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THE EARLY PERMIAN MEGAFLORA FROM THE REŞIŢA BASIN, SOUTH CARPATHIANS, ROMANIA

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ABSTRACT. The Autunian deposits of the Reşiţa Basin (Getic Nappe) belong stratigraphically to the Ciudanoviţa Formation, with two members, the first (Gîrlişte Member) being represented by black shales and the second by red beds (Lişava Member). This paper presents the succession of the fossil flora that is well represented within the first member by mixed Autunian and Late Stephanian taxa (pteridosperms, arthropsids) while the second member bears a less well-preserved flora, represented almost exclusively by Walchiaceae conifers.

KEY WORDS: compressive megaflora, Variscan molasse, Autunian, Reşiţa Basin, South Carpathians, Romania

INTRODUCTION

The Banat region lies in the south-western part of Romania, partly on the southern end of the South Carpathians. The studied area is between the Reşiţa and Anina-Steierdorf (north-south) towns and Lupac and Secu (west-east) towns. The studied macroflora was collected by the author or by previous geologists from the following outcropping areas: Ciudanoviţa, Lupac, Bîrzaviţa Valley, Clocotici, Anina (Fig. 1).

In the area various Uranium underground mines occur, now closed, such as Jitin, Ciudanoviţa and Gîrlişte Pits, the stratigraphic level of Uranium extraction being the basal Autunian black shales (Gîrlişte Member).

The Variscan molasse (Westphalian A? – D – Stephanian – Autunian) deposits within the South Carpathians occur within the main structural units of the Carpathians, the Getic Nappe and the Danubian Autochtonous, in the Banat region (South-Western Romania).

