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# MACROFUNGI ON BEECH DEAD WOOD IN THE SLOVENIAN FOREST RESERVES RAJHENAVSKI ROG AND KROKAR

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Abstract

Fungi, observed during the two-year inventory (2000-2001) on beech dead wood in the Slovenian forest reserves of Rajhenavski Rog and Krokar are listed. For the inventory 211 fallen trees were selected, 109 in Rajhenavski Rog and 102 in Krokar, representing all different decay phases and size categories. Lichenised fungi were not included in the inventory with the exception of few species. Corticiaceous fungi were collected and collections preserved but not classified. Altogether, 244 species including several rare species of macromycetes were found on beech dead wood in the forest reserves. The results are compared with published inventories of fungi on beech wood in particular forest reserves.

Key words: fungi, macromycetes, beech, *Fagus sylvatica* L., wood, coarse woody debris, forest reserve, Slovenia

# *GLIVE NA ODMRLEM BUKOVEM LESU V SLOVENSKIH GOZDNIH REZERVATIH RAJHENAVSKI ROG IN KROKAR*

Izvleček

*V prispevku so navedene glive, ki smo jih ugotovili v dveletni inventarizaciji (2000 – 2001) na odmrlem bukovem lesu v slovenskih gozdnih rezervatih Rajhenavski Rog in Krokar. Za popis smo izbrali 211 podrtih dreves (109 v Rajhenavskem Rogu, 102 v Krokarju), ki so bila različnih dimenzij in v vseh fazah razgradnje. Razen nekaj izjem, lihenziranih gliv nismo popisali. Skorjaste glive smo nabrali in jih shranili v zbirko, vendar jih nismo determinirali. Na odmrlem bukovem lesu smo v obeh gozdnih rezervatih skupaj popisali 244 vrst makromicet, med njimi številne redke vrste. Rezultate smo primerjali z objavljenimi popisi gliv na bukovem lesu v obeh gozdnih rezervatih.*

*Ključne besede: glive, makromicete, bukev, Fagus sylvatica L., les, veliki lesni ostanki, gozdni rezervat, Slovenija*

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# 1 INTRODUCTION
UVOD

Mycota differs considerably in natural settings when compared to managed forest stands (NORTH / TRAPPE / FRANKLIN 1997, CHRISTENSEN / EMBORG 1996, O'DELL / LUOMA / MOLINA 1992, LUOMA / FRENKEL / TRAPPE 1991, WATERS *et al.* 1997). Wood produced in natural forests undergoes decomposition in the forest while in managed forest stands most of it is removed as timber. Wood is the most significant element of total biomass produced in forest ecosystems. The diversity of wood decomposing biota and the overall flow of nutrients in managed forests is strongly affected and diminished by timber removal when compared to natural forests (CHRISTENSEN / EMBORG 1996). An abundance of dead wood in all decay stages in natural forests is critical to the succession of wood decomposing fungi and offers a range of habitats necessary for the growth of other fungi as well. However, the ratio of (ecto)mycorrhizal to saprobic fungi in natural forests is low compared to managed stands. Sporocarp inventory provides reliable insight into the fungal community structure and development in decaying wood as spores are the most important dispersal agent of wood decay fungi (HEILMANN-CLAUSEN 2001).

Two semi-natural forest reserves, Krokar and Rajhenavski Rog in the Dinaric region, were chosen for this study. Both are beech (*Fagus sylvatica* L.) and fir (*Abies alba* Mill.) dominated forests with characteristics of the terminal succession phase of a virgin forest because they were protected in 1894 and not previously exploited. The characteristics of the two forest reserves and of the research plots monitored for coarse woody debris (CWD) are presented in KRAIGHER *et al.* (2002).

This study is part of a NAT-MAN (Nature-based management of beech in Europe QLRT1-CT99-1349) research project; its working package WP 6 focuses on the contribution of beech CWD to the plant and fungal diversity. General and detailed methodology was fixed in accordance with all cooperating research groups. The aim of the study is to document fungal species diversity on beech CWD in two forest reserves in Slovenia by the same methodology and in the same time span as in similar studies in forest reserves in Denmark, Belgium, Hungary and The Netherlands in the framework of the NAT-MAN project. Data about fungal species composition is presented here. Results

of further analyses of fungal succession, relations to wood decay stages, observations and taxonomic treatment of species not included in NAT-MAN scope of research and comparison to other investigated forest reserves will be presented in future contributions.

**Previous research**

Extensive research of fungi, lichens and vegetation in Slovenian forest reserves was conducted from 1975 to 1985 (HOČEVAR 1978, HOČEVAR *et al.* 1980a,b,c, 1985, 1995). In Dinaric forest reserves (Strmec, Pečka, Rajhenavski Rog, Krokar, Kopa and Bukov vrh), 368 species of wood degrading, terricolous and biotrophic (pathogenic) species of fungi and 205 taxa of lichens (among these 13 on genus level and 11 on variety level) were revealed. The systematic studies were performed on research plots on a 100 x 100 m grid and thus the results can be compared with the present research.

Valuable data about mycota of the Dinaric region was published by Milica Tortić, the noted Croatian mycologist whose career is devoted mostly to the research of wood degrading fungi. Only her work concerning beech wood inhabiting fungi is cited here. In her early works, she published lists of wood degrading, mycorrhizal and other terricolous fungi in forests of Gorski Kotar and National park Plitvička jezera, which are ecologically similar to Slovene forest reserves in the Dinaric region and geographically close (TORTIĆ 1966a,b, 1973, 1979a). Later she published new findings and taxonomic works on polypores (TORTIĆ 1970, 1974, 1977, 1979b, 1980a, TORTIĆ / KOTLABA 1976) and on corticiaceous fungi (TORTIĆ 1980b, 1982, 1983, TORTIĆ / JELIĆ 1972). The majority of the cited locations are in the Dinaric forests of Croatia and Slovenia and include fungi on beech wood; some locations are in fir and beech dominated national parks in southern Dinaric region (TORTIĆ 1981, 1984). In spite of Tortić's numerous publications, fungi in Dinaric forests are still poorly known and under-investigated, especially in comparison to the knowledge of fungi in Central European beech and fir dominated forests.

