

Specimens from the palaeobotanical collection of National Institution Museum of Natural History of Republic of North Macedonia, Skopje

Vladimir Bozukov¹, Biljana Karamachoska² and Biljana Garevska²

¹Department of Plant and Fungal Diversity and Resources, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Acad. G. Bonchev Str., Bl. 23, Sofia 1113, Bulgaria.

E-mail: vladimir_bozukov@yahoo.com

²National Institution Museum of Natural History of Republic of North Macedonia, Blvd. Ilinden 86, Skopje

E-mail: b.karamachoska@musmacscinat.mk; b.garevska@musmacscinat.mk

Abstract

The palaeobotanical collection of the NI Museum of Natural History of RN Macedonia in Skopje is presented. It contains 159 specimens, representing mainly leaf imprints of angiosperms and leafy twigs of gymnosperms. The taxa found in the collection are 60. The fossil material was collected by Spasa Stojanovič from four localities in RN Macedonia. According to previous information, the age of the deposits, that of Sudik is late Eocene, and of the other three - Oslomej, Suvodol and Vitolište is late Neogene. The difference in the taxonomic and quantitative composition of the Palaeogene flora and those of the late Neogene flora shows the evolution of the flora and vegetation during the Neogene on the territory of RN Macedonia.

Key words: Eocene, Miocene, Oslomej, palaeobotanical collection, Pliocene, Sudik, Suvodol, Vitolište

INTRODUCTION

The fossil materials from previous studies of the macro palaeoflora of RN Macedonia (Table 1) are in most cases unknown whether and where they are stored.

Table 1. An alphabetical list of authors, palaeomacroflora locality in RN Macedonia and their age after the authors.

Author	Locality	Age after the source
Dumurdzanov et al., 1981	Vitolište	Late Pliocene
Kitanov, 1993	Lukovo	Pliocene
Kitanov, 1996	Zhivoyno	Pliocene
Mihajlovich & Lazarevich, 2004	Suvodol	Late Neogene
Mihajlovich & Ljubotenski, 1994	Nemanjica, Bekirli, Šeoba, Krivi Dol, Ramadanica, Sudik	Late Eocene
Milakovich, 1955	Krivi Dol	Paleogene
Milovanovich, 1968	Kočani area	Paleogene
Milovanovich & Mihajlovich, 1988	Sokolarci, Spachevo	Oligocene
Pantich, 1954	Nemanjica, Bekirli, Šeoba, Ramadanica	Eocene
Pantich, 1956	Pulich	Late Pliocene
Pantich & Nikolich, 1956	Oslomej, Zhivoyno	Pliocene
Stojanova et al., 2017	Nerezi Formation (Mariovo Basin)	Late Miocene

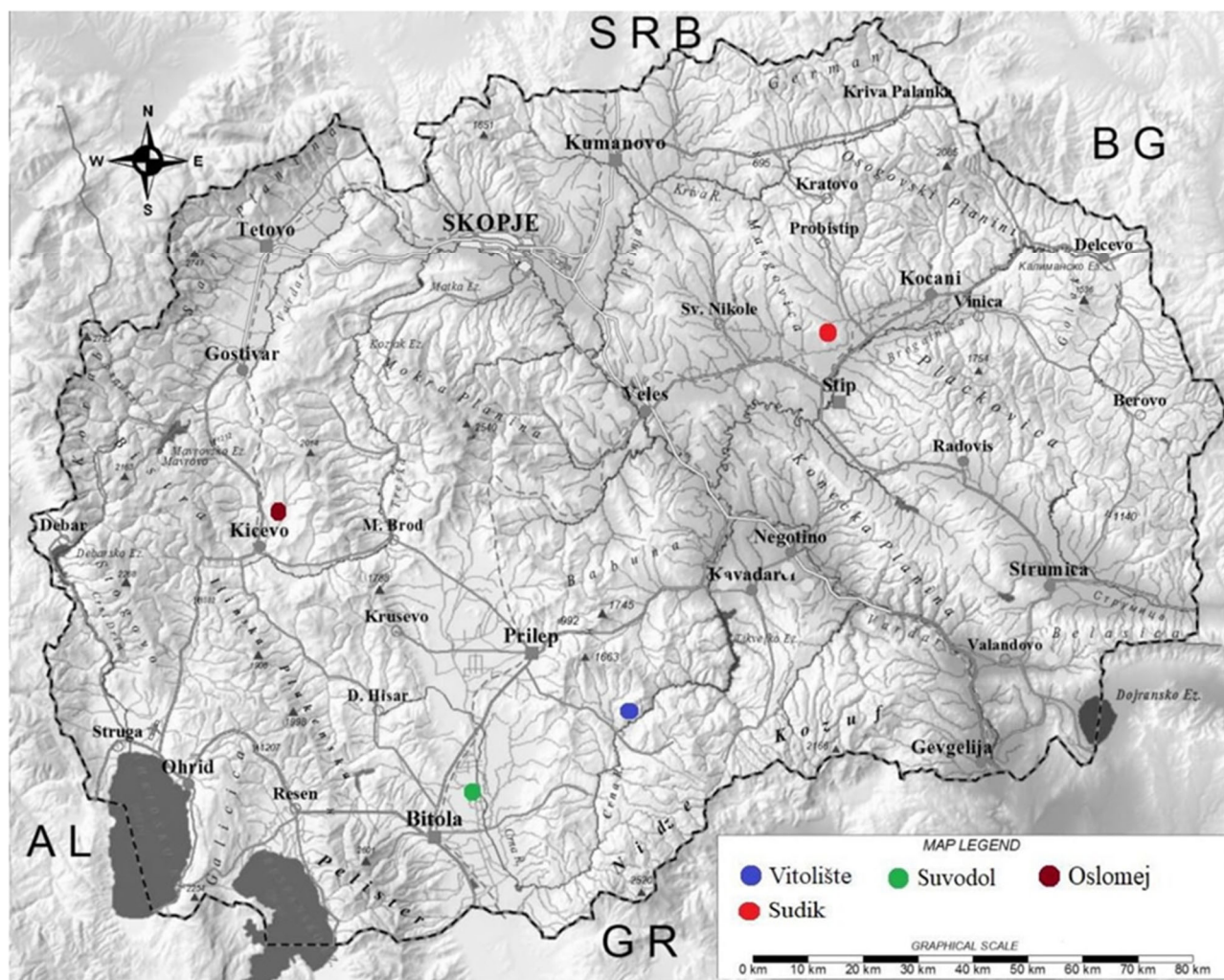


Figure 1. A map showing studied palaeoflora localities.

