

# Interspecific interactions between golden jackals (*Canis aureus*) and other mesocarnivores at bait stations in Ljubljansko barje

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**Abstract.** Considering the recent expansion of the golden jackal's (*Canis aureus*) range, we set out to determine its interspecific interactions at potential food sources with other mesocarnivores in Ljubljansko barje, the area where the first territorial groups in Slovenia were recorded. We set bait and camera traps at six different locations. When analysing the recordings, it seemed that red foxes (*Vulpes vulpes*) were in all probability avoiding jackals at stationary food sources on a fine spatial scale. In addition, we recorded a case of the possible interference competition between the golden jackal with the European badger (*Meles meles*).

Key words: intraguild competition, golden jackal, *Canis aureus*, territorial pair

**Izvleček. Medvrstni odnosi med evrazijskim šakalom (*Canis aureus*) in drugimi mezokarnivori ob postajah z vabo na Ljubljanskem barju** – V luči nedavnega širjenja areala evrazijskega šakala (*Canis aureus*) smo želeli ugotoviti, kakšni medvrstni odnosi z drugimi mezokarnivori se vzpostavljajo ob potencialnem prehranskem viru na Ljubljanskem barju, območju, kjer so bile v Sloveniji prvič zabeležene teritorialne skupine. Na šestih lokacijah smo postavili vabe in fotopasti. Opazili smo, da se lisica (*Vulpes vulpes*) na stacionarnih prehranskih virih verjetno izogiba šakalom na fini prostorski skali. Poleg tega smo opazili obnašanja, ki bi lahko bila povezana z interferenčno kompeticijo šakala z jazbecem (*Meles meles*).

Ključne besede: znotrajcehovska kompeticija, zlati šakal, *Canis aureus*, teritorialni par

## Introduction

The golden jackal (*Canis aureus*) is a medium-sized carnivore of the canid family (Canidae). In recent decades, we have observed a rapid expansion of its range to the west, northwest and north of Europe, after the initial expansion waves in the 19<sup>th</sup> and 20<sup>th</sup> centuries (e.g., Lanszki et al. 2015, Rutkowski et al. 2015, Čirović et al. 2016, Krofel et al. 2017, Markov et al. 2018, Spassov & Acosta-Pankov 2019, Potočnik et al. 2019, Stronen et al. 2021). The species has also found a suitable habitat in Slovenia, where the first territorial groups were confirmed in

Ljubljansko barje in 2009 (Krofel 2009), with the vast majority of the population originating from an expansion of the Pannonian population (Stronen et al. 2021). Considering the jackal's status of a relatively new species in the area, its ecology is still largely unknown in local communities.

One of the intriguing issues of ecological interest, aside from interspecific interactions between the jackal and its prey species, is its relationship with other autochthonous mesocarnivores (Potočnik et al. 2019). Intraguild competition, which occurs when two species use similar resources in a similar way, is an important mechanism regulating the abundance, structure, and existence of predator populations (Polis & Myers 1989).

With this in mind, we wished to examine the relationship between the jackal as a newcomer and the already existing members of the mesocarnivore guild in the area.

## Materials and methods

Between 20.2. and 27. 5. 2022, we set camera traps and baits (1 kg sliced apples and 5 ml of fish oil per sampling area) to attract animals at six different localities in Ljubljansko barje. First, we placed the cameras at three localities, where members of the local hunting club (LD Brezovica) reported jackal sightings. If no mesocarnivore was recorded within three weeks (or only rare sightings were made), we moved the camera to a different locality (in proximity of jackal tracks or scat, if we found some). Two camera traps were later rearranged (one of them twice), so we were able to observe what was going on at six different locations (Tab. 1) in Ljubljansko barje, near the villages of Bevke and Podplešivica (Fig. 1).

**Table 1.** Information on six locations with baits in Ljubljansko barje, at which presence of the jackal and other mesocarnivores were observed in spring 2022.

**Tabela 1.** Informacije o šestih lokacijah z vabo na Ljubljanskem barju, na katerih je bilo opaženo pojavljanje šakala in drugih mezokarnivorov spomladi 2022.