## 2 MATERIAL AND METHODS
## MATERIAL IN METODE

For the inventory, 211 fallen trees were selected, 109 in Rajhenavski Rog and 102 in Krokar. The number differs from that reported in KRAIGHER *et al.* (2002) because one tree in Krokar, leaning on its neighbour, was excluded from analyses, and four trees in Rajhenavski Rog were not yet marked at the beginning of fungal inventory. The selection was made in an attempt to evenly cover all the decay phases (1 = least decomposed to 6 = most decomposed), and size categories of trees (diameter in cm: under 31, 31 – 45, 46 – 60, 61 – 75, above 75). For the inventory of lignicolous fungi, parts of trees were noted separately including snags, logs, crowns, tree bases and uprooted parts as well as smaller broken fragments torn apart by tree fall on hard rocky ground. A special attempt was also made to investigate the underside of smaller fragments of wood by overturning them and carefully placing them to the original position. When such operation would damage or destroy the wooden remnant it was not overturned and left intact. The inventory was made over two years (2000, 2001). Each of the 211 fallen trees was visited at least three times. On average, each tree was inspected for about 15 minutes each visit. Actual inspection time differed considerably because of different number of sporocarps and other species found on a particular tree. Early and late decay phases (1, 5 and 6) required less time than intermediate decay phases (3 and 4). Dates of excursions and visitors are listed in Table 1. Altogether, 22 days were spent for the fieldwork.

Most of the inventory was performed by the first author alone as was recommended by the NAT-MAN project work methods. The relative positions of numbered dead trees were mapped for easier orientation. Special equipment was prepared and used for the recording of data and for the acquisition of fungi for later classification in the laboratory. The data on fungal occurrence was recorded with a voice-activated tape recorder fixed on the operator's chest for hand-free operation. Comments about the site, position of the logs, hints finding a specific log, new events on the plot (e. g. falling of stumps), weather conditions and other details were also recorded. It was also found useful to record the observer's general impression of the daily work at the end of the inventory before leaving the site. It was found very important to have free hands at all times for moving through the young dense beech stand, climbing around the branches of fallen crowns of early decay stages, reaching difficult accessible positions or for overturning wooden remnants.

Table 1: Fieldwork data
*Preglednica 1: Podatki o terenskem delu*

| Date / *Datum* | Site / *Ploskev* | Remarks / *Opombe* |
|---|---|---|
| 08.05.2000 | Rajhenavski Rog | First visit |
| 10.05.2000 | Krokar | First visit |
| 30.08.2000 | Rajhenavski Rog | Pilot inventory with Jože Kosec |
| 16.09.2000 | Rajhenavski Rog | Inventory |
| 17.09.2000 | Rajhenavski Rog | Inventory |
| 23.09.2000 | Rajhenavski Rog | Inventory |
| 24.09.2000 | Rajhenavski Rog | Inventory |
| 24.10.2000 | Krokar | Inventory |
| 31.10.2000 | Krokar | Inventory |
| 04.11.2000 | Krokar | Inventory |
| 18.11.2000 | Rajhenavski Rog | Inventory |
| 25.11.2000 | Rajhenavski Rog | Inventory |
| 02.12.2000 | Rajhenavski Rog | Inventory with Jože Kosec |
| 16.06.2001 | Rajhenavski Rog | Inventory |
| 17.06.2001 | Rajhenavski Rog | Inventory |
| 25.06.2001 | Krokar | Inventory with Gregor Podgornik and Jože Kosec |
| 01.07.2001 | Krokar | Inventory |
| 29.07.2001 | Rajhenavski Rog | Inventory |
| 21.09.2001 | Krokar | Inventory |
| 29.09.2001 | Rajhenavski Rog | Inventory, Peter Odor and Klaas van Dort performing bryophyte inventory |
| 30.09.2001 | Rajhenavski Rog | Inventory with Jože Kosec, Peter Odor and Klaas van Dort performing bryophyte inventory |
| 14.10.2001 | Rajhenavski Rog | Inventory with Morten Christensen and Jakob Heilmann - Clausen, Tine Grebenc and Tobias Froeslev |
| 21.10.2001 | Krokar | Inventory with Morten Christensen and Tobias Froeslev |
| 31.10.2001 | Rajhenavski Rog | Inventory with Jože Kosec |

Collected fungal specimens were placed in covered plastic boxes (18 x 9 x 3 cm) with 10 small compartments. Boxes and compartments were numbered. Two sets of 16 boxes were arranged, taking one set (for 160 specimens) in the field. Few specimens needed more space and were stored separately in bigger boxes. For the collecting of samples, a sharp hand knife and larger hunting knife were used. The most interesting specimens (rare, new to the collector, etc.) were photographed on location when weather conditions allowed. Each tree was inspected by segments noted separately, starting from snag or uprooted part going on to the first part of log toward the crown and turning back on the other side of the log.

The specimens were identified in the laboratory working on fresh material when possible. The rest of the specimens were dried and determined at the end of the fieldwork from

exiccata. For the classification of fungi, various taxonomical sources were used (BARAL / KRIEGLSTEINER 1985, BAS *et al.* 1990, BERNICCHIA 1990, BREITENBACH / KRAENZLIN 1984, 1986, 1991, 1995, 2000, CHRISTENSEN 2001, CITERIN / EYSSARTIER 1998, DENNIS 1981, DISSING 1966, DOI 1969, 1972, DONADINI 1979, 1981, 1984, HANSEN / KNUDSEN 1992, 1997, 2000, HILBER / HILBER 1980, HJORTSAM / LARSSON / RYVARDEN 1988, HOHMEYER 1986, JAHN 1979, JU / ROGERS 1996, JÜLICH 1984, KITS VAN WAVEREN 1985, KRIEGLSTEINER 2000, LÆSSØE / GRANMO / SCHEUER 1999, LÆSSØE / HEILMANN-CLAUSEN / CHRISTENSEN 2000, LE GAL 1941, MAAS GEESTERANUS 1992, MILLER 1961, MOSER 1978, MUNK 1957, NORDEN / LUNDQUIST 1993, NUSS / HILBER 1977, PIERI / RIVOIRE 1997, POUZAR 1985a,b,c, ROGERS / JU 1998, ROSSMAN *et al.* 1999, RYVARDEN / GILBERTSON 1993, SENN-IRLET 1995, STANGL 1989, SVRČEK 1970, WATLING / GREGORY 1993). The nomenclature follows HANSEN / KNUDSEN 1992, 1997, 2000 and was adopted according to the NAT-MAN proposal as a part of a common methodology.

The most important samples were saved or their location on the CWD noted and marked for recollection. Polypores and some corticiaceous fungi were determined by the third author, ascomycetes by the second author and the rest by the first author. The literature review and comparison of findings with published results was performed by the fourth author.

## 3 RESULTS AND DISCUSSION
## REZULTATI IN RAZPRAVA

For the scope of the NAT-MAN project only selected groups of fungi were included for the inventory. Other fungal species found during the inventory (i. e. small ascomycetes with sporocarps under 3 mm, most corticiaceous fungi, some lichens and fungi, growing on sporocarps of bigger polypores) were excluded from the analyses and will be dealt with in further work.