Materials determined by Kitanov (1993, 1996) from the Lukovo and Zhivoyno localities are stored in the palaeobotanical collection of Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences.

The creation of a palaeobotanical collection in the fund of Museum of Natural History in Skopje (MNH Skopje) is a new stage in the development of the research of the fossil flora of RN Macedonia. The basis of this palaeobotanical collection was fossil material collected in the period 1984-1989 by Spasa Stoyanovich from the localities Sudik (Štip area), Oslomej (Kičevo area), Suvodol (Bitola area), Vitolište (Mariovo area) (Fig. 1). For the palaeofloras of Sudik (late Eocene) and Oslomej (Pliocene) there are already data published by Mihajlovic and Lubotenski (1994) and Pantich and Nikolich (1956), respectively. Data on fossil flora from Vitolište (late Pliocene) are presented by Dumurdzanov et al., (1981), Mihajlovich & Lazarevich (2004) pub-

lished data on late Neogene flora from the Suvodol coal mine.

Locality **Sudik** is situated about 10 km north of town Štip, and belongs to eastern part of the Vardar zone in the territory of the Republic of North Macedonia (Fig. 2).

The largest space of locality belongs to the Tertiary sediments which include Eocene and Neogene sediments and vulcanite with ignimbrite and andesite, also tuffs and breccias. In several places between Ovče Pole, river Bregalnica, and Slan Dol on Tertiary sediment are found abundant macro, microfauna, and flora which is considered as Upper Eocene – Priabonian geological age (Rakicevich et al., 1976).

The Sudik site belongs to the Ovče Pole Basin, which is a large Paleogene sedimentary mass with NW-SE trend that is superimposed on varied rocks. It is composed of 3.5 km thick succession, which is subdivided into five lithostratigraphical units: basal

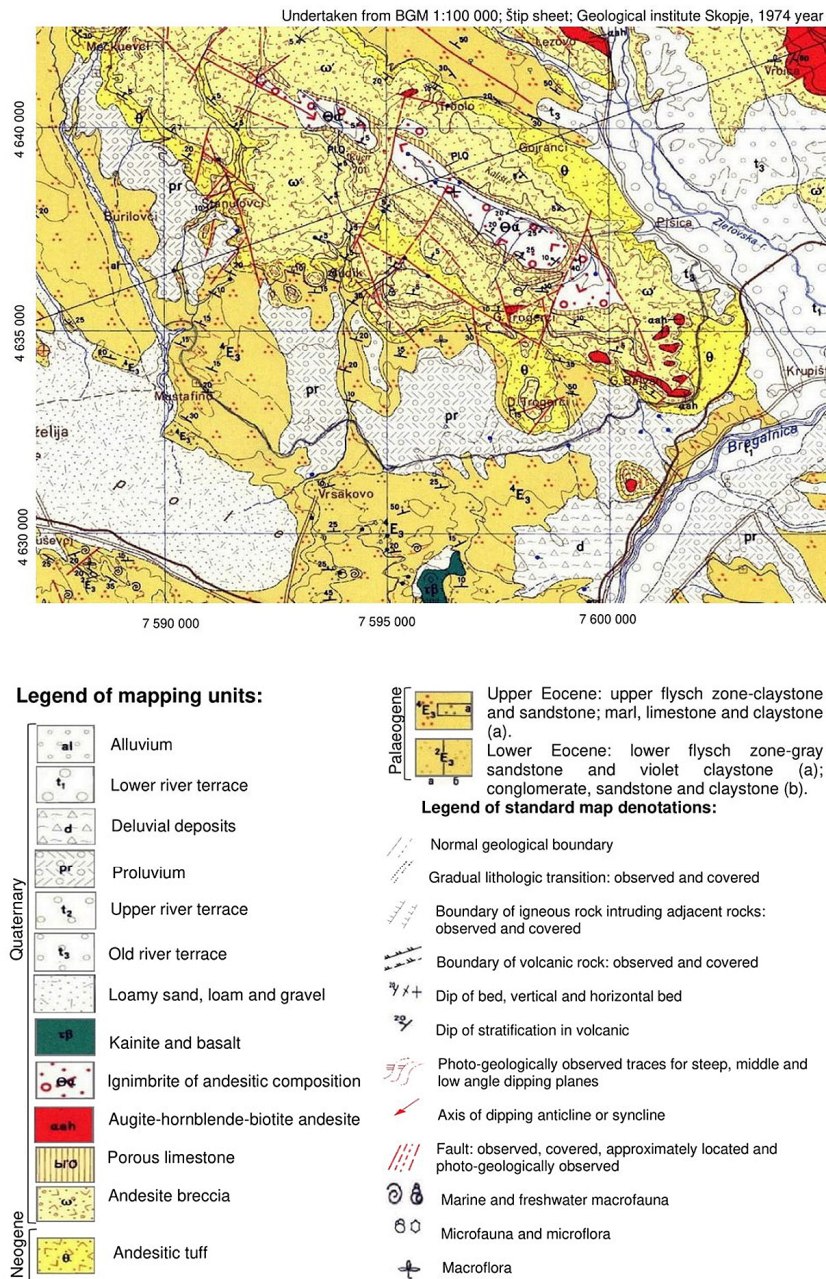


Figure 2. Geological map of the locality Sudik.

unit, lower flysch unit, unit of yellow sandstones, upper flysch unit and carbonate-sandy unit). Lithologic composition of basal lithozone is represented by conglomerates, sandstones, clays and carbonate layers (represented by limestones and marls). The lower flysch lithozone is represented by rhythmic occurrence and prevalence of sandstones over conglomerates and with rare interlayers of clays, marls and siltstones. Lithologic composition of the lithozone of yellow sandstones is represented with sandstones with yellow-brown colour and thin interlayers of clays. Lithologic

composition of the upper flysch lithozone is represented with clay-marly layers that rhythmically alternate with sandstones, siltstones, clays, and carbonate-sandy unit is represented by marly clays and oolitic limestones (Maksimovič et al., 1954; Stojanova et al., 2012). The age of the studied sediments (Late Eocene–Early Oligocene) has been determined by means of macrofossils and microfossils (planctonic and benthic foraminifers).

