

Comparative data on the palynomorphological features of pollen grains of two Albania's species of the Campanula pyramidalis complex (Campanulaceae)

Blerina Pupuleku^{1*}, *Donald Shuka*², *Gëzim Kapidani*³, *Klea Trokoliçi*⁴

¹ - University of Elbasan "A. Xhuvani", Faculty of Natural Sciences, Department of Biology, pc 3001, Elbasan, ALBANIA

² - University of Vlorë "Ismail Qemali", Department of Biology, pc 9401, Vlorë, ALBANIA

³ - University of Tirana, Faculty of Natural Sciences, Department of Biology, pc 1001, Tirana, ALBANIA

⁴ - University of Elbasan "A. Xhuvani", Faculty of Natural Sciences, Department of Biology, Student of Master of Science in Environment Protection, pc 3001, Elbasan, ALBANIA

*Corresponding author: blerina.pupuleku@hotmail.com

Abstract. Two Balkan species of the *Campanula pyramidalis* complex, respectively *Campanula montenegrina* and *Campanula austroadriatica* were analyzed based on comparative methodology for their palynomorphological features, and provided the evidence of similarities and differences of palynological features between them. Palynomorphological features of these species were described for the first time. Pollen grains of two species resulted to be triporate with circular pores, isopolar with radial symmetry, spheroidal shape in polar view and wide oval in equatorial one. The exine sculpture of pollen grains appeared echinate in all studied subpopulations, and it was accompanied by spinules in pollen grains of *C. austroadriatica* and pollen grains of *C. montenegrina*. The largest sizes of the pollen grains were identified at *C. austroadriatica* population collected near Perast, for the length of pores were identified in pollen grains of Shirokë-Zogaj and Petrovac populations and for the width was identified in pollen grains of Shkalla e Tujanit and Kruja Castle populations. As for the exine, it was thicker at pollen grains of *C. austroadriatica* populations of Shirokë-Zogaj, Petrovac and near Perast localities. The smallest sizes for length of pollen grains and length of pores were found in *C. austroadriatica* collected at Shirokë-Zogaj, while for the width of pollen grains were found in pollen grains of *C. austroadriatica* collected in Montenegro populations and *C. montenegrina* of Albanian localities. The smallest width of pores was observed in pollen grains of *C. austroadriatica* collected in Petrovac. The exine was thinner in all populations of *C. austroadriatica* collected in Albanian localities.

Key words: Pollen grains, palynological features, exine, *C. austroadriatica*, *C. montenegrina*.

Introduction

With more than 100 taxa, the bellflower genus is one of the largest in the western Balkan countries. Between them, *Campanula pyramidalis* complex is widely distributed and represented

by five species, three of which *Campanula austroadriatica*, *C. montenegrina* and *C. versicolor* occurs in Albania, Croatia and Montenegro (Janković et al., 2016; Janković et al., 2019; Lakušić et al., 2013; Shuka, 2018; Shuka et al., 2019). *C. austroadriatica*

has a restricted distribution range in the coastal and Mediterranean part of the south Croatia, Montenegro and north-west and central part of Albania (Lakušić et al., 2013; Shuka, 2018; Shuka et al., 2019). *C. montenegrina* occurs in the continental parts along the border line between Montenegro and north-western part of Albania and *C. versicolor* that is widely distributed over all Albania, Greece, North Macedonia and south of Kosovo, west of Bulgaria and southeast of Italy (Janković et al., 2019; Lakušić et al., 2013; Shuka, 2018; Shuka et al., 2019). Since the last species include three subspecies and many isolated subpopulations are very variable, their taxonomic status remains unresolved and under discussion, below we are focused in the study of pollen grains morphological features of two narrow distribution range species: *C. austroadiatica* and *C. montenegrina* (Bogdanović et al., 2014; Erkara et al., 2008; Janković et al., 2016; Janković et al., 2019; Khansari et al., 2012; Lakušić et al., 2013; Mačukanović-Jocić & Jarić, 2016). So far from the members of Campanulaceae family in Albania, only three species, *C. patula*, *C. lingulata* and *C. rapunculus* were described for their palynomorphological features (Kallajxhiu, 2011; Kapidani, 1996; Pupuleku, 2002; Qosja et al., 1996). According to the literature (Avetisjan, 1950; Erdtman, 1960; Erkara et al., 2008; Kallajxhiu, 2011; Kapidani, 1996; Khansari et al., 2012; Mačukanović-Jocić & Jarić, 2016; Pupuleku, 2002) and confirmed by our study too, the basic shape of the pollen grains of the genus species of *Campanula* was shown as spheroidal in polar view (view from which it is possible to observe the shape, sculpture and apertures of pollen grains in polar position) and wide oval in equatorial one, except the pollen grains of rapunculoides and ramosissima species, which have spheroidal shape in both views. Here after, we described the key morphological characteristics of pollen grains of two species of the *Campanula pyramidalis* complex from the palynomorphological features, giving a contribution to the Balkans palynology.