The number of fieldwork days performed in Krokar was 7 and in Rajhenavski rog 15. Nevertheless the reliability of the results of the inventory from both forest reserves is the

same. The difference in the duration of the fieldwork is the result of a higher number of fungal species and their higher frequency, and additionally it is also the result of much more heavily piled and in some cases also scattered beech CWD in Rajhenavski Rog forest reserve.

The total number of occurrences (i. e. all fungal species found on all dead trees) is 2.040 for Rajhenavski Rog and 889 for Krokar with the mean species richness (i. e. number of fungal species per dead tree) 12,3 and 5,9 respectively. The number of species found per tree was 0-55 in Rajhenavski Rog and 0-27 in Krokar. There is a striking difference between two sites, Rajhenavski Rog being much more abundant in total number of species and in species richness per tree. A more even frequency distribution of species per tree is also characteristic for Rajhenavski Rog. Of the selected fungal categories for the NAT-MAN inventory, 244 fungal species were found: 138 in Krokar and 206 in Rajhenavski Rog; 36 of them were only in Krokar and 106 only in Rajhenavski Rog (Table 2).

The comparison of fungal species list with previously published records of beech woody debris fungi in forest reserves Krokar and Rajhenavski Rog (Table 2) reveals that 61 species found during this research have been already detected in Krokar (48 %) and 62 species in Rajhenavski Rog (30 %). On the other hand, there are 22 species listed for Krokar and 18 species listed for Rajhenavski Rog (HOČEVAR et. al. 1985, 1995) that were not detected in the present survey. When the lists are compared, the differences in nomenclatural and taxonomical approach should be taken in account. Differences among present and previous lists of beech CWD fungi are, in our opinion, the result of broader ecological interest on fungal diversity in previous research. Thus, the results are less focussed on the beech CWD, which was the only survey object in the present research, although with NAT-MAN project restrictions on the fungal groups.

Table 2: List of macrofungi on beech woody debris in forest reserves Krokar and Rajhenavski Rog. Numbers indicate the number of dead trees on which a particular fungal species was found, the + symbol indicates that the species was also found in previous research (HOČEVAR *et al.* 1985, 1995).

*Preglednica 2: Seznam makrogliv na bukovih lesnih ostankih v gozdnih rezervatih Krokar in Rajhenavski Rog, številke pomenijo število odmrlih dreves, na katerih je bila ugotovljena določena vrsta, oznaka + pomeni, da je bila vrsta ugotovljena tudi v prejšnjih raziskavah (HOČEVAR et al. 1985, 1995).*

| Species / *Vrsta* | Krokar | | Rajhenavski rog | |
|---|---|---|---|---|
| *Agrocybe praecox* (Pers.: Fr.) Fayod | | | 1 | |
| *Amanita pantherina* (DC.: Fr.) Krombh. | 1 | | 1 | |
| *Antrodiella hoehnelii* (Bres.) Niemelä | 1 | + | | |
| *Armillaria lutea* Gillet | 4 | + | 23 | + |
| *Ascocoryne cylichnium* (Tul.) Korf | 15 | | 30 | |
| *A. sarcoides* (Jacq.: Fr.) Groves & Wilson | 6 | + | 12 | + |
| *Baeospora myriadophylla* (Peck) Sing. | | | 1 | |
| *Biscogniauxia nummularia* (Bull.: Fr.) O.K. | 5 | + | 3 | |
| *Bjerkandera adusta* (Willd.: Fr.) P.Karst. | 23 | + | 43 | + |
| *Boletus calopus* Fr. | | | 2 | |
| *B. pascuus* (Pers.) Krombh. | 1 | | | |
| *Bulgaria inquinans* (Pers.: Fr.) Fr. | 2 | + | | |
| *Calocera cornea* (Batsch: Fr.) Fr. | 11 | + | 21 | |
| *Camarops tubulina* (Alb. & Schw.) Shear | 2 | | 1 | |
| *Cantharellus tubaeformis* (Bull.: Fr.) Fr. | | | 2 | |
| *Ceriporia excelsa* (Lund.) Parm. | 2 | | 9 | |
| *C. purpurea* (Fr.) Donk | | | 1 | + |
| *C. reticulata* (Hoffm.: Fr.) Dom. | 4 | | 6 | |
| *Ceriporiopsis gilvescens* (Bres.) Dom. | 2 | + | 10 | + |
| *C. mucida* (Pers.:Fr.) Gilb. & Ryvarden | | | 1 | |
| *C. pannocincta* (Rom.) Gilb. & Ryvarden | 1 | | | |
| *Cerrena unicolor* (Bull.: Fr.) Murr. | | + | 1 | + |
| *Clavulina coralloides* (L. : Fr.) J. Schroet. | 1 | | 2 | |
| *Clitocybe nebularis* (Batsch: Fr.) P.Kumm. | 2 | | 3 | |
| *Clitopilus prunulus* (Scop.: Fr.) P.Kumm. | | | 1 | |
| *C. scyphoides* (Fr.: Fr.) Singer | | | 1 | |
| *Collybia butyracea* (Bull.: Fr.) P.Kumm. | | | 2 | |
| *C. cookei* (Bres.) J.D.Arnold | 1 | | | |
| *C. dryophila* (Bull.: Fr.) P.Kumm. | 4 | | 1 | |
| *C. hariolorum* (DC.: Fr.) Quél. | 4 | | | |
| *C. peronata* (Bolt.: Fr.) P.Kumm. | | | 1 | |
| *Conocybe aporus* Kits Wav. | 1 | | 9 | |
| *C. subpubescens* P.D.Orton | 2 | | 11 | |
| *Coprinus disseminatus* (Pers.: Fr.) Gray | 2 | | | |