Neogene is represented with Pliocene andesitic tuffs found through Upper Eocene sediments. Andesitic tuffs are gray-white, yellow, and rosy rocks with a large percentage (about 70%) of shattered grains, decomposed, kaolinization and limonization. The composition and structure of andesitic tuffs show that they have accumulated in an aqueous environment. Pliocene-Quaternary andesitic breccias cover a larger area than tuffs. The andesitic breccias contain tuffs, ignimbrites, andesites, and porous limestones with fossils, which are found in certain Lithological units. This indicates the existence of multiple phases of volcanic activity. According to Rakicevich et al. (1976) in the breccias and between breccias and ignimbrite there are fossils, algae, gastropods, bones of birds, and silicified wood found near the villages of Sudik, Trogerci, Trolo, and Gorni

Balvan. Porous limestones are thick about 10-15 m and represent cessation of volcanic activity. Cyanites and basalts are breakthrough Paleogene sediments and strongly opalized on surrounding sediments. The young Holocene deposits occupy a large area and are represented by old, lower, and upper river terraces, proluvial, alluvial and diluvial deposits which are made of gravel, sand, and clay.

Locality **Oslomej** is placed in Kičevo valley, about 5 km north of the town of Kičevo (Fig. 3). The site is characterized by lithological structure represented

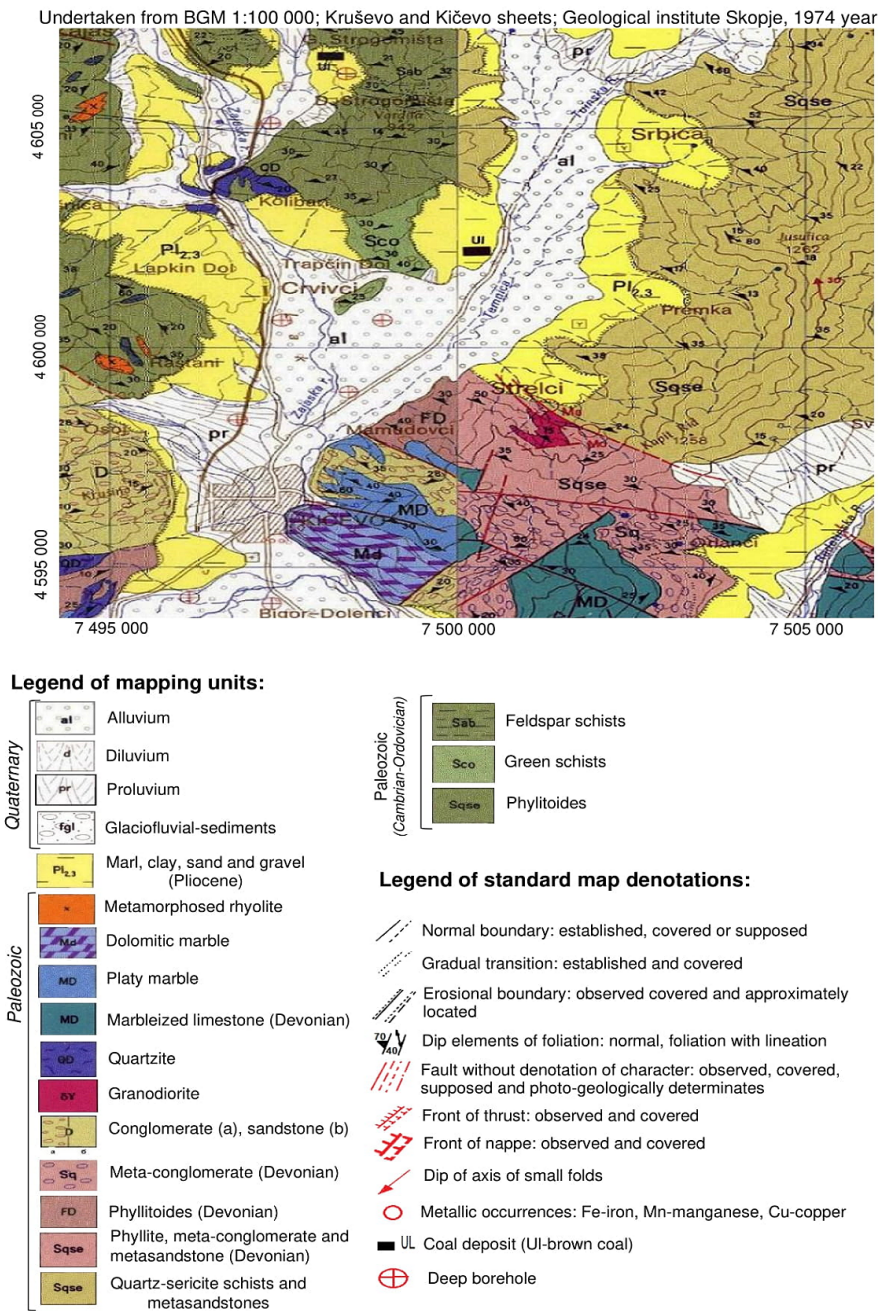


Figure 3. Geological map of the locality Oslomej.

with different rocky types on metamorphic and magmatic rocks of the Paleozoic complex, and Neogene - Quaternary sediments. Pliocene sediments are located on the peripheral parts of the Kičevo valley, and the central part is covered with Quaternary sediments. Paleozoic is presented with Cambrian – Ordovician and Devonian metamorphic and magmatic rocks (phyllitoides, feldspar schists, metasandstones, metaconglomerates, quartz, etc). Pliocene sediments are represented by gravel and sand, which in the upper layers pass in green and gray, and there are brown clay

sands, clays, sands with traces of gravel. According to Petkovski et Ivanovski (1980), Quaternary sediments are formed of alluvial, diluvial, proluvial, and glaciofluvial materials, which are represented by clay, sand, and gravel. Pliocene sediments of transgressively border the Paleozoic schists, and the thickness of the rocks in the Kicevo valley is around 250 m.

There are layers of coal in the Pliocene sedimentary complex. Same coal layers are found downstream of river Temnica. Coal appearance is connected with Pliocene Lake which was spared between the towns of Kičevo and Makedonski Brod, downstream of rivers Treska and Zajaska (Dumurdzanov et al. 1979). According to the investigated fossil flora in coal sediments by Pantich et Nikolich (1956) it was confirmed that the formation of coal in the Kičevo valley is in the Middle Pliocene.