In this paper, only the Autunian flora from the Getic

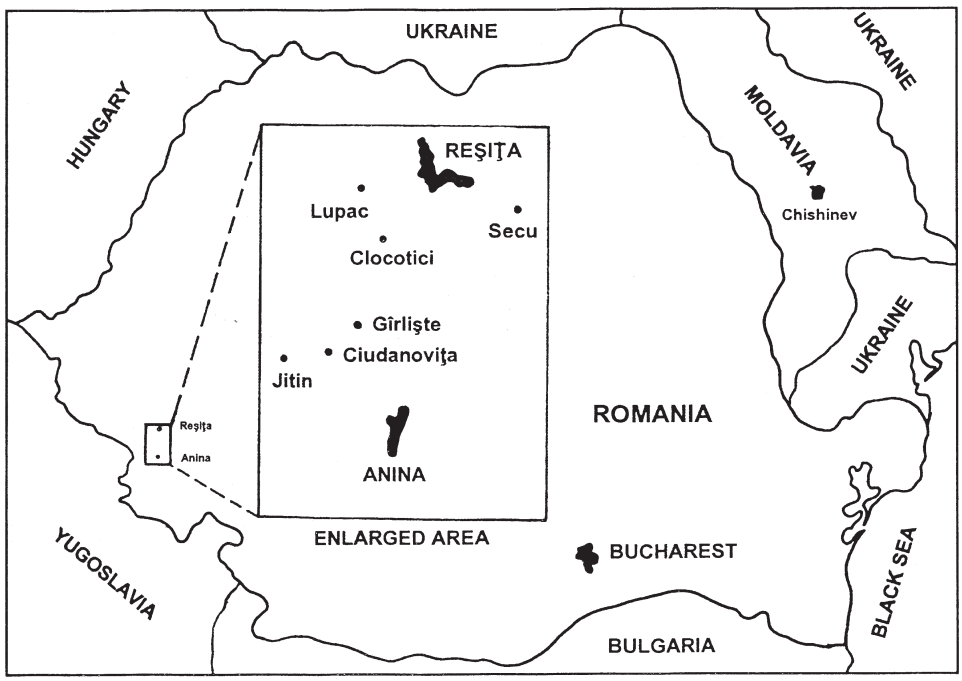

Fig. 1. Occurrence of the Permian plant bearing localities in the Banat region

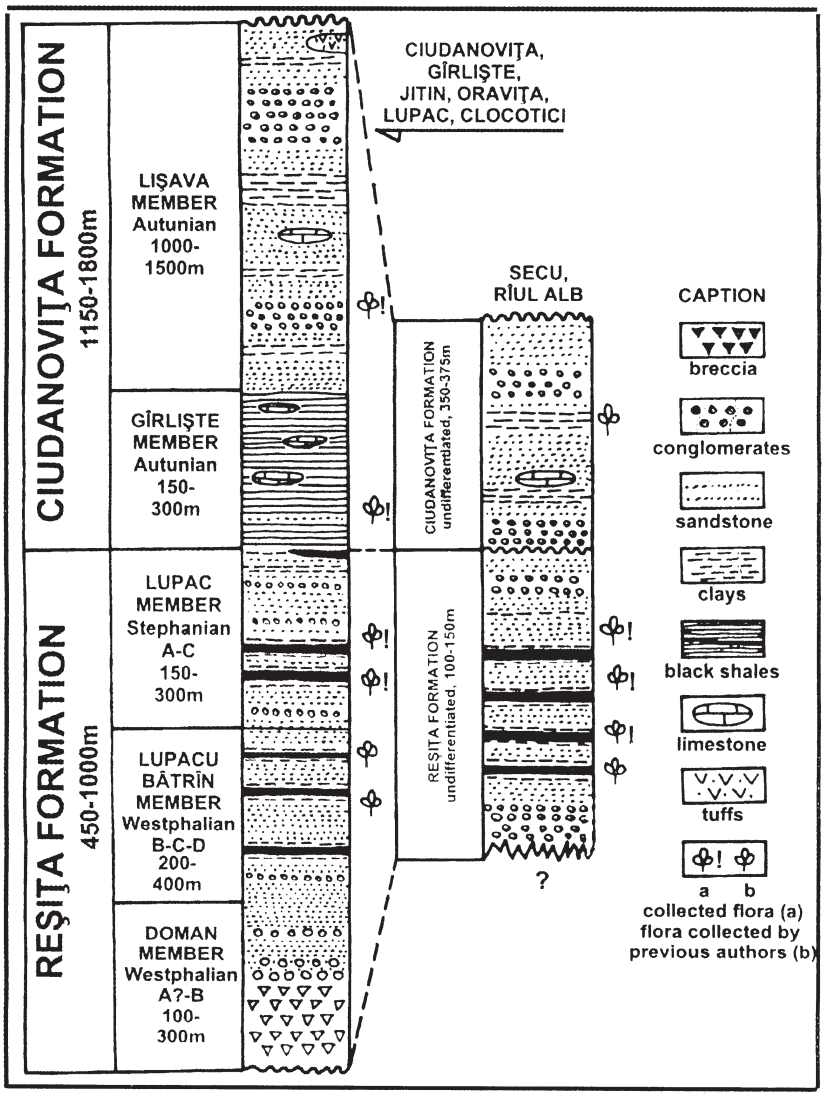

Fig. 2 Stratigraphic column for the Upper Palaeozoic deposits of the Reşiţa Basin

Nappe is discussed. The sedimentary outcrops centre mainly around Reşiţa and they represent the first sedimentary cycle of the south-western sedimentary cover of the Getic Nappe, known as the Reşiţa Basin (Codarcea 1940).

STRATIGRAPHY

The sedimentary sequences of the Variscan molasse within the Reşiţa Basin overlay unconformably the crystalline basement of the Getic Nappe. These deposits are overlain unconformably by the alpine cycle sedimentary sequences that begin with the Scythian (Lower Triassic) or with the Hettangian (Lower Jurassic). The Variscan sediments belong to the Reşiţa Formation (Bucur 1991), Westphalian A? – Stephanian C in age and to the Ciudanoviţa Formation (Bucur 1991), Autunian in age (Fig. 2). The Upper Carboniferous succession contains a rich megaflora assemblage (Biţoianu 1973, 1987, 1988) known since the second half of the last century and it has been recently synthesised by Dragastan *et al*. (1997).

The Autunian deposits are included within the Ciudanoviţa Formation, with two heterochronous, partially juxtaposed members: the Gîrlişte Member (Lower Autunian), represented mainly by black shales and Lişava Member (?Middle – Upper Autunian), with red sandstones, conglomerates and clays (red beds).

