STRUCTURAL FEATURES IN A STAND THAT GROWS ON EXTREME SITES FROM BISTRIȚA RIVER BASIN

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Abstract

The structural features in a stand that grows on extreme sites from Bistriţa River Basin were analyzed in a stand of Small-leaved lime mixed with different species. Its composition is 7SLI2BE1SY, the current age of 130 years and it is located on rolling land, with 45^0 land slope and southwestern exposition. The total number of trees ·ha^{-1} is 602, which corresponds to a density index higher than 1.2. The base area corresponding to experimental area is 45.6 m^2·ha^1. The volume amounts to 469.6 m^3·ha^{-1}, with the highest value to Norway spruce species, followed by Small-leaved lime, Beech and Sycamore maple. The researched stand has a double-storey structure. The maximum number of trees is recorded at diameter category of 12 cm (18%) and 28 cm (11%). The value of arithmetic mean diameter for the total area is 25.9 cm, with a standard deviation of ± 14.6 cm. The coefficient of variation is 56.1 %, therefore the experimental area shows a pronounced variability, due to different number and age of component species. The average height is 18.1 m. The value of the standard deviation for heights is ± 6.9 m. The coefficient of variation is set to 38.5 % and as a result the experimental area is relatively uniform in terms of heights. The species with the highest share identified are specifically ordered, namely Norway spruce occupies the central and northeast parts of the area, respectively Small-leaved lime in the southwest central part. The appearance that the upper surface of the stand canopy displays, which defines its vertical profile, presents a trend of developing some stepped profiles. Thus, it is found the appearance of one or several levels of vegetation and in some cases the aspect is that of a relatively inequable stand, on significant areas.

Key words: vegetation, extreme, stand, composition, volume, parameters, structure, indices, diameter, height, profile

INTRODUCTION

Geographically, Crucea Forestry District is situated in the middle of Bistriţa River Basin, Zugreni - Broşteni area, occupying a part of the eastern slope of the Eastern Carpathians. From altitudinal point of view, we meet very high amplitude, from 650m to 1790m. The average slope of the land is 29º. After Koppen classification, the area is situated in the Dfkx climate region, with wet climate and cool summers, with average precipitation of about 900 mm/year, with average annual temperature under 18°C. The average multi-annual temperature is 4.3°C and fluctuates according to the altitude from about 6°C to 2-3°C. The soils are, in general, medium deep to deep, with clay to sandy clay texture, weak but quite frequently half-skeletal or skeletal, with the rock on the surface. The aridity index has an average value of about 53 and evapotranspiration around 538mm.

The objectives of the research article refer to: the presentation of some general structural elements specific to an experimental surface that

grows on extreme sites; the statistical analysis of some biometric parameters; highlighting the spatial structure of the stand researched through two-dimensional profiles.

THE STUDY SITE

The permanent researched experimental area is located in Crucea Forestry District, located on the eastern part of the Eastern Carpathians, on Bistrița River Valley. It is characterized by a rugged terrain, the slope being the dominant geomorphological unit. As limiting factors, there are the slope and the reduced edaphic volume. The stand where research has been done is part of 90D forest unit, working section VII Pârâul Leşului. It is a stand of Small-leaved lime mixed with different species, its composition is (according to the management plan) 7SLI2BE1SY, the current age of 130 years and it is located on rolling land, with 45^0 land slope and southwestern exposition.

Fig. 1. The study site (90D forest unit, working section VII Pârâul Leşului)

MATERIAL AND METHOD

In the researched stand, an experimental area was placed, in square shape of 10,000 m^2 (100m / 100m) in which elementary areas of 100 m^2 (10m x 10m) were delineated. All trees with diameter of 1.30 m higher than 8 cm were inventoried. The following parameters were registered in the inventory notebook: the number of tree, species, diameter of 1.30 m, total height, pruning height, two diameters of crowns, plan position of the trees in Cartesian coordinates (x,y).

