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SHORT COMMUNICATION

Species composition in low mountain beech (*Fagus sylvatica* L.) stands in the Bieszczady National Park under the global warming

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ABSTRACT: The author analyzes the changes in the tree species composition of *Dentario glandulosae-Fagetum* Klika 1927 em. Mat. 1964 in the mountain stands of Bieszczady National Park in 1993–2003. The analysis takes into account the changes over a ten-year period in the number and volume structure of each tree species in each stand layer: young natural regeneration, undergrowth, and mature stand. Additionally, after comparing the results with the natural Carpathian forests' structure, the adaptation level of the present tree species composition to the current climate and soil conditions, as well as probable directions of future changes have been assessed. A ten-year period is too short to find significant changes in stand species structure but it is possible to see some trends: beech share in stands is increasing and fir is decreasing.

Keywords: Bieszczady National Park; beech stands; species composition; climate changes

Recent researches in low mountain primeval forests in the Carpathians show that the tree species diversity has decreased as silver fir is being displaced by beech (*Fagus sylvatica* L.) (Jaworski, Karczmarski 1990, 1991; Jaworski et al. 1994; Jaworski, Skrzyszewski 1995). Korpeľ (1989) observed the decrease in Douglas fir (*Pseudotsuga menziesii* Franco) share in stands where it used to occur naturally especially in the last 15–25 years. On the other hand, however, beech is going up in these stands, a process presently typical throughout all the Carpathians.

The cause might be traced back to the global warming resulting from the increase in the volume of carbon dioxide in the atmosphere, particularly over the last decades (Fabijanowski, Jaworski 1996). Following the climate analysis in the West Carpathians, Obrębska-Starklowa et al. (1994) assessed that the total rise in temperature in the immediate vicinity of the Carpathians and Tatras in the course of the current warming process is typical of Central Europe. Between 1881 and 1990 the rise amounted to 0.9–1.3°C, which is similar to the results of Jones's et al. research (1986) involving the analysis of air temperature changes starting from 1851. Also Primault (1995), who analyzed the data of five Swiss weather stations starting in 1863, revealed a clear trend resulting in a 1.3-centigrade increase.

Dobrowolska (1998) contends that the climate warming contributes to a dramatic dying process of spruce (*Picea abies* [L.] H. Karst.) and pine (*Pinus sylvestris* L.), while other tree species, such as fir and beech, have managed to develop successfully despite the changing environmental conditions.

Fig. 1. Research area – Bieszczady National Park

The aim of this work is to evaluate the change in species composition in low mountain beech forests in the Bieszczady Mountains and to compare the current species composition with the species composition of primeval beech forests in the Carpathians.

Area and method of research

The research area was located in the Bieszczady National Park (BNP), in south-eastern Poland (Fig. 1). Together with Uzansky National Park (Ukraine) and Poloniny National Park (Slovakia), it is the central part of the International Biosphere Reserve East Carpathians, the first trilateral reserve which was established under the UNESCO-MaB (Man and the Biosphere) programme. With the area of 29,201 hectares, the BNP spans the most interesting ranges of the Bieszczady Mountains in terms of its landscape qualities as well as unique fauna and flora. Climatic conditions are typical of mountains regions: average yearly temperature is between 2°C (higher than 1,075 m above sea level) and 4°C (650–1,075 m a.s.l.), average yearly precipitation is about 1,100 to 1,200 mm (max – July: 150–170 mm; min – January: 70 mm), snow is staying about 120 days per year.

The database for this study includes:

– The results of Jaworski's (Jaworski, Karczmarski 1990, 1991; Jaworski, Skrzyszewski 1995; Jaworski et al. 1991, 1994, 1995, 2000) and Korpel's (1989) research in Carpathian primeval forests.
– The results of measurements carried out in the BNP in 1993 by the Bureau of Forest Management and Geodesy (Przemysl Department) in the test plots of the statistic-mathematical forest inventory and control system (BULIGL O/Przemyśl 1996).
– The results of measurements repeated in 2003 in 100 test plots of this system in the lower-mountain zone (pure beech stands).

The 100 test plots were selected randomly from the net of 362 permanent, circular test plots (0.04 ha each) which were localized in the nodes of a regular 500 m^2 net (Fig. 2). Only pure beech stands on mountain forest site in low mountain zone – *Dentario glandulosae-Fagetum-typicum* – were taken into consideration (Fig. 3).

