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Original scientific paper

THE PHENOTYPIC PLASTICITY OF of *Picea omorika* /Panč./Purkyne MORPHOLOGICAL POLLEN TRAITS

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The variability of morphological traits of *Picea omorika* /Panč./Purkyne pollen was analyzed in two successive years on the pollen sampled from 24 trees in a seed stand at the site of Bela Zemlja in the area of Mt. Zlatibor (Serbia). The aim of the research was to obtain the index of phenotypic plasticity of the equatorial and polar axes and the coefficient of shape of pollen. According to the obtained results, Serbian spruce pollen grains are 93.3 µm/53.2 µm in size with their shape being oblate 57.5%. The climate characteristics of the study years initiated different responses of the pollen traits for each tree. Reaction norms were slightly steep and they crossed as confirmed by the significant interaction between the variability factors of the year and the tree. In the year with lower temperatures and less precipitation, the mean values of the equatorial axis were higher and the polar axis smaller, giving the pollen grain a more oblate form. According to the results of the applied model of analysis of variance where the year and the tree, as well as the interaction between them, were taken as factors of variability, the values of the pollen equatorial axis (length) and the coefficient of shape showed statistically significant differences between the years. Genetic variability (interindividual differences) for the values of both axes of pollen grains was confirmed by statistically significant differences between the trees in a single year. Interindividual differences in the observed morphological pollen traits were affected by environmental conditions specific to the year of sampling (statistically significant year x tree interaction). All the analyzed traits

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showed interindividual differences in the values of the plasticity index. The lowest values of plasticity were obtained for the equatorial axis (length) of the pollen grain, and they were significantly different from the plasticity indexes of the other traits analyzed herein. The plasticity of pollen traits has an important role in the controlled selection and breeding of species with the aim of obtaining more resistant genotypes with a greater ability to adapt to the fluctuations of environmental factors caused by global climate change.

Keywords: *Picea omorika*, pollen dimension, pollen shape, index of plasticity

INTRODUCTION

The study of the impact of environmental factors is aimed at evaluating the patterns of variability of morphological traits of pollen induced by the changes in climate factors on the reproductive potential of plants (KNIGHT *et al*., 2005). Apart from physiological, morphological traits of pollen are those that directly affect the pollen germination capacity, fertilization and further reproduction and indirectly the growth and development of plants (KIRK, 1993; DE LEONARDIS *et al*., 1995; FERRAUTO *et al*., 2015), which makes them extremely important in the controlled selection of high-quality genotypes - pollinator trees. The study of morphological traits of pollen grains is of great importance in the systematics and taxonomy of plants (SHAH *et a*l., 2005; PANAHI *et al*., 2012; WRONSKA-PILAREK *et al.*, 2016; JIA *et al*., 2014; SOARES *et al.*, 2017), as well as in the analyses carried out to determine the somatic or gametophytic ploidy level (DE STORME *et al*., 2013). The study of pollen morphology (its dimensions, surface area, volume, surface structure) is also relevant from the aspect of global climate change (KNIGHT *et al.,* 2005). The periods of increasing temperatures and changing amounts of precipitation and levels of radiation together with the presence of air pollutants significantly affect the properties of pollen (FOSTER and AFONIN, 2005; REZANEJAD, 2012). According to EJSMOND *et al*. (2011, 2015), higher temperatures that increase desiccation rates make plants produce larger pollen grains and thus compensate for the lack of water. The above-stated authors (EJSMOND *et al*., 2011, 2015) propose the use of pollen size and shape in the models of paleoenvironmental reconstruction of climate change. Pollen morphology also reflects the increasing levels of environmental pollution. The fact that the size and the germination rate of pollen decrease with an increase in the levels of pollution makes pollen a reliable environmental indicator (PUKACKI and CHALUPKA, 2003; AZZAZY, 2016).

The above aspects of the study of pollen morphology did not include the plasticity of pollen traits as a very important factor of adaptation to spatial and temporal changes of the environment. The plasticity of traits is the result of various selective pressures in the environment and represents the capacity of the genotype, or the ability to exploit the limited resources available for the survival in stressful environments (COUSO and FERNANDEZ, 2012). During the anther development, environmental conditions affect the size of pollen grains, which means that the values of pollen traits are not determined only by genetics. The variability of genotypes in response to changing environments or the genotype-environment interaction points to the existence of the plasticity of pollen traits, which is important from the aspect of both ecology and evolution. Genotypes with the greater plasticity of pollen traits are more likely to mitigate the heterogeneity of environmental conditions, and such mother plants provide pollen for the next generation, which represents a new dimension between the natural selection and variability observed at the population level (DELPH *et al*., 1997). Evolutionary biology is based on the concept of phenotypic plasticity, or the capacity of a genotype (the reaction norm) to produce a range of phenotypes under different environmental conditions (VALLADARES *et al*., 2000; and references therein). The phenotypic plasticity is the difference in plant trait values along the environmental gradient (JI *et al*., 2017). The present study is the first attempt (according to the literature) to quantify the phenotypic plasticity of the morphological traits of *Picea omorika* pollen analyzing the pollen of the same genotype (tree) in two successive years with different climate characteristics.

