UDC 55 CODEN - GEOME 2 In print: ISSN 0352–1206
On line: ISSN 1857–8586

Geologica Macedonica

Journal of the Geological Institute at the Faculty of Natural and Technical Sciences, University "Goce Delčev"-Štip, R. Macedonia

Galena - Zletovo

Geologica Macedonica	Vol. 37	No 1	pp. 1–94	Štip 2023
Geologica Macedonica	Год.	Број	стр.	Штип

UDC 55
CODEN – GEOME 2

In print: ISSN 0352–1206
On line: ISSN 1857–8586

GEOLOGICA MACEDONICA

Geologica Macedonica	Vol. **37**	No 1	pp. 1–94	Štip 2023
Geologica Macedonica	Год.	Број	стр.	Штип

Geologica Macedonica	Vol. 37	No 1	pp. 1–94	Štip 2023
Geologica Macedonica	Год.	Број	стр.	Штип

GEOLOGICA MACEDONICA

Published by: Издава:
"Goce Delčev" University in Štip, Faculty of Natural and Technical Sciences, Štip, North Macedonia
Универзитет „Гоце Делчев“ во Штип, Факултет за природни и технички науки, Штип, Северна Македонија

Technical editor — Технички уредник
Blagoja Bogatinoski — **Благоја Богатиноски**

Proof-reader — Коректор
Alena Georgievska — **Алена Георгиевска**

Address — Адреса
GEOLOGICA MACEDONICA EDITORIAL BOARD — **GEOLOGICA MACEDONICA РЕДАКЦИЈА**
Faculty of Natural and Technical Sciences — Факултет за природни и технички науки
P. O. Box 96 — пошт. фах 96
MK-2000 Štip, North Macedonia — МК-2000 Штип, Северна Македонија
Tel. ++ 389 032 550 575 — Тел. 032 550 575
E-mail: todor.serafimovski@ugd.edu.mk

400 copies — Тираж: 400
Published twice yearly — Излегува два пати годишно

Printed by: — Печати:
2[ri] Avgust – Štip — 2[ри] Август – Штип

Price: 10 € — Цена: 600 ден.

This issue is published in June 2023 — Бројот е отпечатен во јуни 2023

Geologica Macedonica	Vol. 37	No 1	pp. 1–94	Štip 2023
Geologica Macedonica	Год.	Број	стр.	Штип

TABLE OF CONTENTS

Geologica Macedonica / *Geologica Macedonica*	Vol. / Год. **37**	No / Број 1	pp, / стр. 1–94	Štip / Штип 2023

СОДРЖИНА

397
GEOME 2
Manuscript received: March 10, 2023
Accepted: May 12, 2023

Geologica Macedonica, Vol. **37**, No. 1, pp. 75–83 (2023)
On print ISSN 0352 – 1206
On line ISSN 1857 – 8586
UDC: 551.781.3:561(497.714)
https://doi.org/10.46763/GEOL23371075gj

Original scientific paper

FOSSIL FLORA FROM PALEOGENE SEDIMENTS OF THE SERTA LOCALITY IN THE TIKVEŠ BASIN, REPUBLIC OF NORTH MACEDONIA

Lazar Ǵorgiev, Violeta Stojanova, Goše Petrov, Violeta Stefanova

*Faculty of Natural and Technical Sciences, "Goce Delčev" University in Štip,
Blvd. "Goce Delčev" 89, P.O. Box 201, 2000 Štip, North Macedonia*
violeta.stojanova@ugd.edu.mk

A b s t r a c t: The Tikveš Paleogene basin is located in the central part of the territory of Macedonia and belongs to the central part of the Vardar zone. The flora collected in the sandstone-clay sediments from the lower flysch lithozone from the Serta locality (Tikveš basin) has been recorded and described for the first time in Macedonia. One species from the fossil flora has been identified as *Equisetum parlatorii*. These new findings provide information on the past and present distribution and history of *Equisetum* and exemplify the importance of biogeographic and evolutionary processes in the geological past. As one of the reasons for the reduction in the size of today's *Equisetum* from the recent vegetation, the significant climatic changes that were the result of the Himalayan orogeny during the Late Miocene are assumed.