The **Suvodol** site belongs to the Pelagonian basin, and is located about 19 km northeast of the town of Bitola (Fig. 4). The lithological structure is represented with different rocky types of Paleozoic complex, Mesozoic rocks, and Neogene-Quarter sediments. The Paleozoic rocks are presented with phyllite and carbonate series. Phyllite series

breaks younger magmatic rocks (schistose granodiorite, granite, etc.) and is covered with carbonate series in the upper flow of the river Crna (Karajanovich et Ivanovski, 1979). The Mesozoic rocks are presented with conglomerates, diabase, granite, etc. According to the lithological composition Neogene and Quaternary complex is heterogenic, and can be stand out two genetic types alluvial sediments and proluvial coastal sediments. The alluvial sediments are composed of gravel and variegated sand and clay materials. The proluvial coastline sediments are composed of clay-sand materi-

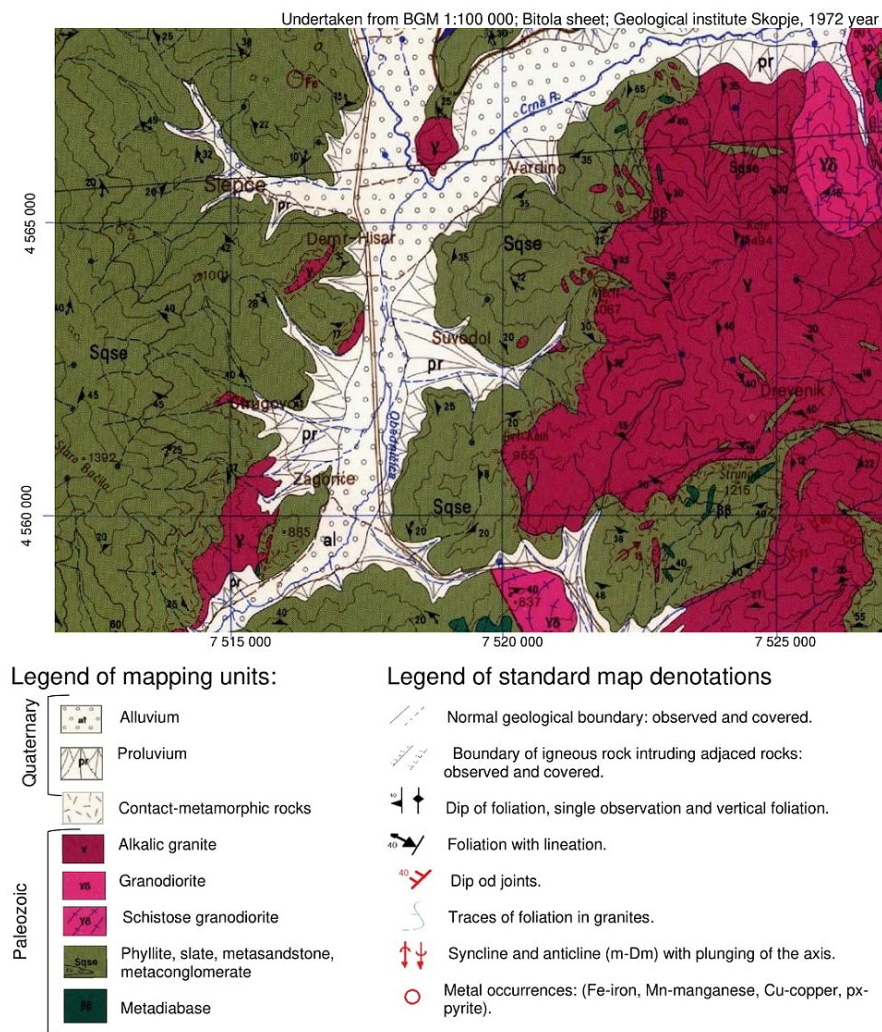


Figure 4. Geological map of the locality Suvodol.

al which thickness is between 5-10 m. The Suvodol site was formed in the so-called Suvodol Bay which enters the slopes of the Selecka mountain. According to Karajovich et Ivanovski (1979), the pitch is built by Quaternary sediments. These sediments lay on Pliocene sediments along with valley river Crna.

The area of the **Vitolište** is located about 46 km SE of the town of Prilep (Fig. 5). Geological composition is diverse, and there are separated complexes of Precambrian, Cambrian, and Paleozoic metamorphic rocks. Also, there are Tertiary and Quaternary sediments and magmatic rocks. The Precambrian metamorphic complex is characterized by gneisses – the mica schists series, where the most dominant are diverse types of gneisses, as well as, marble series composed of dolomite and calcite marbles (Dumurdzanov et al., 1981). The Cambrian sediments lay transgressive over the Precambrian rocks, and are

presented with phyllite-mica schist, carbonaceous schists, and marbles. The Mesozoic complex is composed of Jurassic magmatic rocks, ophiolites presented with gabbro, peridotite, serpentinite, and cretaceous sediments (sandstones, shales, clay shales, conglomerates, etc.).

The Tertiary – Quaternary complex is composed of Pliocene sediments, Pliocene – Pleistocene, and Holocene rocks. After lithostratigraphical studies of the Pliocene sediments in the basin of Mariovo, two units had been determined:

- Lower facies of gravel, sand, and clay with layers of coal,
- Upper facies of gravel, sands, and silty clays material.

According to Dumurdzanov et al. (1981), in the Lower facies in the locality Vitolište are found fossil plants similar to those of Zhivoyno village (*Castanea sativa*, *Taxodium distichum*, *Quercus pseudocastanea*, etc.).

This facies begins with a transgressive material of gravel and siltstone which is covered with layers of sand, sandy clay, siltstone and clay. According to the geological map (Fig. 5) comes to changes of sediments without any rule in a vertical and horizontal row.

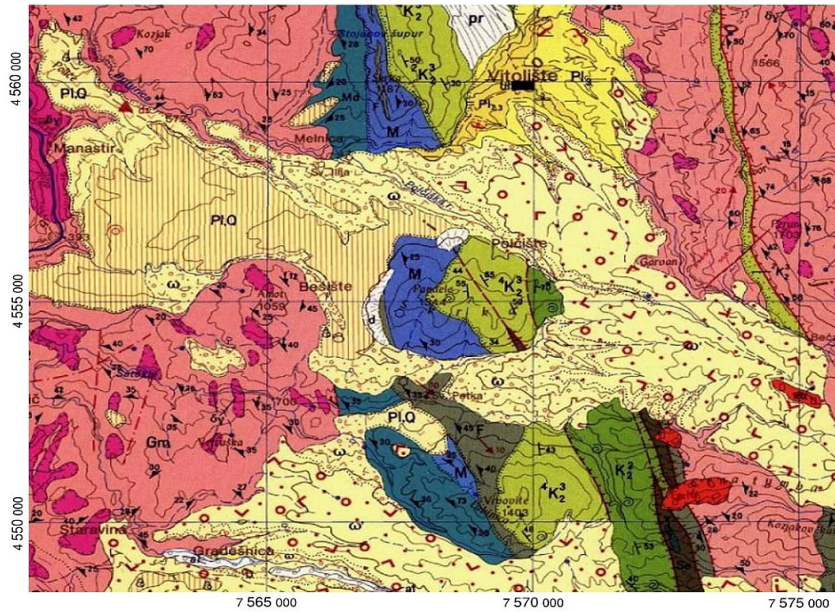
The Upper Pliocene facies is presented by yellow gravel and gravel clay.