To the western part of the Reşiţa Basin (Lupac, Ciudanoviţa, Lişava, Clocotici), the Autunian overlays continuously the Stephanian deposits, while to the eastern part (Secu, Rîul Alb) a sedimentary gap occurs between the two sequences (Năstăseanu *et al.* 1973), as a tectogenetic effect. A possible sedimentary gap may occur at the Westpahlian/Stephanian boundary, as an effect of the Asturian phase (Dragastan *et al*. 1997).

The Lower Autunian Gîrlişte Member is represented mainly by a succession of black shales, 150–300 m

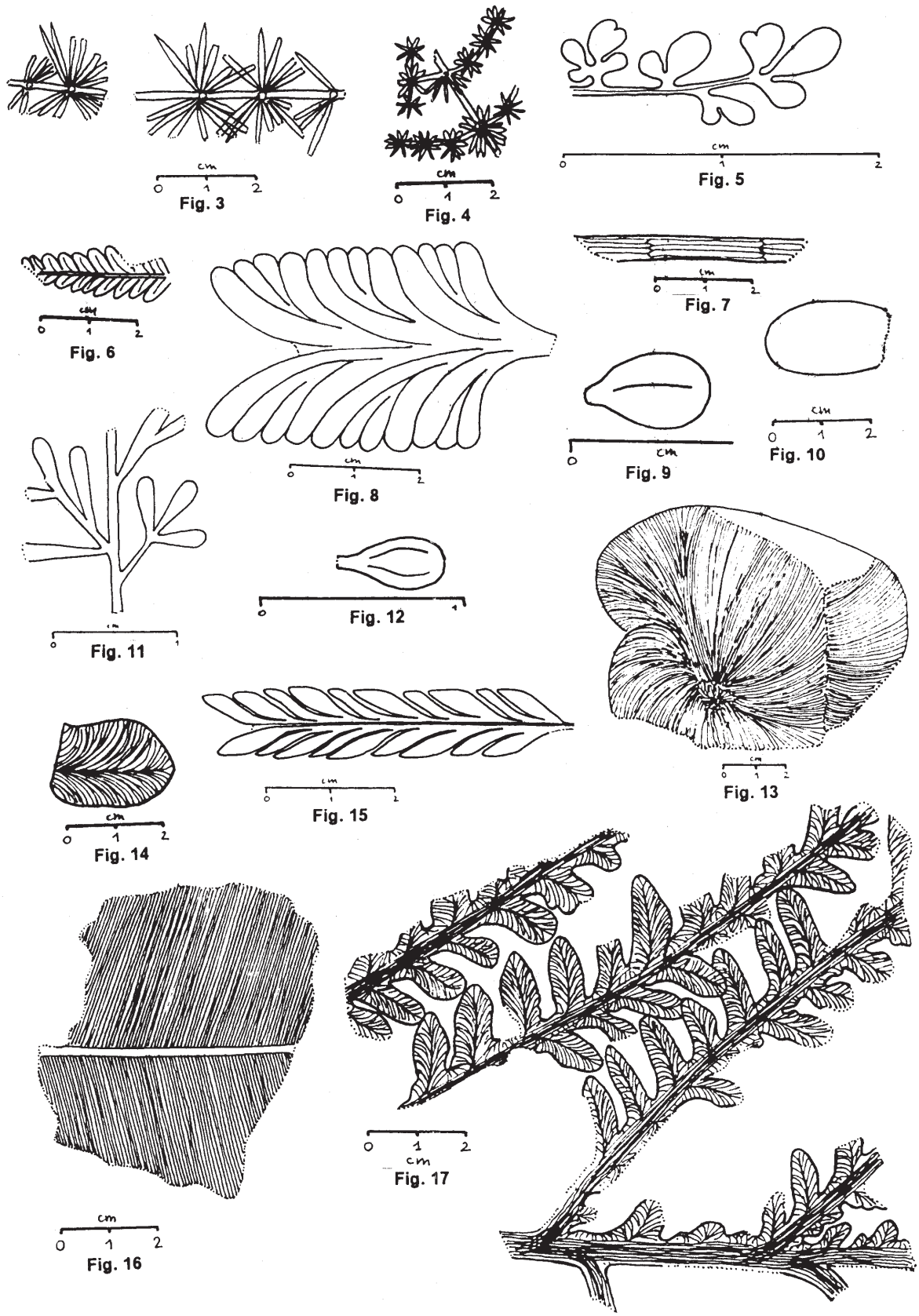

Fig. 3–17. **3**. *Annularia stellata*, P23.865.B/F1. **4**. *Annularia* cf. *sphenophylloides*, P21.200/F1. **5**. *Arnhardtia scheibei*, P52/C2/E16/F1, Ciudanovița, Popa collection. **6**. *Autunia conferta*, P23.865F/F1, Clocotici, Stănoiu collection. **7**. ? *Calamites* sp. or axis of *Sphenophyllum* sp., P52/C2/E3/F1. **8**. *Autunia naumannii*, P52/C2/E14/F1, Ciudanovița, Popa collection. **9**. *Carpolithes* sp. B, P52/C2/E19, F2, Ciudanovița, Popa collection. **10**. *Carpolithes* sp. A, P23, 865B/F1, Clocotici, Eufrosin collection. **11**. *Gracilopteris bergeronii*, P52/C2/E8/F1, Ciudanovița, Popa collection. **12**. ? *Otovicia* sp., P52/C2/E1/F2, Ciudanovița, Popa collection. **13**. *Cyclopteris* sp., P211.98, Lupac, Eufrosin collection. **14**. *Odontopteris* sp., P52/C2/E12/F1, Ciudanovița, Popa collection. **15**. *Lodevia suberosa*, P23.865C, Clocotici, Stănoiu collection. **16**. ? *Taeniopteris* sp., P.23.865B/F1, Clocotici, Stănoiu collection. **17**. *Rachyphyllum schenkii*, P21.196/F1, probably Lupac, Eufrosin collection

thick. The sequence presents lacustrine depositional features, being rich in macro- and micro-, flora and fauna. The ?Middle – Upper Autunian Lişava Member is a typical New Red Sandstone sequence. The continental, fluviatile depositional systems dominate the succession, subsidiary lacustrine or flooding plain systems being represented.