This study aims to provide: 1) The comparative analysis of morphological features of two Balkan species of the *Campanula pyramidalis* complex; 2) The evidence of similarities and differences of palynological features between these species.

Materials and Methods

The pollen grains of two Balkan species of the *Campanula pyramidalis* complex: *C. montenegrina* and *C. austroadiatica* were studied from fresh flowers collected at the end of September and beginning of October during years 2020, 2021 and 2022. The study includes pollen grains from five different subpopulations of Albania and Montenegro localities as follows:

- *C. montenegrina* was collected in Gropat e Selcës and Selca waterfall along Albanian-Montenegrin border;
- *C. austroadiatica* was collected in limestone coastal rocks of Petrovac city and 2 km before Perast in the road from Kotorr to Perast village in Montenegro. The Albanian localities of this species includes collection on the rocky slope faces along the Shkodra Lake shore, between Shiroka and Zogaj villages as well as in Kruja castle - Shkalla e Tujanit. The last occurrence also represents the southern limits of species distribution range known so far.

Morphological characteristics of pollen grains were studied by using three analytical methods as follows:

- Acetolysis of Erdtman method (Erdtman, 1960);
- Acetolysis of Avetisjan method (Avetisjan, 1950);
- Basic fuchsine of Smoljaninova & Gollubkova method (Smoljaninova & Gollubkova, 1953).

The method of basic fuchsine was used to study the shape and dimensions of pollen grains and aperture, which in some cases enabled us to identify the sculpture elements of exine.

Whereas two methods of acetolysis were used to get the best results of the study of sporoderm elements and features of aperture. During the application of the Erdtman method, a greater loss of the number of pollen grains is observed compared to the Avetisjan method.

There were prepared 3 - 6 microscope slides by different methods and they were studied by "Motic" microscope in the laboratory of University of Elbasan "Aleksandër Xhuvani". The slides are stored in a place with no direct sunlight in Palynotheque of the Department of Biology. The microscopic photos of pollen grains of studied species have been taken with magnification x400 and x1000 taken by Pupuleku Blerina and Trokoliçi Klea.

Results

Campanula austroadriatica Kovacic & D. Lakusic

Populations of *Campanula austroadriatica* (Fig. 1A) collected in Shkalla e Tujanit and Kruja castle have monads and isopolar pollen grains with radial symmetry. According to the type of aperture, pollen grains were triporate with circular pores. In polar view, pollen grains had spheroidal shape, whereas in equatorial one, they had wide oval shape ($P/E=0.99$).

The exine appeared echinate, where spines formed a compact carpet. Spines had sharp tips, 2-3 times longer than wider, accompanied by flat conical spinules. The exine appeared with two equal layers and its thickness varied from 0.75 to 1.35 (1.05) μm . The cytoplasm appeared granular (Fig. 2). The length of pollen grains varied from 25.5 to 29.25 (27.45) μm , while their width varied from 25.5 to 29.85 (27.69) μm . The length of pores varied from 2.7 to 4.35 (3.3) μm , whereas their width varied from 3.15 to 4.8 (3.69) μm (Table 1).

Populations of *C. austroadriatica* (Fig. 1A) collected in the limestone rocks along Shkodra Lake (Shuka, 2018; Shuka et al., 2019), have the same features with the pollen grains of *C. austroadriatica* population in Shkalla e Tujanit and Kruja castle, but differed only in the ratio of size of the pollen grains according to the polar axis compared to the equatorial one which was 1.01 (P/E).

The exine appeared echinate, where spines formed a carpet, but not compact. Spines had sharp tips, were conical with wide base and short. The exine appeared with two equal layers and its thickness varied from 0.75 to 1.5 (1.02) μm . The cytoplasm appeared granular (Fig. 3). The length of pollen grains varied from 24.45 to 28.5 (26.56) μm , while their width varied from 24.3 to 28.5 (26.36) μm . The length of pores varied from 2.4 to 4.65 (3.19) μm whereas their width varied from 3.0 to 4.5 (3.56) μm (Table 1).

Populations of *C. austroadriatica* (Fig. 1A) collected in Petrovac, Montenegro have the same features with the pollen grains of *C. austroadriatica* population collected in Shkalla e Tujanit and Kruja castle and Shirokë but differed only in the ratio of size of the pollen grains according to the polar axis compared to the equatorial one which was 1.01 (P/E).

