

AN OVERVIEW OF PALEOZOIC AND MESOZOIC SITES WITH MACROFLORA IN SERBIA

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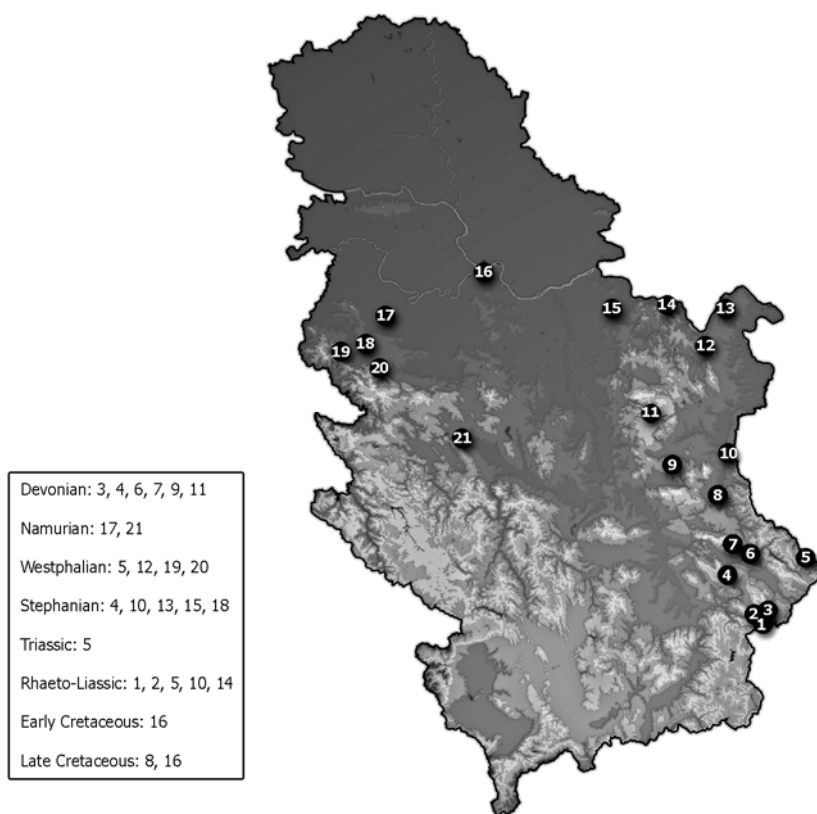
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The greatest number of the Paleozoic and the Mesozoic sites with macroflora is situated in Eastern Serbia. The best-represented ages are the Upper Devonian, Stephanian and Rhaeto-Lias (Triassic-Jurassic), while the Westphalian, Upper Triassic and Cretaceous were less well preserved. This paper includes an overview of the published sites with macroflora, as well as the list of recorded genera and species, with special weight given to presence of certain taxa and general characteristics of listed paleovegetations. Thanks to the remains of plants from all periods from the Devonian to the Late Cretaceous, it was possible to follow the main development phases of vegetation through the Paleozoic and the Mesozoic in Serbia. The development of vegetation is the easiest to follow during the Stephanian and during the Rhaeto-Lias, as these periods have yielded most macro-remains. The richest sites of Stephanian vegetation are from area between the rivers Mlava and Pek, while the richest sites of the Rhaeto-Lias vegetation are in Vrška Čuka (Stara Planina). The remains of the Devonian plants are also abundant, particularly in Svrlijske planine Mts., but they are mostly fragmented, uniform and difficult to determine. The Cretaceous flora was recorded at several localities in the vicinity of Belgrade and Knjaževac. It is the least studied of all the described floras. The Triassic flora has the poorest distribution and so far only one site was recorded at Stara Planina Mt.

Key words: Devonian, Carboniferous, Rhaeto-Liassic, Cretaceous, Serbia, paleoflora.

INTRODUCTION

Generally speaking, Serbia is very rich in fossil macroflora. It is particularly important to note that macrofloras are known from almost all geological period from the Devonian to the Neogene – in this region. The fossilized plant remains recorded in Serbia originated in the Devonian (Middle and Upper), Carboniferous (Namurian, Westphalian and Stephanian), Carboniferous-Permian, Triassic, Triassic-Jurassic (Rhaeto-Lias), Cretaceous (Lower and Upper), Paleocene, Eocene, Oligocene, Miocene, Pliocene and Pleistocene. In theory, it is possible to successfully follow some of the main vegetation and climatic changes in this area during the last 400 million years, especially if palynological analyses are included.



Map 1. - Position of studied localities and macrofloras: 1. Ruj planina Mt.; 2. Zvonce; 3. Zvonačka banja; 4. Suva planina Mt.; 5. Stara planina Mt.; 6. Belava Mt.; 7. Svrljiške planina Mts.; 8. Knjaževac; 9. Rtanj Mt.; 10. Vrška Čuka; 11. Kučaj; 12. Porečka reka, r.; 13. Miroč planina Mt.; 14. Dobra on Danube; 15. Area between rivers Mlava and Pek; 16. Belgrade; 17. Belotić; 18. Pecka river; 19. Krupanj; 20. Bobova; 21. Loznička reka, r.

However, in practice, the flora of the Cenozoic, is much better studied than the flora of the Mesozoic and the Paleozoic, and it may be concluded that the studies of the flora of Paleozoic and Mesozoic are marginalized, as they are rarely mentioned and have never been systematized and presented in one place.

As modern paleobotany increasingly pays its attention especially to the flora of the Carboniferous, Jurassic and Cretaceous, it is necessary to pay more attention to the paleofloras of Serbia as well. Therefore, this paper is an overview of all the studies published of the Paleozoic and Mesozoic floras from the territory of Serbia.

