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COMPARATIVE MORPHOLOGICAL ANALYSES IN MARGINAL BEECH POPULATIONS

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Abstract: *There are several reports regarding the occurence of Fagus orientalis individuals at the hot margins of the beech distribution range in Romania. The aim of this paper is to analyse the morphological variation in marginal populations of beech, where two morphological forms (F. sylvatica and F. orientalis) might coexist according to the literature. The analyses focused on the most discriminating leaf descriptors: lamina length and number of secondary veins pairs. Additionally, comparative evaluations of the number of stomata per unit area (mm^2) were done. Only a limited number of individuals showed specific characteristics of F. orientalis in two out of the three populations sampled. However, the morphological differences between taxa were small.*

Key words: *Fagus sylvatica, Fagus orientalis, leaf morphology, cluster analysis.*

1. Introduction

The genus *Fagus* belongs to the family *Fagaceae* and it is considered one of the most important genera of woody plants, both economically and ecologically [7]. It comprises 8-10 tree species in the temperate zone of the northern hemisphere [3], [11]. In Europe, two species of beech have been distinguished: *Fagus sylvatica* and *F. orientalis*. These two species have been reported to be interfertile. However, other two taxa are also mentioned in Europe: *F. taurica* and *F. moesiaca* [10], [4]. The taxonomic status of beech from the Balkan Peninsula is not yet clearly defined and morphological description of *F. moesiaca* and *F. taurica* is rather vague [9].

In Romania, the genus *Fagus* is represented by three taxa: *F. sylvatica*, *F. orientalis* and *F.* x *taurica*. The latest is considered a natural hybrid resulted from ancestral contact between *F. sylvatica* and *F. orientalis* [13]. The differentiation among the three taxa can be done according to several characteristics: 1) the length and width of the leaf lamina; 2) the petiole length; 3) the number of veins pairs; 4) the basal appendages of cupules forms [11], [13].

So far, no detailed morphological analyses have been carried out in order to clarify the presence of *F. orientalis* individuals in Romania. This study aims

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at describing the leaf morphological variation in marginal beech populations located at the hot margins of beech distribution in south-eastern Romania.

2. Material and Methods

2.1. Plant material

Leaf samples were collected from shoots in three marginal beech populations (two situated in Covurluiului Plateau - eastern Romania and one in Luncavița forest - south-eastern Romania) [5], [14]. A total of 157 adult trees were sampled (21 trees from Tălăşmani, 50 trees from Buciumeni and 86 trees from Luncavița). The geographical coordinates of these stands are shown in Table 1.

Table 1

Geographical coordinates

Population	Latitude	Longitude
Luncavița	$45^0 16' 09'' ,89$	$28^0 10' 54'' ,92$
Tălăşmani	$46^0 07' 13'' ,82$	$27^0 50' 21'' ,49$
Buciumeni	$46^0 01' 48'' ,63$	$27^0 17' 54'' ,11$

2.2. Morphological and statistical analyses

Five leaves/per tree were scanned using WinFolia software and 7 variables were assessed (Fig. 1) [17]: leaf area (LA), lamina length (LL), leaf width (LW), petiole length (PL), distance between veins (DBV), distance between the lower point of the lamina and the maximum width point on the axis (LMW) and number of veins pair (NV) [1], [2], [11], [13].

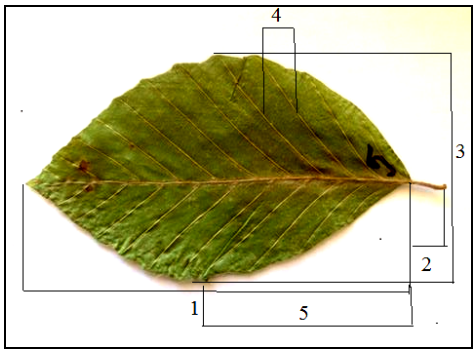

Fig. 1. *Beech leaf scanned with WinFolia software: 1 - lamina length (LL); 2 - petiole length (PL); 3 - leaf width (LW); 4 - distance between veins (DBV); 5 - distance between the lower point of the lamina and the maximum width point on the axis (LMW)*

The number of stomata per leaf area (S) was determined using a microscope and the software QuickPhotoMicro 2.3 (Fig. 2.) [15].

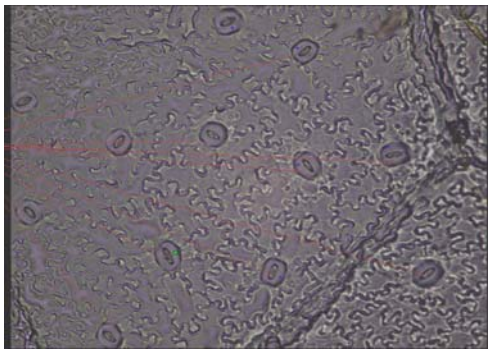

Fig. 2. *Number of stomata determinated using software QuickPhotoMicro 2.3.*

Principal Component Analysis (PCA) and Cluster Analysis (Complete Linkage and Manhattan distances) [16] were done using STATISTICA software version 8.

3. Results and Discussions

3.1 Leaf descriptors

The mean values of leaf morphological traits are shown in Table 2. The petiole length was significantly correlated with lamina length (LL) and leaf area (LA). The mean values vary between 0.55 (Buciumeni stand) and 3.01 (Tălaşmani stand). The number of veins pairs was between 7 and 10. Morphological leaf traits were not significantly different (P>0.05) among the three marginal beech populations.

The high density of stomata is considered a xeromorphic adaptation [2]. The highest value was obtained in Buciumeni.