Key words: fossil macroflora; *Equisetum parlatorii*; Paleogene sediments; Tikveš basin

INTRODUCTION

The Paleogene is one of the most intriguing intervals in the Earth history, marked by significant in paleodynamic, palaeoclimate and in marine productivity. On the territory of Macedonia sediments of Paleogene age are widespread and show certain lithofaces diversity as a result of different conditions of sedimentation in sedimentation basins. A general characteristic of Paleogene sediments is that they all lie transgressively through all older formations from Precambrian to Mesozoic that along the edges of the basins are represented by conglomerates and sandstones, while in the internal parts there are fine-grained sediments, marls and clays. Paleogene sediments of the Tikveš basin are rich in fossil and have been studied by several authors. The first data for Late Eocene (Priabonian) age, based on gastropods, bivalves, corals and nummulitids from the Tikveš basin, gave Maksimovič et al. (1954). Later Stojanova (Stojanova, 2008; Stojanova et al., 2011, 2013; Stojanova, Petrov, 2012) also confirmed the Upper Eocene-Oligocene range of these sediments. The found association of benthic foraminifers and nannofossils in the upper flysch lithozone of Tikveš Paleogene basin gives an opportunity to identify a biostratigraphic subzone – Bolivina which belongs to the zone Planulina costata (Bugrova, 1988) and nanofossil zone NP19 – NP 21 (section Krivolak). The fossil flora found in the lower flysch lithozone has been reviewed and determined.

LITHOSTRATIGRAPHY OF PALEOGENE IN THE TIKVEŠ BASIN

The Tikveš basin is located in the central part of the territory of Macedonia and belongs to the central part of the Vardar zone (Figure 1).

Paleogene sediments developed in the Tikveš basin, extending in the direction of NW-SE, occupy more than 20% of the area and have a great thickness that reaches 3000–3500 m. Most of these are found in edge parts of the Tikveš basin while the central parts of the basin are covered by Neogene and Quaternary sediments. Paleogene in the Tikveš basin is developed in flyschoid and flysch facies. Depending on the lithological composition of flysch in Paleogene sediments there are four lithostratigraphic units: basal lithozone, lower flysch lithozone, lithozone of yellow sandstones, and upper flysch lithozone. The basal lithozone of the Tikveš basin is represented by conglomerates, and sandstones which alternately change into clayey soil and sandy marls, and pelitomorphic limestone.

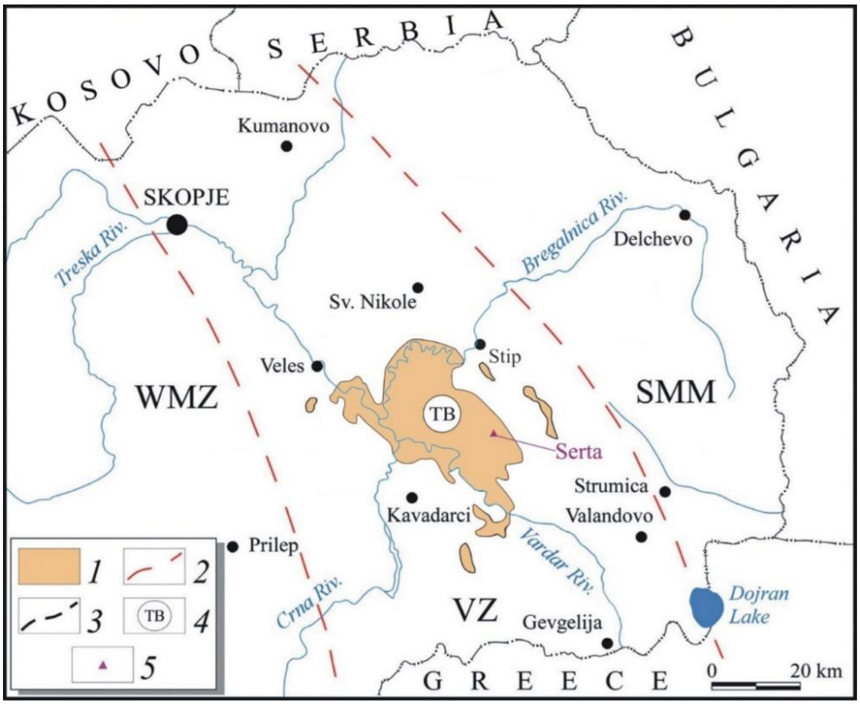

Fig. 1. Distribution of Paleogene sediments in the Tikveš basin, Republic of North Macedonia: 1) Paleogene sediments. 2) Tectonic boundary: SMM – Serbian-Macedonian massif. VZ – Vardar zone. WMZ – western Macedonian zone. 3) Basin boundary. 4) Tikveš basin. 5) Studied section

The lower border of the basal lithozone is transgressive, and the upper border is concordant, and continuously passes into the lower flysch lithozone. The thickness varies from 350 to 700 m.

