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Review of Jurassic Plants from the Anina (Steierdorf) Coal Mining Area, South Carpathians, in the Collections of the Geological Survey of Austria

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2 Text-Figures, 2 Plates, 1 Table

Romania
Paleobotany
Pteridophyta
Gymnospermophyta
Lias
Dogger

Contents

Überblick über jurassische Pflanzen der Anina (Steierdorf) Kohlenlagerstätte, Südkarpaten, aus der Sammlung der Geologischen Bundesanstalt in Österreich

Zusammenfassung

Die paläobotanische Sammlung der Geologischen Bundesanstalt in Wien enthält 375 Handstücke von gut erhaltenen Pflanzenfossilien aus den unter- und mitteljurassischen kohleführenden Schichten des Resita-Beckens im Südwesten Rumäniens. Die Pflanzenfossilien waren im 19. Jahrhundert hauptsächlich im Kohlegebiet von Anina (früher Steierdorf) gesammelt worden. Wenige Stücke stammen aus dem Gebiet von Doman im Resita-Becken und dem Ielişeva-Tal im Sirinia-Becken. Das Florenspektrum setzt sich aus Sphenopsida, Filicopsida (Pteridophyta), Pteridospermopsida, Cycadopsida, Ginkgopsida and Coniferopsida (Gymnospermophyta) zusammen. Die Pteridospermen zeichnen sich durch selten erhaltene morphologische Merkmale und neue Elemente aus. Die Bennettiteen, welche in anderen Aufsammlungen aus dem Anina-Kohlegebiet selten vorkommen, sind mit verschiedenen und gut erhaltenen Taxa vertreten. Die vorliegende Arbeit präsentiert die ersten Ergebnisse der systematischen Bearbeitung dieser wissenschaftlich und historisch bedeutsamen Sammlung.

Abstract

The paleobotanical collections of the Geological Survey of Austria (GBA = Geologische Bundesanstalt) include 375 hand specimens of well preserved plant compressions of Early and Middle Jurassic age that were collected during the 19th Century from the Reşiţa Basin, South Carpathians, Romania. These hand specimens were collected mainly from the Anina coal mining area and are well known in the classical paleobotanical literature as Steierdorf (367 hand specimens) and Doman (six hand specimens), Reşiţa Basin, belonging to the Getic Nappe. Two hand specimens were also collected from Ielişeva Valley, Sirinia Basin, Danubian Units. The plants belong to Sphenopsida and Filicopsida (Pteridophyta) and to Pteridospermopsida, Cycadopsida, Ginkgopsida and Coniferopsida (Gymnospermophyta). The pteridosperms show rare features and new elements and the bennettialeans, which are rare in other collections, are various and well preserved. These are the first results on this significant fossil plant collection as part of a larger systematic revision work.

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Text-Fig. 1.
Geographic position of Anina, Doman and of Ielişeva Valley in South-East Europe.