MATERIAL AND METHODS

This paper presents a list of the Mesozoic and Paleozoic sites in Serbia and their recorded species, including a qualitative representation of each species and their position in the higher taxonomic categories. These lists were compiled using only papers that have already been published. In order to more easily locate each plant in the tables, they have been listed according to their alphabetic and not phylogenetic order. The data in this paper includes only macrofloras, which are mostly preserved as compressions or impressions of their leaves or stems. The names of studied taxa were cited as they were presented in the original papers, without revision. The mentioned collections are stored in Belgrade: at the Natural History Museum (Černjavski 1934, Milaković 1953, Pantić 1951a, 1960, 1963a); Faculty of Mining and Geology (Pantić 1951b, 1952, 1955a, 1955b, 1960, 1963b) and at the Geoinstitute (Milovanović 1995).

Tables with all species, localities and references are given in Appendix I.

RESULTS AND DISCUSSION

The Devonian Flora (Tab. 1; 6)

Serbia's Devonian paleoflora was studied on several occasions from 1957 to 1959. (Pantić 1960, 1963a, 1963b). All sites of flora from the Devonian period are located in Eastern Serbia in adjacent areas: Zvonačka Banja (Ordovci); Belava (stream Pantelej - Crni vrh); Suva Planina (Ravni Del); Rtanj Mt. (northern foothills); Kučaj (Gradište); Svrljiške Mts. (Periš and Belanovski Vrh). There are a total of 7 recorded sites; 5 sites include floras both from the Middle and Upper Devonian, while the sites at Rtanj and Belanovski Vrh include only flora from the Upper Devonian.

Table 1. - List of the Devonian taxa.

TRIMEROPHYTA	
MIDDLE DEVONIAN	UPPER DEVONIAN
<i>Psilophyton</i> sp.	
LYCOPODS (<i>Lycopodiophyta</i>)	
MIDDLE DEVONIAN	UPPER DEVONIAN
<i>Protolepidodendron scharyanum</i>	<i>Cyclostigma hercynium</i> <i>Cyclostigma ursinum</i> "comb. n." <i>Cyclostigma</i> sp. <i>Stigmaria devonica</i> "n. sp."
HORSETAILS (<i>Equisetophyta</i>)	
MIDDLE DEVONIAN	UPPER DEVONIAN
<i>Calamophyton primaevum</i>	<i>Sphenophyllum subtenerimum</i>
PROGYMNOSPERMS (<i>Progymnospermopsida</i>)	
MIDDLE DEVONIAN	UPPER DEVONIAN
<i>Aneurophyton germanicum</i>	<i>Archeopteris roemeriana</i>

The plants of the Middle and Upper Devonian are easily distinguishable from each other in most localities, as the Upper Devonian is characterized by the first tree-like lycopods *Cyclostigma*, which are quite dissimilar from the gentle, small-sized plants of the Middle Devonian, including *Psilophyton*, *Calamophyton* or *Protolepidodendron*. It is particularly important to pay attention to the recorded *Archeopteris roemeriana* Goepp. (Pantić 1960) from the group of *Progymnospermopsida*. This large tree, quite tall by Devonian standards, was one of the first plants with seeds. The presence of *Archeopteris* indicates that this area had a well-developed Devonian forest during the Upper Devonian times. This is all important information, as the first land animals evolved in such type of forests.

N. Pantić gives a new combination and describes new taxa for the Devonian flora of Serbia: *Cyclostigma ursinum* (Jongmans) Pantić and *Stigmaria devonica* Pantić (Pantić 1960), however in spite of the detailed description there is not diagnosis in Latin.

The Carboniferous and early Permian Flora (Tab. 2; 7-9, 13)

Floras of Paleozoic and Mesozoic of Serbia have been relatively poorly studied. The greatest, but still insufficient, number of papers pertains to flora of Carboniferous period (Pantić & Dulić 1991). Concerning the number of Carboniferous sites (about two dozen), as well as the quite rich collections at the Natural History Museum (inv. nos. 71- 172 and coll. nos.

Table 2. - List of the Carboniferous taxa.

