

THE USE OF CAVES BY THE EDIBLE DORMOUSE (*Myoxus glis*) IN THE SLOVENIAN KARST

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During field research on the Slovene high southern plateau, we collected data on the presence of edible dormouse in the 43 caves. Field research was undertaken for such signs of dormice in the caves as runs, droppings, hair and dead animals. Additional records are based on direct observations of live animals. In the majority of cases, caves which reveal the obvious presence of dormice are not accessible to the stone marten. The droppings and even bodies of edible dormice in the caves might be an important nutrient input for troglobionts. According to its frequent occurrence in a cave habitat, we can classify the edible dormouse as a cave dwelling animal.

Key Words: dormice occurrence, cave selection, Slovenia

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Tijekom terenskih istraživanja na južnoj slovenskoj uzvisini, skupili smo podatke o prisutnosti sivog puha u 43 špilje. Istraživani su znakovi koji su govorili o njegovoj nazočnosti – tragovi, izmet, dlaka i mrtve životinje. Dodatni podaci temelje se na promatranju živih životinja. U većini slučajeva špilje, u kojima je očita prisutnost puhova, nisu dostupne kuni bjelici. Izmet, pa čak i tijela sivih puhova mogu biti važan izvor hrane za troglobionte. Zbog česte pojave u špiljama, sivog puha možemo ubrojiti u životinje koje žive u špiljama.

Ključne riječi: pojava puhova, izbor špilja, Slovenija

INTRODUCTION

The edible dormouse (*Myoxus glis*) is a very common animal in Slovenia. It prefers broad-leaved deciduous and mixed woodland in karst areas (KRYŠTUFEK, 1991). The edible dormouse is a nocturnal arboreal rodent which usually breeds in hollow trees, but also burrows between tree roots or rocks in the ground (STORCH, 1978; ANDÉRA, 1986; KRYŠTUFEK, 1991). There were published reports (TVRTKOVIĆ, 1975)

of direct observations of dormice located deep in karst caves. SCARAVELLI & BASSI (1994) report on nests of edible dormice found in locations deep in caves. According to VIETINGHOFF-RIESCH (1960) and MORRIS & HOODLESS (1992), the edible dormouse usually hibernates underground in small cavities without any nest material at depths of about 20–100 cm.

In Slovenia the edible dormouse is a very well known animal, and the fact that dormice inhabit caves has been known for centuries.

VALVASOR, in the 17th century (1994), describes the harvesting of edible dormice for food in the ground holes called »polšine«. »Polšine« are small, 5–10 cm diameter, entrances into spacious caves used by dormice. Around the entrance the rocks are covered with earth and the leaves have usually been removed. There are reports that in summer and autumn, Slovene local dormice hunters caught up to 50 animals in front of these »polšine« (ŠIVIC, 1926; BAŠ, 1984; ŠUŠTERŠIČ, 1964/65). Due to increased caving activities in Slovenia, there have been a lot of new reports of dormouse observation in the caves. My intention was to collect data on dormouse occurrence in Slovene caves and to identify the factors that influence dormouse cave selection.

STUDY AREA AND METHODS

Slovenia is a karstic country, two thirds of the land having a karstic limestone character. In this area, more than 6000 caves are already known and each year cavers describe many new caves (Cave Register IZRK). We can divide the Slovenian karst area into Alpine karst, Dinaric karst and isolated sub-Alpine and sub-Dinaric karst (HABIČ, 1993). The high karst of Notranjsko, Dolenjsko and the low karst of Dolenjsko and Bela Krajina, where field research was undertaken, belong to the Dinaric karst of southern Slovenia. The high karst of southern Slovenia is mainly covered with beech (*Fagus sylvatica*) and mixed beech and fir forest (*Abieti-Fagetum dinaricum*). Areas in the low karst of Notranjsko, Dolenjsko and Bela krajina are also covered with oak (*Quercus sp.*) and hornbeam (*Carpinus betulus*) forests. Other tree species are less important for edible dormouse presence.

In field research, we have investigated a large number of caves of a few different types. Research was carried out on sink holes, big cave systems, caves with underground rivers, rock shelters, horizontal caves as well as vertical caves such as shafts, potholes, sinkholes. When descending in shafts, we usually used special caving equipment (single rope technique). The names of the caves investigated, their registration numbers and characteristics (type, depth, length) are gathered in the Cave Register of the Karst Research Institute ZRC in Postojna. Some of the caves occupied are not yet scientifically described and therefore some data were not available.