Locality no.	Description	Latitude	Longitude	Sampling period
1	Birches southeast of Bevke	45.971742	14.369633	20. 2. – 27. 5. 2022
2	Field west of Podplešivica	45.997065	14.371528	20. 2. – 19. 3. 2022
3	Apple tree in field west of Podplešivica	45.996554	14.371988	20. 2. – 12. 3. 2022
4	A stand of trees southeast of Bevke	45.969368	14.371991	12. 3. – 8. 4. 2022
5	Next to animal trail southeast of Bevke	45.971011	14.368605	26. 3. – 27. 5. 2022
6	Bushes near animal trail southeast of Bevke	45.971033	14.369041	8. 4. – 15. 5. 2022

We set the camera traps to record a 40-second-long video upon movement detection. We checked the bait stations eleven times (26. 2., 6. 3., 12. 3., 19. 3., 26. 3., 3. 4., 8. 4., 18. 4., 2. 5., 6. 5., 15. 5. 2022) to retrieve footage, add bait, and replace camera trap batteries. After each field visit, we reviewed the recordings, selected videos where the target species (mesocarnivores) were present. We excluded incidental footage (e.g., triggered by wind) or footage of non-target species (most frequently *Capreolus capreolus*, *Lepus europaeus*).



**Figure 1.** The top left image represents an outline of Ljubljansko barje with sampling locations Podplešivica and Bevke. The map at the top shows the sampling localities (abbreviation Loc.) at Podplešivica and the bottom map the sampling localities at Bevke.

**Slika 1.** Slika levo zgoraj prikazuje obris Ljubljanskega barja z vzorčnima lokacijama Podplešivica in Bevke. Zgornja karta prikazuje vzorčni točki (okrajšava Loc.) v Podplešivici, spodnja pa vzorčne točke v Bevkah.

During the analyses of selected videos, we identified the species and individuals' behaviours, as well as recorded date and time of video recordings. We considered activity of the species present in multiple clips within a 30-minute period as one sighting, unless visible differences existed between two individuals (e.g., specific markings, size...).

## Results and discussion

From a total of 3,531 videos, in 334 of them the mesocarnivore species were present. The species observed most often were golden jackal (65 times) and European badger (64 times), followed by red fox (12 times), beech marten (*Martes foina*) (3 times) and European wildcat (*Felis silvestris*) (2 times) (Tab. 2).

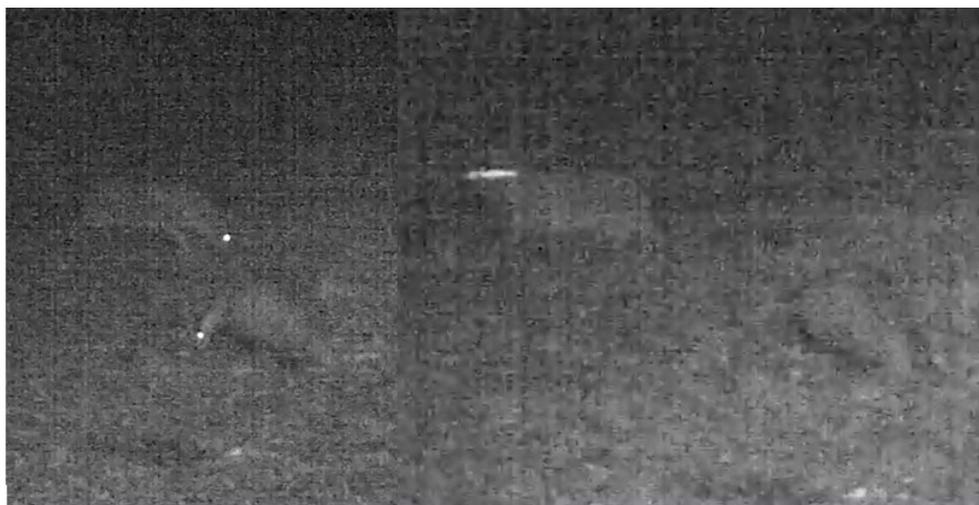
**Table 2.** Number of observations of five different mesocarnivores at bait stations, set at six different locations in Ljubljansko barje in spring 2022. Letters refer to: A – golden jackal, B – European badger, C – red fox, D – beech marten, E – European wildcat. The numbers refer to the number of individuals recorded during the given sampling period.  
**Tabela 2.** Število opažanj petih različnih mezokarnivorov na šestih lokacijah z vabo na Ljubljanskem barju spomladi 2022. Črke se nanašajo na: A – evrazijski šakal, B – jazbec, C – lisica, D – kuna belica, E – divja mačka. Številke se nanašajo na število posameznih osebkov, posnetih v danem obdobju vzorčenja.

