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DEGRADATION OF MOUNTAINOUS BEECH FORESTS (*Fagetum moesiacae montanum* B. Jov. 1953) IN THE SOUTHWEST SERBIA

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Abstract: *The degradation of mountainous beech forests in various habitat conditions in the territory of southwest Serbia is presented in this paper. Various forms of degradation on limestone and acid siliceous rocks are especially highlighted. Considering the different conditions relating to the parent rock and soil characteristics, the phases of degradation differ significantly. The research area is the wider area of Peštersko-sjenički plateau with the slopes of the surrounding mountains, so it can be said that it represents southwest Serbia.*

Keywords: degradation, beech, habitat, southwest Serbia.

DEGRADACIJA PLANINSKIH ŠUMA BUKVE (*Fagetum moesiacae montanum* B. Jov. 1953) U JUGOZAPADNOJ SRBIJI

Sažetak: *U radu je prikazana degradacija planinskih šuma bukve u različitim uslovima staništa na području jugozapadne Srbije. Posebno su istaknuti različiti oblici degradacije na krečnjacima i na kiselim silikatnim stenama. S obzirom na različite uslove koji se odnose na geološku podlogu i na karakteristike zemljišta, faze degradacije se bitno razlikuju. Oblast istraživanja je šire područje Peštersko-sjeničke visoravni sa ograncima okolnih planina, tako da se može reći da ono reprezentuje jugozapadnu Srbiju.*

Ključne reči: degradacija, bukva, stanište, jugozapadna Srbija.

1. INTRODUCTION

The vegetation succession is a long-term process, and Mišić (1962, 1964) dealt with origin, succession and degradation of forest vegetation in Serbia in the middle of the last century. Some of the research of succession of European vegetation was dealt with by Horvat et al. (1974) in the Southeast Europe, Jávorka and Csapody (1979) in Central Europe, and Tomić (1992) researched phytocoenoses in Serbia.

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Although beech is the most abundant tree species in Serbia, and its ecological and economic importance is huge, the degradation of forests of this species is increasingly present, and the annual degree of afforestation with beech is low (Ćirković-Mitrović et al, 2022). By destroying vegetation, primarily by excessive felling, improper cultivation of steep slopes, deterioration of physical and chemical properties of the soil and the like, man has become the main factor in general degradation of the soil and the environment. Sprout forests and degraded forests are treated as an ecosystem burdened by anthropogenic influence, but the influence of some environmental factors is not excluded. By disruption of only one part of the ecosystem other segments are also disturbed in different scope and intensity. The disruption of stand canopy leads to changes and disruption of the soil solum, which has a backward effect on the state of vegetation. Furthermore, steep slopes, shallow and skeletal soils on limestone worsen the living conditions, so beech forests in such habitats are rather unstable forest ecosystems subject to degradations (Tomić, 2006).

Negative anthropogenic influences which lead to regressive succession of the ecosystem, simultaneously lead to the decrease of species diversity (Lakušić, 2005). The trend of afforestation of beech habitats by coniferous trees, which was particularly pronounced in the second half of the 20th century in the territory of the whole Serbia, in some cases may lead to decrease of floristic diversity and occurrence of degradation (Cvjetićanin, Bjelanović, 2007; Stajić et al., 2022).

By adopting the ecological aspect in renewal of forests, degraded forest ecosystems should return to the original state or state that is the least distant from it, which requires research of the way of origin, the estimate of current state and estimate of the trend of ecosystem development, with and without additional anthropogenic influences. The process of regressive succession of forest ecosystems is best reflected through regressive succession of vegetation. Defining the degree of degradation of certain phytocoenoses through study of degradation stages and phases is one of the most important prerequisites for the correct selection of tree species for afforestation and ameliorations (Tomić et al., 2011). In succession of vegetation, it is important to study primeval forests, completely natural ecosystems in which there were no interventions of any kind carried out by humans. The laws by which forest stands grow and regenerate are visible in them (Martać et al., 2022).

Mixed deciduous-coniferous forests and beech forests have been under great negative effects and were massively destroyed in the researched area. Beech formed with Norway spruce and fir mixed forests of the shallow karst of southwest Serbia. Nevertheless, beech forests as a member of paleogenetic forests of this area, persisted a little longer and on larger areas, although they are mostly sprout forests by origin and predominantly degraded. On limestone beech forests conquered cooler expositions, while warm sides have been degraded to meadows and pastures.

The research in this paper gives basis for determination of directions in which degradation of beech forests took place in different habitat conditions. Also, the intensities of degradation are different as a consequence of different environmental conditions and zooanthropogenic influences.