PHYTOSTRATIGRAPHY

Within the basal succession of the black shales Gîrlişte Member, a rich macroflora assemblage was recorded. This basal association was collected from Lupac, Ciudanovița, Bîrzavița and partly from Clocotici and it includes Stephanian and even Westphalian taxa, such as ? *Calamites* sp., *Annularia stellata*, *Sphenophyllum oblongifolium*, *Asterophyllites longifolius*, *Pecopteris polymorpha*, *P.* cf. *polymorpha*, *Neuropteris cordata*, *Neuropteris* sp., *Odontopteris* sp., *Cordaites principalis*, together with pure Autunian taxa: *Autunia conferta*, *A. naumannii*, *Arnhardtia scheibei*, *Lodevia suberosa*, *Rhachyphyllum schenkii*, *Sphenocallipteris bergeronii*, ?*Otovicia* sp., *Walchia piniformis*, *Ernestiodendron filiciformis*. Within the Lişava Member red beds, the compressions are represented only by Walchiaceae. This floral succession reflects climatic changing conditions. During the Early Autunian, when the black shales were deposited, the biotope was characterized by warm and wet conditions, while during ?Middle – Late Autunian, when the red beds occurred, the climate became more arid and less favourable for floral diversification.

The Stephanian/Autunian boundary (Lupac and Gîrlişte Members) represents a gradual transition pointed out by the changing from the Stephanian flora dominated by pecopterids (*Pecopteris arborescens*, *P. feminaeformis*, *P. polymorpha*, *Alethopteris zeilleri* in Bițoianu 1988, Dragastan *et al*. 1997) to the Autunian flora dominated by the peltasperman pteridosperms and conifers of Walchiaceae. Antonescu (1980) recorded the assemblage with *Thymnospora* and *Spinozonotriletes* as a marker for the Stephanian C or D at Gîrlişte and (in Antonescu & Năstăseanu 1977) the assemblage with *Florinites* (*F. pumicosus*, *F. guttatus*) and *Potonieisporites* (*P. novicus*, *P. bharadwaji*, *P. neglectus*) as markers for the Lower Autunian in the same area.