Sampling period	Loc. 1	Loc. 2	Loc. 3	Loc. 4	Loc. 5	Loc. 6
20. - 26. 2. 2022	A-5	/	/	/	/	/
26. 2. - 6. 3. 2022	/	/	/	/	/	/
6. - 12. 3. 2022	A-1, B-13, C-1, D-1	C-3	/	/	/	/
12. - 19. 3. 2022	B-5, C-4	/	/	/	/	/
19. - 26. 3. 2022	B-5	/	/	/	/	/
26. 3. - 3. 4. 2022	B-5	/	/	C-1	B-4	/
3. - 8. 4. 2022	A-4, B-6, C-1	/	/	/	A-1, B-2	/
8. - 18. 4. 2022	A-1, B-2	/	/	/	A-2, B-6	A-1, B-5, D-1, E-1
18. 4. - 2. 5. 2022	A-2, B-2, C-2	/	/	/	A-3	A-5
2. - 6. 5. 2022	A-3, B-2	/	/	/	A-3, E-1	A-7
6. - 15. 5. 2022	A-2, B-5	/	/	/	A-1, B-1	A-9
15. - 27. 5. 2022	A-8	/	/	/	A-7, B-1, D-1	/
<b>Total</b>	<b>A-26, B-45, C-8, D-1, E-0</b>	<b>A-0, B-0, C-3, D-0, E-0</b>	<b>A-0, B-0, C-0, D-0, E-0</b>	<b>A-0, B-0, C-1, D-0, E-0</b>	<b>A-17, B-14, C-0, D-1, E-1</b>	<b>A-22, B-5, C-0, D-1, E-1</b>

Because the jackal and red fox are more closely related and occupy similar ecological niches compared to other mesocarnivores present in the study area, the species are expected to have the highest rate of intraguild competition, with the jackal being the dominant species (Scheinin et al. 2006). The data collected suggest that such interspecific relationship between the two species also exists in Ljubljansko barje. Both species were present at only one of the sampling localities (Loc. 1; Tab. 2). At the other five localities we either detected the jackal (Loc. 5, 6; Tab. 2), the fox (Loc. 2, 4; Tab. 2) or neither of them (Loc. 3; Tab. 2).

When we compared the frequency of species recorded during our research with the recorded relative abundance of each species in the barje (LISjak 2022), we noted a significantly lower occurrence of foxes in our recordings. Using data from the regional area (Notranjsko LUO) as well as from the studied hunting ground (LD Brezovica) recorded from 1. 1. 2018 to 19. 9. 2022, we can approximate the relative species densities based on the annual mortality (excluding culling), which represents a random subsample of the present population (i.e., traffic mortality, disease...). These show that the mortality rate of fox exceeded that of jackals by 19.6 times at the regional level of Notranjsko LUO and by 13.0 times at the local scale of the hunting ground LD Brezovica (LISjak 2022). Based on this data we would expect a significantly higher ratio of foxes to jackals present in our study area. However, we recorded the presence of the jackal 5.4 times more often than that of the fox. Of course, we do have to note that the mortality rate doesn't necessarily reflect the actual state of natural populations, but it was the only data regarding species abundance available at this time. Thus, although the data clearly indicate coexistence between red fox and golden jackal, they also point at partial exclusion at a fine spatial scale – a conclusion similar to that of Tsunoda et al. (2018).

However, the data recorded on jackal interaction with badgers were somewhat more unexpected, as jackals appear to be quite cautious around this species, although some authors suggest a bigger difference in resource partitioning between the two of them (Tsunoda et al. 2018). The video recorded by a camera trap at 3:07 a.m. on 8. 3. 2022, shows a jackal nearing a badger feeding on the bait. The jackal demonstrates a typical posture of alertness (Fig. 2, left) and flees after interacting with the badger (Fig. 2, right).