Table 2: (continuation)
*Preglednica 2: (nadaljevanje)*

| Species / *Vrsta* | Krokar | | Rajhenavski rog | |
|---|---|---|---|---|
| *C. micaceus* (Bull.: Fr.) Fr. | 8 | + | 23 | + |
| *C. radians* (Desm.: Fr.) Fr. | | | 1 | |
| *Cortinarius anomalus* (Fr.: Fr.) Fr. | | | 1 | |
| *C. atrovirens* Kalchbr. | | | 2 | |
| *C. battailei* (Moser) Hziland | | | 2 | |
| *C. venetus* (Fr.) Fr. | | | 2 | |
| *C. violaceus* (L.: Fr.) S. F. Gray | | | 1 | |
| *Crepidotus applanatus* (Pers.) P.Kumm. | 4 | | 14 | |
| *C. epibryus* (Fr.: Fr.) Quél. | 2 | | | |
| *C. mollis* (Schaeff.: Fr.) Staude | | + | 2 | + |
| *C. variabilis* (Pers.: Fr.) Kumm. | 1 | + | | + |
| *C. versutus* (Peck) Sacc. | | | 1 | |
| *Cystoderma carcharias* (Pers.) Konr. & Maubl. | | | 2 | |
| *Cystolepiota seminuda* (Lasch) Bon | | | 2 | |
| *Datronia mollis* (Sommerf.: Fr.) Donk | 6 | + | 6 | + |
| *Dentipellis fragilis* (Pers.: Fr.) Donk | 6 | + | 3 | + |
| *Discina parma* J.Breitenb. & Maas Geest. | | | 3 | + |
| *Elaphomyces granulatus* Fr. | 1 | | | |
| *Entoloma rhodopolium* (Fr.: Fr.) P.Kumm. | 1 | | 4 | |
| *Eutypa spinosa* (Pers.: Fr.) Tul. & C.Tul. | 33 | + | 55 | + |
| *Exidia glandulosa* (Bull: Fr.) Fr. | 5 | + | 12 | + |
| *Flammulaster limulatus* (Fr.) Watling | 2 | | 4 | |
| *Flammulina velutipes* (Curt.: Fr.) P.Karst. | | | 3 | |
| *Fomes fomentarius* (L.: Fr.) Fr. | 42 | + | 67 | + |
| *Fomitopsis pinicola* (Swartz: Fr.) P.Karst. | 2 | + | 26 | + |
| *Galerina camerina* (Fr.) Kühn. | 3 | | 1 | |
| *G. cerina* Smith & Sing. | 3 | | 1 | |
| *G. marginata* (Batsch) Kuhner | 12 | | 25 | |
| *G. mniophila* (Lasch) Kühn. | | | 4 | |
| *G. pallida* (Pilát) Horak & Moser | | | 2 | |
| *G. stylifera* (Atk.) Smith & Sing. | | | 1 | |
| *G. triscopa* (Fr.) Kuhner | 1 | | 2 | |
| *Ganoderma lipsiensis* (Batsch) Atk. | 4 | + | 19 | + |
| *Hebeloma radicosum* (Bull.: Fr.) Ricken | | | 1 | |
| *H. sinapizans* (Paul.) Gillet | | | 2 | |
| *Helvella crispa* Scop.: Fr. | 1 | | | |
| *H. elastica* Bull. | | | 2 | |
| *H. lacunosa* Afz.: Fr. | | | 1 | |
| *H. nigricans* Pers. | | | 1 | |
| *Henningsomyces candidus* (Pers.: Fr.) O.K. | 2 | | | |
| *Heterobasidion annosum* (Fr.) Bref. | 1 | | | |
| *Hohenbuehelia fluxilis* (Fr.: Fr.) P.D. Orton | | | 4 | |
| *H. mastrucata* (Fr.: Fr.) Singer | | | 1 | |
| *Humaria hemisphaerica* (Wigg.: Fr.) Fuckel | | | 1 | |
| *Hydnum rufescens* Fr. | | | 1 | |
| *Hygrophorus pudorinus* (Fr: Fr.) Fr. | | | 3 | |
| *Hyphodontia flavipora* (syn. Schizpora f.) | 1 | | | |
| *H. paradoxa* (Schrad.: Fr.) E.Langer & Vesterh. | | | 1 | |

Table 2: (continuation)
*Preglednica 2: (nadaljevanje)*

| Species / *Vrsta* | Krokar | | Rajhenavski rog | |
|---|---|---|---|---|
| *Hypholoma capnoides* (Fr.: Fr.) P.Kumm. | | | 4 | |
| *H. fasciculare* (Huds.: Fr.) P.Kumm. | 2 | + | 18 | + |
| *H. lateritium* (Schaeff.: Fr.) P.Kumm. | 1 | + | 10 | + |
| *Hypocrea albofulva* Berk. & Broome | 1 | | | |
| *H. gelatinosa* (Tode: Fr.) Fr. | 2 | | 1 | |
| *H. lutea* Tode (Petch) | | | 2 | |
| *H. rufa* (Pers.) Fr. | 4 | | 6 | |
| *Hypoxylon cohaerens* (Pers.: Fr.) Fr. | 8 | | 10 | |
| *H. fragiforme* (Pers.: Fr.) Kickx | 20 | + | 18 | + |
| *H. macrocarpum* Pouz. | | | 1 | |
| *H. multiforme* (Fr.: Fr.) Fr. | | | 2 | |
| *H. rubiginosum* (Pers.: Fr.) Fr. | 1 | | 1 | |
| *Hypsizygus tessulatus* (Bull.: Fr.) Sing. | | | 1 | |
| *Inocybe bongardii* (Weinm.) Quél. | | | 1 | |
| *I. fuscidula* Vel. | | | 1 | |
| *I. petiginosa* (Fr.: Fr.) Gillet | 1 | | 2 | |
| *Inonotus nodulosus* (Fr.) P.Karst. | 12 | + | 10 | + |
| *Ischnoderma resinosum* (Schrad.: Fr.) P.Karst. | 1 | + | 8 | + |
| *Laccaria amethystina* Cooke | 5 | | 7 | |
| *L. laccata* (Scop.: Fr.) Berk. & Br. | | | 1 | |
| *Laccaria tortilis* (Bolt.) Cooke | | | 1 | |
| *Lactarius acris* (Bolt.: Fr.) Gray | | | 1 | |
| *L. blennius* (Fr.: Fr.) Fr. | 2 | | 1 | |
| *L. glutinopallens* Britzelm. | | | 1 | |
| *L. pallidus* (Pers.: Fr.) Fr. | | | 1 | |
| *L. rubrocinctus* Fr. | | | 1 | |
| *L. salmonicolor* R.Heim & Lecl. | 2 | | 5 | |
| *L. subdulcis* (Bull.: Fr.) Gray | 9 | | 11 | |
| *Laxitextum bicolor* (Pers.: Fr.) Lentz | 1 | | | + |
| *Lentaria epichnoa* (Fr.) Corner | | | 2 | |
| *L. mucida* (Pers.: Fr.) Corner | 1 | | 17 | |
| *Lenzites betulinus* (L.: Fr.) Fr. | | | 1 | |
| *Leotia lubrica* Scop.: Fr. | | | 1 | |
| *Lepiota cristata* (Bolt.: Fr.) P.Kumm. | | | 1 | |
| *Lycoperdon echinatum* Pers.: Pers. | | + | 2 | |
| *L. perlatum* Pers.: Pers. | | | 4 | |
| *L. pyriforme* Schaeff.: Pers. | 9 | + | 16 | + |
| *Marasmius alliaceus* (Jacq.: Fr.) Fr. | 20 | + | 21 | + |
| *M. bulliardii* Quél. | 1 | | 2 | |
| *M. wynnei* Berk. & Br. | 1 | | 2 | |
| *Megacollybia platyphylla* (Pers.: Fr.) Kotl. & Pouz. | | + | 2 | + |
| *Melanophyllum aimatospermum* (Bull.: Fr.) Kreisel | | | 1 | |
| *Mutinus caninus* (Huds.: Pers.) Fr. | 1 | | | |
| *Mycena acicula* (Schaeff.: Fr.) P.Kumm. | | | 2 | |
| *M. alba* (Bres.) Kühn. | | | 1 | |
| *M. arcangeliana* Bres. | 12 | | 18 | |
| *M. aurantiomarginata* (Fr.) Quel. | | | 1 | |
| *M. crocata* (Schrad.: Fr.) P.Kumm. | 6 | + | 19 | + |