Introduction

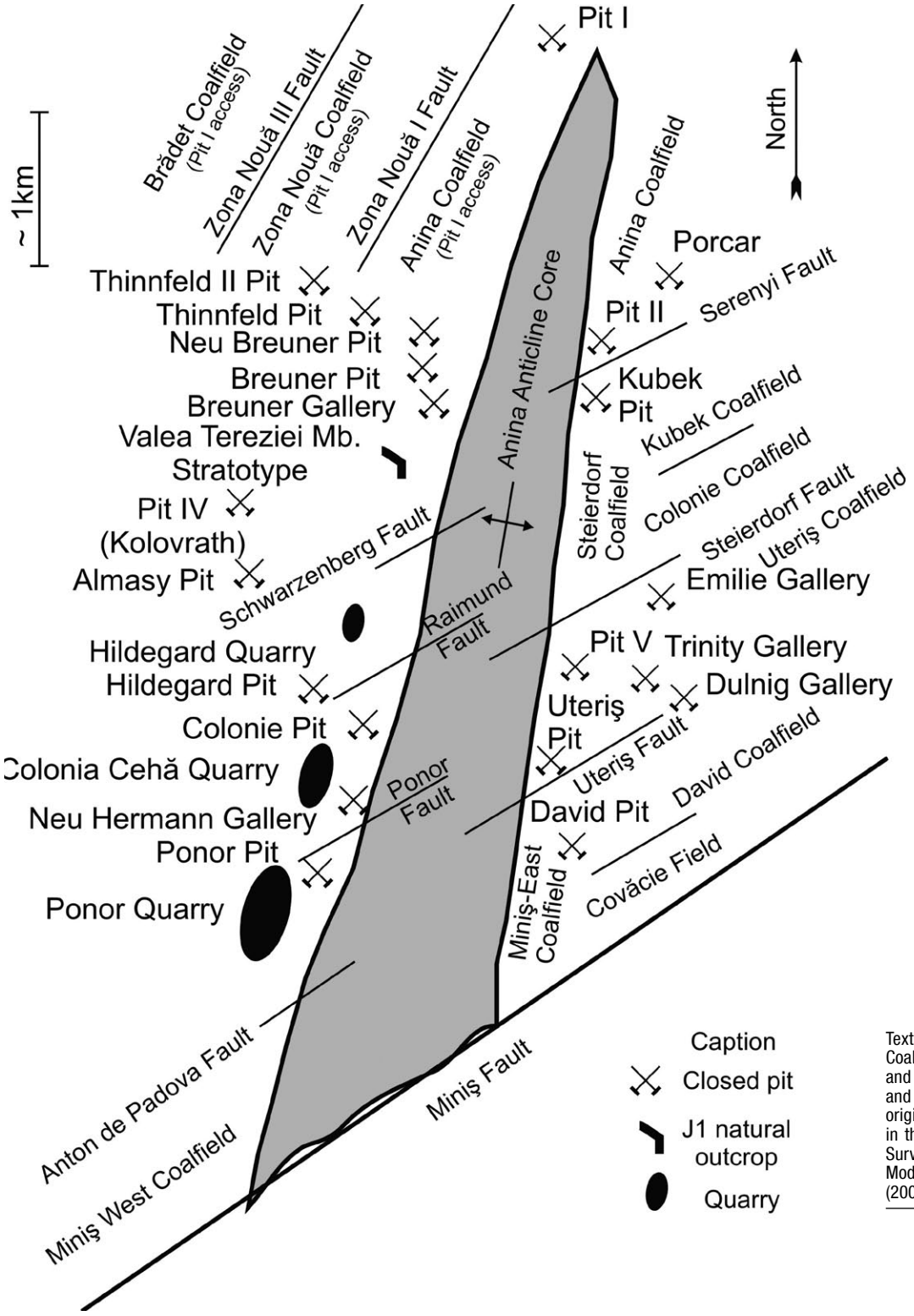
Anina is a unique Early Jurassic plant locality in SW Romania due to the richness and the high diversity of fossil plants it yields (Text-Fig. 1). More than 120 plant taxa have been identified from the area, along with vertebrate burrows and tracks. Such a diversity and degree of preservation suggest a valuable "Fossillagerstätte" locality (POPA, 1997, 1998, 2000a, 2009). The Jurassic flora of Anina (Steierdorf) is a typical Early Jurassic coal flora, which was situated in the Eurosinian Region in the European Province and occurred on the northern frame of the Tethys realm (POPA, 1998, 2000a, 2009). The continental Jurassic outcrops of Anina are exceptional because the mining activities opened the sediment layers three-dimensionally and permitted unique three-dimensional collecting (POPA, 2000a).

Modern Anina represents the main coal mining town, with Steierdorf, the old town, in the southern neighborhood and Breuner, Uteriş, Hildegard, etc. as other old mining neighborhoods and coalfields. The coal miners arrived from the state of Styria (Steiermark) in Austria as part of a miners' relocation plan in order to boost the coal production in the South Carpathians. The mining activity in Anina began in 1794 in Steierdorf, and it quickly developed into an intricate, complex system of deep coalfields connected through galleries, mining horizons, open cast mines, and accessed by deep pits, blind pits, underground mining horizons, and usual galleries (Text-Fig. 2). The coal mining activities stopped in 2006, several months after a tragic mining accident, with the closure of the most important and deepest coal pit in Anina, the coal Pit I of the Anina Northern Coalfield. During more than 200 years of activity, the coal mining complex in Anina became one of the deepest in Europe, reaching a depth of 1300 m. Today, except small, privately operated galleries in Southern Ponor (Crivina), the open cast mines such as Ponor, Colonia Cehă (Czech Colony) and Hildegard, are the last remnants of the former quarries, together with large colliery pits; all of them very rich in well preserved fossil plants.

Significant collections with particular value to the paleobotanical heritage of the Early and Middle Jurassic from the South Carpathians, including valuable compressions from Anina, are as follows :

1. University of Bucharest, Faculty of Geology and Geophysics, Laboratory of Paleontology: M.E. Popa, I. Preda, C. Eufrosin and I.Z. Barbu collections, Bucharest.
2. Geological Institute of Romania, Geological Museum: A. Semaka and M.E. Popa collections, Bucharest.
3. Babes-Bolyai University, Faculty of Geology and Biology: J. Petrescu and H. Humml collections, Cluj-Napoca.
4. Banat Museum: H. Humml collection, Timişoara.
5. Anina Highschool, "Trustul de Cărbuni Anina" collection (TCA), Anina.
6. Municipal Museum of Reşiţa, Reşiţa, with unknown collectors.
7. Geological Survey of Austria (GBA), Vienna, collections from the 19th Century, with collectors such as F. Seeland.
8. Museum of Natural History, Budapest, unknown collectors.
9. Geological Museum of Hungary, Budapest, unknown collectors.