The exine appeared echinate, where spines did not have sharp ends, varied from conical to trapezoidal with wide base and their length was two times longer than wider. The exine appeared with two equal layers and its thickness varied from 1.2 to 1.5 (1.38) μm . The cytoplasm appeared granular (Fig. 4). The length of pollen grains varied from 25.65 to 33.0 (28.9) μm , while their width varied from 25.05 to 31.05 (28.65) μm . The length of pores varied from 2.55 to 4.65 (3.46) μm whereas their width varied from 2.7 to 4.35 (3.39) μm (Table 1).

Populations of *C. austroadriatica* (Fig. 1A) collected near Perast (Kotorr, Montenegro) have the same features with the pollen grains of *C. austroadriatica* population collected in Shkalla e Tujanit and Kruja castle, but differed only in the ratio of size of the pollen grains according to the polar axis compared to the equatorial one which was 1.0 (P/E).

The exine appeared echinate, where spines were conical, had sharp ends but were short. The spines did not have the same length. The exine appeared with two equal layers and its thickness varied from 1.2 to 1.5 (1.39) μm . The cytoplasm appeared granular (Fig. 5). The length of pollen grains varied from 26.55 to 34.35 (31.05) μm , while their width varied from 24.0 to 34.5 (30.98) μm . The length of pores varied from 2.7 to 4.5 (3.71) μm whereas their width varied from 3.0 to 4.5 (3.76) μm (Table 1).



Fig. 1. (A) *Campanula austroadriatica* and (B) *C. montenegrina* taken by [Shuka Donald].



Fig. 2. Pollen grains of *Campanula austroadriatica* (Shkalla e Tujanit and Kruja Castle)
(a), (c): Equatorial view x1000; (b): Polar view x1000.



Fig. 3. Pollen grains of *Campanula austroadriatica* (Shirokë-Zogaj)
(a), (c): Polar view x1000; (b): Equatorial view x400.



Fig. 4. Pollen grains of *Campanula austroadriatica* (Petrovac)
(a), (b): Polar view x1000; (c): Equatorial view x1000.

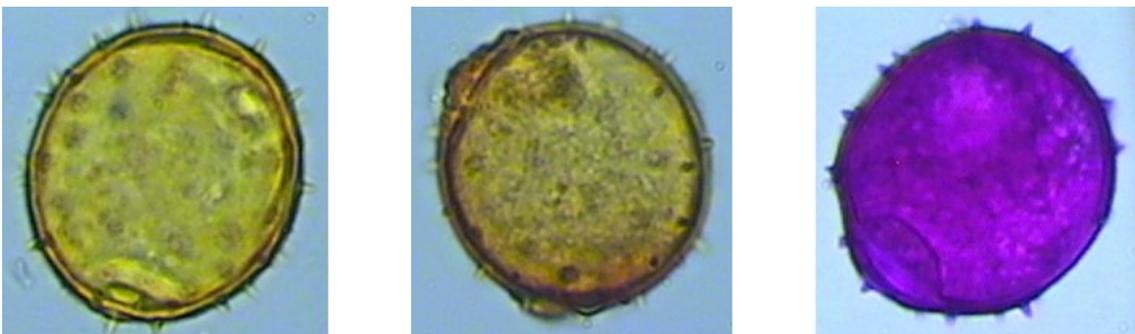


Fig. 5. Pollen grains of *Campanula austroadriatica* (Perast, Kotorr)
(a), (c): Equatorial view x1000; (b): Polar view x1000.

***Campanula montenegrina* Jankovic & Lakusic**

Purple flower with close-bell shape. Plant with 50-60cm height stems. In subalpine regions with sub Mediterranean climate. Plants were collected fresh in Gropat e Selcës and Selca waterfall during flowering time at the end of September (Shuka, 2018; Shuka et al., 2019) (Fig. 1B).

Populations of *Campanula montenegrina* collected in Gropat e Selcës and Selca waterfall localities in Albania have monads and isopolar pollen grains with radial symmetry. According to the type of aperture, pollen grains were triporate with circular pores. In polar view, pollen grains had spheroidal

shape, whereas in equatorial one, they had wide oval shape (P/E=0.99).

The exine appeared echinate, where spines formed a compact carpet. They were conical, with wide base, which did not go more than two times longer than wider, accompanied by spinules. The exine appeared with two equal layers and its thickness varied from 0.9 to 1.35 (1.11) μm . The cytoplasm appeared granular (Fig. 6). The length of pollen grains varied from 24.6 to 28.5 (26.3) μm , while their width varied from 24.0 to 28.8 (26.45) μm . The length of pores varied from 2.85 to 4.5 (3.43) μm whereas their width varied from 3.15 to 4.7 (4.05) μm (Table 1).

