

OVERVIEW OF THE POST-MIOCENE MACROFLORAS OF SERBIA AND OTHER COUNTRIES OF FORMER YUGOSLAVIA

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The paper provides a list of published post-Miocene flora found in the territory of former Yugoslavia, presenting Pliocene, Pleistocene and sub-recent paleoflora from Serbia, North Macedonia, Croatia, Slovenia, Bosnia and Montenegro. The author has listed all the localities and papers she has been able to access. Most of these paleofloras had been researched and published by Pavle Ivanović Černjavski, formerly a curator of the Natural History Museum in Belgrade. Consequently, a large number of paleofloras discussed in this paper is still kept at this Museum.

Keywords: Pliocene, Pleistocene, paleobotany, Yugoslavia, Serbia, North Macedonia

INTRODUCTION

From the year 1886, when the first macro-floristic research was published (Žujović 1886), until today, a large number of fossil plants – from almost all geological periods, from Devonian to Pleistocene – were found in the territory of Serbia. The majority of the collected fossil material was, however, from the Miocene and Pliocene. The Miocene flora has been well researched and there is a wealth of information available about it, both in electronic form and in the English language. With that in mind, one

could say that data on the Miocene floras of Serbia is readily available. On the other hand, much less is known about Pliocene, Pleistocene or sub-recent fossil flora of Serbia and other countries that were once part of former Yugoslavia. These floras have been researched and described, but the majority of the relevant findings have been published in Serbian, Macedonian, Croatian or Slovenian, without any translation into English - which today serves as the “bridge-language” in the world of science. Most of these floras were published between the years 1928 and 1979, and, except in rare cases, cannot be found on the Internet. Thus, though these floras were published, they are essentially forgotten and completely unknown to the general paleobotanical public.

For the above reasons, it has been noted that previously published studies of fossil plants of the Pliocene, Pleistocene and sub-recent age from Serbia and the surrounding regions should be presented in one place in order to make this information easily accessible to interested researchers.

Research background

Initial research into the post-Miocene flora in the study area began in 1894, when Hermann Engelhardt (Engelhardt 1895) published the Pliocene flora of Slavonski Brod. Thereafter, it seems that nothing else was published until 1928 when Pavle Ivanovič Černjavski, professor of botany and later curator at the Natural History Museum in Belgrade, published his research on the sub-recent flora of Smederevska Palanka (Černjavski 1928). Being a botanist by profession, he collected and identified Pliocene and earlier flora with great ease and without a need for too much time (Djordjević Milutinović 2018). His work on identification was very diligent and descriptive, and he made efforts to identify a genus, sometimes even the species, based on nothing more but a single fragment. Considering that he was the only paleobotanist in Serbia at the time, and that there were many fossil plants at the Museum, he believed that each finding was important and that it should be published so that a written trace would remain of the site where it was found. This is why some of his papers sometimes describe collections consisting of only a few specimens. Although he collected many of the paleoflora himself, he would also often receive (for the purposes of identification) fossil plants from colleagues who were conducting various geological explorations. For example, Fran Šuklje would send him flora from Croatia, Martin Munda and Filip Lipoglavšek from Slovenia, Nikola Izmajlov from North Macedonia, etc. Also, since he was Russian by origin, Černjavski had excellent cooperation with other highly educated Russians who lived primarily in Serbia, but also in other parts of Yugoslavia. They too would send paleoflora from various territories to Černjavski for identification, e.g. N. Muravjov from Monte-

negro, Lav Rajevski from Croatia, the Grebenščikov brothers from Serbia, A. Malohov from North Macedonia and so on. Thanks to this “network of numerous helpers”, Černjavski was in contact with the fossil flora of not only Serbia but also other parts of the then Yugoslavia. After Černjavski, Pliocene and later floras were, to a lesser extent, dealt with by Dr Borko Milaković (Geological Survey of Serbia) and academician Dr Nikola Pantić (University of Belgrade), who explored mainly the sites of North Macedonia. The last of these, as we would call them, “older papers” was published in 1979 (Pantić *et al.* 1979). More recently, several paleoflora from the study areas have been published (Adžić *et al.* 2013, Djordjević Milutinović & Čulafić 2010, Đorđević Milutinović 2016), and they are also presented in this paper.

In addition to those that had been published, the author took the opportunity to also publish a hitherto unpublished collection that was found at the Natural History Museum in Belgrade while preparing this paper – the Pliocene/Pleistocene collection from the Ugljevik site (Bosnia and Herzegovina), which Černjavski only lightly mentioned in his article (Černjavski 1948b: 50), stating that it was yet to be published. Černjavski defined this collection and prepared it for publication, but it was never published because he had to leave Yugoslavia in early 1951. The fact that Černjavski had prepared it for publication, and that, as far as the author is aware, this is the only information on the finding of post-Miocene flora in Bosnia and Herzegovina, helped us in our decision to also mention this paleoflora.

MATERIAL AND METHODS

The main purpose of this paper is to provide a one-stop overview of the post-Miocene macroflora that were researched in Serbia and other countries that used to make up former Yugoslavia (Fig. 1). Most of this research relates to Serbia and North Macedonia. The presented material is certainly not complete, but nevertheless might be of great assistance to those exploring post-Miocene paleoflora.