In May 2008 the study and systematic revision of the collection at the Geological Survey of Austria began. This collection has been nearly unknown to scientists, but due to the moving of the Geological Survey and its collections from the Palais Rasumofsky, where the survey has been located for more than 150 years, to the new address and to the re-organization of the collection and advertisements to the scientific community, the material is now accessible and available for study. The fossil plant collection of the Geological Survey of Austria includes a highly significant collection of Early and Middle Jurassic plants from the South Carpathians that was collected more than 100 years ago, when the Banat region, part of which is in the South



Text-Fig. 2.
Coalfields and mining works pits and galleries in Anina (Steierdorf and northern Anina), indicating the origin of the plant material stored in the collection of the Geological Survey of Austria.
Modified and completed from POPA (2000a, 2000b, 2009).

Carpathians, was included in the Austrian empire. The collection counts 375 hand specimens of plant compressions and impressions. The precise dates of collecting and the names of collectors were partly lost, but the "Jahrbuch" of the Geological Survey includes notes that state that plant remains from Steierdorf were sent to the Survey by J. Kudernatsch and F. Seeland (e.g. FOETTERLE, 1850: p. 357, 1851: p. 144, ANONYMUS, 1852: p. 158). A great deal of information regarding the occurrence of this flora and sometimes the old taxon names were mentioned on the old labels. The plant fossils were collected from the South Carpathians, from basins such as Reşița, and Sirinia. More than 98 % of the hand specimens (367 out of 375) were collected from Anina. Some hand specimens were collected from Doman (6 out of 375), which is also a former mining center of the Reşița Basin, and two hand specimens were collected from the Ielişeva Valley, an unexpected occurrence of Jurassic plants in the Sirinia Basin, Danubian Units (Text-Fig. 1).

Geology of the Anina (Steierdorf) Coal Mining Area

The Reşiţa Basin is the largest sedimentary basin of the Getic Nappe (MURGOCI, 1905), occurring towards the southern end of the South Carpathians, Romania. Anina (Steierdorf) is located in the center of the Reşiţa Basin, an area with thick sedimentary deposits. The Mesozoic sequence includes Lower Jurassic – Cretaceous formations and overlays unconformably the Upper Palaeozoic (Upper Carboniferous – Permian) formations and the crystalline basement (RĂILEANU et al., 1957; PETRESCU et al., 1987). It begins with the continental Steierdorf Formation, Hettangian–Sinemurian in age, the Jurassic coal measure and the only Jurassic continental formation of the Reşiţa Basin (BUCUR, 1991, 1997; POPA & KEDZIOR, 2008). The Steierdorf Formation is conformably overlain by the black, bituminous shales of the Uteriş Formation, Pliensbachian – Middle Toarcian in age. The rest of the Mesozoic succession, up to the Upper Aptian, is represented by marine, carbonate formations (RĂILEANU et al., 1957; MUTIHAC, 1958, 1990; BUCUR 1991, 1997).

The Steierdorf Formation is 60–250 m thick and includes continental, coal bearing sediments, deposited in an intramontane depression. The Formation is represented by two members: the basal, coarse Dealul Budinic Member, Hettangian in age, and the Valea Tereziei Member, Hettangian–Sinemurian in age. The Dealul Budinic Member includes conglomerates, coarse sandstone and rare mudstone. Its base is red colored, and it is dominated by alluvial environments. The Valea Tereziei Member includes cyclic depositions of sandstone, mudstone, coal seams, conglomerates and clays, and represents the proper coal measure, yielding eight coal seams with a large lateral distribution, extracted from all coalfields in Anina. Fluviatile, lacustrine and marsh environments dominate the Valea Tereziei Member, with frequent layers of paleosoils.

History of Paleobotanical Researches

The Jurassic flora of Steierdorf was first cited by FOETTERLE (1850), who published the first list of taxa, followed by the monographs of ETTINGSHAUSEN (1852) and ANDRAE (1855). ETTINGSHAUSEN (1852) introduced and cited important taxa, and ANDRAE (1855) reviewed the work of ETTINGSHAUSEN and described additional species. These works were completed by STAUB (1896). In the 19th Century, KRASSER (1915, 1922) and THOMAS (1930) published more species from Steierdorf. SEMAKA (1962a, b) contributed with two monographs of Anina and Doman, among many other titles dealing with the Jurassic flora of the Reşiţa Basin. HUMML (1957, 1963, 1969) described Early Jurassic plants from Anina and generally from the South Carpathians and was the first to report data from underground mining horizons. GIVULESCU (1998) and POPA (2000a, 2009) reviewed and emended the floras of the Reşiţa Basin. These authors studied paleobotanical material collected by themselves and revised previous collections, using cuticular analysis for systematic and paleoecological considerations and also refined the phytostratigraphy of the Jurassic deposits of the area (POPA, 2000a, b). A complete historical account of paleobotanical researches in the South Carpathians dealing with Mesozoic and Paleozoic plants was given by POPA (2009). The phytostratigraphy of the Steierdorf Formation was first studied by SEMAKA (1962a, 1965), who introduced the Assemblage zone with *Nilssonia orientalis* for the Steierdorf Formation. Later, POPA (2000a, 2000b) characterized the Taxon range zone with *Thaumatopteris brauniana,* marking the Hettangian for the Dealul Budinic Member and partly for the Valea Tereziei Member (up to a refractory clay layer between Coal seams nos. 3 and 4), and the Acme-Zone with *Nilssonia* cf. *orientalis*, marking the Sinemurian for the upper sequence of the Valea Tereziei Member.

