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ASPECTS OF ROMANIAN EARLY JURASSIC PALAEOBOTANY AND PALYNOLOGY. PART V. *THAUMATOPTERIS BRAUNIANA* FROM ŞUNCUIUŞ

MIHAI E. POPA[1], OVIDIU BARBU[2], VLAD CODREA[2]

Abstract. The fern *Thaumatopteris brauniana* (POPP) SCHWEITZWER 1978 (Order Filicales, Family Dipteridaceae) is a remarkable phytostratigraphic marker for the Hettangian-Sinemurian continental sequences in the Reşiţa and Sirinia basins (South Carpathians), representing the guide fossil for the *T. brauniana* Assemblage Zone (the former *T. schenkii* Assemblage Zone HARRIS 1937). This species was recorded, discussed and described in detail Jameson Land (North Greenland), Sweden, Poland, Germany, Iran, and Hungary. In Romania, Popa (2000a) studied in detail this species from the South Carpathians, the Reşiţa and Sirinia basins. This paper presents the first find of *T. brauniana* in Şuncuiuş, demonstrating the validity of Harris' *T. brauniana* Assemblage Zone (former *schenkii* Zone) in Apuseni Mountains, Şuncuiuş respectively, as well as a discussion with regard to old and new ideas dealing with the phytostratigraphy of continental Lower Jurassic deposits in Romania.

Keywords: Paleobotany, macroflora, Early Jurassic, Filicales, Dipteridaceae, *Thaumatopteris brauniana*, phytostratigraphy, Şuncuiuş Formation, Recea Member, Romania.

INTRODUCTION

The Early Jurassic paleoflora from Şuncuiuş (Apuseni Mountains) was first described by Semaka (1969) as the "*Selenocarpus*-flora from Apuseni Mountains", due to the high frequency of the Matoniaceous fern *Selenocarpus muensterianus* that occurs in this locality. The flora described by Semaka (1969) included Sphenopsids, and Filicopsids (Matoniaceae, Dipteridaceae, Incertae sedis), while other studies detailed the systematic lists (Czier, 1994), and the paleoecology of this locality (Givulescu, 2002). The systematic list of plants collected from Şuncuiuş counts about 40 taxa that are now currently under revision. The paleoflora from Şuncuiuş is typically compressive, usually lacking of cuticles, with a medium to high degree of preservation.

GEOLOGICAL SETTING

The septentrional part of the Apuseni Mountains (NW Romania) belongs to the Inner Dacides structural realm (Sandulescu, 1984). It includes three main units, from the base towards the top: the Bihor Unit (with autochthonous position), overthrusted by the Codru and Biharia nappe systems. The intra-Turonian tectogenesis built the Inner Dacides.

The Bihor Unit is made of a metamorphic and magmatic basement covered by detritic and carbonated Permian and Mesozoic sediments (Ianovici *et al.*, 1976). Red conglomerates, sandstones and shale represent the Permian deposits. The Triassic is unconformably overlaying the basement, including Werfenian detritic sequences, followed by Anisian-Norian dolomites, limestones, shales and sandstones. In the northern sector of the Bihor Unit, the Triassic sedimentation ended earlier, when compared to the southernmost sectors. In the Pădurea Craiului Mountains, the last Triassic sequences are Ladinian. During post-Ladinian times, the entire area had been emerged and a karstic relief was developed on Triassic limestone.

A new sedimentary cycle begun during the Early Jurassic ("Liassic"), having very different features, when compared to the Triassic cycle. The Lower Liassic sequence is mainly detritical, dominated by sandstones, interlayered with clays, in the so-called "Gresten facies". In the Lowermost Jurassic deposits of Pădurea Craiului Mountains, Mészáros *et al.* (1999) defined the Şuncuiuş Formation (post-Ladinian – Early Sinemurian), including three members: Balnaca, Recea and Valea Boiului Members.

The fossils are rather rare in these deposits. However, some bivalves, ammonites and corals were recorded in the Valea Boiului Member (Early Sinemurian), these assemblages, together with nannoplankton assemblages (Mészáros *et al*., 1999), pointing to several marine transgressions in this area.

