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REGENERATION IN CANOPY GAPS OF THE DINARIC BEECH-FIR VIRGIN FORESTS

ZNAČAJKE POMLAĐIVANJA U PROGALAMA DINARSKIH BUKOVO-JELOVIH PRAŠUMA

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The research was carried out in two typical Dinaric beech-fir (*Omphalodo-Fagetum* Marinček et al. 1992) virgin forests: Čorkova Uvala (Croatia) and Rajhenavski Rog (Slovenia). Growing under similar habitat conditions, both virgin forests stretch across a range of between 740 m and 1030 m above the sea level, upon a typical karst relief, the geological parent rock of chalk, at an average yearly air temperature of 6°C – 8°C, and with a yearly precipitation ranging between 1600 mm and 2000 mm. Twelve canopy gaps were taken as samples in both forests. Upon the rectangular 5m x 5m square nets laid in each gap quantitative and qualitative properties of the seedlings and the relative vegetation cover of the ground vegetation species were measured. For light analysis, hemispheric photography was taken of each plot.. In Rajhenavski Rog we established extremely poor regeneration of the silver fir, while the common beech regenerated considerably better when compared to the virgin forest of Čorkova Uvala. There were considerable differences between the two virgin forests in terms of the areas of canopy gaps and the levels of diffuse and direct radiation. The very poor regeneration of the fir in Rajhenavski Rog is the consequence of excessive number of game, as compared to the Čorkova Uvala virgin forest. The much better regeneration of the beech in Rajhenavski Rog is caused by the higher level of light upon the larger areas of the canopy gaps, which is the result of the fir dieback.

Key words: canopy gap, natural regeneration, diffuse and direct light, Dinaric virgin forests, *Fagus sylvatica* L., *Abies alba* Mill.

INTRODUCTION
UVOD

The stability of forest ecosystems depends on the interaction of abiotic and biotic factors, that either directly or indirectly affect the morphology and dynamics of stands (Kimmins, 2004; Franklin, 2002; Frelich, 2003). The abiotic and biotic factors in forest ecosystems cause various disturbances. Thus, the wind, fungi, and insects through interaction cause the fall of a dead standing tree, initiating the formation of canopy gaps. These openings are considered as basic initiators of virgin forest dynamics in the European moderate zone (Diaci et al., 2003; Korpel 1989; Nagel et al., 2006). The newly formed openings are the places where the natural regeneration of a forest stand begins (Watt, 1923). It is there where the dynamic process of forest stand regeneration takes place (Watt, 1923). The size of the canopy gap changes the ecological conditions that define the occurrence of the species and the density of the seedlings. The new growth within the canopy gaps depends on a number of factors such as the interracial and introracial competition, mortality, game, pests and diseases. They are responsible for the development and survival of the seedlings (Kimmins, 2004).

The research was carried out in the canopy openings of the Dinaric beech-fir virgin forests (*Omphalodo-Fagetum* Marinček et al. 1992.). Beech-fir forests are the most significant forest ecosystems of the Dinaric mountain massif in southeastern Europe. These forests have a preserved stand structure and they regenerate naturally. The permanent natural regeneration secures their stability and sustainability. In the last several decades, the Dinaric beech-fir forest ecosystems have been under the impact of a number of unfavourable factors that have affected their stability and sustainability. Some of these factors are climatic changes, soil acidification, re-introduction of herbivores, harmful insects, economic errors, etc. Consequently, significant changes in the beech-fir mixture ratio and continuous absence of fir regeneration have taken place (Diaci et al., 2007; Boncina et al., 2003; Roženbergar, 2000, Matić et al., 1996). The beech-fir virgin forest ecosystems can also be directly affected by harmful factors. However, these can serve as a direct example of natural forest stand dynamics under such conditions. The aim of this research is to compare the properties of the seedlings in the canopy gaps of the beech-fir virgin forests, in relation to the light and habitat conditions.

MATERIAL AND METHODS
MATERIJAL I METODE RADA

The research was carried out in the virgin forests of Čorkova Uvala (Croatia) and Rajhenavski Rog (Slovenia). Growing under similar habitat conditions (Table 1), both stands are considered as typical examples of the Dinaric beech-fir virgin forests (*Omphalodo-Fagetum* Marinček et al. 1992.).

