Marković, M., Gagić-Serdar, R., Rakonjac, Lj., Konatar, B., Lučić, A., Radovanović, T., Tešović, M. (2024). Research Of An Adult Woody Albino Mesian Beech Characteristics (Fagus Moesiaca, Asine Pigmente) In Central Serbia. , 70 (2): 171-182. https://doi.org/10.17707/AgricultForest.70.2.13

DOI: 10.17707/AgricultForest.70.2.13

Miroslava MARKOVIĆ[1], Renata GAGIĆ-SERDAR*[1], Ljubinko RAKONJAC [1], Bojan KONATAR [1], Aleksandar LUČIĆ [1], Tanja RADOVANOVIĆ[2], Marko TEŠOVIĆ [2]

RESEARCH OF THE CHARACTERISTICS OF AN ADULT WOODY ALBINO MESIAN BEECH (*FAGUS MOESIACA, ASINE PIGMENTE*) AS A TREE FORM IN CENTRAL SERBIA

SUMMARY

The paper presents the beginning of the research on the characteristics of albino beech in the Central Serbia region. The studied beech is perennial, of sprout origin, fruitful, and most likely parasitic on the parent tree, considering that its lack of chlorophyll renders it unable to feed and grow on its own. By measuring the physical characteristics of common and albino beeches that share the same root system, and by comparing the length and width of their leaves, the obtained results show that the leaves of albino beech are noticeably smaller. The average length of leaves of common beech is 7.19 cm, while the average length of leaves of albino beech is 6.08 cm. The average width of leaves of common beech is 3.83 cm, whereas the average width of leaves of albino beech is 3.35 cm. To achieve transpiration as a basic physiological function of any tree form, albinism causes significant weakening of the maximum strength and sap during water transport. Additionally, since the leaf is deprived of any of the essential pigments - chlorophyll (a, b, c, d), anthocyanin, carotene - this results in dwarf growth or the formation of bush-like forms of trees. For genome sequencing, it is planned to take samples of leaves with and without pigment and preserve them in liquid nitrogen at a temperature of -195°C in special canister freezers with liquid nitrogen. The view on the phenomenon and the potentially still unrecognized mechanisms of functioning of the plant itself, as well as the plants around it, fungi associated with its root system, or even the discovery of a completely new network or system of connections, remains to be uncovered. What enables the nutrition and influx of basic sugars into this plant may be revealed through the sequencing of its entire genome, which is a basic, logical, and one of the first steps to be taken. The exact location of the plant is kept confidential at this time.

Keywords: beech, albinism, chlorophyll, parasitism, mycorrhiza, Serbia

[1] Miroslava Markovic , Renata Gagic-Serdar *(corresponding author: serdarrenata79@gmail.com), Ljubinko Rakonjac; Konatar Bojan, Lučić Aleksandar, 1Institute of Forestry, Kneza Višeslava 3, 11030 Belgrade, Serbia

[2] Radovanović Tanja, Tešović Marko, Forest enterprise „Srbijašume, Forestry holding „ Niš“, Prvomajska 4b, Serbia

Notes: The authors declare that they have no conflicts of interest. Authorship Form signed online.

Recieved:15/05/2024 *Accepted:21/06/2024*

INTRODUCTION

Albinism (from Latin *albus*: white) occurs in both animals and plants and is defined as a congenital or hereditary inability of an organism to produce pigment or coloration. Albinism is a recessive gene and usually results in reduced chances for survival of such organisms. The probability of the occurrence of albinism is 1 in 20,000, but the occurrence of albinism in plants means that due to the lack of chlorophyll pigment (a, b, c, or d), they are unable to transform solar energy into food. As a result, after seed germination, they usually do not live more than a few days or weeks, making the presence of adult albino individuals extremely rare worldwide.