The Recea Member (Early Hettangian-Early Sinemurian) deposits contain small accumulations of macroflora, recorded for the first time by Semaka (1969). The fossils discussed in this paper were collected from the Recea Member, the Hettangian-Sinemurian age being demonstrated by the occurrence of *T. brauniana*.

[1] *University of Bucharest, Faculty of Geology and Geophysics, Laboratory of Palaeontology, 1, N. Balcescu Ave., 70111, Bucharest, Romania. E-mail: mihai@mepopa.com*

[2] *Babeş-Bolyai University, Faculty of Geology and Biology, Department of Paleontology, 1, M. Kogălniceanu Str., 3400, Cluj-Napoca, Romania. E-mails: obarbu@bioge.ubbcluj.ro; vcodrea@bioge.ubbcluj.ro*

MATERIAL AND METHODS

The fossil material is compressive, it occurs several clay hand specimens curated at the Paleontology-Stratigraphy Museum of the Babes-Bolyai University from Cluj-Napoca (PSMUBB). The fossils were collected during the fall of 1986, by two of the authors (C.V. and B.O.) from the Recea Quarry, at Şuncuiuş. The degree of preservation is rather high, the plant fragments having well-preserved morphological and anatomical features, although it generally lacks cuticles.

The fossil material was prepared mechanically (using chisels) and studied with a Zeiss dissecting microscope. The photographs were taken using a Canon Power Shot S110 Digital Elph camera, and they were enhanced with Corel Photopaint ver. 11 and assembled with Corel Draw ver. 11 in Plate 1. The reference list was formatted using the Endnote ver. 6 reference manager.

SYSTEMATICS

Phylum Pteridophyta
Class Filicopsida
Order Filicales
Family Dipteridaceae
Genus *Thaumatopteris* GOEPPERT 1841

The Dipteridaceous genus *Thaumatopteris* GOEPPERT 1841 is separated from genus *Dictyophyllum* LINDLEY & HUTTON 1834 on several important characters, such as the general leaf architecture, the pinna rachis insertion to the petiole, the pinna dissection and base, the number of sporangia per sorus and the number of spores per sporangium. However, when the preservation degree is low, these differences are difficult to assess, leading some authors to consider even the synonymy between the two taxa. Moreover, nomenclatural problems related to genus *Thaumatopteris* itself are added, due to the fact that the type species of *Thaumatopteris*, *T. muensterii*, is currently assigned to genus *Dictyophyllum*.

Harris (1931, 1961), Oishi and Yamashita (1936) and more recently by Schweitzer (1978) and Popa (2000a) discussed in detail the systematic and taxonomy of the *Thaumatopteris* genus. For Romania, Popa (2000a, b) discussed in detail the systematics, taxonomy, distribution and phytostratigraphy of genus *Thaumatopteris*, based on material collected by this author from Reşiţa and Sirinia basins, and therefore these aspects will not be detailed again in this paper. Previous authors cited *Thaumatopteris* species from Romania, such as Hantken (1878), Krasser (1922), Mateescu (1958), and Semaka (1958, 1961, 1962).

Thaumatopteris brauniana (NATHORST) SCHWEITZER 1978

Pl. 1, Figs. 1-5

1863 *Thaumatopteris brauniana* POPP, 399-417.
1878 *Thaumatopteris schenki* NATHORST, p. 46, Pl. 6, Fig. 1, Pl. 8, Fig. 4.
1907 *Thaumatopteris schenki* NATHORST, p. 1-9, Pl. 1, Figs. 1-11, Pl. 2, Figs. 1-18.
1922 *Thaumatopteris brauniana* KRASSER, p. 351.
1958 *Thaumatopteris brauniana* MATEESCU, p. 11, Pl. 5.
1958 *Thaumatopteris brauniana* SEMAKA, p. 414.
1961 *Thaumatopteris brauniana* SEMAKA, p. 392.
1962 *Thaumatopteris brauniana* SEMAKA, p. 174.
1978 *Thaumatopteris brauniana* SCHWEITZER, p. 36-49, Text-figs. 20, 23, 24, 26-28, 30, 31, Pl. 4, Figs. 5-9, Pl. 5, Figs. 1-7, Pl. 6, Figs. 1-3.
1998 *Thaumatopteris schenkii* POPA, p. 179.
2000 *Thaumatopteris brauniana* POPA, p. 111-115, Text-figs. IV.30-32, Pl. 39, Figs. 1-3, Pl. 40, Figs. 1-2, Pl. 41, Figs. 1-4, Pl. 42, Figs. 1-4, Pl. 43, Figs. 1-4.