Serbian spruce (*Picea omorika* /Panč./Purkyne) is tertiary relict flora and a Balkan endemic species. This species used to be widely distributed across Europe, but today it is restricted to small isolated communities occupying a narrow region of Serbia and Bosnia and Herzegovina (BATOS and NIKOLIĆ, 2013). Serbian spruce has been studied from several aspects: the analysis of site conditions and the structure of small populations (DINIĆ, 1997, ALEKSIĆ and GEBUREK, 2014), paleopalynology (ČOLIĆ, 1986), breeding (ISAJEV, 1987), embryogenesis (BUDIMIR, 2003), genetic structure (MILOVANOVIĆ *et al*., 2007; NASRI *et al*., 2008), biology of flowering and fruiting (BATOS, 2013), etc. However, there are few published studies on morphology and viability of Serbian spruce pollen, especially the influence of environmental factors on the pollen traits (BATOS and NIKOLIĆ, 2013).

Serbian spruce pollen is anemophilous, i.e. adapted to wind pollination, which is typical of coniferous species (Figure 1). As with most coniferous species of the genera *Abies*, *Cedrus*, *Picea* and *Pinus*, pollen grains of Serbian spruce have two air-filled bladders developed laterally from the body of the pollen grain, unlike the species of *Larix*, *Tsuga or Pseudotsuga* genera which lack the bladders. In the dry state, the pollen of Serbian spruce is light yellow to brown with adjoining but not fully fused air-filled bladders which move apart when hydrated. Pollen of broadleaved species has no air bladders, and besides the differences in the pollen structure, coniferous species have significantly larger pollen than broadleaved species (ERDTMAN, 1952). Among conifers, firs have very large pollen grains (POPNIKOLA, 1970; ARISTA and TALAVERA, 1994) compared to the smaller pollen of pines (PHIPPS *et al*., 1995), while oaks (*Quercus* sp.) belong to broadleaved species that have significantly larger pollen compared to the very small pollen of willows (*Salix* sp.) (ERDTMAN, 1952). According to ERDTMAN`s (1952) classification of the size and shape of pollen (P/E), Serbian spruce is a species with large oblate pollen (Table 1).

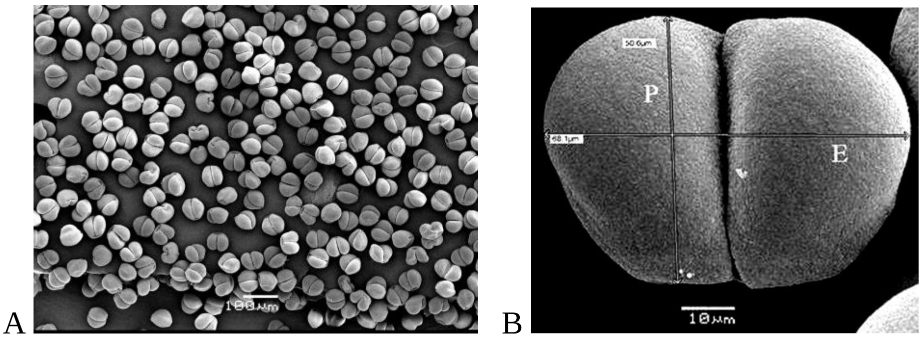

Figure 1. Scanning Electron Micrographs (SEM) of *Picea omorika* /Panč./Purkyne pollen structure.

A (magnification x100) and B (magnification x1400) polar and equatorial axis of pollen grain.

Table 1. Size of pollen grains of woody species.

