

Inheritance of Type of Tree Habit in *Vilina bukva* Beech Population from Čajnice

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Abstract

According to the oral tradition, four to five degrees of kinship back, at the locality of the village of Batočići, the hamlet of Bare, the municipality of Čajnice – Republic of Srpska in BiH, there was an appearance of a tree with atypical sympodial graft in the spiral or alternating position of annual growth with a different tendency of negative heliotropism. This tree reached a height of up to 20 m and died at the age of about 170 years. According to the oral tradition, after a longer period, between two and three degrees of kinship backward, the appearance of new single beech trees with the same characteristics in the formation of habit was observed. These new trees appeared successively in a relatively narrow space around the first tree, which for this reason was called the "Mother of Fairy Beech". Morphological characteristics of tree habit in this beech population conform with the variety of "tortuous beech" *Fagus sylvatica* var. – *tortuosa*, as well partly conforming to the variety of "weeping beech" *Fagus sylvatica* var. *pendula*. In this research, the question of inheritance of irregular sympodial branching with a tendency of negative heliotropism in the population of "Fairy Beech from Čajniče" has been raised, regardless of the characterization of the varieties. Thus, in the population of *Fairy Beech* from Čajniče, which makes about 40 trees in relatively close surroundings, four trees aged over 30 years have been identified in order to determine whether their tree form is reproduced by vegetative cloning and generatively, by seed. The research was conducted in the period from 2014 to 2016 at the Institute for Genetic Resources of the University of Banja Luka. The results show that the form of habit of all four parent trees are conveyed by branching as well as by seed, which proves that there was a mutation of the first tree, i.e. the mother of *Fairy Beech* from Čajniče, which is transmitted to the offspring.

Key words: negative heliotropism, grafting, seedlings

Introduction

In the populations of beech *Fagus sylvatica* L. in natural habitats in Europe, there are sporadic occurrences and varieties of "tortuous beech" *Fagus sylvatica* var. *tortuous* and "weeping beech" *Fagus sylvatica* var. *pendula* (Packham, 2012). Research suggesting certain differences in genetic characterisation between the two varieties (Gallois et al., 1998, Gallois et al., 1999) are not decidable, and therefore the morphological appearance of the tree is taken as the basic indicator of this property.

Namely, the variety "tortuous beech" forms a tree with irregular branching in the spiral or alternating position of annual increments with different tendency of negative heliotropism. The variance "weeping beech" forms a tree with minor irregularities in branching in accordance with the spiral or alternate position of annual skeletal increments and the formation of long one-year increments that exhibit a strong tendency of geotropism, that is, they fall or hang from the very point of branching (or tissue injury).

In the locality of the village of Batočići, the hamlet of Bare, the municipality of Čajniče, in the Republic of Srpska, Bosnia and Herzegovina, a spontaneous population of beech trees was noted, which can be morphologically classified as the variety "tortuous beech" – *tortuosa*, although numerous increments appear in these trees conforming to the variety "weeping beech" – *pendula*. The open question of genotypic characterization in these studies is also the fact that the analyses relate to the individual trees of generative origin in the beech populations or single seeded trees, which also raises the question of the genotypic characterization of parents.

The description and representation of the tree with atypical branching in spiral or alternating position of the annual increments with different tendencies of negative heliotropism at the locality of the village of Batočići, the hamlet of Bare at an altitude of ≈ 1080 m, where they occurred, was repeated on several occasions (Đurić et al, 2016).

Based on these data it is evident that in the locality of the village of Batočići, the municipality of Čajniče, there appeared a certain number of beech trees with a characteristic growth, conforming to the variety "tortuous beech" – *tortuosa* and partly to "weeping beech" – *pendula*.

In this study, the emphasis was not on genotypic characterization and the difference of varieties, *tortuosa* or *pendula*, but an open question was raised pertaining to the inheritance of the property of irregular sympodial branching with the tendency of negative heliotropism in the population of "Fairy Beech from Čajniče".