Material and Methods

The plant material is compressed and flattened and is represented by compression and impression fossils. The hand specimens stored in the GBA collection were recorded on cards that provided an accurate record of each plant fragment as a taxon. The cards also provided information about specimen photographs, position on hand specimen, degree of preservation, age, occurrence of the hand specimen, record number, and drawer where it is stored. The fossil material was photographed using an 8 megapixel Canon Powershot S3 IS digital camera with a supermacro mode, permitting accurate close-ups of plant fragments. Cuticles were sampled using needles for maceration using Schulze Reagent, which is currently in progress. The labels associated with the hand specimens record historic coal mining pits in Anina, all of which are closed today. Unfortunately, the majority of the hand specimens do not have labels detailing their occurrence in Anina, although they were most probably collected from underground mines, as the rest of the labels always shows precise underground occurrence (Text-Fig. 2). Nevertheless, the identified occurrence of the material, as it resulted from the original labels found in association with the hand specimens of the GBA collection, is as follows:

1. Emmerichstollen: unidentified occurrence, probably a small gallery.
2. Alexander Liegendflöz: bed of Coal seam no. 1, unidentified pit.
3. Emiliestollen: Emilie Gallery in Steierdorf, next to Pit V (Text-Fig. 2: east side).
4. Neu Hermann: New Hermann Gallery, towards the Colonia Cehă open cast mine, with hand specimens collected from “Neu Hermann Grube” and “Liegend des Liegendflözes” (bed of Coal seam no. 1) (Text-Fig. 2: west side).
5. Dreifaltigkeitsstollen: Saint Trinity gallery, from Uteriş Pit towards the forest, next to Plopa, hand specimens collected from Coal seams nos. 2 and 3 (Text-Fig. 2: east side).
6. Dulnigstollen or Dulnitz: the gallery and underground Horizon Dulnitz, often found written as Dulnig as well (synonym), hand specimens collected from “Liegend des Hauptflözes” (bed of Coal seam no. 7). The Dulnig or Dulnitz underground horizon was an underground horizon for coal extraction occurring on the eastern flank of the Anina Anticline (with a Permian core), along the +600 meters elevation level, connecting various pits and galleries. Engineer Dulnitz worked for the construction of the Anina–Lişava railway.

7. Colonieschacht: Colonie Pit, in Steierdorf, next to the IPEG (later, the Romanian Geological Prospecting and Exploration Company) headquarters in Anina. Hand specimens collected from "Liegend des II Liegendflözes" (bed of Coal seam no. 2) and from 2 meters above the Hauptflöz (Coal bed no. 7) (Text-Fig. 2: west side).
8. Hildegardschacht: Hildegard Pit, hand specimens collected from "9 m lieg. v. II Liegendflöz" (9 meters in the bed of Coal seam no. 2) and from 2 meters above Hauptflöz (Coal bed no. 7) (Text-Fig. 2: west side).
9. Uterischschacht: Uteriş Pit, hand specimens collected from "Liegend des II Liegendflözes" (bed of Coal seam no. 2), from "Zwischen II – n. III Liegendflöz, Dulnig Horizont" (bed of Coal seams nos. 2 and 3, Dulnig underground horizon) and from "Liegendflöz Dulnig, Dreifaltig Mittel" (sandstone interlayer of Coal seam no. 3, Dulnig underground Horizon) (Text-Fig. 2: east side).
10. Porcar: Porcar or Porkar is the old name of the creek next to what is now Pit II, in the Sigismund neighborhood of Anina, hand specimens collected from "Liegend des Hauptflözes" (bed of Coal seam no. 7) (Text-Fig. 2: east side).
11. Kübeckschacht: Kübeck Pit, hand specimens collected from the "Dulnig Horizont" (the Dulnig or Dulnitz Horizon) (Text-Fig. 2: east side).
12. Breunerschacht: Breuner Pit (Text-Fig. 2: west side).
13. Neu Breunerschacht: New Breuner Pit, occurred at the end of what is now Stadion street, under the sterile dump of the Pit III (Text-Fig. 2: west side).
14. Thinnfeldschacht: Thinnfeld Pit, occurred in the yard of the Christian Orthodox church in Anina, Breuner neighborhood (Text-Fig. 2: west side).
15. Thinnfeld II Schacht: Thinnfeld Pit II, above the mining highschool in Anina, next to today's greenhouses (Text-Fig. 2: west side).
16. Almasy: Almasy Pit was a pit for air pumping in the underground mining complex, next to Pit IV, Terezia Valley (Text-Fig. 2: west side).

