



New Insights into the Trophobiology and Human Perception of the Golden Jackal *Canis aureus* Linnaeus, 1758 (Mammalia: Canidae) in the Danube Delta and Surroundings: between Myth and Reality

Mihai Marinov¹, Angela M. Ionică², Andrei D. Mihalca³, Vasile Alexe¹, Alexandru Doroșencu¹, Marian Tudor¹, Janos B. Kiss¹ & Lucian E. Bolboacă¹

¹ Danube Delta National Institute for Research and Development, 165 Babadag Street, 820112 Tulcea, Romania

² CDS-9, Regele Mihai I al României Life Science Institute, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Calea Mănăştur, 400372 Cluj-Napoca, Romania

³ Department of Parasitology and Parasitic Diseases, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Calea Mănăştur, 400372 Cluj-Napoca, Romania

Abstract: The present study aimed to provide a review on the trophobiology of the golden jackal *Canis aureus* in the Danube Delta Biosphere Reserve (DDBR) and surroundings and to investigate its implication for economic losses in local rural communities. The damage evaluation was performed by direct questioning of locals and written questionnaires. Most locals from all investigated areas declared damages caused by golden jackals. The responders also declared that the number of attacks has increased during the past years. Most attacks occurred during the winter season at night time. Most of the attacked animals were free-roaming and unsupervised. The great majority believed that other species of carnivorous animals might have been involved in what was considered a jackal attack but over 90 % of responders agreed to the reduction of jackal populations. The present study indicates a general belief that golden jackals are dangerous predators causing economic damage by attacks on domestic animals within the DDBR but demonstrates that the extractions are unnecessary management measures.

Key words: questionnaires, golden jackal, damage, human perception

Introduction

The Danube Delta is situated in eastern Romania in the Dobrogea region. Founded in 1990 and added to the UNESCO World Natural Heritage list in 1991, the Danube Delta Biosphere Reserve (DDBR) covers a total of 5800 km² and includes 30 types of ecosystems (GÂȘTESCU & Știucă 2008), with almost 10,000 plant and animal species (DOROFTEI, unpublished data). The Danube Delta also represents one of the most important stopover sites for migratory birds, with an

estimated two million individuals belonging to over 300 avian species using the region's ecosystems each year (HAHN et al. 2009, MARINOV et al. 2019).

The golden jackal *Canis aureus* Linnaeus, 1758 (Carnivora: Canidae) is the most widespread jackal species. Its distribution range includes most of SE Europe, some parts of eastern and central Europe and southern Asia (ARNOLD et al. 2012, HOFFMANN et al. 2018). The populations from northern and eastern Africa that have previously been considered as

*Corresponding author: lucian.bolboaca@ddni.ro

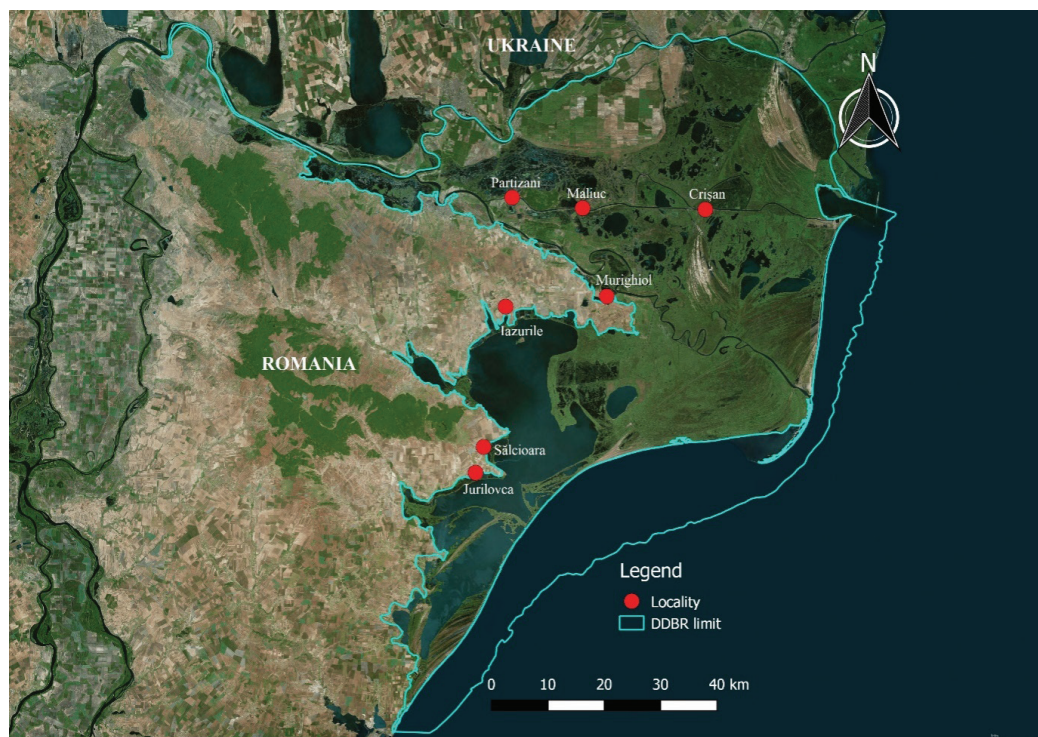


Fig. 1. Limits of the Danube Delta Biosphere Reserve and localities where the questionnaires were distributed.

