

## OBSERVATION OF EURASIAN BEAVER (*CASTOR FIBER* L.) IN THE JOPIĆEVA CAVE (CROATIA)

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**Baković, N., Bosner, N. & Baković, R.: Observation of Eurasian beaver (*Castor fiber* L.) in the Jopićeva Cave (Croatia). *Nat. Croat.*, Vol. 33, No. 1, 183-190, 2024, Zagreb.**

After its reintroduction in northern Croatia, the Eurasian beaver (*Castor fiber* L.) successfully spread to new areas along streams. Although the beaver has spread in a part of Croatia covered with karst, the information published to date about beavers using caves has been sparse. Since the first observation in the Matešićeva Cave – Popovačka Cave System near Slunj in 2021 and two caves in Plitvice Lakes National Park in 2022, the beaver and traces of its activity was recorded several times in Jopićeva Cave near Krnjak in the period from March to June 2022. In the same year, beaver activity was recorded near Krnjak in the surface stream Bent connected with cave streams. The spatial and field analysis of this locality showed it is likely that the entry of the beaver into the cave, diving through karst spring Vrelce, was induced by limited access to compatible surface habitats and additional pressures induced by humans. More research is needed for a better understanding of the importance of caves for beavers and the species limitations determined by karst areas.

**Keywords:** beaver, Dinaric karst, caves, karst springs, Croatia

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Europski dabar (*Castor fiber* L.) nakon reintrodukcije u sjevernu Hrvatsku uspješno se proširio na nova područja uz vodotoke. Iako se dabar proširio u dijelu Hrvatske prekrivenom kršom, dosad je malo objavljenih podataka o dabrovima koji koriste špilje. Od prvog opažanja u Sustavu Matešićeva špilja – Popovačka špilja kod Slunja 2021. godine i dvije špilje u Nacionalnom parku Plitvička jezera 2022. godine, dabar i tragovi njegove aktivnosti više su puta zabilježeni u Jopićevoj špilji kod Krnjaka u razdoblju od ožujka do lipnja 2022. godine. Iste godine zabilježena je aktivnost dabra kod Krnjaka u površinskom potoku Bent koji je povezan sa špiljskim potocima. Prostorna i terenska analiza ovog lokaliteta pokazala je da je vjerojatno da je ulazak dabra u špilju, roneći kroz krški izvor Vrelce, bio potaknut ograničenim pristupom kompatibilnim površinskim staništima i dodatnim pritiscima izazvanima od strane čovjeka. Potrebna su dodatna istraživanja za bolje razumijevanje važnosti špilja za dabara i ograničenja ove vrste koja uvjetuju krška područja.

**Ključne riječi:** dabar, dinarski krš, špilje, krški izvori, Hrvatska

The Eurasian beaver (*Castor fiber* L.) is one of the largest native European rodents. It is a semi-aquatic species associated with aquatic systems in proximity to woody riparian vegetation (NOLET & ROSELL, 1998). The beaver became extinct in Croatia in the 19th century (TVRTKOVIĆ, 1994), but the introduction of this species in the 1996-1998 period (GRUBEŠIĆ, 2008) in just several locations of northern Croatia led to the widening of its