The paper lists names of species and other taxa, the way they were provided in the original papers, without revising or changing those names that have in the meantime become synonymous. For the sake of clarity, the author has listed the species in alphabetical order. Also, the inventory or collector numbers as well as photographs of individual specimens were provided regarding the specimens of fossil plants that are kept at the Natural History Museum in Belgrade. In addition to the paleoflora described during the period 1928–1979 (when most localities were

published), the author also provided an overview of later studies, aiming to present a comprehensive picture of the localities where Pliocene, Pleistocene, and sub-recent flora were found and to offer insight into the representation of particular genera and species.



Fig. 1. – Map of the study area: 1. Živojno; 2. Leskoec and Carina; 3. Vranjevci; 4. Valandovo; 5. Vodoča; 6. Pulići; 7. Oslomej; 8. Katlanovo; 9. Matka; 10. Bukovik; 11. Kisela voda; 12. Živonje; 13. Erenika River; 14. Lavoš and Brnjača; 15. Berane; 16. Blace; 17. Pljevlja; 18. Prijepolje; 19. Iline Vode; 20–21. Ždrilo and Seline; 22. Guvno; 23. Radenka; 24. Ugljevik; 25. Slavonski Brod; 26. Čortanovci; 27. Kikinda; 28. Glogovac; 29. Zgornje Jezersko.

The issue of age

The same issue frequently occurred in the works of P. Černjavski, and especially in those of N. Pantić and B. Milaković: the problem of identifying the age of the described flora. Namely, considering that at the time when they wrote their papers the Pontian belonged to the Early

Pliocene (and not to the Miocene, as is the case today), the age identified as “Lower Pliocene” can be often found in the older works; however, we cannot be certain whether the period in question is actually the Pontian or post-Pontian. In other words, we cannot be certain whether it is the Miocene or Pliocene. The author of this paper made the selection of paleoflora in the following way: the Early Pliocene floras, dominated by Arcto-Tertiary floristic elements, are presented, such as the Glogovac flora, for example (Černjavski 1933b) or the Katlanovo flora (Milaković 1955). In such cases, the opinion of P. Černjavski that *Taxodium* appeared in the territory of Serbia and North Macedonia in the Pontian, but not later, was also taken into account (Černjavski 1948b: 56).

RESULTS AND DISCUSSION

Some of the presenting papers do not contain a closer description of the fossils or photographs, and it is therefore impossible to know whether they are in fact compressions or impressions. In such cases, the fossils are described as leaf imprints.

Holocene: Zgornje jezersko, Slovenia (Fig. 1: 29; Pl. 2, fig. 4). Leaf impressions in travertine (Černjavski 1948a). Note: the collection is kept at the Natural History Museum in Belgrade. Paleobotanical Collection, Coll. No. 5.

List of taxa in Černjavski (1948a), and number of specimens:

<i>Abies alba</i>	rare
<i>Acer pseudolatanus</i> fructus	1
<i>Acer pseudoplatanus</i>	very frequent
? <i>Corylus avellana</i>	1
<i>Cyperaceae</i> leaves and twigs	frequent
<i>Fagus moesiaca</i>	en masse
<i>Phragmites communis</i>	
<i>Picea excelsa</i> en masse	1
<i>Prunus</i> cf. <i>silvestris</i>	rare
<i>Salix</i> cf. <i>caprea</i>	frequent
<i>Salix</i> cf. <i>silesiaca</i>	2
<i>Salix</i> sf. <i>cinerea</i>	very frequent

Pleistocene / Holocene: Village Vodoča near Strumica, North Macedonia. (Fig. 1: 5). Leaf impressions in tufa (Černjavski 1928). Note: There is no indication on the amount of collected material.

List of taxa in Černjavski (1928):

<i>Carpinus betulus</i>	<i>Clematis vitalba</i>
<i>Carpinus orientalis</i>	<i>Cornus mas</i>

<i>Cornus sanguinea</i>	<i>Prunus</i> sp.
<i>Corylus avellana</i>	? <i>Quercus pubescens</i>
<i>Euonymus europaeus</i>	<i>Rhamnus frangula</i>
? <i>Fagus sylvatica</i>	<i>Salix caprea</i>
<i>Hedera helix</i>	<i>Salix alba</i>
<i>Juglans regia</i>	<i>Tamus communis</i>
<i>Ostrya carpinifolia</i>	? <i>Tilia tomentosa</i>
<i>Phragmites communis</i>	<i>Ulmus campestris</i>
<i>Pinus</i> sp.	<i>Ulmus</i> sp.
<i>Populus tremula</i>	<i>Viburnum opulus</i>

Pleistocene / Holocene: Pljevlja, near the source of the Breznica River, Montenegro (Fig. 1: 17). Leaf impressions in tufa (Černjavski 1929). Note: There is no indication on the amount of collected material.

List of taxa in Černjavski (1929):

<i>Acer pseudoplatanus</i>	<i>Fontinalis antipyretica</i>
<i>Carpinus betulus</i>	<i>Ostrya carpinifolia</i>
<i>Cinclidotus fontinaloides</i>	<i>Salix caprea</i>
<i>Corylus avellana</i>	<i>Tilia parvifolia</i>
<i>Fagus sylvatica</i>	

Pleistocene / Holocene: Prijepolje, near Jerinin grad, in the Mileševka River, Montenegro (Fig. 1: 18). Leaf impressions in tufa (Černjavski 1929).