DESCRIPTION

The material is sterile, represented by frond fragments that occurred at various positions within the leaf (basal, median and apical frond fragments).

Pinnae rachises are inserted radially to the petiole (fragment P6, Pl. 1, Fig. 1), they are 1.5-2mm wide, smooth, straight, rarely punctuated or with rare, small-sized thorns (fragment P6). Towards the distal ends, the rachises are smooth, without punctuations or thorns (fragment P7). Basal fragments are represented by samples P6 and P11 (Pl. 1, Figs. 1, 5), fragment P6 showing the radially distributed (funnel shape) rachises. The basal lamina is made of rounded, separated, sub-triangular pinnules (or "lobes"), without any basal web of lamina. The width of the basal pinnules ("lobes") varies between 5-7mm, and their length between 4-7mm (fragment 6). Soon, these lobes reach 10-15mm, becoming elongated (fragment P11). The venation is anastomozed, with a primary vein ("midvein" or "midrib"), very narrow, slightly sinuous, without reaching the apex, its width and length increasing towards the median parts of the pinnae, reaching soon 0.5-0.6 mm in width. The lamina is inserted to the upper part of the rachis, sometimes becoming slightly depressed towards the rachis or to the primary vein.

The median parts of the pinnae show straight, smooth rachises, strongly elongated pinnules, perpendicularly inserted, with straight or wavy, undulated margin and rounded apex, with the lamina always inserted to the upper (adaxial) surface of the rachis. The base of the pinnules is entire, never constricted, sometimes and rarely occurring a slightly decurrent basal web, never surpassing 0.5 mm in width. The length of the pinnules can reach 50-60 mm or even more, but the fragmented state of the lamina does not allow precise measurements, while the width varies between 3-8 mm (fragments P7, 9, 10, 12, Pl. 1, Figs. 2, 4, 5). The ratio between the

length and the width is difficult to assess due to the fragmented state of the material. The midrib is straight, smooth, very clearly depressed (the lamina is a little bit curved downwards when reaching the midrib), 0.7-1.1 mm in width. The rest of the venation is anastomozed, with fine, polygonal meshes.

To the apical parts (fragment P9, Pl.1, Fig. 4), the rachis is narrow and smooth, the pinnules are very densely inserted to the rachis, becoming very narrow and long. The decurrent basal web can reach 0.7 mm in width, while the width of the lobes can reach 3 mm to their base and 2 mm towards their middle parts.

DISCUSSION

The Şuncuiuş material shows the typical characters of *Thaumatopteris*, such as radial pinna rachises, which are not bilaterial, on two separate arms, like in *Dictyophyllum*, the lack of a basal web, elongated pinnule shape, margin and lack of decurrence. It has elongated, slightly undulated pinnules, more similar with those collected by Popa from Bigăr, while the material collected from Anina has usually shorter, more finely undulated, or deeply dissected, lobed pinnules that give the bipinnate character of pinnae (Popa, 2000a). The variation of the pinnule's margin, ranging from entire, undulate, and deeply dissected is triggered mainly by climatic, and possibly by nutrient factors.

The species *Thaumatopteris brauniana* POPP 1863 represented initially the deeply lobed or bipinnate type of the *T. brauniana* (POPP) SCHWEITZER 1978 frond. The unipinnate type of *T. brauniana* (POPP) SCHEWEITZER 1978, initially named *T. schenkii* NATHORST 1878, was considered as a separated taxon till Schweitzer (1978) demonstrated that *T. schenkii*, together with other taxa, are junior synonyms of *T. brauniana*. This idea is also supported by the Romanian material from the South Carpathians (Popa, 2000a), collected mainly from Anina (Reşiţa Basin) and Bigăr (Sirinia Basin), and from Apuseni Mountains (Şuncuiuş). Popa (2000a) detailed the occurrences of *T. brauniana* in Romania, as well as the synonymy lists for this species, and this is why these lists and taxonomical aspects are not re-discussed here. The paper of Schweitzer (1978) cleared the debate initiated by Harris (1961) over the taxonomic status of some sterile *Thaumatopteris* fragments. The *Thaumatopteris* denomination should be kept as valid also for sterile fragments, as long as they show typical features such as frond architecture elements or pinnae and pinnules features.