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range and population recovery (GRUBEŠIĆ *et al.*, 2015; HALLEY *et al.*, 2021). Beavers are well adapted to various habitats in proximity to aquatic ecosystems (NOLET & ROSELL, 1998), but specific study on beavers in the context of karst areas is missing. Beavers in Croatia were noted in the shallow karst southwest of Karlovac between 2003 and 2006, in the karstic rivers Kupa, Dobra and Korana (GRUBEŠIĆ, 2008). A main characteristic of karst terrain is the absence of surface water bodies due to the high permeability of soluble carbonate deposits. Surface water runoff is high, so there is an abundance of intermittent streams and perennial streams are limited dominantly to the areas with impermeable deposits (FORD & WILLIAMS, 2007). Slightly acidic rainwater has created various geomorphological forms such as caves and crevices of various sizes and shapes (PALMER, 2007). Many of them are inhabited by mammals and other animals as shelters (e.g. hibernation sites for bats) (GOTTSTEIN MATOČEC *et al.*, 2002; TVRTKOVIĆ, 1974). There are several references to the North American beaver (*Castor canadensis* Kuhl, 1820) being found in American caves. Beavers and the traces of their presence (footprints, mats, branches) have been observed in several caves near the cave entrances and channels with constant darkness (ELLIOT, 2003; HOBBS III, 2012; ZIGLER *et al.*, 2020). The European beaver was observed in a cave for the first time in the Matešičeva Cave – Popovačka Cave System (cadastral number HR00957) in May 2021 by the members of the Speleology Department of the Željezničar Mountaineering Society, Zagreb (pers. comm. Tina Bosner and Ruđer Novak). This cave is located right next to the bank of the River Korana (JELINIĆ, 1998) in the administrative area of Slunj in Croatia. The presence of the European beaver in caves was also recorded along the Korana River in Croatia (AUGUSTINOVIĆ *et al.*, 2022) in the caves Vila Jezerkinja (cadastral number HR04532) and Šupljara (cadastral number HR02513) (AUGUSTINOVIĆ *et al.*, 2024), but these locations are upstream of the Matešičeva Cave – Popovačka Cave System. In neighbouring Slovenia, the beaver was observed in Vidovec Cave (cadastral number 3342) along the river Kupa/Kopa (KEPIC *et al.*, 2023).

This paper aims to share new findings of Eurasian beavers visiting karst caves in Croatia and to discuss some implications of karst terrain for beaver ecology. The study location was in the Brebornica area of Krnjak municipality situated in the area of Kordun, Croatia (South-Eastern Europe) (Fig. 1). This area is part of the Inner Dinaric Karst Belt (GARAŠIĆ, 2021). Data for this study were collected in Jopićeve Cave (in Zvono Hall), Vrelce Spring and Bent Stream. Jopićeve Cave (cadastral number HR02370) is a complex multilevel cave system with a maze of channels extending more than 6 km. The lowest cave channels have several streams. Among them, the largest is a subterranean stream called Potok A, with several other smaller influents (Potok B, Potok C, Potok D). After flowing through the cave Potok A reaches the surface and forms a karst spring called Vrelce (ČEPELAK, 1978). The distance between Zvono Hall (small plateau near Potok A, 20 x 10 m), and Vrelce spring is approximately 120 m. The last 8 m of the channel containing Stream A, before reaching Vrelce Spring, is completely flooded and forms a siphon (ČEPELAK, 1978, 1981). Water from the Vrelce spring forms a small stream called Bent. It is a shallow and narrow stream with well-preserved meanders and riparian woody vegetation especially in the upper area. The Bent has one small intermittent tributary. After 1.1 km, the Bent Stream inflows into the Brebornička River. After joining several other tributaries (several kilometres long) they flow into the Korana River.

Data in Jopićeve Cave, Vrelce Spring, and Bent Stream were collected by authors during research into cave protists in Jopićeve Cave (February 2021 – January 2023; total of 21 visits).