The lithological composition of the sediments from the lower lithozone of the flysch is different and is represented by several lithological members, which change rhythmically, building certain sequences of two, three or four members: medium-grained sandstone, fine-grained sandstone, marl, clay and limestone. The lowest member of the sequence is usually the coarsest grained and the highest is the finest grained. Sandstones are the most common members of the sequence and occur in beds and banks 20–200 cm thick. Marls and clays are rarer members of the sequence and occur in thin layers 5–30 cm thick. The lower border is concordant and it represents a gradational transition of basal lithozone into lower flysch lithozone. The upper border is concordant and sharp, and it stands out because of the characteristic yellow-brown color of the sandstones covering the lower flysch lithozone. The thickness of the lower flysch lithozone is 300 m. The age of the sediments was previously determined by fossil macrofauna macroforaminifers, macroflora as Upper Eocene (Maksimovič et al., 1954; Temkova, 1958).

The lithological composition of the lithozone of yellow sandstones is represented with yellow sandstones with layers and inner layers of clayey soil and marls. The lower and upper borders of the lithozone of yellow sandstones are continuous and clear, which separates this unit from the lower and upper flysch lithozone. The thickness of this lithozone ranges from 100 to 400 m. The age of the lithozone of yellow sandstones is determined as Priabonian with macroforaminifera, gastropods, bivalvia and anthozoa (Maksimovič et al., 1954; Temkova, 1958). The upper flysch lithozone is isolated as being a separate lithostratigraphic unit because of the rhythmic occurrence and prevalence of clayey soil and sandstones with the presence of thin inner layers of marls, aleurolites and limestones. The lower border of the upper flysch lithozone is continuous, clear, outlined and separated from the yellow sandstones lithozone. The upper border of this lithozone is mostly covered in effusive rocks and younger sediment deposits, parts of which are uncovered and decomposed. The thickness of the upper flysch lithozone ranges from 2000 to 2500 m. Late Eocene (Priabonian) age of the upper flysch lithozone is determined with microforaminifera, macroforaminifera, gastropods, bivalves, anthozoa, and nanofossils, given by Maksimovič et al. (1954), Džuranov et al. {1999); Stojanova (2008); Stojanova et al. (2011, 2013); Stojanova, Petrov, 2012, 2014); Valchev et al. (2013).

SERTA SECTION

The Serta section is located in the northeastern part of the Tikveš basin, 4 km SW of the village of Leskovica (Figure 2), and it comprises about 100 m of the lower flysch unit. It is represented by conglomerates of 1.3 m thick and layers of clays and marls with a thin interlayers of sandstones by 0.15–2.5 m thick (within the lower part), and alternating layers of clays and sandstones (within the upper part).