The snow-white color of leaf tissue is due to the partial or complete loss of chlorophyll pigments and the incomplete differentiation of chloroplast membranes, which hinders or completely prevents photosynthesis, a process that plays a crucial role in the growth and development of plants (Kumari *et al*, 2009). Therefore, if chlorophyll is absent or deficient for any reason (primarily due to mutations), or if the chloroplast as an organelle is not functioning properly, it leads to a highly probable fatal outcome for the plant organism.

It is important to note that just as an albino person must take protective measures, a plant must do the same, although it is far more complex in its case. At the beginning of the development of an albino plant, there are certain mechanisms that allow it to nourish itself and develop its first leaves, enabling it to begin continuous and reliable self-care (seed reserves or direct connection with a neighbor). These are nutrients in the form of fats contained in the tissue within the cotyledons. By breaking down these molecules, the plant obtains more than enough energy to sprout into the beginnings of a stem and root and to produce its first white leaves. Once these nutrients are completely used up, the plant without chlorophyll depletes all its reserves, after which it will not be able to survive on its own and will soon wither, thus ending its life cycle. Given that the albino plant lacks the ability to develop reproductive organs, it prevents the possible error from spreading to its offspring, as anticipated by evolution. However, this phenomenon has also been observed later on in the development, allowing some plants to mature to a level of fertility and thus leave offspring that inherit these traits. Naturally, the development of these albino plants is not due to chlorophyll (any type from a to d), but possibly to a range of factors: genetic mutations, extremely complex interactions between spatially close living organisms, perhaps a pigment that doesn't behave like the others – some new and unique environmental conditions...

One of them is a specific phenomenon involving fungi - mycorrhiza. Characterized as a type of interspecies relationship between two or more organisms, mycorrhiza conditions or facilitates their survival by participating in the transport of molecules between the fungal mycelium and the plant's root system. If such a mutated albino specimen occurs, it manages to survive and develop into an adult exclusively by parasitizing the fungus (more as a symbiont than a kleptoparasite, as the fungus also stores nitrogen from the air in this manner). Such individuals are known as mycoheterotrophs. The most well-known example of a mycoheterotrophic

plant is *Monotropa uniflora* (Yang and Pfister, 2006). As a mycoparasite, it draws from the mycelium in the existing mycorrhizal network between fungi (which were determined to be mostly from the genus *Russula*) and conifers, obtaining sugars originating from the conifers that were originally destined for the fungus. This makes it a true, adapted albino individual, enabling it to live a full lifespan despite a trait that would in nature almost certainly result in its shortened life expectancy.

Another exception is found in the albino sequoias (*Ghost sequoia*; for normal trees with half plant organ *pigmente chlorophille* possession it is *S. giganteum*, (Lindl.) J.Buchh., 1939), where specimens over 100 years old and up to 20 meters in height have been found. These trees propagate through propagules - underground stems from which new individuals emerge. They feed on roots, thus behaving as parasites. The tree parasitized by the albino specimen does not reject it because concentrations of toxic metals within the white needles (nickel, cadmium, copper, etc.) are deposited far from the photosynthetic leaves, thus not hindering their function, giving these mutated individuals an adaptive advantage.

The albinism of the specimen described herein - the beech from the Central Serbia area, which is surviving with all vital organs intact, has so far never been recorded anywhere, nor have similar specimens been documented or described in the entire global flora. Since this is a sprout stand and an ancient, decayed, shared root / root flare (conditionally speaking), the discussion chapter mentions the surrounding plants as being directly or indirectly linked to this system. The potential connections could include proximity, links to the same decayed branch in the ground, or something that is yet to be explained but cannot even be surmised at this time. This truly unique research on the albino beech as a flowering plant from the family Fagaceae and as a specific discovery could offer an entirely new perspective, possibly even shedding light on phenomenological aspects and perhaps even unrecognized mechanisms of the plant's functioning, the plants around it, fungi associated with its root system, or even the discovery of a completely conditionally termed new network or system of connections that enable the nutrition and supply of basic sugars to this plant. Considering that it evidently does not produce them on its own, or it does so by a yet unknown method, this should be elucidated as soon as possible - even during this vegetation season, phenology allowing. As science would suffer a significant loss if this specimen were to perish by tragic circumstance, the related work should be highly prioritized and expedited, precisely because of the value of this singular specimen.