List of taxa in Černjavski (1929), and number of specimens:

<i>Carpinus betulus</i>	numerous
<i>Fagus sylvatica</i>	frequent
<i>Ostrya carpinifolia</i>	numerous
<i>Tilia</i> cf. <i>parvifolia</i>	rare

Pleistocene / Holocene: Erenika River (level: 337 m), near Djakovica, Serbia (Fig. 1: 13; Pl. 3, fig. 2). Leaf compressions and impressions in marly clay (Černjavski 1948b). Note: The collection is kept at the Natural History Museum in Belgrade; Paleobotanical Collection, Coll. No. 158, Inv. Nos. 228, 1457–1459.

List of taxa in Černjavski (1948b), and number of specimens:

<i>Pinus</i> sp. seed	1
<i>Quercus pseudocastanea</i>	1
<i>Castanea atavia</i>	1
<i>Parrotia fagifolia</i>	1

Late Pleistocene: Valandovo, North Macedonia (Fig. 1: 4). Leaf impressions in tufa (Černjavski 1928, 1930).

List of taxa in Černjavski (1928, 1930), and number of some specimens:

<i>Acer pseudoplatanus</i>	rare
<i>Acer</i> sp.	
<i>Alnus glutinosa</i>	rare
<i>Corylus avellana</i>	
? <i>Euonymus europaeus</i>	
<i>Fagus sylvatica</i>	
<i>Hedera helix</i>	en masse
<i>Ostrya carpinifolia</i>	
<i>Quercus</i> cf. <i>pubescens</i>	en masse
? <i>Quercus pubescens</i>	
<i>Quercus</i> cf. <i>sessiliflora</i>	en masse
<i>Rubus</i> cf. <i>anatolicus</i>	rare
<i>Salix</i> cf. <i>caprea</i>	rare
<i>Scolopendrium vulgare</i>	rare
<i>Tilia</i> sp.	rare
<i>Ulmus carpinifolia</i>	very frequent
<i>Ulmus</i> cf. <i>campestris</i>	rare
<i>Ulmus</i> sp.	

Late Pleistocene: Kisela voda, Vodno Mountain, North Macedonia (Fig. 1: 11). Impressions in tufa (Černjavski 1930). Note: Part of the collection is kept at the Natural History Museum in Belgrade; Paleobotanical Collection, Coll. No. 83.

List of taxa in Černjavski (1930), and number of specimens:

<i>Quercus</i> cf. <i>cerris</i>	en masse
<i>Quercus</i> cf. <i>conferta</i>	en masse
<i>Quercus</i> cf. <i>pedunculata</i>	en masse
<i>Quercus</i> cf. <i>pubescens</i>	en masse
<i>Quercus</i> cf. <i>sessiliflora</i>	en masse
<i>Salix</i> cf. <i>caprea</i>	
<i>Tilia</i> sp.	several
<i>Ulmus</i> cf. <i>campestris</i>	several
<i>Ulmus</i> cf. <i>montana</i>	several

Late Pleistocene: Monastery Matka near Šiševo, North Macedonia (Fig. 1: 9; Pl. 1, fig. 3). Leaf and fruits impressions in tufa (Černjavski 1930). Note: Similar flora – although it was never confirmed that it is exactly the same described by Černjavski – is kept at the Natural History Museum in Belgrade; Paleobotanical Collection, Coll. Nos. 94, 95, 96.

List of taxa in Černjavski (1930), and number of specimens:

<i>Acer platanoides</i>	rare
<i>Acer pseudoplatanus</i> leaves and fruit	not frequent

<i>Acer tataricum</i> leaves and fruit	not frequent
<i>Betula verrucosa</i>	very frequent
<i>Clematis</i> cf. <i>flammula</i>	rare
<i>Euonymus</i> cf. <i>europaeus</i>	rare
<i>Fraxinus</i> sp.	rare
<i>Hedera helix</i>	rare
<i>Juglans regia</i>	rare
<i>Juniperus excelsa</i>	several
<i>Juniperus excelsa</i> f. <i>retinospora</i>	rare
<i>Platanus orientalis</i>	rare
<i>Populus tremula</i>	rare
<i>Quercus</i> cf. <i>cerris</i>	very frequent
<i>Quercus</i> cf. <i>conferta</i>	very frequent
<i>Quercus</i> cf. <i>pedunculata</i>	very frequent
<i>Quercus</i> cf. <i>pubescens</i>	very frequent
<i>Quercus</i> cf. <i>sessiliflora</i>	very frequent
<i>Salix</i> cf. <i>alba</i>	very frequent
<i>Salix</i> cf. <i>caprea</i>	infrequent
<i>Salix</i> cf. <i>cinerea</i>	infrequent
<i>Sorbus aria</i>	rare
<i>Tilia</i> sp.	rare

Late Pleistocene: Kikinda, Serbia (Fig. 1: 27; Pl. 1, fig. 1). *In situ*, at the site where *Mammuthus trogonotherii* was found. Mummified leaves and tree trunks in coarse-grained sandstone (Marković *et al.* 1997). The collection is kept at the Natural History Museum in Belgrade; Paleobotanical Collection, Coll. No. 14, Inv. Nos. 557–572.

List of taxa in Marković *et al.* (1997), and number of specimens:

<i>Salix</i> cf. <i>triandra</i>	1
<i>Salix</i> cf. <i>fragilis</i>	2
<i>Salix</i> sp.	9
? <i>Salix</i> sp.	1
<i>Dicotylophyllum</i> sp.	1

Pliocene / Pleistocene: Ugljevik, Bosnia and Herzegovina (Fig. 1: 24; Pl. 1, fig. 6). Leaf impressions in yellowish, much decayed sandstone. Note: this collection has not been published to date (see chapter Material and Methods). The collection is kept at the Natural History Museum in Belgrade; Paleobotanical Collection, Coll. No. 140; Inv. Nos. 1339–1348. The collection consists of dozens of fragments, but only few of them can be identified.