C. aureus are now recognised as belonging to *Canis lupaster* Hemprich and Ehrenberg, 1833 (GAUBERT et al. 2012, KOEPFLI et al. 2015, VIRANTA et al. 2017). The species distribution in Europe is highly dynamic, including dramatic declines until 1960, comebacks between 1960 and 1970, and expansions starting from the 1980s (ARNOLD et al. 2012). In Romania, the question whether the golden jackal is an autochthonous or allochthonous species is still a matter of debate. Although the first official report of this species dates from 1929 (Călinescu 1930), its presence has been mentioned in the 18th Century (1716) by Dimitrie Cantemir in his work *Descriptio Moldaviae* under the local name *hylacus* or Turkish name *ciacal* (ANGELESCU 2004). Furthermore, palaeozoological evidence indicates the occurrence of golden jackals in eastern Romania (Techirghiol area) since the Neolithic period (NECRASOV & HAIMOVICI 1962). Between 1929 and 1975, golden jackal sightings were rare and some authors considered they were erratic specimens that had crossed the frozen Danube to southern Romania, particularly from the Balkans, during harsh winters (VASILIU 1961, ANDRONIC 1966, IOVĂNEL 1996). The first distribution map for golden jackals in Romania dates from 1994 and reveals the existence of established populations in the Dobrogea Region (eastern Romania) and along the Danube's floodplain (ŞELARU 2014). Since then, the jackal populations have greatly expanded their geographical range,

including in 28 of 41 counties of Romania (PAPP et al. 2014) but the exact drivers of expansion were not thoroughly investigated. Although the chronology of the golden jackal in Romania (in the context of its European expansion) was thoroughly documented (Rösler 2012, 2013), its population index remained unclear. For instance, while some authors (e.g. ARNOLD et al. 2012) estimated the Romanian population to be 600 individuals in 2011, in the same year the national hunting share approved by the Romanian Ministry of Environment and Forestry was 3158 specimens (REGULATION 1.384 2011).

Although there are few studies on the trophobiology of golden jackals in SE Europe (LANSKI et al. 2008, 2015, RAICHEV et al. 2013, Bošković et al. 2013, PENEZIĆ & ČIROVIĆ 2015, ČIROVIĆ et al. 2016, VLASSEVA et al. 2017, LANGE et al. 2021), in Romania they are scarce (BANEA 2021). Even in the volume *Romania's Fauna, Mammalia, Carnivora*, the trophic spectrum of the species is described mostly based on data from Azerbaijan and Tajikistan, completed by some general information referring to the Delta, such as "ground-nesting birds and their chicks" (MURARIU & MUNTEANU 2005). However, in recent years, an increasing number of rural communities from the DDBR and surroundings have claimed damages caused by golden jackals, particularly losses in sheep herds. Such human-wildlife conflicts elicit challenges for management and policy. The national legislation

allows hunting of jackals throughout the year but irrational extractions of a significant number of individuals without investigating the veracity of such claims would represent a fundamental error. Therefore, the present study aimed to assess the trophobiology of the golden jackal *C. aureus* in the DDBR and surroundings as well as to investigate its implication in economic losses of local communities.

Materials and Methods

The present study was undertaken in two steps: a review of trophobiology studies performed in and around the DDBR and an assessment of golden jackal populations and economic damages caused to locals implemented in 2015-2016.

The assessment of populations was performed by direct monitoring, using direct observations of animals, passive acoustic observations and tracks assessments (from Monday to Friday) in five well-defined areas (Maliuc, Sălcișoara, Jurilovca, Murighiol and Partizani) of the DDBR between January and November 2015 and in January 2016. Thus, a medium density could be calculated. The damage evaluation in the study area was performed first by direct (face-to-face) questioning of random locals involved in agriculture and animal breeding in the five study areas, then by the distribution of written questionnaires containing 14 questions regarding golden jackal's damages and human attitudes towards the species to the local people from seven localities (Fig. 1). We received 154 questionnaires answered. The results from the questionnaires were statistically analysed using EpiInfo™ software (CDC, USA). The percentage of responders that gave a positive or negative answer (or no answer) was calculated for each question (where applicable) and the 95% Confidence Interval (CI) was established.