MATERIAL AND METHODS

Samples for analysis were taken from a beech stand on a private property, in the area of the Municipality of Aleksinac, Golešnica cadastral municipality. The albino beech, several years old, is of sprouting origin (growing out of a stump). The terrain is inaccessible and very steeply sloped, at the elevation of 600.049 meters above sea level and the eastern exposure.

On April 18, 2024, soil samples were collected using the standard method at depths of 0-10 cm, 10-20 cm, and 20-30 cm for the following pedological analyses:

active and exchangeable acidity; accessible forms of P_2O_5 i K_2O; total humus and nitrogen; soil texture composition. If the pH in KCl is less than 7, hydrolytic acidity and base sum will be examined, and if the pH is greater than 7, the content of free carbonates will be assessed.

Samples of the roots of the albino beech were collected using a random sampling method for potential examination of the presence of mycorrhizal fungi. At the same time, samples of leaves with and without pigment were collected in order to measure their physical characteristics (leaf length and width) and chemical composition (content of toxic metals within albino leaves - nickel, cadmium, and copper).

For the purposes of genome sequencing, samples of leaves with and without pigment will be collected and preserved in liquid nitrogen at a temperature of -195°C using special canister freezers.

RESULTS AND DISCUSSION

However unfavorable albinism may be viewed as a characteristic in nature, it is evident that it manages to find a way to survive and contribute to the already rich diversity of the plant world.

The examined albino beech specimen is surrounded by several beech trees without any signs of mutations (with green leaves) that originate from the same stump (picture 1), suggesting that it feeds and develops at the expense of the parent root system. The albino beech is spherical in shape, about 50cm tall, with the presence of fruit cupules observed on it (picture 2).

Picture 1. Appearance of the albino beech specimen

Picture 2. Fruit of the albino beech

Picture 3. Leaf of the albino beech

Picture 4. Geometridae on an albino leaf

Picture 5. Albino leaf damage

Table 1. Dimensions of leaves from albino and green beech collected from the same root by random sampling

No.	Leaf length (cm)		Leaf width (cm)	
	Albino	Green	Albino	Green
1	6.8	3.7	7.1	4.5
2	7.5	4.3	4.3	2.5
3	7.4	4.4	7.8	4.3
4	5.6	3.5	5.6	3.4
5	7.0	4.0	9.4	5.2
6	7.5	3.6	9.2	4.7
7	7.2	3.5	7.0	3.6
8	6.6	3.5	8.0	3.8
9	2.6	1.2	7.5	3.9
10	7.1	3.6	7.9	3.9
11	4.4	2.3	5.2	2.7
12	3.1	1.4	7.8	4.3
13	7.0	3.8	7.0	3.5
14	8.2	4.8	6.6	3.5
15	3.4	1.5	3.9	1.8
16	6.8	3.6	8.5	4.5
17	7.1	4.0	7.6	3.7
18	5.2	2.4	8.9	4.9
19	7.4	4.3	8.0	4.1
20	5.9	3.5	5.0	2.7
21	7.7	4.4	8.5	4.5
22	3.5	1.5	6.6	3.3
23	6.5	3.7	6.8	3.6
24	2.5	1.2	8.5	5.0
25	6.3	3.6	4.6	2.4
26	7.2	4.1	7.2	3.6
27	5.5	3.4	7.8	4.1
28	6.7	4.3	6.6	3.8
29	6.1	3.5	9.0	4.7
30	6.6	3.9	7.7	4.3