Field research was undertaken for signs of dormice in the caves, such as runs, droppings, hair and complete skeletons. In the caves occupied by edible dormouse there are conspicuous runs on the walls, stalagmites and stalactites, similar to those



Fig. 1. In the caves occupied by edible dormouse there are conspicuous dark, fatty runs on the walls, stalagmites and stalactites, similar to those of rats in houses.

of rats in houses (PREBEN, 1977). Runs have the appearance of a fatty deposite and are much more obvious on white cave flowstone (Fig. 1). We collected data on type of cave, type of forest above the cave and the presence of the stone marten (*Martes foina*) as a potential predator of dormice in the cave. Additional records are based on observations by other cavers, biologists, dormice hunters and foresters.

RESULTS

Field research yielded data on the presence of edible dormouse in 43 caves (table 1). In almost the same number of caves, the presence of dormice was not confirmed. Table 1 gives data only about caves occupied by dormice. The depths and lengths of the caves used are very various. They range from small shelters to big underground systems, but medium sized caves and shafts are preferred. Two thirds of the caves used

Table 1. Collected data on edible dormouse cave occurrence in southern Slovenia.

Name of the cave (Slovenian register number of cave)	type of cave (meters)	depth of cave (meters)	length of cave (meters)	type of signs found in the cave, observation	place of signs in the cave	presence of stone marten	type of forest above the cave
Postojnska jama (747)	2.3/5.4	-115	19555	live and dead animal	2500 m, -150m	-	<i>Pinus nigra</i> , <i>Carpinus</i> , <i>Fagus</i>
Križna jama (65)	5.4/4.2	-32	8163	live and dead animal	400m, -40m	-	<i>Abieti-Fagetum</i>
Križna jama 2 (6286)	4.2	-80	1415	live animal, runs, old hole	200m, -20m	-	<i>Abieti-Fagetum</i>
Turšičeva skednena (579)	5.1	-2	15	live animal	on the roof, entrance	-	<i>Abieti-Fagetum</i>
Partizanska jama (1405)	5.3	-20	80	live animal	entrance	-	<i>Abieti-Fagetum</i>
Brezno na Benčinovem (2301)	5.5	-22	26	live animal	entrance	-	-
Lisičja jama na Lazcih (511)	5.5	-45	54	old hole- hunting	entrance	-	-
Kotrnača (4367)	5.6	-104	250	runs, droppings, bones	on bottom, -60m	0	<i>Abieti-Fagetum</i>
Lipiška jama (311)	5.3	-397	1194	runs	on bottom	?	<i>Quercus</i> , <i>Ostryja</i>
Veliko brezno v Susjaku (3422)	5.5	-266	266	bones	on bottom, -400m	0	<i>Abieti-Fagetum</i>
»Brezno pod hotelom«	5.5	-10	(15)	droppings, hairs	on the wall	-	<i>Ostryja</i> , <i>Corylus</i>
Škocjanske jame (735)	5.4/2.1	-425	5800	live animal (young)	on the wall, 200m	-	<i>Quercus</i> , <i>Ostryja</i>
Nevaino brezno na Kunču (5158)	5.5	-40	40	live animal	entrance	-	<i>Carpinus</i> ,
Jazbina (114)	5.2	0	123	live animal	on entrance, old hole	-	<i>Picea</i> , <i>Fagus</i> ,
»Brezno pod hríbom«	5.5	-10	(10)	live animal	on entrance	-	<i>Fagus</i> , <i>Quercus</i>
Levakova jama (517)	5.2	-20	350	young in nest	on entrance	-	<i>Fagus</i> , <i>Quercus</i>
Kostanjeviška jama (518)	5.2	0	438	live animal	on entrance	-	<i>Ostryja</i> , <i>Corylus</i>
Jama v Hrvaškem gaju (6233)	5.3	-16	55	old hole, hunting	on entrance	-	<i>Fagus</i>
Ajdovska jama pri Nemsški vasi (417)	5.2	-5	62	live animal	on entrance	-	<i>vineyard, strub</i>
Ajdovska jama na Radolji (6165)	5.2	-15	48	live animal	on entrance	-	<i>Fagus</i>
Brezno XII zbora (5249)	5.5	-49	55	old hole, huntind	on entrance	0	<i>Abieti-Fagetum</i>
Medvedova jama na Pečki	5.1	-10	10	runs, hunting	on entrance	?	<i>Abieti-Fagetum</i>
Jama za spomenikom (5160)	-	-16	27	live animal	on entrance	-	<i>Abieti-Fagetum</i>
Brezno za spomenikom (5468)	5.5	-56	60	live animal	on entrance	-	<i>Abieti-Fagetum</i>
Travnj dol 4 (6223)	5.5	-13	20	dormouse hole	on entrance	-	<i>Fagus</i> , <i>Carpinus</i>
Travnj dol 5 (6224)	5.5	-9	15	dormouse hole	on entrance	-	<i>Fagus</i> , <i>Carpinus</i>
Travnj dol 6 (6225)	5.5	-11	13	dormouse hole	on entrance	-	<i>Fagus</i> , <i>Carpinus</i>
Seč 2 (6218)	5.5	-10	10	dormouse hole	on entrance	-	<i>Fagus</i> , <i>Carpinus</i>
Jama pod Štalami (4008)	5.5	-43	69	droppings, runs	on entrance	+	<i>Abieti-Fagetum</i>
Jama v Suhli rebri (4082)	5.3	-84	425	droppings, runs	on the wall, -40m	+	<i>Quercus</i> , <i>Ostryja</i>