At one part of the locality, there is Pliocene – Pleistocene complex, presented by andesites modified by hydrothermal activities, volcanogenic – sediment formation, breccia, quartzlatites, and tuffs. In this complex is found fossil flora with late Pliocene age.

The andesite appearance is connected with volcano activities of Kozuf area and can be found on several sites which penetrate Triassic sediments. The volcanic sediments appear in several places as an extension of sedimentation in Pliocene Lake.

At the beginning of the Upper Pliocene the mountains surrounding Mariovo (Vitolište) has been

Undertaken from BGM 1:100 000; Vitolište sheet; Geological institute Skopje, 1980 year



Legend of mapping units:

<table border="0"> <tr> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">Quaternary</td> <td>al</td> <td>Alluvium</td> </tr> <tr> <td></td> <td>d</td> <td>Diluvium</td> </tr> <tr> <td></td> <td>pr</td> <td>Proluvium</td> </tr> <tr> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">Pliocene-Pleistocene</td> <td>PlQ</td> <td>Travertine</td> </tr> <tr> <td></td> <td>Qz</td> <td>Quartzlatite</td> </tr> <tr> <td></td> <td>Qzbr</td> <td>Quartzlatitic breccia</td> </tr> <tr> <td></td> <td>Qzagg</td> <td>Quartzlatitic agglomerates and tuffs</td> </tr> <tr> <td></td> <td>PlQ</td> <td>Volcanogenic-sedimentary formation</td> </tr> <tr> <td></td> <td>And</td> <td>Andesites</td> </tr> <tr> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">Pliocene</td> <td>Pl₃</td> <td>Gravel, sands and siltyclays</td> </tr> <tr> <td></td> <td>Pl₂₃</td> <td>Gravel, sands and clays with coal</td> </tr> </table>	Quaternary	al	Alluvium		d	Diluvium		pr	Proluvium	Pliocene-Pleistocene	PlQ	Travertine		Qz	Quartzlatite		Qzbr	Quartzlatitic breccia		Qzagg	Quartzlatitic agglomerates and tuffs		PlQ	Volcanogenic-sedimentary formation		And	Andesites	Pliocene	Pl ₃	Gravel, sands and siltyclays		Pl ₂₃	Gravel, sands and clays with coal	<table border="0"> <tr> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">Cretaceous</td> <td>K₁</td> <td>Plate and thickbedded limestones</td> </tr> <tr> <td></td> <td>K₂</td> <td>Sandstones, shales and conglomerates</td> </tr> <tr> <td></td> <td>K₃</td> <td>Sandstones, shales, clay shales and conglomerates</td> </tr> <tr> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">Jurassic</td> <td>G</td> <td>Gabbro</td> </tr> <tr> <td></td> <td>Per</td> <td>Peridotite and serpentinite</td> </tr> <tr> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">Cambrian</td> <td>M</td> <td>Marbles</td> </tr> <tr> <td></td> <td>F</td> <td>Phyllite-mica schist, greenschists and carbonaceous</td> </tr> <tr> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">Precambrian</td> <td>Gm</td> <td>Massive medium to coarse grained granodiorite</td> </tr> <tr> <td></td> <td>M</td> <td>Calcite marbles</td> </tr> <tr> <td></td> <td>Md</td> <td>Grey to greyish dolomitic marbles</td> </tr> <tr> <td></td> <td>Gm</td> <td>Banded muscovite gneisses</td> </tr> <tr> <td></td> <td>Gmb</td> <td>Banded muscovite-biotite gneisses</td> </tr> </table>	Cretaceous	K ₁	Plate and thickbedded limestones		K ₂	Sandstones, shales and conglomerates		K ₃	Sandstones, shales, clay shales and conglomerates	Jurassic	G	Gabbro		Per	Peridotite and serpentinite	Cambrian	M	Marbles		F	Phyllite-mica schist, greenschists and carbonaceous	Precambrian	Gm	Massive medium to coarse grained granodiorite		M	Calcite marbles		Md	Grey to greyish dolomitic marbles		Gm	Banded muscovite gneisses		Gmb	Banded muscovite-biotite gneisses
Quaternary	al	Alluvium																																																																				
	d	Diluvium																																																																				
	pr	Proluvium																																																																				
Pliocene-Pleistocene	PlQ	Travertine																																																																				
	Qz	Quartzlatite																																																																				
	Qzbr	Quartzlatitic breccia																																																																				
	Qzagg	Quartzlatitic agglomerates and tuffs																																																																				
	PlQ	Volcanogenic-sedimentary formation																																																																				
	And	Andesites																																																																				
Pliocene	Pl ₃	Gravel, sands and siltyclays																																																																				
	Pl ₂₃	Gravel, sands and clays with coal																																																																				
Cretaceous	K ₁	Plate and thickbedded limestones																																																																				
	K ₂	Sandstones, shales and conglomerates																																																																				
	K ₃	Sandstones, shales, clay shales and conglomerates																																																																				
Jurassic	G	Gabbro																																																																				
	Per	Peridotite and serpentinite																																																																				
Cambrian	M	Marbles																																																																				
	F	Phyllite-mica schist, greenschists and carbonaceous																																																																				
Precambrian	Gm	Massive medium to coarse grained granodiorite																																																																				
	M	Calcite marbles																																																																				
	Md	Grey to greyish dolomitic marbles																																																																				
	Gm	Banded muscovite gneisses																																																																				
	Gmb	Banded muscovite-biotite gneisses																																																																				

Legend of standard map denotations:

—	Normal boundary: observed and covered	⊕	Microflora; microfauna; marine macrofauna
- - -	Erosional boundary: observed and covered	⊕	Macroflora, freshwater macrofauna
— / —	Gradual lithological transition	■ UL	Deposit of lignite
— / — / —	Magmatic intrusive contact: observed and covered	○	Occurrence of metals (um-minerals of uranium, Fe-iron, Ni-nickel, Mn-manganese, Cr-chromium, Cu-iron, Ni-nickel, Sb-antimony, As-arsenic, Tl-thallium)
— / — / — / —	Basal contact of effusive vulcanite: observed and covered	●	Deposits of non-metals (cy-cyanite, g-garnet, f-feldspar, q-quartz, m-muscovite, dz-diatomaceous earth, pe-perlite, kl-kaolinite, tk-talc, az-asbestos, b-travertine)
30°	Dip of bed, single measurement	△	Occurrence of non-metals (cy-cyanite, g-garnet, f-feldspar, q-quartz, m-muscovite, dz-diatomaceous earth, pe-perlite, kl-kaolinite, tk-talc, az-asbestos, b-travertine)
30°	Dip of foliation, single measurement	▲	Deposits of non-metals (cy-cyanite, f-feldspar, m-muscovite, dz-diatomaceous earth, pe-perlite)
30°	Foliation with lineation	⊕	Quarry of decorative stone
30°	Dip of axis of small folds	⊕	Larger landslides
— / — / —	Fault without denotation of character: observed, approximately and photo-geologically located		
— / — / — / —	Diapiric contact: observed and covered		
— / — / — / — / —	Overthrust front: observed and covered		