The population of "*Fairy Beech* from Čajniče"

For this research, it is important to ascertain that, according to the oral tradition of the hamlet of Bara and the village of Batočiči, it can be concluded that at this site, at least four to five degrees of kinship back, i.e. about 170 years ago, one tree appeared reaching the height of up to 20 m with successive formation of one-year increments in spiral and irregular order with a tendency of negative heliotropism. According to the oral tradition, numerous miraculous properties were attributed to the appearance of this tree, due to its specific appearance, and therefore its name "*Vilina Beech*" / *Fairy Beech* (Mičić and Đurić, 2017). According to the same tradition, at least three to four degrees of kinship back, the successive emergence of new single beech trees with the same characteristics of branch formation was recorded in a relatively close environment of the first tree - "*Vilina Beech*". The consecutive appearance of these individual trees with a certain time distance has led to the fact that it was the first such tree, which was called the "Mother of *Vilina Beech*" (Fig. 1).

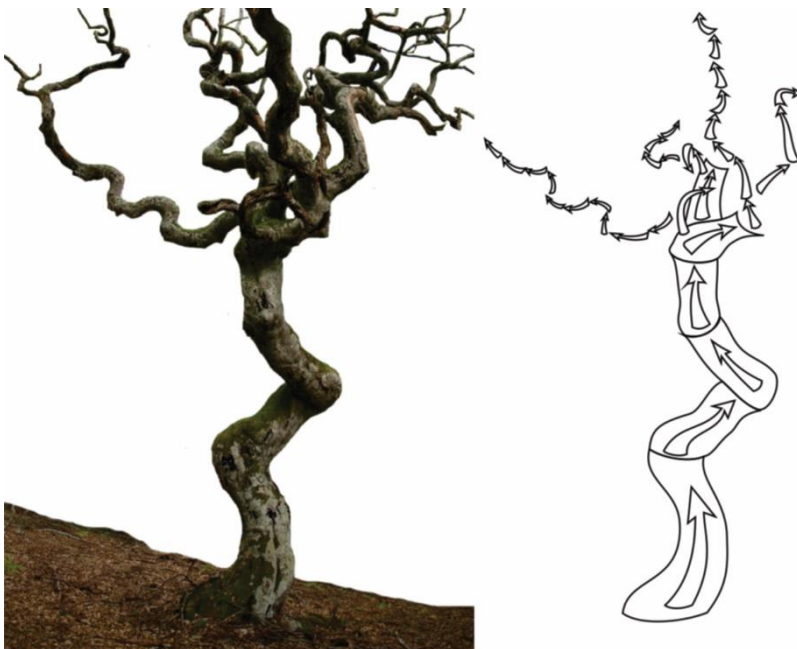


Fig. 1. Dried tree of the "Mother of *Vilina Beech*" from Čajniče, with a schematic overview of one part of the growth path of annual increments of the tree

Due to the specific relationship of the local population towards these trees¹, at the locality of the hamlet of Bara, the village of Batočiči, a spontaneous population of ≈ 40 beech trees was created which was called "*Vilina* Beech from Čajniče".

The first study of beech populations called "*Vilina* Beech from Čajniče" was carried out at the Institute for Genetic Resources of the University of Banja Luka.

Bearing in mind that perennial continuity led to the appearance of individual beech trees with a characteristic form of habit, an open question was raised whether this phenomenon was inherited or it was a certain morphism of unknown cause, which was the very aim of this research.

Material and Methods

The development and basic morphological characteristics of the growth of beech trees with irregular branching in spiral or alternating position of annual increments with different tendencies of negative heliotropism at the locality of the hamlet Bare, the village of Batočiči near Čajniče, show some differences that can be visually linked with the degree of insolation of these trees (Fig. 2). The differences in the form of spontaneously formed trees in the population of *Vilina* Beech from Čajniča should be considered in conjunction with the different genetic constitution, given their generative origin, that is, the fact that these trees are spontaneously formed from seed of different genetic constitution of parents.

The open question about the occurrence and spontaneous spread of this beech population is whether there is a mutation that affected the first parent tree - the "Mother of *Vilina* Beech" or this phenomenon may be related to a certain morphism conditioned by an unknown factor of habit.