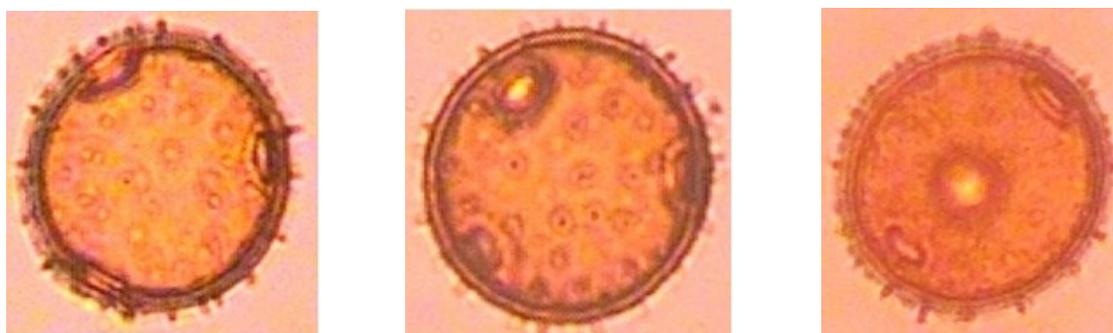


Fig. 6. Pollen grains of *Campanula montenegrina* (a), (c): Equatorial view x1000; (b): Polar view x1000

Table 1. Minimum, average and maximum compared sizes of pollen grains of *Campanula pyramidalis* complex

Palynological features Species and locality	Value	Length of polar axis, μm	Length of equatorial axis, μm	Length of porus, μm	Width of porus, μm	Exine thickness, μm
<i>Campanula austroadriatica</i> (Shkalla e Tujanit and Kruja Castle)	Minimum	25.5	25.5	2.7	3.15	0.75
	Maximum	29.25	29.85	4.35	4.8	1.35
	Average	27.45	27.69	3.3	3.69	1.05
<i>Campanula austroadriatica</i> (Shirokë-Zogaj)	Minimum	24.45	24.3	2.4	3.0	0.75
	Maximum	28.5	28.5	4.65	4.5	1.5
	Average	26.56	26.36	3.19	3.56	1.02
<i>Campanula austroadriatica</i> (Petrovac, Montenegro)	Minimum	25.65	25.05	2.55	2.7	1.2
	Maximum	33.0	31.05	4.65	4.35	1.5
	Average	28.9	28.65	3.46	3.39	1.38
<i>Campanula austroadriatica</i> (Perast, Kotorr, Montenegro)	Minimum	26.55	24.0	2.7	3.0	1.2
	Maximum	34.35	34.5	4.5	4.5	1.5
	Average	31.05	30.98	3.71	3.76	1.39
<i>Campanula montenegrina</i> (Gropat e Selcës and Selca waterfall)	Minimum	24.6	24.0	2.85	3.15	0.9
	Maximum	26.3	26.45	3.43	4.05	1.11
	Average	28.5	28.8	4.5	4.7	1.35

Discussion

Palynomorphological study of two species of the *Campanula pyramidalis* complex showed that their pollen grains were monads, isopolar with radial symmetry, triporate with circular pores, spheroidal in polar view and wide oval in equatorial one, with granular cytoplasm and echinate exine sculpture which made the difference between species.

With regard to two different subpopulations of Montenegro localities (Petrovac and near Perast), the differences based on spines indicated that the pollen grains of *C. austroadriatica* collected near Perast had conical short spines with different length and with sharp ends, whereas in pollen grains of *C. austroadriatica* collected in Petrovac, the spines varied from conical to trapezoidal with the same length which were two times longer than wider.

The pollen grains of the studied subpopulations differed in the exine sculpture which appeared with the compact spines carpet at *C. austroadriatica* collected in the localities of Shkalla e Tujanit and Kruja Castle and *C. montenegrina* and not very dense one at *C. austroadriatica* collected in Shirokë-Zogaj. They differed also by the spines, which appeared from two to three times longer than wider in pollen grains of *C. austroadriatica* collected in Shkalla e Tujanit-Kruja Castle localities and Petrovac, to not more than two times longer than wider in pollen grains of *C. montenegrina* and short in pollen grains of *C. austroadriatica* collected in Shirokë-Zogaj and in near Perast locality. Another element of sporoderm, which differentiated the pollen grains of the studied species were the spinules, which only appeared in pollen grains of *C. austroadriatica* collected in Shkalla e Tujanit and Kruja Castle locality and in pollen grains of *C. montenegrina*.