Figure 5. Geological map of the locality Vitolište.

uplifted again and at the future lake bottom coarse terrigenous material was accumulated. Tectonic movements, accompanied by the intensive activity of volcanoes Nidze and Kozuf producing tephra material, filed up to Pliocene Lake by tuff, agglomerate and volcanic breccia. Because of the volcanic activity comes to deposition of volcanic breccia and quartzlatite in the Pliocene Lake. Most probably the last phase of

sedimentation in Pliocene Lake is the deposition of porous limestone. Holocene is present with alluvial and diluvial deposits.

MATERIAL AND METHODS

The palaeobotanical collection of the MNH Skopje consists of 159 fossils with inventory numbers from 4001618 to 4001777. The fossil material from the palaeobotanical collection of the museum is mainly imprints of leaves of angiosperms. A small part of them are leafy twigs of gymnosperms, and there are only three imprints of disseminules, respectively: a cone of the genus *Pinus*, a samara of the genus *Fraxinus* and an acorn of the genus *Quercus*.

The sedimentary rocks that preserved the leaf imprints has a different composition at the individual localities, as mentioned above. These are mainly diatomite and clays.

The fossil material from the Sudik locality was determined by S. Stoyanovich, and the one from the other three sites was determined or revised by V. Bozukov. The determination of leaf types followed the scheme for leaf morphology of the angiosperms plants of Dilcher (1974).

In some cases, when fossil material is determined and where there are not enough morphological features for its exact identification, we have used

the abbreviations "aff." (short for "species affinis") and "cf." (short for "confer", meaning "compare"). The first abbreviation is used when the fossil material is to be compared and it is the closest relative of a recent species. The second abbreviation is used when fossil species are compared. According to Palamarev & Petkova (1987), when the fossil specimens display all leaf morphological features typical of contemporary

species, it is difficult to determine a separate fossil species. This is the reason why the authors add "fossilis" (foss.) following the species name of the recent species. That way, the fossil form of the contemporary species is separated from the recent one (for example, *Castanea sativa* foss.). The current paper applies the same approach.

RESULTS

The botanical identification of the fossil material yielded 60 taxa (Table 2), of which 53 are determined until species level, while five are determined to a genus level and one to a class level.

The most abundant is the material from Suvodol locality - 84 specimens. It includes 15 families and 23 genera. The most common family here is the Fagaceae with four genera. The genera *Quercus*, *Fagus* and *Castanea* dominate the number of imprints over other tree species in this local palaeoflora. The family Lauraceae is represented by three genera, but is very weak in quantitative terms. The families Betulaceae and Taxodiaceae follow with two genera each and a relatively significant presence. Family Myricaceae with two genera dominates quantitatively over other shrubs.

Thirty-one fossils have been preserved from the Vitolište locality. It registered 15 families and 17 genera. The two genera *Quercus* and *Fagus*, which are

members of the family Fagaceae, dominate the number of imprints over other tree species. Family Lauraceae is represented by two genera, but is very weak in quantitative terms. Family Myricaceae with genus *Myrica* dominates quantitatively over other shrubs.

The fossil material from the Oslomej locality represents 24 imprints. Seven families and 10 genera are registered in it. Again, the family Fagaceae dominates among tree species with the genera *Quercus* and *Fagus*. Family Salicaceae is represented by two genera. Family Lauraceae is represented by two genera, but is very weak in quantitative terms.

The poorest in composition and quantity is the Sudik locality - 19 imprints. Seven families and nine genera are registered in it. Family Lauraceae dominates both taxonomically with 2 genera and 3 species and quantitatively. Second in importance is the family Fagaceae with two extinct genera – *Eotrigonobalanus* and *Trigonobalanopsis*. The other families have one fossil of one species. An exception is the family Rhamnaceae, whose species *Ziziphus ziziphoides* is represented by 4 fossils, which testifies to its relatively wider distribution.

DISCUSSION

The difference between the Paleogene (late Eocene) flora from Sudik (Mihajlovic & Lyubotenski 1994) and the late Neogene flora from Oslomej,

Table 2. An alphabetical list of taxa in the collection, their geographical and stratigraphical distribution and specimen inventory number.

Taxon	Eocene	Pliocene		
	Sudik	Oslomej	Suvodol	Vitolište
<i>Alnus</i> aff. <i>glutinosa</i> Gaertn.			4001731	
<i>A. gaudinii</i> (Heer) Knobloch & Kvaček			4001722 4001766 4001767	
<i>Ampelopsis hirschi</i> Bužek, Kvaček & H. Walther			4001733	
<i>Betula subpubescens</i> Goepf.			4001748	
<i>Bumelia</i> aff. <i>lanuginosa</i> (Michx.) Pers.				4001688
<i>Callitriche</i> aff. <i>cophocarpa</i> Sendtn. (Fig. 6)	4001636			
<i>Castanea sativa</i> Mill. foss.			4001698 4001700 4001724 4001727 4001756 4001763 4001777	

<i>Celastrus</i> sp.	4001631			
<i>Cephalotaxus fortunei</i> Hook. foss.			4001706	
<i>Comptonia difformis</i> (Sternb.) Berry			4001741	
<i>Daphnogene bilinica</i> (Unger) Kvaček & Knobloch	4001620 4001622 4001625		4001747	
<i>D. cinnamomea</i> (Rossm.) Knobl.	4001618 4001619 4001621	4001660		
<i>Daphnogene lanceolatum</i> Ung.				4001678
Dicotyledonae gen. set spec. indet.	4001635			
	4001634			
<i>Eotrigonobalanus</i> cf. <i>furcinervis</i> (Rossm.) Walth. et				
<i>Eotrigonobalanus furcinervis</i> (Rossm.) Walth.			4001707	
" <i>Eucalyptus</i> " <i>oceanica</i> Ung. The systematic affinity to genus <i>Eucalyptus</i> is questionable	4001624			4001674
<i>Fagus gussonii</i> Masal.		4001637 4001638 4001642 4001643 4001645 4001646 4001647 4001650	4001703 4001705 4001717 4001719 4001746 4001751 4001770 4001771	4001690 4001665
<i>Ficus congener</i> Pilar				4001680
<i>Fraxinus</i> sp. - samara			4001776	
<i>Glyptostrobus europaeus</i> (Brongn.) Ung.			4001711 4001754 4001760 4001772	4001675
<i>Laurophyllum acutimontanum</i> Mai	4001633			
<i>Laurophyllum</i> sp.	4001629			
<i>Libocedrites salicornioides</i> (Ung.) Endl.				4001676
<i>Lauraceophyllum (Litsea) primigenia</i> (Unger.) Givulescu et Olos			4001710	
<i>Magnolia dsundzaeana</i> (Palb.) Takht.			4001704	
<i>M. mirabilis</i> Kolak.		4001658		4001689
<i>Myrica banksiaefolia</i> Ung.			4001697 4001708 4001713 4001714 4001715 4001718 4001733 4001734	4001684 4001685 4001691 4001692

