HIGH MOUNTAIN FOREST STRUCTURE IN CĂLIMANI MTS. (EASTERN CARPATHIANS)

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Abstract

The aim of this paper was to highlight some structural elements (distribution of the number of trees per diameter classes, specific natural regeneration and dead wood) in an old-growth timberline stand located in Northern Eastern Carpathians (Calimani Mts.). The distribution of the number of trees per diameter classes is common with uneven aged stands, both for total stand and also for Norway spruce trees. For cembra pine, it is typical of even aged trees stands. Meyer theoretical distribution best expresses the experimental distribution of the number of trees per diameter categories for total stand and for Norway spruce trees and theoretical gamma distribution is specific to cembra pine. Seedling numbers in specified heights categories (0.5 m, 0.7 m and 1.3 m) increases for cembra pine and Norway spruce and decreases for Mountain ash as the considered height category. The total volume of dead wood is 169.7 $m^3 \cdot ha^{-1}$. Studying the dynamics of old-growth timberline forest structure has an important role in forest management due to concerns about the values pertaining to biodiversity in forest ecosystems.

Key words: old-growth forest, uneven aged stands, natural regeneration, dead wood, Eastern Carpathians.

INTRODUCTION

Forestry in general was based and used with skill and discernment the laws of nature, being thus ecological in a sense very similar to the modern acceptance of the word. The fundamental principles of forest management implemented on large geographical areas (nature must be left to work alone; nature knows better than man what it should do for the good of the forest), is intended to bring a better understanding of nature by the people (Bândiu, 1994). Forest management based on the dynamics and on the structure of natural forests is a nature-oriented and ecological sustainable management that is close to nature. The interest for old-growth forest dynamics integration in planning and forest management has increased as a result of concerns about the values of biodiversity and maintaining ecological functions in the managed forests (Giurgiu, 1995; Metslaid et al., 2007).

The effects of abiotic disturbance factors (wind and snow) have an important role in the environmental dynamic, with a well-defined role in the evolution of the structure of forest ecosystems (Barbu, Cenuşă, 2001; Kuuluvainen, 2002; Svoboda, Pouska, 2008; Castagneri et al., 2008; Bolte et al., 2010; Čada, Svoboda, 2011; Krumm et al., 2011; Lamedica et al., 2011).

Deadwood underlies the regeneration process in forests from mountain areas. It provides suitable conditions for saplings to take root and for seedlings to develop, especially for the coniferous that grow in the sub-alpine forests (Bellingham, Richardson, 2006; Vorčák et al., 2006; Lonsdale et al, 2008, Pouska et al., 2010; Bače et al., 2011, 2012).

The aim of this paper was to highlight some structural elements (distribution of the number of trees per diameter and height classes, height - diameter relationship classes, specific natural regeneration and dead wood) in an old-growth timberline stand located in Northern Eastern Carpathians (Calimani Mts.).

MATERIAL AND METHOD

In order to achieve the objectives of this research, a permanent experimental plot of 1.0 ha (100mx100m) was established, located at an altitude of 1550 m in Călimani Mountain. The forest vegetation is represented by a mixture of Norway spruce (*Picea abies*) and cembra pine (*Pinus cembra*) with disseminated mountain ash elements (*Sorbus aucuparia*).

The study plot has been installed and 2007 and re-inventoried in 2012. Specific biometric elements were recorded (species, diameter, height, positional class) seedlings (species, height) and dead wood (species, diameter, degradation class). The spatial position of mature trees, seedlings and dead wood were also recorded in a local reference system.

For statistical analysis classical methods were used: analysis of statistical indicators (mean, standard deviation, variation coefficient etc.) and the distribution of the number of trees per diameter and height classes (Giurgiu, 1979).

Seedling distribution was highlighted by species and height categories. Dead wood was characterized by species and decay classes (0 - recently dead; 1 – weakly decayed; 3- medium decayed; 4 - very decayed; 4 – almost decomposed) and total volume. Trunks of dead wood volume were calculated by assimilating their form with a truncated cone.

Data processing was performed with the Statistica 8 and Microsoft Excel programmes.

RESULTS AND DISSSIONS

Analysis of statistical parameters from Călimani permanent experimental plot is shown in Table 1.

Table 1

Statistical parameters for experimental plot Călimani

Parameter	Total stand	Norway spruce (MO)	Cembra pine (PIC)	Mountain ash (SC)
Medium DBH (cm)	13.3	11.5	31.6	13.1
Minim DBH (cm)	2.1	2.1	2.1	2.3
Maxim DBH (cm)	83.2	71.1	83.2	29.3
Standard deviation (diameter)	13.5	11.4	19.3	10.4
Variation coefficient (%) (diameter)	102.0	99.4	61.1	79.5
Medium height (cm)	8.4	7.8	14.4	10.0
Minim height (cm)	0.6	0.6	1.9	4.2
Maxim height (cm)	32.5	32.5	30.0	14.3
Standard deviation (height)	6.8	6.6	6.2	3.8
Variation coefficient (%) (height)	81.3	84.5	43.0	38.1
Number of trees per hectare	1605	1462	137	6
Basal area per hectare ($m^2 ha^{-1}$)	45.2	30.4	14.7	0.1

The statistical analysis shows that the stand composition from study stand is 9MO1PIC (by number of trees) and 7MO3PIC (after basal area).