Table 2: (continuation)
*Preglednica 2: (nadaljevanje)*

| Species / *Vrsta* | Krokar | | Rajhenavski rog | |
|---|---|---|---|---|
| *M. erubescens* Höhn. | | | 6 | |
| *M. galericulata* (Scop.: Fr.) Quél. | 14 | | 12 | |
| *M. haematopus* (Pers.: Fr.) P.Kumm. | 9 | + | 29 | + |
| *M. hiemalis* (Osb.: Fr.) Quél. | 1 | | 3 | |
| *M. minutula* (Peck) Sacc. | 1 | | 1 | |
| *M. polygramma* (Bull.: Fr.) Gray | | + | 1 | |
| *M. pseudocorticola* Kuhn. | 5 | | 2 | |
| *M. pura* (Pers.: Fr.) P.Kumm. | 3 | | 5 | |
| *M. renati* Quél. | 10 | + | 6 | + |
| *M. sanguinolenta* (Alb. & Schw.: Fr.) P.Kumm. | | | 2 | |
| *M. speirea* (Fr.: Fr.) Gillet | | | 5 | |
| *M. stylobates* (Pers.: Fr.) P.Kumm. | 1 | | | |
| *M. tintinabulum* (Fr.) Quél. | | | 3 | |
| *Mycoacia fuscoatra* (Fr.: Fr.) Donk | | | 1 | + |
| *Nemania atropurpurea* (Fr.: Fr.) Pouzar | 3 | | 1 | |
| *N. carbonacea* Pouzar | 1 | | | |
| *N. chestersii* (Rogers & Whalley) | | | 1 | |
| *N. colliculosa* (Schwein.: Fr.) Granmo | | | 1 | |
| *N. diffusa* (Sowerby) Gray | | | 1 | |
| *N. serpens* (Pers.: Fr.) Gray | 1 | | 6 | |
| *Neobulgaria pura* (Fr.) Petrak | 6 | + | 11 | + |
| *Omphalina epichysium* (Pers.: Fr.) Quél. | 1 | | 1 | |
| *Ossicaulis lignatilis* (Pers.: Fr.) Redhead & Ginns | | | 1 | |
| *Oudemansiella mucida* (Schrad.: Fr.) Höhn. | 16 | + | 35 | + |
| *Panellus serotinus* (Pers.: Fr.) Kuhn. | 8 | | 33 | + |
| *P. stipticus* (Bull.: Fr.) P.Karst. | 9 | + | 6 | + |
| *Peniophora incarnata* (Pers.: Fr.) P.Karst. | 1 | | | + |
| *Peziza arvernensis* Boud. | 1 | | 8 | |
| *P. michelii* (Boud.) Dennis | | | 1 | |
| *Phellinus ferruginosus* (Schrad.: Fr.) Pat. | 1 | + | | |
| *Phlebia livida* (Pers.: Fr.) Bres. | 4 | | 1 | |
| *P. radiata* Fr.: Fr. | 5 | | 13 | + |
| *P. tremellosa* (Schrad.: Fr.) Burds. & Nakas. | 1 | | 3 | + |
| *Phleogena faginea* (Fr.: Fr.) Link | 2 | | 7 | |
| *Pholiota mutabilis* (Scop.: Fr.) Kumm. | 1 | + | 4 | + |
| *P. squarrosoides* (Peck) Sacc. | | + | 7 | + |
| *Phyllotopsis nidulans* (Pers.: Fr.) Singer | 4 | | 4 | |
| *Physisporinus vitreus* (Pers.: Fr.) P.Karst. | 3 | | 2 | |
| *Pleurotus ostreatus* (Jacq.: Fr.) P.Kumm. | | + | 3 | + |
| *P. pulmonarius* (Fr.) Quél. | 7 | | 22 | |
| *Plicaturopsis crispa* (Pers.: Fr.) Reid | 1 | + | 6 | + |
| *Pluteus cervinus* (Batsch) Singer | 2 | + | 10 | + |
| *P. chrysophaeus* (Schaeff.) Quél. | 5 | | 12 | |
| *P. exiguus* (Pat.) Sacc. | | | 1 | |
| *P. hispidulus* (Fr.: Fr.) Gillet | | | 4 | |
| *P. nanus* (Pers.: Fr.) P.Kumm. | | | 1 | |
| *P. phlebophorus* (Dittm.: Fr.) P.Kumm. | | | 9 | |
| *P. plautus* (Weinm.) Gillet | | | 2 | |