The processing of field data pursued, first of all, the analysis of general structural elements (stands composition, number of trees per hectare, base area per hectare, per hectare volume, respectively density index). A second aspect of the research refers to the statistical analysis of

biometric parameters: mean values (average - $\bar{x}$) and dispersal indices (standard deviation – *s*, the coefficient of variation - *s%,* the minimum and maximum value of the considered variables). The following indices have also been calculated, referring to the diameter: the mean diameter of the base area, the central mean diameter by the trees number, the central diameter of the base area, Weisse mean diameter and Hohenadl mean diameters. The next parameters have been determined according to heights: Lorey mean height, the mean height of arithmetic mean tree, the mean height of the mean tree of base area, the mean height of the central tree of the base area and the upper height.

Field data processing was performed using statistical and mathematical methods from forestry, with programs specific to every analyzed research aspect. The experimental distributions indices were calculated using the facilities of Microsoft Excel and the structural profiles were obtained with ProArb program.

RESULTS AND DISSCUSIONS

Measurements and further processing of data led to the conclusion that there was identified a total number of nine species of forest trees (NS, SLI, BE, SY, AR, ESF, AH, BI, PO) of which the largest percentage is held by Small-leaved lime, Norway spruce, Beech and Sycamore maple (Fig. 2). The composition, expressed in terms of the number of trees in the researched experimental area, is 4NS4SLI1BE1SY. Outspread, there are AR, ESF, AH, BI, PO. Regarding the composition according to the species volume, it is 5NS2SLI2BE1SY.

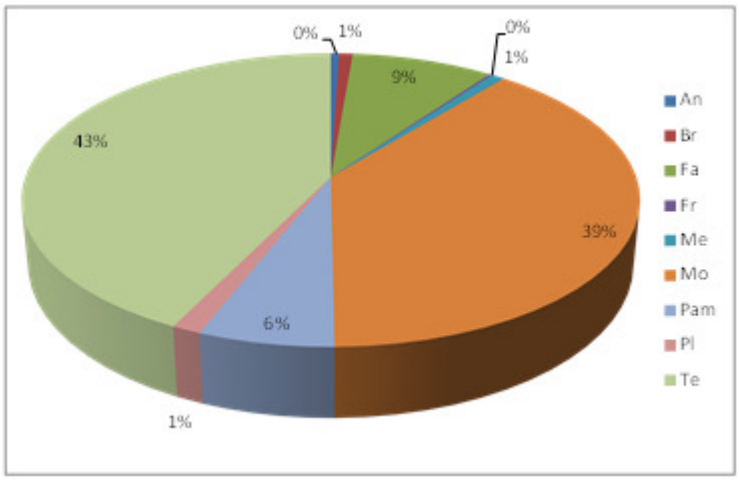

Fig. 2. The range of species identified in the experimental area
AR- Alder , ESF - European silver fir, BE - Beech, AH - Ash, BI - Birch,
NS - Norway spruce, SY - Sycamore maple, PO – Poplar, SLI- Small-leaved lime

In the experimental area, the total number of trees ·ha-1 is 602, which corresponds to a density index higher than 1.2. The largest number of trees ·ha-1 was identified to Norway spruce, followed by Small-leaved lime, Beech and Sycamore maple. Two percent of the number of trees, especially from Norway spruce species, displays stem breakage, highlighting a weak stand harmed in unfavorable wind action.

The base area corresponding to the experimental area is 45,6 m2·ha-1. The highest value of the base area is registered to Small-leaved lime species, followed by Norway spruce, Beech and Sycamore maple.

The volume is 469,6 m3·ha-1, the highest value is recorded to Norway spruce species, followed by Small-leaved lime, Beech and Sycamore maple (Fig. 3).