Table 1. Continued.

Name of the cave (Slovenian register number of cave)	type of cave	depth of cave (meters)	length of cave (meters)	type of signs found in the cave, observation	place of signs in the cave	presence of stone marten	type of forest above the cave
Brezno v cerju (5510)	5.5	-35	45	runs, hairs	on the bottom	0	<i>Quercus</i>
»Jama v Kneškem dolu«	5.5	-(60)	(70)	runs, droppings	on the bottom, -60	0	<i>Quercus</i>
»Brezno v Suhem vrhu«	5.5	-(20)	(20)	runs, droppings, hair, bones	on the bottom, -20	0	<i>Abieti-Fagetum</i>
Jama Suha reber (6589)	5.6	-(53)	(70)	runs, droppings	on the wall, on bottom	0	<i>Abieti-Fagetum</i>
Francetova jama (2083)	5.3	-8	33	live animal	on the roof	?	<i>Carpinus, Quercus</i>
»Brezno pod grelcem«	5.5	-(140)	(150)	bones, runs	on bottom, -140m	0	<i>Abieti-Fagetum</i>
Trojno brezno 2 (6256)	5.3	-12	34	live animal	-	-	-
»Ebenthal«	5.4	-	-	dormouse hole	on entrance	-	<i>Carpinus, Quercus</i>
Štalarca (6255)	5.3	-9	23	live animal	-	-	<i>Abieti-Fagetum</i>
Brezno pri rodeževi cesti (6323)	5.5	-11	11	live animal	-	-	<i>Abieti-Fagetum</i>
»Fotrovo brezno«	5.6	-40	50	dormouse hole	-	-	<i>Carpinus, Quercus, Picea</i>
Žiglavca	5.5	-85	90	live animal	-	-	<i>Ostrya</i>
Jama Sv. Loja (6285)	5.3	-20	200	droppings, hole on bottom	on bottom	+	<i>Abieti-Fagetum</i>

Type of cave:

2.1 - Permanent sinkhole, 2.3 - Periodical sinkhole, 4.2 - Cave with underground river, 5.1 - Rock shelter, 5.2 - Horizontal cave, 5.3 - Cave with shaft-type entrance, 5.4 - Cave system, 5.5 - Simple shaft, 5.6 - Stepped shaft. Presence of stone marten: 0 - not present, + - present, ? - not present but possible, - - no data.