Systematics

The collection from Anina (Steierdorf) at the Geological Survey of Austria includes Pteridophytes (Sphenopsids, Flicopsids) and Gymnospermophytes (Pteridospermopsids, Ginkgopsids, Cycadopsids and Coniferopsids). In comparison to other collections from Anina, Bryophytes and Lycopsids are missing. The taxa from Anina and the few specimens from Doman and Ielişeva Valley are included in Table 1.

The Sphenopsids are represented by *Schizoneura carcinoides* (Harris) Weber 1968, an important coal generator for the Steierdorf Formation throughout the whole basin, and by *Equisetites* sp., with both leaves and rhizomes. The Marattiales include *Marattia intermedia* (Munster) Kilpper 1964 (sometimes with pinnules in connection to the rachis), and the Filicales include representatives of Dipteridaceae, Osmundaceae, Matoniaceae, Dicksoniaceae and Incertae sedis. The family Dipteridaceae include *Clathropteris meniscoides* (Brongniart) Brongniart 1828, *Dictyophyllum nilssonii* (Brongniart) Goeppert 1846, *Thaumatopteris brauniana* (Popp) Schweitzer 1978, *Hausmannia* div. sp. (sometimes very large fragments, both rounded as in *H. buchii* (Andrae) Richter 1906 and linear), among others. The Osmundaceae include *Osmundopsis sturii* (Raciborski) Harris 1931, while the Matoniaceae are represented by *Phlebopteris formosa* (Givulescu & Popa) Schweitzer et al. 2009 and possibly *Matonia braunii* (Goeppert) Harris 1980. The Dicksoniaceae include *Coniopteris hymenophylloides* (Brongniart) Harris 1961, *C. murrayana* (Brongniart) Harris 1961, *Kylikipteris arguta* (Lindley & Hutton) Harris 1961 (both sterile and fertile), among others, while the Incertae sedis are represented by *Cladophlebis denticulata* (Brongniart) Nathorst 1876 (often very well preserved) (Pl. 2, Fig. 1), *C. nebbensis* (Brongniart) Nathorst 1871 (most probably sterile foliage of Osmundaceae representatives; very frequent, especially *C. denticulata*), *Spiropteris* sp., and fern rhizomes.

Seed-ferns of uncertain affinities (Pteridospermopsida, Incertae sedis) include *Ptilozamites cycadea* (Berger) Schenk 1887, *Pachypteris speciosa* (Ettingshausen) Popa 2000, *P. rhomboidalis* (Ettingshausen) Doludenko 1974 (Pl. 2, Fig. 2) (foliage probably belonging to the Corystospermales), *Sagenopteris* sp. among others. *Pachypteris rhomboidalis* (Ettingshausen) Doludenko 1974 sometimes has very long pinnules, a rare feature in this species. An interesting and rare record is that of *Cycadopteris obtusifolia* (Andrae) Popa 2000, a Middle Jurassic seed-fern from Ielişeva Valley, the only representative from that occurrence, occurring only in two hand specimens. *C. obtusifolia* was recorded from Middle Jurassic marls of the Tâlva Zânei Formation in Anina, this being the first occurrence reported elsewhere.

Cycadales include *Nilssonia* cf. *orientalis* Heer 1878 (Pl. 2, Fig. 3) and *N.* cf. *undulata* Harris 1932, and *Ctenis* sp. (very large leaves). The Cycadeoidales (Bennettitales) are particularly diverse and well preserved, represented by foliage such as *Zamites* div. sp., *Otozamites* div. sp., *Ptilophyllum* div. sp. (Pl. 1, Fig. 3), *Pterophyllum* div. sp., *Nilssoniopteris* sp., by cortical remains such as *Bucklandia* sp., and by reproductive structures such as *Weltrichia alfredii* (Krasser) Popa 2000 (Pl. 1, Fig. 4), *W. givulescui* Popa 2001 (pollen bearing reproductive organs), *Cycadolepis* sp. (Pl. 1, Fig. 2) (usually female sporophylls) and *Bennetticarpus* sp. (Pl. 1, Fig. 1) (ovulate organs). Interesting to note is the association between *Ptilophyllum* sp. foliage, with *Cycadolepis* sp., and *Bennetticarpus* sp., on hand specimen GBA2008/128/2 that was collected in Kübeckschacht, a rare occurrence in Anina. Such associations (excepting *Bennetticarpus* sp., which is actually rare) are common for the roofs of Coal seam nos. 6 and 7, which are Sinemurian in age. The *Cycadolepis* sp. material in hand specimen GBA2008/128/2 may represent fragmented (broken) rays of *Weltrichia* structures (Popa, 2001), and do not necessarily represent female reproductive fragments.