Species	References		Length (μm)	Diameter (μm)
Abies alba			156.5	107.4
Abies concolor	Popnikola, N.	1970	143.5	97.4
Abies grandis			132.1	98.8
Abies pinsapo	Arista, M., Talavera, S.	1994		90.9
Larix sp.	Said, C., Villar, M., Zandonella, P.	1991	60.0	
Carpinus sp.	Akhondnezhad, S., Nejadsattari, T., Sattarian, A., Asri, Y., Bagheriieh Najjar, M.B.	2011	24.9-35.2	23.1-28.2
Castanea sp.	Liu, Y., Zetter, R., Ferguson, D.K., Mohr, B.A.R.	2007	14.2	11.7
Fagus, sp.	Liu, Y., Zetter, R., Ferguson, D.K., Mohr, B.A.R.	2007	32.4	35.5
Juglans regia	Mert, C.	2010	33.3-37.5	
Picea glauca			98.9	54.9
Picea mariana	Lindbladh, M., O Konnor, R., Jacobson, L.G.	2002	84.6	46.6
Picea rubens			89.7	46.5
Picea omorika	Grbović, B.	1998	93.9	51.8
Picea omorika	Erdtman, G.	1943	57.0-116.0	57.0-87.0
Picea sp.	Jia, Z.R., Wang, J.H., Zhang, S.G.	2014	84.3-118.8	
Picea omorika			87.1	
Picea omorika	Jovančević, M.	1962	81.0	56.0
Picea orientalis	Ho, R.H., Sziklai, O.	1972	85.3	56.4
Picea sitchensis			108.2	72.0
Pinus sp.	Phipps, J.C., Osborn, M.J., Stokey, A.R.	1995	50.0-70.0	27.0-43.0
Pinus heldreichii	Ilvessalo-Pfaffli, S.M., Pejoski, B.	1975	60.0-62.0	
Pinus sylvestris	Daničić, V., Isajev, V., Mataruga, M., Cvjetković, B.	2012	54.4	35.6
Quercus sp.	Erdtman, G.	1952	25.0-50.0	
Quercus petraea			31.4	30.1
Quercus pubescens	Wronska-Pilarek, D., Danielewicz, W., Bocianowski, J., Malinski, T., Janyszek, M.	2016	31.8	30.3
Quercus robur			30.8	29.3
Quercus robur	Batos, B.	2014	39.0	21.7
Quercus robur subsp. *edunculiflora*	Panahi, P., Pourmajidian, M.R.. Fallah., A ., Pourhashemi, M.	2012	29.7	29.1
Quercus robur	Rushton, B.S.	1976	26.74	
Quercus petraea			29.37	
Salix sp.	Erdtman, G.	1952	10.0-25.0	
Tsuga mertensiana	Ho, R.H., Sziklai, O.	1972	70.0	61.0

The aim of this study was to evaluate the effects of environmental factors in two successive years of observation on the variability of the analyzed traits of Serbian spruce pollen grains. Our study included the assessment of the phenotypic plasticity of the length (equatorial axis), the width (polar axis) and the coefficient shape of pollen grain, as well as the estimation of genetic variability, i.e. interindividual differences between trees in each study year, which would form a solid basis for the development of appropriate breeding programs and maintenance of good-quality production.

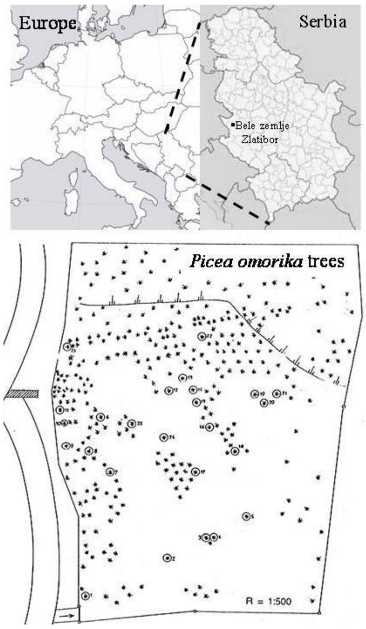

Figure 2. The location of the seed stand at the site of Bela Zemlja (Zlatibor Mountain) and the position of the marked *Picea omorika* trees from which pollen was collected.

MATERIALS AND METHODS

Climate data

The study of the effects of environmental factors - climate (including temperature and amounts of precipitation per year and for the period immediately prior to pollen maturation. i.e. January-May) used the data of Zlatibor hydrometeorological station of the Republic Hydrometeorological Service of Serbia for the pollen collection years (www.hidmet. gov.rs) (Figure 3).

Pollen was sampled from 24 trees growing in a seed stand at the site of Bela Zemlja (lat. 43º 81' N, long. 19º 79' E) on Mount Zlatibor, Serbia (Figure 2) in two successive years (1991 and 1992). The stand of 0.5 ha in size is located on the site of *Quercetum farnetto - cerris* at an altitude of 680 m. It was established using seed material originating from natural habitats of this species on Mt. Tara (Serbia) (ISAJEV, 1987).

Twigs with half-matured microstrobiles were sampled from the south-facing outer sides of the crown at a height of 3-5 m. Sampling was carried out in May in two successive years. Pollen maturation was completed under laboratory conditions using the method of ‘aquatic cultures’. Anthers ruptured and the pollen was released within 48 hours. The collected pollen was dried in a pollen drier at +30ºC/48 h, purified using a set of mesh sieves with the final sieve size of 0.2 mm, and stored in a fridge at +5ºC in a desiccator with $CaCl_2$ until it was to be used.