Table 1. Characteristics of the studied sites and stands
Tablica 1. Značajke istraživanih staništa i sastojina

	Čorkova uvala	Rajhenavski rog
Location / *Lokacija*	44°55'N/15°32'E	45°66'N/15°01'E
Area (ha) / *Površina (ha)*	80,5	52,1
Level above sea (m) / *Nadmorska visina (m)*	860 - 1030	740 - 880
Average yearly temperature (°C) *Prosječna godišnja temperatura (°C)*	7	6 - 8
Average yearly precipitation (mm) *Prosječna godišnja količina oborina (mm)*	1600 - 1700	1500 - 1900
Wood stock (m^3/ha) / *Drvna zaliha (m^3/ha)*	671	758
Soil / *Tlo*	Brown soil on limestone / *Smeđe tlo na vapnencu*	
Parent rock / *Geološka podloga*	Limestones with dolomite inserts *Vapnenci s ulošcima dolomita*	

Twelve canopy gaps were chosen for the research. Five of them were in the virgin forest of Čorkova Uvala, while seven gaps were in the virgin forest of Rejhenavski Rog. The margins of the gaps formed by the canopy rims of the surrounding trees were measured with GPS devices. These gaps appeared some ten years ago. They are covered by 3 m-high-seedlings. Regular 5m x 5m square networks are laid over the gaps in the direction north – south. Over the network intersections there are 1.5m x 1.5m test plots. On an area of 2.25 m^2 of each plot a relative coverage (($\pm$1 %)) of seedlings, ground vegetation, leaf litter, rock, dead wood, naked soil and moss has been estimated. The density of the saplings and seedlings of the woody species according to the following height classes was measured: sapling/seedlings up to 50cm, and over 51 cm. Besides the number of the seedlings, the damage caused by the game was estimated (1 – damaged; 0 – undamaged). Upon each plot, at a height of 1.30 m above the ground, hemispheric photography was taken using Nikon 995 digital camera and calibrated hemispheric lenses for the purpose of calculating the relative amount of average yearly quantity of direct (FDIR%) and diffuse (FDIF%) radiation. The hemispheric photography was carried out by the WinSCANOPY 2003b programme (Règent Instruments inc.). Four separate microhabitat groups were defined on the basis of the relation between the diffuse (FDIF%) and direct (FDIR%) radiations. Within each microhabitat group of both virgin forests, the differences in regeneration and habitat properties were determined by means of the Kruskal-Wallis ANOVA test. The differences in light and regeneration density were analysed with the Mann-Whitney U test (λ=0.05). The ground vegetation analysis was carried out by comparing the Ellenberg eco-indicator indexes (Ellenberg, 1992).

RESULTS
REZULTATI

Gap morphology and light
Morfologija progala i svjetlo

The average area of canopy gaps in the Rajhenavski Rog virgin forest was 640.15±166 m^2, while the one in Čorkova Uvala was 486.50±91 m^2 (Z=-2.2162; P=0.026678).

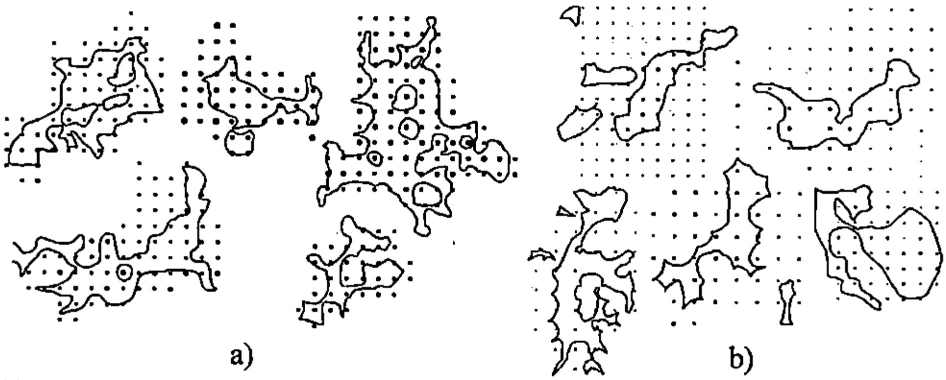

Figure 1: Ground plan of sampled gaps with a network od experimental plots: a) Rajhevanski Rog, b) Čorkova uvala