The minimum sizes, as shown in Fig. 7, were observed in the pollen grains of *C. austroadriatica* collected in Petrovac regarding the length of pollen grains and the length and width of pore, while the minimum sizes of the width of pollen grains was identified at *C. austroadriatica* near Perast. The exine is thick equally in pollen grains of both individuals

collected in different localities. The lowest in terms of average sizes were found in *C. austroadriatica* pollen grains collected in Petrovac for all palynological indicators (Fig. 8).

As noticed from the Fig. 9, the data of both sizes of pollen grains and width of porus were higher at pollen grains of *C. austroadriatica* collected near Perast, while the length of porus had higher value at pollen grains of *C. austroadriatica* collected in Petrovac. The exine thickness had the same value in pollen grains of both individuals collected in different areals.

Based on the data presented in Fig. 10, we noticed that length of pollen grains and pore had lower values at *C. austroadriatica* collected in Shirokë-Zogaj, while the width of pollen grains was smaller at *C. austroadriatica* collected near Perast and *C. montenegrina*. Pore width was smaller at *C. austroadriatica* collected in Petrovac. The exine appeared thinner in *C. austroadriatica* pollen grains collected at Shkalla e Tujanit-Kruja Castle and Shirokë-Zogaj.

In Fig. 11, we can distinguish those average sizes of length of polar and equatorial axis had higher values in pollen grains of *C. austroadriatica* collected near Perast and lower ones in pollen grains of *C. montenegrina* and *C. austroadriatica* collected in Shirokë-Zogaj locality respectively. The lowest average dimensions of length and width of pores were found in pollen grains of *C. austroadriatica* collected in Shirokë-Zogaj and Petrovac, while the highest ones were found in pollen grains of *C. austroadriatica* collected near Perast and *C. montenegrina*. The exine was the thinnest in *C. austroadriatica* collected in Shirokë-Zogaj and the thickest in *C. austroadriatica* collected near Perast.

Referring to the data Fig. 12, the larger sizes regarding the length of the polar and equatorial axis were found to be in the pollen grains of *C. austroadriatica* collected near Perast. Pore length had higher values in *C. austroadriatica* pollen grains collected in Shirokë-Zogaj and Petrovac and pore width had higher values in *C. austroadriatica* pollen grains collected in Shkalla e Tujanit and Kruja Castle. The exine was thicker in *C. austroadriatica* pollen grains collected in Shirokë-Zogaj, Petrovac and near Perast localities.

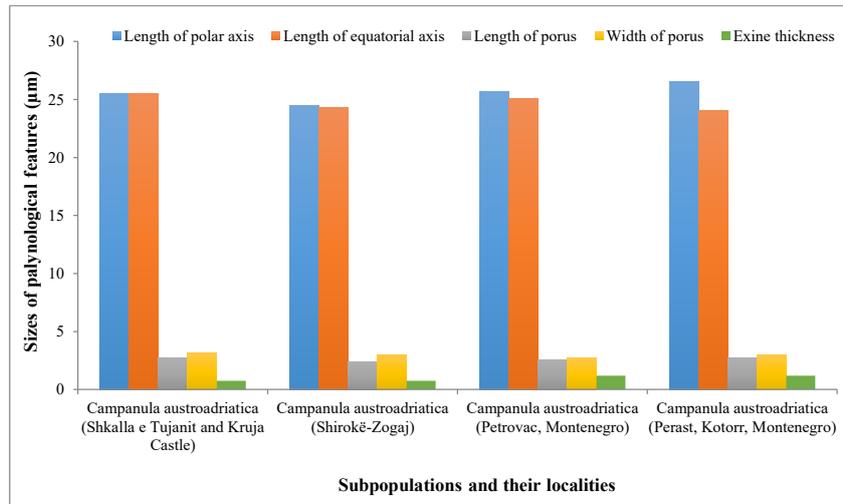


Fig. 7. Minimum sizes of pollen grains of *Campanula austroadriatica* collected in 2 different areals of the country of Montenegro (Petrovac and Perast, Kotorr)