LYCOPODS (<i>Lycopodiophyta</i>)		
NAMURIAN	WESTPHALIAN	STEPHANIAN
<i>Lepidodendron</i> cf. <i>velthemii</i>	<i>Bothrodendron</i> sp.	
<i>Lepidodendron</i> cf. <i>volkmannianum</i>	<i>Lepidodendron lanceolatum</i>	
<i>Lepidodendron</i> sp.	<i>Lepidodendron ophiurus</i>	
<i>Prelepidodendron</i> sp.	<i>Lepidodendron simile</i>	
<i>Sigillariopsis</i> sp.	<i>Lepidodendron</i> sp.	
	<i>Lepidophyllum lanceolatum</i>	
	<i>Sigillaria scutelata</i>	
	<i>Sigillariophyllum</i> sp.	
HORSETAILS (<i>Equisetophyta</i>)		
NAMURIAN	WESTPHALIAN	STEPHANIAN
<i>Asterocalamites scrobiculatus</i>	<i>Calamites</i> cf. <i>gigas</i>	<i>Annularia sphenophylloides</i>
<i>Calamites radiatus</i>	<i>Sphenophyllum emarginatum</i>	<i>Annularia stellata</i>
<i>Mesocalamites cristiformis</i>		<i>Asterophyllites equisetiformis</i>
		<i>Calamites</i> sp.
		<i>Equisetites</i> sp.
		<i>Sphenophyllum oblongifolium</i>
		<i>Sphenophyllum thoni</i>
		<i>Phyllothea</i> sp.
FERNS (<i>Polypodiophyta</i>)		
NAMURIAN	WESTPHALIAN	STEPHANIAN
<i>Pecopteris (Dyothea) aspera</i>	“ <i>Alloiopteris tenuissima</i> ”	<i>Asterotheca arborescens</i>
	(= <i>Corynepteris tenuissima</i>)	
	“ <i>Dactylothea plumosa</i> ”	<i>Asterotheca</i> sp.
	(= <i>Seftenbergia plumosa</i>)	
	<i>Pecopteris</i> sp.	<i>Pecopteris arborescens</i>
		<i>Pecopteris condoleana</i>
		“ <i>Pecopteris feminaeformis</i> ”
		(= <i>Nemejcopteris feminaeformis</i>)
		<i>Dicksonites pluckeneti</i>
		(Syn. <i>Pecopteris pluckeneti</i>)
		“ <i>Pecopteris cf. plumosa</i> ”
		(= <i>Seftenbergia plumosa</i>)
SEED FERNS (<i>Pteridospermales</i>)		
NAMURIAN	WESTPHALIAN	STEPHANIAN
<i>Neuropteris</i> cf. <i>condrusiana</i>	<i>Mariopteris saueri</i>	<i>Alethopteris grandini</i>
? <i>Neuropteris rectinervis</i>	<i>Neuropteris gigantea</i>	<i>Alethopteris</i> cf. <i>subelegans</i>
	<i>Neuropteris</i> cf. <i>scheuchzeri</i>	<i>Alethopteris</i> sp.
	<i>Neuropteris</i> sp.	<i>Callipteridium</i> cf. <i>crassinervium</i>
	<i>Sphenopteris</i> cf. <i>obtusiloba</i>	<i>Callipteridium gigas</i>
	<i>Sphenopteris</i> sp.	“ <i>Callipteris conferta</i> ”
		(= <i>Autunia conferta</i>)
		<i>Linopteris brongniarti</i>
		<i>Linopteris germari</i>
		<i>Odontopteris</i> aff. <i>brardi</i>
		<i>Odontopteris minor</i>
		<i>Rabdocarpus</i> sp.
		<i>Trigonocarpus</i> sp.
CORDAITES & CONIFERS (<i>Cordaitales</i> & <i>Coniferales</i>)		
NAMURIAN	WESTFALIAN	STEPHANIAN
	<i>Cordaitantus</i> sp.	<i>Cordaites palmaeformis</i>
		<i>Cordaites principalis</i>
		<i>Cordaites</i> sp.
		<i>Samaropsis</i> sp.
		<i>Walchia linearifolia</i>
		<i>Walchia</i> cf. <i>piniformis</i>

36, 40.) which are yet to be published (Djordjević-Milutinović 2010), it may be concluded that the Carboniferous flora (especially of Stephanian) had a greater number of specimens and is therefore more important than previously thought.

THE NAMURIAN

So far there is only a single published article on the Namurian flora (Milovanović 1995), which includes only the list of the most abundant species and two most typical sites in Western Serbia: Loznička Reka and Belotić. This flora is very similar to the flora of Westphalian and includes mostly some arborescent lycopsids (*Lepidodendron*, *Sigillariopsis*), tree ferns (*Pecopteris*), and seed ferns (*Neuropteris*).

THE WESTPHALIAN

Only six localities with Westphalian flora have been recorded so far. Four in Eastern Serbia: three of them are in Stara Planina Mt.: Čuštica (Pantić 1955a), Tovarnica and Zaskovci (Pantić 1962); while one is on the river Porečka reka near Donji Milanovac (Pantić 1963b). There are two localities in Western Serbia: Stolice (near Krupanj) and Bobova. (Milovanović 1995). The flora of the Westphalian age is highly distinguishable from the later flora of Stephanian by the much greater amount of lepidophyta (*Lepidodendron sensu lato*, *Sigillaria*, *Bothrodendron*, *Sigillariophyllum* etc.) which are, except sigillarias, almost absent from the flora of the Stephanian. It is also obvious that the leaves (fronds) of the seed fern *Neuropteris* are much better represented at the Westphalian sites, while their presence is negligible in the Stephanian sites

THE STEPHANIAN

Most Carboniferous plant fossils of Eastern Serbia belong to the Stephanian age. Presently records have been published from 15 sites. The richest localities for this flora are situated in the broader area between the rivers Mlava and Pek (Pantić 1952) with 9 localities, and in Vrška Čuka (Pantić 1951a) with 3 localities. A small number of fossils are also recorded on Suva Planina Mt. (Pantić 1955a) and Miroč Mt. (Pantić 1963b). The only locality situated in Western Serbia is on the bank of the Pecka river near its confluence with the Jadar river. (Pantić 1951b).

Records show, the best-represented genus to be *Cordaites* (it is recorded in 11 out of 15 localities), and which has also been recorded at the Westphalian sites. Other well-represented genera were *Linopteris*, *Pecopteris/Asterotheca*, *Odontopteris*, and, partially, *Alethopteris*. In addition to these arborescent ferns and seed ferns there was also an abundance of typical representatives of azonal marsh vegetation, including the genera *Annularia*, *Asterophyllites* and to a lesser extent *Sphenophyllum*, while *Calamites* is recorded only in two localities.

Unfortunately, the flora from the locality of Pecka river in Western Serbia has been poorly studied. Only 3 taxa have been recorded: *Phyllotecta*, *Cordaites* and *Equisetites*. Therefore nothing specific may be concluded, except that neither *Phyllotecta* nor *Equisetites* have been recorded in the other localities. However, as they belong to the azonal marsh vegetation they probably had local character and could therefore not assist us in the reconstruction of zonal vegetation.

The first records regarding the presence of Carboniferous flora in Serbia are mentioned in a paper by Jovan Žujović (1886, pp. 77) who cites two localities that provided Carboniferous plant remains. The first site was studied by Josif Pančić and F. Hoffman in the village of Mustapić, while the second was studied by Jovan Žujović and D. Sturr in the village of Kladurova (both of these localities are situated in an area between the rivers Mlava and Pek, and they belong to the Stephanian flora).