Slika 1. Tlocrt uzorkovanih progala s mrežom pokusnih ploha: a) Rajhenavski rog, b) Čorkova uvala

The average value of the diffuse radiation (FDIF%) measured in the Rejhenavski Rog gaps was 10.88%, compared to the respective Čorkova Uvala value of 7.23% (U=47972.50,00; P<0.0000). The average direct radiation (FDIR%) in Rajhenavski Rog was 8.13%, while the one in Čorkova Uvala was 4.88% (U 55263.50; P< 0.0000).

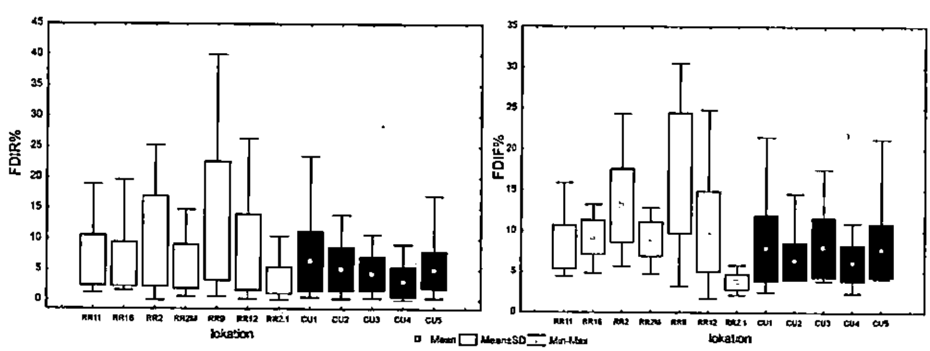

Figure 2: Average relative values of dffuse (FDIF%) and direct (FDIR%) solar radiation in the gaps of virgin forests of Rajhenavski Rog (RR) and Čorkova Uvala (CU)

Slika 2. Prosječne relativne vrijednosti difuznog (FDIF%) i direktnog (FDIR%) sunčevog zračenja u progalama prašuma Rajhenavski rog (RR) i Čorkova uvala (CU)

Regeneration
Pomlađivanje

Significant differences in the young growth density according to the defined height classes (Table 2) were established of all variables except for the total saplings and the saplings of the beech and fir. The average sapling density was 1.98 pcs/m^2 in Čorkova Uvala and 1.90 pcs/m^2 in Rajhenavski Rog (U=1438.5; P=0.083105).

Table 2. Average density values of seedlings and saplings by tree species in Rajhenavski Rog and Čorkova Uvala; the results of Mann-Whitney U-test for the selected variables

Tablica 2. Prosječne vrijednosti gustoće ponika i pomlatka prema vrstama drveća u Rajhenavskom rogu i Čorkovoj uvali; rezultati Mann-Whitney U-testa za odabrane varijable

Variables - *Varijable*	Rajhenavski rog	Čorkova uvala	U	p
	pcs/m^2 - *kom/m^2*			
Total seedling / *Ukupni ponik*	1.90	1.98	1438.50	0.08311
Fagus seedling / *Bukov ponik*	0.72	1.10	10879.00	0.11993
Abies seedling / *Jelov ponik*	1.08	1.35	568.00	0.81051
Sapling, h<50 cm / *Pomladak*	2.01	0.69	44594.50	0.00000
Fagus sapling, h<50 cm / *Bukov pomladak*	1.74	0.23	31577.00	0.00000
Abies sapling, h<50 cm / *Jelov pomladak*	0.27	0.46	64838.50	0.00484
Sapling, h>50 cm / *Pomladak*	2.67	0.50	37321.50	0.00000
Fagus sapling, h>50 cm / *Bukov pomladak*	2.67	0.33	32289.00	0.00000
Abies sapling, h>50 cm / *Jelov pomladak*	-	0.17	61117.50	0.00006