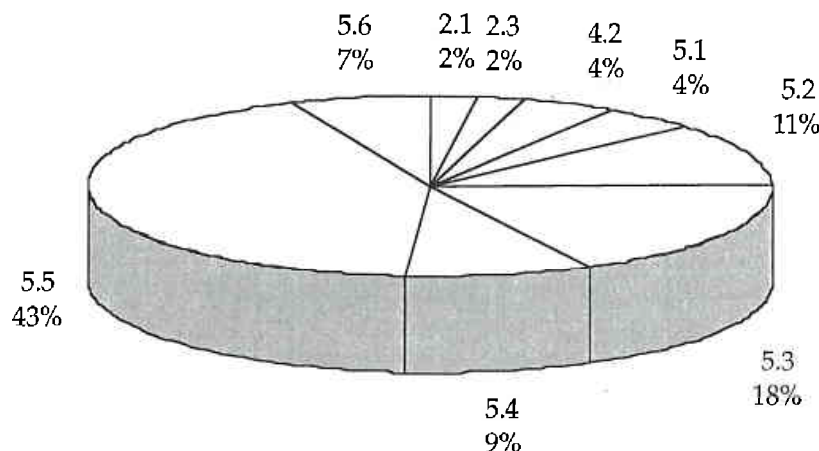


Fig. 2. The percentage of occurrence of dormice in different types of caves.
 2.1 – Permanent sinkhole, 2.3 – Periodical sinkhole, 4.2 – Cave with underground river,
 5.1 – Rock shelter, 5.2 – Horizontal cave, 5.3 – Cave with shaft, 5.4 – Cave system,
 5.5 – Simple shaft, 5.6 – Stepped shaft.

have a vertical character (Fig. 2). We located the presence of dormice in 19 (43 %) simple shafts, in 3 (7 %) stepped shafts and in 8 (18 %) horizontal caves with a shaft-type entrance. There are also reports of the presence of dormice even in big underground cave systems with underground rivers such as Postojnska jama, Križna jama and Škocjanske jame. Dormice occurred in 4 (9 %) such big horizontal cave systems and in 5 (11 %) simple horizontal caves. Rock shelters and sinkholes were rarely occupied. We found the presence of dormice in one permanent sinkhole (2 %), one periodical sinkhole (2 %), in two caves with an underground river (4 %) and in two rock shelters (4 %).

Types of edible dormouse signs found in the caves are also various. Obvious runs and deposits of droppings are the commonest. There are a lot of reports of direct observations of live animals or even reports of caves which first became known from dormouse ground holes or »polšine«. Direct observations of live dormice have usually been made at the entrances of caves, while the animals were entering or leaving; however, there were also a few direct observations in deep locations, too. Signs have been observed on cave walls and bottoms. In one case, a nest with a litter was found. Caves with entrances not accessible to the marten were the most populated with dormice; and on the contrary, wherever stone marten scats were found, there were no signs of the dormouse. Only in three cases was the presence of the edible dormouse and the stone marten established in the same cave. Some caves were easily accessible to the marten, but no signs of the stone marten were found. In the majority of cases, caves in which the presence of dormice is obvious are not accessible to the stone marten.

Caves in mixed fir and beech forests (*Abieti-Fagetum*) are the most occupied by edible dormice. Among the 39 caves, 17 (43 %) caves are situated in this forest type. Next come different types of mixed deciduous *Fagus sylvatica*, *Carpinus betulus*, *Quercus sp.* and *Ostrya carpinifolia* forests.

DISCUSSION

According to the list of caves used, we may draw the conclusion that the occupation of caves by the edible dormouse in the southern Slovenian karstic plateau is common. Caves offer good hiding and, probably, hibernating places. Underground caves make suitable substitutes when there is a lack of suitable hollow trees. This is more obvious in edible dormouse rich years.

The great number of limestone caves and the suitable forest conditions (beech and fir mixed forests, beech and oak forests being preferred) play a key role in the great percentage of caves that are occupied by the edible dormouse in the southern Dinaric part of Slovenia. Type of cave and predator accessibility also have an important influence on dormouse cave selection. It is obvious that steep horizontal caves, or shafts, which are usually not accessible to predators, are the most favoured by dormice. Signs of stone martens were also found deep inside the caves. The remains of edible dormouse in stone marten winter scats suggest predation upon cave-hibernating dormice (POLAK, 1994). Some marten hunters have stated that they have observed stone martens penetrating well-known dormice holes or »polšine«. By tracking them in the fresh snow, hunters (oral reports) have established that stone martens can stay in such polšine for several days.