Measurements were carried out according to the methodology of the statistic-mathematical forest inventory and control system that has been widely

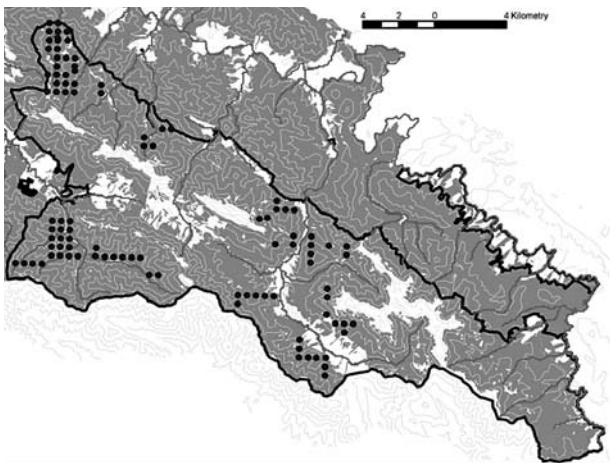

Fig. 2. Location of test plots

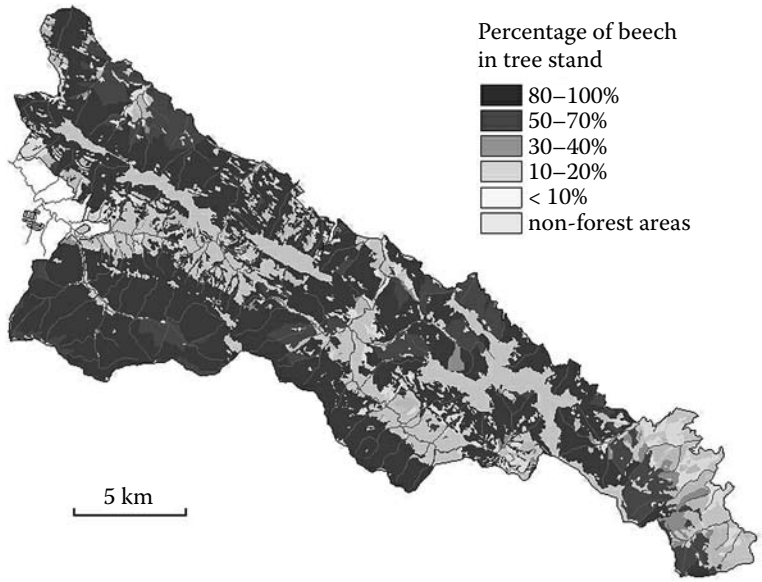

Fig. 3. Location of beech stands in Bieszczady National Park (source: Przybylska, Kucharzyk 1999)

adopted in Poland (Rutkowski 1989; Przybylska 1993, 1995). The acquired field data were analyzed to show changes in the number of trees and stands volume of species composition in beech forests in the Bieszczady Mountains in 1993–2003. All forest layers were taken into account: mature stand (trees with dbh > 7 cm), undergrowth (trees with height > 0.5 m and dbh < 7 cm), and natural regeneration (trees and seedlings smaller than 0.5 m). Results were compared with historical stands structure similar to primeval Carpathian beech forests showed in Korpeľ and Jaworski works.

RESULTS

The research shows that the most important tree species in beech forests in the Bieszczady Mountains are beech, fir (*Abies alba* Mill.) and sycamore (*Acer pseudoplatanus* L.). The analysis of the structure of the number of trees (Fig. 4) may prove that in the species composition of a mature stand (in 2003) beech is the dominant species (88.7% – 606 trees/ha), while as an addition there is fir (5.7% – 39 trees/ha), and sycamore (3.8% – 26 trees/ha). Other tree species amount to less than 3%.

During the 10-year control period (1993–2003) the percentage of these species did not noticeably change: beech – 87.4% (608 trees/ha), fir – 6.0% (42 trees/ha), sycamore – 4.1% (28 trees/ha). The absolute decrease in the number of trees was 12 trees per ha, which shows a slight advantage of a natural tree loss (loss = 42 trees/ha/10 years) over the growth of trees over a 7-cm dhb threshold (growth = trees per ha/10 years).

In the analysis of the species structure according to the tree volume (Fig. 5) one can note the share of fir, being almost twice as high as its share in the total number of trees (in 2003: 9.5% – 49.51 m^3/ha).