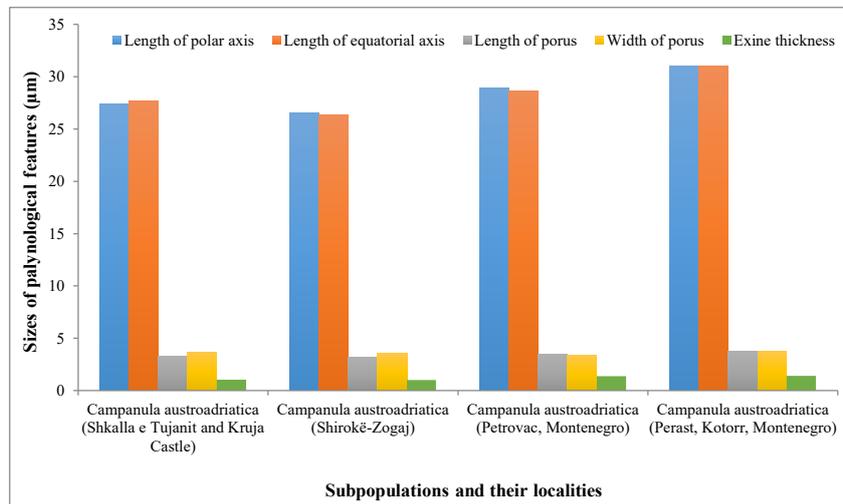


Fig. 8. Average sizes of pollen grains of *Campanula austroadriatica* collected in 2 different areals of the country of Montenegro (Petrovac and Perast, Kotorr)

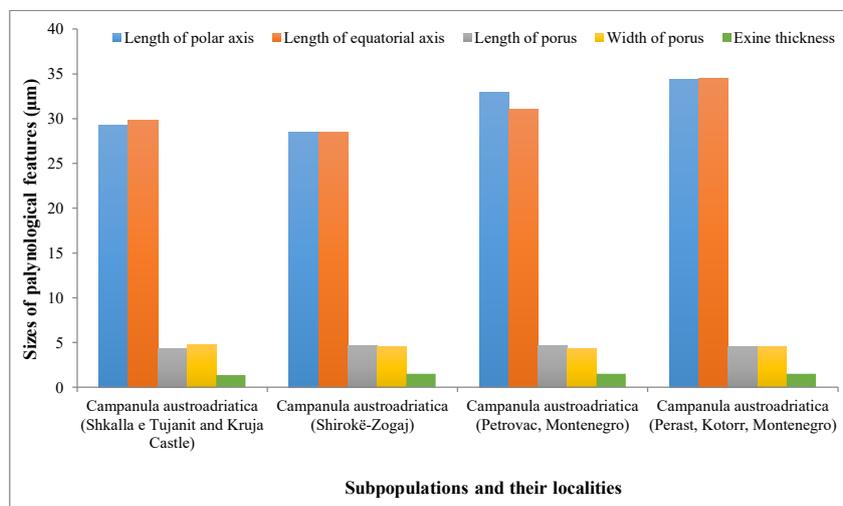


Fig. 9. Maximum sizes of pollen grains of *Campanula austroadriatica* collected in 2 different areals of the country of Montenegro (Petrovac and Perast, Kotorr)

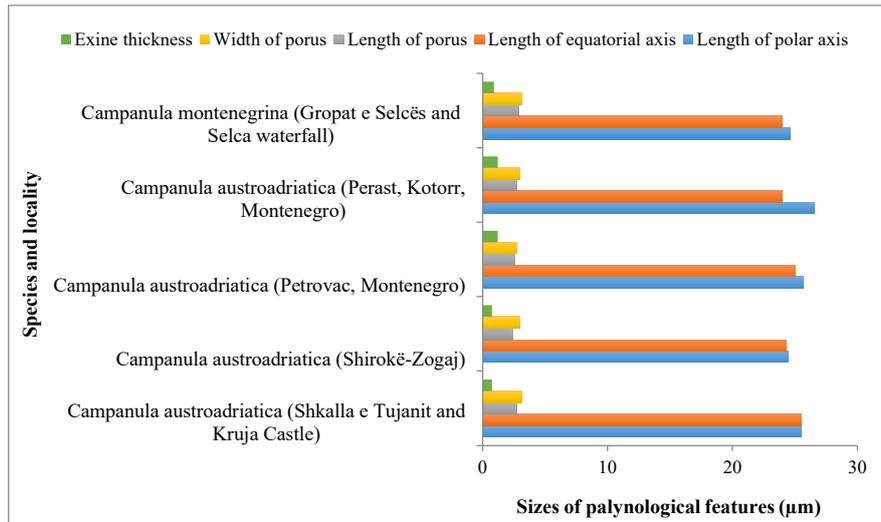


Fig. 10. Minimum sizes of pollen grains of *Campanula austroadriatica* collected in 4 different areals and *Campanula montenegrina*