2. METHOD OF THE RESEARCH

The research area is the wider area of Peštersko sjenički plateau with the slopes of surrounding mountains, so it can be said that it represents southwest Serbia.

With regard to complex researches, different methods were applied in this paper for determining characteristics of climate, soil, recent forest vegetation, manner of regressive successions–degradations, as well as the reconstruction of natural potential vegetation. The study of recent forest vegetation was performed according to the principles and methodology of the French-Swiss school Braun-Blanquet (Braun-Blanquet, 1964). Potential vegetation was determined according to geographic and environmental-habitat complexes. According to these complexes for climatogenic, climatoregional, azonal, interzonal communities a scheme of its regressive succession was given through vegetation stages all the way to pasture and meadow communities. The basic method for determining the directions of degradation is applying succession series from real vegetation to barren land.

3. THE RESULTS OF THE RESEARCH

3.1 Characteristics of the Habitat

The community of mountainous beech forest *(Fagetum moesiacae montanum* Jovanović 1953) as the most represented community in the area of research has very wide ecological amplitude. In terms of elevations the stands of mountainous beech occur in the belt between 1,000 and 1,600 m above sea level. They occur also in lower elevations in the form of smaller stands and groups of trees, but in general at lower elevations around rural settlements beech forests are completely destroyed, so in progressive succession those places are occupied by pioneer tree species. The best stands that were researched were located up to around 1,280 m above sea level, which is also optimal belt of beech forests spreading for this geographic belt. On higher elevations of over 1,450 m beech occurs in the form of partially preserved stands on western, southwestern and southern exposures. In terms of slope, in this area it occurs on very different slopes and positions, on cliffs, steep slopes, plateaus but it is best preserved on longer sides of moderate slope facing north. In general, it can be said that it occurs on limestone parent rock and on acid quartz conglomerates and sandstone and diabase-chert.

Accordingly, and according to other differences which occur as a consequence of different other conditions the community is divided in two sub-communities: *calcicolum* and *silicicolum.* Beech stands on limestone occur on limestone humus and on brown limestone soil as a dominant type on which beech occurs, and on acid parent rocks on dystric cambisol.

182 species are included in the floristic composition of the researched community of mountainous beech, which indicates that the community of beech is very rich (Rakonjac *et al.*, 2014). In the first layer there are 10 tree species; 25 shrub species in the second layer and 147 species that occur in the layer of ground vegetation. The richness of certain relevés with plant species is a consequence of bad stand conditions, i.e. presence of species of grass communities due to the broken canopy.

3. 2. Characteristics of the community

The canopy of the researched stands ranges from 0.5 to 0.9, which indicates that the stands are degraded or recently rejuvenated, so they have not succeeded to cover by crowns the surface of the land. Regarding the height of the trees they do not show high values and heights range from 8 to 26 m. The values of mid-diameter range from 14 to 28 cm. Average distance between trees is not large and amounts up to 4 m, bearing in mind good shoot vigour. Out of the tree species in the first layer, only slightly more significant in terms of presence degree, wild cherry (*Prunus avium*) occurs, but in form of individual trees. *Acer platanoides*, *Betula pendula*, *Carpinus betulus*, *Picea abies*, *Pyrus pyraster*, *Populus tremula*, *Salix caprea* and *Ulmus carpinifolia* occur individually in some of the relevés.

In places where the degradation is more pronounced there is a more massive occurrence of species in the shrub layer, as a response to the increased inflow of light. *Fagus sylvatica*, *Corylus avellana* and *Rosa penduline* occur in the second layer in all relevés also as a sign of degradation and greater inflow of light, and *Crataegus monogyna* occurs slightly less frequent

In **ground flora layer** *Aremonia agrimonioides* occurs with the highest degree of presence, then with the smaller degree of presence *Anemone nemorosa*, *Fragaria vesca*, *Glechoma hirsuta* and *Helleborus odorus*.

3.3 Regressive successions

The community of beech on acid siliceous rocks (*Fagetum moesiacae montanum silicicolum*) occurs in the mosaic with the community *Populo-Betuletum* and pioneer community of birch (*Betuletum verrucosae*), most frequently in the belt of elevations from 1050 to1200 m. In the belt of rural settlements, the community of beech succeeded to survive in the shape of smaller woods and small rural forests. Here beech forests are degraded with significant participation of aspen, birch, and hazel. Almost there is no preserved stand which would represent real natural beech forests in their optimal conditions.