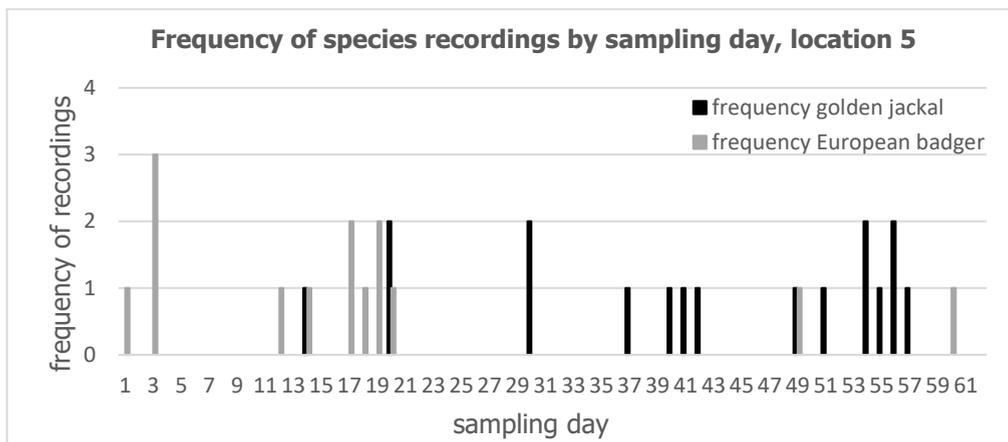


**Figure 2.** In the left image, we see a jackal in the upper left corner displaying high alertness, while a badger is feeding (bottom right). The right image shows the badger approaching the jackal, which flees from the study area.

**Slika 2.** Levo vidimo šakala v zgornjem levem delu slike. Z držo izkazuje visoko previdnost, medtem ko se jazbec hrani (desno spodaj). Desna slika kaže jazbeca, ki se šakalu približuje, ta pa zbeži z območja snemanja.

On the video taken on 10. 4. 2022 at 1:56 a.m., a badger can be seen showing clear aggression (hissing, growling, scratching at the ground). However, it is unclear what the aggression is directed at. We suspect it may be directed at a jackal, as the bait station in question

represents the central area of the breeding pair's territory. Several photo-monitoring events show jackals being aggressive towards badgers (Potočnik et al. 2019). The behavioural differences could be a consequence of the age and social status of the individual animals involved. Interestingly, badgers predominated during the colder months of the study period, before the somewhat higher temperatures and the first heavier rains, when there is presumably a greater variety and abundance of naturally available food. Thereafter, the frequency of badger sightings at bait stations largely declined, while the frequency of jackal sightings increased (Fig. 3). This shift in species presence indicates a potential difference in interactions at stationary food sources in different time periods.



**Figure 3.** The frequency of jackal and badger recordings by sampling days (sampling from 26 March to 27. 5. 2022) at site five. The graph clearly indicates that at around the same time when the frequency of badger recordings drops, the frequency of jackal recordings increases.

**Slika 3.** Graf prikazuje frekvenco pojavljanja šakala oziroma jazbega na posamezen vzorčni dan (vzorčenje od 26. 3. do 27. 5. 2022) s 5. vzorčne lokacije. Vidimo, da na točki, ko frekvenco pojavljanja jazbega močno upade, naraste frekvenco pojavljanja šakala.

The jackal is reported to be a highly adaptable and opportunistic species (Lanszki et al. 2015, Penezić & Čirović 2015, Spassov & Acosta-Pankov 2019, Potočnik et al. 2019). In light of this, we found some behaviours of the territorial pair present here interesting. On 7. 4. 2022 at 3:45 a.m., a camera first shows a pregnant female feeding on bait at location five near Bevke. Her presence is later recorded almost every night, while the male never ate or approached the bait, but just lurked in the background (Fig. 4).

It is possible that the female's increased need for food during the gravidity and lactation period made her take greater risks to find enough food in the human dominated environment. After the whelping, which we estimate to had happened around 2nd May 2022, the female also visited the bait during daylight hours, although this is not the golden jackal's peak activity period (Fig. 5). We believe this happened as a consequence to the female's increased need for calories in the lactation period. As the female was visibly pregnant (and later lactating) and had a distinctive coloured coat on her back (stripes), we believe that all these observations relate to the same individual.



**Figure 4.** In the image we can see a female golden jackal (front) feeding on the bait. The male (circled red) stands in the distance and observes. The camera never recorded him feeding on the bait. The image was taken on the 24th of April 2022 at 3:45 AM.

**Slika 4.** Na fotografiji vidimo brejo samico evrazijskega šakala (spredaj), ki se hrani z vabo. Samec (obkrožen z rdečo) stoji zadaj in zgolj opazuje, njegovo hranjenje na vabi ni nikoli zabeleženo. Posnetek je nastal 24. 4. 2022 ob 3.45.



