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## The Fir as a Destructor of the Forest Communities in the Republic of Macedonia

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### Abstract

In the last 20-30 years in the forests in the Republic of Macedonia has been noted increasing presence of the fir. There are a number of factors that condition the spread of the fir, mainly the higher protection from the harmful effects of the anthropo-zoogenic factor, and changes in the environmental conditions. The spread of the fir is most intense in the zone of the beech forest region, but expansion is observed in the higher oak regions, too. This occurrence is a result of two main reasons: i) spread of the fir regarding natural regeneration; ii) spread of the fir by sowing fir seed in the beech and oak forest communities. The fir as a shade-tolerant species is the one which can survive and thrive as an understory of beech forests and it is capable to have a long time to rest awaiting the favourable moment for expansion in height. In the struggle for light in natural successive processes the fir manages to overcome the beech, which is confirmed by the fact that in high density beech forests the fir's offspring successfully adapt to site conditions. Thus, it is evident the phytocoenological destructing role of the fir particularly in the beech forest communities in the Republic of Macedonia. In addition, the plant diversity in pure fir forests is poorer than in mixed fir forests. Confirmation of this finding are the data obtained from the management plans which shows the changing of the structure of the forests by composition and volume in favour of the fir.

**Keywords:** Fir, spread, expansion, destructor, forest community.

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### Introduction

In the paper are observed data related to research conducted of the phytocoenological characteristics of the fir and forest communities with fir in Macedonia. From previous research, that of the authors and their works listed in the references section, it is important to mention the research of Em (1961, 1962, 1974), Gudeski and Rizovski (1968), Džekov (1988), and certain new data of Acevski and Simovski (2009, 2010, 2012), Simovski (2011), particularly those regarding the fir and its forests. In addition to field examination, the experts were able to consult database of past literature.

This paper is providing survey or overview of some of the most important fir characteristic and forests with fir in Macedonia. It is important to note the largest part of the study area was conducted in a national park established more than 60 years ago, with minimal human activities and highlighting the fir's natural bio-ecological characteristics as a species and as a part of communities. The National Park Mavrovo is the largest of all national parks in Macedonia. By declaring the area as a national park the forest vegetation and

overall vegetation covers special treatment under the protection and improvement. Namely, today there is reduced volume of excessive and illegal logging and grazing in the forests. Therefore, the forest vegetation is found today in different development stages of progressive succession. With increasing dendrofloral population growth and forest cover, forests with fir today occupy larger areas and have significantly greater growing stock; new research show about 73% expansion of fir's communities territory and more than 65% increase in fir's wood reserve/growing stock. Simultaneously, the spread of fir is most intense in the zone of beech forest region, but expansion is also observed in the higher oak regions as a result of its ecology and reduced anthropo-zoogenic influence. However, phytocoenological observed is the occurrence of fir as destructor, especially in beech/beech-fir forests and spruce-fir forest. In these areas can occur to attenuation of floristic and biological diversity, i.e. leaving these areas only by nature will inevitably lead to greater uniform and reaching the final stages of forest dynamics.

Likewise, the circumscribed analysis hopefully will generate discussion for protection of significant forest communities and species in the national parks and thus in Macedonia, concerning human (in) activities in the forest areas.

New insights arising from this research are very important, taking into account the rapid progress of studies on vegetation in Europe and thus solve the important synhorological, syndynamical, and particularly synaecological issues regarding the ecology of the fir and fir's presence in the forest communities.

### Material and methods

The most important tasks of this research are determination and description the fir's spread and the expansion of fir as an individual and in forest communities in the Republic of Macedonia. Therefore, mainly are analyzed fir's bio-ecological characteristics, such as ability to spread, reproduce by seed, light regime, floral composition of fir related forests, site conditions etc. Also, due to the importance of human (in)activities, special attention are given to some of the areas under fir cover in the national parks, emphasize the National Park Mavrovo as the largest in the country (by overall territory and by the areas with fir). Likewise, researched are other linkages with fir forests and forest communities within the Park, regarding the past and recent territory of the fir/fir related communities and fir's growing stock/wood reserve. Finally, noted are foreseeing of the spread and territorial expansion of the fir and its impact/influence from a phytocoenological aspect, with accent on natural forest dynamics.

