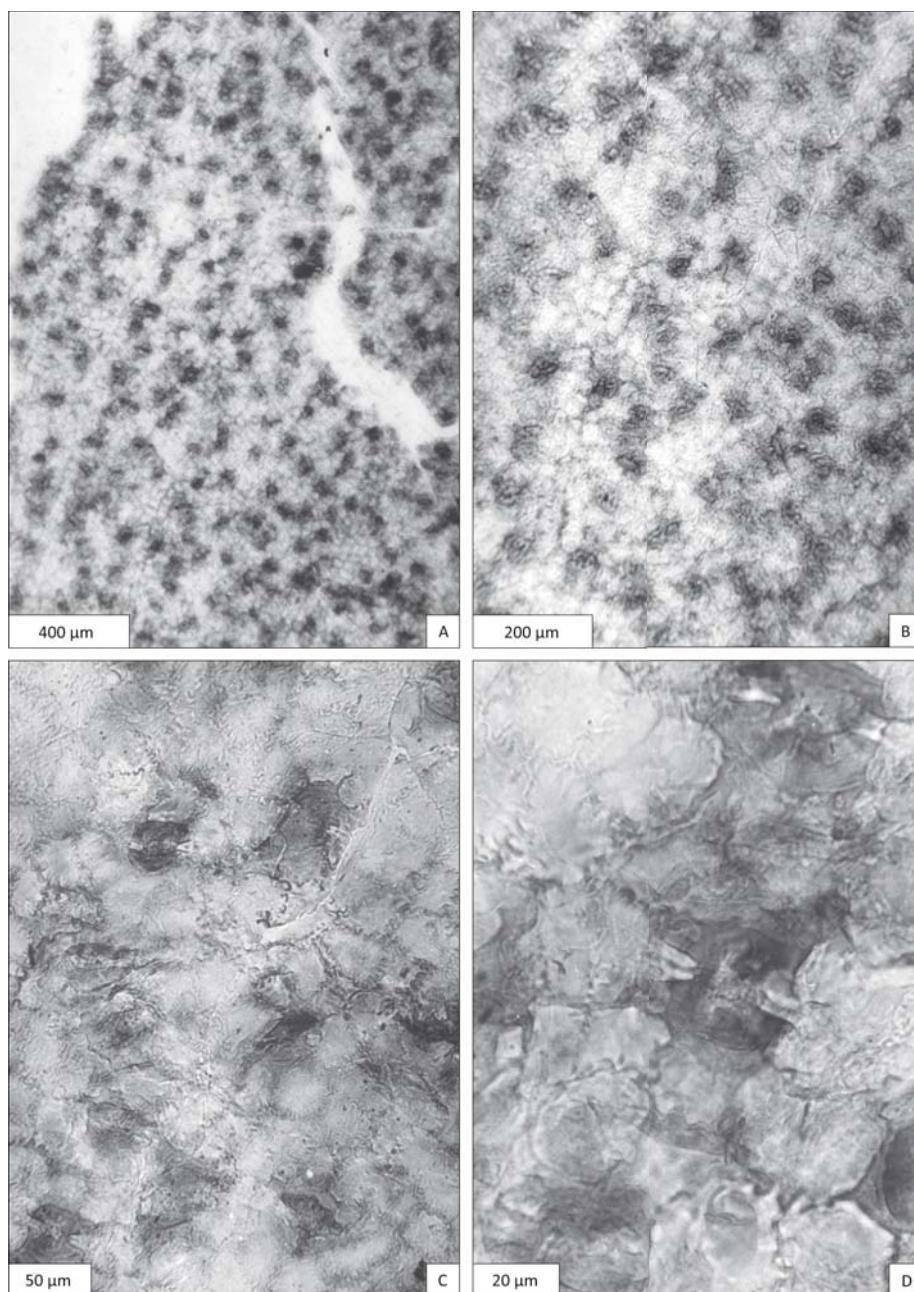
*Biostratigraphic units:* *Clathropteris meniscioides* Biozone, *Banatozamites chlamydostomus* Subzone.

*Age:* Hettangian *pro parte* – Sinemurian.

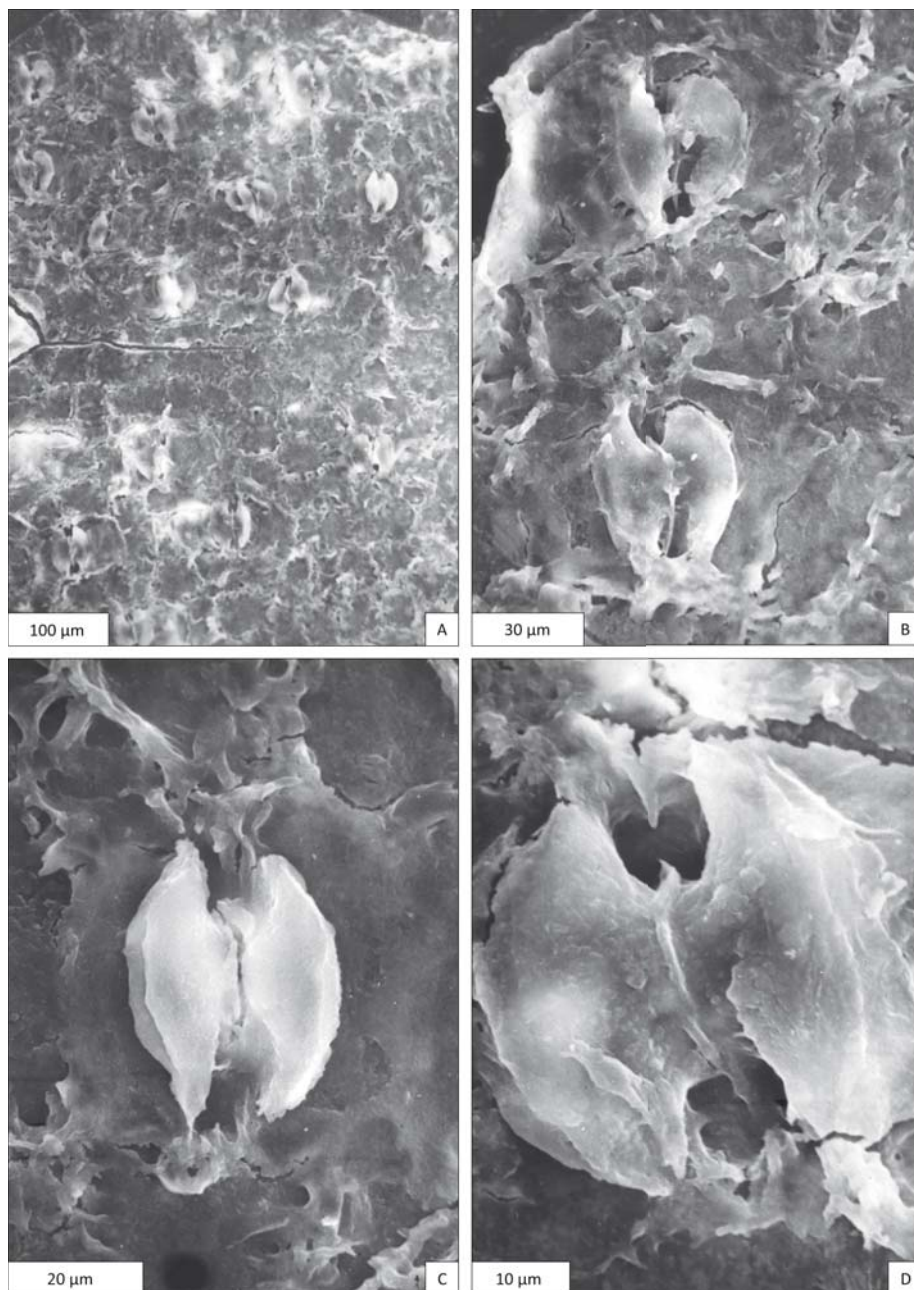
*Material:* Hand specimen HNHN-BP-602231-1; Slides HNHN-BP-LM-ZC-15 and HNHN-BP-SEM-ZC-3.