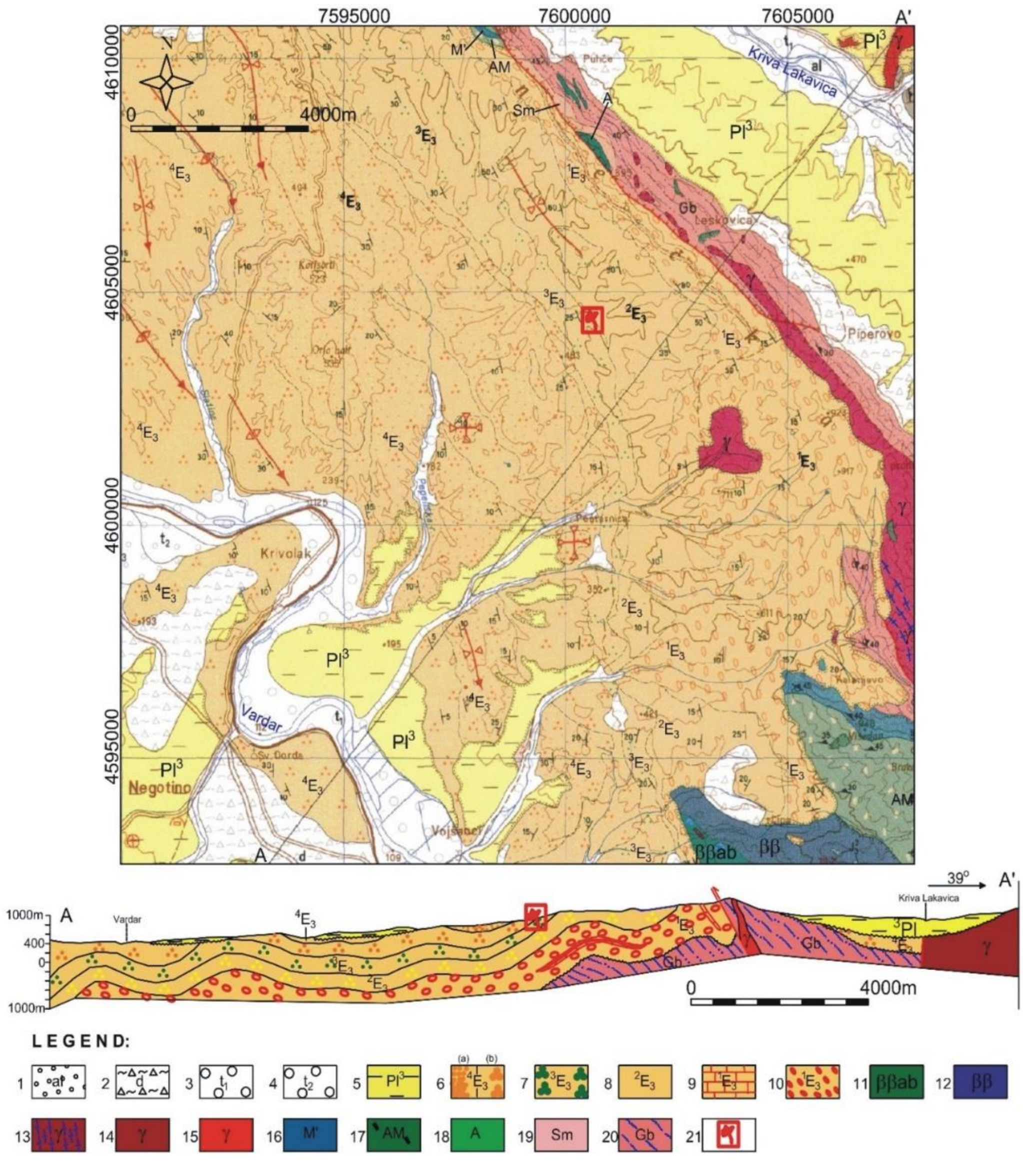

Fig. 2. Geological map and profile of part of the Tikveš basin with location of found macroflora.
Legend: Holocene: 1) Alluvium; 2) Deluvium; 3) Lower river terrace; 4) Middle river terrace. Pliocene: 5) Sandy series.
Upper Eocene: 6a) Yellow sandstones; 6b) Upper flysch lithozone; 7) Lower yellow sandstones; 8) Lower flysch lithozone;
9) Limestones; 10) Conglomerate flysch. Jurassic: 11) Spillite; 12) Diabase; 13) Schistous granite; 14) Medium granied granite;
15) Granite of Štip. Lower Paleozoic: 16) Marble; 17) Series of amphibolite schists with marble. Precambrian: 18) Amphibole schits;
19) Micaschists; 20) Biotite gneiss. 21) Location of macroflora found

A larger number of samples were taken from the Serta section, and the sampling was carried out in gray-green sandy-clay layers and charred organic matter by 0.8 m thick (Figures 3 and 4). The fossil flora found at this site has been reviewed and determined.

The sandstone with fossil remains of macroflora is marked with red lines.

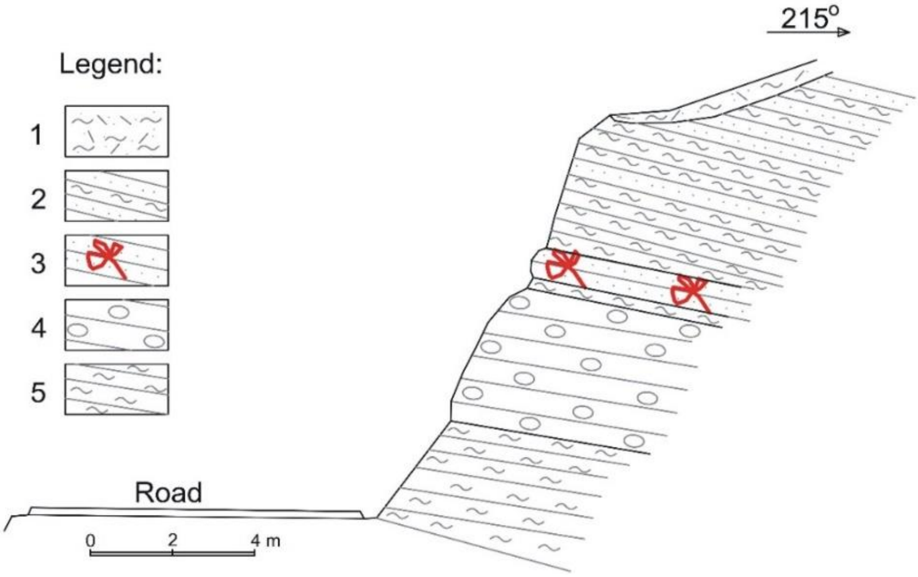

Fig. 3. Geological section of Serta
Legend: 1) Deluvium. 2) The most alternating layers of clays and sandstones. 3) Sandy with fossil remains of macroflora and carbonized organic material. 4) Conglomerates with mostly rounded pieces and a thin layer of clay. 5) Clay with thin layers of sandstone

Fig. 4. Profile photo of the Serta locality

MATERIAL AND METHODS

Macrofloristic research covers the lower flysch lithozone of the Serta locality (Tikveš basin). The fossil flora was found in the sand-clay sediments with a thickness of approximately 80 cm. A large number of samples were collected, where a large number of fragmented (4–15 cm long and 1–3 cm wide) tubular and striated stems (rhizomes) with root tubers were found. The color of the specimens agrees most often with that of the rock (greenish yellow to gray). The fossil remains were studied macroscopically.