Within the completed surveys, the standard phytocoenological method of *Braun-Blanquet* is used. The nomenclature of the forest communities is noted according *Prodromus phytocoenosum Jugoslaviae* (1986). For conducting field surveys mostly are used topographic maps S=1:25000, satellite and aero photo imagery, GPS measurements and more, in the most part provided by forestry-geomatic laboratory techniques in GIS Lab at the Ss. Cyril and

Methodius University in Skopje, Faculty of Forestry in Skopje.

### Results and discussion

The European silver fir, *Abies alba* Mill., concerning its natural distribution in the Republic of Macedonia and the region is interesting theme for a long period of time, particularly its taxonomy and morphology. Namely, in 1925, Turril determined *Abies alba* Mill. in Macedonia as *Abies alba* var. *acutifolia* Turr., and Mattfeld in the south-western parts of Bulgaria as a new species: *Abies borisii-regis* Matt. (Em, 1974; Džekov, 1988). Today, these two scientific names are accepted as synonyms (Džekov, 1988).

The Macedonian, Bulgarian or the Balkan fir (*Abies borisii-regis* Matt.) has an intermediary characteristics (distribution, morphology and ecology) between *A. alba* Mill. and the Greek fir, *A. cephalonica* Loud. (Em, 1974). The distribution range mostly on western parts of Macedonia, i.e. west of the river Vardar and r. Lepenec. It is a mountain tree, settled on an altitude of 1000-1800 m, rarely at 800-2000 m a.s.l., on various rocks, but mostly on dusky sites (NW-N-NE) The lowest altitude is determined by Gudeski and Rizovski (1968) on 490 m, in Demir Kapija region. Ecologically, the fir is a (thermo-) mesophile, but it is interesting to note that although the population of the fir is correlated to sites of a minimum of 900 mm average precipitation per year, it cannot be found as a continuous or wide forest belt following above the isohietic line (Em, 1961, 1974). In addition, the fir is settled in the mountain massifs of west to north-west Macedonia, parts of south-west and south and smaller areas to the east. There are, also, very small territories with fir in the central parts. According to Em (1974), beside the above mentioned minimum average of precipitation, assumptions for extinction of the fir in suitable areas for the needs of timber for the mining and mining settlements in the past are more likely to be correct.

The fir is a very shade tolerant species. Most often it reproduces by seed under the cover of the parental stand. It possesses high ability to have a long time to rest waiting the favourable moment for expansion in height.



Figure 1. Large fruitfulness of *Abies borisii-regis* Mattf., mountain massif Bistra, Republic of Macedonia (2010)

In the struggle for light in natural successive processes the fir manages to overcome many species, particularly the beech as a shade tolerant species too (in high density beech forests the fir's offspring successfully adapt to site conditions). Concerning some of the heliophile species which thrive with the fir at higher altitudes, such as some oaks, pines, spruce, the fir has overwhelming power to develop and grow above their canopy, particularly when the forest cover is dense. This is very important because the expansion and the destruction role of the fir refer to fir related forests composed of these species as edificatory. During the conducted field research period (2010-2012), in all communities where fir is found in the upper part of the crown shows large fruitfulness (Figure 1); fertile branches are literally packed with cones with seeds, especially within the boundaries of the

National Park Mavrovo in 2010 (Acevski and Simovski, 2010, 2012; Simovski, 2011).

Hereafter are noted some of the most important influence and impact of the fir and forests with fir in natural stand dynamics in Macedonia.

According to Acevski and Simovski (2010, 2012) and Simovski (2011), in recent time, a significant notice in submontane beech forest (ass. *Festuco heterophyllae-Fagetum* Em 1965) is the phenomenon of spreading of the fir (*Abies borisii-regis* Mattf.). Likewise, certain sites have occurrence of the spread of fir in current beech floor of the montane beech forests (ass. *Calamintho grandiflorae-Fagetum* Em 1965). These forests exposed to invasion by fir in the future will tend to grow in mixed beech-fir forest (Acevski and Simovski, 2010, 2012; Simovski, 2011). These occurrences refer particularly in the national parks in Macedonia (Figure 2).