The measurement of pollen grains was done using hydrated pollen (immediately after soaking the pollen into a drop of distilled water). A sample of 25 pollen grains x 24 trees x 2 years (a total of 1200 pollen grains measured) was used to measure the following two pollen dimensions: length (E) - equatorial axis (µm) and width (P) - polar axis (µm) (Fig. 1A and B). The measurement was performed using the ocular micrometer of the LAICA GALEN III microscope system with a 40x objective and a 10x eyepiece, with the *Topica TP-5001* camera and computer.

Coefficient of shape

The value of the coefficient of shape was calculated according to the formula (ERDTMAN, 1952):

$$\text{pollen grain coefficient of shape} = 100*P/E$$

The plasticity index

The plasticity index (IP_i) for each of the analyzed trees (i) was obtained using the formula (VALLADARES *et al*., 2000; COUSO and FERNANDEZ, 2012):

$$IP_i = (VAR_{max}-VAR_{min})/ VAR_{max}$$

for the morphological traits of pollen (VAR) values of polar and equatorial axes, as well as the pollen grain coefficient of shape. VAR_{max} has a higher value in one year compared to the other year of observation.

Statistical analysis

The results of the research are presented using descriptive statistics, testing differences between mean values (t-test results). A nested ANOVA model with the following sources of phenotypic variation was used: the year (estimation of environmental variability), the tree (estimation of genetic variability - interindividual variability, nested in the year of observation) and the year x tree interaction (estimation of the plasticity of morphological traits of pollen). The model uses the year as a fixed factor and the tree as a random factor of phenotypic variability. Differences in the values of the plasticity index were tested using the F-test of equality of variances. SAS statistical package (SAS INSTITUTE, INC. 2011) was used for the statistical analysis of data.

RESULTS

The study of environmental conditions refers to the analysis of basic climate data for the years of pollen collection. The data on temperature and amount of precipitation point to obvious differences between the years of pollen collection. The mean annual temperature and precipitation in the first year (6.6ºC and 73.1 mm, respectively) were lower compared to the second year (8.0ºC and 83.0 mm, respectively). Also, the same pattern was obtained in the calculations for the months prior to the pollen maturation (January - May): in the first year, the values of temperature and precipitation were also lower (2.3ºC and 61.1 mm, respectively), compared to the second year (3.5ºC and 71.5 mm, respectively) (Figure 3).

According to the obtained results, pollen grains of Serbian spruce have the following dimensions: length (equatorial axis) = 93.3 µm, width (polar axis) = 53.2 µm and the coefficient of shape = 57.5% (mean values for both years). The mean values of the equatorial axis of pollen were higher in the first year which had less precipitation and lower temperatures both on the annual level and in the months prior to pollen maturation (January-May) (Figure 3), while the polar axis and the coefficient of shape had smaller values (statistically significant according to T-test for the comparison of the mean values between years (Figure 4). The reaction norms of the analyzed morphological traits of pollen grains in two successive years, presented for each individual tree, were slightly steep and they crossed each other pointing to the existence of plasticity (Figure 4).

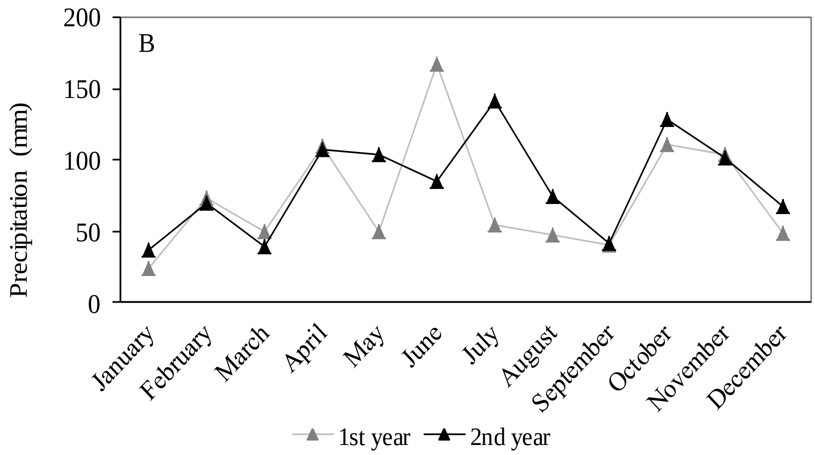

Figure 3. Data on temperature and amount of precipitation during the years of pollen collection (1991 and 1992) – Hydrometeorological station Zlatibor (northern latitude 43º 44'; eastern longitude 19º 43') (*www.hidmet.gov.rs*).