*Description and measurements:* Small-sized pinnate leaf preserved on a length of 116 mm, with maximal width in its medial portion of 51 mm (Fig. 2B). Although its base is not entirely preserved and the apex is not exactly known, the shape of the leaf may be estimated to elliptical, as it gradually narrows both in the proximal and distal part of the fragment. The rachis is slender and thin, of 1–2 mm wide, slightly curved in its proximal third. It is almost completely concealed by the closely set and alternately disposed segments attached on its upper side at an insertion angle generally of about 80°, but angle reducing proximally and distally to about 50°. The preserved segments, 21 pairs in number, are disposed alternately, while the whole leaf supposing had 25–30 pairs. The segments are lanceolate, typically of 30 mm long and 6 mm wide, decreasing near the extremities of the fragment even to about half of these dimensions. They possess entire margins, symmetrically contracted and slightly rounded base attached in the middle of the basal margin, and acute apex. The veins are very thin, apparently diverging from the segment base. Macroscopically they are almost indistinguishable, but microscopically the cuticle sometimes shows dichotomous veins.





**Figure 6.** *cf. Zamites* sp. 2 Czier. Abaxial cuticle (HNHM-BP-LM-ZC-15). From Anina, Romania, Valea Terezia Sandstone Member, Steierdorf Formation, *Banatozamites chlamydostomus* Subzone of the *Clathropteris meniscioides* Biozone, Hettangian *pro parte* – Sinemurian. (A) General view of the cuticle; (B) Stomatal and non-stomatal bands; (C) Portion of a stomatal band; (D) Stomata and epidermal cells.



**Figure 7.** *cf. Zamites* sp. 2 Czier. Abaxial cuticle (HNHM-BP-SEM-ZC-3). From Anina, Romania, Valea Terezia Sandstone Member, Steierdorf Formation, *Banatozamites chlamydostomus* Subzone of the *Clathropteris meniscioides* Biozone, Hettangian *pro parte* – Sinemurian. (A) Non-stomatal band between two stomatal bands; (B) Stomata and epidermal cells; (C) Stomatal apparatus; (D) Stoma with distinct polar spaces.

Adaxial cuticle unfortunately not present in the slides, but the abaxial cuticle is well developed (Fig. 6A). It indicates an epidermis composed by narrow, just about 80  $\mu\text{m}$  wide costal fields (non-stomatal bands corresponding to the veins) alternating with much wider, about 250  $\mu\text{m}$  wide intercostal fields (stomatal bands corresponding to the regions between the veins) (Fig. 6B). The costal fields usually consist of two rows of squarish, rectangular to elliptical epidermal cells typically of 30 / 30  $\mu\text{m}$  (range 20–100 / 20–40  $\mu\text{m}$ ), which possess marked sinuous walls; the sinuosities are thick, of about 10  $\mu\text{m}$  long (wave-length) and 10  $\mu\text{m}$  wide (amplitude) (Fig. 7A). The intercostal fields contain somehow alike but more rounded or even polygonal ordinary epidermal cells, and irregularly disposed stomata that usually are transversely oriented to the direction of the bands (Fig. 7B); just some of them may have the pore oriented in any direction (Fig. 6C). The stomatal apparatus is paracytic, showing circular stoma typically of 35  $\mu\text{m}$  diameter (Fig. 7C). The guard cells possess semicrescent thickenings and distinct polar spaces (Fig. 7D), so at the end of their margins they appear as having four endings resembling with some horns (Fig. 6D). The subsidiary cells are small to medium-sized, of about 30  $\mu\text{m}$  wide, with almost smooth walls. The maximal diameter of the stomatal aperture is of 22  $\mu\text{m}$ . The stomata are densely scattered, about 100 per sq.mm, the stomatic index being 6–8 %. The periclinal wall of any epidermal cell may possess circular trichome bases, each of about 8  $\mu\text{m}$  in diameter.

*Discussion:* Reported to cf. *Zamites* sp. 1, this specimen presents marked differences, rendered in a table of comparison (Tab. 1). These differences make necessary a clearly distinction, therefore, the specimen is determined as cf. *Zamites* sp. 2. Otherwise, the discussion already given is effectual here too.

**Table 1.** The main differences between the characters of cf. *Zamites* sp. 1 Czier, and cf. *Zamites* sp. 2 Czier.

| Character                                        | cf. <i>Zamites</i> sp. 1      | cf. <i>Zamites</i> sp. 2       |
|--------------------------------------------------|-------------------------------|--------------------------------|
| <i>Macro-morphology</i>                          |                               |                                |
| Size of the leaf                                 | Medium                        | Small                          |
| Shape of the leaf                                | Linear-lanceolate             | Elliptic                       |
| Segment apex                                     | Acute or acuminate            | Acute                          |
| <i>Abaxial epidermis</i>                         |                               |                                |
| General aspect and width of the costal fields    | Wide, about 150 $\mu\text{m}$ | Narrow, about 80 $\mu\text{m}$ |
| Disposition of stomata in the intercostal fields | In rows                       | Irregular                      |
| Shape and length/width of typical stoma          | Elliptic, 48/32 $\mu\text{m}$ | Circular, 35/35 $\mu\text{m}$  |
| Maximal diameter of the stomatal aperture        | 28 $\mu\text{m}$              | 22 $\mu\text{m}$               |
| Stomatic index                                   | 15 %                          | 6–8 %                          |
| Ornamentation of the epidermal cells             | Papilla                       | Trichome                       |



cf. *Zamites* sp.

1. 1989 *Zamites andraeanus* (Semaka) Giv. Givulescu and Farcașiu, p. 139 (part)
2. 1989 *Zamites aninaensis* (Semaka) Giv. Givulescu and Farcașiu, p. 139 (part)
3. 1989 *Zamites* sp. Givulescu and Farcașiu, p. 139 (part)
4. 1989 *Zamites* sp. Givulescu and Farcașiu, p. 139 (part)
5. 1989 *Zamites aninaensis* (Semaka) Giv. Givulescu, p. 30
6. 1989 *Zamites* sp. 2. Givulescu, p. 30
7. 1989 *Zamites schmiedeli* Stbg. Givulescu, p. 30, plate 1, fig. 1
8. 1991 *Zamites vachrameevii* Doludenko. Givulescu, p. 17, plate 1, figs. 1, 2

*Localities:* Anina (1, 2, 3, 4, 5, 6, 7); Vulcan (8).

*Lithostratigraphic units:* Steierdorf Formation, Valea Terezia Sandstone Member (1, 2, 3, 4, 5, 6, 7); Codlea-Vulcan Formation, Vulcan Sandstone Member (8).

*Biostratigraphic units:* *Clathropteris meniscioides* Biozone, *Banatozamites chlamydostomus* Subzone (1, 2, 3, 4, 5, 6, 7, 8).

*Age:* Hettangian *pro parte* – Sinemurian (1, 2, 3, 4, 5, 6, 7, 8).

*Discussion:* Adaxial cuticle not figured (1, 2, 3, 4, 5, 6, 7, 8).

aff. *Zamites* sp. Czier

(Fig. 2C–D)

*Locality:* Anina (coordinates 45°05'30"N 21°51'12"E), Caraș-Severin County, Banat region, Romania.