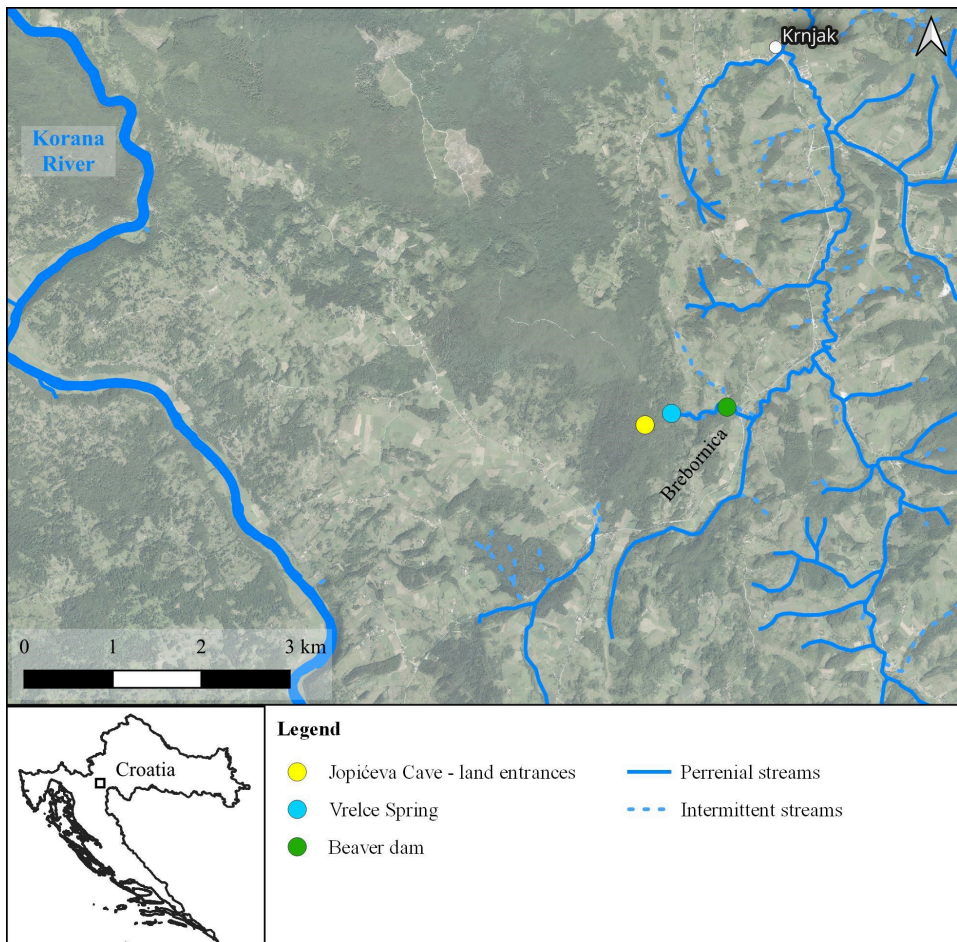
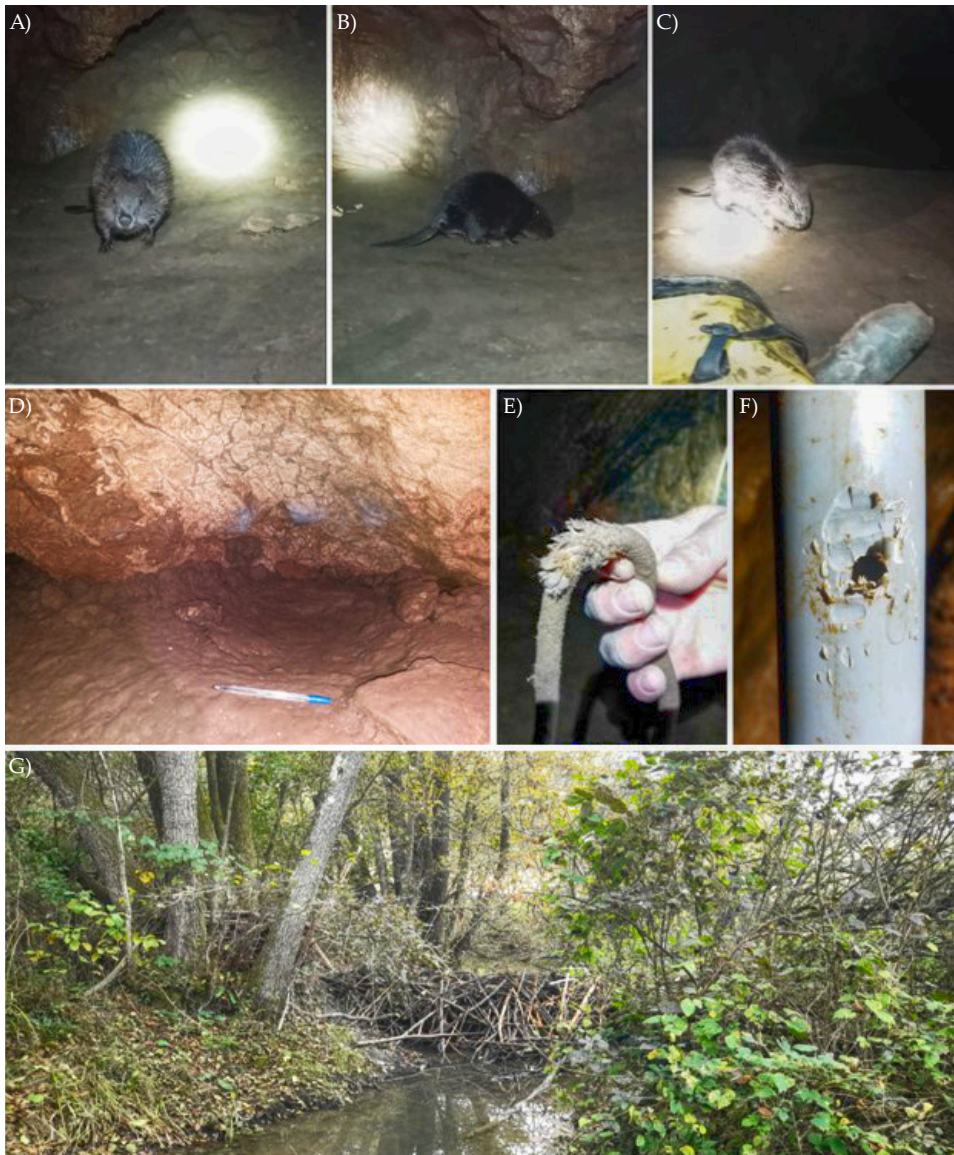