The distribution of the size and shape of pollen was made using the sample of all measured pollen grains from both years of collection. The largest percentage of pollen grains have a length in the range from 90 to 99 μm both in the first and in the second year (53.0% and 43.0%, respectively); the width of pollen ranges from 40-49 μm (51.8%) in the first year and 50-59 μm (39.0%) in the second year (Figure 5). Distribution of the size and shape of pollen was further related to the total number of analyzed trees. The highest percentage of trees both in the first (72.0%) and in the second year (83.3%) have pollen with the length (equatorial axis) in the range from 90 to 99 μm and width (polar axis) in the range from 50 to 59 μm (84.0% and 95.8% in the first and second year respectively). The highest percentage of trees in both years of research had the coefficient of pollen shape ranging from 50% to 59%, (66.6% and 48.0% respectively) (Figure 6).

In both years of research, some trees were always in the group with the largest pollen, among which tree marked 11 had the largest pollen amounting to 102.0 vs. 56.7 and 104.8 vs. 60.1 (first and second years respectively).

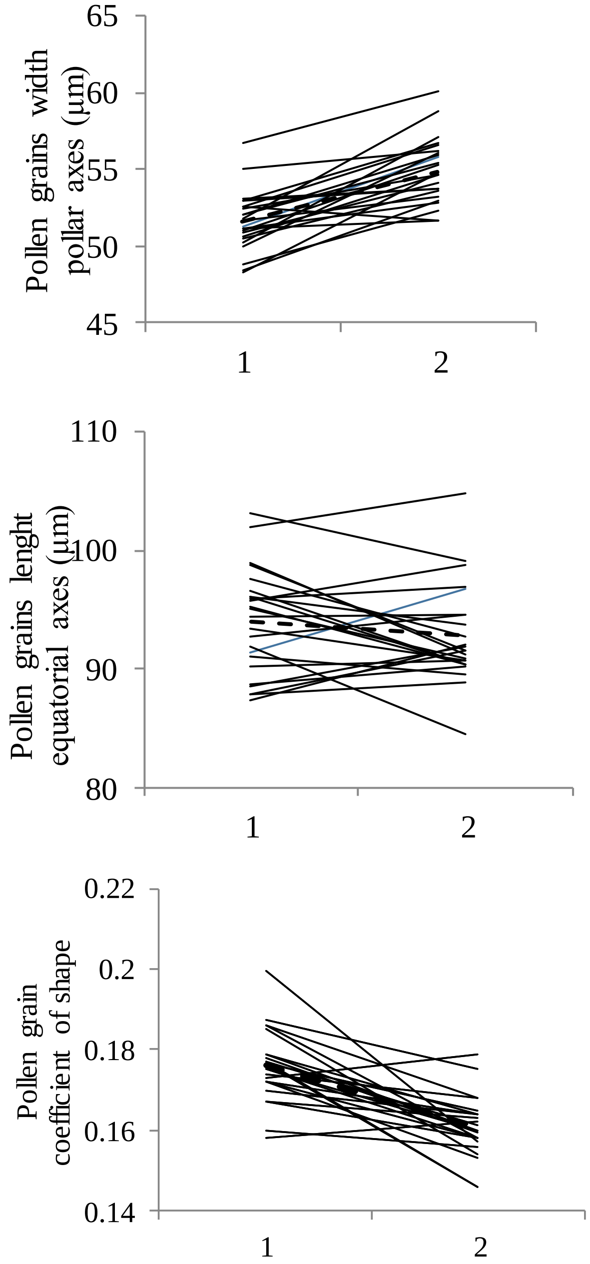

Figure 4. Reaction norms of *Picea omorika* morphological pollen traits in two successive years of observation (1st and 2nd year of observation; 1991 and 1992 respectively).