The beech sapling density was 1.10 pcs/m^2 in Čorkova Uvala, and 0.72 pcs/m^2 in Rajhenavski Rog ((U=10879, P=0,119926). The fir sapling density in Čorkova Uvala was 1.35 pcs/m^2, and in Rajhenavski Rog it was 1.08 pcs/m^2 (U=568; P=0.810512). The average density of the ≤ 50 cm seedlings was 2.01 pcs/m^2 in-Rajhenavski Rog, while the one in Čorkova Uvala was 0.69 pcs/m^2 (U=44594.50; P=0.00000). The ≤ 50 cm beech density in Rajhenavski Rog was 1.74 pcs/m^2, while the respective value in Čorkova Uvala was 0.23 (U=31577; P=0.00000).

Unlike beech, the average density of the fir up to 50 cm height was 0.46 pcs/m^2, which is twice as big than in Čorkova Uvala, while in Rajhenavski Rog it was 0.27 pcs/m^2 (U=64838.50; P=0.00006). The average > 50 cm beech density is eight times higher than in Rajhenavski Rog, i.e. 2.67 pcs/m^2, while in Čorkova Uvala it is 0.33 pcs/m^2 (U-32289; P=0.00000). Unlike the beech, the fir seedlings higher than 50 cm are entirely absent in Rajhenavski Rog, while in Čorkova Uvala its density is 0.17 pcs/m^2 (U=61117.50; P=0.00006).

Analysis of microsite conditions
Analiza mikrostanišnih prilika

The analysis of the young growth, the ground vegetation, and the quantity of regeneration according to the defined microhabitat types as to the relation between

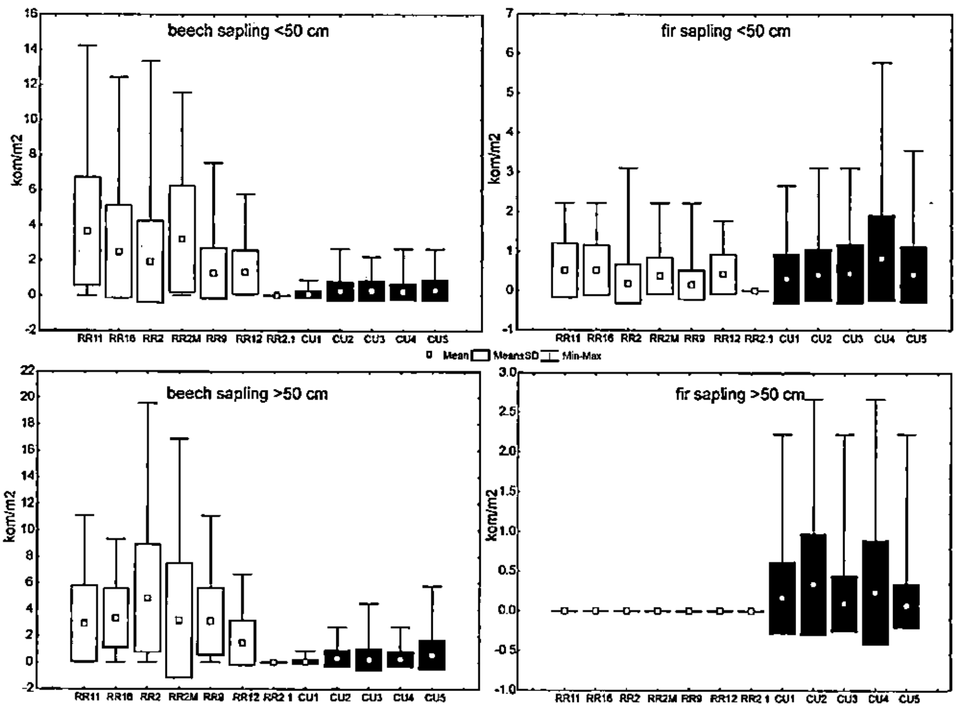

Figure 3: Box&Whisker plot of average density values of beech and fir seedlings [pcs/m²] in the investigated gaps of Rajhenavski Rog (RR) and Čorkova Uvala (CU) by height class

Slika 3. Box&Whisker prikaz prosječnih vrijednosti gustoće pomlatka bukve i jele [kom/m²] u istraživanim progalama Rajhenavskog roga (RR) i Čorkove uvale (CU) prema visinskim klasama

the diffuse (FDIF%) and direct (FDIR%) radiation has revealed significant differences between all variables except for the beech young growth in Rajhenavski Rog (Table 3). In Čorkova Uvala significant differences were determined only in the relative soil coverage by ground vegetation.