The Lower Autunian/?Middle – Upper Autunian boundary (Gîrlişte and Lişava Members) is easily marked facially but rather difficult to be emphasised biostratigraphically. The scarcity of the peltasperman remains within the red beds suggests the boom of the Walchiaceae and the decrease of the pteridosperms as an indicator of this boundary.

HISTORY OF PALAEOBOTANICAL AND PALYNOLOGICAL RESEARCH

A preliminary systematic study of the Autunian flora from the mentioned region has been carried out by few previous authors, but the taxa were never figured or described, until recently (Popa in Dragastan *et al.* 1997). Papers dealing especially with the Permian megaflora from the Reşița Basin have not been written previously the same situation occurs regarding the same age megaflora from other basins (Svinița, Presacina, Cerna). This represents an aim for future work. Štur (1870) cited the first Westphalian-Stephanian and Autunian macrofloristic assemblages from the various occurrences. Von Telegd (1890) mentioned a macroflora assemblage collected from Anina. Schreter (1910) collected a flora near Reşița and Bițoianu (1973, 1974) cited various taxa from outcrops within the Bîrzavița Valley.

Antonescu & Năstăseanu (1976) and Antonescu (1980) gave the most compressive image of the Autunian stratigraphy from the Reşița Basin, their work being based on palynological study. Bițoianu (1988) made a synthesis of the whole Upper Carboniferous macroflora from Lupac area, the Permian macroflora being cited tangentially.

MATERIAL AND METHODS

The samples collected by the author or by previous geologists working in the same area (I. Stănoiu, C. Eufrosin) belong to both Autunian members.

In the field, the author collected while describing in detail the outcrops and collecting with stratigraphic and sedimentologic control. In the laboratory, the samples were split to show optimally the leaf remains, these being described, photographed and drew. Specimens were studied with a Zeiss (GSZ type) and the photography was undertaken using a Praktica MTL5 camera fitted with a Pentacon wide-angle objective and rings, within a static photographic device. Each sample with all the leaf fragments was inventoried with its card and all the card contents are now introduced in the Palaeobotanical database (Microsoft Access for Windows ’97).

SYSTEMATIC ASPECTS OF THE COLLECTED AUTUNIAN FLORA

Within the mentioned collections, 26 taxa heve been identified, having various stratigraphical positions. It is interesting to note that the Romanian Late Carboniferous – Early Permian flora of the Reşița Basin resembles a lot with the classic coeval floras from Saint-Etienne, Autun and Lodeve (Doubinger 1954; Doubinger *et al*. 1995, Galtier & Broutin 1995). The general spectrum of the flora is the following:

Phylum Pteridophyta [*)]

Class Sphenopsida

Order Equisetales

1. ? *Calamites* sp. or axis of *Sphenophyllum* sp. (Fig. 7)
2. *Annularia* cf. *stellata* Schlotheim (Fig. 3)
3. *Annularia* cf. *sphenophylloides* (Zenker) Gutbier (Fig. 4)
4. *Asterophyllites longifolius* (Sternberg) Bongniart (Pl. 1, fig. 2)

Order Sphenophyllales

1. *Sphenophyllum oblongifolium* (Germar et Kaulfuss) Unger (Pl. 1, fig. 6)

Phylum Gymnospermophyta

Class Pteridospermopsida

Order Peltaspermales

1. *Autunia conferta* (Sterberg) Kerp (Fig. 6)
2. *Autunia naumannii* (Gutbier) Kerp (Fig. 8)
3. *Arnhardtia scheibei* (Gothan) Haubold et Kerp (Fig. 5)
4. *Lodevia suberosa* (Sterzel) Haubold et Kerp (Fig. 15)
5. *Gracilopteris bergeronii* (Zeiller) Kerp, Naugolnykh et Haubold (Fig. 11)
6. *Rhachyphyllum schenkii* (Heyer) Kerp (Fig. 17)

Incertae sedis (Pteridophyllae)

1. *Neuropteris* cf. *cordata* Brongniart (Pl. 1, fig. 7)
2. *Neuropteris* sp. (Pl. 2, fig. 4)
3. *Odontopteris* sp. (Fig. 14)
4. *Pecopteris polymorpha* Brongniart (Pl. 2, fig. 1)
5. ?*Linopteris* sp. (Pl. 1, fig. 5)
6. *Cyclopteris* sp. (Fig. 13)