THE CARBONIFEROUS-PERMIAN (Tab. 9)

In the area of Vrška Čuka (Stara Planina Mt.), on the stream banks of the Surdžijski Potok, Bonin Potok and Uzunov Potok, the recorded flora mostly belongs to the Stephanian stage, but does contain a larger amount of the species *Autunia conferta* Stern. (*Callipteris conferta* Brong. in Pantić 1951a) which appeared in the Latest Stephanian and Early Permian. According to that, N. Pantić believed that the fossil flora from the upper parts of this series belonged to the Early Permian or at least to the Carboniferous-Permian boundary (Pantić 1951a).

According to plant remains, it may be concluded that during the Westphalian period Serbia had the usual lycopod-vegetation, dominated by various arborescent clubmosses, mostly *Lepododendron (sensu lato)* and *Sigillaria*, as well as by the accompanying marsh genera *Annularia*, *Calamites*, *Asterophyllites* etc. During the Stephanian, as expected, there is a pronounced absence of lycopods, which were mostly replaced by tree ferns (*Pecopteris* / *Asterotheca*) and seed ferns (*Linopteris*, *Odontopteris*, *Alethopteris*).

The Triassic Flora (Tab. 3; 10)

In terms of macroflora, the Triassic is very poorly represented in Serbia. Presently there is data published from only a single locality that has Triassic flora (Pantić & Protić 1960). Flora from this period has only been recorded on the river banks of the Dojkanička Reka and Jelovačka Reka in Stara Planina.

In addition to the common azonal species such as *Equisetites*, there are also records of the xeromorphic *Schizoneura paradoxa* Schimp. & Moug., which is characteristic for the Triassic sediments of Europe. The other recorded plants include two species of conifers: a leaf imprint of *Yuccites* sp. (cf. *Pelourdea* in Kustatcher *et al.* 2004) and a twig imprint of *Voltzia heterophylla* Bgt.

Table 3. - List of the Triassic taxa.

HORSETAILS (<i>Equisetophyta</i>)
<i>Equisetites moungeoti</i>
<i>Schizoneura paradoxa</i>
SEED FERNS (<i>Pteridospermales</i>)
? <i>Neuropteridium intermedium</i>
CONIFERS (<i>Coniferales</i>)
<i>Voltzia heterophylla</i>
<i>Yucites</i> sp.

The Triassic - Jurassic (Rhaeto-Lias) Flora (Tab. 4; 11)

The flora of the Rhaeto-Liassic has been studied in Serbia on a number of occasions, but only a few papers have been published so far (Černjavski 1934; Pantić 1955a; Pantić 1955b; Pantić & Cvetičanin 1962). This paleoflora has been recorded at 7 sites, all of them in Eastern Serbia: Stara Planina Mt. (Markov Dol), Dobra (at Danube), mine “Jerma” (Ruj Mt.), Vrška Čuka (coal mine “Vrška Čuka”, Zvonce and Mala Čuka).

According to the plants recorded it may be concluded that the Rhaeto-Lias flora of Serbia had been dominated by lush tropical vegetation with a large number of cycads and bennettites (*Ctenis*, *Nilssonia*, *Ptylophyllum*, *Podozamites* etc.) and tree ferns, primarily *Cladophlebis* and *Marattiopsis*. The seed ferns, which were edificatory species of Carboniferous associations, became almost absent in the Rhaeto-Lias, which is expectable as they had reached their zenith in the Carboniferous and, during the Triassic, this group of plants was on its way to extinction. The genera present in the Rhaeto-Lias, in this case *Sagenopteris* and *Thinnfeldia*, should be considered to be relicts. Although gymnosperms had been in expansion during the Mesozoic, in the studied localities they were represented mostly by cycads and bennettites, while conifers and *Ginkgoales* were scarce. The exception is the flora from the locality Markov Dol on Stara Planina Mt., where the species *Baiera longifolia* Heer was actually dominant in the association. This is the only locality where flora has been recorded a few meters above the coal layer, as all other floras of the Rhaeto-Liassic are immediately above the coal layer. Therefore, N. Pantić (in Pantić & Cvetičanin 1962) concluded that this association did not represent typical marsh vegetation.

Table 4. - List of the Rhaeto-Liassic taxa.

HORSETAILS (*Equisetophyta*)*Equisetites columnaris**Equisetites* sp.

FERNS (*Polypodiophyta*)*?Chiropteris* sp.*Cladophlebis denticulata**Cladophlebis haiburnensis**Cladophlebis* sp.*Dictyophyllum nilssoni**Gutbieri angustiloba**Marattiopteris* cf. *munsteri**Spiropteris* sp.*Thaumatopteris* cf. *munsteri**Todites williamsoni*

SEED FERNS (*Pteridospermales*)*Sagenopteris* cf. *nilssoniana**Sagenopteris phillipsi**Thinnfeldia* cf. *schwarzi*

CYCADS & BENETTITES**(*Cycadales* & *Cycadeoidales*)***Ctenis* cf. *fallax**Ctenis sulcicaulis**Ctenis* sp.*Lomahopteris schimperi**Nageiopsis longifolia**Nilssonia* cf. *acuminata**Nilssonia* cf. *minima**Nilssonia orientalis**Otozamites gracilis**Podozamites lanceolatus**Pterophyllum propinquum**Pterophyllum* sp.*Ptylophyllum pecten**Taeniopteris tenuinervis**Zamites buhianus*

GINKGOPHYTES (*Ginkgoales*)*Baiera longifolia**Baiera munsteriana**Baiera taeniata*

CONIFERS (*Coniferales*)*Pagiophyllum* cf. *kurri**Pityophyllum longifolium*

The Cretaceous Flora (Tab.5; 12)

In Serbia, there are two groups of localities that contain Cretaceous paleoflora: in the vicinity of Belgrade and in the vicinity of Knjaževac. There are 5 localities in the vicinity of Belgrade: Straževica, Makiš and the stream Zbegovište (Aptian); Duboka Jaruga (Albian) and Banovo Brdo (Cenomanian). In the vicinity of Knjaževac there are two localities that have Upper Cretaceous flora: the mine “Dobra Sreća” (Maastrichtian¹) and the stream Nenadovac (Maastrichtian).