¹ The appearance of the first beech tree with unusual branching and growth, according to oral tradition was given certain mythological properties by the local population. First of all, thunders avoided hitting this hut at an altitude of about 1100 meters, which had been a regular occurrence, and then the breaking of branches or the breaking of these trees in the family of the perpetrator caused unexpected and premature deaths. Retellings from one generation to another, about the connection of the "*Vilina* Beech" tree with unexplainable events, had the consequence of the paternal protection of this phenomenon by the local inhabitants, and ultimately only to recording their representation, i.e. a successive emergence of individual trees in the immediate environment. The specific relationship of inhabitants to these trees is documented by the fact that the first tree in this locality was called the "Mother of *Vilina* Beech", and once dried (it is estimated that it had been over 150 years old), it stood for years as a monument with which people continued having a mythological relationship.



Fig. 2. Different forms of trees in the population of *Vilina* Beech from Čajniče (the tree shown on the left is alone at the foothill, i.e. it is exposed to constant sunlight, whilst the tree on the right is in the forest stands and occasionally exposed to sunlight).

The research covered four vital trees over 30 years old with certain differences in their very morphology (close to the variety of *tortuosa* and with some morphological elements of the *pendula* variety). Parent trees were marked with VB1, VB2, VB3 and VR4. In the autumn of 2013, seeds were collected from these parent trees by collecting husks with mature seeds. The seed was stratified in plastic containers of 15 × 25 cm. Also, in January 2014, graft branches were taken from the parent trees and stored in fridge until mid-March when grafting was conducted. The rootstock for grafting consisted of 80-100 cm high two-year seedlings of beech, taken from the forests of Starčevica in the vicinity of Banja Luka. The rootstock was removed during February and planted in plastic containers of 25 × 35 cm.

The grafting was carried out by performing English joining of graft branches with two twigs. For each parent tree, 30 rootstocks were grafted. In the spring of 2015, analyzes of scion development and status of seedlings were carried out, and in the fall, morphometry of all developed increments was performed on graft scions and seedlings.

Morphometric analyzes in seedlings were carried out in the fall of 2015 and 2016 and included the development of the habit of seedlings according to the following indicators:

- The number of developed seed increments. In standard seedlings *Fagus sylvatica* L. it was expected that a strong increment with a dominant peak growth will develop from the seed;

- With seedlings showing branching properties soon after the formation of seed increment, analyzed were the angles of branching of developed lateral branches (relation to heliotropism). Morphometric analyzes of grafts of four parent trees comprised the development and scion branching angles and their development in the fall of 2015 and 2016.

Thus, if the atypical system of branching and thus the atypical form of the tree from the population of *Vilina* Beech from Čajniče is transferred by vegetative cloning and seed, then it is a confirmation that there was a mutation of the first parent tree, the "Mother of *Vilina* Beech", which was transferred by seed on the progeny, which managed to stay in this location, which also led to the formation of a population with an atypical form of habit called the "*Vilina* Beech from Čajniče".

If the atypical form of the tree from the population of *Vilina* Beech from Čajniče is not transmitted by vegetative cloning and seed, then it is a confirmation that the atypical form of beech trees at the hamlet of Bara, Batočiči village near Čajniče represents a morphism induced by an unknown factor.

Results and Discussion

In this research, the issue of inheritance of the atypical form of beech trees in the population of *Vilina* Beech from Čajniče was raised. More specifically, the question raised was whether the emergence of these trees was caused by a mutation transferred as such by inheritance or a type of morphism is present at this location under the influence of an unknown factor.

The analysis of four parent trees from the population of *Vilina* Beech from Čajniče (Figures 3, 4) shows the following:

- All grafts produced in 2015 and 2016 display the property of negative heliotropism;
- The analyzes of the branching angle of the first increment of scions, and the individual increments on scions, shows clearly that, by the branching angle, the increments dominantly fall in the group with an angle below 45 °,
- On the basis of the development of scions of all four parent trees (VB1, VB2, VB3 and VB4) and their branching, it can be reliably asserted that the graft branching has irregular forms with an expressed tendency of negative heliotropism. Based on the expressed growth and development of grafts, it can be safely asserted that there was a mutation in the original tree "Mother of *Vilina* Beech from Čajniče" transmitted by vegetative cloning, the consequence of which is the formation of an atypical beech tree with negative heliotropism.