The classification based to Flora Europaea (1964) defines Pteridophyta, Sphenopsida, Equisetaceae.

***Systematic paleobotany*.** The paleoflora collection found consists of a large number of impressions and molds of one kind of horsetail with morphological details such as tubular and striated stems (rhizomes) with root tubers.

Division: Pteridophyta Schimper, 1879.

Class: Polypodiopsida Cronquist, Takht. & W. Zimm., 1966.

Order: Equisetales DC. ex Bercht. and J. Presl, 1820.

Family: Equisetaceae Michx. ex de Candolle, 1804.

Genus: *Equisetum parlatorii* (Heer) Schimper 1869 (Plate 1, Figures 1–6) – Heer, 1855 (p. 109, Plate 42, Figure 2 (*Physagenia parlatorii*)); Schimper, 1869 (p. 261); Schimper, 1874 (p. 5, Plate 8, Figures 12–16); Andreánszky, 1959 (p. 44, Plate 7, Figures 1–3).

Plate 1. Plant material. **1–6**: *Equisetum parlatorii* from the Serta section (Tikveš basin)

***Material*:** Lots of samples.

***Description*:** A large number of fragments of stems with nodes, 3–15 cm long and 1 cm wide. The stems are joined at the nodes. Four distinct ribs can be seen on the surface at the stems. They are located along the length of the stem at an equal distance from each other. At the top of one of them, a fourth tuber can be seen, located linearly. Next to the rhizome with the tubers is a short fragment of horsetail stem or rhizome.

***Discussion*:** Heer (1855) described numerous specimens from the Tertiary flora of Switzerland. Andreánszky (1959) published the species from the Sarmatian and Badenian floras of Hungary. There are several specimens in the Miocene flora of Verőce (Hungary; Hably in progress). It occurs in several European Tertiary floras as *Equisetum* sp. (Akhmetiev et al., 2009).

***Note*:** The parallel grooves distinctly seen on the rhizome, the presence of the internode and the characteristically arranged root tubers point at the genus *Equisetum*. The position of the rhizome and tubers in the section suggests their occurrence in situ.

***Stratigraphic occurrence*:** Lower flysch lithozone, Tikveš basin, Upper Eocene.

DISCUSSION

Serta section is entirely composed by pteridophytic elements, where it is dominated *Equisetum*. Such presence and predominance of horsetails makes this association of fossil plants quite interesting as it gives good indications of the previous structure of the community and its environmental conditions.

Horsetails, the unique survivors of a very ancient group of vascular plants, the Sphenophyta, have a history reaching back to the Upper Devonian and may represent the world's oldest fossil genus of living vascular plants (Stewart and Rothwell, 1993). *Equisetum* L. is the only living, free-sporing morphologically distinct genus of sphenophyte (PPGI, 2016).

Equisetum-like fossils, commonly known as Equisetostachys, Equisetites, and Equisetum, have been reported from the Mesozoic and Cenozoic sediments of the Northern Hemisphere by stems fragments, leaf sheaths, rhizomes, or tubers (Brown, 1975; Sun et al., 2013).

Extant species of Equisetum are herbaceous in nature (smallannual herbs) (Zhang et al., 2007; Aung et al., 2020). These plants have unique morphological features, including articulated stems, with longitudinal ridges or furrows, enclosed within leaf sheaths (Taylor and Taylor, 1993).

The good preservation of the material (i.e. the large size of most specimens) suggests that the plants were buried near the growing site with minimum transport, indicating their autochthonous or para-autochthonous origin. Therefore, paleoenvironmental requirements inferred from fossils directly reflect local conditions at the time of deposition. Living horsetails are clonal plants characterized by an extensive underground rhizome from which aerial stems arise. Because of their growth habitextant species horsetails usually grow in wet and sunny places, such as standing water of shallow ponds or ditches, along river and lake margins, marshes, or wet meadows (Hauke, 1990). Fossil plant remains that have been found in the dark gray greenish sandy-clay sediments of this unit in several places in the Tikveš basin (southwestern slopes of Serta, Haji Redzepli, Lipa) are represented by *Libitina* sp. *alpina*, *Sequoia cottsiae Oogonia chara* (Maksimovič et al., 1954), indicate the living conditions of the locality.