Fig. 1. Study location

A beaver (Fig. 2 A-C) was observed inside Jopićeve Cave in the part of the cave called Zvono in March 2022 in an area characterized by permanent darkness. The body of the individual was approximately 60 cm long. It swam along the cave stream (Potok A), showing a reaction to electrical lights from two cavers present inside the cave. After several minutes, the individual climbed the land plateau in Zvono Hall. In several attempts, it tried to chew smaller rocks on the plateau, which was video-documented. It then came within two metres of the the cavers and accepted food (fresh radish, pastry).

The presence of the beaver in Jopićeve Cave was observed also indirectly. Traces of beaver gnawing were noted on the rope (Fig. 2 E) left in the cave in April 2022 on the plateau in Zvono Hall. A beaver also visited a small hall near the main plateau in which a second cave stream named Potok B flows and damaged a plastic pipe (Fig. 2 F) in June 2022. Traces of beaver footprints were visible in several places in Zvono Hall near the shores of Stream A and Stream B on horizontal and vertical surfaces (April and June 2022). On the edge of the plateau, which is never flooded, a beaver mat was observed



**Fig. 2.** Live individual of Eurasian beaver inside the cave (A-C); beaver mat (D); damaged rope (E) and plastic pipe (F) by beaver; beaver dam on Bent Stream in October 2022 (G)

(Fig. 2 D). There was no organic material in the mat (branches etc.), only one rubber glove was observed for one month, but later it was absent (possibly it was removed from the mat as trash by speleologists). Since this period there have been no recent records of the beaver visiting the cave.

Traces of beaver gnawing have been registered on riparian vegetation surrounding the stream Bent. In October 2022 a beaver dam (Fig. 2 G) was observed in the Bent 700

m from the spring Vrelce, but during the next visit in November 2022, this location had been completely demolished by the inhabitants of a nearby village. The villagers reported that beavers had damaged their crops in the last five years, and stated that they had used electric fencing (recorded on the site). Their opinion on beavers was negative.