Table 3 shows the highest frequency of relative young growth coverage in Rajhenavski Rog in the habitat of type B (high level of diffuse and direct radiation). The fir saplings in Rajhenavski Rog most frequently occur as type C, which is defined by a low level of solar radiation. The fir seedlings mostly occur here as type D, under the conditions of much diffuse radiation and a low level of direct radiation. In Čorkova Uvala, the ground vegetation is the mostly developed as type A, with more direct and less diffuse radiation.

Analysis of seedling increment and damage
Analiza prirasta i oštećenosti pomlatka

The average height of the beech young growth in Rajhenavski Rog is 140 cm, while in Čorkova Uvala it is 122 cm (U=15976.50; P=0.000001). The length of

Table 3. Average values of tested variables with the Kruskal-Wallis test for microsite types determined with the level of diffuse and direct solar radiation

Tablica 3. Prosječne vrijednosti testiranih varijabli Kruskal-Wallis testom za tipove mikrostaništa određene razinom difuznog i direktnog sunčevog zračenja

	Microhabitat type according to solar radiation *Tip mikrostaništa s obzirom na sunčevo zračenje*				
	A	B	C	D	
	DIF%<Med >DIR%	DIF%>Med >DIR%	DIF%<Med <DIR%	DIF%>Med <DIR%	
Rajhenavski rog	(N = 71)	(N = 147)	(N = 147)	(N = 70)	*p*-value
Regeneration / *Pomlađivanje* (%)	63	72	43	48	0.00000
Ground vegetation / *Prizemno rašće* (%)	17	10	15	13	0.00000
Beech-seedling / *Bukov ponik* (N/ha)	6385	3447	1935	889	0.00010
Fir-seedling / *Jelov ponik* (N/ha)	3693	3326	7317	5968	0.00000
Beech / *Bukva* (N/ha)	43631	61285	59834	64698	0.06200
Fir / *Jela* (N/ha)	2128	2147	3296	5206	0.00010
Čorkova uvala	(N = 81)	(N = 88)	(N = 87)	(N = 82)	*p*-value
Regeneration / *Pomlađivanje* (%)	21	24	16	17	0.80120
Ground vegetation / *Prizemno rašće* (%)	46	40	37	31	0.00670
Beech-seedling / *Bukov ponik* (N/ha)	1481	1162	4138	1355	0.58130
Fir-seedling / *Jelov ponik* (N/ha)	4444	4394	4342	5908	0.78350
Beech / *Bukva* (N/ha)	6584	5707	6079	3957	0.08670
Fir / *Jela* (N/ha)	5322	7677	5977	6179	0.72600

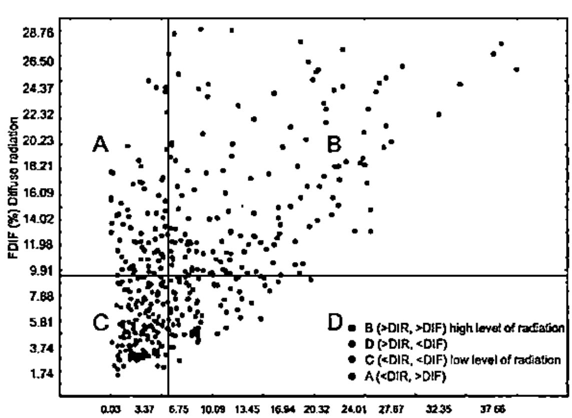

Figure 4: Relationship of direct (FDIF%) and diffuse (FDIF%) average solar radiation in the gaps of Rajhenavski Rog. Full lines indicate median values for both components. A, B, C and D are defined microsite types with regard to the median value of particular components of solar radiation.