Cenozoic fossil history of Equisetum

The Cenozoic Equisetum fossils have been recorded mainly from Asia, North America and Europe, with a few fossil records from Australia, New Zealand and South America (Table 1, Figure 5). Ample fossil evidence indicates that this sphenopsid was widespread during the Cenozoic period. Fossil evidence indicates that the genus Equisetum flourished without hindrance from the Eocene to Pleistocene in North America. Fossil species *Equisetum parlatorii* was reported by Penhallow (1908) from Alberta (Palaeocene) (Table 1).

As one reason for the disappearance of this sphenophyte from today's vegetation, as well as the reduction in the size of today's Equisetum, significant changes in climate due to the orogeny of the Himalayas during the Late Miocene are assumed.

T a b l e 1

Cenozoic (Palaeocene-Eocene) macrofossil records of Equisetum in the World

Age	Fossil species	Locality	Organ	Reference
	E. ezoense	Japan	–	Endo (1968)
	Equisetum sp.	Japan	–	Matsuo, 1967
	Equisetum sp.	Alberta	–	Berry, 1930
Palaeocene-Eocene	*E. magnum*	United States	Rhizome and stem	Hickey (1977)
	E. newberryi	North America	–	Knowlton and Cockerell, 1919
	E. robustum	Washington state	–	Newberry (1898)
	E. oppositum	China	Rhizome tuber	Yang et al. (2016)
Palaeocene	*E. alexoensis*	Canada	Stem	Bell (1949)
	E. arcticum	Norway	–	Heer (1868), 1878
	E. parlatorii	Alberta	–	Penhallow (1908)
	Equisetum sp.	Alberta and Canada	–	Dawson, 1875
	E. boreale	Greenland	–	Heer (1868),1869; Bell (1949)
	E. canaliculatum	United States	–	Knowlton, 1899
	E. deciduum	United States	–	Knowlton, 1899
	E. coloradense	Colorado	–	Knowlton (1919), 1930
	Equisetum sp.	Colorado	–	Knowlton (1919), 1930
	E. costatum	Canada	–	Heer, 1878
	E. fluviatoides	Canada	Vegetative and fertile remains	Mciver and Basinger, 1988
	Equisetum sp.	California	–	Potbury, 1932
	E. haguel	United States	–	Knowlton, 1899