Table 1. Autunian macroflora occurrence

1. Point P51/C2, Popa collection, Ciudanovița Pit, within the Lișava Member (red beds);
2. Point P52/C2, Popa collection, Ciudanovița road, within the Gîrliște Member (black shales);
3. Clocotici, Ion Stănoiu collection, within the Gîrliște Member (black shales);
4. Lupac, Corneliu Eufrosin collection, within the Gîrliște Member (black shales);
5. Anina, Eufrosin collection, within the Gîrliște Member (black shales);
6. Bîrzavița Valley, Eufrosin collection, within the Gîrliște Member (black shales);
7. Unknown occurrence, within the Gîrliște Member (black shales).

Species	1	2	3	4	5	6	7
Alethopteris zeilleri (Ragot) Wagner							X
Annularia cf. *stellata* Schlotheim			X				
Annularia cf. sphenophylloides (Zenker) Gutbier						X	
Arnhardtia Scheibei (Gothan) Haubold et Kerp		X					
Asterophyllites Longifolius (Sternberg) Brongniart			X				
Autunia conferta (Sternberg) Kerp		X	X				
Autunia naumannii (Gutbier) Kerp		X					
? *Calamites* sp.		X	X				
Carpolithes sp. A			X				
Carpolithes sp. B.		X					
Cordaites principalis Germar							X
Cyclopteris sp.				X			
Ernestiodendron filiciformis (Schlotheim) Florin							
Gracilopteris bergeronii (Zeiller) Kerp,Naug.et Haub.		X					
? *Linopteris* sp.						X	
Lodevia suberosa (Sterzel) Haubold et Kerp			X				
Neuropteris cf. *cordata* Brongniart						X	
Neuropteris sp.				X			
Odontopteris sp.		X					
? *Otovicia* sp.		X					
Pecopteris cf. *polymorpha* Brongniart							X
Pecopteris polymorpha Brongniart				X			
Rhachyphyllum Schenkii (Heyer) Kerp			X	X			X
Sphenophyllum oblongifolium (Germar et Kaulfuss) Unger			X				
? *Taeniopteris* sp.			X				
Walchia piniformis (Sternberg) Kerp	X	X		X	X	X	

[1)] The identification of taxa and the taxonomical units represent the author's point of view

7. *Pecopteris cf. polymorpha* Brongniart (Pl. 2, fig. 2)
8. ? *Taeniopteris* sp. (Fig. 16)
9. *Alethopteris zeilleri* (Ragot) Wagner (Pl. 1, fig. 1)

Class Cordaitopsida

Order Cordaitales

1. *Cordaites principalis* Germar (Pl. 1, fig. 3)

Class Coniferopsida

Order Coniferales

Family Walchiaceae

1. *Walchia piniformis* (Sternberg) Kerp (Pl. 2, fig. 3)
2. *Ernestiodendron filiciformis* (Schlotheim) Florin (Pl. 1, fig. 4)
3. ? *Otovicia* sp. (Fig. 12)

Incertae sedis (seeds)

1. *Carpolithes* sp. A (Fig. 10)
2. *Carpolithes* sp. B. (Fig. 9)

This assemblage has its occurrence shown in Table 1.

CONCLUDING REMARKS

The Autunian continental deposits belonging to the Reşiţa Basin preserve a rich compressive megaflora. The preservation degree and the diversity is higher within the basal Autunian black shales and lower within the red beds. Within the black shales, the pteridophytes, pteridosperms and conifers are diverse, represented by Late Stephanian taxa continuing during the Autunian (*Sphenophyllum oblongifolium*, *Asterophyllites longifolius*, *Pecopteris polymorpha*, *Cordaites principalis*, etc.) and by typical Autunian taxa (*Autunia conferta*, *A. naumannii*, *Rhachyphyllum schenkii*, *Walchia piniformis*, etc.). Within the red beds deposits, the megaflora is almost exclusively represented by Walchiaceae (*Walchia piniformis, Ernestiodendron filiciformis* and possibly other types).