The leaf descriptor values were similar to those reported in other studies conducted in other parts of Europe [8], [12] in *F. sylvatica*. Values obtained for lamina lenght (LL), lamina area (LA) and leaf width (LW) are lower than the values obtained for morphological descriptors in natural population of *Fagus orientalis* [1].

Mean values of leaf descriptors Table 2

Stand	LA (cm)	LL (cm)	PL (cm)	LW (cm)	LMW (cm)	DBV (cm)	NV	S
Tălăşmani	35,81	9,22	1,18	5,57	4,34	0,93	8,68	53,52
Buciumeni	37,13	9,29	0,89	5,79	4,39	0,87	8,93	56,01
Luncaviţa	36,08	9,28	0,90	5,63	4,43	0,88	9,03	51,82

For abbreviation of leaf descriptors see section 2.2

3.2. ANOVA

By using eight variables, the populations were compared using ANOVA. For the majority of the morphological descriptors, no significant differences were recorded between the sampled stands (P>0.05).

Only two morphological traits showed significant differences: stomata density ($0.01 < p < 0.05$) and petiole length (highly significant differences; p= 0.00; see Table 3) [5].

Results from Levene's test for homogenity of variances Table 3

Var	MS Effect	MS Error	F	P
LA	0,37	10,80	0,03	0,99
LL	0,01	0,10	0,09	0,91
PL	0,48	0,02	18,66	0,00
LW	0,02	0,09	0,26	0,76
LMW	0,03	0,08	0,43	0,64
DBV	0,00	0,00	0,75	0,47
NV	0,34	0,20	1,68	0,18
S	96,56	27,10	3,52	0,03

3.3. Principal Component Analysis and Cluster Analysis

According to the PCA, the first two factors explain 66% of the total variability (Fig. 3). Even if the sampled individuals are located in different three stands, they do not separate in the graph. As a consequence, a single morphological group was generated, which could be explained by: 1) uncertainty of the *F. orientalis* existence amongst the sampled trees, on one hand, 2) the very low discriminating power of the eight variables used, on the other hand.

Furthermore in cluster analysis two main groups were identified (Fig. 4.). Even so, in the smaller group from the left part of the graph, individuals of both *F. sylvatica* and *F. orientalis* were included. The same situation was also observed in the second group from de right part of the graph.

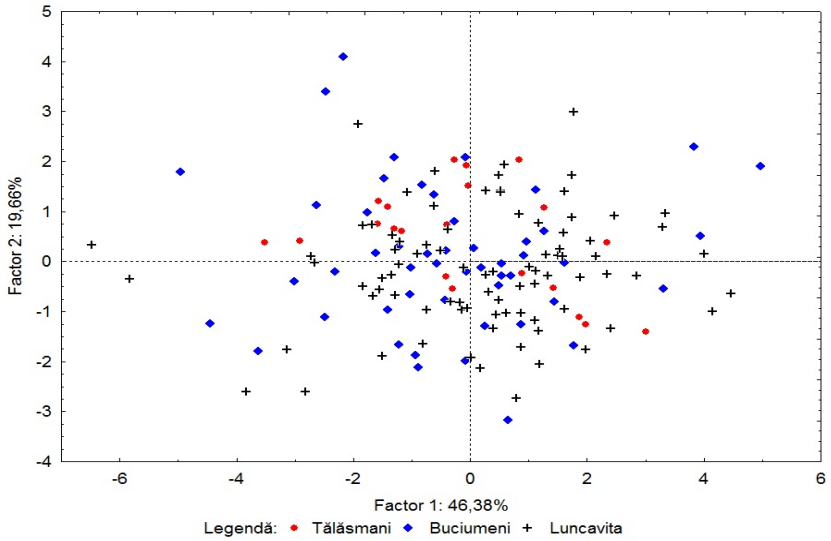

Fig. 3. *PCA diagram*

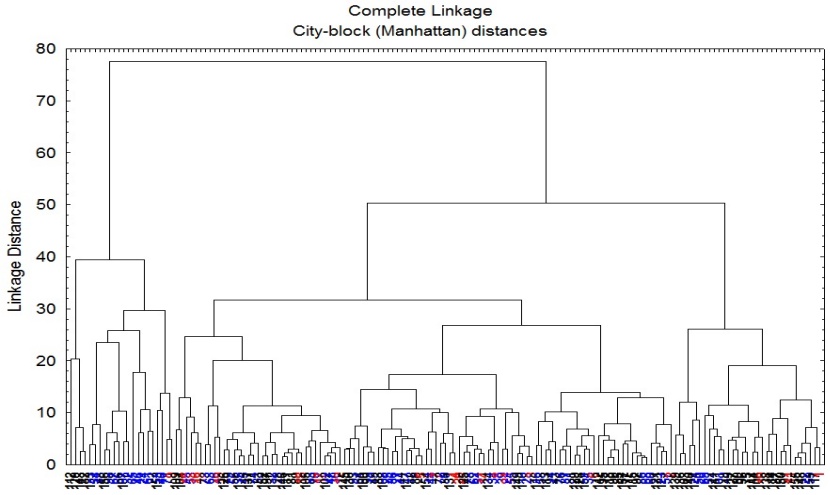

Fig. 4. *Cluster diagram* ***(Tălăşmani, Buciumeni, Luncavița)***

4. Conclusion

Based on our set of leaf variables, only one morphological group was revealed. The population Talasmani represents a pure *F. sylvatica* and the populations Buciumeni and Macin represent a mixture between the two taxa: *F. sylvatica* and *F. orientalis*. Additional morphological (mainly fruits) descriptors should be analyzed to test for the existence of *F. orientalis* individuals. The inclusion of pure *F. sylvatica* and *F. orientalis* will help the analysis.

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