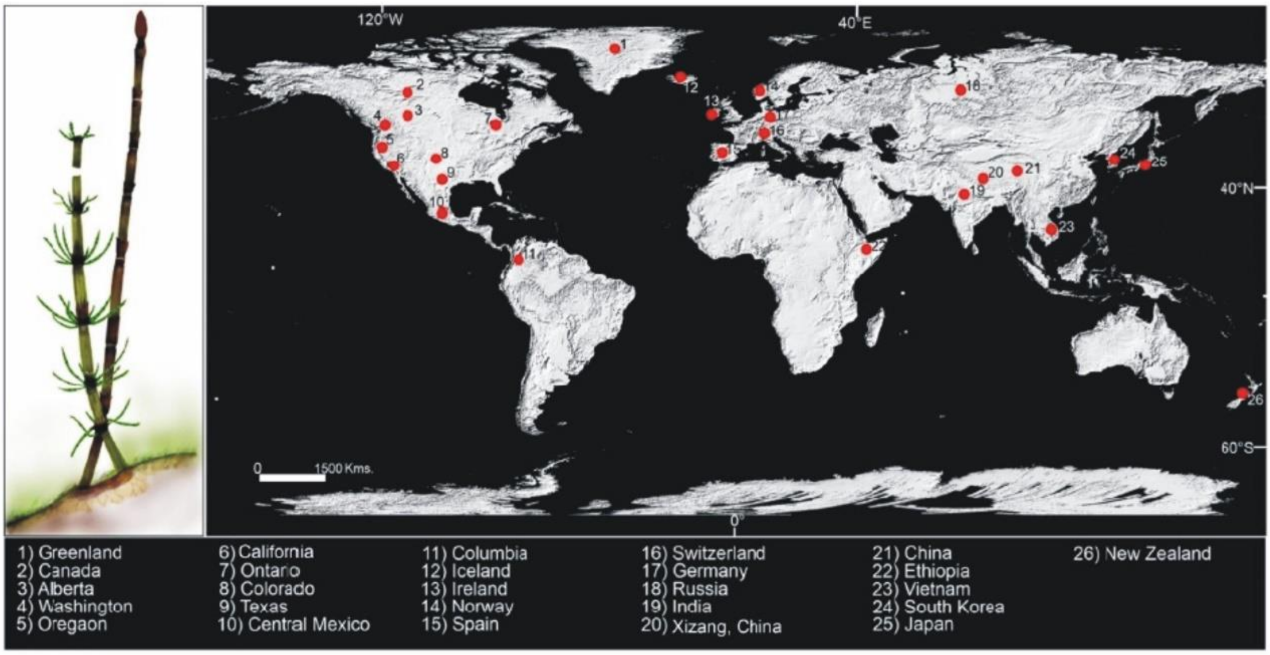

Fig. 5. Cenozoic macrofossil records of *Equisetum* in the World

CONCLUSIONS

The flora collected in the sandstone-clay sediments from the Serta locality (Tikveš basin) has been recorded and described for the first time in Macedonia. The species *Equisetum parlatorii* (Heer) Schimper found represents part of a littoral plant community growing in a wet environment (wetland), shallow or shallow (inner shelf) environment, and that it was composed of a population of tall *Equisetum* sp. plants that occupied the low parts of the lower flysch lithozone. These new findings provide information on the distribution and history of *Equisetum* in the past and present and represent are an example of the importance of biogeographical and evolutionary processes in the past.

In the future, with the possibility of following a palynological analysis of these same sediments, all with the aim of confirming their age.

Acknowledgements: The authors are thankful to Assoc. Prof. dr. Vladimir Bozukov from the Institute of Biodiversity and Ecosystem Research (Bulgarian Academy of Sciences) for the determination of macroflora and valuable suggestions and improving.

REFERENCES

Akhmetiev, M., Walther, H., Kvaček, Z. (2009): Midlatitude Palaeogene floras of Eurasia bound to volcanic settings and palaeoclimatic events – experience obtained from the Far East of Russia (Sikhote-Alin') and Central Europe (Bohemian Massif). *Acta Musei Nationalis Pragae, B: Historia Naturalis* **65** (3–4), 61–129.

Andreánszky, G., (1959): *Die Flora der Sarmatischen Stufe in Ungarn. Akadémiai Kiadó,* Budapest.

Arsovski M., Dumurdžanov N. (1995): Alpine tectonic evolution of the Vardar zone and its place in the Balkan region. *Geologica Macedonica*, **9**, 1, 15–22.

Aung, A.T., Huang, J., Van Do, T., et al. (2020): Three new fossil records of *Equisetum* (Equisetaceae) from the Neogene of south-western China and northern Vietnam. *Phyto Keys* **138**, 3e15.

Brown, J. T. (1975): Equisetum clarnoi, a new species based on petrifactions from the Eocene of Oregon. *Am. J. Bot*. **62**, 410–415.

Bugrova, E. M. (1988): Zonal subdivision of the south USSR on benthic foraminifers. *Acad. Sci. of the USSR*, **300**, 1, 169–171 (in Russian).

Džuranov S., Tuneva V., Dumurdžanov N. (1999): Microforaminifera findings near the village of Čardaklija in the Ovče Pole Paleogene basin, Republic of Macedonia. *Geologica Macedonica*, **13**, 1, 57–68.

Hauke, R. L., (1990): *Equisetaceae.* In: *Pteridophytes and Gymnosperms*. Springer, Berlin, Heidelberg, pp. 46–48.

Heer, O. (1855): *Die tertiäre Flora der Schweitz* **I**, pp. 117, Winterthur.

Heer, O. (1856): *Die tertiäre Flora der Schweitz* **II**, pp. 107, Winterthur.

Heer, O. (1859): *Die tertiäre Flora der Schweitz* **III**, pp. 377, Winterthur.

Hristov, S., Karajovanović, M., Straćkov, M. (1973): *Basic Geological Map of SFRJ*, sheet Kavadarci, 1:100 000 (map & interpreter), Federal Geological Survey, Belgrade, 62 pp.

Iljinskaja, I. A. (1968): *Neogene floras of the Transcarpathian region of the U.S.S.R.* (in Russian). Nauka, Leningrad, pp. 121.

Kovar-Eder, J., Krainer, B. (1990): Faziesentwicklung und Florenabfolge des Aufslusses Wörth bei Kirchberg / Raab (Pannon, Steirisches Becken). *Annalen des Naturhistorischen Museums in Wien* **91**, 7–38.

Krainer, B. **(**2008): Miocene macro and microflora of Reith (Austria). *PANGAEA***.** https://doi.org/10.1594/PANGAEA.696108

Maksimović, B., Sikošek, B., Marković, O., Veselinović, M. (1954): *Geologic composition and tectonic structure of a part of Ovče Pole and Tikveš with paleontological documentation.* Geological Survey Papers, 4. R. Macedonia, pp. 177 (in Macedonian).

Penhallow, D. P. (1908): *A Report on Tertiary Plants of British Columbia*. Government Printing Bureau, Canada, p. 1013. collected by Lawrence M. Lambe in 1906: together with a discussion of previously recorded Tertiary floras.

PPG, I. (2016): A community-derived classification for extant lycophytes and ferns. *J. Syst. Evol*. **54** (6), pp. 563–603.