			4001736 4001737 4001738 4001739 4001740 4001749	
<i>Nyssa ornithobroma</i> Ung.				4001686
<i>Paleolobium heterophyllum</i> Ung. = <i>Sloanea olmediaefolia</i> (Unger) Kvaček et Hably				4001683
<i>Persea braunii</i> Heer		4001657		
<i>Persea pliocenica</i> (Laurent) Kolak.			4001693	4001672
<i>Phragmites</i> sp.				4001661
<i>Pinus</i> aff. <i>halpensis</i> Mill.			4001758	
<i>Populus alba</i> L. foss.			4001696	
<i>P. nigra</i> L. foss.		4001639		
<i>P. populina</i> (Brongn.) Knobloch				4001663
<i>Potamogeton</i> sp.			4001728	
<i>Quercus</i> aff. <i>ilex</i> L. - acorn				4001664
<i>Q. cardanii</i> Mass.		4001648 4001649 4001651	4001695 4001712 4001716 4001721 4001725 4001729 4001730 4001757 4001759 4001768 4001769 4001775	4001666 4001669 4001671 4001681
<i>Q. cf. lukidensis</i> Knobloch et Velitzelos				4001673
<i>Q. kubinyi</i> (Kovats ex Ettingsh.) Czechtz			4001744 4001750 4001752 4001753	
<i>Q. mediterranea</i> Ung.			4001699 4001702 4001723 4001726 4001733 4001764 4001765 4001774	4001662
<i>Q. neriifolia</i> A. Braun			4001733	
<i>Q. pseudocastanea</i> Goepf.			4001755	
<i>Q. sosnowskyi</i> Kolak.				4001667 4001670
<i>Rhododendron ponticum</i> L. foss.			4001709 4001720	
<i>Ruppia pannonica</i> Ung.				4001679

<i>Typha latissima</i> A. Braun		4001656 4001659	4001745 4001773	4001668
<i>Ulmus carpinoides</i> Goepp.		4001654		
<i>Vitis sylvestris</i> C.C. Gmel. foss.		4001644		
<i>Ziziphus ziziphoides</i> (Ung.) Weyland	4001623 4001628 4001630 4001632			4001687



Figure 6. *Callitriche* aff. *cophocarpa* Sendtn. (measuring bar 1 cm).

Suvodol and Vitolište is significant. It is in line with the changes in the European flora in time. These changes are related to the gradual disappearance of paleotropical elements and their replacement by arctotertiary ones. Climate change during the transition from the Paleogene to the Neogene has led to changes in the flora and vegetation of the European continent, to finally reach their modern appearance. Despite the small amount of fossil material from Sudik, it is clear that arctotertiary elements are missing. The composition of this palaeoflora includes exotic genera and their species, whose recent analogues are not found in Europe today or have completely disappeared. Extinct genera from the families Lauraceae

(*Daphnogene*, *Laurophyllum*) and Fagaceae (*Eotrigonobalanus*, *Trigonobalanopsis*) played a dominant role here.

In contrast, the three late Neogene floras are dominated by species close in morphology to modern European ones (Pantich & Nikolich, 1956; Dumurdzanov et al., 1981; Mihajlovich & Lazarevich 2004). The role of the family Lauraceae, for example, is greatly reduced and there are single specimens. The families Fagaceae and Betulaceae are represented by species that are related to the recent ones of genera *Quercus*, *Fagus*, *Castanea*, *Alnus*, *Betula*. But there are still members of the family Taxodiaceae, whose role in the formation of coal deposits is great.

Regarding the age of some of the late Neogene flora considered here, it is necessary to make a refinement that takes into account the changes made in the geochronological scale in recent decades (Popov et al 2004, 2006). In particular, it is a question of the transfer of Pontian from the Pliocene epoch to the Miocene epoch. This means that the palaeoflora of Oslomej should be considered as early Pliocene (Dacian) and not as defined by Pantich and Nikolich (1956) middle Pliocene. Moreover, the same authors compare the palaeoflora from Oslomej and that from Kurilo (Sofia Basin, Bulgaria) (Stoyanoff & Stefanoff, 1929), declaring the first one to be younger. According to the latest data, the flora from Kurilo is late Pontian-early Dacian age (Palamarev et al. 2005), which means that the palaeoflora from Oslomej should be late Miocene (late Pontian) age.

The age of Vitolište palaeoflora is determined by Dumurzhanov et al. (1981) as late Pliocene. The authors compare it with that of Zhivoyno (Kitanov 1996), but the relatively large presence of fossils of the genus *Myrica* and the lack of such from Zhivoyno suggests the possibility that the age is the Miocene-Pliocene boundary (late Pontian-early Dacian). A similar composition of the fossil flora from Vitolište is possessed by the palaeoflora from Garmen, Gotse Delchev Basin (Kitanov 1984a), which was discovered in SW Bulgaria and is dated as late Pontian-early Dacian age (Kitanov 1984b).

The palaeoflora from Suvodol deserves special attention, as the material from it in the collection is the most abundant both in taxonomic and quantitative terms. The flora-bearing sediments from the Suvodol coal mine were studied by palynological analysis (Ivanov 2002) and diatom analysis (Ognianova-Rumenova 2005). The results show that their age is the boundary between the Miocene and Pliocene. Fossil macroflora from this locality was studied by Mihajlovich and Lazarevich (2004).

CONCLUSIONS

One of the main goals of museums is to present scientific facts in a shape convenient for perception by its various visitors. Based on the presence of the palaeobotanical collection, the MNH Skopje can present to the citizens of the capital and its guests an interesting exposition. In this way the visitors will be able to learn about the possibilities for fossilization of plant parts and see traces of plants that existed millions of years ago. With the opportunity to present fossils

from different geological periods - Paleogene and Neogene, it can clearly and easily present the course and trends in the evolution of flora and vegetation on the territory of RN Macedonia. This will certainly expand people's knowledge of the nature that surrounds them.