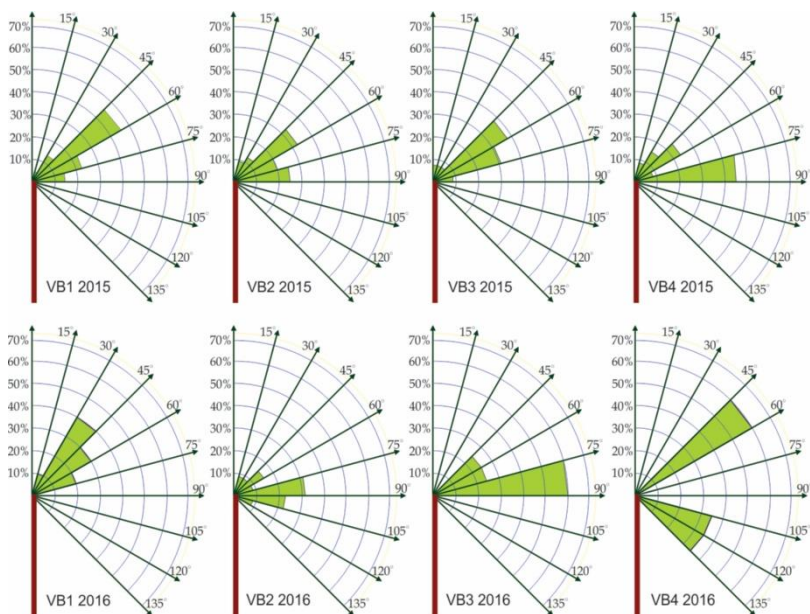


Fig. 3. Graphical overview of branching representation classified according to the branching angle on grafts of parent trees of "Vilina Beech from Čajniče"

The question, whether this is the tree branching conforming to the variety "tortuous beech" (*Fagus sylvatica* L. var. *tortuosa*) or the variety "weeping beech" (*Fagus sylvatica* L. var. *pendula*), or a variation between the two described varieties, remains open.

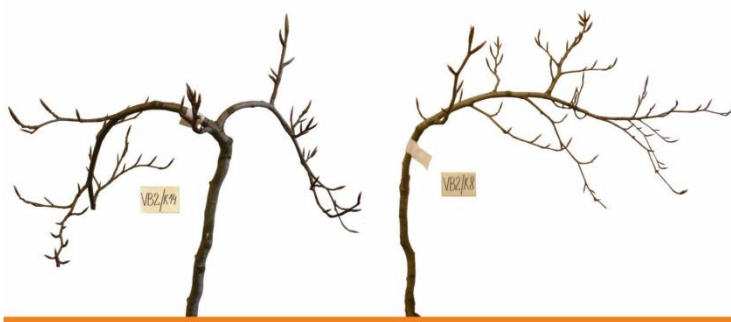


Fig. 4. The appearance of grafts of the VB2 parent tree in the third year (age of the scion is three years)

The fact that this mutation is inherent, that is, that it is transmitted through vegetative cloning makes these researches realistically possible in the future.

The analysis of the development and branching of seedlings produced from the seeds of four parent trees of "Vilina Beech from Čajniče" (Figures 5, 6) shows the following:

- All produced seedlings of all four parent trees branched out immediately after germination;
- In all seedlings, there is an expressed tendency towards sympodial branching and formation of increments of negative heliotropism;
- The property of the formation of atypical trees by branching with a tendency of negative heliotropism, in all seedlings of four parent trees, clearly shows that this mutation from the originally mutated tree "Mother of Vilina Beech from Čajniče" is also transmitted by the generative reproduction, i.e. by seed.

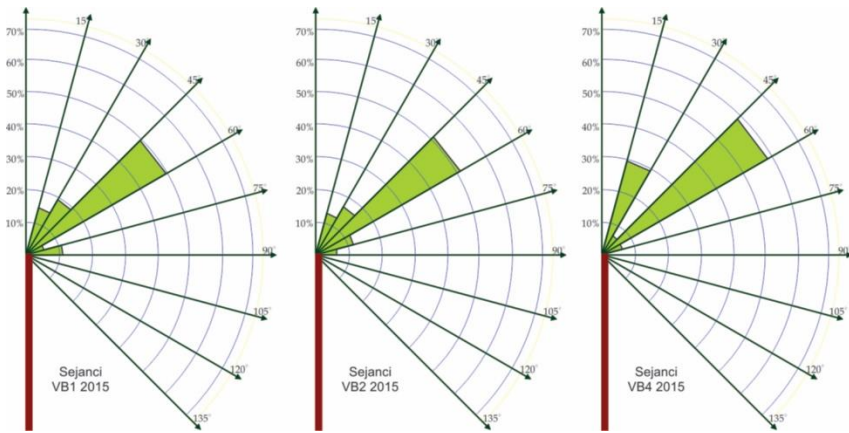


Fig. 5. Graphical overview of branching representation classified according to the branching angle on one-year seedlings of "Vilina Beech from Čajniče"