*Lithostratigraphic units:* Steierdorf Formation, Valea Terezia Sandstone Member.

*Biostratigraphic units:* *Clathropteris meniscioides* Biozone, *Banatozamites chlamydostomus* Subzone.

*Age:* Hettangian *pro parte* – Sinemurian.

*Material:* Hand specimen HNHM-BP-602231-2.

*Description and measurements:* Fragment of a pinnate leaf (Fig. 2C), preserved on a length of 56 mm and width of 30 mm, representing a portion not far from its hypothetical apex. The rachis, preserved along the whole fragment, is straight and very narrow, of only 0.6 mm wide. On its upper side, at 50° angle of insertion, there are attached alternate segments, distantly disposed, with gaps of 2.5 mm between them. The segments are lanceolate, possessing entire margins and acute to acuminate apex (Fig. 2D). Their length is about 27 mm, and their width of 4 mm. The venation is hardly seen as the specimen is rather poorly preserved, but on some better preserved portions the segments show 14 apparently parallel veins.

*Discussion:* The very narrow rachis of this specimen does not allow clear statement regarding the attachment of the segments, so it is not clear enough if they are attached by a small area in middle of the basal margin or not. The macroscopic generic determination needs, therefore, at least a “cf.”, however, owing to the absence of any cuticle finally is needed “aff.”.

aff. *Zamites* sp.

1. 1855 *Zamites Schmiedelii* Sternb. Andrae, p. 39, plate 9, fig. 1 (part)
2. 1855 *Zamites Schmiedelii* Sternb. Andrae, p. 39, plate 9, figs. 1 (part), 2, 3
3. 1855 *Zamites Schmiedelii* Sternb. Andrae, p. 39 (part), plate 9, fig. 4
4. 1855 *Zamites Schmiedelii* Sternb. Andrae, p. 39 (part), plate 11, fig. 7
5. 1855 *Zamites* oder *Pterophyllum*. Andrae, p. 42, plate 8, fig. 1a
6. 1921 *Zamites Andraei* Stur. Krasser, p. 362 (part)
7. 1921 *Zamites Andraei* Stur. Krasser, p. 362 (part)
8. 1930 *Zamites Schmiedelii* Andrae. Thomas, p. 399, text-figs. 9, 10
9. 1947 *Zamites schmiedeli* Sternb. Langer, p. 25, plate 3, fig. a
10. 1958 *Zamites schmiedelii* Sternberg. Semaka, p. 414, tab. 3
11. 1962 *Otozamites schmiedelii* (Sternberg) Semaka. Oarcea and Semaka, p. 241 (part)
12. 1962 *Otozamites schmiedelii* (Sternberg) Semaka. Oarcea and Semaka, p. 241 (part)
13. 1962 *Otozamites andraeanus* Semaka. Oarcea and Semaka, p. 241 (part)
14. 1962 *Otozamites andraeanus* Semaka. Oarcea and Semaka, p. 241 (part)
15. 1962 *Otozamites andraeanus* Semaka. Oarcea and Semaka, p. 241 (part)
16. 1962a *Otozamites* div. sp. n. Semaka, p. 532 (part)
17. 1962a *Otozamites* div. sp. n. Semaka, p. 532 (part)
18. 1962a *Otozamites* div. sp. n. Semaka, p. 532 (part)
19. 1962a *Zamites schmiedelii* Sternberg. Semaka, p. 533 (part), 542 (part), 550 (part), 554 (part), tab. 1 (part)
20. 1962c *Otozamites andreanus* n. p. Semaka, p. 95 (part)
21. 1962c *Otozamites andreanus* Semaka. Semaka, p. 95 (part), plate 1, text-figs. 2, 3
22. 1964 *Zamites* sp. Mateescu, p. 100, plate 3, fig. 1
23. 1966 *Zamites* sp. Zborea et al., p. 50
24. 1970 *Otozamites schmiedelii* (Sternberg) Semaka. Semaka, p. 28, 50, plate 21 (part), tab. 14
25. 1989 *Zamites schmiedeli* Presl in Stbg. Givulescu and Farcașiu, p. 139

26. 1989 *Zamites aninaensis* (Semaka) Giv. Givulescu and Farcașiu, p. 139 (part)
27. 1996 *Zamites andraeanus*. Berg, p. 54, tab. 1 (part)
28. 1996 *Zamites andraeanus* (Semaka) Givulescu. Berg, p. 54 (part), 56 (part), tab. 1 (part)
29. 1996 *Zamites andraeanus* (Semaka) Givulescu. Berg, p. 54 (part), 56 (part), tab. 1 (part)
30. 1996 *Zamites andraeanus* (Semaka) Givulescu. Berg, p. 54 (part), 56 (part), plate 2, fig. 7, tab. 1 (part)
31. 1996 *Zamites aninaensis*. Berg, p. 54 (part), 56 (part), plate 2, fig. 5, tab. 1 (part)
32. 1996 *Zamites schmiedeli* Sternberg. Berg, p. 55 (part), pl. 1, figs. 4, 6
33. 1996 *Zamites schmiedeli* Sternberg. Berg, p. 55 (part)

*Localities:* Anina (1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 21, 25, 26, 27, 28, 29, 30, 31, 32, 33); Cristian (6); Doman (13); Anina and/or Doman (20); Vulcan (22); Crasna (23); Berzasca (24).

*Lithostratigraphic units:* Steierdorf Formation or Dealul Zânei Formation (1, 2, 4, 5, 8, 9, 20); Steierdorf Formation, Valea Terezia Sandstone Member (3, 10, 12, 15, 16, 18, 19, 21, 25, 26, 27, 28, 29, 30, 31, 32, 33); Cristian Formation, Valea Schneebrich Sandstone Member (6); Steierdorf Formation, Dealul Budinic Conglomerate Member or Valea Terezia Sandstone Member (7, 11, 13, 14, 17); Codlea-Vulcan Formation, Vulcan Sandstone Member (22); Baia de Aramă Formation, Valea Sunătorii Argillaceous Member (23); Svinița Formation, Ogașul Murguceva Limestone Member (24).

*Biostratigraphic units:* *Clathropteris meniscioides* Biozone or *Carpolithes liasinus* Biozone or *Anomozamites spectabilis* assemblage (1, 2, 4, 5, 8, 9, 20); *Clathropteris meniscioides* Biozone, *Banatozamites chlamydostomus* Subzone (3, 10, 12, 15, 18, 19, 21, 22, 25, 26, 27, 28, 29, 30, 32, 33); *Anomozamites marginatus* Biozone (6); *Carpolithes liasinus* Biozone (7, 11, 13, 14, 16, 17, 23, 24); *Clathropteris meniscioides* Biozone (31).

*Ages:* Hettangian – Toarcian (1, 2, 4, 5, 8, 9, 20); Hettangian *pro parte* – Sinemurian (3, 10, 12, 15, 16, 18, 19, 21, 22, 25, 26, 27, 28, 29, 30, 31, 32, 33); Sinemurian *pro parte* (6, 23); Hettangian – Sinemurian (7, 11, 13, 14, 17); Pliensbachian *pro parte* (24).

*Discussions:* The material is only macroscopically described and figured (1, 2, 3, 4, 5, 9, 10, 16, 21, 24, 30, 31, 32); the material is only macroscopically described and is not figured (6, 7, 11, 12, 13, 14, 15, 17, 18, 19, 20, 23, 25, 26, 27, 28, 29, 33);

the material is only microscopically described and figured, both cuticles are known, but the hand specimen is unidentifiable (8); the material is only macroscopically figured and is not described (22).