List of taxa in Paleobotany Collection, Coll. No. 40:

<i>Alnus</i> cf. <i>incana</i>	
<i>Carpinus</i> cf. <i>betulus</i>	1

<i>Carpinus</i> cf. <i>grandis</i>	1
<i>Juglans</i> sp.	1
<i>Quercus</i> aff. <i>nereifolia</i>	2
<i>Rhamnus</i> sp.	2
<i>Salix varians</i>	1
? <i>Zelkova</i> sp.	1

Pleistocene: Ždrilo and Seline, Croatia. (Fig. 2: 21–22). Leaf impressions in clay sediment (Adžić *et al.* 2013). Note: There is no indication on the amount of collected material. Much more information on this paleoflora can be found in manuscript Adžić (2012).

List of taxa in Adžić *et al.* (2013):

<i>Acer</i> cf. <i>rubrum</i>	<i>Pterocarya</i> sp.
<i>Alnus</i> sp.	<i>Quercus</i> cf. <i>trojana</i>
<i>Buxus</i> sp.	<i>Quercus</i> spp.
<i>Castanea</i> sp.	<i>Taxodium</i> sp.
<i>Fagus</i> sp.	<i>Tilia</i> sp.
<i>Liquidambar</i> cf. <i>europaea</i>	<i>Zelkova</i> cf. <i>carpinifolia</i>

Pliocene / Pleistocene: Lake Blace, Serbia (Fig. 1: 16; Pl. 2, fig. 5). Leaf impressions and compressions in marly sandstones or similar (Černjavski 1932a). Note: The collection is kept at the Natural History Museum in Belgrade; Paleobotanical Collection, Coll. No. 8, Inv. Nos. 174–188.

List of taxa in Černjavski (1932a), and number of specimens:

<i>Betula</i> cf. <i>pubescens</i> vel <i>Alnus viridis</i>	rare
<i>Alnus</i> sp.	rare
<i>Carpinus</i> cf. <i>betulus</i>	rare
<i>Castanea</i> cf. <i>sativa</i>	frequent
? <i>Fagus</i> sp.	rare
<i>Quercus</i> cf. <i>roburoides</i>	1
<i>Salix</i> sp.	2
<i>Ulmus longifolia</i>	very frequent
<i>Ulmus carpinooides</i>	very frequent

Pliocene / Pleistocene: Iline vode near Kragujevac, Serbia (Fig. 1: 19; Pl. 2, fig. 6). Leaf impressions and compressions in marly sandstones (Černjavski 1932b). Note: the collection is kept at the Natural History Museum in Belgrade; Paleobotany Collection, Coll. No. 50, Inv. Nos. 1365–1383.

List of taxa in Černjavski (1932b), and number of specimens:

<i>Alnus</i> cf. <i>incana</i>	3
<i>Carpinus</i> cf. <i>betulus</i>	1
<i>Carpinus</i> cf. <i>orientalis</i>	1

<i>Castanea</i> cf. <i>sativa</i>	
<i>Cinnamomum polymorphum</i>	5
? <i>Fagus</i> cf. <i>pliocenica</i>	2
<i>Fraxinus ornus</i>	few impressions
<i>Incertae sedis Monocotyledonae,</i>	
<i>Cyperaceae et Gramineae</i>	
? <i>Juglans regia</i>	2
? <i>Ostrya carpinifolia</i>	1
<i>Pistacia terebinthus</i>	several
<i>Populus balsamoides</i>	
<i>Populus latior</i>	
? <i>Prunus laurocerasus</i>	1
<i>Rhamnus</i> sp.	many imprints
? <i>Sabal</i> sp.	many imprints
<i>Salix</i> sp.	rare
<i>Ulmus carpinoides</i>	several
<i>Ulmus longifolia</i>	several

Pliocene / Pleistocene: Guvno, Sibnica, Serbia (Fig. 1: 22; Pl. 1, fig. 2). Leaf impressions in yellowish sandy marl (Đorđević Milutinović 2016). Note: The collection is kept at the Natural History Museum in Belgrade; Paleobotanical Collection, Coll. No. 24, Inv. Nos. 467–544.

List of taxa in Đorđević Milutinović (2016), and number of specimens:

? <i>Acer</i> sp.	1
? <i>Alnus cercopiaefolia</i>	1
<i>Alnus</i> cf. <i>ducalis</i>	1
<i>Alnus ducalis</i>	1
<i>Alnus</i> sp.	3
? <i>Alnus</i> sp.	2
<i>Alnus</i> vel <i>Fagus</i>	1
<i>Alnus</i> vel <i>Populus</i>	1
<i>Alnus</i> vel <i>Zelkova</i>	2
<i>Betula</i> sp.	1
Betulaceae vel Ulmaceae	3
<i>Carpinus grandis</i>	6
<i>Carpinus</i> sp.	1
<i>Carpinus</i> sp. fructus	1
Coniferaceae leaves (<i>Taxus</i> , <i>Picea</i> , <i>Abies</i>)	2
? <i>Cornus</i> sp. vel <i>Cotoneaster</i> sp.	2
<i>Corylus</i> sp.	1
<i>Dicotylophyllum</i> cf. Fabaceae	1
<i>Dicotylophyllum</i> deciduous type	22
<i>Dicotylophyllum</i> scleromorphic type	2