Table 2: (continuation)
*Preglednica 2: (nadaljevanje)*

| Species / *Vrsta* | Krokar | | Rajhenavski rog | |
|---|---|---|---|---|
| *P. podospileus* Sacc. & Cub. | 2 | | 4 | |
| *P. romellii* (Britz.) Sacc. | 3 | | 3 | |
| *P. thomsonii* (Berk. & Br.) Dennis | | | 2 | |
| *P. umbrosus* (Fr.) P.Kumm. | | | 1 | |
| *Podofomes trogii* (Fr.) Pouzar | 1 | | | |
| *Polyporus arcularius* Batsch.: Fr. | 1 | | | |
| *P. brumalis* (Pers.) Fr.: Fr. | 6 | + | 5 | + |
| *P. ciliatus* Fr.: Fr. | | + | 3 | + |
| *P. squamosus* (Huds.: Fr.) Fr. | 3 | + | 5 | + |
| *P. varius* (Pers.) Fr.: Fr. | 6 | + | 16 | + |
| *Postia caesia* (Schrad.: Fr.) P. Karst. | 1 | + | 1 | + |
| *P. subcaesia* (David) Jülich | 1 | | | + |
| *Psathyrella lacrymabunda* (Bull.: Fr.) Moser | 1 | | | |
| *P. piluliformis* (Bull.: Fr.) P.D.Orton | 1 | | 5 | |
| *P. pyrotricha* (Holmskj. : Fr.) Moser | | | 1 | |
| *Pseudoclitocybe cyathiformis* (Bull.: Fr.) Singer | | | 14 | |
| *Pycnoporellus fulgens* (Fr.) Donk | | | 1 | |
| *Pycnoporus cinnabarinus* (Jacq.: Fr.) P.Karst. | | | 2 | + |
| *Ramaria flavosalmonicolor* | 1 | | | |
| *Resupinatus applicatus* (Batsch: Fr.) Gray | | | 2 | |
| *Rhodocybe nitellina* (Fr.) Sing. | 1 | | | |
| *Rickenella fibula* (Bull.: Fr.) Raith. | | | 10 | |
| *R. swartzii* (Fr.: Fr.) Kuyper | | | 1 | |
| *Ripartites tricholoma* (Alb. & Schw.: Fr.) P.Karst. | | | 1 | |
| *Russula anthracina* Romagn. | | | 2 | |
| *R. badia* Quél. | | | 1 | |
| *R. cavipes* Britz. | 1 | | 5 | |
| *R. cyanoxantha* (Schaeff.) Fr. | 1 | | | |
| *R. delica* Fr. | 1 | | | |
| *R. innocua* (Singer) Bon | | | 1 | |
| *R. mairei* Singer | | | 1 | |
| *R. ochroleuca* Pers. | 1 | | 3 | |
| *R. queletii* Fr. | | | 2 | |
| *R. undulata* Vel. | 1 | | | |
| *Schizophyllum commune* Fr.: Fr. | 1 | + | 3 | + |
| *Simocybe centunculus* (Fr.: Fr.) P.Karst. | 2 | | 18 | |
| *Skeletocutis nivea* (Jungh.) Keller | | + | 1 | + |
| *Steccherinum nitidum* (Pers.: Fr.) Vesterh. | 1 | | 1 | |
| *S. ochraceum* (Pers.: Fr..) Gray | 3 | + | 5 | + |
| *Stereum hirsutum* (Willd.: Fr.) Gray | 14 | + | 26 | + |
| *S. insignitum* Quel. | | + | 1 | + |
| *S. rugosum* (Pers.: Fr.) Fr. | 1 | + | | + |
| *S. sanguinolentum* (Alb. & Schwein.: Fr.) Fr. | 1 | | | |
| *S. subtomentosum* Pouz. | | | 1 | |
| *Stigmatolemma urceolata* (Wallr.: Fr.) Donk | | | 1 | |
| *Stropharia aeruginosa* (Curt.: Fr.) Quél. | | | 1 | |
| *S. cyanea* (Bull.) Tuomikoski | | | 1 | |
| *Tarzetta spurcata* (Pers.) Harmaja | 1 | | | |

Table 2: (continuation)
*Preglednica 2: (nadaljevanje)*

| Species / *Vrsta* | Krokar | | Rajhenavski rog | |
|---|---|---|---|---|
| *Trametes cervina* (Schwein.) Bres. | 2 | | | |
| *T. gibbosa* (Pers.: Fr.) Fr. | 5 | + | 16 | + |
| *T. hirsuta* (Wulfen: Fr.) Pilat | 6 | + | 15 | + |
| *T. pubescens* (Schumach.: Fr.) Pilát | 1 | | | |
| *T. versicolor* (L.: Fr.) Quel. | 10 | + | 35 | + |
| *Tremella mesenterica* Retz: Fr. | 2 | + | 1 | |
| *Trichaptum pergamenum* (Fr.) G. Cunn. | | | 7 | |
| *Tricholoma atrosquamosum* (Chev.) Sacc. | 1 | | | |
| *T. saponaceum* (Fr.: Fr.) P.Kumm. | | | 1 | |
| *Tricholomopsis rutilans* (Schaeff.: Fr.) Sing. | 1 | | | |
| *Tyromyces chioneus* (Fr.: Fr.) P.Karst. | | | 1 | |
| *Ustulina deusta* (Hoffm.: Fr.) Lind | 9 | + | 25 | + |
| *Xerula melanotricha* Dörfelt | | + | 1 | |
| *X. radicata* (Relhan: Fr.) Dörfelt | 2 | + | 9 | + |
| *Xylaria hypoxylon* (L.: Fr.) Grev. | 14 | + | 26 | + |
| *X. longipes* Nitschke | | | 1 | |
| *X. polymorpha* (Pers.: Fr.) Grev. | 6 | + | 14 | + |
| *Xylobolus frustulatus* (Pers.: Fr.) Boidin | 1 | | | |

Fieldwork revealed insight in fungal chorology. Many small discomycetes appear only in the spring. Small agaricales growing on CWD with large diameters appeared in hot summer months. The collection of resupinate polyporaceous and pyrenomycetous fungi in summer was not fruitful because sporocarps lacked developed spores and hence were unclassifiable. Late autumn is generally the most fruitful time for collection. In the first year of the inventory, the autumn weather without snow lasted until mid December and surprisingly high species richness was observed in November. Some fungal species first appeared after the first frosts or snow and lasted until heavy snow cover and freezing cold in the forest.

Some groups were under-collected (*Mycena, Pluteus*) as more time would be needed for the fieldwork. The genus *Mycena*, mostly consisting of species with minute sporocarps appearing in hundreds after a prolonged rainy period in late October, would deserve special attention. Even more effort would be needed for the inventory of white, whitish, and dull coloured thin layered corticiaceous fungi, consisting of sporocarps only a few hyphal layers thick, appearing on the wooden surface of the logs, looking like the »remnants of old paint«. Interesting mycota also appear on dead, partly decomposed

sporocarps of bigger polypores, especially on *Fomes fomentarius* and *Fomitopsis pinicola.*

A significant number of mycorhizal species in these forest reserves connected to fir (*Cortinarius atrovirens*, *Elaphomyces granulatus*, *Hygrophorus pudorinus*, *Lactarius glutinopallens*, *L. salmonicolor*, *Podofomes trogii*, *Russula badia*, *R. cavipes* and *R. queletii*) are present growing on the late decay stages (5, 6) of the decomposed beech wood. Some species reported on conifers were found to grow on beech. *Pycnoporellus fulgens* and some small discomycetes (not included in the present study) show this feature. *Fomitopsis pinicola* is also known primarily growing on conifers, but in Rajhenavski Rog it was recorded on 23 % of all dead beech trees being monitored.

## 4 CONCLUSIONS
## ZAKLJUČKI

The inventory revealed important segments of fungal diversity in Krokar and Rajhenavski Rog. It gave some insight to fungal sociology and succession on dead wood of beech, but this field of work will be covered in the scope of other NAT-MAN project activities.