Results

Review of trophobiology studies

Regarding the diet of the golden jackals, most studies indicate that the species is a scavenger of improperly discarded carcasses of livestock (LANGE et al. 2021). In areas where animal livestock is rare, the main food source is represented by small mammals (LANZKI & HELTAI 2002, LANZKI et al. 2006, 2010, 2016, MARKOV & LANZKI 2012, PENEZIĆ & ČIROVIĆ 2015, VLASSEVA et al. 2017, LANGE et al. 2021), followed by fruits and vegetables (RADOVIĆ & KOVAČIĆ 2010, LANGE et al. 2021). In a review regarding the diet composition of the golden jackal in the SE Europe (LANGE et al. 2021), the authors pointed out

that there is no documented case in the literature for domestic animals hunted by golden jackals.

The diet of golden jackals in the DDBR and surroundings was poorly studied; the only reliable data were published by ANGELESCU (2004) as part of his PhD thesis. In his study, in collaboration with the Danube Delta National Institute for Research and Development, 68 stomachs were examined, among which 19 were empty. From the remaining, the content consisted of both animal and plant remains. The plant food (19 encounters) consisted mainly of fruit and seeds, originating from both forest and cultivated species. During the autumn, maize seeds *Zea mays*, sunflower seeds *Helianthus annuus* and grapes *Vitis vinifera* were consumed. Leaves of numerous plants and herbs were also found. Out of the 40 stomachs that had animal content, five were found to contain insects, mainly coleopterans and hemipterans. One individual stomach content, along with pieces of meat, included larvae of the dipteran *Hypoderma diana*, which is parasitic in the epidermis of cervids (HASSAN et al. 2010), indicating that an infected animal was eaten. In descending order according to frequency, the following wildlife species were found: wild boar *Sus scrofa*, roe deer *Capreolus capreolus*, European hare *Lepus europaeus*, raccoon dog *Nyctereutes procyonoides*, golden jackal *Canis aureus*, muskrat *Ondatra zibethicus*, water vole *Arvicola amphibius*, European ground squirrel *Citellus citellus*, lesser mole-rat *Spalax leucodon* and Romanian hamster *Mesocricetus newtoni*. A small number of birds were also found, such as common starling *Sturnus vulgaris*, common quail *Coturnix coturnix* and Eurasian jay *Garrulus glandarius*. Near the investigated dens, remains of pheasant *Phasianus colchicus*, mallard *Anas platyrhynchos*, crow species *Corvus* spp. and Eurasian magpie *Pica pica* were found, especially during the growth period of the pups. The identified domestic animals were pig *Sus scrofa domestica*, sheep *Ovis aries*, dog *Canis lupus familiaris*, chicken *Gallus gallus domesticus* and turkey *Meleagris gallopavo*. Other contents, such as plastic material, including sausage wrappers, strings and paper, were also identified, suggesting again a scavenging behaviour in proximity to human settlements (ANGELESCU 2004).

Population assessment and economic damages

For the results of population estimations based on direct monitoring, see Table 1. The interviews with the people revealed variable results. In Sălcișoara, golden jackals have been established around 1995 and the population has shown a remarkable increase. There was no information that jackals had attacked or killed any domestic mammal. However, it was no-

ticed that during the winter periods, jackals enter the villages and attack unenclosed poultry. In Jurilovca, no jackal attacks were reported in the locality but there is information on annual attacks on pastures, on unsupervised newborn calves, poultry and piglets. In the Partizani area, nocturnal attacks were reported annually. According to locals, jackals killed a total of four lambs, six newborn calves and 14 piglets, in most cases unsupervised and unenclosed animals. In Murighiol area, the interviewed people declared that jackals attack lambs, adult sheep, goats and piglets during the night. In most cases, the attacked animals were unsupervised and unenclosed. In some instances, the locals declared attacks on poultry but after further questioning, it was concluded that jackals were misidentified, confused with red foxes *Vulpes vulpes*. In Maliuc area, according to locals, attacks occur annually, and 15 unsupervised calves were killed and eaten by jackals. Attacks on baby goats and lambs were also declared. The animals were unsupervised.

Overall, 154 persons from seven localities responded to the written questionnaires (Table 2). On the first question (*Does the jackal produce damage in your area?*), the great majority of people (143; 92.86%; 95% CI 87.58-96.33) answered “yes”. The affirmative responses/location ranged from 71.43% (95% CI 41.90-91.61) in Iazurile to 100% in four localities (Sălcioara, Partizani, Maliuc and Crişan). The second question represents an extension of the first one, asking the number of known examples. The responses are presented in Table 3.

For the third question (*Did you sustain any damages?*), the frequency of positive answers was 110 (71.43%; 95% CI 63.60-78.41), while 36 responders (23.38%; 95% CI 16.94-30.86) declared they had not been damaged. The others did not respond. In Partizani, the frequency of positive answers was 100% (95% CI 79.41-100).