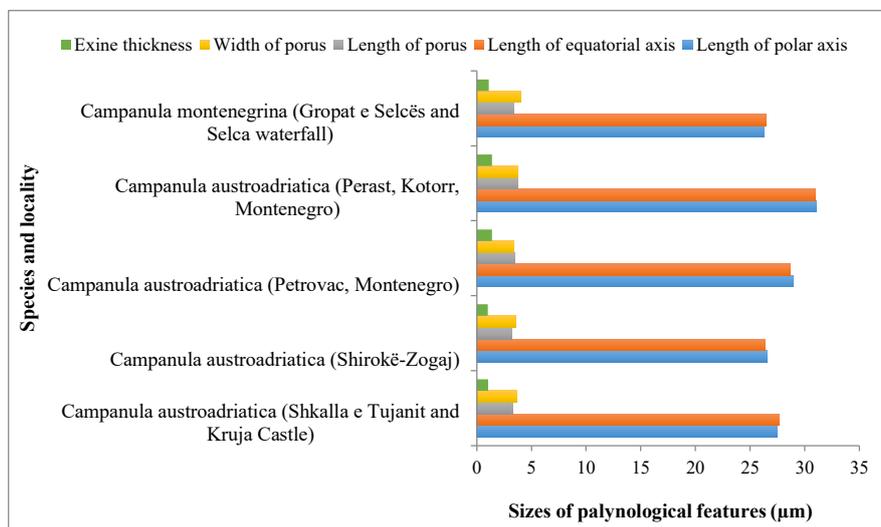


Fig. 11. Average sizes of pollen grains of *Campanula austroadriatica* collected in 4 different areals and *Campanula montenegrina*

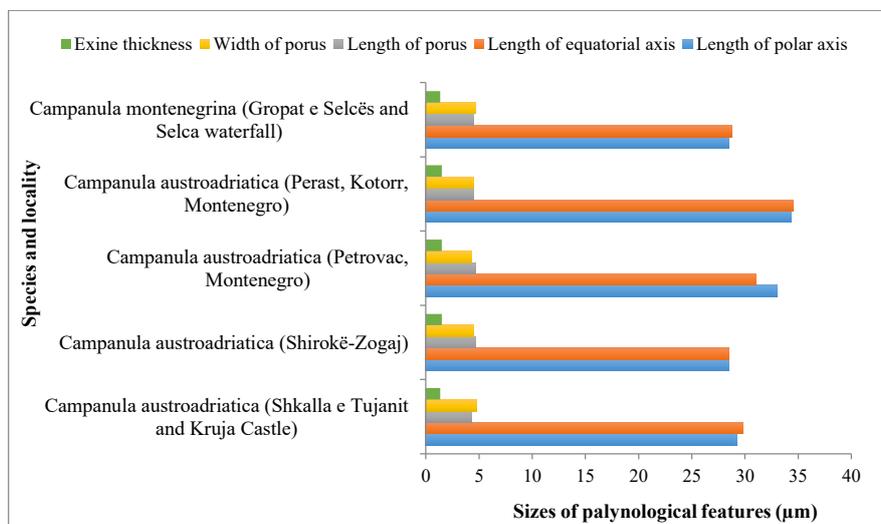


Fig. 12. Maximum sizes of pollen grains of *Campanula austroadriatica* collected in 4 different areals and *Campanula montenegrina*

Conclusions

Our palynological study of *Campanula pyramidalis* complex, contributes to the identification of distinguishing features between species, using the significant palynological feature - the sculpture of the exine, which made the difference between the five studied subpopulations of Albania and Montenegro localities.

The pollen grains of five subpopulations differed in some features as follows:

- To the pollen grains of *C. austroadriatica* collected in the localities of Shkalla e Tujanit and Kruja Castle, as well as to the pollen grains of *C. montenegrina* noted a compact spines carpet, while to the pollen grains of *C. austroadriatica* collected in Shirokë-Zogaj locality this carpet had rare spines;

- Spines were 2-3 times longer than wider in pollen grains of *C. austroadriatica* collected in Shkalla e Tujanit-Kruja Castle localities and Petrovac, was not more than 2 times longer than wider in pollen grains of *C. montenegrina* and short in pollen grains of *C. austroadriatica* collected in Shirokë-Zogaj locality and in near Perast;

- Spinules were present in pollen grains of *C. austroadriatica* collected in Shkalla e Tujanit and Kruja Castle and *C. montenegrina* and they were absent in pollen grains of *C. austroadriatica* collected in Shirokë-Zogaj, Petrovac and Perast.

The largest sizes for most of the palynomorphological indicators of pollen grains were identified to *C. austroadriatica* collected near Perast. While with regards to the wideness of pores the largest sizes were identified to *C. austroadriatica* pollen grains collected in Shkalla e Tujanit and Kruja Castle and as for the length of the pore the largest sizes were observed in *C. austroadriatica* pollen grains collected in Shirokë-Zogaj and Petrovac. As for the exine, it was thicker at pollen grains of *C. austroadriatica* populations of Shirokë-Zogaj, Petrovac and near Perast localities.