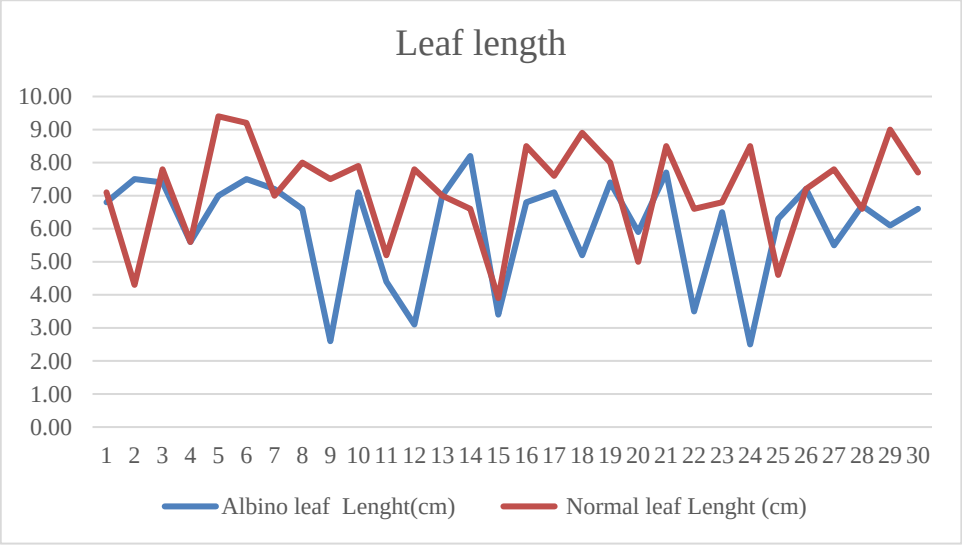
The occurrence of a beech with snow-white leaves was first noticed in the fall of 2022 by the owner of the forest. The leaves of this beech are of pure white color (Image 3), very thin and silky compared to the green leaves of the surrounding trees. During the control inspection in April 2024, a noticeably higher presence of defoliators –winter moths (Geometridae) (Picture 4) was recorded on these leaves, as well as damage to the leaf mass - chew marks (Picture 5), which is a consequence of the extremely soft leaves that caterpillars can chew more easily. The goals and

main purpose of the research is precisely the importance of further examining the importance of beech forests in Europe and further studying them as an ecosystems.

Physical characteristics of the examined leaves of *Fagus moesiaca, asine pigmente* - albino beech

The leaves of the albino beech are of regular shape, somewhat smaller in size than the green leaves (Table 1), while this year's twigs are light, pale pink in color.

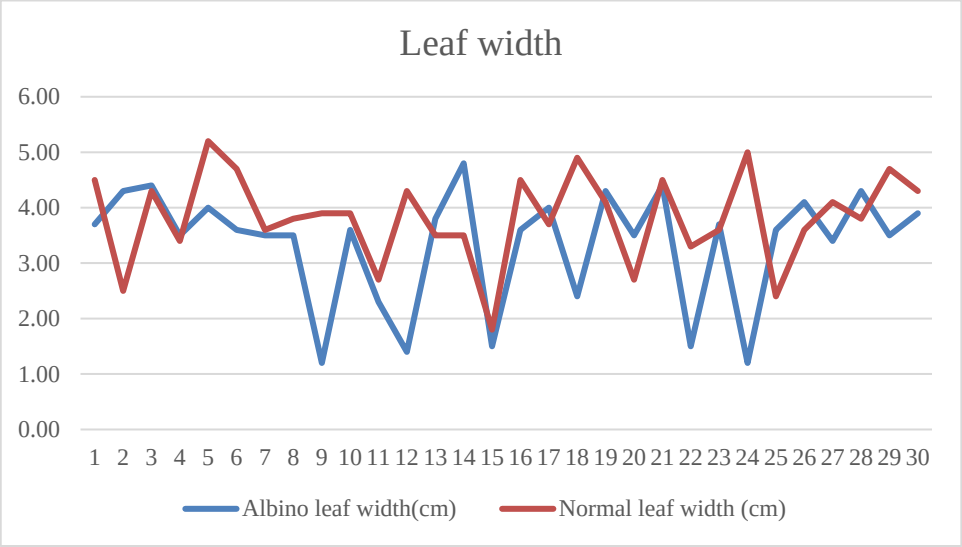
According to the literature sources (Silva *et al.*, 2020), albino plants exhibit reduced growth, which is why a comparison of the leaf sizes of white and green beech was performed. Graph 1 shows the leaf length of the albino beech and the common beech from the same site. The parameter used for the graph is leaf length. For the purposes of comparison, 30 leaves of each type were measured. It is apparent that the leaves of the common beech are somewhat larger, with the maximum length being 9.4 cm, while the longest leaf of the albino beech is 8.2 cm. The average leaf length of the common beech is 7.19 cm, while the average length of the albino beech leaves is 6.08 cm. It can also be observed that in the selected sample of 30 measured leaves, 24 leaves of the common beech were longer than those of the albino beech. In other words, 80% of the albino beech leaves in the sample recorded smaller dimensions when length is used as the parameter.