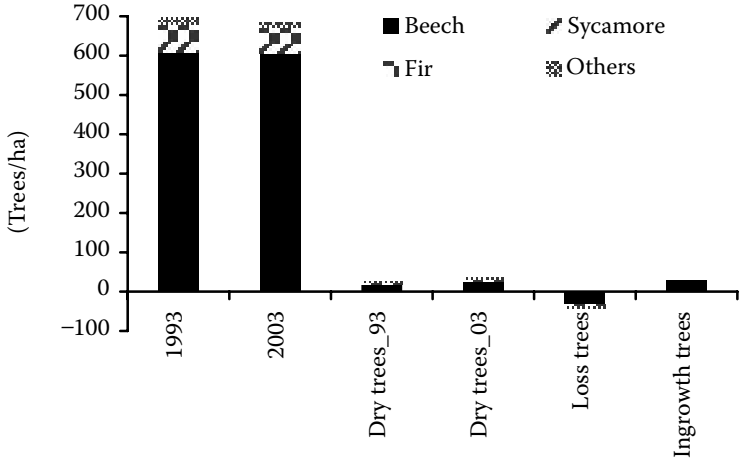

Fig. 4. Species structure in low mountain zone beech forests in the Bieszczady Mountains according to the number of trees (for years: 1993–2003) and compared with dry trees, loss ones and ingrowth trees

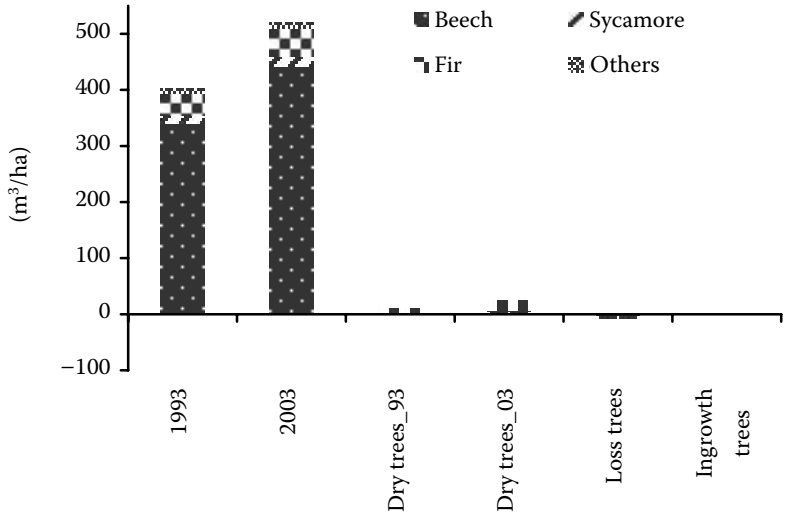

Fig. 5. Species structure in low mountain zone beech forests in the Bieszczady Mountains according to the volume of trees (for years: 1993–2003) and compared with dry trees, loss ones and ingrowth trees

At the same time, as much as 15% of the whole fir population in the examined beech forests is dry-wood, whose share exceeds 60% of the total dimension of dry-wood (17.14 m^3/ha). Among live trees the dominance of beech is still definite – 84.9% (441.26 m^3/ha), while the share of sycamore amounts to 3.5% (18.27 m^3/ha).

Comparing the 2003 volume structure of the examined tree stands with the 1993 results reveals the lack of any essential changes in the species composition of Bieszczady low mountain beech forests (the share of beech was 84.2% – 339.57 m^3/ha, fir – 10.0% – 40.26 m^3/ha, and sycamore – 3.5% – 14.27 m^3/ha).

Fig. 6 shows species structure of primeval beech stands according to stand volume. Beech dominates strongly but its share is a little lower than in the test plots (77%). Moreover, as an addition there is fir (13%), sycamore (3%), and spruce (6%).

The species composition of natural regeneration in the examined beech forests basically adheres to the parent stand (Figs. 7 and 8). Its structure consists of almost only three tree species: the dominant beech and fir, and sycamore as an addition. As for undergrowth (Fig. 7), however, a higher share of beech is noticeable (2003: 91.5% – 2,666 trees/ha) and there is nearly no sycamore (0.3% – 9 trees/ha). The share of fir is 8% (233 trees/ha). As for natural regeneration (Fig. 8), much less beech is to be found there (70.4%), and the dominant additional species is sycamore (18.7%), leaving fir far behind (4.8%).