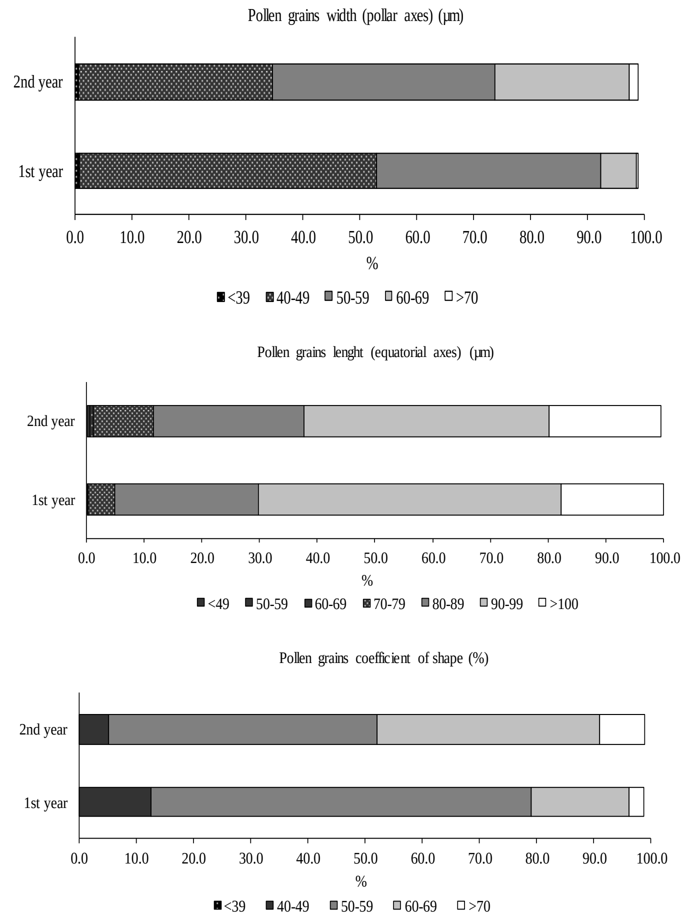

Figure 5. The distribution of pollen according to the value ranges for the equatorial (length) and polar (width) axes and *Picea omorika* pollen grains coefficient of shape (1st and 2nd year of observation; 1991 and 1992 respectively).

The results of the applied model of the analysis of variance confirmed that the climate factors of the study years (environmental variability) had statistically significant effects on the values of the equatorial axis of pollen grains (year effect $P < 0.05$). Interindividual variability (genetics) was statistically significant for all analyzed morphological traits of pollen (tree effect $P < 0.05$). The year x tree interaction was statistically significant for the width (polar axis) and the coefficient of shape of pollen grains, indicating that the differences between the trees depended on the climate factors in each of the study years (Table 2).

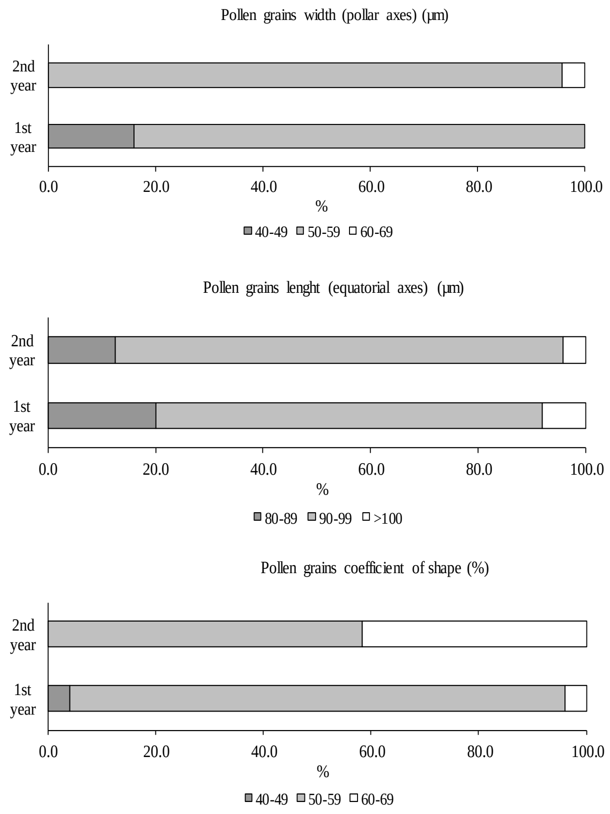

Figure 6. The distribution of trees according to the value ranges for the polar and equatorial axes and the coefficient of shape of *Picea omorika* pollen grains (1st and 2nd year of observation; 1991 and 1992 respectively).

Table 2. The analyses of variance (ANOVAs) were performed separately for each of the pollen morphological traits, with year and tree and their interaction as sources of variation (the year was a fixed and the tree was a random factor).

		Pollen polar axis (width) (µm)		Pollen equatorial axis (length) (µm)		Pollen grains coefficient of shape (%)	
Source of variation	df	MS	F value	MS	F value	MS	F value
Year	1	454.66	2.13	3289.82	60.06^{****}	0.067	46.82^{****}
Tree	23	698.82	3.28^{***}	149.61	2.76^{***}	0.002	1.38
Year x Tree	23	213.79	2.55^{****}	54.29	1.29	0.002	1.58^{*}
Error	1150	83.65		42.17			

* p < 0.05, ** p < 0.01, *** p < 0.001, **** p < 0.0001

Interindividual variability of the plasticity index was obtained for each of the analyzed morphological traits of pollen (Figure 7). The mean value of the plasticity index for all trees was the highest for the coefficient of shape (0.09) compared to the values of the plasticity index for the equatorial and polar axes (0.04 vs. 0.06). The coefficients of variation (CV%) of the plasticity index for the equatorial and polar axes and for the coefficient of shape of pollen grains were smaller and approximately the same for all properties (0.55, 0.59 and 0.61, respectively). The values of the plasticity index were the smallest for the equatorial axis of the pollen grain, and according to the F-test statistically significantly different compared to other traits (all <0.05) (Figure 7).