The comparison between present and previous lists of fungi in both forest reserves shows that the number of field days was not decisive for thorough insight into fungal diversity. Although in previous research, 22 field days (from 1976 to 1982) were spent in Rajhenavski Rog and 14 in Krokar (from 1975 to 1982), fewer fungi were revealed on beech CWD. In our opinion the methods of inspection are critical for fungal biodiversity studies; these must be detailed, focussed on the object of research and must not be a general, overall collection of fungi. The differences between present and previous results of fungal inventories can also be partially explained by different time spans of observation (two years in this research and 6 and 7 years in previous inventories).

The comparison between number of species in Krokar and Rajhenav reveals significant differences. Although these differences can, at first sight, be attributed to fewer field days spent on the inventory in Krokar, the reason most probably lies in unfavourable

ecological conditions for sporocarp production in this forest reserve. A similar ratio of species as was found for fungi was also established for mosses (ODOR / VAN DORT 2002). Direct field observations revealed that in Krokar, because of its top position on a high plateau exposed to direct and frequent winds, the microclimate differs much from the situation in Rajhenavski Rog, being surrounded by vast area of closed forest.

The fungal biodiversity revealed represents only a part of the total fungal biodiversity of selected sites, because important groups (Corticiaceae, small Ascomycetes) and special habitats were not included. When the evaluation of the biodiversity of fungi in Dinaric forests is attempted, another very important part of the fungal biodiversity in relation to fir should be taken into account.

## 5 POVZETEK

*Glive se v naravnih gozdovih zelo razlikujejo od gliv v gospodarskih gozdovih. Les, ki nastaja v naravnih gozdovih, je podvržen naravnim procesom razkroja v gozdu; v gospodarskih gozdovih ga odvzamemo iz gozda kot hlodovino in ga uporabimo drugje. Ker je les najpomembnejši del celotne proizvedene biomase v gozdu, sta raznolikost organizmov, ki ga razkrajajo, in pretok hranil v gospodarskem gozdu s tem odvzemom močno spremenjena oziroma zmanjšana. Velika količina odmrlega lesa v vseh stopnjah razkroja je ključnega pomena za nemoteno sukcesijo gliv razkrojevalk lesa; nudi tudi celo vrsto posebnih bivališč za druge glive. Popis trosnjakov daje zanesljiv vpogled v strukturo glivne skupnosti in njenega razvoja v razkrajajočem se lesu, saj so trosi najpomembnejši dejavnik za razširjanje gliv razgrajevalk lesa.*

*Za popis gliv smo izbrali 109 dreves v Rajhenavskem Rogu in 102 drevesi na Krokarju. V okviru projekta NAT-MAN smo raziskovali le izbrane skupine gliv. Druge glive, ki smo jih našli pri popisu (majhne zaprtotrosnice s trosnjaki <3 mm, večina skorjastih gliv, nekateri lišaji, glive na trosnjakih velikih luknjičark), niso bile upoštevane in bodo obravnavane v naslednjih prispevkih.*

*Skupno število najdb (t. j. vse vrste gliv na vseh velikih lesnih ostankih) je bilo 2040 v Rajhenavskem Rogu in 889 v Krokarju; v prvem gozdnem rezervatu smo na posameznem odmrlem drevesu v povprečju našli 12,3 (oz. med 0 in 55), v drugem pa 5,9 (0 – 27) vrst.*

*Med obema lokacijama obstaja izrazita razlika – v Rajhenavskem Rogu smo ugotovili bistveno večje skupno število vrst in večjo raznolikost gliv na posameznem drevesu; za ta rezervat je značilna tudi enakomernejša razporeditev vrst na lesnih ostankih. Od izbranih skupin gliv za NAT-MAN projekt smo ugotovili 244 vrst gliv – 138 na Krokarju in 206 v Rajhenavskem Rogu (od tega 36 vrst samo na Krokarju, 106 pa samo v Rajhenavskem Rogu; preglednica 2).*

*Primerjava seznama gliv z objavljenimi podatki o glivah na bukovem lesu v gozdnih rezervatih Krokar in Rajhenavski Rog (HOČEVAR et al. 1985, 1995) kaže, da je 61 vrst iz pričujoče raziskave že bilo ugotovljenih na Krokarju (48 %), 62 pa v Rajhenavskem Rogu (30 %). V objavljenih delih je navedenih 22 vrst gliv za Krokar in 18 za Rajhenavski Rog, ki jih v naši raziskavi nismo ugotovili. Pri primerjanju podatkov moramo upoštevati nomenklaturne razlike, zato bo popolna primerjava obeh seznamov narejena s taksonomskim delom v prihodnosti. V preteklih raziskavah je bil raziskovalni cilj širši, saj so bile obravnavane glive na vseh vrstah lesnih gostiteljev in tudi mikorizne ter druge talne glive.*

*Terensko delo je razkrilo tudi nekatere horološke zanimivosti. Številne majhne diskomicete poženejo samo spomladi. Vroči poletni meseci so lahko zanimivi za majhne lističarke, ki rastejo na lesnih ostankih z velikim premerom. Zbiranje resupinatnih luknjičark in pirenomicet poleti ni bilo uspešno, ker so bili trosnjaki nedozoreli in še niso oblikovali trosov, po katerih bi jih določili. Pozna jesen je na splošno najuspešnejša za nabiranje. V prvem letu popisa je jesensko vreme brez snega trajalo do sredine decembra; v novembru je bila opažena presenetljivo velika vrstna raznolikost. Nekatere glive se pojavijo takoj po prvih zmrzalih ali po prvem snegu in jih najdemo, dokler jih ne prekrije debela snežna odeja oziroma ne prinese mraz v gozd zimski počitek. Nekatere skupine gliv so bile nabrane premalo obsežno (Mycena, Pluteus), saj bi bilo za njihovo natančnejšo obravnavo potrebno dolgotrajnejše terensko delo. Posebno pozornost bi bilo treba posvetiti rodu čeladic (Mycena), katerih drobni trosnjaki poženejo v stotinah po dolgih deževjih v poznem oktobru. Še več naporov bi zahtevala inventarizacija belih, belkastih in temnih tankoslojnih trosnjakov skorjastih gliv, ki so sestavljeni iz le nekaj hifnih slojev (na površini lesa so vidni kot »ostanki stare barve«). Zanimiva mikota se pojavlja tudi na trosnjakih velikih luknjičark, še posebno na Fomes fomentarius in Fomitopsis pinicola. Iz seznama gliv (preglednica 2) je razvidno, da obstaja očiten vpliv*