In comparison with the 1993 results, some general changes in the composition of Bieszczady beech forests' natural regeneration can be found – the changes that may contribute to the composition of the mature tree stand in the near future. Both the undergrowth and the natural regeneration reveal the increasing number of beech trees (2.0% and 14.5% respectively). At the same time, the share of additional tree species lowered notably, especially with fir in the natural re-

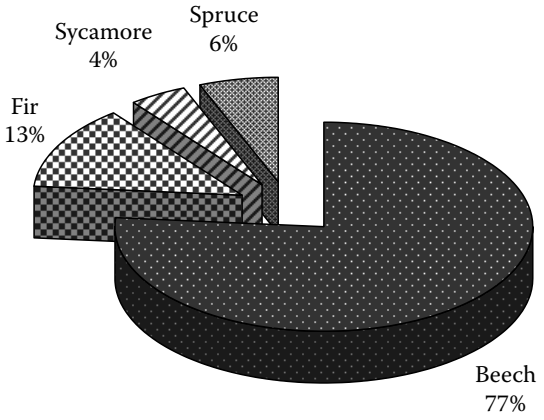

Fig. 6. Tree volume structure in the Carpathian beech primeval forests (according to Jaworski's researches in the Babia Góra NP, Bieszczady NP and Gorce NP)

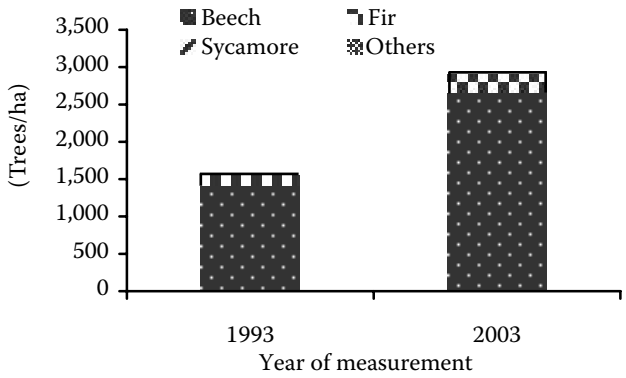

Fig. 7. Species structure of undergrowth in low mountains zone beech forests in the Bieszczady Mountains (for years: 1993–2003)

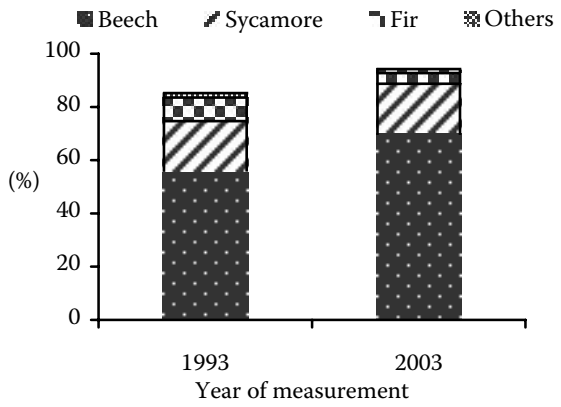

Fig. 8. Species structure of natural regeneration in low mountain zone beech forests in the Bieszczady Mountains (for years: 1993–2003)

generation (by almost 50%) and sycamore – mainly in the undergrowth (by 70%).

The species structure of primeval beech forests generally consists of three tree species (Figs. 9 and 10). The dominant species is beech, with only 57% share in the natural regeneration (Fig. 10), but a 90% share in the undergrowth (Fig. 9). The main additional species is fir, with 25% share in the natural regeneration and 8% share in the undergrowth. The third place is taken by sycamore (17% in the natural regeneration) or spruce (2% in the undergrowth).

CONCLUSIONS AND DISCUSSION

The research conducted in 2003 showed beech as the dominant species in mature forest stands, with a share of 88.7% in the number of trees and 84.9% in the total stand volumes. Additional tree species

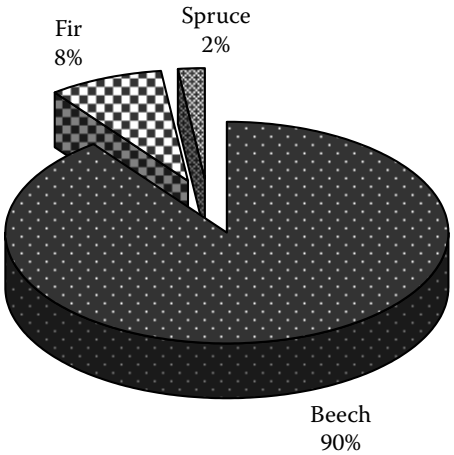

Fig. 10. Species structure of undergrown in Carpathian beech primeval forests (according to Jaworski's researches in the Babia Góra NP, Bieszczady NP and Gorce NP)