**? *Zamites* sp.**

1. 1850 *Zamites*. Foetterle, p. 357
2. 1860a *Zamites Schmiedelii* Strnbg. Stur, p. 57 (part)
3. 1860a *Zamites Schmiedelii* Strnbg. Stur, p. 57 (part)
4. 1860b *Zamites* sp.? oder *Pterophyllum* sp.? Stur, p. 58
5. 1871 *Podozamites* cf. *Schmiedelii* Sternb. Stur, p. 464
6. 1878 *Zamites Schmidelii* Presl. Hantken, p. 64 (spelling error for *schmiedelii*)
7. 1878 *Zamites Schmiedelii* Presl. Hantken, p. 65
8. 1878 *Zamnites Barrei* St. n. sp. Hantken, p. 69
9. 1878 *Zamites Barrei*. Hantken, p. 69
10. 1878 *Cycadopteris Barrei*. Hantken, p. 69
11. 1878 *Cyclopteris barrei*. Hantken, p. 70
12. 1878 *Pterophyllum Barrei*. Hantken, p. 71
13. 1878 *Zamites meriani*. Hantken, p. 70
14. 1878 *Zamites* sp. Hantken, p. 71
15. 1890 *Zamites Schmiedelii* Sternb. Telegdi Roth, p. 96
16. 1891 *Zamites Schmiedelii* Sternb. Telegdi Roth, p. 89 (part)
17. 1891 *Zamites Schmiedelii* Sternb. Telegdi Roth, p. 89 (part)
18. 1891 *Zamites gracilis* Kurr. Telegdi Roth, p. 93
19. 1891 *Zamites*. Bene, p. 329
20. 1906 *Zamites gracilis* Kurr. Telegdi Roth, p. 25
21. 1911 *Nilssonina polymorpha* Schenk. Toula, p. 17
22. 1951 *Z. schmideli*. Barbu, p. 130
23. 1957 *Zamites banaticus* Stur. Mateescu, p. 9
24. 1957 *Zamites rigidus* Andrae. Mateescu, p. 9
25. 1961 *Otozamites* typus. Semaka, p. 392, tab. 1
26. 1961 Unbestimmbare Reste. Semaka, p. 393 (part)
27. 1962 *Zamites gracilis* Kurr. Oarcea & Semaka, p. 241 (part)
28. 1962 *Zamites gracilis* Kurr. Oarcea & Semaka, p. 241 (part)
29. 1962 *Zamites* sp. Oarcea & Semaka, p. 241
30. 1962 *Zamites* sp. Oarcea & Semaka, p. 241 (part)
31. 1962 *Zamites* sp. Oarcea & Semaka, p. 241 (part)
32. 1962b *Zamites gracilis* Kurr. Semaka, p. 217

33. 1962 *Folia zamitoides*, *Folia zamitoidea*. Iliescu & Semaka, p. 115, 116
34. 1962 *Zamites* sp. Iliescu & Semaka, p. 116, 117
35. 1962 *Zamites* sp. Drăghici & Semaka, p. 41
36. 1963 *Zamites* sp. Humml, p. 194
37. 1963 *Otozamites schmiedelii* (Sternberg) Semaka. Humml, p. 195 (part)
38. 1963 *Otozamites schmiedelii* (Sternberg) Semaka. Humml, p. 195 (part)
39. 1963 *Zamites* sp. (typus *Otozamites*). Humml, p. 195
40. 1963 *Zamites* sp. Humml, p. 195
41. 1963 *Otozamites schmiedelii* (Sternberg) Semaka. Humml, p. 196 (part)
42. 1963 *Otozamites schmiedelii* (Sternberg) Semaka. Humml, p. 196 (part)
43. 1963 *Otozamites andraeanus* Semaka. Humml, p. 196
44. 1963 *Otozamites aninaensis* Semaka. Humml, p. 196 (part)
45. 1963 *Otozamites aninaensis* Semaka. Humml, p. 196 (part)
46. 1963 *Otozamites schmiedelii* (Sternberg) Semaka. Humml, p. 196 (part), 197
47. 1963 *Zamites* sp. Humml, p. 196
48. 1963 *Zamites* sp. Humml, p. 197 (part)
49. 1963 *Zamites* sp. Humml, p. 197 (part), 198 (part)
50. 1963 *Zamites* sp. Humml, p. 197 (part), 198 (part)
51. 1963 *Zamites* sp. Humml, p. 198 (part)
52. 1963 *Zamites* sp. Humml, p. 199
53. 1970 *Zamites* sp. Semaka, p. 17, 50, tab. 7
54. 1970 *Zamites* sp. Semaka, p. 25, 50, tab. 10
55. 1970 *Zamites* sp. Semaka, p. 26, 50, tab. 11
56. 1970 *Zamites* sp. Semaka, p. 27, 50, tab. 12
57. 1972 *Zamites* sp. Semaka et al., p. 436, 439, tab. 1 (part)
58. 1972 *Zamites* sp. an sp. n. Semaka et al., p. 439, tab. 1
59. 1989 *Zamites andraeanus* (Semaka) Giv. Givulescu and Farcașiu, p. 139 (part)
60. 1996 *Zamites* Cf. *schmiedelii*. Berg, p. 54, tab. 1
61. 1996 *Zamites aninaensis*. Berg, p. 54, tab. 1 (part)
62. 1996 *Zamites aninaensis* (Semaka) Givulescu. Berg, p. 54 (part), 56 (part), tab. 1 (part)
63. 1996 *Zamites* sp. Berg, p. 54, 56, tab. 1 (part)

*Localities:* Anina (1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 22, 27, 28, 29, 30, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 59, 60, 61, 62, 63); Holbav (2, 4); Cristian (3, 21); Doman (19, 23, 24, 31, 32, 36); Buschmann mine (25); Berzasca (26); Mehadia (33, 34); Baia de Aramă (35); Not exactly known (52); Co-

zla (53); Pietrele Albe (54); Dragosella (55); Crivi valley (56); Viezuroi mine (57, 58). *Lithostratigraphic units*: Steierdorf Formation, Valea Terezia Sandstone Member (1, 5, 6, 7, 17, 19, 23, 24, 28, 30, 32, 37, 39, 43, 45, 48, 49, 59, 60, 61, 62, 63); Codlea-Vulcan Formation, Vulcan Sandstone Member (2, 4); Cristian Formation, Valea Schneebrich Sandstone Member (3, 21); Dealul Zânei Formation *pro parte* (8, 9, 10, 11, 13); Dealul Zânei Formation, Valea Sodoi Marl Member (12, 14); Steierdorf Formation, Dealul Budinic Conglomerate Member or Valea Terezia Sandstone Member (15, 16, 27, 29, 31, 36, 38, 40, 41, 42, 44, 46, 47, 50, 51); Steierdorf Formation, Uteriș Argilitic Member (18, 20); Steierdorf Formation or Dealul Zânei Formation (22, 52); Svinița Formation, Ogașul Vodânișchi Sandstone Member (25, 53, 54, 55, 56); Svinița Formation, Ogașul Murguceva Limestone Member (26); Mehadia Formation, Valea Ciumoasa Conglomerate Member (33, 34); Baia de Aramă Formation, Dealul Spineni Marl Member (35); Schela Formation (57, 58). *Biostratigraphic units*: *Clathropteris meniscioides* Biozone, *Banatozamites chlamydostomus* Subzone (1, 2, 4, 5, 6, 7, 17, 19, 23, 24, 28, 30, 32, 37, 39, 43, 45, 48, 49, 59, 60, 61, 62, 63); *Anomozamites marginatus* Biozone (3, 21); Not defined, "Layers with *Gryphaea*" (8, 9, 10, 11, 13); Not defined, "*Anomozamites spectabilis* assemblage" (12, 14); *Clathropteris meniscioides* Biozone (15, 16, 25, 27, 29, 31, 35, 36, 38, 40, 41, 42, 44, 46, 47, 50, 51, 54, 55, 56, 57, 58); *Carpolithes liasinus* Biozone (18, 20, 26); *Clathropteris meniscioides* Biozone or *Carpolithes liasinus* Biozone or *Anomozamites spectabilis* assemblage (22, 52); *Clathropteris meniscioides* Biozone, *Leptostrobus laxiflora* Subzone (33, 34); *Clathropteris meniscioides* Biozone, *Neocalamites carcinoides* Subzone (53). *Ages*: Hettangian *pro parte* – Sinemurian (1, 2, 4, 5, 6, 7, 17, 19, 23, 24, 25, 28, 30, 32, 37, 39, 43, 45, 48, 49, 54, 55, 56, 59, 60, 61, 62, 63); Sinemurian *pro parte* (3, 21); Aalenian *pro parte* (8, 9, 10, 11, 13); Toarcian (12, 14); Hettangian – Sinemurian (15, 16, 27, 29, 31, 35, 36, 38, 40, 41, 42, 44, 46, 47, 50, 51, 57, 58); Pliensbachian (18, 20); Hettangian – Toarcian (22, 52); Pliensbachian *pro parte* (26); Hettangian *pro parte* (33, 34); Hettangian *pro parte* - Sinemurian *pro parte* (53).