<i>Dicotylophyllum</i> sp. <i>camptodromus</i>	3
<i>Fagus</i> ? <i>pliocenica</i>	1
Leguminosae	1
Microphyllum indet. ?Leguminosae ?Ericaceae	4
Microphyllum indet. ? <i>Myrtis</i> , ? <i>Olea</i> ? <i>Ligustrum</i>	1
Microphyllum indet.	1
<i>Microphyllum</i> indet. ? <i>Carpinus</i> , ? <i>Ostrya</i>	1
<i>Monocotyledonae</i> cf. Poaceae	1
<i>Myrica</i> sp vel <i>Quercus</i> aff. <i>neriifolia</i>	1
? <i>Myrica</i> sp.	1
? <i>Ostrya</i> sp.	1
<i>Quercus</i> type <i>roburoides</i> vel <i>Populus</i>	1
Rosaceae ? <i>Crataegus</i> cf <i>monogina</i>	1
Ulmaceae vel <i>Carpinus</i> , <i>Ostrya</i>	1
<i>Ulmus carpinoides</i>	8
<i>Ulmus</i> sp.	3
? <i>Ulmus carpinoides</i>	1
? <i>Ulmus</i> sp.	4
<i>Ulmus</i> vel <i>Carpinus</i>	2
<i>Ulmus</i> vel <i>Prunus</i>	2
<i>Zelkova</i> sp.	1
<i>Zelkova zelkovifolia</i>	3

Late Pliocene: Village Vranjevci near Bitolj, North Macedonia (Fig. 1: 3; Pl. 1, fig. 4). Leaf impressions in greyish clay (Černjavski 1948b). Note: There is no indication on the amount of collected material. The part of this collection is kept at the Natural History Museum in Belgrade; Paleobotanical Collection, Coll. No. 162, Inv. Nos. 1476–1477.

List of taxa in Černjavski (1948b):

<i>Sequoia langsdorfii</i>	<i>Fagus pliocenica</i>
<i>Carpinus grandis</i>	<i>Quercus pseudocastanea</i>

Late Pliocene: Bukovik, near the city of Pehčevo, North Macedonia (Fig. 1: 10). Leaf imprints in dark-red iron ore (Pantić & Pavlovski 1975).

List of taxa in Pantić & Pavlovski (1975), and number of specimens:

<i>Fagus</i> cf. <i>pliocenica</i>	1
<i>Laurus</i> sp.	1
<i>Monocotyledonae</i> gen et sp. indet.	en masse
<i>Quercus pseudocastanea</i>	1
<i>Quercus</i> sp. roburoid type	5

Early Pliocene: Surroundings of villages Lavoš and Brnjača near Peć, Serbia (Fig. 1: 14). Leaf imprints in grey-yellowish marl (Černjavski 1933b).

List of taxa in Černjavski (1933b), and number of specimens:

<i>Buxus sempervirens</i>	1
<i>Fagus sylvatica</i> L. vel <i>F. orientalis</i>	1
<i>Glyptostrobus europaeus</i>	2
<i>Laurus nobilis</i>	2
<i>Pinus</i> sp.	several
<i>Pterocarya castaneafolia</i>	1
<i>Quercus gaudinii</i> aff. <i>Q. ilex</i>	1
<i>Salix</i> sp.	1

Early Pliocene: Lignite coal mine near the railway station in Čortanovci, Sremski Karlovci, Serbia (Fig. 1: 26; Pl. 2, fig. 1). Leaf imprints in sandy marl and one stump or twig fossil, (Černjavski 1933a). Note: Part of this collection is kept at the Natural History Museum in Belgrade; Paleobotanical Collection, Coll. No. 64, Inv. No. 1493.

List of taxa in Černjavski (1933a), and number of specimens:

<i>Glyptostrobus europaeus</i>	en masse
<i>Phragmites</i> sp.	en masse
<i>Typha</i> sp.	en masse

Early Pliocene: Village Živonje (Rožden), North Macedonia (Fig. 1: 12; Pl. 1, fig. 5). Leaf compressions and impressions in clay marl (Laskarev 1950). Note: The collection is kept at the Natural History Museum in Belgrade, Paleobotanical Collection, Coll. No. 93, Inv. No. 1494, 1495. In addition to the taxa cited by Laskarev, this collection also includes *Ostrya*, *Juglans* cf. *acuminata*, *Ulmus* and *Corylus*. There is no indication on the amount of collected material.

List of taxa in Laskarev (1950):

<i>Acer</i> cf. <i>pseudoplatanus</i>	<i>Juglans</i> sp.
<i>Alnus kefersteinii</i>	<i>Pterocarya</i> sp.
<i>Carpinus grandis</i>	<i>Salix</i> cf. <i>varians</i>

Early Pliocene: Village Živojno near Bitolj, North Macedonia (Fig. 1: 1). Leaf imprints in coal sediment (Laskarev 1950). Note: There is no indication on the amount of collected material except *A. pseudoplatanus*.

List of taxa in Laskarev (1950):

<i>Acer pseudoplatanus</i> 70%	<i>Populus</i>
<i>Alnus</i>	<i>Quercus roburoides</i>
? <i>Castanea</i>	<i>Ulmus</i>
<i>Fagus</i>	

Early Pliocene, Dacian: Village Živojno near Bitolj, North Macedonia (Fig. 1: 1). Leaf imprints in coal clay (Pantitch & Nikolitch 1956).