Graph 1. Leaf length of the albino and common beech

Graph 2 shows the comparison of the leaf width of the albino beech and the common beech from the same site. The parameter used for this graph is leaf width. It is apparent that once again, in this case, the leaves of the common beech are somewhat larger, with the maximum width being 5.2 cm, while the widest leaf of the albino beech has a width of 4.8 cm. The average width of the common beech leaves is 3.83 cm, while the average width of the albino beech leaves is 3.35 cm. It can also be observed that in the selected sample of 30 measured leaves, 24 leaves of the common beech were wider than those of the albino beech. In other words, 60% of

the albino beech leaves in the sample recorded smaller dimensions when width is used as the parameter.



Graph 2. Leaf width of the albino and common beech

Diagram 1. Difference between the average size of albino and green leaves

Diagram 1 shows the difference between albino and green leaves, with the note that average values were used for the illustration. The larger, dark green leaf represents the common beech and has a width of 7.19 cm and a length of 3.83 cm, while the smaller, light leaf represents the albino beech and has a width of 6.08 cm and a length of 3.35 cm.

Height and thickness characteristics and causes of the dwarf and bushy form of the specimen *Fagus moesiaca, asine pigmente* - albino beech

In plants with chloroplasts without pigment, the absorption through the root and the pressure necessary for the transport of water from the root to the leaf would be too weak for heights over 1-1.5 meters (Wheeler-Dubas 2017, taken from https://simbioza.bio.bg.ac.rs/albino-biljke/). To achieve transpiration as the basic physiological function of any tree form, this would be the maximum power and reach for water transport when the leaf is devoid of any of the essential pigments: chlorophyll (a, b, c, d), anthocyanin, carotene... Anything contrary in terms of trunk length and height, due to the basic laws of physics, would be an insurmountable problem and could even kill the plant, especially during the period when dormancy ends - that is, when vegetation survives the winter. The sap flow, i.e., the strong movement of plant juices through the vessels of the xylem and phloem from the root hairs to the stomata and vice versa (but with assimilation solutions) where transpiration and water release occur, would be impossible. The existence of another plant and its connection to it would be, hypothetically speaking, sufficient to sustain a specimen with dwarf characteristics, but only those that are related to and connected with the morphological traits of a specimen with such chloroplast structure - organelles with such pigmentation, and even without any pigment. In short, the existence of a connection with another specimen explains the height, i.e., the lack of potential for this beech to achieve even the average height and thickness growth typical for the species over the years. Albinism brings with it a dwarf form, limited growth, and the expected formation of multiple shoots similar to bushy forms in tree forms (taken from http://bioloska.blogspot.com/2012/12/albino-biljke-bez-zelenog-hlorofila-u.html).