Slika 4. Odnos između direktnog (FDIF%) i difuznog (FDIF%) prosječnog sunčevog zračenja u progalama Rajhenavskog Roga. Pune linije predstavljaju vrijednosti mediane za obje komponente. A, B, C i D definirani tipovi mikrostaništa obzirom na medianu vrijednosti pojedine komponente sunčevog zračenja.

the top shoot is 16.87 cm in Rajhenavski Rog, and in Čorkova Uvala it is 12.32 cm (U=15262; P==000001). In Čorkova Uvala, the average height of the fir is 74 cm, with the length of the terminal shoot of 5.61 cm. In Rajhenavski Rog, no fir higher than 50 cm was measured. The average damage of the beech seedlings in Rejhenavski Rog is 26.3%, while in Čorkova Uvala the respective value is 13.9% (U=22774; P=0.0001). The fir damage of 31.8% is also higher in Rajhenavski Rog. In Čorkova Uvala this value is 11.3% (U=9424; P<0.0001).

Analysis of ground vegetation
Analiza prizemnog rašća

The analysis of the floral composition by means of the Ellenberg eco-indicator values included only the species the relative proportion of which on the plots was higher than 1% (Table 4). Table 4 shows that *Cardamine trifolia has* the highest frequency of 22.44% on the Rajhenavski Rog plots. The percentage of the same species in Čorkova Uvala was 0.28%. In Čorkova Uvala, the highest proportion in the floral composition was that of *Rubus hirtus* (43.15%), while in Rajhenavski Rog the respective value was only 0.4%. The species that grow in Rajhenavski rog at a high proportion of 91% are represented in Čorkova Uvala by only 19%.

The eco-diagram (Figure 5) shows significant deviations between the Ellenberg indicator values of light and soil acidity. Čorkova Uvala shows lower pH values, while Rajhenavski Rog has a lower level of relative light.

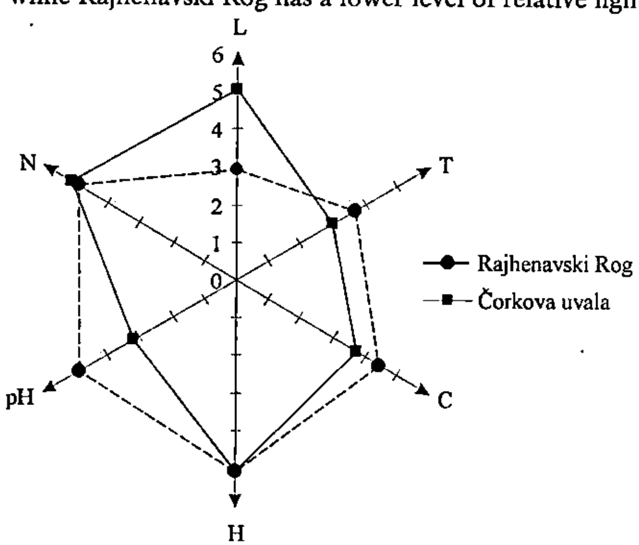

Figure 5: Ecodiagram of Ellenberg's indicator values calculated on the basis of relative participation of the species with cover exceeding 1% in the sample plots, with L (light), T (temperature), C (continentality), H (humidity), pH (acidity), N (nitrogen)

Slika 5. Ekodijagram Ellenbergovih indikatorskih vrijednosti izračunatih na osnovi relativne zastupljenosti vrsta pokrovnosti veće od 1% na pokusnim plohama gdje su: L (svjetlost), T (temperatura), C (kontinentalnost), H (vlaga), ph (kiselost), N (dušik)

Table 4. Species from the layer of ground vegetation with relative cover exceeding 1% in sample plots. Ellenberg's indicator values: L (light), T (temperature), C (continentality), H (humidity), pH (acidity), N (nitrogen). PER – relative frequency in sample plots, x – no indicator value exists for a given element. AVERAGE** - average of Ellenberg's indicator values multiplied by the percentage participation of a given species in sample plots.