*Discussion*: The material is not described and not figured (1–63).

### Stratigraphic distribution of the Romanian *Zamites* material

The revision of the Romanian *Zamites* material does not alter the map of geographical distribution presented at the beginning of this work. The map may be used together with the attached table (Tab. 2) containing the stratigraphic distribution of the taxa, which are present in the fossil flora of the localities.



**Table 2.** Chronostratigraphic, tectonostratigraphic, lithostratigraphic, and biostratigraphic distribution of the Romanian *Zamites* material.

| Localities     | Chronostratigraphy                                        | Tectonostratigraphy | Lithostratigraphy                                            | Biostratigraphy                                                                    | Taxa                                             |
|----------------|-----------------------------------------------------------|---------------------|--------------------------------------------------------------|------------------------------------------------------------------------------------|--------------------------------------------------|
| Cristian       | Sinemurian <i>pro parte</i>                               | Leaota              | Cristian Formation, Valea Schneebrich Sandstone Member       | <i>Anomozamites marginatus</i> Biozone                                             | aff. <i>Zamites</i> sp.,<br>? <i>Zamites</i> sp. |
| Crivi valley   | Hettangian <i>pro parte</i> – Sinemurian                  | Danubian            | Svinița Formation, Ogașul Vodănișchi Sandstone Member        | <i>Clathropteris meniscioides</i> Biozone                                          | ? <i>Zamites</i> sp.                             |
| Berzasca       | Pliensbachian <i>pro parte</i>                            | Danubian            | Svinița Formation, Ogașul Murguș Limestone Member            | <i>Carpolithes liasinus</i> Biozone                                                | aff. <i>Zamites</i> sp., ?<br><i>Zamites</i> sp. |
| Buschmann mine | Hettangian <i>pro parte</i> – Sinemurian                  | Danubian            | Svinița Formation, Ogașul Vodănișchi Sandstone Member        | <i>Clathropteris meniscioides</i> Biozone                                          | ? <i>Zamites</i> sp.                             |
| Pietrele Albe  | Hettangian <i>pro parte</i> – Sinemurian                  | Danubian            | Svinița Formation, Ogașul Vodănișchi Sandstone Member        | <i>Clathropteris meniscioides</i> Biozone                                          | ? <i>Zamites</i> sp.                             |
| Dragosella     | Hettangian <i>pro parte</i> – Sinemurian                  | Danubian            | Svinița Formation, Ogașul Vodănișchi Sandstone Member        | <i>Clathropteris meniscioides</i> Biozone                                          | ? <i>Zamites</i> sp.                             |
| Cozla          | Hettangian <i>pro parte</i> – Sinemurian <i>pro parte</i> | Danubian            | Svinița Formation, Ogașul Vodănișchi Sandstone Member        | <i>Clathropteris meniscioides</i> Biozone, <i>Neocalamites carcinoides</i> Subzone | ? <i>Zamites</i> sp.                             |
| Mehadia        | Hettangian <i>pro parte</i>                               | Danubian            | Mehadia Formation, Valea Ciomoasa Conglomerate Member        | <i>Clathropteris meniscioides</i> Biozone, <i>Leptostrobus laxiflora</i> Subzone   | ? <i>Zamites</i> sp.                             |
| Viezuroi mine  | Hettangian – Sinemurian                                   | Danubian            | Schela Formation                                             | <i>Clathropteris meniscioides</i> Biozone                                          | ? <i>Zamites</i> sp.                             |
| Crasna         | Sinemurian <i>pro parte</i>                               | Danubian            | Baia de Aramă Formation, Valea Sunătorii Argillaceous Member | <i>Clathropteris meniscioides</i> Biozone                                          | aff. <i>Zamites</i> sp.                          |
| Baia de Aramă  | Hettangian – Sinemurian                                   | Danubian            | Baia de Aramă Formation, Dealul Spineni Marl Member          | <i>Clathropteris meniscioides</i> Biozone                                          | ? <i>Zamites</i> sp.                             |

|                   |                                          |       |                                                                                            |                                                                                                                                |                                                                                                                                                                      |
|-------------------|------------------------------------------|-------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Anina             | Hettangian <i>pro parte</i> – Sinemurian | Getic | Steierdorf Formation, Valea Terezia Sandstone Member                                       | <i>Clathropteris meniscioides</i> Biozone, <i>Banatozamites chlamydostomus</i> Subzone                                         | cf. <i>Zamites</i> sp. 1 Czter, cf. <i>Zamites</i> sp. 2 Czter, cf. <i>Zamites</i> sp., aff. <i>Zamites</i> sp. Czter, aff. <i>Zamites</i> sp., ? <i>Zamites</i> sp. |
|                   | Hettangian – Toarcian                    | Getic | Steierdorf Formation or Dealul Zânei Formation                                             | <i>Clathropteris meniscioides</i> Biozone or <i>Carpolithes liasinus</i> Biozone or <i>Anomozamites spectabilis</i> assemblage | aff. <i>Zamites</i> sp., ? <i>Zamites</i> sp.                                                                                                                        |
|                   | Hettangian – Sinemurian                  | Getic | Steierdorf Formation, Dealul Budinic Conglomerate Member or Valea Terezia Sandstone Member | <i>Clathropteris meniscioides</i> Biozone                                                                                      | aff. <i>Zamites</i> sp., ? <i>Zamites</i> sp.                                                                                                                        |
|                   | Pliensbachian                            | Getic | Steierdorf Formation, Uteriș Argilic Member                                                | <i>Carpolithes liasinus</i> Biozone                                                                                            | ? <i>Zamites</i> sp.                                                                                                                                                 |
|                   | Toarcian                                 | Getic | Dealul Zânei Formation, Valea Sodoi Marl Member                                            | Not defined ("Anomozamites spectabilis assemblage")                                                                            | ? <i>Zamites</i> sp.                                                                                                                                                 |
|                   | Aalenian <i>pro parte</i>                | Getic | Dealul Zânei Formation <i>pro parte</i>                                                    | Not defined ("Layers with <i>Gryphaea</i> ")                                                                                   | ? <i>Zamites</i> sp.                                                                                                                                                 |
|                   | Hettangian – Sinemurian                  | Getic | Steierdorf Formation, Dealul Budinic Conglomerate Member or Valea Terezia Sandstone Member | <i>Clathropteris meniscioides</i> Biozone                                                                                      | aff. <i>Zamites</i> sp., ? <i>Zamites</i> sp.                                                                                                                        |
|                   | Hettangian <i>pro parte</i> – Sinemurian | Getic | Steierdorf Formation, Valea Terezia Sandstone Member                                       | <i>Clathropteris meniscioides</i> Biozone, <i>Banatozamites chlamydostomus</i> Subzone                                         | ? <i>Zamites</i> sp.                                                                                                                                                 |
|                   | Hettangian <i>pro parte</i> – Sinemurian | Getic | Codlea-Vulcan Formation, Vulcan Sandstone Member                                           | <i>Clathropteris meniscioides</i> Biozone, <i>Banatozamites chlamydostomus</i> Subzone                                         | cf. <i>Zamites</i> sp., aff. <i>Zamites</i> sp.                                                                                                                      |
|                   | Hettangian <i>pro parte</i> – Sinemurian | Getic | Codlea-Vulcan Formation, Vulcan Sandstone Member                                           | <i>Clathropteris meniscioides</i> Biozone, <i>Banatozamites chlamydostomus</i> Subzone                                         | ? <i>Zamites</i> sp.                                                                                                                                                 |
| Not exactly known | Hettangian – Toarcian                    | Getic | Steierdorf Formation or Dealul Zânei Formation                                             | <i>Clathropteris meniscioides</i> Biozone or <i>Carpolithes liasinus</i> Biozone or <i>Anomozamites spectabilis</i> assemblage | ? <i>Zamites</i> sp.                                                                                                                                                 |