Analysing the mean diameter value is found to have the greatest value for cembra pine (31.6 cm), while the minimum diameter is 2.1 cm and maximum diameter is 83.2 cm, for total stand. Regarding the standard deviation of the diameter the highest values is for cembra pine (19.3 cm). The coefficient of variation of the diameter has the highest value for Norway spruce species (99.4%).

The distribution of the number of trees per diameter classes reflects horizontal stand structure and the competition relations (in this case intraspecific). Distribution of the number of trees per diameter categories is typical for an uneven aged forest, both for total stand and for Norway spruce. For cembra pine this distribution is typical for even aged stands. (figure 1).

Compensation of experimental distribution of the number of trees per diameter classes was performed with Meyer theoretical distribution for total stand and for Norway spruce. Gamma theoretical distribution was used to compensate the distribution of the number of trees per diameter classes for cembra pine species (Giurgiu, 1979).

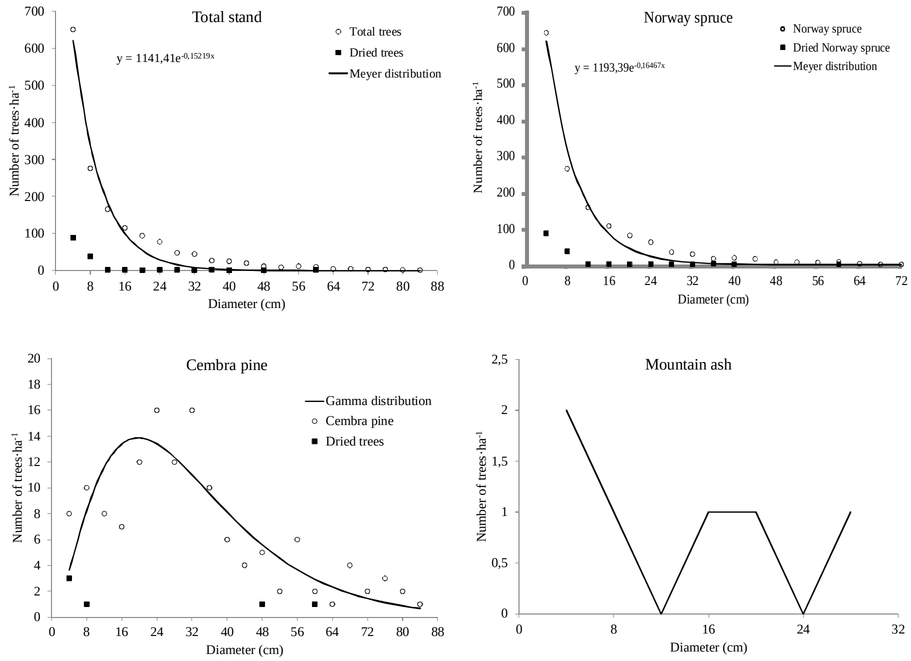

Fig. 1. Distribution of the number of trees per diameter classes

In both cases χ^2 test indicates that the difference between the experimental and theoretical distribution is insignificant. That indicates the studied experimental distributions are subject to specific theoretical distributions considered.

In terms of average height, the highest value is recorded at cembra pine (14.4 m), while the minimum height is 0.6 m and the maximum height is 32.5 m for total stand (figure 2). Standard deviation and coefficient of variation recorded the highest values for Norway spruce (6.6 m and 84.5%) (table 1).

As with the distribution of the number of trees per diameter classes, compensation of the distribution per height categories were carried out with the Meyer theoretical distribution for Norway spruce species and Gamma theoretical distribution for cembra pine (Giurgiu, 1979) (figure 3).

In both cases χ^2 test indicates that the difference between the experimental and theoretical distribution is insignificant. This result indicates that the studied experimental distributions are subject to specific to the theoretical distributions that were taken into account.