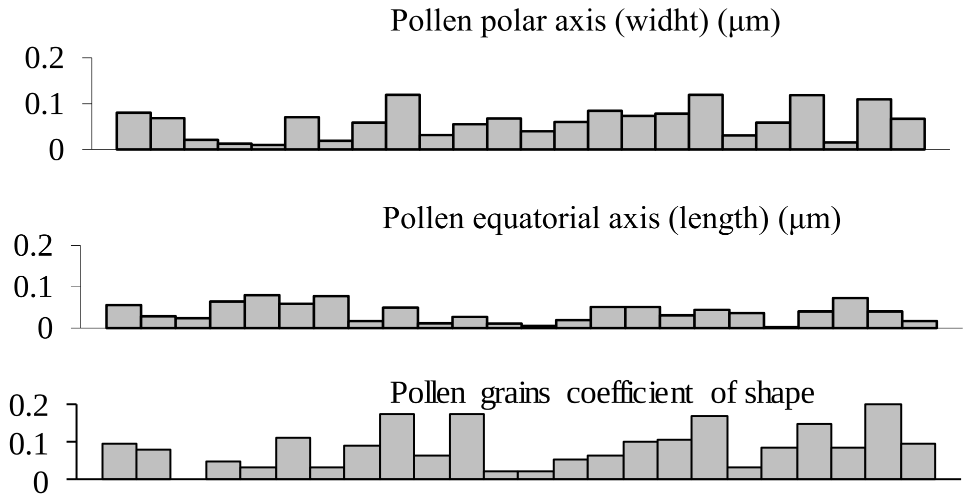

Figure 7. Values of polar (width) and equatorial axis (length) plasticity index and pollen grains coefficient of shape of the analyzed *Picea omorika* trees.

DISCUSSION

As global climate change alters the environment in which an organism exists, plasticity is one of the mechanisms that assistance organisms adapt to newly created conditions. According to current knowledge, phenotypic plasticity is determined by genetics and heredity and as such makes the important potential for the evolution of species. Plasticity is primarily a characteristic of a particular trait, which makes the knowledge of the extent of genotypic plasticity (their norm of reaction) necessary in breeding programs (NICOTRA *et al.*, 2010).

In the life cycle of plants, male fertility, production of viable pollen in heterogeneous environmental conditions is crucial for the plant sexual reproduction. According to the obtained results, plasticity is trait-specific. The plasticity index was the smallest for the equatorial axis of *P. omorika* pollen grains, while the values of the plasticity index for the polar axis and the coefficient of pollen shape were statistically several times higher. Interindividual variability was obtained for all the analyzed morphological traits of pollen grains, which indicates that genotypes (trees) had different capacities of response to changing environmental conditions in two successive years. The literature also states that the tree (genotype) is an important factor in the variability of pollen dimensions (BATOS, 2014). A high and variable degree of plasticity of pollen traits and the existence of the genotype-environment interaction enable the continuity of the genetic variability of pollen traits (DELPH *et al*., 1997). The results of the applied model of the analysis of variance proved the effects of environmental factors on the length or the equatorial axis of pollen grains. All the traits showed statistically significant variability between genotypes i.e. trees (genetic variability) as well as plasticity, i.e. statistically significant interaction (except for the length).

The reason for the low environmental response (lower values of the plasticity index, below 0.20; Figure 7) probably lies in the fact that the study years had similar climate conditions, so these preliminary results show that this kind of experiment should be carried out for a longer period of time. It is also important to include a greater number of traits. Apart from fertility traits, for instance, eco-physiological traits should be included. They would give a better insight into the adaptation of organisms to newly formed suboptimal environments.

The obtained values of pollen dimensions are in accordance with the literature data and classify Serbian spruce as a species with large pollen. Variability of pollen grain dimensions was confirmed not only between the analyzed trees (genotypes) but also within the samples of pollen harvested from the same tree (intraindividual variability). According to POPNIKOLA (1970), these differences are caused by different positioning of flowers in the tree crown, different nutritional conditions and the position of the anther in the inflorescence (the largest pollen is from the upper north and west facing part of the crown). In order to minimize this effect, microstrobiles were sampled only from one side of the crown, as indicated in the methods section.