The ginkgoales include *Ginkgoites* div. sp., *Sphenobaiera* div. sp., while the Czekanowskiales are represented by *Czekanowskia rigida*. The conifers include incertae sedis taxa such as *Brachyphyllum* sp., *Geinitzia* sp., *Elatocladus* sp., *Podozamites* div. sp. (foliage) and *Ourostrobus* sp. (cone). Further investigations using cuticle analysis of gymnosperms will increase the understanding of the taxa recorded in the GBA collection, and the sampled cuticles are the subject of current work. Cuticle preservations are frequent in seed-ferns, ginkgoaleans, rarer in cycads and bennettites and they are almost lacking in czekanowskialeans and conifers.

Conclusions

The Early and Middle Jurassic flora of the South Carpathians curated in the paleobotanical collection of the Geological Survey of Austria (GBA) is a significant, highly valuable historical collection that records a high diversity of species. From these points of view, this collection represents an accurate synopsis of the Jurassic flora of the Reşiţa Basin in the South Carpathians. The collection yields a series of rarities, such as atypical or rare fragments of ferns (*Marattia intermedia*, *Cladophlebis* div. sp. *Hausmannia* div. sp.), seed-ferns (*Pachypteris rhomboidalis*, *Cycadopteris obtusifolia*), cycads (*Ctenis grandis*), and bennettites (*Bennetticarpus* sp. associated with *Cycadolepis* sp. and *Ptilophyllum* sp.). This collection is also of national historic interest because it records fossil plants collected from pits and galleries closed during the 19th and 20th Century.

Acknowledgements

The authors thank the Geological Survey of Austria (GBA) for providing the paleobotanical collections of the South Carpathians. Many thanks to Mr. Dumitru Anescu, the former Chief Geologist of the Anina mining complex, for advice regarding the old names of coal shafts and underground mining horizons. The authors thank also Tillfried Cernajsek, the former director of the library of the Geological Survey of Austria, for kindly providing, copying and scanning old geological and topographical maps of Steierdorf. We thank Ms. Karen Bacon, University College Dublin, for improving the English version of the manuscript. This work was supported financially by the CNCSIS (Romanian National University Research Council – NURC) grant no. 436/1.10.2007 to Mihai E. Popa (P.I.).

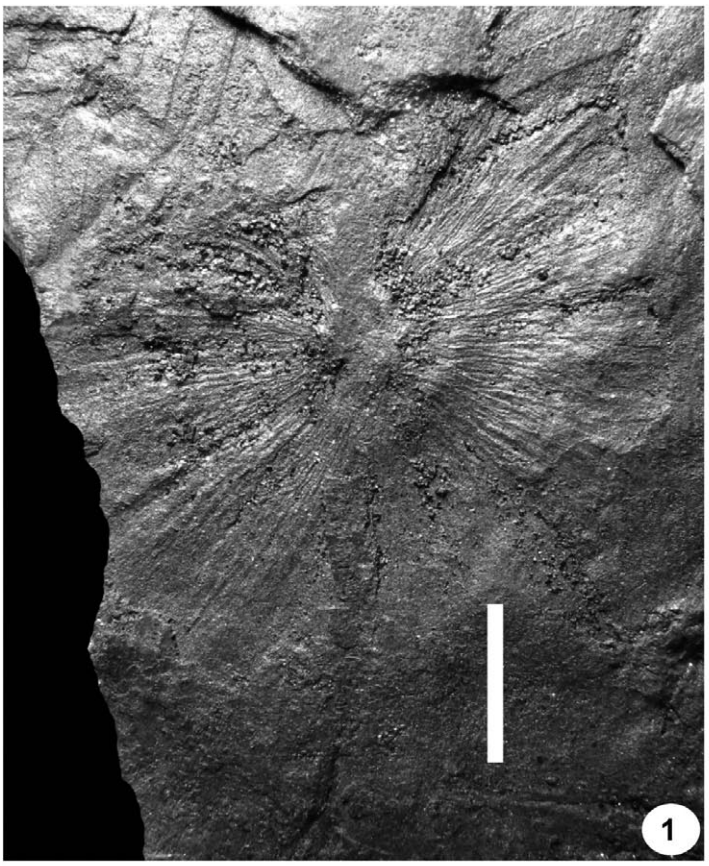
Plate 1

Fig. 1. *Bennetticarpus* sp., Inv. no. GBA2008/128/2, plant fragment 1, Kübeckschacht, Sinemurian, Anina. Scale bar: 10 mm.

Fig. 2. *Cycadolepis* sp., Inv. no. GBA2008/128/2, plant fragment n, Kübeckschacht, Sinemurian, Anina. Scale bar: 10 mm.

Fig. 3. *Ptilophyllum* sp., Inv. no. GBA2008/128/2, plant fragment n, Kübeckschacht, Sinemurian, Anina. Scale bar: 10 mm.