Regarding the affected domestic species (question 4), most answers referred to poultry (chicken, ducks, geese, turkeys) and sheep, while the most affected locations seem to be Sălcioara and Maliuc (Table 4). Multiple answers were also given. From the fifth question, regarding the known number of attacked animals, the results revealed that in most cases sheep and goats were involved (Table 5). Regarding the time of attacks (question 6), 122 persons (79.22%; 95% CI 71.95-85.33) declared that the attacks happened during the night, while 21 (13.64%; 95% CI 8.64-20.09) stated they occurred during the day. The others (11; 7.14%; 95% CI 3.62-12.42) declared they did not know. According to the responses, in Sălcioara and Partizani, the attacks happened exclusively during the night. The responses received to the seventh ques-

Table 1. Estimation of the golden jackal populations within the study areas.

Location	January - November 2015	January 2016
Sălcioara	40-50	20
Murighiol	50-60	55
Maliuc	40-50	40
Partizani	50-80	105
Jurilovca	100-200	180

Table 2. Number of received written responses at each locality.

Locality	Answers
Jurilovca	36
Sălcioara	30
Murighiol	27
Iazurile	14
Partizani	16
Maliuc	17
Crişan	14
Total	154

Table 3. Frequency of answers received for the second question *If yes, how many examples do you know?* Legend: *Obtained by calculation, from the responses providing an accurate number.

Locality	No answer	Inaccurate responses		None	Total given examples*
		Many	Few		
Jurilovca	0	0	0	3	745
Sălcioara	0	15	4	1	76
Murighiol	2	16	2	4	12
Iazurile	4	0	1	0	107
Partizani	0	0	0	0	615
Maliuc	2	1	0	0	45
Crişan	0	9	0	0	27
Total	8	41	7	8	1627

tion indicate that most of the attacks targeted unenclosed and unsupervised animals (Table 6).

According to responses received to the eighth question, autumn and winter were the seasons when jackal attacks on livestock were more frequent (Table 7); multiple answers were also given. For the ninth question (*Did jackals enter your locality?*), 118 persons (76.62%; 69.14-83.06) gave a positive response, 26 (16.88%; 95% CI 11.33-23.75) a negative one, while the rest (10; 6.49%; 95% CI 3.16-11.62) had no knowledge on the matter. Unanimous positive answers were recorded in Sălcioara and Partizani.

To the tenth question, referring to damages produced in the year prior to the study (2015), the majority (136; 88.31%; 95% CI 82.16-92.92) declared that they have occurred, while some had no knowl-

Table 4. Frequency of answers received for the fourth question: *In which domestic animals do you know losses were produced?* Legend: * new-born; ** young; *** adult; ^Acombined reports for all species.

Locality	Sheep		Goats		Cattle		Pigs	Poultry ^A	No knowledge	Total
	**	***	**	***	*	**				
Jurilovca	2	0	0	1	7	1	3	42	5	53
Sălcioara	1	0	0	0	0	0	0	110	1	111
Murighiol	18	8	12	7	4	1	1	11	4	62
Iazurile	8	7	4	7	0	0	0	4	4	30
Partizani	2	5	2	2	4	0	3	21	0	39
Maliuc	16	3	17	9	16	1	1	5	0	67
Crișan	6	7	5	7	7	1	2	20	0	55
Total	53	30	40	33	38	4	10	213	15	417

Table 5. Frequency of answers received for the fifth question: *How many domestic animals do you know were attacked by jackals?* Legend: * new-born; ** young; *** adult; ^Acombined reports from all species.

Locality	Sheep		Goats		Cattle		Pigs	Poultry ^A	Just number (no species)	No knowledge
	**	***	**	***	*	**				
Jurilovca	3	0	0	0	21	16	40	12	5	0
Sălcioara	0	0	0	0	0	0	0	20	25	1
Murighiol	20	4	11	7	2	0	0	11	0	3
Iazurile	0	145	0	7	0	0	0	25	0	0
Partizani	13	44	0	10	12	0	16	144	0	0
Maliuc	119	2	252	85	48	0	0	0	0	0
Crișan	3	2	4	14	7	0	2	64	239	0
Total	158	197	267	123	90	16	58	276	269	4

Table 6. Frequency of answers received for the seventh question: *Were the attacked domestic animals enclosed or free roaming; supervised or unsupervised?*

Locality	Supervised		Enclosed		No knowledge
	Yes	No	Yes	No	
Jurilovca	2	22	0	2	10
Sălcioara	3	28	0	8	1
Murighiol	8	11	5	2	4
Iazurile	4	2	0	4	4
Partizani	14	3	0	1	0
Maliuc	3	16	1	7	0
Crișan	8	7	0	1	2
Total	42	89	6	25	21

Table 7. Frequency of answers received for the eighth question: *Which is the season or period of the year when jackals produce damages?*