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PLATES

Plate 1

1. *Alethopteris zeilleri*, sample “158”
2. *Asterophyllites longifolius*, P23.865/F1, Clocotici, Stănoiu collection
3. *Cordaites principalis*, P21.204/F1, Bîrzavița, Eufrosin collection
4. *Ernestiodendron filiciformis*, P21.206/F1, Clocotici, Eufrosin collection
5. ? *Linopteris* sp., P21.191, Bîrzavița, Eufrosin collection
6. *Sphenophyllum oblongifolium*, P23.865E, Clocotici, Stănoiu collection
7. *Neuropteris cordata*, P21.201/F1, Bîrzavița, Eufrosin collection

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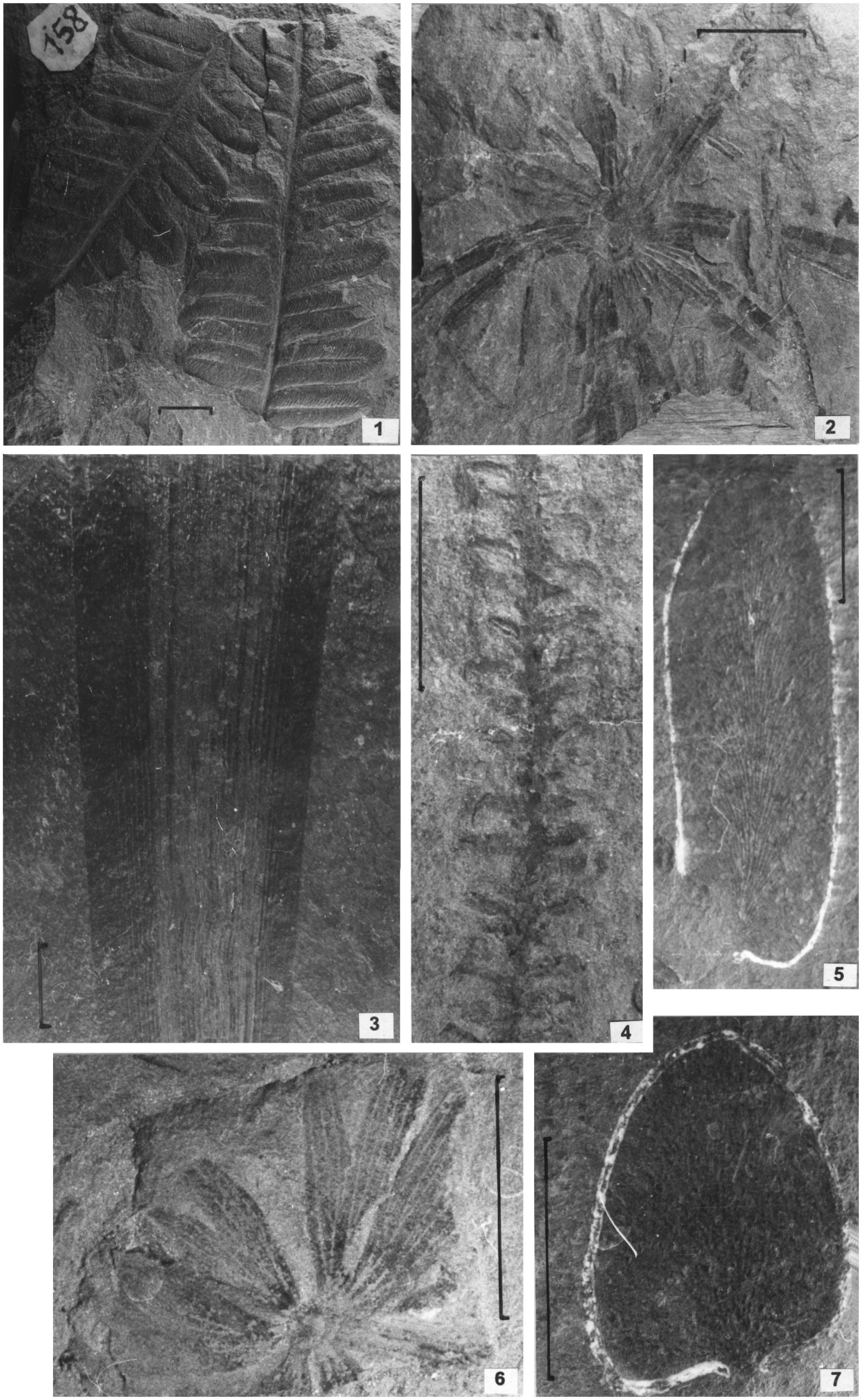
158
1
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7