Fig. 4. *Weltrichia alfredii* (Krasser) Popa 2000, Inv. no. GBA2008/128/240, plant fragment 1, Sinemurian, Anina. Scale bar: 10 mm.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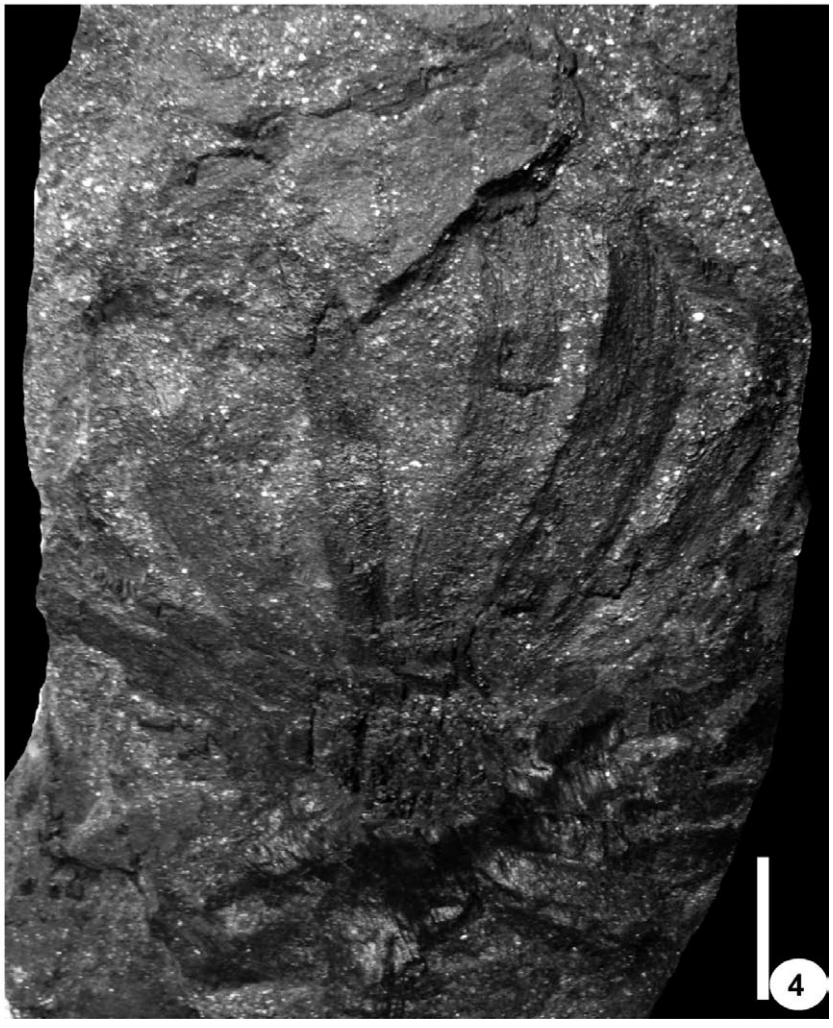
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Plate 2

Fig. 1. *Cladophlebis denticulata* (Brongniart) Nathorst 1876, Inv. no. GBA2008/128/190, plant fragment n, Hildegardschacht, Anina. Scale bar: 10 mm.

Fig. 2. *Pachypteris rhomboidalis* (Ettingshausen) Doludenko 1974, Inv. no. GBA2008/128/19, plant fragment 2, Hildegardschacht, 2 meters above the Coal seam no. 7 (Sinemurian), Anina. Scale bar: 10 mm.

Fig. 3. *Nilssonia* cf. *orientalis* Heer 1878, Inv. no. GBA2008/128/5, plant fragment 1, Colonieschacht, Anina. Scale bar: 10 mm.