List of taxa in Pantitch & Nikolitch (1956), and number of specimens:

<i>Acer</i> cf. <i>pseudoplatanus</i>	several leaves and one fruit
<i>Alnus kefersteinii</i>	numerous leaves and several fruit
<i>Carpinus grandis</i>	several
<i>Fagus</i> sp.	1
<i>Juglans acuminata</i>	1
<i>Pterocarya denticulata</i>	numerous
<i>Salix varians</i>	1

Early Pliocene: Pulići, North Macedonia (Fig. 1: 6). Leaf compression and impressions in diatom soil (Pantitch 1956).

List of taxa in Pantitch (1956) and number of specimens:

<i>Acer</i> cf. <i>pseudoplatanus</i>	1
<i>Acer</i> sp.	1
<i>Castanea atavia</i>	2
<i>Fagus pliocenica</i>	1
<i>Liquidambar europaeum</i>	3
<i>Poacites aequalis</i>	1
<i>Populus balsamoides</i>	1
<i>Quercus</i> cf. <i>ilex</i>	several
<i>Quercus pseudocastanea</i>	3
<i>Quercus</i> sp.	1

Early Pliocene, Dacian: The Prespa Basin, in springs between the villages of Leskoec and Carina, North Macedonia (Fig. 1: 2). Leaf imprints in marl clay (Pantić *et al.* 1979)

List of taxa in Pantić *et al.* (1979) and number of specimens:

<i>Abies</i> sp. twig	
<i>Acer</i> sp. fructus	1
<i>Betula prisca</i>	1
<i>Carpinus grandis</i>	1
<i>Carya serraefolia</i>	2
<i>Castanea atavia</i>	several
<i>Fagus</i> cf. <i>pliocenica</i>	1
<i>Juglans acuminata</i>	1
<i>Pinus</i> sp. seed and bristles	several
<i>Quercus pseudocastanea</i>	en masse
<i>Quercus</i> cf. <i>drymeja</i>	1
<i>Ulmus carpinoides</i>	1
<i>Ulmus longifolia</i>	2
<i>Zelkova ungeri</i>	1

Early Pliocene, Dacian: The Oslomej mine near Kičevo, North Macedonia (Fig. 1: 7). Leaf imprints in coal clay (Pantitch & Nicolitch 1956).

List of taxa in Pantitch & Nicolitch (1956), and number of specimens:

<i>Alnus kefersteinii</i>	en masse
<i>Alnus</i> sp.	several
<i>Carya</i> sp.	1
<i>Fagus pliocenica</i> aff. <i>F. ferruginea</i>	1
<i>Fagus sylvatica</i> aff. <i>F. pliocenica</i>	1
<i>Pteridium</i> cf. <i>aquilinum</i>	2
<i>Pterocarya</i> cf. <i>denticulata</i>	2
<i>Salix angusta</i>	1
<i>Tsuga</i> cf. <i>canadensis</i>	1

Early Pliocene: Berane, Police, Montenegro (Fig. 1: 15; Pl. 2 fig. 3). Leaf compression and impression in marly sediments (Djordjević Milutinović & Čulafić 2010). Note: The collection is kept at the Natural History Museum in Belgrade; Paleobotanical Collection, Coll. No. 0 B13, Inv. Nos. B13/ 413PO1–527PO111; 1487–1489.

List of taxa in Djordjević Milutinović & Čulafić (2010), and number of specimens:

<i>Acer dasycarpoides</i>	2
<i>Acer palaeosaccharinum</i>	2
<i>Acer</i> sp.	14
<i>Alnus gaudinii</i>	5
<i>Betula</i> sp. Semen	6
<i>Betulaceae</i>	1
<i>Carpinus grandis</i>	2
<i>Fabales</i>	13
<i>Fagus pristina</i>	1
<i>Glyptostrobus europaeus</i>	5
<i>Juglandaceae</i>	7
<i>Lauraceae</i>	2
“ <i>Persea</i> ” sp.	1
“ <i>Phragmites</i> ” <i>oeningensis</i>	3
<i>Poaceae</i>	2
<i>Prunus</i> sp.	1
<i>Pterocarya paradisiaca</i>	8
<i>Rosa bohémica</i>	1
<i>Rosaceae</i>	3
? <i>Rhamnus</i> sp.	1
<i>Salix lavateri</i>	1
<i>Salix varians</i>	1

<i>Sapotacites minor</i>	1
<i>Ulmus carpinoides</i>	3
<i>Ulmus furcinervis</i>	1
<i>Ulmus pyramidalis</i>	1

Early Pliocene: Slavonski Brod, Croatia (Fig. 1: 25). Leaf compression and impression (Engelhardt 1895). Note: Given the fact that this work was published more than 100 years ago (in 1895), the author also consulted contemporary findings from the field to determine the age (Mandić *et al.* 2015). There is no indication on the amount of collected material, at least 2 or 3 specimens by taxon.