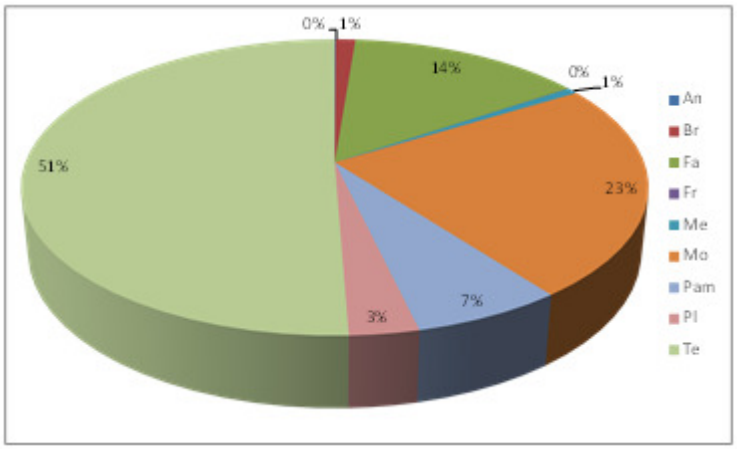

Fig. 3. The percentage occupied by the volume of the forest species identified in the experimental area

The analysis of trees distribution on diameter classes indicates that the researched stand has a double-storey structure. When analyzing the entire stand, the maximum number of trees is recorded under diameter 12 cm (18%) and 28 cm (11%). The maxima corresponding to the aforementioned diameters maintain also to Norway spruce species (24% to diameters of 12 cm, respectively 12% to diameters of 28 cm) and Small-leaved lime (13% to diameters of 12 cm, respectively 11% to diameters of 28 cm). A maximum to diameters of 12 cm (23%) is characteristic to Beech, while Sycamore maple has the same values for most categories of identified diameters in the field work (Fig. 4).

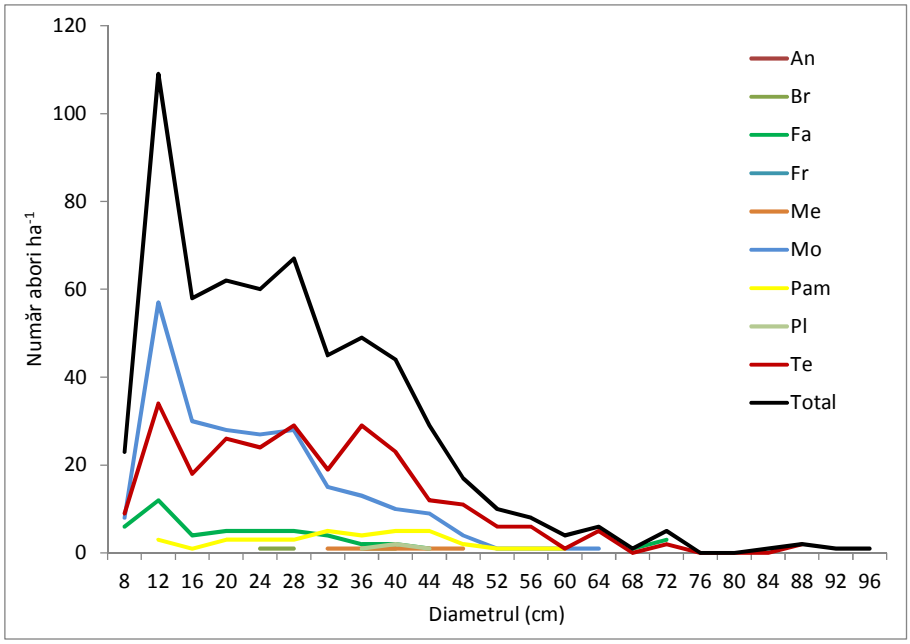

Fig. 4. Trees distribution on diameter classes

The value of arithmetic mean diameter for the total area is 25.9 cm, with a standard deviation of ± 14.6 cm. Regarding the coefficient of variation, which sets framing the experimental area on degrees of variability, its value is 56.1 %. As a result, the experimental area shows a pronounced variability, which is explained by inhomogeneity of the population, due to different number and age of the component species (Tab. 1).