The peculiarity of entomological damage on *Fagus moesiaca, asine pigmente* - albino beech

The coloration or mimicry of early oak defoliators from the family Geometridae - winter moths varies from light brown and reddish-brown to green in different shades. Insect species that generally live in Central Serbia, due to the dominant acting agents (adaptation to the environment and coloration derived from food), are mainly brown, green, or yellow-green in color. In the case of darker colors, they originate from tannins proved to be secreted by all attacked plants, or from other pigments when these pigments are the main component of their diet. This is especially true for specimens whose assimilation organs are the main source of nutrients. It is important to note that on-site (on the leaves of the described beech specimen), there were two larvae of the large winter moth found: one almost completely white, and the other beige in color (Picture 4), which specifically indicates and correlates with the coloration of the branches, which are reddish-pink, and the snow-white leaves. Just as it is characteristic of albinism in the animal kingdom, systematically categorized into the classes of reptiles, birds, and mammals, albinism is marked by the absence of melanin pigment and the reddish-pink coloration of the irises. It appears that our (human) vision is capable of recognizing colors of this spectrum in the same way.

Albinism as a phenomenon in plants of different systematic affiliations in *Fagus moesiaca, asine pigmente* - albino beech

Similar to parasitic plants and mycoheterotrophs, chlorophyll (i.e., photosynthetic capacity) may be lacking, but such plants are forced to live in symbiosis with fungi that obtain food from autotrophic plants (mycorrhiza). Although this relationship can even lead to the death of the host, mycoheterotrophic plants are not classified as parasites because they do not harm the host, which is the case with the examined beech specimen. All specimens of the same species in the immediate vicinity are in optimal health and vitality, without visible changes in defoliation or chlorosis, and even healthier with regard to the presence of damage. Mycelium, or the tissue or hyphae of fungi, is present, connecting root systems through a mechanism called mycorrhiza. Mycorrhiza is generally associated with the Fabaceae family in nature, so these fungi (among beeches) need to be thoroughly investigated (Yang & Pfister, 2006). Since these are not semi-parasitic plants (i.e., specifically the analyzed albino specimen), it is logical that they also lack the basic organs typical for them –haustoria, and nothing resembling such a connection has been observed. This separation in this sense is clearly visible.

Due to the exclusion of this phenomenon, haustoria (from Latin *haurire* - to draw, absorb) or so-called suckers are a specific type of organ in parasitic and semi-parasitic flowering plants that grow into the body of the host plant, from where they extract nutrients. The widely known orchids are a typical example (Wheeler-Dubas, 2017; accessed on April 29, 2024).

Another option that was taken into consideration is the so-called Beechdrops (‘beech tears”) event. Plants exhibiting this phenomenon show an intriguing characteristic of producing two types of flowers and the way in which pollination occurs. The first type has open corollas (chasmogamous inflorescences), where cross-pollination typically occurs, usually at the top of the inflorescence. In the second case, with closed (cleistogamous) flowers, self-pollination is evident, most often at the base of the inflorescence. This is particularly noticeable during mass flowering in the spring, as seen in Picture 6, where these flowers are quite large and prominent (http://dept.ca.uky.edu/PLS220/Formparasite.pdf).

Regressive evolution in *Fagus moesiaca, asine pigmente* - albino beech

Albino flowering plants (like the beech described here) are often the result of regressive evolution, which, along with the absence of chlorophyll in holophytes, is a phenomenon and deviation that merits detailed and thorough investigation of individual genes, groups of genes, or entire sequences within the genome. This can be done using the latest methodology which currently being developed. In typical and state-of-the-art research of this phenomenon, called DNA sequencing, the 3D spatial structure of the chlorophyll molecule from the organelle – chloroplast - is shown in Diagram 2, while the material for these studies is taken from the nuclear content.