1


2


3

Group	No.	Taxon	Previous identification
Sphenopsida Equisetales	1	*Equisetites* sp. (rhizome)	-
	2	?*Equisetites* sp. (leaves)	-
	3	*Schizoneura carcinoides*	-
Filicopsida Marattiales Marattiaceae	1	*Marattia intermedia*	-
Filicopsida Filicales Matoniaceae	1	*Phlebopteris formosa*	-
	2	*?Matonia braunii*	-
	3	*?Matonia* sp.	-
Filicopsida Filicales Dipteridaceae	1	*Clathropteris meniscoides*	
	2	*Dictyophyllum* cf. *nervulosum*	-
	3	*Dictyophyllum* cf. *nilssonii*	-
	4	*Dictyophyllum nilssonii*	*Dictyophyllum obtusifolium; Camptopteris nilssonii*
	5	*Dictyophyllum* sp.	-
	6	*Hausmannia* sp. *A*	-
	7	*Hausmannia* sp. *B* (elongated)	-
	8	*Thaumatopteris brauniana*	-
	9	?*Thaumatopteris brauniana* (fertile)	-
Filicopsida Filicales Dicksoniaceae	1	*Coniopteris hymenophylloides*	-
	2	*Coniopteris murrayana*	-
	3	*Coniopteris* sp.	-
	4	*Eboracia lobifolia*	-
	5	?*Eboracia* sp.	-
	6	*Kylikipteris arguta* (fertile and sterile)	-
	7	?*Kylikipteris arguta*	-
Filicopsida Filicales Osmundaceae	1	*Osmundopsis sturii*	-
Filicopsida Filicales Incertae sedis	1	*Cladophlebis denticulata*	*Asplenites roessertii*
	2	*Cladophlebis nebbensis*	-
	3	*Cladophlebis* cf. *haiburnensis* (affinities with *Cladophlebis denticulata* as well)	-
	4	*Cladophlebis* cf. *nebbensis*	-
	5	*Cladophlebis* sp.	*Speirocarpus grestenensis*
	6	*Rhizomes*	-
	7	*Spiropteris* sp.	-
Gymnospermophyta Pteridospemopsida Incertae sedis	1	*Cycadopteris* cf. *obtusifolia*	-
	2	*Cycadopteris obtusifolia*	-
	3	?*Komlopteris nordenskjoeldii*	-
	4	*Pachypteris rhomboidalis*	*Sagenopteris elongata*
	5	*Pachypteris* cf. *rhomboidalis*	-
	6	*Pachypteris speciosa*	*Thinnfeldia rhomboidalis*
	7	*?Pachypteris* sp.	-
	8	*Ptilozamites cycadea*	-
	9	*?Ptilozamites* sp.	-
	10	*Sagenopteris* sp.	-
Gymnospermophyta Cycadopsida Cycadales	1	*Ctenis* sp.	*Pterophyllum hauerii*
	2	„*Macrotaeniopteris*“ sp. (large *Nilssonia* sp.)	*Nilssonia polymorpha*
	3	*Nilssonia* cf. *orientalis*	*Nilssonia polymorpha*
	4	*Nilssonia* cf. *undulata*	-
	5	*Nilssonia* sp.	-
	6	?*Nilssonia* sp.	-

Group	No.	Taxon	Previous identification
Gymnospermophyta Cycadopsida Cycadeoidales	1	*Anomozamites* sp.	-
	2	?*Anomozamites* sp.	-
	3	*Bennetticarpus* sp.	-
	4	?*Bennettitolepis* sp.	*Cupressites* sp.
	5	*Bucklandia pustulosa*	-
	6	*Cycadolepis* sp.	-
	7	*Nilssoniopteris* sp.	-
	8	*Otozamites* cf. *mandelslohii* (some very small)	-
	9	*Otozamites* cf. *molinianus*	*Pterophyllum imbricatum*
	10	*Otozamites* sp. A	*Otozamites mandelslohii*
	11	*Otozamites* sp. B	*Zamites* sp.
	12	*Otozamites* sp. C	*Zamites* sp.
	13	*Pseudoctenis* sp.	*Pterophyllum crassinerve; Zamites* sp.
	14	?*Pseudoctenis* sp.	-
	15	*Pterophyllum* sp.	*Pterophyllum longifolium; Pterophyllum andraei*
	16	*Pterophyllum* sp. (small type)	-
	17	*Ptilophyllum* cf. *maculatum*	*Otozamites brevifolius*
	18	*Ptilophyllum* sp.	*Pterophyllum rigidum*
	19	*Weltrichia alfredii*	-
	20	*Weltrichia givulescui*	-
	21	*Weltrichia* sp.	-
	22	*Zamites andraeanus*	*Zamites brevifolius*
	23	*Zamites* cf. *andraeanus*	-
	24	*Zamites aninaensis*	-
	25	*Zamites* cf. *feneonis*	-
	26	*Zamites schmiedelii*	*Pterophyllum longifolium; Pterophyllum andraei*
	27	*Zamites* cf. *schmiedelii*	-
	28	?*Zamites* sp.	-
Gymnospermophyta Ginkgopsida Ginkgoales	1	*Ginkgoites* cf. *rarefurcata*	
	2	*Ginkgoites* sp.	*Baiera taeniata; Cyclopteris digitata*
	3	*Ginkgoites* sp. X	-
	4	?*Ginkgoites* sp.	-
	5	*Sphenobaiera* cf. *longifolia*	-
	6	*Sphenobaiera* cf. *pulchella*	-
	7	*Sphenobaiera* sp.	-
Gymnospermophyta Incertae sedis Czekanowskiales	1	*Czekanowskia* cf. *rigida*	-
	2	*Czekanowskia* sp.	-
Gymnospermophyta Coniferopsida Incertae sedis	1	*Brachyphyllum* cf. *expansum*	*Thuites germarii*
	2	*Brachyphyllum* sp.	*Cupressites* sp.
	3	?*Brachyphyllum* sp.	*Cupressites* sp.
	4	?*Cupressinocladus* sp.	-
	5	*Elatocladus* sp.	-
	6	*Genitzia* sp.	*Thuites germarii*
	7	*Ourostrobus* sp. and *Geinitzia* sp. (in anatomical connection)	-
	8	*Pagiophyllum* sp.	*Thuites germarii*
	9	*Podozamites* cf. *distans*	-
	10	?*Podozamites paucinervis*	-
	11	?*Podozamites* sp.	-

Table 1.
Preliminary list of taxa recorded from the Jurassic plant collection of the Geological Survey of Austria.

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