Table 1

General statistical data on mean diameter and mean height in the researched experimental areas

Species	Statistical parameters									
	Diameter (cm)					Height (m)				
	$\bar{x}$	sd	cv (%)	min	max	$\bar{x}$	sd	cv (%)	min	max
Total	25.9	14.6	56.1	6	94	18.1	6.9	38.5	4	35.3
NS	21.6	11.1	51.2	7	61	17.1	7.4	43.1	5.5	33.2
SLI	28.4	14.7	51.6	6	88	18.6	6.6	35.6	4	31.5
BE	26.8	22.6	84.5	8	94	16.9	7.8	46.0	4.6	44.8
SY	31.2	12.0	38.4	10	60	20.1	5.3	26.1	10.6	35.3

The minimal value of the mean diameter is 6 cm (Small-leaved lime) and the maximal value resulting from the processing of the field data is 94 cm (Beech). The values of mean diameter for the component species are below the average of experimental area for Norway spruce (by 17%) and

above the average for Small-leaved lime (by 10%), Beech (by 3 %) and Sycamore maple (by 20%) (Table 1). The standard deviation registers values lower than the average for Norway spruce (by 24%) and Sycamore maple (by 18%), respectively higher for Small-leaved lime (by 1%) and Beech (by 55%). In turn, the coefficient of variation has a dynamic different from that of the mean diameter and of the standard deviation, meaning that it records values lower than the average for Norway spruce (by 9%), Small-leaved lime (by 8%) and Sycamore maple (by 32%), respectively higher for Beech (by 51 %) (Tab. 1).

The mean height is 18.1 m. The value of the standard deviation for heights is ± 6.9 m. The coefficient of variation is 38.5 %, therefore the experimental area is relatively uniform, if we refer to the variability of population in terms of heights. The minimal value in relation to the component species of the experimental area is 4 m (Small-leaved lime) and the maximal value is 35.3 m (Sycamore maple). For a diameter of 60 cm height, the superiority of Norway spruce height is established, in comparison with deciduous trees from the composition of the area, with about 5 m (Fig. 5).

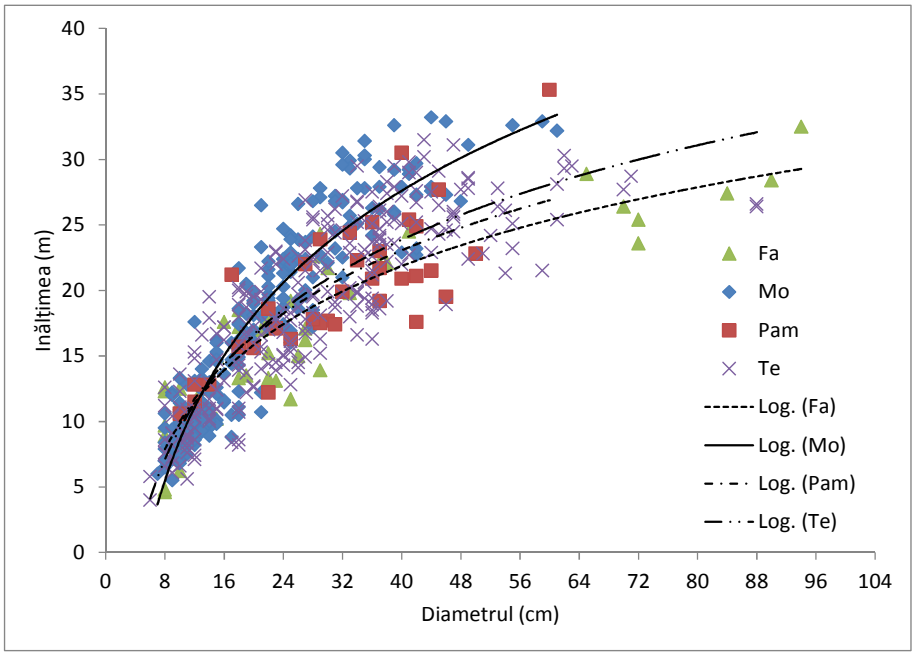

Fig. 5. Heights diagram for the species from the researched experimental area

For comparison, it was considered appropriate the calculation of other categories of diameters (the mean diameter of the base area, the central mean diameter by the number of trees, the central diameter of the base area, Weisse mean diameter, respectively Hohenadl mean diameters) and heights

(Lorey mean height, the mean height of arithmetic mean tree, the mean height of mean tree of the base area, the mean height of the central tree of the base area and the upper height) used in dendrometrical interpretations to analyze the particularity of stands that grow on extreme sites in Bistrita Valley (Tab. 2).