For Şuncuiuş, Czier & Popescu (1988) described a material assigned to *Dictyophyllum* cf. *rugosum*, re-described in Czier (1994) as *Dictyophyllum munsterii*, as well as in the translation of 2000 of Czier's paper of 1994. This material is rather similar with *T. brauniana* (excepting the pinnules insertions that are anyway unclearly illustrated), but unfortunately these papers (Czier and Popescu, 1988; Czier, 1994, 2000) have very low quality text-figures and plates, therefore Czier's identifications remain ambiguous.

Dr. Maria Barbacka collected *T. brauniana* in Hungary from the Mecsek Mountains (personal communication), where the Assemblage Zone with *T. brauniana* (former Zone with *T. schenkii*) is also recognized. The Jurassic flora of Mecsek is also the closest, and the most similar flora to that from Şuncuiuş, and from this point of view the new findings of *T. brauniana* in Şuncuiuş should be regarded as normal, although this taxon was never recorded from the latter occurrence.

PHYTOSTRATIGRAPHY

Genus *Thaumatopteris*, with its species *T. brauniana* (POPP) SCHWEITZER 1978, including its junior synonym *T. schenkii* NATHORST 1878, is significant for the phytostratigraphy of Lower Jurassic deposits in Greenland, Europe and Asia, marking at least for Europe and Greenland the Hettangian and Sinemurian stages. The Assemblage Zone with *Thaumatopteris brauniana* was defined by Harris (1937) as the Assemblage Zone with *Thaumatopteris schenkii* for Lower Jurassic (Hettangian-Sinemurian) continental Kap Stewart Formation from Jameson Land, East Greenland. It is a successful biostratigraphic unit for Lower Jurassic deposits of Europe, as it was lately recognized in Sweden, Denmark, Poland, Germany, and Hungary (Lundblad, 1950, Vakhrameev, 1991). In Romania, mainly for the South Carpathians, it was recognized by Semaka (1962, 1965), and re-defined and detailed by Popa (1998, 2000a, b).

Czier (1994), in his kis-doctorate work that was later translated in Romanian (Czier, 2000), and in a different paper (Czier, 1995), defined the so-called "*Clathropteris meniscioides* Zone" for Lower Jurassic deposits of the whole Romania, not only for those confined to the Şuncuiuş Formation in Apuseni Mountains. Based on the relative abundance of *C. meniscioides* from Recea quarry in Şuncuiuş, and on few hand specimens from Anina (South Carpathians) found in Budapest, Czier concluded that the Assemblage Zone with *T. brauniana* should be rejected in Romania, and that the "*Clathropteris meniscioides* Zone" should be used instead. There is no reason for defining a new assemblage zone for the South Carpathians, where the *brauniana* Zone is well documented (Popa, 2000a, b), and for Apuseni Mountains, especially as now *T. brauniana* is described from the Şuncuiuş Formation. This is why the *T. brauniana* Zone should be kept for the Apuseni

Mountains, as a valid and useful biostratigraphic unit, in the way it is kept for the South Carpathians too.

CONCLUSION

Thaumatopteris brauniana is described for the first time from Şuncuiuş, within the Şuncuiuş Formation, Apuseni Mountains, on material collected in 1986. *T. brauniana* is a useful phytostratigraphical tool, marking the Hettangian-Sinemurian stage within continental deposits in Europe, and it indicates the existence of the *T. brauniana* Assemblage Zone in Apuseni Mountains, Şuncuiuş Formation respectively. Previous ideas for using a parallel phytostratigraphical zonation in Romania are rejected. The species *T. brauniana* from Şuncuiuş has typical *Thaumatopteris* characters, although the bipinnate character of pinnae does not occur, this variation aspect being linked to climatic and possibly to nutrient factors.