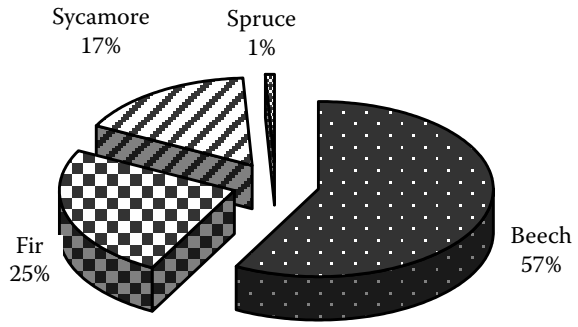

Fig. 9. Species structure of natural regeneration in Carpathian beech primeval forests (according to Jaworski's researches in the Babia Góra NP, Bieszczady NP and Gorce NP)

include fir (5.7% in the tree count and 9.5% in stand volumes) and sycamore (3.8% and 3.5% respectively). Other species' total share (spruce, goat willow, aspen poplar, mountain ash, hazel, mountain elm, ash) is less than 2%.

According to Jaworski's group, the primeval lower mountain forests in plant association *Dentario glandulosae-Fagetum* in Eastern Carpathians (Bieszczady Mts.) are mostly composed of three tree species: beech, fir, and sycamore (Jaworski et al. 1991, 1995, 2000), and in Western Carpathians (Beskidy Mountains: Babia Góra, Gorce): beech, fir, and Norway spruce (Jaworski, Karczmarski 1990; Jaworski, Skrzyszewski 1995). The domination of beech in the Bieszczady Mountains is much higher than in the Beskidy Mts. Analyses by Skrzydłowski (1998) indicate that the mean share of beech amounts to 74.4% in Eastern Carpathians, and 54.5% in Western Carpathians.

In comparison to the 1993 data, the tree species structure of beech stands did not change: beech share in total tree count was about 87.4% and in the total stand volume – 84.2%, fir – 6% and 10% and sycamore – 4.1% and 3.5% respectively.

The results do not confirm Korpel's observations (1989); the researcher pointed out the essential decrease in the share of fir in Carpathian forests over the last 15–25 years, accompanied by the increasing share of beech. No explicit decrease in the share of fir was also noticed across the neighbouring stands in Ukraine in the Carpathians Natural Park (Karczmarski, Loryś 1993).

On the other hand, the analysis of natural regeneration indicates some trends that may contribute to the future development of mature beech stands in Bieszczady. Both in undergrowth and in natural seedlings significant increase in the number of beech (2.0% and 14.5% respectively) can be observed, while the share of fir has decreased by 1.0% and 4.6%

respectively. However, one may assume that the 10-year period is too short to link the results with the climate change. Such doubts can be found in a paper by Fabijanowski and Jaworski (1996). Moreover, as Trepińska (1993) observed, mountain climate shows relatively low susceptibility to temperature changes. Thus, although general trends are similar, the fluctuations are weak and may even show a reverse trend.

On the basis of presented results we can say:

– Today's species composition of the BNP's lower-mountain beech forests is noticeably dominated by beech, with an addition of fir and sycamore. Such a composition is also typical of Carpathian primeval forests.
– After the 10-year control period the species composition of mature forest stands did not reveal any material changes that could be linked to global climate changes. Only some evidence of the loss in the fir volume and the increase in beech volume was collected.
– However, the increasing share of beech, accompanied by a decrease in the share of fir, is typical of the natural seedlings' tier, especially of the wildling. Nevertheless, it may not be unequivocally considered as a permanent direction of changes in the structure of the BNP's lower-mountain beech forests that would stem from the global climate changes.

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Druhová skladba horských porostů buku (*Fagus sylvatica* L.) v Národním parku Bieszczady v podmínkách globálního oteplování

ABSTRAKT: Autoři analyzují změny druhové skladby dřevin společenstva *Dentario glandulosae-Fagetum* Klika 1927 em. Mat. 1964 v horských porostech Národního parku Bieszczady v letech 1993 až 2003. Analýza je zaměřena na změny počtu jedinců a objemové struktury všech dřevin a všech porostních etáží (přirozené zmlazení, podrost a dospělé porosty) za desetiletou periodu sledování. Po srovnání výsledků s údaji ze strukturovaných přirozených karpatských lesů byl formulován jednak odhad adaptační úrovně současné druhové skladby na současné klima a půdní podmínky, jednak pravděpodobný směr budoucích změn v porostech. I když je desetiletá perioda poměrně krátké období na identifikaci průkazných změn ve struktuře druhové skladby porostů, lze z výsledků identifikovat některé trendy: zvyšování podílu buku a snižování podílu jedle v druhové skladbě.

Klíčová slova: Národní park Bieszczady; bukové porosty; druhová skladba; klimatické změny

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