By careful search for such dormouse signs as runs and droppings in caves, we have been able to demonstrate the presence of them in the majority of suitable caves. Furthermore, it is evident, that many caves are accessible only to small mammals. These small entrances, or »polšine«, are usually the only surface entrance into big undiscovered caves. Slovene cavers, searching for new, undescribed caves, sometime use polšine as potential new cave entrances. Digging and widening them have led to the finding of a lot of new caves.

In some districts of the Slovene karst, there are many newly described caves that were found in this way (LADIŠIĆ, 1992). Several names for caves, such as »Polšina, Povšina, Pušina, Polhova jama, Polšje brezno« reveal a connection with dormice (Cave Register, IZRK).

The droppings and even the bodies of edible dormice in the caves might be an important nutrient input for troglobionts. According to its frequent occurrence in a cave habitat, we can classify the edible dormouse as cave dwelling or troglonexic animal.

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SUMMARY

**The use of caves by the edible dormouse (*Myoxus glis*)
in the Slovenian karst**

S. Polak

The edible dormouse is in Slovenia a very well known animal, and dormouse limestone cave penetration has been known for centuries. In the past, Slovene dormouse hunters usually harvested dormice at their ground holes »polšine«. These are usually small entrances into big underground or cave spaces. During field research on the Slovene high southern plateau, we collected data on the presence of edible dormouse in the 43 caves. Field researches was undertaken for such signs of dormice in the caves as runs, droppings, hair and dead animals. Additional records are based on direct observations of live animals. The data assembled show that

different factors influence dormice cave selection. Our findings suggest that medium sized caves and shafts are preferred. Two thirds of caves used have the character of a vertical shaft. In the majority of cases, caves which reveal the obvious presence of dormice are not accessible to the stone marten. Stone martens were also found deep inside the caves, and the remains of dormice in their winter scats suggests predation upon cave-hibernating dormice. Caves in areas covered with mixed beech and fir forests are the most occupied with edible dormouse. Slovene cavers, searching for new undiscovered caves sometimes use dormice ground holes, or »polšine«, as potential new cave entrances. Digging and widening the holes has resulted in the finding of a number of new caves. The droppings and even bodies of edible dormice in the caves might be an important nutrient input for trogloliths. According to its frequent occurrence in a cave habitat, we can classify the edible dormouse as a cave dwelling animal.

SAŽETAK

Korištenje špilja slovenskog krša od strane sivog puha (*Myoxus glis*)

S. Polak

Sivi puh je u Sloveniji vrlo poznata životinja, a njegovo ulaženje u pukotine u vapnencu poznato je stoljećima. U prošlosti su slovenski lovci obično lovili puhove u njihovim skloništima u zemlji, »polšinama«. To su obično mali ulazi u veće podzemne ili špiljske prostore. Tijekom terenskih istraživanja na južnoj slovenskoj uzvisini, skupili smo podatke o prisutnosti sivog puha u 43 špilje. Istraživali su se znakovi koji su govorili o njegovoj nazočnosti – tragovi, izmet, dlaka i mrtve životinje. Dodatni podaci temelje se na promatranju živih životinja. Prikupljeni podaci pokazuju da na puhov odabir špilje utječu različiti faktori. Naša istraživanja ukazuju na to da puhovi preferiraju špilje i otvore srednjih veličina. Dvije trećine korištenih špilja imaju osobine okomitog otvora. U većini slučajeva špilje, u kojima je očita prisutnost puhova, nisu dostupne kuni bjelici. Kune bjelice su također pronađene duboko u špiljama, a ostaci puhova u njihovim zimskim izmetinama ukazuju na lov puhova koji hiberniraju u špiljama. Špilje u područjima s miješanom bukavom i jelovom šumama su najnaseljenije sivim puhovima. Slovenski špiljari, u potrazi za novim, neotkrivenim špiljama ponekad koriste rupe u tlu, ili »polšine«, kao moguće nove ulaze u špilje. Njihovo proširivanje urodilo je otkrićem znatnog broja novih špilja. Izmet, pa čak i tijela sivih puhova mogu biti važan izvor hrane za trogloliths. Zbog česte pojave u špiljama, sivog puha možemo ubrojiti u životinje koje žive u špiljama.