Figure 2. Expansion of *Abies borisii-regis* Mattf. in ass. *Calamintho grandiflorae-Fagetum* Em 1965, National Park Mavrovo, Republic of Macedonia (2010)

Beech-fir forest communities (ass. *Abieti-Fagetum macedonicum* Em /1962/ 1985) in the Republic of Macedonia settle expressed mesophilic sites in the zone of beech forest region of 1100 to 1600 m a.s.l. Forests are densely assembled (canopy closure). Beech-fir forest communities are characterized by clearly marked floral structure. The floor of trees is in dominance of *Fagus sylvatica* ssp. *moesiaca* Malý (Balkan beech) and *Abies borisii-regis* Mattf. (Macedonian fir). The floor of shrubs is mostly characterized by shade tolerant species.

According to Acevski and Simovski (2010, 2012) and Simovski (2011), in these forests there is a clear hostility to the spread of fir, and it manifests itself mostly with high emergence of offspring (Figure 3). This results due to many factors, primarily on:

- Reduced anthropo-zoogenic influence, notably in the past 50 years,
- Preference for changing climate conditions and
- Changes in light regime across these forests, which requires and provides opportunity for fir, with high shade-tolerance, very easy to reproduce by seed.

Based on the current state of these forests, they are with high commercial significance, since they are most productive, easily renewable (large vegetative ability of the beech, great reproductive ability of the seed-fir) and very high importance in biodiversity (habitats of many species of flora and fauna).

The spruce-fir forest (ass. *Abieti-Piceetum scardicum* Em /1958/ 1985) is one of the moist interesting communities for research, especially concerning the forest dynamics and natural succession processes in the National Park Mavrovo. Synhorological, this community represents the southernmost spruce forest in its European range. It is found only in the basin of the river Adžina Reka (1400-1800 m a.s.l.). The spruce-fir forest is a relic from the last period of glaciations. According to Acevski and Simovski (2010, 2012) and Simovski (2011), there are a number of reasons that conditioned the survival of the forest in this region to date, although it spent a long period of glaciations. As part of those reasons would be quoted:



Figure 3. Offspring of fir in ass. *Abieti-Fagetum macedonicum* Em (1962) 1985, mountain massif Bistra, Republic of Macedonia (2008)

- Exposure, i.e. positioning of the woods, with north-northwest exposure, or is in constant shade,
- Climate conditions, i.e. the area where the forest extends has a specific microclimate, characterized by relative high humidity of the air and soil throughout the year and the reason for this is that this area is a zone of so-called rain curtain, moist air masses that penetrate the Adriatic always cause heavy rainfall and snow and high relative humidity and
- Antropo-zoogenic impact, i.e. as a result of a rare population of this area was not subject to degradation processes (cutting, burning, uproot, destroy, etc.).

The floor of the trees is characterized by large forest canopy closure and it is dominated by *Picea abies* Karst. (Norway spruce) and *A.borisii-regis* Mattf. At this floor there is very small presence of other species, primarily due to spruce-fir dominance and expressed shade tolerance. At the ground floor vegetation are encountered

number of expressed mesophilic and acidophilic species.

Today, in the spruce-fir forest are observed processes of extinction of the Norway spruce, especially drying large number of spruce individuals. There is a decrease in the population of spruce offspring, and on account of it- an aggressive expansion of the fir (*Figure 4*). Reasons for this are many, and as a part of them are (Acevski and Simovski, 2010, 2012; Simovski, 2011):

- Change of the microclimate and light regime in the community,
- Achieving the climax of the old spruce trees and
- Aggressive competition by fir.