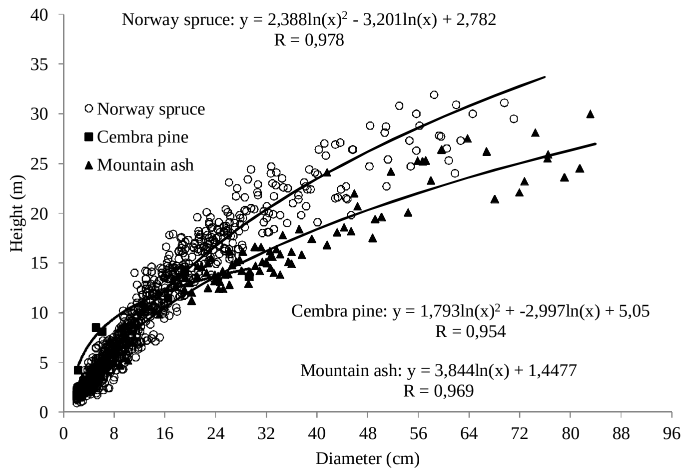

Fig. 2. Relation between diameter and height

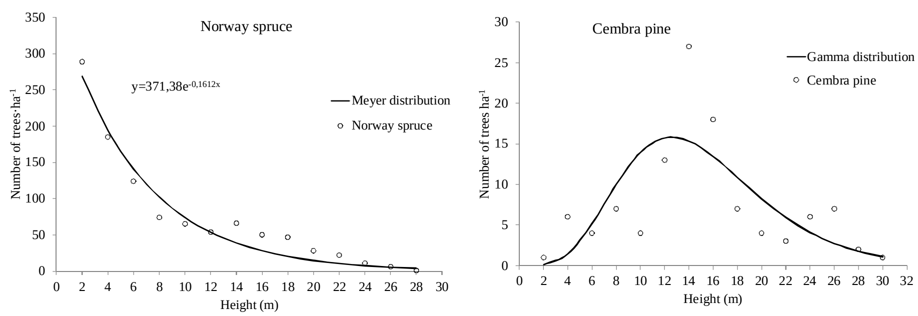

Fig. 3. Distribution of the number of trees per height classes

The distribution of seedling by categories of heights varies with species (figure 4). For Norway spruce the percent of seedling number are as follows: 26% of seedling height is in the 0.5 m category, 29% in the 0.7 m category of height and 45% in the 1.3 m height category. For cembra pine values range between 76% of seedling in the 0.5 m category of height, 14% in the 0.7 m category and 10% in the 1.3 m height category.

Values for mountain ash are as follows: 15% of seedling is in the 0.5 m category of height, 37% in the category 0.7 m and 48% in the 1.3 m height category.

Regarding the volume of the dead wood, it reaches a total of 169.7 $m^3 \cdot ha^{-1}$. For the total strand, when it comes to the distribution of dead wood volume by categories of degradation, the percentages are as follows: 28% of the dead wood is in degradation class 0.1% in class 1.2% in class 2.16% in class 3 and 53% in degradation class 4 (figure 5).

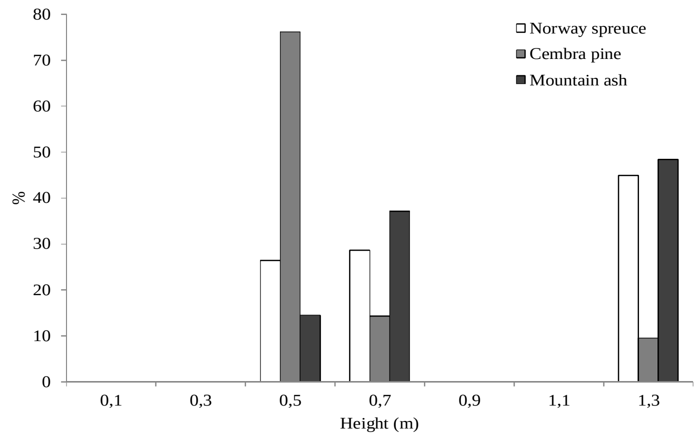

Fig. 4. Seedling distribution by height category

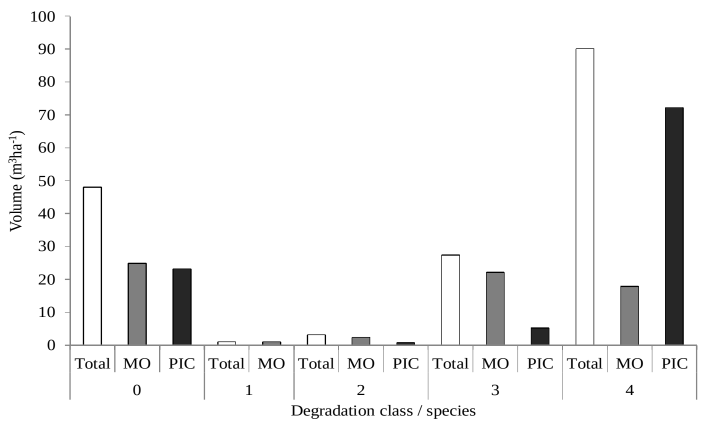

Fig. 5. The volume occupied by dead wood in relation to degradation categories

Values of the volume occupied by dead wood, in relation with species and with categories of degradation for Norway spruce are: class 0 is comprised of 36% of the volume, class 1 - 1%, class 2 - 3%, class 3 - 32% and class 4 - 26%. For cembra pine the volume values are as follows: class 0 is comprised of 23% of the degradation volume, class 1 - 0%, class 2 - 1%, class 3 - 5% and class 4 - 71%.

CONCLUSIONS

The study of the natural high mountain forest structure has an important role in forest management due to concerns about biodiversity values in forest ecosystems.

A comprehensive analysis on the dynamics of the structural elements in natural forests indicates that nature has been successful in creating forest structures that provide sustainable protection against natural hazards.

Acknowledgments

This work was supported by a grant of the Romanian National Authority for Scientific Research (CNCS – UEFISCDI), Project Number PN-II-RU-TE-2011-3-0040.

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