Locality	Season				No knowledge
	Spring	Summer	Autumn	Winter	
Jurilovca	5	30	34	29	1
Sălcioara	29	30	30	29	0
Murighiol	19	5	5	15	4
Iazurile	5	4	7	7	4
Partizani	0	3	4	16	0
Maliuc	16	14	14	16	0
Crișan	14	13	12	13	0
Total	88	99	106	125	9

edge (16; 10.39%; 95% CI 6.06-16.32) or denied (2; 1.30%; 95% CI 0.16-4.61). The negative responses were received from Murighiol and Iazurile, while unanimous positive answers were recorded in four localities (Sălcioara, Partizani, Maliuc and Crișan). Regarding the frequency of damages (question 11), 104 of the responders (67.53%; 95% CI 59.53-74.85) declared that they happen annually. The rest gave variable answers (Table 8). When asked whether the claimed attacks could be attributed to other species,

such as foxes or dogs (question 12), only 47 persons (30.52%; 95% CI 23.36-38.44) denied that possibility. Other 15 (9.74%; 95% CI 5.55-15.56) were uncertain but willing to accept the idea, while 68 (44.16%; 95% CI 36.17-52.37) answered “yes”. The rest (24; 15.58%; 95% CI 10.25-22.30) did not answer or declared they did not know.

The frequency of positive and negative answers to question 13 (*Do you fear the jackals?*) were similar, but slightly in favour of positives (85; 55.19%;

Table 8. Frequency of answers received for the eleventh question: *Which is the frequency of damages (every year or only in some years, starting more intensely from which year)?*

Locality	Every year	Only in some years	More frequently	More intensely starting from year	No knowledge/ no answer
Jurilovca	24	2	1	0	9
Sălcioara	27	0	1	1 (2010)	1
Murighiol	21	0	0	2 (2014; 2016)	4
Iazurile	7	0	0	3 (2015)	4
Partizani	11	1	0	3 (2010-2011)	4
Maliuc	13	0	0	11 (2010-2016)	1
Crişan	1	0	0	0	2
Total	104	3	2	20	25

95% CI 46.98-63.20). The final question (*Do you agree to the limitation of the number of jackals?*) was answered positively by the great majority (139; 90.26%; 95% CI 84.44-94.45). Only two persons (1.30%; 0.16-4.61) declared they were against it, while 13 (8.44%; 95% CI 4.09-13.22) did not answer or declared they did not know.

Discussion

Although the golden jackals are considered carnivorous predators, in the absence of prey they can be temporarily omnivorous, having various percentages of plant components in their diet (MARINOV et al. 2018). In the DDBR, according to available sources, vegetal content was retrieved in 38.77% of cases, consisting mainly of fruits and seeds. Previous studies performed in Asia (Azerbaijan and Tajikistan) revealed 26.2% plant contents, including melons, olives, sugar beet, Solanaceae fruits, berries and wheat (cited after MURARIU & MUNTEANU 2005). In India, several studies have reported an intense consumption of fruit and plants (SANKAR 1988, MUKHERJEE 1998, KHAN et al. 2017). In Israel, fruits were identified with a frequency of 31.3% (BORKOWSKI et al. 2011). In Croatia, the vegetal content had a frequency of 34.1% and consisted mainly of grapes, figs and juniper (RADOVIC & KOVACIC 2010). A study performed in Bulgaria revealed that plants were a secondary food source, with an overall frequency of 19.7%, including plums, pears, sunflower seeds and grassy vegetation (MARKOV & LANSZKI 2012). It seems that at least during some periods of the year, fruits represent an important part of the jackals' diet. In all of the above-mentioned studies, the main food source consisted of various species of domestic and wild mammals, followed by birds and invertebrates (mostly insects). The jackals easily hunt and consume small game animals (e.g. hares) and rodents, which represent their main food source (LANSZKI & HELTAI 2002, LANSZKI et al. 2006, 2010, 2016, MARKOV & LANSZKI 2012, PENEZIĆ & ČIROVIĆ 2015,

VLASSEVA et al. 2017, LANGE et al. 2021). The presence of medium-sized or large animal fragments in the gastric content (e.g. sheep, deer, boar) is very likely a consequence of the jackals' necrophagous behaviour (BORKOWSKI et al. 2011). However, the possibility of such animals being injured or in poor condition, and hunted by the golden jackals cannot be fully excluded. It was repeatedly observed that golden jackals hunt young, old or infirm animals surpassing their size 4-5 times (JHALA & MOEHLMAN 2004).

One interesting aspect is the finding of fragments of other canids. Previous research revealed that in areas where the jackal populations have increased, fox and raccoon dog populations declined. The interspecific competition manifests also in direct confrontation and predation – foxes and raccoon dogs being physically eliminated by jackals (LANSZKI & HELTAI 2002, BIHARI et al. 2007). During the present study, three possible cases of cannibalism were identified. However, necrophagy, with the consumption of corpses of other jackals, cannot be excluded.