The flora of the Cretaceous is the least studied macroflora in Serbia after the flora of the Triassic, although there are numerous fossil remains. Only four papers have been published on this topic to this day: Milaković (1953), Pantić (1955b), Pantić & Nikolić (1955), Pantić & Nikolić (1963) and Pantić & Ilić (1972).

According to the recorded species it may be concluded that the flora of the Cretaceous can be divided into two distinct floristic groups: the flora of the Lower Cretaceous and the flora of the Upper Cretaceous. The flora of the Lower Cretaceous - Straževica, Makiš, Zbegovište and Duboka Jaruga (Milaković 1953, Pantić 1955b) is dominated by tree ferns, cycads, bennettites and conifers, and the most common genera are *Cladophlebis*, *Podozamites* and *Protophyllocladus*. On the other hand, the flora of the Upper Cretaceous - Banovo Brdo, mine “Dobra Sreća” and stream Nenadovac is absolutely dominated by angiosperms (Pantić & Nikolić 1955; Pantić & Nikolić 1963; Pantić & Ilić. 1972). This contrast in composition of floras in the Lower and Upper Cretaceous of Serbia is so distinct that it is the best possible indicator of the vegetation change that happened in Cretaceous due to the expansion of angiosperms. It should be noted that the monocots *Phyllotaenia* and *Typha* were recorded for Lower Cretaceous (Tab. 12), which is useful information for studies of angiosperm evolution. The most common genera of the Upper Cretaceous were *Credneria*, *Eucalyptus*, *Myrica* and *Monocotylophyllum*, while the most common gymnosperms were *Nilssonia* and *Widdringtonites*. It is necessary to mention the genus *Eucalyptus* is the only genus to have appeared both in the Lower and Upper Cretaceous. The absence of any representatives of *Ginkgoales* is unusual.

It should be also noted that N. Pantić (in Pantić & Nikolić 1955) had recorded two new taxa for Cretaceous flora: *Nilssonia serbiaca* Pantić and *Credneria petkovići* Pantić. However, just as in the case of previous two species from Devonian, although the paper includes a detailed description of these specimens, the diagnosis in Latin is not provided.

¹ And Danian, Early Paleocene.

Table 5. - List of the Cretaceous taxa.

HORSETAIL (<i>Equisetophyta</i>)	
LOWER CRETACEOUS	UPPER CRETACEOUS
<i>Equisetites</i> sp.	
FERNS (<i>Polypodiophyta</i>)	
LOWER CRETACEOUS	UPPER CRETACEOUS
<i>Cladophlebis</i> cf. <i>denticulata</i>	? <i>Asplenium foersteri</i>
<i>Cladophlebis ungeri</i>	
<i>Gleichenia kurriana</i>	
<i>Lacopteris dunkeri</i>	
<i>Pecopteris murchisoni</i>	
CYCADS & BENETITES (<i>Cycadales</i> and <i>Cycadeoidales</i>)	
LOWER CRETACEOUS	UPPER CRETACEOUS
<i>Dioonites</i> cf. <i>dunkerianus</i>	<i>Nilssonia serbiaca</i> "n. sp."
<i>Nilssonia alaskana</i>	<i>Nilssonia</i> cf. <i>serbiaca</i>
<i>Otozamites</i> cf. <i>conimbriscensis</i>	
<i>Podozamites lanceolatus</i>	
<i>Zamites</i> sp.	
CONIFERS (<i>Coniferales</i>)	
LOWER CRETACEOUS	UPPER CRETACEOUS
<i>Pinus</i> sp.	<i>Callitris</i> sp.
<i>Pityostrobus (Pinites) andraei</i>	<i>Sequoia reichenbachii</i>
<i>Protophyllocladus polymorphum</i>	<i>Widringtonites reichi</i>
<i>Protophyllocladus</i> cf. <i>subintegrifolius</i>	<i>Widringtonites subtilis</i>
<i>Sphenolepis sternbergiana</i>	
ANGIOSPERMS (<i>Angiospermae</i>)	
LOWER CRETACEOUS	UPPER CRETACEOUS
<i>Eucalyptus angusta</i>	<i>Aenigmatophyllum gothani</i>
<i>Eucalyptus geinitzi</i>	<i>Aralia formosa</i>
<i>Phyllothaenia</i> sp.	<i>Cocculus</i> cf. <i>cinnamomeus</i>
<i>Typha</i> sp.	<i>Credneria petkovići</i> "n. sp."
	<i>Credneria purkyne</i>
	<i>Credneria tenuinervis</i>
	<i>Credneria</i> sp.
	<i>Dawalquea insignis</i>
	<i>Dawalquea</i> sp.
	<i>Diospyros cretacea</i>
	<i>Dryophyllum</i> sp.
	<i>Eucalyptus angusta</i>
	<i>Eucalyptus</i> sp.
	<i>Ficus daphnogenoides</i>
	? <i>Laurophyllum nervillosum</i>
	<i>Leguminosae</i>
	<i>Monocotyllophyllum</i> sp.
	<i>Myrica serrata</i>
	<i>Myrica zenkeri</i>
	<i>Myricanthium amentaceum</i>
	<i>Proteophyllum</i> cf. <i>decorum</i>
	<i>Proteophyllum dichotomium</i>
	<i>Proteophyllum subtile</i>
	<i>Sterculia</i> sp.
	? <i>Tetraphyllum dubium</i>

CONCLUSION

The Paleozoic and Mesozoic of Serbia include paleofloras of the Devonian (Middle and Upper), Carboniferous (Namurian, Westphalian and Stephanian), Carboniferous-Permian, Triassic (Lower), Triassic-Jurassic (Rhaeto-Lias) and Cretaceous (Lower and Upper). Almost all studied localities with macroflora are situated in Eastern Serbia, which is an indication that, since the Devonian, terrestrial environments existed throughout most of the time in this area where vegetation has developed. In most cases (except in Triassic) these have been forest associations.