Desktop and field analysis of the hydrological network of the wider area (Fig. 1) showed that the largest watercourse east from the Vrelce Spring is Brebornička River, while other watercourses are small, shallow, and close to full desiccation during summer or intermittent streams that flow only during high rain events. West of the Vrelce Spring, the closest surface water body is the River Korana (Fig. 1) at a distance of 4.5 km to the southwest, 5.5 km to the west, and 9.6 km to the northwest.

Karst areas provide an abundance of shelters for various mammals such as bats, small rodents, and carnivores that enter subterranean spaces (GOTTSTEIN MATOČEC *et al.*, 2002; TVRTKOVIĆ, 2012), so it is not surprising that beavers, as facultative visitors, also take advantage of such locations. Dinaric karst (GARAŠIĆ, 2021; MIHEVC *et al.*, 2010) is very rich in various caves and caverns close to the surface running waters, and some of them could potentially be convenient for beavers. Because beavers were relatively recently reintroduced in Croatia (GRUBEŠIĆ, 2006) the full extent of habitats this species uses in karstified areas is yet to be determined.

Research by NOLET & ROSELL (1994) showed that beavers released in new areas occupy habitats based on their quality, while ŠIMŮNKOVÁ & VOREL (2015) identified mating as an important driver of beaver dispersion. In the case of the Jopićeva Cave entry of the beaver into the cave could have been induced primarily by the search for a compatible habitat. Despite the natural condition of the Bent Stream, it is short, narrow, and shallow and has limited capacity for supporting beaver populations. Other compatible habitats for beavers are east from the Vrelce Spring where perennial streams are present. The vast waterless area west of the Vrelce Spring (ranging from 4.5 to 9.6 km of air distance from the river Korana) (Fig. 1, Fig. 2) is the best representation of the challenges beavers face in karst areas. Beavers occupy very narrow areas along river habitats, even though their longitudinal travel distance can range in kilometer scale (NOLET & ROSELL, 1998). In our example (Fig. 1, Fig. 3) the combination of a large distance from the River Korana and the demanding karstified terrain make this land migration less probable. All the so far recorded localities of European beavers in caves (AUGUSTINOVIĆ *et al.*, 2024; KEPIĆ *et al.*, 2023; pers. comm. Tina Bosner and Ruđer Novak) are located right next to large rivers (Fig. 3). In contrast, the beaver population in the vicinity of Jopićeva Cave is exposed to the most intense pressure due to dry periods caused by the rapid sinking of water in the karst terrain. The absence of perennial surface streams and large waterless areas are typical features of karst terrains all around the world (GUNN, 2004). These extreme environmental conditions could be a limiting factor of beaver distribution in karst areas and might induce the use of caves as alternative shelters in a waterless environment. This is also supported by data about North American beaver residing in caves as several of them was found in caves far from the perennial streams (GORE & BAKER, 1989). There is also a waterless barrier to further beaver migration in the population at the spring area of the river Korana (AUGUSTINOVIĆ *et al.*, 2024).

Additional pressure on beaver population in the Brebornica area produces the kind of conflict with humans detected in other parts of the world (NOLET & ROSELL, 1998). Even though research shows that beavers produce little damage to crops (Lod-