These are only partial notes of the reasons for reduction of the spruce. To discover all the reasons that contribute to the withering of this important scientific spruce forest, it is necessary to set up monitoring stations for detailed monitoring of all environmental factors. But, it is important to emphasize an indicator that there are major environmental

changes in this area. Namely, in the vicinity of this forest is determined the appearance of species that are drought resistant species i.e. represent of a steppe floral element,

European barberry, *Berberis vulgaris* L. (Acevski and Simovski, 2010, 2012; Simovski, 2011).



Figure 4. Aggressive competition of fir's offspring despite *Picea abies* Karst. in ass. *Abieti-Piceetum scardicum* Em /1958/ 1985, mountain massif Šar Planina, National Park Mavrovo, Republic of Macedonia (2010)

Pure fir forests (ass. *Fago-Abietetum meridionale* Em 1973) in the Republic of Macedonia are often subject to scientific discussion, mostly in course of the existence of this type of just pure fir forests (not as an admixture of some other communities or mixed forests), but are an important phenomenon. They are found on slopes with altitude from 1000 to 1600 m a.s.l. Site conditions are characterized by strong mountain climate with mesophilic specificity, characterized by no noticeable occurrence of summer drought. The forests of fir have a dense canopy closure, where the floor of the trees is an absolute dominance of *A. borisii-regis* Mattf. Very rarely are found individuals or small groups of trees of *F. s. ssp. moesiaca* Malý. The localities where this forest is in initial stage also are observed some pioneering remnants. The floor of shrubs is poorly differentiated mainly because of the wide area of fir's offspring

and dense canopy closure. Ground floor is characterized by a small number of plant species. Overall, pure fir forests have poorer floral composition despite mixed fir forests (fir with thermo-mesophile oaks, pines, beech, rarely /hop-/hornbeams), as a very important indicator for the forest dynamics and site conditions (Em, 1974; Forest management plans).

Pure fir forests are in progressive succession. According to Acevski and Simovski (2010, 2012) and Simovski (2011), the territorial expansion of the fir is observed with massive fir spread in dense closure of common juniper (*Juniperus communis* L.) thickets in zone of high-montane pastures, particularly within the National Park Mavrovo.

In the National Park Pelister it is interesting to highlight the competitive character of the fir in the struggle to achieve domination raised by the natural forest

dynamics. Namely, according to Acevski and Simovski (2009), the old Macedonian pine (*Pinus peuce* Gris.) forest classified as ass. *Pteridio-Pinetum peucis* Em 1962 (= *Digitali viridiflorae-Pinetum peucis* Em /1960/1962) subass. *abietetosum* Em 1962 naturally will be replaced with fir/beech-fir forest due to similar reasons as the spruce-fir forests:

- Change of the microclimate and light regime in the community,
- Achieving the climax of the old Macedonian pine trees and
- Aggressive competition by fir.

In this forest community, since there are reduced anthropo-zoogenic activities for more than 60 years, ground floor is covered completely by the common bracken (*Pteridium aquilinum* L.) as a result of the changed light regime and humidity and this favourable the shade-tolerant offspring of the fir and beech, despite pioneer Macedonian pine species (Acevski and Simovski, 2009).

In thermo-mesophile oak forest communities (*Orno-Quercetum petraeae* Em 1968 subass. *carpinetosum betuli* Em) at many localities on mountains in the Republic of Macedonia are noticed fir individuals of neighbouring mixed beech-fir forests. Knowing this, 30 years ago on these localities (in inner areas of Macedonia) are taken activities for artificial seeding of the fir. Today, according to data in most of the forest management plans, these forests are in good condition.

Fir and forests with fir, as mentioned previously, are in processes of territorial expansion. It is interesting to follow the territorial expansion of fir particularly in areas where the anthropo-zoogenic influence is reduced to minimum, for getting as more adequate results as it can in this research. Namely, as noted in *Table 1*, in 1985,

according to Forest management plan of the National Park Mavrovo, these forests cover area of 5175.9 ha. In 2010, according to the phytocoenological map of the Park (Acevski and Simovski, 2010; Simovski, 2011), there are 8949.68 ha covered by fir communities. Hence, there is an enlargement of the fir's territory for about 73% in a period of 25 years.