Community of aspen and birch (*Populo-Betuletum*) is a form of degradation of mountainous beech forest which has almost disappeared due to constant anthropogenic influence. It occurs on deeper soils, stagnosols, luvisols, dystric cambisols to mildly eutric, less exposed to the sun, where there is less evaporation of soil moisture. The presence of this community is pronounced in overshadowed river valleys, where there is enough moisture and favourable climatic currents, but without strong wind, while it is not present on southern slopes of smaller rivers. On very deep stagnosols the community is present also on slightly sloping warmer slopes, but as soon as you enter into the belt above river valleys and warmer conditions, shallower dystric cambisols, you enter in the area of potential community of Sessile oak and Turkey oak. On deeper soils above rivers and brooks the community of aspen and birch with significant participation of hazel represents the final stage of degradation of forest vegetation.

Degradation of community *Fagetum moesiacae montanum silicicolum* on eutric rankers, cambisols and colluviums goes over *Populo-Betuletum*, while on dystric cambisols and dystric rankers transitional stage is *Betuletum verrucosae*. The

final stage of regressive successions in above-mentioned conditions are meadows and pastures of the type *Brometo-Cynosuretum*, *Nardetum strictae* and *Festuco-Chrysopogonetum grylli*, and on warmer expositions meadows and pastures of the type *Nardetum strictae* and *Festuco-Chrysopogonetum grylli* (Table 1).

This community regenerates well in favourable edaphic and climatic conditions due to great shoot vigour of aspen and birch, so the degradation does not develop to meadow and pasture communities. In the belt more significantly above river courses, on dystric soils, which are shallower than stagnosols and luvisols the degradation of beech does not stop by the community *Populeto-Betuletum*, but through hazel bush growth (*Coryletum avellanae*) goes to meadows and pastures. Meadow and pasture communities which originate from further forest degradation are communities of the type *Brometo-Cynosuretum, Nardetum strictae* and *Festuco-Chrysopogonetum grylli.*

Table 1. *Scheme of regressive succession and degradation phases of the community Fagetum moesiacae montanum*

Devastation (opening of the canopy, leaf forage cutting, clearing)	
↓	↓
On overshadowed, colder, north and northeast exposures, more moist soils, stagnosols, and deep dystric cambisols stand canopy becomes opened, aspen and birch enter tree layer	On brown limestone soils, on deeper limestone humus devastation leads to mass occurrence of hazel (*Corylus avellana*) in second layer with hawthorn (*Crataegus monogyna*) and Alpine rose (*Rosa pendulina*)
↓	↓
Further devastation, removal of beech	Devastation of the first layer
↓	↓
Aspen and birch form a community **(*Populo-Betuletum*)**	Hazel conquers the entire area **Formation of hazel bush growth *Coryletum avellanae***
↓	↓
Further devastation (opening of the canopy, grazing)	Cutting, devastation, stamping, grazing and other zooanthropogenic influences
↓	↓
Aspen is massively regenerated by means of coppice shoots, in lower positions it dominates, in middle appears with birch and hazel and in upper there is hazel bush growth	Disappearance of hazel bush growth and appearance of common juniper ***Juniperus communis*** among remaining groups of hazel
↓	↓
Formed areas with aspen, birch and hazel in lower positions, where the degradation of forests on deep acid brown soils and stagnosols ends.	**Forming of community of common juniper *Juniperetum communis***
↓	↓
Further degradation by means of clearing, excessive grazing, and stamping and other zooanthropogenic influences in middle and higher positions of slopes	Cutting of common juniper for rural needs, grazing, stamping, burning of common juniper
↓	↓
Communities of meadows and pastures (community of the type ***Brometo-Cynosuretum*, community of *Nardetum strictae* and pastures of *Festuca* and *Chrysopogon gryllus Festuco-Chrysopogonetum grylli*)**	***Formation of pasture of the type Festucetum, Cariceto-Brometum erecti, Rhinantho - Cynosuretum cristati.***

Out of the rocky canyons, valleys and depressions, potential vegetation of the lower belt of this part of the plateau from 1,050 to 1,200 m above sea level and

on the slopes up to 40º is *Fagetum moesiacae montanum calcicolum*. It is the area composed from limestone humus and brown limestone soils. The degradation of this community by means of excessive logging goes through beech stands with the participation of wild cherry (*Prunus avium*) and aspen (*Populus tremula*). In the second layer there is significant occurrence of *Corylus avellana, Rosa pendulina, Crataegus monogyna, Viburnum lantana, Euonymus verrucosus, Daphne mezereum*, etc.