*Tablica 4. Vrste iz sloja prizemnog rašća s relativnom pokrovnošću većom od 1% na pokusnim plohama. Ellenbergove indikatorske vrijednosti: L (svjetlost), T (temperatura), C (kontinentalnost), H (vlaga), ph (kiselost), N (dušik). PER – relativna učestalost na pokusnim plohama, x – ne postoji indikatorska vrijednost za određeni element. AVERAGE** - prosjek Ellenbergovih indikatorskih vrijednosti pomnožen postotnim učešćem određene vrste na pokusnim plohama.*

Species list *Vrsta*	Ellenberg indicator values *Ellenbergov koeficijent*						Rajhenavski Rog	Čorkova uvala
	L	T	C	H	pH	N	PER	PER
Rosa arvensis	5	5	2	5	7	5	1.68%	-
Senecio fuchsii	7	x	4	5	x	8	1.71%	0.19%
Lamiastrum galeobdolon	2	4	5	5	7	5	1.98%	0.07%
Anemone nemorosa	x	x	4	x	5	x	2.03%	0.02%
Brachypodium sylvaticum	4	5	5	5	6	6	6.26%	0.03%
Sanicula europaea	4	5	5	5	8	6	9.40%	0.01%
Galium odoratum	2	5	4	5	x	5	12.94%	4.76%
Oxalis acetosella	1	x	4	6	x	7	15.67%	13.95%
Cardamine trifolia	3	4	4	5	8	6	22.44%	0.28%
Omphalodes verna	4	6	6	5	7	0	14.20%	-
Daphne mezereum	4	x	4	5	7	5	2.44%	0.23%
AVERAGE**	3	4	4	5	5	5	90.75%	19.54%
Geranium robertianum	4	6	5	4	5	5	-	1.33%
Athyrium filix-foemina	3	4	4	5	0	5	0.15%	2.92%
Galium odoratum	2	5	4	5	x	5	12.94%	4.76%
Rhamnus fallax	6	4	5	4	8	3	-	5.38%
Sambucus nigra	7	5	4	5	x	9	-	6.36%
Dryopteris filix-mas	3	x	5	5	5	6	0.34%	13.86%
Oxalis acetosella	1	x	4	6	x	7	15.67%	13.95%
Rubus hirtus	7	4	3	5	4	4	0.64%	43.15%
AVERAGE**	5	3	4	5	3	5	29.74%	91.71%

DISCUSSION AND CONCLUSIONS
RASPRAVA SA ZAKLJUČCIMA

The canopy gaps in the Rajhenavski Rog virgin forest have a more complex shape and a bigger average area than the ones in Čorkova Uvala. The reasons for this may be connected with a rather intensive fir dieback in Rajhenavski Rog at the end of the last century (Bončina et al., 2002). The bigger gap areas are related to higher levels of light, which accounts for the five times higher density of the beech young growth in Rajhenavski Rog than in Čorkova Uvala. On the other hand, the fir young growth density in Čorkova Uvala (0.63 pcs/m^2) is twice as high as in Rajhenavski

Rog (0.27 pcs/m²). Such a small number of fir saplings are insufficient for a normal inflow of the fir young growth into the stands (Jarni et al., 2005). In addition, in Rajhenavski Rog any fir higher than 50 cm has not been recorded, while in Čorkova Uvala their number is 0.17 (pcs/m²). A high density of herbivores in Slovenia explains the deficit of the fir in higher height classes in Rajhenavski Rog. The research on the young growth damage established twice as big beech damage, and three times as big fir damage in Rajhenavski Rog than in Čorkova Uvala. The population density of the doe in Rajhenavski Rog is 0.9 pcs/100 ha (Jerina, 2006), while in Čorkova Uvala the respective value is 0.8 pcs/ha (Anonymous, 2007). The population of the deer in Rajhenavski Rog is 6.6 pcs/ha, which is thirty times more than in Čorkova uvala (0.2 pcs/100 ha). In Čorkova Uvala a normal density of 1 piece/100 ha of the herbivore population was estimeted (Meyera (1977). According to Senn (2003), silver fir is the species most damaged by game in south and south-east Europe. We consider the high number of herbivores as the reason of the poor inflow of the silver fir into the higher height classes, which resulted in the break of the most important link in the circle of natural regeneration in the virgin forest of Rajhenavski Rog. In future, this may lead to serious changes in the structure and shape of these virgin forests.