From a scientific point of view, the palaeobotanical collection of the museum will be a database for palaeobotanical research in RN Macedonia. Information from it should be used to clarify the stratigraphy of the various flora-bearing sediments in the country and neighboring countries.

The increase of the collection, the inclusion of more fossils in it from more localities will contribute to the increase of its scientific significance and will make the exposition of phytofossils more attractive.

ACKNOWLEDGEMENTS

We are very grateful for the collection material supplied for examination by MSc. Spasa Stojanovič (MNH - Skopje), MSc. Olivera Matevska (MNH - Skopje) for managing the palaeobotanical project and Andrijana Petkovska (Geohydroconsulting - Skopje) for the electronic version of geological maps. Many thanks to d-r Violeta Stojanova and d-r Valentin Paraschiv for review and for helpful comments on manuscript.

REFERENCES

- Dilcher, D. 1974. Approaches to the identification of Angiosperm leaf remains, *Bot. Rev.*, 40(1): 1-157.
- Dumurdzanov, N., Stojanov, R. and Pertovski, K. 1979. Geology of the sheet Kruševo, K 34-91, Geology survey of Belgrade, SFRY: 6-50.
- Dumurdzanov, N., Hristov, S., Pavlovski, B. and Ivanova, V. 1981. Geology of sheets Vitolište and Kajmakčalan, K 34-104, K34-116, Geology survey of Belgrade, SFRY, : 5-55.
- Ivanov, D. 2002. Late Neogene flora and vegetation from the Bitola Basin (F.Y.R. of Macedonia) based on palynological data, *Acta Univ. Carol. – Geol.*, 46 (4): 65-74.
- Karajanovich, T. and Ivanovski, T. 1979. Geology of the sheets Bitola and Lerin, K 34-103 and K 34-115, Geology survey of Belgrade, SFRY: 5-55.
- Kitanov, G. 1993. Paleofloristic data about the Pliocene flora of Debur region (SR of Macedonia). I. Fossil flora from the village of Loukovo – Debur region, *Fitologija*, 44: 61-70.

- Kitanov, G. 1996. Paleofloristic data about the Pliocene flora of the Republic of Macedonia. II. The fossil flora of the village of Zhivoino – Bitola region, *Fitologija*, 48: 60-67.
- Maksimovič, B., B. Sikošek, O. Marković, M. Veselinović. 1954. Geološki sastav i tektonska struktura jednog dela Ovčeg Polja i Tikveša sa paleontološkom dokumentacijom. – Trudovi na Geološki zavod na NRM, 4, Skopje, 1–177 (in Macedonian).
- Mihajlovic, D. and Lazarevic, Z. 2004. Fossil flora from the late Neogene of the Bitola area, Macedonia: Beograd, Bulletin CXXV, Serbian Academie Science, Classe Science Mathematics et Nature Science, no. 42.
- Mihajlovich, D. and Ljubotenski, T. 1994. Upper Eocene flora of Ovče Polje, Macedonia, *Geol. Carp.*, 45(4): 203-210.
- Milakovich, B. 1955. Paleogene fossil flora of Krivi Do village, northwestern of Štipa. *An. Geol. Penins. Balk.*, 23: 107-112.
- Милованович, Л. 1968. Извештај о резултатима одредбе макро флоре из околине Кочана. - Фонд стручних докумената Геоинститута - Београд.
- Milovanovich, L. and Mihajlovich, D. 1988. Paleogene flora from Kočane area, *An. Geol. Penins. Balk.*, 52: 333-340 (in Serbian).
- Ognianova-Rumenova, N. 2005. Upper Neogene siliceous microfossil from Pelagonia Basin (Balkan Peninsula), *Geol. Carpath.*, 56(4): 347-358.
- Palamarev, E., Bozukov, V., Uzunova, K., Petkova, A. & Kitanov, G. 2005. Catalogue of the Cenozoic plants of Bulgaria (Eocene to Pliocene), *Phytol. Balcan.*, 11 (3): 215-364.
- Palamarev, E. & Petkova, A. 1987. La macroflore du Sarmatien. – In: Tzankov, V. (ed.), *Les fossiles de Bulgarie*, 8(1), pp. 3-275. *Bulg. Acad. Sci., Sofia* (in Bulgarian with French abstract).
- Pantich, N. 1954. Fossil flora of Ovče Polje and Tikveš, *Bull. Inst. Geol. Rep. Macedonienne*, 4: 165-170 (in Serbian).
- Pantich, N. 1956. Note sur les restes fossiles végétales de Pulić (Macédoine), *Bull. Inst. Geol. Rep. Macedonienne*, 5: 233-244.
- Pantich, N., and Nicolich, V. 1956. Supplément à la connaissance de la flore pliocène de Macédoine, *Bull. Inst. Geol. Rep. Macedonienne*, 5: 90-109.
- Petkovski, P., and Ivanovski, T. 1980. Geology of the sheet Kičevo, K 34-90, Geology survey of Belgrade, SFRY: 5-57.
- Popov, S.V., Rögl, F., Rozanov, A.Y., Steininger, F.F., Shcherba, I.G., Kovac, M.E., (2004) Lithological-Palaeogeographic maps of Paratethys. 10 Maps Late Eocene to Pliocene, *Cour. Forsch.-Inst. Senckenberg*, 250: 1-46.
- Popov, S.V., Shcherba, I.G., Ilyina, L.B., Nevesskaya, L.A., Paramonova, N.P., Khondkarian, S.O., Magyar, I., (2006) Late Miocene to Pliocene palaeogeography of the Paratethys and its relation to the Mediterranean, *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 238(1-4), 91-106.
- Rakikevich, T., Dumurdzanov, N. and Petkovski, P. 1976. Geology of the Štip sheet, K 34-81, Geology survey of Belgrade, SFRY: 5-59.
- Stojanova, V., G. Petrov, V. Stefanova. 2012. Biostratigraphy of the Ovče Pole Paleogene basin, R. Makedonija. *Geologica Macedonica*, 26, 2, 53–63.
- Stojanova, V., Petrov, G., and Stefanova, V. 2017. Macroflora from of the Mariovo coal deposits, Republic of Macedonia. National Conference with international participation Geosciences, 7-8 Dec 2017, Sofia, Bulgaria, :97.
- Stoyanoff, N., Stefanoff, B. 1929. Beitrag zur Kenntnis der Pliozänflora der Ebene von Sofia, *Rev. Bulg. Geol. Soc.*, 1(3): 4-120.