In terms of diameters, the superiority of central diameter of the base area is found for all species of the researched areas. Accordingly, the height of the central tree of the base area is the largest (for comparison disregarding the dominant height).

Table 2

The values corresponding to some statistical parameters appropriate to the diameters and heights of the researched area

Unit / species	Statistical parameters										
	Diameter (cm)						Height (m)				
	d_g (cm)	d_{median} (cm)	d_{gM} (cm)	d_{Weisse} (cm)	$d_{Hohenadl}$ (cm)		h_{Lorey} (m)	h_d (m)	h_g (m)	h_{gM} (m)	h_{dom} (m)
Area 1 - Total	31.1	24.0		27.0	11.4	40.5	23.2				27.1
NS	25.6	19.5	33.0	23.0	10.5	32.7	22.8	19.1	21.5	25.0	28.5
SLI	33.3	27.0	41.1	31.0	13.7	43.0	23.1	20.3	22.0	24.2	26.2
BE	33.9	20.0	70.5	23.0	4.1	49.4	25.0	18.4	20.4	26.8	26.2
SY	34.8	32.0	41.1	36.0	19.2	43.2	22.7	20.7	21.8	23.3	26.3

The horizontal profile of the area indicates that the identified component species are specifically located, namely Norway spruce and Small-leaved lime (the majority of species in the area) occupy the central and northeast parts of the area (Norway spruce) and the southwest central part of the area (Small-leaved lime). In some parts from northwest and southwest the two species are not mixed with any other species. Beech is distributed in bundles (biogroups, clumps) in the center and Sycamore maple in biogroups (2-4 specimens of trees), especially in the area occupied by Small-leaved lime (center and southeast) (Fig. 6).

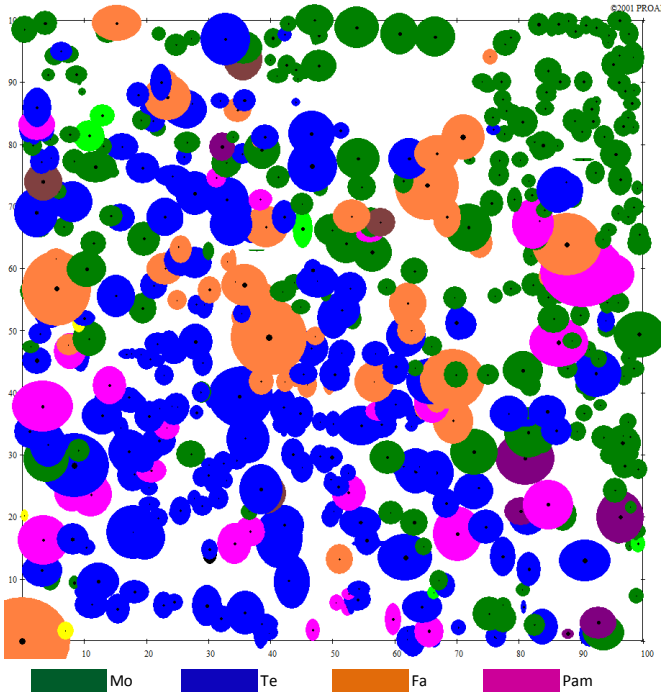

Fig. 6. Horizontal profile of the experimental area

It turns out, more or less obvious, a natural setting in the experimental area. In the lower section of the area (20 m - 40 m), a first level consists of Little-leaf Linden, the second level, in the making, consisting of young Norway spruce, Small-leaved lime and Beech (Fig. 7A). In the middle of the experimental area (40 m - 60 m) it can be noted a stronger differentiation of the levels of vegetation due to the presence in a larger number of different stand elements stand of components species. A first level consists of Small-leaved lime, Beech and Norway spruce and the second one consists of the same tree species, in the vast majority. In some areas, the structure is typical to a relatively inequable forest (Fig. 7B).