## Results and Conclusions

The excellent preservation of bennettitalean abaxial cuticle is not enough to define new genera and species.

The absence of the adaxial cuticle makes even the best *Zamites* preparations useless for specific determination.

The revision of the published *Zamites* material, plus the herein described and figured new specimens, documents the presence of this genus in the Romanian fossil flora by cf. *Zamites* sp. 1 Czier, cf. *Zamites* sp. 2 Czier, cf. *Zamites* sp., aff. *Zamites* sp. Czier, aff. *Zamites* sp., and ? *Zamites* sp.

The usage of “cf.”, “aff.”, or even of “?” before the name *Zamites* is necessary for the entire so far published Romanian material attributed to this genus, because no one of the specimens is provided with complete thus diagnostically useful macro- and microscopical description and figuration.

There exists no evidence to prove the presence of any valid full species of *Zamites* in the fossil flora of Romania.

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## References

- Andrae, K. J. 1855. – Beiträge zur Kenntnis der fossilen Flora Siebenbürgens und des Banates. – *Abhandlungen der Kaiserlich-Königlichen Geologischen Reichsanstalt* 3: 1–48.
- Andrews, H. N. 1955. – Index of Generic Names of Fossil Plants, 1820–1950. *Geological Survey Bulletin* 1013: 1–262.
- Barbu, V. 1951. – Paleontologia. In: Stamatiu, M. (Ed.): *Manualul Inginerului de Mine*, 1. – (Editura Tehnică) București, 1315 p.
- Bene, G. 1891. – Über die geologischen Verhältnisse der Lyas-Kohlengruben von Resicza-Domán und ihrer Umgebung. – *Földtani Közlöny* 10–11: 325–338.
- Berg, D. 1996. – Genul *Zamites* în Liasicul inferior de la Anina. – *Studii și Cercetări, Științele Naturii* 2: 53–63.
- Brongniart, A.T. 1828. – *Histoire des végétaux fossiles, ou recherches botaniques et géologiques sur les végétaux renfermés dans les diverses couches du globe*, 1. – (G. Dufour and Ed. D'Ocagne Libraries-Éditeurs) Paris, 136 p.

- Brongniart, A.T. 1843. – *Énumération des genres de plantes cultivées au Museum d'histoire naturelle de Paris suivant l'ordre établi dans L'école de botanique en 1843*. – (Fortin, Masson et cie) Paris, 136 p.
- Carruthers, W. 1870. – On fossil Cycadean stems from the Secondary Rocks of Britain. – *Transactions of the Linnean Society of London* **26**: 675–708.
- Czier, Z. 1989. – Două plante fosile noi pentru România, din Liasicul inferior de la Șuncuiuş (Judeţul Bihor). – *Crisia* **19**: 745–751.
- Czier, Z. 1990. – Istoricul cercetărilor paleobotanice în Judeţul Bihor (România). – *Crisia* **20**: 583–601.
- Czier, Z. 1991. – Propunere pentru o nouă rezervaţie paleobotanică în Judeţul Bihor. – *Nymphaea, Folia naturae Bihariae* **21**: 173–177.
- Czier, Z. 1992. – Repertoriul punctelor fosilifere cu floră liasică din România. – *Nymphaea, Folia naturae Bihariae* **22**: 67–70.
- Czier, Z. 1993. – Notă preliminară cu privire la importanţa ştiinţifică a zăcămintului cu plante fosile de la Șuncuiuş (Munţii Pădurea Craiului, România). – *Analele Universităţii din Oradea, Geografie* **3**: 48–53.
- Czier, Z. 1994. – On a new record of *Selenocarpus muensterianus* (Presl) Schenk from the Fireclay Formation of Șuncuiuş (Romania) and the Lower Liassic age of the Flora. – *Review of Palaeobotany and Palynology* **82**: 351–363.
- Czier, Z. 1995a. – Two new species of *Cladophlebis* (Plantae, Filicales) from the Lower Liassic of Romania. – *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte* **1**: 39–50.
- Czier, Z. 1995b. – Two new fossil plant species from the Lower Liassic of Anina, Romania: *Ptilophyllum aninaensis* n. sp. and *Williamsonia aninaensis* n. sp. – *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte* **12**: 747–755.
- Czier, Z. 1995c. – Paleobotanical biostratigraphy of the terrestrial Liassic of Western Romania. – *Studia Universitatis Babeş-Bolyai, Geologia* **40**: 95–104.
- Czier, Z. 1995d. – The bibliography of the Liassic flora from Romania. – *Studia Universitatis Babeş-Bolyai, Geologia* **40**: 105–111.
- Czier, Z. 1996a. – *Banatozamites* Czier, gen. nov. (Cycadeoidales) from the lower Liassic of Romania. – *Review of Palaeobotany and Palynology* **94**: 345–356.
- Czier, Z. 1996b. – A Körös-vidék és a Bánság liász flórájának kutatástörténete és irodalma. – *A Debreceni Déri Múzeum Évkönyve*: 7–19.
- Czier, Z. 1997a. – Additions to the scientific activity of palaeobotanist Dr. Alexandru I. Semaka in Bihor County. – *Nymphaea, Folia naturae Bihariae* **23-25**: 13–16.
- Czier, Z. 1997b. – Revision of the Lower Liassic macroflora from the Pădurea Craiului Mountains (Romania). – *Nymphaea, Folia naturae Bihariae* **23-25**: 17–28.
- Czier, Z. 1997c. – On the palaeofloristic and palaeophytogeographic significance of the Lower Liassic macroflora from the Pădurea Craiului Mountains (Romania). – *Nymphaea, Folia naturae Bihariae* **23-25**: 29–34.
- Czier, Z. 1998a. – *Ginkgo* foliage from the Jurassic of the Carpathian Basin. – *Palaeontology* **41**: 349–381.
- Czier, Z. 1998b. – A concordance and bibliography of Carpathian - Pannonian Liassic macroflora localities. – *Nymphaea, Folia naturae Bihariae* **26**: 125–146.