However, due to lack of detailed phytocoenological survey, there is a difficulty to compare additional past data regarding the fir's community area.

The growing stock/wood reserve of the fir in Macedonia is observed by means of the National Park Mavrovo using similar past literature as for the territorial expansion. In fact, according to Forest management plans of the Park in 1975 the growing stock of the fir is 485610 m<sup>3</sup>. Yet, in 2010 (Trajkov, 2011), there are 804148 m<sup>3</sup> fir's growing stock. This means increase of over 65% of fir's growing stock for a period of 35 years (*Figure 5*).

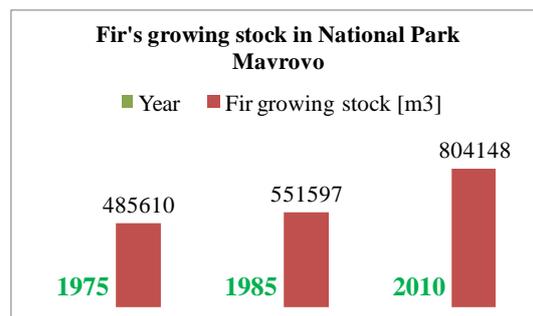


Figure 5. Fir's growing stock in the National Park Mavrovo, Republic of Macedonia

Nevertheless, at this moment, firm correlation of fir's territorial expansion and its growing stock is disputable.

Table 1. Area under fir and forests with fir in the National Park Mavrovo, Republic of Macedonia

Forest community	1985	2010
<i>Abieti-Fagetum macedonicum</i> Em (1962) 1985	5027.3	6911.23
<i>Fago-Abietetum meridionale</i> Em 1973		1867.35
<i>Abieti-Piceetum scardicum</i> Em (1958) 1985	148.6	171.1
<b>Total area [ha]</b>	<b>5175.9</b>	<b>8949.68</b>

## Conclusions

On the basis of the determined actuality of fir and fir-related forests in the Republic of Macedonia, hereafter are the main conclusions.

The fir (*Abies borisii-regis* Mattf.) in its natural progressive stand dynamics in the Republic of Macedonia is in territorial expansion (e.g. 73% enlargement of forest cover under fir and fir-related communities in the National Park Mavrovo).

One of the most important reasons for fir's territorial expansion and phytocoenological destructive influence in the beech region (zone) is fir's biological ability to reproduce on dense canopy closure (0.9-1.0). This characteristic makes fir the most competitive species (despite thermo-mesophile oaks, hornbeams, beech, pines, spruce).

Diminished anthropo-zoogenic impact (protected areas/national parks, reduced stockbreeding, depopulation) has also influenced the fir's natural expansion.

The occurrence of the fir's expansion and its aggressive ability to influence as a destructor within/on different forest communities from biological aspect has negative impact, i.e. creation of a uniform forest stands. Therefore, the fir has influence in decrease of the appearance and development of various species of flora (and fauna).

However, the pure fir forests are characterized by increase of the growing stock/wood reserve. From economic point of view, these forests are in the field of interest of every forestry as an economy-based branch. Accordingly, this is why are undertaken fir's seeding activities, mainly in pure beech forests (over 65% increase of fir's growing stock).

According to recent research on pure Macedonian pine forests and mixed spruce-fir forests, these stands are now in climax-highest peak in development of their natural dynamics. In these forests, the fir will concurrently emerge as a destructor and as a future prime tree species, establishing new forest communities.

Besides the destructive role in the beech region, the fir is starting to occur as a destructor in zone of high-montane pastures.

These pastures, due to long period of reduced stockbreeding (grazing), are in form of thickets of junipers (*Juniperus spp.*). Here, the fir population is in initial stage of development, because of the dense shrub cover of the junipers (as protection).

The expansion of the fir in the high-montane pastures in the future should be of great scientific importance, in course of finding correlation to this occurrence not only as a result of the anthropo-zoogenic influence, but linked with global climate change (e.g. occurrence of *Berberis vulgaris* L.).

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