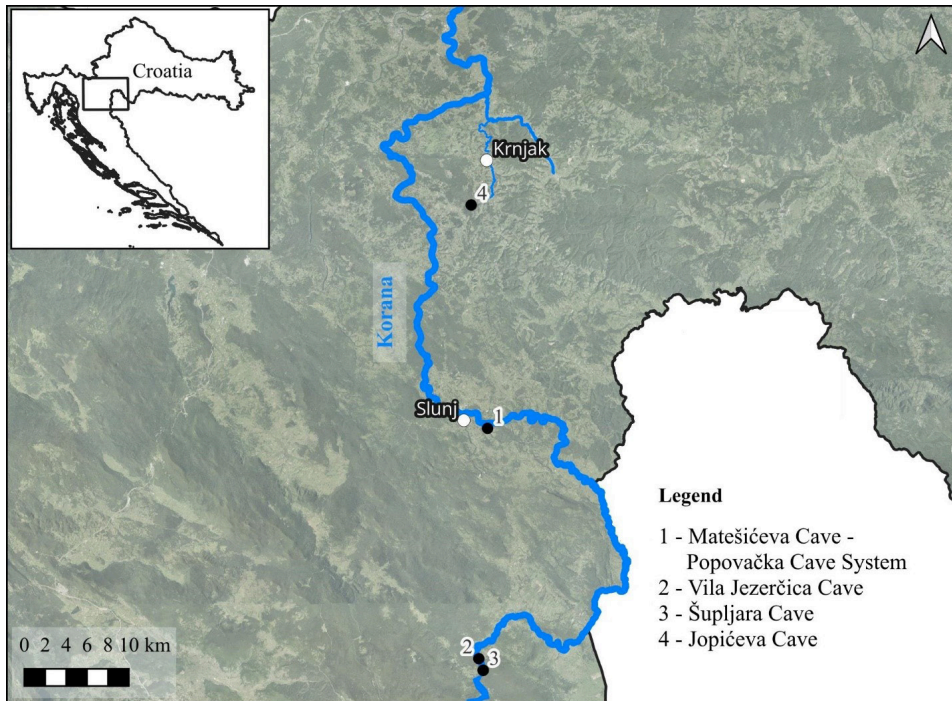


Fig. 3. Findings of the Eurasian beaver in Croatian caves (literature data and this study)

BERG-HOLM *et al.*, 2022; MIKULKA *et al.*, 2020), local people perceive beavers as offenders in crop damage. The activation of electrified fences for the protection of crops and the demolition of beaver dams in the Brebornica area additionally reduce the available habitat for this species. All these factors could contribute to the selection of caves as shelters from predators and humans.

Beaver activity in Jopićeva Cave was observed from March to June 2022, which implies that the beaver enters and exits Jopićeva Cave willingly, and is not trapped. Even though beavers live in larger groups (HARTMAN, 1997), only one beaver mat was found in the cave which indicates the presence of only one individual. Only one individual was recorded in the Matešičeva Cave – Popovačka Cave System too (pers. comm. Tina Bosner and Ruđer Novak) and Vidovac Cave (KEPIC *et al.*, 2023), which share the hydrology type (stream exiting cave) of Jopićeva Cave. Single mats were noted also by GORE & BAKER (1989) for North American beaver in caves confirming that they are used as short-term shelters for this species, but the same study also mentions a cave sustaining a beaver family. In the example of Jopićeva Cave it is important to point out that most of the cave channel between Zvono Hall and Vrelce Spring is accessible only by boat or only by diving equipment, so available data on beavers in this cave are currently limited to the information gathered from Zvono Hall. Beavers are nocturnal animals (GRUBEŠIĆ, 2008), and the fact that they entered multiple times 120 m deep inside the Jopićeva Cave implies they have good orientation in a cave environment.

Caves share many traits with other beaver shelters (holes and dams) (GRUBEŠIĆ, 1994) such as flooded entrances (in some caves), high air humidity, and limited presence of

light. Flooded cave entrances represent ideal natural protection from predators and human disturbances. Important traits of caves are also the small variations of temperatures that are very close to the annual temperatures of the area (CULVER & PIPAN, 2009). This means that in winter months temperatures in caves are higher than outside the cave which could be an advantage in winter periods when food availability is limited and energy saving represents an advantage (NOLET & ROSELL, 1994). The use of karst caves by beavers, even as a temporary shelter, shows the high adaptation abilities of this species. There are frequent hydrological extremes in karst areas (e.g. desiccation of watercourses, droughts) and caves could enable beavers to survive these periods. At the same time, the fast flooding of caves could induce beaver fatalities. The ecological implication of conditions present in karst areas should be additionally researched to protect caves used by beavers.

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