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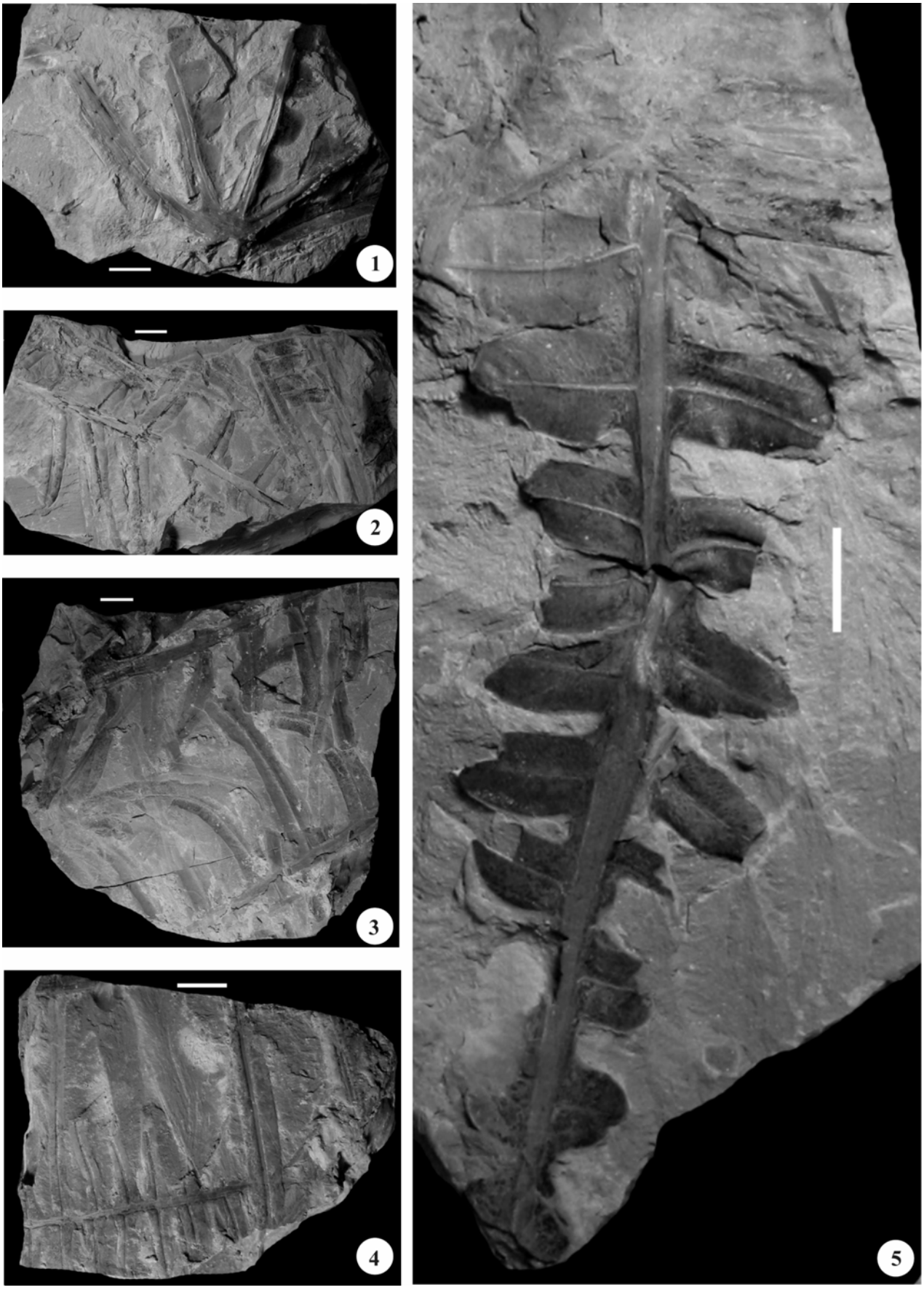
PLATE I

Figure 1. *Thaumatopteris brauniana*, sample P6, Şuncuiuş, Recea Quarry.
Figure 2. *Thaumatopteris brauniana*, sample P12, Şuncuiuş, Recea Quarry.
Figure 3. *Thaumatopteris brauniana*, sample P8, Şuncuiuş, Recea Quarry.
Figure 4. *Thaumatopteris brauniana*, sample P9, Şuncuiuş, Recea Quarry.
Figure 5. *Thaumatopteris brauniana*, sample P11, Şuncuiuş, Recea Quarry.
All scale bars indicate 10 mm.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