List of taxa in Engelhardt (1895):

<i>Acer bruckmanii</i>	<i>Platanus aceroides</i>
<i>Acer sismondiae</i>	<i>Podogonium knorri</i>
<i>Alnus kefersteinii</i>	<i>Populus leucophylla</i>
<i>Berchemia multinervis</i>	<i>Porana ungeri</i>
<i>Betula parvula</i>	<i>Prunus acuminata</i>
<i>Cassia berenices</i>	<i>Pterocarya denticulata</i>
<i>Cassia hyperborean</i>	<i>Pterocarya massalongi</i>
<i>Cassia phaseolites</i>	<i>Quercus crenatifolia</i>
<i>Castanea kubinyi</i>	<i>Quercus deuterogona</i>
<i>Celtis trachytica</i>	<i>Quercus gigas</i>
<i>Cinnamomum scheuchzeri</i>	<i>Rhamnus eridani</i>
<i>Euonymus szantoinus</i>	<i>Rhus meriani</i>
<i>Fagus macrophylla</i>	<i>Robinia rageli</i>
<i>Fagus pyrrhae</i>	<i>Salix macrophylla</i>
<i>Ficus tiliaefolia</i>	<i>Salix varians</i>
<i>Betula</i> sp.	<i>Sapindus haszlinnyi</i>
<i>Juglans acuminata</i>	<i>Sterculia tenuinervis</i>
<i>Juglans bilinica</i>	<i>Taxodium distichum miocenicum</i>
<i>Laurus princeps</i>	<i>Ulmus plurinerva</i>
<i>Liquidambar europaea</i>	<i>Viburnum trilobatum</i>
<i>Oreodaphne heeri</i>	<i>Vitis teutonica</i>
<i>Palaeolobium oeningense</i>	<i>Ziziphus plurinervis</i>
<i>Persoonia laurina</i>	<i>Ziziphus tiliaefolius</i>
<i>Planera ungeri</i>	

? Pliocene or Pontian: Glogovac, Croatia (Fig. 1: 28; Pl. 3, fig. 1). Leaf compressions and impressions in marl (Černjavski 1933a). Note: Although Černjavski states that the layers are of the Late Pontian age, we are also providing the overview of the flora of Glogovac considering that no Mediterranean or subtropical floral elements, or *Taxodium* which is characteristic of the Pontian, were found in it (Černjavski 1948b: 50). Consequently, this flora looks more like being of the Early

Pliocene than of the Pontian age. The collection is kept at the Natural History Museum in Belgrade; Paleobotanical Collection, Coll. No. 99.

List of taxa in Černjavski (1933a), and number of specimens:

? <i>Aesculus</i> sp.	1
? <i>Corylus</i> sp.	3
<i>Alnus</i> cf. <i>cycladum</i>	1
<i>Alnus</i> cf. <i>sporadum</i>	3
<i>Alnus kefersteinii</i>	en masse
<i>Byttneria aequalifolia</i>	1
<i>Glyptostrobus europaeus</i>	en masse
<i>Juglans acuminata</i>	1
<i>Pteris</i> sp.	1
<i>Pterocarya castaneafolia</i>	1

Pliocene or Pontian: Katlanovo, North Macedonia (Fig. 1: 8; Pl. 2, fig. 2). Leaf compressions and impressions in red iron and mica sandstone (Milaković 1955). Note: Although B. Milaković was not certain whether this flora was from the Lower-Miocene or the Pontian, the author included it in the list of Pliocene flora because Milaković did not mention any subtropical or Mediterranean floral elements. The collection is kept at the Natural History Museum in Belgrade; Paleobotany Collection, Coll. No. 83.

List of taxa in Milaković (1955), and number of specimens:

? <i>Andromeda protogea</i>	1
? <i>Acer trilobatum</i>	1
<i>Carpinus grandis</i>	in large numbers
<i>Platanus aceroides</i>	3
<i>Populus balsamoides</i>	1
<i>Populus</i> cf. <i>latior</i>	2
<i>Salix</i> sp.	1
<i>Ulmus carpinoides</i>	in large numbers
<i>Ulmus longifolia</i>	2

Early Pliocene or Miocene: Village Radenka, Braničevo, Serbia (Fig. 1: 23). Leaf imprints in greenish marl (Černjavski 1933a). Note: Considering that *Acer* and *Myrica* are most similar to Miocene and Oligocene morphoforms, Černjavski leaves open the possibility that these layers belong to the Miocene. There is no indication on the amount of collected material.

List of taxa in Černjavski (1933a):

<i>Acer</i> cf. <i>integrilobium</i>	<i>Myrica</i> cf. <i>sagoriana</i>
<i>Acer</i> cf. <i>rubifolium</i>	<i>Myrica</i> cf. <i>banksiaefolia</i>
<i>Glyptostrobus europaeus</i>	<i>Myrica</i> cf. <i>laevigata</i>
<i>Myrica</i> cf. <i>hakeaefolia</i>	

CONCLUSION

Future study of the post-Miocene flora in the area of former Yugoslavia could provide very interesting and valuable data, especially in the area of the Holocene and Pleistocene paleoflora since, as can be noted from the above, it seems that the entire region, especially North Macedonia and Serbia, is abundant in post-Miocene fossil plants. These floras were researched only incidentally and rarely, and little is known about them; however, within a multidisciplinary and comprehensive project they might be able to tell us a great deal about the climate changes that took place during the Pliocene, Pleistocene and beyond. The ultimate benefit of exploring these macrofloras is the fact that they can be easily compared to recent species and phytocenoses and that errors in habitat and ecosystem reconstruction, unlike the reconstruction of Miocene or older flora, would therefore be minimal. The Late Pliocene and Pleistocene floras are also an excellent source of information on the appearance and changes to the ecosystems in which the original *Homo* spp. lived and migrated, which is a topic that has become increasingly relevant in recent years.