Regarding the effects of the environment on pollen traits, the literature provides different data. This is mainly due to the synergy of a number factors and the inability to study their individual effects separately. VARIS *et al*. (2011) did not reach a clear conclusion about the effects of the pollen origin (provenance) and the temperature on the pollen size, germination and pollen tube growth of Scots pine (*Pinus sylvestris* L.) in Finland. The above-stated authors found that the pollen from northern populations was more hydrated and larger in size, while the pollen from southern populations had better germination rates and pollen tube growth. They also pointed to significant differences between genotypes. GRIENER *et al*. (2015) analyzed the size of *Nothofagus* pollen using 157 samples from a large area of the southern hemisphere and 458 Antarctic samples from the Eocene, Oligocene and Miocene periods. They concluded that during the geological epochs of the tertiary period, climate change and reduced moisture brought about an increase in the size of pollen, which is why they propose the use of pollen size in the reconstruction of changing climate conditions in the distant past.

According to JATO *et al*. (2002), pollen traits are particularly affected by temperatures and moisture in the months immediately prior to pollen maturation, when buds awaken from dormancy and pass into the growing phase. In our study, the analysis of temperature and precipitation at both the annual level and the months before the maturation of the pollen shows that in the year with higher temperatures and increased precipitation (the warmer but humid year) pollen was smaller (smaller value of the length-equatorial axis). The width of pollen grains or the polar axis had a different pattern of values: it attained higher values in the year with higher temperatures and increased precipitation and pollen grains were more spheroid in shape (Figure 4). According to EJSMOND *et al*. (2011; 2015), higher temperatures that increase desiccation rates make plants produce larger pollen grains and thus compensate for the lack of water. The results obtained herein lead us to the hypothesis on the effects of hydration on the shape of pollen. For more specific conclusions, it is necessary to continue the research for a longer period of time.

Literature provides controversial data regarding the correlation between the pollen size and its vitality. Some researchers do not have a clear position (VARIS *et al*., 2011 and references within), while others confirm the positive correlation between the size of pollen grains and the vitality of pollen (DOYLE *et al*., 2002; KELLY *et al*., 2002; ATLAGIĆ *et al*., 2009).

The direct correlation between the size and the vitality of pollen propose the size as a criterion in the selection of pollen in cases of controlled hybridization and selection of desirable genes when a quick assessment of the quality of pollen is required. In this sense, the results obtained from the study of marked trees that were always in the group with the largest pollen are very useful and a make a good basis for the future individual selection and other breeding methods.

According to the current literature findings, this is the first research on the plasticity index of pollen traits. These preliminary results justify future research of the plasticity not only of morphological traits of pollen but also of the vitality and energy of germination (the length of pollen tube) of one and several species in relation to the environmental factors. Furthermore, this kind of research can have an ecological aspect as part of the environmental monitoring pollution and climate change impacts. The monitoring of the pollen plasticity is important for the understanding of the scope of adaptation to the emerging changes in the environment in evolutionary aspect. The results presented are part of a multi-year experiment carried out on Picea omorika pollen grains. This experiment was conducted more than two decades ago (1991 and 1992) and it is a part of climate change monitoring for the Serbian spruce (*Picea omorika* /Panč./Purkyne) pollen morphological traits. In the coming years, it is planned to re-sample pollen from the same trees and locations in order to monitor the impact of global climate change in a long time scale. The results presented here are related to a part of analyzes carried out, while other analyzes are in preparation for publication. The results of this research can contribute to individual selection and breeding, as well as to the preservation of this important coniferous species - endemic and tertiary relict of the Balkan Peninsula.

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FENOTIPSKA PLASTIČNOST MORFOLOŠKIH OSOBINA POLENA *Picea omorika* /Panč./Purkyne

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Izvod

Indeks plastičnosti morfoloških osobina polena *Picea omorika* /Panč./Purkyne analiziran je na uzorku 24 stabla iz semenske sastojine na lokalitetu Bela Zemlja (planina Zlatibor, Republika Srbija) u dve sukcesine godine. Prema dobijenim rezultatima polenovo zrno omorike ima dimenzije 93.3 μm/53.2 μm i spljoštenog je oblika (57.5%). Klimatski uslovi analiziranih godina su inicirale različit odgovor osobina polena za svako stablo. Interindividualne razlike u vrednosti indeksa plastičnosti su zabeležene za sve analizirane osobine (ekvatorijana osa, polarna osa, koeficijent oblika). Norme reakcije su bile blago strme i ukrštale se što je i potvrđeno značajnom interakcijom faktora varijabilnosti godine i stabla. Plastičnost osobina polena ima značaja u kontrolisanoj selekciji i oplemenjivanju vrste u cilju dobijanja genotipova sa većom otpornošću i adaptacijom na fluktuacije sredinskih faktora izazvanih globalnim klimatskim promenama.

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