The scarcity of available food represents both selection factor and driver of migration (STENIN et al. 1983). Our field observation indicate the concentration of important numbers of individuals in areas where food resources are easily accessible, such as zootechnic farms and along the seaside, where the currents frequently bring dead animals. However, considering the remarkable agility of the species and its territorial requirements (1.3-6 km²/family, according to MURARIU & MUNTEANU 2005), we believe that the official estimation of 2400 individuals in the region of the Danube Delta (ANONYMOUS 2018) is overestimated. Furthermore, the aggressive expansion and concentration in some particular areas, at least in Romania, may also have a social component related to the general improper management of household waste in rural areas, particularly food items and (or) carcasses of livestock animals that are not cremated.

The locals have demonised the golden jackal, and their general perception of the species is nega-

tive. This fact has been revealed both by the fear generated by this species and by the general agreement for the population size revealed in the course of the present study. According to the discussions and following questionnaires, the golden jackals have been incriminated for attacks on several species of livestock, such as newborn and young cattle, small ruminants of any age, piglets and several poultry species. Indeed, consumption of domesticated animals has been reported by several authors (e.g. STENIN et al. 1983, YOM-TOV et al. 1995, BORKOWSKI et al. 2011) but, in many cases, the analysed material originated from carcasses. Although the majority of reports seems improbable, at least a part of the declared attacks corresponds to reality. However, due to the lack of knowledge of the species and inconsistencies noticed in the received written answers, we regard the claimed damages as exaggerated and sometimes even invented, e.g. declarations of personal damage, combined with not knowing any examples of jackal attacks and (or) lost animals. Furthermore, the real attacks may have also been performed by other carnivorous species, including stray dogs *Canis lupus familiaris*, red foxes *Vulpes vulpes* and mustelids such as *Martes* spp. or *Mustela putorius*. Either way, generally, the attacked animals were free-roaming and unsupervised. Therefore, the use of fencing systems and the supervision of grazing animals would greatly reduce economic losses, regardless of the species blamed for the attacks.

The increased number of attacks declared during the winter is plausible due to a reduction of other available food sources but that is also valid for all species of potential predators.

The DDBR is a protected area, having a variety of habitats and ecosystems of importance to biodiversity conservation. The golden jackal within the DDBR represents a top predator; therefore, it is a valuable element within the trophic network. However, to identify the trophic patterns of golden jackal populations and their dynamic in DDBR habitats, further research is required. Nevertheless, considering that the claimed damages were supported by trophobiology studies only to a small extent, we believe that limitation of the golden jackal population is inexpedient in the absence of further, more detailed studies, aiming to establish their actual role in the ecosystems.

Conclusions

Following the verbal questioning of locals, it was noted that losses caused by the golden jackals are claimed throughout the DDBR and surroundings. The written questionnaires distributed in February

2016 have allowed quantification of claimed damages. However, the results were unreliable as responders were subjective, overestimating the actual damages or simply inventing them. Furthermore, in real situations, in many instances, the species producing the damages may have been other than the golden jackal. The present study indicates a general belief that golden jackals are dangerous predators causing economic damage by attacks on domestic animals within the DDBR and demonstrates that extractions are unnecessary management measures.

Acknowledgement: We thank the Danube Delta National Institute for Research and Development – Ornithological, Hunting and Game Resources Team (G. Bucur, G. Băcescu, P. Cîrpăveche, A. Gal and A. Timofei) for the contribution to the field assessment and questioning respondents. We also thank Professor József Rékási for his precious contributions. This study was financed by Danube Delta Biosphere Reserve Authority, Project *Study to establish the limiting of the number of jackals, wild boars and other game species in the Danube Delta Biosphere Reserve*, Contract no. 106/30.12.2015, Internal contract no. 547/2015).