- Czier, Z. 1998c. – The nomenclatural revision and the taxonomy of the fossil plants kept in the palaeobotanical collection of the Banatului Museum Timișoara. – *Analele Banatului, Științele Naturii* **4**: 15–40.
- Czier, Z. 1999a. – Lithostratigraphic units yielding the lower Jurassic macroflora from Romania. – *Nymphaea, Folia naturae Bihariae* **27**: 5–42.
- Czier, Z. 1999b. – Biostratigraphy of the lower Jurassic from Romania, based on the macroflora fossil record. – *Nymphaea, Folia naturae Bihariae* **27**: 43–58.
- Czier, Z. 1999c. – Originea macroflorei Jurasicului inferior din România. O nouă interpretare paleofitogeografică. – *Nymphaea, Folia naturae Bihariae* **27**: 59–72.
- Czier, Z. 2000a. – *Macroflora liasică din România, cu privire specială asupra Pădurii Craiului*. – (Editura Imprimeriei de Vest) Oradea, 260 p.
- Czier, Z. 2000b. – Determination of the fossil plants kept in Banatului Museum Timișoara. – *Analele Banatului, Științele Naturii* **5**: 37–54.
- Czier, Z. 2000c. – Încadrarea paleoclimatică și paleofitogeografică a macroflorei Jurasicului inferior din România. Locul florei în context european. – *Acta Musei Porolissensis* **23**: 823–834.
- Czier, Z. 2000d. – Rezumatul tezei de doctorat „Flora liasică din Crișana și Banat” (Universitatea Eötvös Loránd - Budapesta, 1994). – *Nymphaea, Folia naturae Bihariae* **28**: 27–46.
- Czier, Z. 2001. – A kárpáti-pannón térség ősnövényföldrajza az alsó-jurában. – *Tisicum, a Jász-Nagykun-Szolnok Megyei Múzeumok Évkönyve* **12**: 17–25.
- Czier, Z. 2002. – The Floristical Affinity Method – a new comparative method. – *Nymphaea, Folia naturae Bihariae* **29**: 11–17.
- Czier, Z. 2003a. – Új ősnövények a vasasi (Mecsek hegység) alsó-jurából. – *Tisicum, a Jász-Nagykun-Szolnok Megyei Múzeumok Évkönyve* **13**: 29–46.
- Czier, Z. 2003b. – Jurassicul inferior continental din România – aspecte prezentate în expoziție temporară la Muzeul Țării Crișurilor. – *Nymphaea, Folia naturae Bihariae* **30**: 199–237.
- Czier, Z. 2004. – Plante fosile din colecția Muzeului Țării Crișurilor, propuse pentru categoria tezaur. – *Nymphaea, Folia naturae Bihariae* **31**: 133–155.
- Czier, Z. 2005. – *Receaphyllum grandis* Czier g. et sp. nov. from the Lower Jurassic of Romania. – *Nymphaea, Folia naturae Bihariae* **32**: 5–22.
- Czier, Z. 2006. – *Cladophlebis mecsekensis* Czier sp. nov. and *Cladophlebis baueri* Czier sp. nov. from the Lower Jurassic of the Carpathian-Pannonian region. – *Nymphaea, Folia naturae Bihariae* **33**: 5–24.
- Czier, Z. 2008. – *Banatozamites remotus* Czier sp. nov. (Cycadeoidales) from the Lower Jurassic of Anina, Romania. – *Nymphaea, Folia naturae Bihariae* **35**: 5–26.
- Czier, Z. 2009. – *Banatozamites calvus* Czier sp. nov. and *Bucklandia aninaensis* Czier sp. nov. from the Lower Jurassic of Anina, Romania. – *Nymphaea, Folia naturae Bihariae* **36**: 5–26.
- Czier, Z. 2010. – The presence of the genus *Ptilophyllum* in the Lower Jurassic flora of Romania. – *Nymphaea, Folia naturae Bihariae* **37**: 5–38.
- Czier, Z. 2011. – Revision of *Ptilophyllum*-like leaves from the Lower Jurassic of Romania. – *Nymphaea, Folia naturae Bihariae* **38**: 5–16.
- Czier, Z. 2014. – Taxonomic attribution of the species *Pterophyllum pectinatum* (Jaeger) Csaki and Ulrichs, em. Czier (Bennettitales) based on cuticular analysis, and its presence in the Euro-Sinian palaeofloristic region. – *Brukenenthal Acta Musei* **9**: 567–586.

- Czier, Z. 2016a. – European Paleofloristic Affinities of the Romanian Jurassic Macroflora. – *Nymphaea, Folia naturae Bihariae* **43**: 13–66.
- Czier, Z. 2016b. – Probleme de stratigrafie cu privire la depozitele continentale ale Jurasicului inferior din România. In: Moisa, G., Goman, I., Șipoș, S. (coord.): *Fragmentarium, studii interdisciplinare în onoarea lui Aurel Chiriac*. – (Editura Muzeului Țării Crișurilor) Oradea, 573 p.
- Czier, Z. 2017. – The Bennettitalean genus *Pterophyllum* in the fossil flora of Romania, and the global phytostратigraphic–paleophytogeographic context. – *Herald of Tver State University, Series Biology and Ecology* **3**: 133–184.
- Czier, Z., Popescu, V. 1988. – Cercetări geologice-paleobotanice asupra Liasicului inferior de la Șuncuiuș – cariera principală Recea (Județul Bihor). – *Crisia* **18**: 597–626.
- Drăghici, C., Semaka, A. 1962. – Observații asupra Liasicului de la Baia-de-Aramă. – *Studii și Cercetări de Geologie, Geofizică, Geografie, Seria Geologie* **7**: 33–44.
- Engler, A. 1892. – *Syllabus der Vorlesungen über spezielle und medizinisch-pharmaceutische Botanik: eine Übersicht über das Pflanzensystem mit Berücksichtigung der Medizinal- und Nutzpflanzen*. – (Gebrüder Borntraeger Verlag) Berlin, 143 p.
- Florin, R. 1933. – Studien über die Cycadales des Mesozoikums nebst Erörterungen über die Spaltöffnungsapparate der Bennettitales. – *Kungliga Svenska Vetenskapsakademiens Handlingar* **12**: 1–134.
- Foetterle, F. 1850. – Verzeichniss der an die k. k. geologische Reichsanstalt gelangten Einsendungen von Mineralien, Petrefacten Gebirgsarten u. s. w. Vom 1. April bis 30. Juni 1850. – *Jahrbuch der Kaiserlich-Königliche Geologische Reichsanstalt* **1**: 350–364.
- Givulescu, R. 1989. – Recherches nouvelles sur les plantes fossiles du Liasique inférieur d'Anina (Roumanie). – *Studia Universitatis Babeș-Bolyai, Geologia - Geographia* **34**: 29–32.
- Givulescu, R. 1991. – *Zamites vachrameevii* Doludenko 1969 in dem Unteren Lias, Rumäniens. – *Acta Palaeobotanica* **31**: 17–21.
- Givulescu, R. 1998. – *Flora fosilă a Jurasicului inferior de la Anina*. – (Editura Academiei Române) București, 90 p.
- Givulescu, R., Farcașiu, V. 1989. – Les Plantes fossiles du Liassique inférieur d'Anina (Roumanie) de la collection du Musée Botanique de Cluj-Napoca. – *Contribuții Botanice*: 139–140.
- Givulescu, R., Czier, Z. 1990. – Neue Untersuchungen über die Floren des Unteren Lias (Rumänien). – *Documenta naturae* **59**: 8–19.
- Hantken, M. 1878. – *A Magyar Korona országainak széntelepei és szénbányászata*. – (Légrády Testvérek) Budapest, 331 p.
- Harris, T.M. 1969. – *The Yorkshire Jurassic Flora. III, Bennettitales*. – (Trustees of the British Museum, Natural History Ed.) London, 186 p.
- Humml, H. 1963. – *Catalogul florei fosile păstrate în Muzeul Regional al Banatului, Timișoara*. – *Studii și Cercetări Științifice, Seria Științe Agricole* **10**: 185–201.
- Iliescu, O., Semaka, A. 1962. – Contribuțiuni la cunoașterea rețeto-liasicului din împrejurimile Mehădiei. – *Dăride Seamă ale Ședințelor Institutului Geologic, Seria Geologie* **48**: 113–119.
- Krasser, F. 1921. – Zur Kenntnis einiger fossiler Floren des unteren Lias der Sukzessionsstaaten von Österreich-Ungarn. – *Sitzungsberichte Akademie der Wissenschaften in Wien, Mathematisch-naturwissenschaftliche Klasse* **130**: 345–373.