**Figure 5.** A female golden jackal visiting the bait during daytime. The picture was taken on the 19th of May 2022 at 7:38 AM, after she presumably gave birth to pups.

**Slika 5.** Samica evrazijskega šakala med dnevnim obiskom vabe. Fotografija je bila posneta 19. 5. 2022 ob 7.38, po predvidenem obdobju kotitve mladičev.

Even though we present results of a rather short study, limited to a relatively few sites, we were able to observe some interesting instances of intraguild interactions at potential stationery feedings sites in Ljubljansko barje. We hope these data will provide valuable initial information on the behaviour of the species in the habitat colonized relatively recently. Further studies should consider conducting a similar experiment with a larger number of sampling sites and locations, as well as monitoring across all seasons, to obtain more comprehensive data set on the interactions and to account for differences in seasonal environmental conditions and various site-specific dependent factors.

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## References

- Ćirović D., Penezić A., Krofel M. (2016): Jackals as cleaners: Ecosystem services provided by a mesocarnivore in human-dominated landscapes. *Biol. Conserv.* 199: 51-55.
- Krofel M. (2009): Confirmed presence of territorial gropus of golden jackals (*Canis aureus*) in Slovenia. *Nat. Slo.* 11: 65-68.
- Krofel M., Giannatos G., Ćirović D., Stoyanov S., Newsome T.M. (2017): Golden jackal expansion in Europe: a case of mesopredator release triggered by continent-wide wolf persecution? *Hystrix* 28: 9-15.
- Lanszki J., Kurys A., Heltai M., Csányi S., Ács K. (2015): Diet composition of the golden jackal in an area of intensive big game management. *Ann. Zool. Fenn.* 52: 243-255.
- LISjak (2022): Lovski informacijski sistem, LISjak. Lovska zveza Slovenije. <https://lisjak.lovska-zveza.si> [accessed 19. 9. 2022]
- Markov G., Heltai M., Nikolov I., Penezić A., Lanszki J., Ćirović D. (2018): Epigenetic variation and distinctness of golden jackal (*Canis aureus*) populations in its expanding Southeast European range. *Cr. Acad. Bulg. Sci.* 71: 787-793.
- Penezić A., Ćirović D. (2015): Seasonal variation in diet of the golden jackal (*Canis aureus*) in Serbia. *Mammal Res.* 60: 309-317.
- Polis G.A., Myers C.A. (1989): The ecology and evolution of intraguild predation: Potential competitors that eat each other. *Annu. Rev. Ecol. Evol. S.* 20: 297-330.
- Potočnik H., Pokorny B., Flajšman K., Kos I. (2019): Evrazijski šakal. *Lovska zveza Slovenije, Ljubljana*, 248 pp.

- Rutkowski R., Krofel M., Giannatos G., Ćirović D., Männil P., Volokh A.M., Lanszki J., Heltai M., Szabó L., Banea O.C., Yavruyan E., Hayrapetyan V., Kopaliani N., Miliou A., Tryfonopoulos G.A., Lymberakis P., Penezić A., Pakeltyté G., Suchecka E., Bogdanowicz W. (2015): A European concern? Genetic structure and expansion of Golden jackals (*Canis aureus*) in Europe and the Caucasus. PLOS One 10(11): e0141236.
- Scheinin S., Yom-Tov Y., Motro U., Geffen E. (2006): Behavioural responses of red foxes to an increase in the presence of golden jackals: A field experiment. Anim. Behav. 71: 577-584.
- Spassov N., Acosta-Pankov I. (2019): Dispersal history of the golden jackal (*Canis aureus moreoticus* Geoffroy, 1835) in Europe and possible causes of its recent population explosion. Biodivers. Data J. 7: 1-22.
- Stronen A.V., Konec M., Boljte B., Bošković I., Gačić D., Galov A., Heltai M., Jelenčić M., Kljun F., Kos I., Kovačić T., Lanszki J., Pintur K., Pokorny B., Skrbinšek T., Suchentrunk F., Szabó L., Šprem N., Tomljanović K., Potočnik H. (2021): Population genetic structure in a rapidly expanding mesocarnivore: golden jackals in the Dinaric-Pannonian region. Glob. Ecol. Conserv. 28: 1-11.
- Tsunoda H., Ito K., Peeva S., Raichev E., Kaneko Y. (2018): Spatial and temporal separation between the golden jackal and three sympatric carnivores in a human-modified landscape in central Bulgaria. Zool. Ecol. 28: 172-179.