References

Avetisjan, B.M. (1950). Simplified acetolysis method for pollen processing. *Botanicheskii Zhurnal*, 35(4), 385-386. (In Russian).

Bogdanović, S., Brullo, S., Rešetnik, I., Lakusić, D., Satovic, Z. & Liber, Z. (2014). *Campanula skanderbegii*: molecular and morphological evidence of a new *Campanula*. *Systematic Botany*, 39, 1250-1260. doi: [10.1600/036364414x682571](https://doi.org/10.1600/036364414x682571).

Erdtman, G. (1960). The acetolysis method. *Svensk Botanicheskii Tidskrift*, 54, 561-564.

Erkara, P. I., Ocak, A. & Pehlivan, S. (2008). Pollen morphology of some Turkish *Campanula* spp. and their taxonomic value. *Bangladesh J. Bot.*, 37(1), 33-42.

Janković, I., Šatović, Z., Liber, Z., Kuzmanović, N., Radosavljević, I. & Lakušić, D. (2016). Genetic diversity and morphological variability in the Balkan endemic *Campanula secundiflora* s.l. (Campanulaceae). *Botanical Journal of the Linnean Society*, 180(1), 64-88.

Janković, I., Šatović, Z., Liber, Z., Kuzmanović, N., Di Pietro, R., Radosavljević, I., Nikolov, Z. & Lakušić, D. (2019). Genetic and morphological data reveal new insights into the taxonomy of *Campanula versicolor* s.l. (Campanulaceae). *Taxon*, 68(2), 340-369.

Kallajxhiu, N. (2011). *Allergopalynological study of allergic plants in the region of Elbasan and allergies caused by them*. Monograph, Elbasan, Albania, Rama Graf ISBN 978-99956-683-2-7 p. 26. (In Albanian).

Kapidani, G. (1996). *Basics of palynology. Spores and pollen grains of some nowadays plants of Albania*. Printing Press "Sejko", Elbasan, Albania, p. 124. (In Albanian).

Khansari, E., Zarrea, S., Alizadehb, K., Attar, F., Aghabeigi, F. & Salmaki, Y. (2012). Pollen morphology of *Campanula* (Campanulaceae) and allied genera in Iran with special focus on its systematic implication. *Flora*, 207, 203-211.

Lakušić, D., Liber, Z., Nikolić, T., Surina, B., Kovačić, S., Bogdanović, S. & Stefanović, S. (2013). Molecular phylogeny of the *Campanula pyramidalis* species complex (Campanulaceae) inferred from chloroplast and nuclear noncoding sequences and its taxonomic implications. *Taxon*, 62(3), 505-524.

Mačukanović-Jocić, M. & Jarić, V. S. (2016). Pollen morphology of the Balkan-Carpathian endemic *Campanula lingulata* Waldst. & Kit. (Campanulaceae), *Matica Srpska J. Nat. Sci. Novi Sad*, 130, 75-82, doi: [10.2298/ZMSPN1630075M](https://doi.org/10.2298/ZMSPN1630075M).

Pupuleku, B. (2002). *Melissopalynological study of honeys from the Elbasan region and pollen grains of some honey plants*. Ph D Thesis, University of Tirana, Tirana, Albania, p. 81. (In Albanian).

- Qosja, Xh., Paparisto K., Vangjeli, J. & Ruçi, B. (1996). *Flora of Albania*, Volume III, Tiranë, Albania, Akademia e Shkencave e Republikës së Shqipërisë, 290-307, Tirana, Albania. (In Albanian).
- Shuka, D. (2018). Outlines on the habitat, ecology, plant assemblages and the endangered status of *Campanula pyramidalis* complex and *Campanula* ser. *garganicae*, in Albania. University of Tirana, p. 55, Tirana, Albania. (In Albanian).
- Shuka, D., Hoda, P. & Diku, A. (2019). The distribution of *Campanula austroadriatica* D. Lakušić & Kovacic and *C. montenegrina* I. Jankovic & D. Lakušić (*Campanula pyramidalis* species complex) in Albania. *Bul. Shk. Ser. Nat.*, 69, 60-77. (In Albanian).
- Smoljaninova, L. A. & Gollubkova, V. F. (1953). L. A. K. Pollen Research Methodology. *Doklady Akademia Nauk SSSR T LXXXVIII*. (1), 125-126, Moscow, Russia. (In Russian).

Received: 24.03.2023
Accepted: 22.04.2023