The top of the experimental area (80 m - 100 m) is especially characterized by the influence of the main species in this area, namely Norway spruce. Thus, a part of the area has a nearly uniform profile, there is only sporadically a second level of vegetation. As Small-leaved lime, Beech and Sycamore maple show in the composition, the vertical profile is diversified, appearing even more levels of vegetation (Fig. 7C).

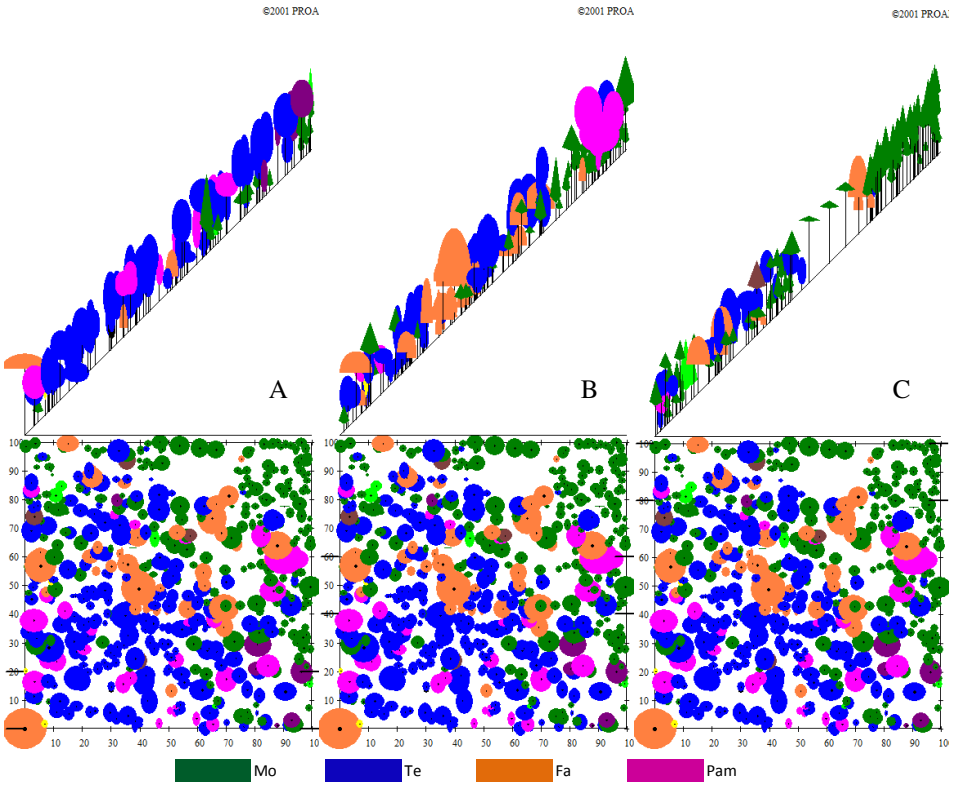

Fig. 7. Vertical profile of the experimental area

CONCLUSIONS

The general structural features in the researched experimental areas from extreme sites indicates, first of all, that the range of identified forest species is significant (nine forest species). As a result, the value of density index is higher than one.

The effect of extreme stationary conditions is found, foremost, on the value of the coefficient of variation of diameters, which indicates that the populations of trees show a pronounced variability. They are heterogeneous, mainly due to different number and age of components species that generate specific stand elements.

The appearance that the upper surface of the canopy stand displays, which defines its vertical profile, presents a trend of developing some stepped profiles. Thus, it is found the appearance of one or several levels of vegetation and in some cases the aspect is that of a relatively inequable stand, on significant areas.

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