The next step would be a fully focused examination of the moot sequence or gene group, but it is possible that due to the uniqueness, intriguing nature, and

exceptional rarity of this phenomenon that is referred to as pigment-less (a, b, c, d) phenomenologically explainable occurrence, the work must entail a well-organized verification of all physiological and vital characteristics of the living plant. Upcoming examinations will involve the entire chromosomal content—the entire mentioned genome of this specimen - precisely because of the relatively new characteristics of chlorophyll that are still being studied, but also for all the reasons mentioned above. On this basis, it is expected that findings will be made and that conclusions will be drawn, which are either partially known or entirely unknown, similar to the results of previous studies conducted worldwide. This is further evidenced by the limited scope in the search for the existing references on albino flowering plants (Angiospermae). Albinism and these plants - the beech from the Central Serbia region, which survives with all its vital organs –do not exist at this time, and only those indirectly related to this phenomenon are mentioned here. According to Candeias M. (2016), among flowering plants or the clade of higher plants, angiosperms [Angiospermae, flowering plants] - here specifically tree forms - this phenomenon is more frequent and linked to the group of semi-parasitic flowering plants—orchids, in which the mechanism of so-called pseudo-kleptoparasitism in feeding has already been explained and studied (retrieved November 14th, 2022).

Picture 6. The appearance of inflorescence of *Fagus moesiaca,* February 20, 2024. Site Kraljeva stolica, Fruška Gora ***Original***

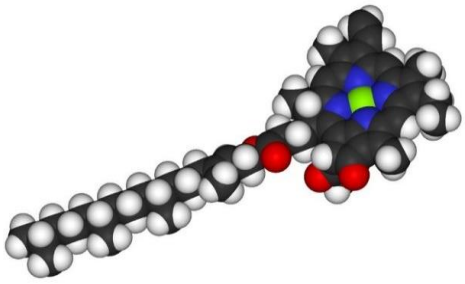


Diagram 2. Spatial model of a chlorophyll molecule, absorbing light in blue (430-490 nm) and red (630-760 nm) parts of the spectrum –where is the green color coming from, ref. [*Monotropa uniflora*, Retrieved November 14, 2022]

However, the study of the beech as a flowering plant from the family Fagaceae may contain entirely new insights into this phenomenon and possibly yet

unrecognized mechanisms of the plant's functioning, the plants around it, fungi associated with the root system, or even the discovery of a completely new network or system of connections that enables the nutrition and supply of basic sugars to this plant, considering that it evidently does not produce them itself [(https://www.enciklopedija.hr/clanak/regresivna-evolucija.;Virtanen *et al.*, 2020)].

CONCLUSIONS

By measuring the physical characteristics of common and albino beeches that share the same root system, and by comparing the length and width of their leaves, the obtained results show that the leaves of albino beech are noticeably smaller. The average length of leaves of common beech is 7.19 cm, while the average length of leaves of albino beech is 6.08 cm. The average width of leaves of common beech is 3.83 cm, whereas the average leaf width of albino beech is 3.35 cm.

A pedological analysis is currently under way to perform the following examinations: active and exchangeable acidity; accessible forms of P_2O_5 i K_2O; total humus and nitrogen; soil texture composition. If the pH in KCl is less than 7, hydrolytic acidity and base sum is examined, and if the pH is greater than 7, the content of free carbonates is assessed.

The examination of the chemical composition of leaves (in particular concentration of toxic metals within albino leaves – nickel, cadmium, and copper) is also in progress.

The sequencing of the genome of albino and green leaves is planned. Continued research is undertaken in order to determine the cause of this mutation and the formation of this extremely rare adult albino beech specimen, but in particular in order to determine the conditions under which it survives in nature and successfully bears fruit.

The conclusions determined by systematic affiliation about albinism as a phenomenon are that this occurrence is more common in lower plants—ferns, Pteridophyta (Pallardy, 2018), then gymnosperms, with the most well-known example being the sequoia [*Sequoia sempervirens* (D. Don) Endl. Gymnospermae]. This occurrence can be caused by both cross-pollination and self-pollination, as seen in this exceptional and very rare specimen - *Fagus moesiaca asine pigmente chlorophyll* (*a, b, c, d*), found right here in Serbia.