Paleofloristic records provide a good evidence of vegetation changes in Serbia over a very long period of time (from the Devonian to the Paleocene), from the first land plants in the Devonian, through giant lycopods and seed ferns in the Carboniferous, to the Jurassic cycads and bennettites and the Cretaceous angiosperms.

The greatest amount of macroflora is recorded from the Stephanian and from the Rhaeto-Lias strata. There is also a large collection from the Devonian sediments, but the plant remains are broken and difficult to determine. The Westphalian flora is poorly represented when compared to the Stephanian one and the fossils are usually ruined and broken. The smallest number of imprints is from the Triassic, while records from the Permian are absent apart from those at the Carboniferous-Permian boundary. There are numerous imprints from the Cretaceous, while the floras of the Early and Late Cretaceous are clearly distinct from a taxonomic standpoint.

Unfortunately, studies of Paleozoic and Mesozoic paleoflora are scarce and there are only a few papers and authors that deal with this topic.

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APPENDIX I

TAXON DISTRIBUTION, LOCALITIES AND REFERENCES OF STUDIED MACROFLORA

THE DEVONIAN

Table 6. - Devonian taxon and localities: 1. Zvonačka Banja; 2. Belava and Crni Vrh potok Pantelej; 3. Suva Planina (Ravni Del), 4. Rtanj Mt.; 5. Kučaj (Gradište); 6. Svrljiške Planine Mt.: Periš (Pantić 1960, 1963b); 7. Svrljiške planine Mt.: Belanovski Vrh (Pantić 1963a, 1963b).

DEVONIAN TAXON	1	2	3	4	5	6	7
<i>Aneurophyton germanicum</i>		X				X	
<i>Archeopteris roemeriana</i>	X						
<i>Calamophyton primaevum</i>	X		X		?X		
<i>Cyclostigma hercynium</i>	X	X	X				X
<i>Cyclostigma ursinum</i> "comb. nova"	X	X	X				X
<i>Cyclostigma</i> sp.			X	X			
<i>Protolepidodendron scharyanum</i>	X	X					
<i>Psilophyton</i> sp.	X	X	X				
<i>Sphenophyllum subtenerimum</i>	X	X					
<i>Stigmaria devonica</i> "n. sp."	X						

THE CARBONIFEROUS

Table 7. - Namurian taxon and localities: Loznička reka river; 2. Belotić (Milovanović 1995).

NAMURIAN TAXON	1	2
<i>Asterocalamites scrobiculatus</i>		X
<i>Calamites radiatus</i>	X	
<i>Lepidodendron</i> cf. <i>velthemii</i>	X	
<i>Lepidodendron</i> cf. <i>volkmannianum</i>	X	
<i>Lepidodendron</i> sp.		X
<i>Mesocalamites cristiformis</i>		X
<i>Neuropteris</i> cf. <i>condrusiana</i>	X	
? <i>Neuropteris rectinervis</i>	X	
<i>Pecopteris (Dyothea) aspera</i>	X	
<i>Prelepidodendron</i> sp.		X
<i>Sigillariopsis</i> sp.	X	

Table 8. - Westphalian taxon and localities: Stara Planina Mt. (1-3): 1. Čuštica (Pantić 1955a); 2. Tovarnica (Pantić & Cvetičanin 1962); 3. Zaskovci (Pantić & Cvetičanin 1962); 4. Porečka reka (Pantić 1963b); 5. Stolice: Krupanj (Milovanović 1995); 6. Bobova (Milovanović 1995).

WESTPHALIAN TAXON	1	2	3	4	5	6
<i>Alethopteris cf. serli</i>					X	
<i>Alethopteris</i> sp.						X
<i>Asterophyllites equisetiformis</i>	X	X	X			
<i>Bothrodendron</i> sp.	X					
<i>Calamites (Mesocalamites) cristiformis</i>					X	
<i>Calamites cf. gigas</i>	X					
<i>Calamites</i> sp.		X		X		
<i>Cordaiantus</i> sp.	X					
<i>Cordaites palmaeformis</i>	X					
<i>Cordaites principalis</i>	X					
<i>Cordaites</i> sp.		X	X			
<i>Dactylothea plymosa</i>			X			
<i>Lepidodendron lanceolatum</i>			X			
<i>Lepidodendron ophiurus</i>		X	X	X		
<i>Lepidodendron simile</i>		X				
<i>Lepidodendron</i> sp.						X
<i>Lepidophyllum lanceolatum</i>	X	X	X			
<i>Mariopteris cf. muricata</i>					X	
<i>Mariopteris sauveri</i>			X			
<i>Neuropteris gigantea</i>	X	X	X	X		
<i>Neuropteris cf. tenuifolia</i>					X	
<i>Neuropteris cf. schlehani</i>						X
<i>Neuropteis cf. scheuchzeri</i>	X	X				
<i>Neuropteris</i> sp.			X			
<i>Sigillaria scutelata</i>		X				
<i>Sigillariophyllum</i> sp.	X					
<i>Sphenophyllum emarginatum</i>	X		X			
<i>Sphenopteris cf. obtusiloba</i>					X	
<i>Sphenopteris</i> sp.			X			
<i>Trigonocarpus</i> sp.						X

THE TRIASSIC

Table 10. - Triassic taxon and localities: Stara planina Mt.: 1. Dojkanička reka, 2. Jelovačka reka (Pantić & Protić 1960).