- Langer, J. 1947. – Über einige Stücke der Liasflora von Steierdorf und der Keuperflora von Lunz. – *Jahrbuch der Geologischen Bundesanstalt* **90**: 21–33.
- Lindley, J., Hutton, W. 1835-1837. – *The fossil flora of Great Britain; or, figures and descriptions of the vegetable remains found in a fossil state in this country. Volume III.* – (James Ridgway and Sons) London, 232 p.
- Mateescu, I. 1957. – Studiul petrografic al cărbunilor din Bazinele Secul și Doman. – *Anuarul Comitetului Geologic* **30**: 5–50.
- Mateescu, I. 1964. – Studiul petrografic al cărbunilor din Bazinul Codlea - Vulcan. – *Studii Tehnice și Economice, Prospekțiuni și Explorări Geologice* **6**: 69–100.
- Morris, J. 1843. *A Catalogue of British Fossils: Comprising The Genera and Species Hitherto Described; With References To Their Geological Distribution and the Localities in Which They Have Been Found.* – (John Morris) London, 372 p.
- Nathorst, A.G. 1913. – How are the names *Williamsonia* and *Wielandiella* to be used? A question of nomenclature. – *Geologiska Föreningens i Stockholm Förhandlingar* **35**: 361–366.
- Oarcea, C., Semaka, A. 1962. – Flora liasică din colecția de la Anina. – *Dări de Seamă ale Ședințelor Comitetului Geologic* **46**: 239–244.
- Oncescu, N. 1951. – Geologia R.P.R. (cu mențiuni despre bogățiile miniere principale). In: Stamatiu, M. (Ed.), *Manualul Inginerului de Mine*, **1**. – (Editura Tehnică) București, 1315 p.
- Schimper, W.P. 1870-1872. – *Traité de Paléontologie végétale, ou la flore du monde primitif dans ses rapports avec les formations géologiques et la flore du monde actuel*, **2**. – (J. B. Bailliere et Fils) Paris, 968 p.
- Schréter, Z. 1912. – Adatok a nyugat-krassószörényi mészkőhegység déli részének hegyszerkezetéhez. – *A Magyar Királyi Földtani Intézet Évi Jelentése 1910-ről*: 124–157.
- Semaka, A. 1954. – Contribuții la flora liasică de la Vulcan-Codlea. – *Buletin Științific, Secțiunea de Științe Biologice, Agronomice, Geologice și Geografice* **6**: 837–856.
- Semaka, A. 1958. – Über die pflanzenführenden Lias-Schichten Rumäniens (I. Getische Decke). – *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte* **8-9**: 407–414.
- Semaka, A. 1961. – Über die pflanzenführenden Liasschichten Rumäniens (II. Danubikum). – *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte* **8**: 389–394.
- Semaka, A. 1962a. – Flora liasică de la Anina (Banat). – *Anuarul Comitetului Geologic* **32**: 527–569.
- Semaka, A. 1962b. – Flora liasică de la Doman (Banat). – *Dări de Seamă ale Ședințelor Comitetului Geologic* **43**: 215–242.
- Semaka, A. 1962c. – Reconsiderarea grupului *Zamites schmiedelii* Sternberg. – *Dări de Seamă ale Ședințelor Comitetului Geologic* **46**: 93–99.
- Semaka, A. 1970. – Geologisch Paläobotanische Untersuchungen im SO-Banater Danubikum. – *Memoiren Geologisches Institut Bukarest* **11**: 5–79.
- Semaka, A., Huică, I., Georgescu, L. 1972. – Noi puncte cu plante liasice în Formațiunea de Schela (Carpații Meridionali). – *Studii și Cercetări de Geologie, Geofizică, Geografie, Seria Geologie* **17**: 435–440.
- Seward, A.C. 1917. *Fossil Plants. A Text-book for Students of Botany and Geology. Volume III. Pteridospermeae, Cycadofilices, Cordaitales, Cycadophyta.* – (Cambridge University Press) Cambridge, 656 p.



- Sincock, C.A., Watson, J. 1988. – Terminology used in the description of bennettitalean cuticle characters. – *Botanical Journal of the Linnean Society* **97**: 179–187.
- Stur, D. 1860a. – Fossile Lias-Pflanzen aus Siebenbürgen. – *Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt, Verhandlungen* **11**: 57–59.
- Stur, D. 1860b. – Ueber das Alter der Kohle von Holbak (und Neustadt) nach der darin vorkommenden Flora. – *Verhandlungen und Mittheilungen des Siebenbürgischen Vereins für Naturwissenschaften in Hermannstadt* **11**: 58–59.
- Stur, D. 1871. – *Geologie der Steiermark: Erläuterungen zur geologischen Übersichtskarte des Herzogthumes Steiermark, Graz, 1865: im Auftrage des Geognostisch-Montanistischen Vereines für Steiermark, geschrieben in den Jahren 1866 bis 1871.* – (Verein) Graz, 654 p.
- Stur, D. 1872. – Beiträge zur Kenntnis der Liasablagerungen von Hollbach und Neustadt in der Umgegend von Kronstadt in Siebenbürgen. – *Verhandlungen der Kaiserlich-Königlichen Geologischen Reichsanstalt* **17**: 341–347.
- Telegdi Roth, L. 1890. – A krassó-szörényi hegység Ny-i része Majdán, Lisava és Stájerlak környékén. – *A Magyar Királyi Földtani Intézet Évi Jelentése 1889-ről*: 86–108.
- Telegdi Roth, L. 1891. – Stájerlak-Anina közvetlen környéke. Jelentés az 1890. évi részletes földtani felvételről. – *A Magyar Királyi Földtani Intézet Évi Jelentése 1890-ről*: 82–112.
- Telegdi Roth, L. 1906. – *Magyarázatok a Magyar Korona Országainak részletes földtani térképéhez. 1883-1902, 1904, 1906-15. Krassova és Teregova környéke. 25. zóna, XXVI. rovat. 1:75.000.* – (Magyar Királyi Földtani Intézet) Budapest, 43 p.
- Thomas, H.H. 1930. – Further Observations on the Cuticle Structure of Mesozoic Cycadean Fronds. – *The Journal of the Linnean Society of London, Botany* **48**: 389–415.
- Toula, F. 1911. – Paläontologische Mittheilungen aus den Sammlungen von Kronstadt in Siebenbürgen. – *Abhandlungen der Kaiserlichen-Königlichen Geologischen Reichsanstalt* **20**: 1–49.
- Zborea, A., Semaka, A., Cioată, R. 1966. – Der Lias von Crasna - Jiu (Rumänien). – *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte* **1**: 44–51.