Sampa Kundu, Taposhi Hazra, Tapan Chakraborty, Subir Bera, Mahasin Ali Khan (2022): Evidence of the oldest extant vascular plant (horsetails) from the Indian Cenozoic. *Plant Diversity*. https://doi.org/10.1016/j.pld.2023.01.004

Schimper, W. (1869): *Traité de Paléontologie végetalé*, I. Paris, 740 pp.

Schimper, W. (1874): *Traité de Paléontologie végetalé*, III. Paris, 896 pp.

Stewart, W. N., Rothwell, G. W. (1993): *Paleobotany and the Evolution of Plants*, Second ed. Cambridge University Press, Cambridge.

Stojanova, V. (2008*): Evolution and Stratigraphy of the Paleogene in the Territory of the Republic of Macedonia*. PhD thesis. Štip, 196 p. (in Macedonian).

Stojanova, V., Petrov, G., Stefanova, V. (2011): Small foraminifers from the Paleogene basins in the Republic of Macedonia. In: *Proc. Nat. Sci. Conf. "GESCIENCES 2011*. Sofia, Bulg. Geol. Soc., 93–94.

Stojanova, V., Petrov, G. (2012): Foraminifers and nannofossils from upper flysh lithozone in the Tikveš Paleogene basin, Republic of Macedonia. *Geologica Macedonica*, **26**, 1, 87–90.

Stojanova, V., Valchev, B., Juranov, S. (2013): Paleogene planktonic foraminifera of the Republic of Macedonia. – *C. R. Acad. Bulg. Sci*., **66**, 717–724.

Stojanova, V., Petrov, G. (2014): Lithostratigraphic characteristics of Paleogene basins in the Republic of Macedonia. *Geologica Macedonica*, **28**, 2, 175-183.

Sun, B. N., Du, B. X., Ferguson, D. K. et al. (2013): Fossil Equisetum from the lower cretaceous in Jiuquan basin, Gansu, northwest China, and its paleoclimatic significance. *Palaeogeogr. Palaeoclimatol. Palaeoecol*. Vol. **38**5, pp. 202–212.

Taylor, T. N., Taylor, E. L. (1993): *The Biology and Evolution of Fossil Plants*. Prentice-Hall, Englewood Cliffs (NJ).

Temkova V. (1958): Paleontološka obrabotka na faunata vo Tikveškiot basen i okolinata. *Trudovi na Geološkiot zavod na NRM*, **6**, pp. 93–123, Skopje.

Valchev, B., Stojanova, V., Juranov, S. (2013): Paleogene hyaline benthic foraminifera (LAGENINA and ROTALIINA) from the Republic of Macedonia. *Rev. Bulg. Geol. Soc.*, **74**, 1–3, 81–110.

Zastawniak, E. (1972): Pliocene leaf flora from Domanski Wierch near Czarny Dunajec (Western Carpathians, Poland). *Acta Paleobotanica* 13, 1–73.

Zhang, Y. L., Ferguson, D. K., Ablaev, A. G., et al. (2007): *Equisetum* cf. *pratense* (Equisetaceae) from the Miocene of Yunnan in southwestern China and its palaeoecological implications. *Int. J. Plant Sci*. **168**, 351–359.

Р е з и м е

ФОСИЛНА ФЛОРА ОД ПАЛЕОГЕНИТЕ СЕДИМЕНТИ НА ЛОКАЛИТЕТОТ СЕРТА ВО ТИКВЕШКИОТ БАСЕН, РЕПУБЛИКА СЕВЕРНА МАКЕДОНИЈА

Лазар Ѓоргиев, Виолета Стојанова, Гоше Петров, Виолета Стефанова

Факултет за природни и технички науки, Универзитет "Гоце Делчев" во Штип
Бул. Гоце Делчев 89, п. фах 201, МК-2000 Штип, Република Северна Македонија
violeta.stojanova@ugd.edu.mk

Клучни зборови: фосилна макрофлора; *Equisetum parlatorii*; палеогени седименти; Тиквешки басен

Тиквешкиот палеогенски басен се наоѓа во централниот дел на територијата на Северна Македонија и припаѓа во централниот дел на Вардарската зона. Флората собрана во песочничко-глинените седименти од долната флишна литозона на локалитетот Серта (Тиквешки басен) првпат е евидентирана и опишана во Македонија. Еден вид од фосилната флора е идентификуван како *Equisetum parlatorii*. Овие нови наоди обезбедуваат информации за дистрибуцијата и историјата на *Equisetum* во минатото и сегашноста и претставуваат пример за важноста на биогеографските и еволутивните процеси во геолошкото минато. Се претпоставува дека една од причините за намалувањето на големината на денешниот *Equisetum* во рецентната вегетација се значајните климатски промени кои биле резултат на хималајската орогенеза за време на доцен миоцен.