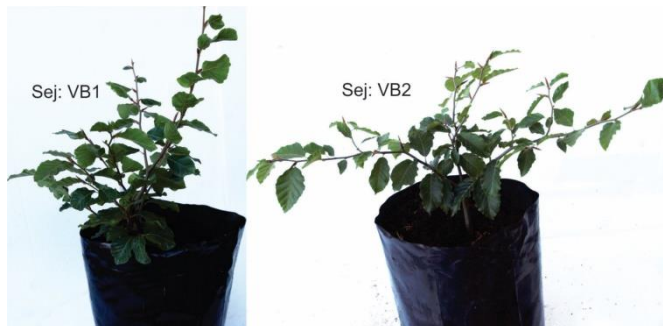


Fig. 6. Seedlings produces from a VB1 and VB2 parent tree seeds in the first year after the sowing. A typical branching directly after the emergence with a tendency of a negative heliotropism is present

Conclusions

The population of *Vilina* Beech from Čajniče, i.e. the population of trees with atypical branching and habit development with a tendency of negative heliotropism, was created by mutation of the native mother tree "Mother of *Vilina* Beech". This mutation is transmitted by vegetative cloning and generatively, i.e. by seed.

The question of whether this mutation is conforming to the described variety of "tortuous beech" (*Fagus sylvatica* L. var. *tortuosa*) or variety "weeping beech" (*Fagus sylvatica* L. var. *pendula*), or it is a special variety, remains open. The fact that this mutation is inherent, i.e. that it is transmitted by vegetative cloning and generatively through seeds, makes these researches realistically possible in the future.

Also, the production of "*Vilina* Beech from Čajniče" planting material is possible with vegetative cloning, with the tree form conforming to the habit of the native tree. The production of seedlings from seed is also possible, but the form of the tree will vary according to the interaction with the genetic constitution of the pollinator.

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Наслеђивање типа хабитуса стабла у популацији вилине букве из Чајничка

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Сажетак

Према усменом предању четири до пет колена уназад на локалитету села Баточићи, засеок Баре, општина Чајничка – Република Српска у БиХ, дошло је до појаве једног стабла са атипичним симподијалним грањањем у спиралном или наизменичном положају годишњих прираста са различитом тенденцијом негативног хелиотропизма. Ово стабло достигло је висину до 20 m, а осушило се у старости од приближно 170 година. Послије дужег временског периода, по усменом предању од два до три колена уназад, уочена је појава нових појединачних стабала букве са истим својствима у формирању хабитуса. Ова нова стабла јављала су се сукцесивно у релативно уском простору око првог стабла, које је из тог разлога названо "Мајка вилина буква". Морфолошке карактеристике хабитуса стабла у популацији вилине букве сагласна су варијетету "крива буква" *Fagus sylvatica* var. – *tortuosa* као и једним дјелом сагласно варијетету "жалосна буква" *Fagus sylvatica* var. – *pendula*. У овом истраживању постављено је питање наслеђивања својства неправилног симподијалног грањања са тенденцијом негативног хелиотропизма у популацији "Вилине букве из Чајничка", без обзира на карактеризацију варијетета. Тако је у популацији вилине букве из Чајничка која чини приближно 40 стабала у релативно блиском окружењу означено четири стабла старости преко 30 година како би се утврдило да ли се њихова форма стабла преноси вегетативним клонирањем и генеративно, сјеменом. Истраживања су изведена у периоду до 2014 до 2016. године у Институту за генетичке ресурсе Универзитета у Бањој Луци. Резултати показују да се форма хабитуса сва четири матична стабла преноси калемљењем као и сјеменом, што доказује да је код првог стабла, тј. "Мајке вилине букве" из Чајничка дошло до мутације која се преноси на потомство.

Кључне ријечи: негативни хелиотропизам, калемљење, сијанци

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