The microhabitat analysis defined by the proportion of the diffuse and direct light established a higher occurrence of fir saplings under the conditions of low radiation of diffuse and direct light. This is the microhabitat type C (Table 3), which is the commonest type under the stand canopy. The young growth of the silver fir in Rajhenavski Rog appears within an ecological niche, with plenty of direct light (microhabitat type D). As a rule, this coincides with the area under the canopy, on the northern sides of the gaps. Diaci 2002, Grassi et al., 2004, and Stancioniu and O'Hara 2006 achieved similar results with the fir young growth. In Čorkova Uvala no significant difference was established between the occurrence of fir and beech in the defined microhabitat types. The beech saplings grow in the conditions of high diffuse radiation (microhabitat type A), which as a rule coincides with the gap itself. The proportion of older beech young growth in all microhabitat types can be explained by the relative sciophilous character of the species and the possibility of polycyclic growth (Collet et al, 2001).

The analysis of the ground vegetation established the differences of the acidity in the top layer of the soil and the differences of light levels. According to Ellenberg eco-indicator indexes, the pH value in Čorkova Uvala is lower than in Rajhenavski Rog. Bakšić et al. (2007) established a low pH value in the beech-fir forest in Čorkova Uvala. According to Matić (1983), the lower pH values stimulate forest regeneration. The comparison of the average values of eco-indicator indexes was used to establish the differences in the light quantity and the pH level.

The conclusion is that natural regeneration is the most significant segment of sustainability and stability of any forest ecosystem. A continuous regeneration process ensures the permanent continuity of benefits offered by the forest ecosystems through economic and non-commercial functions. A successful natural regeneration of the beech and fir is a very complex process depending on a number of ecological factors, primarily on the light. The impact of one among the exogenous factors, in this case the excessive number of herbivores, is essential for successive regeneration of the silver fir, particularly when it comes to virgin forest stands in protected nature areas, where there are no classical forms of ecosystem management.

The paper also presents the ecological niches in terms of light, in which beech and fir grow. Further research should be extended to other beech-fir virgin forests and management forests, particularly for the research on other ecological factors, in order to describe the regeneration variability as thoroughly as possible. In this way we could collect the data on the mechanism of natural regeneration, to be used in sustainable management and the preservation of these forest ecosystems.

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ZNAČAJKE POMLAĐIVANJA U PROGALAMA DINARSKIH BUKOVO-JELOVIH PRAŠUMA

SAŽETAK

Istraživanje je obavljeno u dvije tipične dinarske bukovo-jelove (*Omphalodo-Fagetum* Marinček et al. 1992.) prašume: Čorkova uvala (Hrvatska) i Rajhenavski rog (Slovenija). Obje prašume pridolaze u sličnim stanišnim prilikama. Prostiru se u rasponu nadmorskih visina 740 – 1030 m, na tipičnom krškom reljefu, geološkoj podlozi vapnenca, uz prosječnu godišnju temperaturu zraka od 6 – 8 °C i oborine u rasponu 1600 – 2000 mm/god. U obje prašume uzorkovano je 12 progala. Unutar svake progale postavljena je pravokutna kvadratna mreža dimenzija 5 x 5 m. Na mreži su mjerene i analizirane kvantitativne i kvalitativne osobine pomlatka te relativna pokrovnost vrsta prizemnog rašća. Na svakoj plohi snimana je hemisferna fotografija u svrhu analize svjetla. U prašumi Rajhenavski rog ustanovljeno je izrazito slabo pomlađivanje obične jele i znakovito bolje pomlađivanje obične bukve u usporedbi s prašumom Čorkova uvala. Ustanovljene su značajne razlike u površinama progala i razinama difuznog i direktnog zračenja između dvije prašume. Izrazito slabo pomlađivanje jele u Rajhenavskom rogu posljedica je prekobrojnog stanja divljači u usporedbi sa prašumom Čorkova uvala. Znakovito bolje pomlađivanje obične bukve u Rajhenavskom rogu posljedica je veće razine svjetla prouzrokovane relativno većom površinom progala prouzrokovanom odumiranjem jele.

Ključne riječi: progala, prirodno pomlađivanje, difuzno i direktno svjetlo, dinarske prašume, *Fagus sylvatica* L., *Abies alba* Mill.