*jelke: (a) prisotne so številne mikorizne glive, ki rastejo na končnih razkrojnih fazah bukovega lesa, a so povezane z jelko (npr. Cortinarius atrovirens, Elaphomyces granulatus, Hygrophorus pudorinus, Lactarius glutinopallens, L. salmonicolor, Podofomes trogii, Russula badia, R. cavipes in R. queletii); (b) na lesnih ostankih bukovega lesa smo našli glive, ki so običajno na lesu iglavcev (npr. Pycnoporellus fulgens in nekatere majhne diskomicete, ki jih v prispevku ne obravnavamo; tudi Fomitopsis pinicola je znana predvsem po rasti na iglavcih, vendar smo jo v Rajhenavskem Rogu zabeležili na 23 % vseh pregledanih odmrlih bukovih drevesih).*

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# 7 APPENDICES
PRILOGE

Figure 1: *Lentaria albovinacea* (designated as *L. epichnoa* in Table 2) on CWD 66/2, decay phase 2/3. On CWD 66 the highest number of fungal species (55) was recorded (Rajhenavski Rog, 30.09.2001, photo J.K.)

*Slika 1: Lentaria albovinacea (označena kot L. epichnoa v preglednici 2) na CWD 66/2, razkrojna faza 2/3; na CWD 66 je bilo ugotovljeno največje število (55) glivnih vrst (Rajhenavski Rog, 30.09.2001, foto J.K.)*

Figure 2: CWD 71, decay phase 2 – with 31 fungal species recorded (Rajhenavski Rog, 29.07.2001, photo A.P.)

*Slika 2: CWD 71, razkrojna faza 2 – zabeleženih 31 vrst gliv (Rajhenavski Rog, 29.07.2001, foto A.P.)*

Figure 3: CWD 11/2, decay phase 2, with *Lentaria mucida* (Rajhenavski Rog, 02.12.2000, photo A.P.)

*Slika 3: CWD 11/2, razkrojna faza 2, z Lentaria mucida (Rajhenavski Rog, 02.12.2000, foto A.P.)*

Figure 4: CWD 27/2, decay phase 3 to 4, with *Discina parma* (Rajhenavski Rog, 16.06.2001, photo A.P.)

*Slika 4: CWD 27/2, razkrojna faza 3 do 4, z Discina parma (Rajhenavski Rog, 16.06.2001, foto A.P.)*

Figure 5: *Dentipellis fragilis* can be found only in unmanaged seminatural virgin forests (Krokar, 04.11.2000, photo A.P.)

*Slika 5: Dentipellis fragilis lahko najdemo le v negospodarjenih drugotnih pragozdovih (Krokar, 04.11.2000, foto A.P.)*

Figure 6: *Phyllotopsis nidulans* – another species, characteristical for unmanaged seminatural virgin forests (Krokar, 04.11.2000, photo A.P.)

*Slika 6: Phyllotopsis nidulans – še ena vrsta, ki je značilna za negospodarjene drugotne pragozdove (Krokar, 04.11.2000, foto A.P.)*

Figure 1 / *Slika 1*

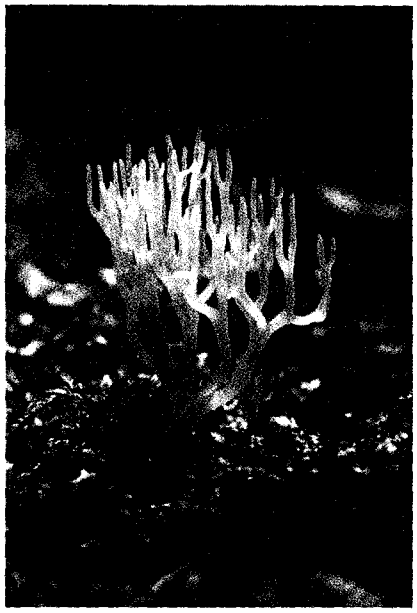

Figure 2 / *Slika 2*

Figure 3 / *Slika 3*

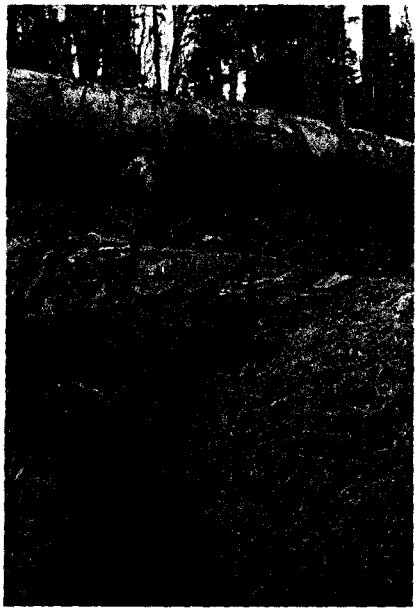

Figure 4 / *Slika 4*

Figure 5 / *Slika 5*

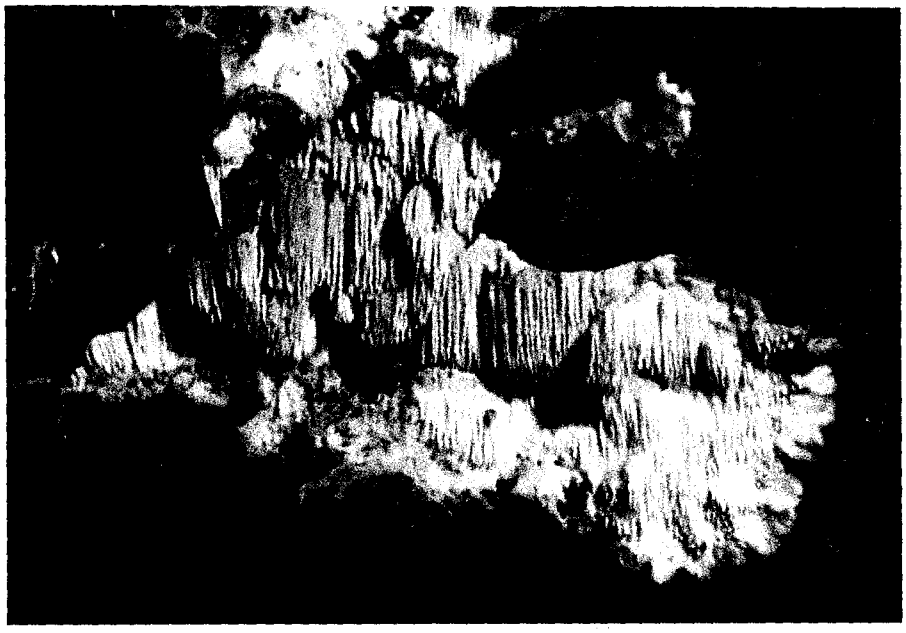

Figure 6 / *Slika 6*