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ПРЕГЛЕД ПОСТ-МИОЦЕНСКИХ МАКРОФЛОРА СРБИЈЕ И ДРУГИХ ЗЕМАЉА БИВШЕ ЈУГОСЛАВИЈЕ

ДЕСА ЂОРЂЕВИЋ МИЛУТИНОВИЋ

Р Е З И М Е

Постмиоценске, односно плиоценске, плеистоценске и субрецен-тне палеофлоре у Србији као и у другим земљама бивше Југославије никада нису систематски истраживане. И мада ове палеофлоре нису малобројне, сакупљене са најмање тридесетак локалитета (највише из

Србије и Северне Македоније), оне су познате само у локалним оквирима и то из неколико разлога: а) резултати о њима публиковани су давно, пре 50 и више година; б) након првих истраживања више нису помињане; в) већина радова је објављена на локалним језицима и у локалним часописима. Готово ни један од овде поменутих старијих радова није лако доступан нити разумљив палеоботаничарима ван региона бивше Југославије. Из тих разлога родила се идеја да се подаци о постмиоценским палеофлорама сакупе и презентују на једном месту. Највећи број ових палеофлора обрадио је и публиковао Павле Иванович Черњавски, некадашњи кустос Природњачког музеја у Београду. Сходно томе већи број овде поменутих палеофлора се и данас налази у овом музеју.

Прву постмиоценску флору са ових подручја описао је Херман Енгелхардт 1895 – палеофлора Славонског Брода у Хрватској. Највећи број радова публиковали су др Павле Иванович Черњавски, академик др Никола Пантић и др Борко Милаковић у периоду између 1928. и 1979. године. У последњих десетак година објављено је неколико радова о постмиоценским флорама Србије, Хрватске и Црне Горе, и ове флоре су такође приказане у раду.

У радовима П. Черњавског, а посебно Н. Пантића и Б. Милаковића, често се понавља један те исти проблем који се односи на одређивање старости појединих флора. Наиме с обзиром да је у време када су они писали радове понт припадао доњем плиоцену (а не миоцену као што је то данас случај), у старијим радовима се често може наићи на датирање “доњи плиоцен” при чему не можемо бити сигурни да ли се ради о понту или постпонтском периоду. Или другим речима да ли се ради о миоцену или плиоцену. Аутор је у оваквим случајевима направио селекцију палеофлора на следећи начин: приказане су оне доњоплиоценске флоре у којима преовлађују арктотерцијарни флорни елементи, као што су флора Глоговца (Ћерњавски 1933b) или флора Катланова (Milaković 1955). Такође је узето у обзир и мишљење П. Черњавског да се *Taxodium* на подручју Србије и Северне Македоније појављује у понту, али не и касније (Ћерњавски 1948b: 50).

Велика погодност истраживања и уопште увида у заступљеност плеистоценских па и плиоценских макрофлора је чињеница да се оне лако могу поредити и на таксономском и на еколошком нивоу са рецентним врстама и фитоценозама при чему је грешка приликом реконструкције појединих станишта у односу на реконструкције миоценских или старијих флора сведена на минимум. Младе плеистоценске флоре су такође одличан извор информација о екосистемима у

којима су се кретали и у којима су живели различити предствници рода *Homo* чији су миграторни путеви водили од Азије ка Европи. С обзиром да су оваква истраживања тренутно актуелна, сматрамо да би приказ постмиоценских палеофора са наведених подручја представљао значајан допринос између осталог и овој теми.

Plate I

1. *Salix* sp. Kikinda, inv.no. 560
2. *Ulmus carpinoides*, Sibnica, inv.no. 510
3. ? *Tilia* sp., Matka, coll.no. 95, 96, 97
4. *Carpinus grandis*, Vranjevci, inv.no. 1477
5. ? *Alnus* sp., Živonje, inv.no. 1494
6. *Carpinus* cf. *grandis* and *Quercus* aff. *nereifolia*, Ugljevik, inv. no. 1345, 1346.

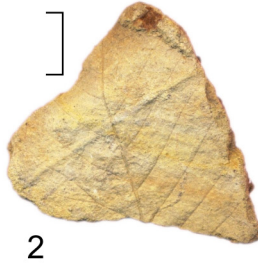
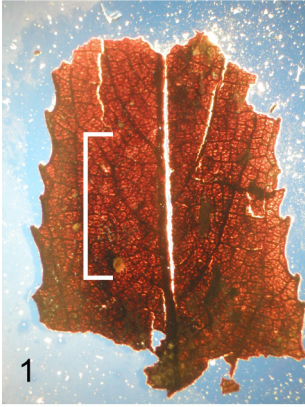


Plate 2

1. ? *Glyptostrobus europaeus*, Čortanovci, inv. no. 1493
2. *Carpinus grandis*, Katlanovo, inv. no. 1491
3. *Carpinus grandis*, Berane, inv. no. 1487
4. ?*Corylus avellana*, Zgornje Jezersko, coll. no. 5
5. *Ulmus carpinoides*, Blace, inv. no. 188
6. *Ulmus carpinoides*, Iline vode, inv. no. 1379



Plate 3

1. *Glyptostrobus europaeus*, Glogovac, inv. no. 1485
2. *Quercus pseudocastanea*, Erenika river, inv. no. 228