Plate 2

1. *Pecopteris polymorpha*, P21.199/F1, Lupac, Eufrosin collection
2. *Pecopteris* cf. *polymorpha*, sample “195”/F1, unknown occurrence
3. *Walchia piniformis*, P23.869D/F1, Clocotici, Stănoiu collection
4. *Neuropteris* sp., P21.195, Lupac, Eufrosin collection

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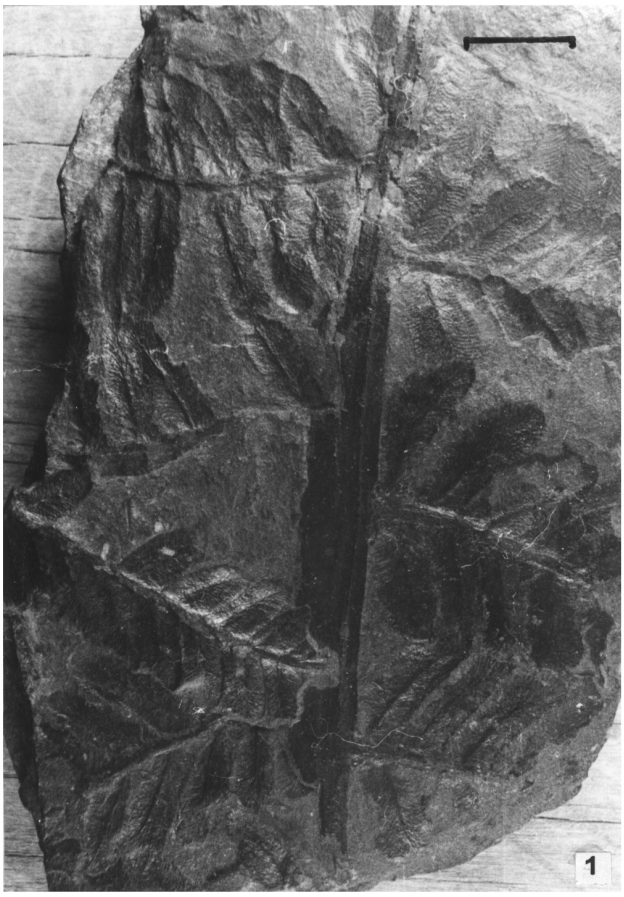
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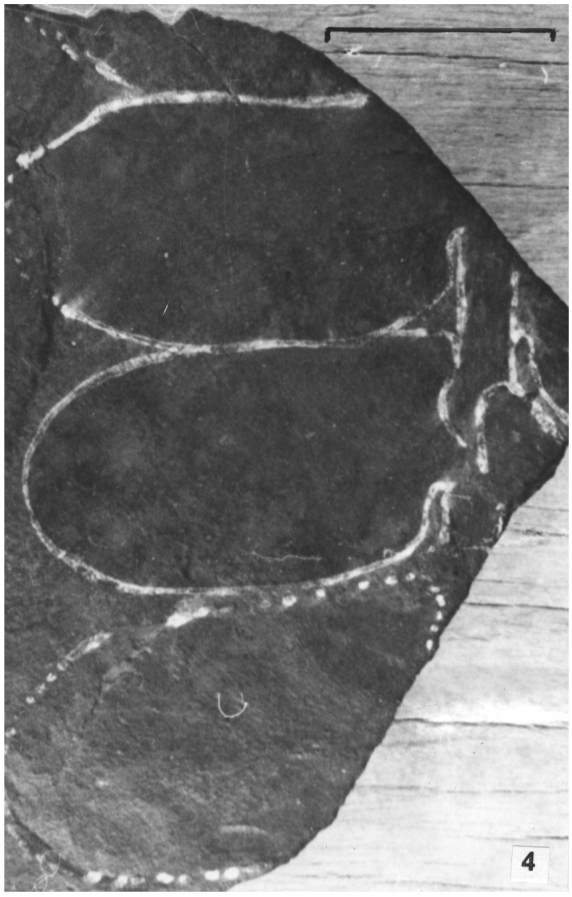
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