TRIASSIC	1	2
<i>Equisetites moungeoti</i>	X	X
? <i>Neuropteridium intermedium</i>	X	
<i>Schizoneura paradoxa</i>	X	
<i>Voltzia heterophylla</i>		X
<i>Yucites</i> sp.	X	

TRIASSIC-JURASSIC (RHAETO-LIASSIC)

Table 11. - Rhaeto-Liassic taxon and localities: Stara planina Mt- Markov Dol (Pantić & Cvetičanin 1962); 2. Dobra na Dunavu (Pantić 1955a); 3. mine "Jerma" Ruj Mt. (Pantić 1955b); Vrška Čuka (4-7): 4. mine "Vrška Čuka" (Pantić 1955a); 5. Vrška Čuka (Černjavski 1934) 6. Zvonice (Černjavski 1934); 7. Vrška Čuka - Mala Čuka (Černjavski 1934).

Rhaeto-Lias	1	2	3	4	5	6	7
<i>Baiera longifolia</i>	X						
<i>Baiera munsteriana</i>							X
<i>Baiera taeniata</i>				X			
<i>Cladophlebis denticulata</i>	X	X	X			X	
<i>Cladophlebis haiburnensis</i>	X						
<i>Cladophlebis</i> sp.	X	X					
? <i>Chiropteris</i> sp.							X
<i>Ctenis</i> cf. <i>fallax</i>				X			
<i>Ctenis sulcaulis</i>				X			
<i>Ctenis</i> sp.				X			
<i>Dictyophyllum nilssoni</i>		X					
<i>Equisetites columnaris</i>			X	X			
<i>Equisetites</i> sp.		X					X
<i>Gutbieri angustiloba</i>				X			
<i>Lomahopteris schimperi</i>	X						
<i>Marattiopteris</i> cf. <i>munsteri</i>						X	
<i>Nageiopsis longifolia</i>			X				
<i>Nilssonia</i> cf. <i>acuminata</i>							X
<i>Nilssonia</i> cf. <i>minima</i>							X
<i>Nilssonia orientalis</i>			X			X	X
<i>Otozamites gracilis</i>	X						X
<i>Pagiophyllum</i> cf. <i>kurri</i>							X
<i>Pteophyllum</i> sp.	X						
<i>Pityophyllum longifolium</i>		X	X	X			
<i>Podozamites lanceolatus</i>		X	X	X			
<i>Pterophyllum propinquum</i>			X				
<i>Ptylophyllum pecten</i>			X		X		X
<i>Sagenopteris</i> cf. <i>nilssoniana</i>							X
<i>Sagenopteris phillipsi</i>		X					
<i>Spiropteris</i> sp.							X
<i>Taeniopteris tenuinervis</i>	X						
<i>Thaumatopteris</i> cf. <i>munsteri</i>		X					
<i>Thinnfeldia</i> cf. <i>schwarzi</i>							X
<i>Todites williamsoni</i>				X			
<i>Zamites buhianus</i>					X		

THE CRETACEOUS

Table 12. - Cretaceous taxon and localities: Vicinity of Belgrade: 1. Straževica (Milaković 1953, Pantić 1955b); 2. Makiš (Milaković 1953); 3. stream Zbegovište (Pantić 1955b); 4. Duboka Jaruga (Pantić 1955b). 5. Banovo Brdo (Pantić & Ilić 1972). Vicinity of Knjaževac: 6. mine „Dobra Sreća“ (Pantić & Nikolić 1955); 7. stream Nenadovac (Pantić & Nikolić 1963).

CRETACEOUS	1	2	3	4	5	6	7
<i>Aenigmatophyllum gothani</i>					X	X	
<i>Aralia formosa</i>						X	X
? <i>Asplenium foersteri</i>						X	
<i>Callitris</i> sp.						X	
<i>Cladophlebis</i> cf. <i>denticulata</i>				X			
<i>Cladophlebis ungeri</i>			X				
<i>Cocculus</i> cf. <i>cinnamomeus</i>						X	
<i>Credneria petkovići</i> sp. n.						X	
<i>Credneria purkyne</i>					X		
<i>Credneria tenuinervis</i>						X	
<i>Credneria</i> sp.						X	
<i>Dawalquea insignis</i>						X	
<i>Dioonites</i> cf. <i>dunkerianus</i>			X				
<i>Dawalquea</i> sp.						X	
<i>Diospyros cretacea</i>					X		
<i>Dryophyllum</i> sp.						X	
<i>Equisetites</i> sp.		X					
<i>Eucalyptus angusta</i>				X	X	X	X
<i>Eucalyptus geinitzi</i>				X			
<i>Eucalyptus</i> sp.					X		
<i>Ficus daphnogenoides</i>						X	
<i>Gleichenia kurriana</i>			X				
<i>Lacopteris dunkeri</i>			X				
? <i>Laurophyllum nervillosum</i>							
Leguminosae					X		
<i>Monocotylophyllum</i> sp.					X	X	X
<i>Myrica serrata</i>						X	
<i>Myrica zenkeri</i>						X	X
<i>Myricanthium amentaceum</i>						X	
<i>Nilssonia alaskana</i>			X				
<i>Nilssonia serbiaca</i> "sp. n."						X	
<i>Nilssonia</i> cf. <i>serbica</i>					X		
<i>Otozamites</i> cf. <i>conimbriscensis</i>	X						
<i>Pecopteris murchisoni</i>			X				
<i>Phyllothaenia</i> sp.	X						
<i>Pinus</i> sp.			X				
<i>Pityostrobus</i> (<i>Pinites</i>) <i>andraei</i>	X						
<i>Podozamites lanceolatus</i>			X	X			
<i>Proteophyllum</i> cf. <i>decorum</i>					X		
<i>Proteophyllum dichotomium</i>						X	
<i>Proteophyllum subtile</i>					X		
<i>Protophyllocladus polymorphum</i>	X						
<i>Protophyllocladus</i> cf. <i>subintegrifolius</i>		X	X				
<i>Sequoia reichenbachii</i>					X		
<i>Sphenolepis sternbergiana</i>	X						
<i>Sterculia</i> sp.					X		
? <i>Tetraphyllum dubium</i>						X	
<i>Typha</i> sp.		X					
<i>Widringtonites reichi</i>						X	X
<i>Widringtonites subtilis</i>						X	X
<i>Zamites</i> sp.	X						