References

- ANDRONIC A. 1966. The Jackal in Bucovina. *Vânătorul și Pescarul Sportiv* 6: 4. (In Romanian).
- ANGELESCU A. 2004. The golden jackal: origin, morphoanatomy, eco-etholgy, management. Editura MMC, Bucharest. (In Romanian).
- ANONYMOUS 2018. [Danube Delta Governor: We need to shoot 1,200 wild boars and 2,400 jackals.] <https://www.digi24.ro/stiri/actualitate/guvernatorul-deltei-dunarii-trebuie-sa-impuscam-1-200-de-mistreti-si-2-400-de-sacali-980713> [accessed 08.2018].
- ARNOLD J., HUMER A., HELTAI M., MURARIU D., SPASSOV N. & HACKLÄNDER K. 2012. Current status and distribution of Golden Jackals (*Canis aureus* L., 1758) in Europe. *Mammal Review* 42: 1–11.
- BIHARI Z., CSORBA G. & HELTAI M. 2007. Atlas of the mammals of Hungary. Kossuth Kiadó, Budapest. (In Hungarian).
- BORKOWSKI J., ZALEWSKI A. & MANOR R. 2011. Diet composition of golden jackals in Israel. *Annales Zoologici Fennici* 48: 108–118.
- BOŠKOVIĆ I., ŠPERANDA M., FLORIJAČIĆ T., ŠPREM N., OZIMEC S., DEGMEČIĆ D. & JELKIĆ D. 2013. Dietary habits of the golden jackal (*Canis aureus* L.) in eastern Croatia. *Agriculturae Conspectus Scientificus* 78: 245–248.
- Călinescu R. 1930. The jackal in Romania. *Zeitschrift für Säugetierkunde* 5.6: 373–375. (In German).
- Čirović D., Penezić A. & KROFEL M. 2016. Jackals as cleaners: ecosystem services provided by a mesocarnivore in human-dominated landscapes. *Biological Conservation* 199: 51–55.
- GAUBERT P., BLOCH C., BENYACOU B., ABDELHAMID A., PAGANI P., DJAGOUN C. A. M. S., COULOUX A. & DUFOUR S. 2012. Reviving the African Wolf *Canis lupus lupaster* in North and West Africa: A Mitochondrial Lineage Ranging More than 6,000 km Wide. *PLoS ONE* 7(8): e42740.
- Gâstescu P. & ȘTIUCĂ R. 2008. Danube Delta Biosphere Reserve. Inst. de Geografie. INCDDD – Tulcea., Ed. CD Press. (In Romanian).