ACKNOWLEDGEMENTS

This study was carried out within the Agreement on realization and financing of scientific research work of NIO in 2024, which is financed by the Ministry of Science, Technological Development and Innovations of the Republic of Serbia no. 451-03-66/2024-03/200027 dated February 5, 2024.

REFERENCES:

Candeias, M. (2016. August 7th). Albino Redwoods. *In Defence Of Plants*. https://www.indefenseofplants.com/blog/2016/8/7/albino-redwoods

Candeias, M. (2019. October 19th). Mutant Orchids Have a lot to Teach Us About Parasitic Plants. *In Defence Of Plants*. https://www.indefenseofplants.com/blog/2019/9/4/mutant-orchids-have-a-lot-to-teach-us-about-parasitic-plants

Kumari, M., Clarke, H. J., Small, I., & Siddique, K. H. M. (2009). Albinism in Plants: A Major Bottleneck in Wide Hybridization, Androgenesis and Doubled Haploid Culture. *Critical Reviews in Plant Sciences*, 28:6, 393-409, DOI: 10.1080/07352680903133252

Monotropa uniflora. (n.d.). *The Botanical Society Of America*. Retrieved November 14th 2022. https://cms.botany.org/home/resources/parasitic-plants/monotropa-uniflora.html

Pallardy, R. (2018. April 8th). Botanical albinos: The science behind plants without chlorophyll. *Earth*. https://www.earth.com/news/albino-plants-without-chlorophyll/

Silva, L.A.S., Sampaio, V.F., Barbosa, L.C.S., Machado, M., Flores-Borges, D.N.A., Sales, J.F., de Oliveira, D.C., Mayer, J.L.S., Kuster, V.C., Rocha, D.I. (2020): Albinism in plants – far beyond the loss of chlorophyll: Structural and physiological aspects of wild-type and albino royal poinciana (*Delonix regia*) seedlings, Plant biology, Volume 22, Issue 5, pp 761-768 https://doi.org/10.1111/plb.13146

Wheeler-Dubas, M. (2017. August 17th). The Plant Without Chlorophyll. *Biophilia: Pittsburgh*. https://www.phipps.conservatory.org/blog/detail/biopgh-blog-the-plant-without-chlorophyll#

Yang, S., & Pfister, D.H. (2006). Monotropa uniflora plants of eastern Massachusetts form mycorrhizae with a diversity of russulacean fungi. *Mycologia*, 98:4, 535-540, DOI: 10.1080/15572536.2006.11832656

WEB LITERATURE:

http://bioloska.blogspot.com/2012/12/albino-biljke-bez-zelenog-hlorofila-u.html Pristupljeno 19. 04. 2024.

https://simbioza.bio.bg.ac.rs/albino-biljke/ Pristupljeno 09 - 19. 04. 2024.

http://bioloska.blogspot.com/2012/12/albino-biljke-bez-zelenog-hlorofila-u.html

Haustorij(e). Hrvatska enciklopedija, mrežno izdanje. Leksikografski zavod Miroslav Krleža, 2013. – 2024. Pristupljeno 29.4.2024.

https://www.enciklopedija.hr/clanak/haustorij

Parasitic plants, PDF (PPP), Root-attached parasites or Beechdrops (*Epifagus americana*) - a holoparasitic plant specific to beech (*Fagus*) tree roots. http://dept.ca.uky.edu/PLS220/Formparasite.pdf Pristupljeno 10.04.2024.

Regresivna evolucija. Hrvatska enciklopedija, mrežno izdanje. Leksikografski zavod Miroslav Krleža, 2013. – 2024. Pristupljeno 29. 04. 2024.

https://www.enciklopedija.hr/clanak/regresivna-evolucija.

Virtanen O., Constantinidou E., Tyystjärvi E. (2020). „Chlorophyll does not reflect green light – how to correct a misconception". *Journal of Biological Education*. 56 (5): 1—8. doi:10.1080/00219266.2020.1858930