APENDIX IITHE FIRST RECORDS REGARDING THE PRESENCE OF
CARBONIFEROUS FLORA IN SERBIA (in Žujovic 1886)

Table 13. - First noted Carboniferous, probably Stephanian, plant fossils. Area between rivers Mlava and Pek: 1. Mustapić; 2. Kladurova.

TAXON	1	2
<i>Alethopteris cf. pteroides</i>	X	
<i>Annularia sphenophylloides</i>		X
<i>Annularia stellata</i>		X
<i>Asterophyllites equisetiformis</i>		X
<i>Calamites cf. citii</i>	X	
<i>Calamites varians</i>		X
<i>Dictyopteris brogniarti</i>		X
<i>Dictyopteris neuropteroides</i>	X	
<i>Diplothemera pluckenetii</i>		X
<i>Lepidodendron cf. rimosum</i>		X
<i>Odontopteris minor</i>		X
<i>Pecopteris gigas</i>		X
<i>Pecopteris grandini</i>		X
<i>Pecopteris pluckenetii</i>	X	
<i>Rhabdocarpus sp.</i>		X
<i>Scoleopteris (Pecopteris) arborescens</i>		X
<i>Sigillaria sp.</i>		X
<i>Sphenophyllum Schlotheimi</i>		X
<i>Sphenopteris integra</i>	X	
<i>Trigonocarpus sp.</i>		X

**ПРЕГЛЕД ПАЛЕОЗОЈСКИХ И МЕЗОЗОЈСКИХ ЛОКАЛИТЕТА
СА МАКРОФЛОРОМ У СРБИЈИ**

ДЕСА ЂОРЂЕВИЋ-МИЛУТИНОВИЋ

РЕЗИМЕ

Највећи број палеозојских и мезозојских локалитета са макрофлором налази се у источној Србији. Квантитативно су највише заступљене биљке горњег девона, стефанијена и рето-лијаса, док су биљке вестфала, горњег тријаса и креде заступљене у мањој мери. У раду је дат преглед свих публикованих локалитета са макрофлором палеозоика и мезозоика Србије, као и листа забележених родова и врста са освртом на њихове еколошке захтеве и системску припадност вишим таксономским категоријама (раздео, класа или ред). Захваљујући биљним остацима могуће је пратити главне фазе у

развоју копнене вегетације Србије током палеозоика и мезозоика, а посебно током стефанијена и рето-лијаса јер из тих периода има највише фосилних биљака. Најбогатија налазишта стефанијенске флоре налазе се на широком подручју између река Млава и Пек, док су најбогатија налазишта ретолијаске флоре на Вршкој чуки. Остаци девонских биљака такође су бројни, посебно на Сврљишким планинама, али су лоше очувани, изломљени и са мало морфолошких детаља тако да детерминација до врсте обично није могућа. Кредна флора нађена је на неколико локалитета у близини Београда и Књажевца, док је флора тријаса нађена само на једном једином локалитету на Старој планини. Највећи број локалитета палеозојских и мезозојских биљака налази се у источној Србији док је у западној забележено свега неколико (нпр. река Пецка, Белотић).

Девон: Биљке средњег и горњег девона нађене су на подручју Сврљишких планина и у околини Звоначке Бање. Фосили, мада бројни, доста су лоше очувани због крупнозрног седимента. Најбројније су лycopсиде (*Cyclostigma*, *Stygmaria*, *Protolepidodendron*), а у мањој мери су заступљени *Psylophyton*, *Arecheopteris*, *Sphenophyllum* итд.

Карбон: На највећем броју локалитета нађене су биљке стефанијена. Највише су заступљени родови *Cordaites*, *Linopteris*, *Pecopteris*/*Asterotheca*, *Odontopteris*, а у мањој мери јављају се *Alethopteris*, *Annularia* и *Asteriphyllites*. Биљке вестфала и намура нађене су у много мањем броју и ту преовлађују *Lepidodendron* s. l., *Sigillaria* и *Neuropteris*. У фитоценолошком смислу флора стефанијена и вестфала се међусобно јасно разликује.

Тријас: биљке тријаса (*Equisetites*, *Schizoneura*, *Voltzia* и *Yuccites*) њађене су у малом броју и то само на једном локалитету на Старој планини.

Рето-лијас (тријас-јура): флора је малобројна али веома лепо очувана. Преовлађују отисци листова голосеменица *Nillsonia*, *Otozamites*, *Zamites*, *Podozamites* и дрвенасте папрати (нпр. *Cladophlebis*). Од Ginkgoales јавља се *Baiera* sp., док се семене парати јављају само спорадично и вероватно представљају реликтне облике.

Креда: у доњој креди (околина Београда) доминирају дрвенасте папрати, цикаси, бенетити и конифере, док у флори горње креде (углавном околина Књажевца) апсолутно доминирају ангиосперме (*Credneria*, *Eucalyptus*, *Myrica* и *Monocotylphyllum*). Овај контраст у саставу флоре доње и горње креде веома је изразит и може бити добар индикатор промена које су се десиле током креде када је дошло до смењивања вегетације голосеменица вегетацијом цветница.