- HAHN S., BAUER, S. & LIECHTI F. 2009. The natural link between Europe and Africa – 2.1 billion birds on migration. *Oikos* 118: 624–626.
- HASSAN M.U., KHAN M.N., ABUBAKAR M., WAHEED H.M., IQBAL Z. & HUSSAIN M. 2010. Bovine hypodermosis – a global aspect. *Tropical Animal Health and Production* 42: 1615–1625.
- HOFFMANN M., ARNOLD J., DUCKWORTH J.W., JHALA Y., KAMLER J.F. & KROFEL M. 2018. *Canis aureus*. The IUCN Red List of Threatened Species 2018: e.T118264161A46194820. <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T118264161A46194820.en>
- IOVĂNEL M. 1996. The jackal in Dolj. *Vânătorul şi Pescarul Sportiv* 6: 4. (In Romanian).
- JHALA Y.V. & MOEHLMAN P.D. 2004. Golden Jackal *Canis aureus* Linnaeus, 1758. In: SILLERO-ZUBIRI C., HOFFMANN M. & MACDONALD D.W. (Eds), Status Survey and Conservation Action Plan Canids: Foxes, Wolves, Jackals and Dogs. IUCN/SSC Canid Specialist Group.
- KHAN K.A., KHAN J.A. & MOHAN N. 2017. Winter food habits of the Golden Jackal *Canis aureus* (Mammalia: Carnivora: Canidae) in Patna Bird Sanctuary, Uttar Pradesh, India. *Journal of Threatened Taxa* 9: 10656–10661.
- KOEPFLI K.P., POLLINGER J., GODINHO R., ROBINSON J., LEA A., HENDRICKS S., SCHWEIZER R.M., THALMANN O., SILVA P., FAN Z., YURCHENK A.A., DOBRYNIN P., MAKUNIN A., CAHILL J.A., SHAPIRO B., ÁLVARES F., BRITO J.C., GEFFEN E., LEONARD J.A., HELGEN K.M., JOHNSON W.E., O'BRIEN S.J., VAN VALKENBURGH B. & WAYNE R.K. 2015. Genome-wide Evidence Reveals that African and Eurasian Golden Jackals Are Distinct Species. *Current Biology*, Vol. 25 (16): 2158–2165.
- LANGE P.N.A.M.J.G., LELIEVELD G. & DE KNEGT J. 2021. Diet composition of the golden jackal *Canis aureus* in south-east Europe – a review. *Mammal Review* 51(2): 207–213.
- LANSZKI J. & HELTAI M. 2002. Feeding habits of Golden Jackal and red fox in south-western Hungary during winter and spring. *Mammalian Biology* 67: 129–136.
- LANSZKI J. & HELTAI M. 2010. Food preference of golden jackals and sympatric red foxes in European temperate climate agricultural area (Hungary). *Mammalia* 74: 267–273.
- LANSZKI J., HELTAI M. & SZABÓ L. 2006. Feeding habits and trophic niche overlap between sympatric golden jackal (*Canis aureus*) and red fox (*Vulpes vulpes*) in the Pannonian ecoregion (Hungary). *Canadian Journal of Zoology* 84: 1647–1656.
- LANSZKI J., GIANNATOS G., HELTAI M. & LEGAKIS A. 2008. Diet composition of golden jackals during cub-rearing season in Mediterranean marshland in Greece. *Mammalian Biology* 74: 72–75.
- 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. *Annales Zoologici Fennici* 52: 243–255.
- LANSZKI J., KURYS A., SZABÓ L., NAGYAPÁTI N., PORTER L.B. & HELTAI M. 2016. Diet composition of the golden jackal and the sympatric red fox in an agricultural area (Hungary). *Folia Zoologica* 65: 310–322.
- MARKOV G. & LANSZKI J. 2012. Diet composition of the Golden Jackal, *Canis aureus* in an agricultural environment. *Journal of Vertebrate Biology* 61: 44–48.
- MARINOV M., DOROŞENCU A., ALEXE V., KISS J.B., MARINOV I.M., BOLBOACĂ L.E., TOŠIĆ K. & TUDOR M. 2019. Breeding Dynamics of Waterbirds in Three Large Mixed Colonies (Purcelu, Nebunu, Martinca) in the Danube Delta, Romania. *Journal of Environmental Protection and Ecology* 20: 1517–1526.
- MARINOV M., ALEXE V., DOROŞENCU A., BOLBOACĂ L.E., KISS J.B., TUDOR M., MUNTEANU I. 2018. The damages caused by the golden jackal in Danube Delta Biosphere Reserve and in surrounding (Romania). *Proceedings of the 2nd International Jackal Symposium, Marathon Bay, Attiki Province, Greece. Hellenic Zoological Archive* 9: 154–155.
- MUKHERJEE S. 1998. Habitat use by sympatric small carnivores in Sariska Tiger Reserve, Rajasthan, India. Ph.D. thesis, Wildlife Institute of India, Dehradun, India.
- MURARIU D. & MUNTEANU D. 2005. Romanian Fauna. *Mammalia. Carnivora*. Editura Academiei Române, Bucharest. (In Romanian).
- NECRASOV O. & HAIMOVICI S. 1962. Study on Neolithic fauna remains (Hamangia culture) discovered during digs at Techirghiol. *Materiale şi Cercetări Arheologice* 8: 175–185. (In Romanian).
- PENEZIĆ A. & ČIROVIĆ D. 2015. Seasonal variation in diet of the golden jackal (*Canis aureus*) in Serbia. *Mammal Research* 60: 309–317.
- RAICHEV E. G., TSUNODA H., NEWMAN C., MASUDA R., GEORGIEV D.M. & KANEKO Y. 2013. The reliance of the golden jackal (*Canis aureus*) on anthropogenic foods in winter in central Bulgaria. *Mammal Study* 38: 19–27.
- RADOVIĆ A. & KOWAČIĆ D. 2010. Diet composition of the Golden Jackal (*Canis aureus* L.) on the Pelješac Peninsula, Dalmatia, Croatia. *Periodicum Biologorum* 112: 219–224.
- REGULATION 1.384. 2011. Ministry of Environment and Forestry of Romania. http://www.cdep.ro/pls/legis/legis_pck.hp_act?id=103518 (accessed 02.2020).
- Rösler R. 2012. On the chorology of the golden jackal (*Canis aureus* L., 1758) in Europe. *Beiträge zur Jagd- und Wildforschung. Camp Reischenschlen/Lüneburger Heide* 36: 151–169. (In German).
- Rösler R. 2013. Contributions to the knowledge of the chronology of Golden Jackals (*Canis aureus* L.) in Europe, with special considerations on Romania. *Revista Pădurilor* 128 (1): 41–46. (In Romanian).
- SANKAR K. 1988. Some observations on food habits of Jackals (*Canis aureus*) in Keolao National Park, Bharatpur, as shown by scat analysis. *Journal of Bombay Natural History Society* 85: 185–186.
- STENIN G., KOLEN N. & MITOV I. 1983. Some aspects of Jackals' dispersion. *Lovno i Ribno Stopanstvo* 7. (In Bulgarian).
- PAPP C.R., BANE A. O.C. & SZEKELY-SITEA A.I. 2014. Applied ecology and management aspects related to the Golden Jackal specific ecological system in Romania. *Acta Musei Marmarosiensis* 9: 275–292.
- VASILIU G.D. 1961. Verzeichnis der Säugetiere Rumäniens. *Säugetierkundliche Mitteilungen* 9 (2): 56–58.
- VIRANTA S., ATICKEM A., WERDELIN L. & STENSETH N.C. 2017. Rediscovering a forgotten canid species. *BMC Zoology* 2,6.
- VLASSEVA A., CHASSOVNIKAROVA T. & ATANASSOV N. 2017. Autumn-winter diet and food niche overlap between red fox (*Vulpes vulpes* L., 1758) and golden jackal (*Canis aureus* L., 1758) in two regions in Bulgaria. *Acta Zoologica Bulgaria* 8: 217–220.
- YOM-TOV Y., ASHKENAZI S. & VINER O. 1995. Cattle predation by the Golden Jackal *Canis aureus* in the Golan Heights, Israel. *Biological Conservation* 73: 19–22.

Received: 12.01.2021

Accepted: 02.03.2021