By further degradation, on brown limestone soils and browned limestone humus hazel thicket appears (*Coryletum avellanae*). Due to constant negative zooanthropogenic influences a community of common juniper *Juniperetum communis* is formed from hazel thicket. Further regression to pasture occurs due to burning of juniper, grazing, cattle stamping all the way to clean poor pastures. The last stage of regression are pastures of the type *Festucetum, Danthonietum calycinae, Cariceto-Brometum erecti, Rhinantho-Cynosuretum cristati.*

4. CONCLUSION

- Degradation of beech forests in the researched area has developed by different intensity and in different directions on limestone and on acid siliceous rocks. On limestone degradation has developed faster to hazel bush growth (*Coryletum avellanae*), without any transitional phase compared to the degradation on siliceous rocks where aspen forest with birch and hazel represented the transitional stage. In upper positions hazel directly conquers areas.
- Community of beech on acid siliceous rocks (*Fagetum moesiacae montanum silicicolum*) regenerates well in favourable edaphic and climatic conditions due to great shoot vigour of aspen and birch, so the degradation does not go to meadow and pasture communities. The final stage of regressive successions in these conditions are meadows and pastures of the type *Brometo-Cynosuretum*, *Nardetum strictae*, etc.
- Since the condition of the soil is less favourable on limestone parent rock, forest degradation was more intensive here from the aspect of capability to create tree layer from aspen and birch which would protect soil from erosion. Degradation of the community *Fagetum moesiacae montanum calcicolum* by means of excessive logging goes over beech stands with the participation of wild cherry (*Prunus avium*) and aspen (*Populus tremula*) to hazel thicket (*Coryletum avellanae*). Further degradation develops to community of common juniper (*Juniperetum communis*), and then the regression continues to pasture of the type *Festucetum, Danthonietum calycinae, Cariceto-Brometum erecti, Rhinantho-Cynosuretum cristati*.

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Summary

Degradation of beech forests in the researched area of southwest Serbia has developed by different intensity and in different directions on limestone and on acid siliceous rocks. On limestone degradation has developed faster to hazel bush growth without any transitional phase, compared to the degradation on silicate rocks where aspen forest with birch and hazel represented the transitional stage.

This community regenerates well in favourable edaphic and climatic conditions due to great shoot power of aspen and birch, so the degradation does not go to meadow and pasture communities. The final stage of regressive successions in the above-mentioned conditions are meadows and pastures of the type *Brometo-Cynosuretum, Nardetum strictae*, etc.

The condition of the soil is less favourable on limestone parent rock, since forest degradation was more intensive from the aspect of capability to create tree layer from aspen and birch which would protect soil from erosion. The degradation of this community by means of excessive logging goes over beech stands with the participation of wild cherry (Prunus avium) and aspen (*Populus tremula*) to hazel bush growth (*Coryletum avellanae*). Further degradation develops to community of juniper (*Juniperetum communis*), and then the regression continues to the pasture of the type *Festucetum, Danthonietum calycinae, Cariceto-Brometum erecti, Rhinantho-Cynosuretum cristati*.

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Rezime

Degradacija bukovih šuma na istraživanom području jugozapadne Srbije odvijala se različitim intenzitetom i u različitim pravcima na krečnjacima i na kiselim silikatnim stenama. Na krečnjacima degradacija se brže odvijala do leskara, bez neke prelazne faze u odnosu na degradaciju na silikatima gde je prelaznu fazu činila šuma jasike sa brezom i leskom.

Ova zajednica se u povoljnim edafskim i klimatskim uslovima dobro obnavlja zahvaljujući velikoj izdančkoj moći jasike i breze, tako da degradacija ne ide do livadskih i pašnjačkih zajednica. Krajnji stadijum regresivnih sukcesija u napred navedenim uslovima su livade i pašnjaci tipa *Brometo-Cynosuretum, Nardetum strictae i dr*

Stanje zemljišta je nepovoljnije na krečnjačkoj geološkoj podlozi jer je degradacija šuma bila intenzivnija sa aspekta sposobnosti stvaranja sprata drveća od jasike i breze koje bi štitile zemljište od erozije. Degradacija ove zajednice putem prekomerne seče ide preko sastojina bukve sa učešćem divlje trešnje (*Prunus avium*) i jasike (*Populus tremula*) do šibljaka leske (*Coryletum avellanae*). Dalja degradacija se odvija do zajednica kleke *Juniperetum communis, a zatim* regresija se odvija do pašnjaka tipa *Festucetum, Danthonietum calycinae, Cariceto-Brometum erecti, Rhinantho-Cynosuretum cristati.*