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The book with the scientific papers of the second international symposium dedicated to the golden jackal and related species

2nd International Jackal Symposium
Marathon Bay, Attiki Greece, 31 Oct-2 Nov 2018

With the endorsement of the IUCN Canid Specialist Group

The book includes works on the golden jackal, wolf, coyote, Ethiopian wolf, African wolf, side-striped jackal and black-backed jackal species.

ΕΛΛΗΝΙΚΗ ΖΩΟΛΟΓΙΚΗ ΕΤΑΙΡΕΙΑ
HELLENIC ZOOLOGICAL SOCIETY

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Overview

The Department of Biology of the National and Kapodistrian University of Athens together with Biosfaira NGO Greece, Crispus NGO Sibiu Romania and GOlden JAckal Informal study Group Europe (GOJAGE) organized the Second International Symposium on jackals and related species, 2IJS.

The aim of the meeting was to create a fertile ground for productive discussions between novice and experienced scientists in the field of golden jackal (*Canis aureus*) research, ecology, conservation and management but also on other related species like Gray wolf (*Canis lupus*), African black-backed jackal (*Canis mesomelas*), side-striped jackal (*Canis adustus*), African wolf (*Canis anthus*), Ethiopian wolf (*Canis simensis*) and coyote (*Canis latrans*). Special focus of 2018 2IJS: **Taxonomy, Monitoring** and **Sustainable Hunting**.

During the 2IJS we organized the jackal three days ecology course of 14 hours with oral lectures held by internationally recognized scientists in the field of jackal and related species ecology like Patricia Moehlman (Tanzania), Claudio Sillero-Zubiri (United Kingdom), Jhala Yadvendradev (India), Nikolai Spassov (Bulgaria), Matt Hayward (Australia), Stanley Gehrt (United States of America), Suvi Viranta (Finland), József Lanszki (Hungary), Wiesław Bogdanowicz (Poland), Duško Ćirović (Serbia), Călin Gherman (Romania), Stoyan Stoyanov (Bulgaria), Miha Krofel (Slovenia) and Giorgos Giannatos (Greece).

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Proceedings of the 2nd International Jackal Symposium,
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Chapter 1: Biology and Behaviour

W11K30

Cooperative breeding and feeding ecology of the African golden jackal.

Patricia D. MOEHLMAN [1*], Steven TEMU [2] and Heribert HOFER [3]

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Research on the demography and reproductive success in a population of golden jackals on the Serengeti short-grass plains began in 1974 and is still continuing. In this study area, golden jackals typically produce litters once a year during the wet season (December to April) which is a period of high food availability. Golden jackals forage for invertebrates, reptiles, birds and mammals up to the size of adult Thomson's gazelle and they scavenge from carcasses killed by larger carnivores.

Most golden jackals formed long-term pair-bonds for up to 6-8 years, and often for life. Thirty-six pairs and their offspring were observed in the wet season during a 14-year period. Offspring that remain on the natal territory are subordinate to their parents. They do not mark the territory, but may assist in the defence of the territory.

Yearling jackals which were present were observed to (1) regurgitate to pups and the lactating female, (2) assist in the defence of the territory, and (3) rest at the den and guard the pups. Individuals that provided food were counted as 'non-parental feeders', yearlings that were observed at the den but did not provide food to the pups or the lactating female were counted as 'peripherals'. Reproductive success in golden jackals was defined as the number of pups surviving to 14 weeks of age, an age when they are weaned and have achieved moderate proficiency in foraging.

We assumed that the behavioural parents (territorial pair) were the genetic parents of the litter born and raised on their territory, as we had no genetic samples to test parentage and relatedness. This was a reasonable assumption because DNA microsatellite analyses on 10 golden jackal families in the same study area between 2002 and 2008 revealed that the pairs acting as behavioural parents were also genetic parents, and helpers were the offspring of the parental territorial pairs and full sibs to the pups which they were helping.

Factors influencing reproductive success were determined by a general linear model in which the dependent variable was number of surviving pups and the predictor variables were (1) the number of non-parental feeders, (2) the variation in seasonal rainfall as an index of environmental variability and quality, and (3) the potential exposure to parvovirus. We classified the years 1985-1990 as years where adults and pups were potentially exposed, and the years 1977-1984 as those when exposure was unlikely.

A breeding pair without assistance raised 1.17 young on average (N = 24). There was a clear and strong effect of the number of provisioning adults (breeding pair plus non-parental feeders) on reproductive success in golden jackals. The addition of one non-parental feeder to the number of provisioning adults was worth 0.858 young once the effects of variability in rainfall and absence of

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parvovirus had been taken into account. The presence of parvovirus was responsible for a decrease in survival of 0.509 pups.

Picture W11K30.1: Golden jackal father and pups, January 2018 © Patricia D Moehlman.

Proceedings of the 2nd International Jackal Symposium,
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W12K30

Adaptability, sociality and success in the wonderfully adaptable Canidae.

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To understand fully the biology of foxes, dogs and wolves, to appreciate their role in the ecosystem and the threats they face, we must know of several things concerning the modern Canidae, the most cosmopolitan Carnivora family. Adapted for the cursorial pursuit of prey in relatively open environments, the Canidae are characterized by a great flexibility of diet, opportunistic and adaptable behaviour, and complex social organisation with much variation within and between species. Their great adaptability has enabled them to flourish in most conditions, and they tend to overlap with human endeavour, as shown by their capacity to evoke strong positive or negative feelings in people. While generalist canid species, although often facing indiscriminate persecution, tend to be more widespread and common, those with restricted ranges or with a narrower ecological niche are more likely to be threatened. This is particularly poignant for cooperative breeding species such as gray wolves, dholes and African wild dogs. While pack-living canids are still found across vast areas, their greater need for abundant prey, high mobility and competition from other large carnivores render them highly vulnerable to persecution and habitat fragmentation, and facing a bleak conservation outlook. Flourishing in most conditions, wild canids tend to overlap with people and their domestic dogs. It is free-ranging domestic dogs which paradoxically threaten many wild canid species, through hybridization, competition and as vectors of disease.

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W13C10

Synanthropic to misanthropic: dynamic behavioural responses by coyotes to urbanization.

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Wildlife can respond to urbanization positively (synanthropic) or negatively (misanthropic), but for some species the response to urbanization varies. We applied concepts from foraging theory to predict synanthropic and misanthropic patterns of space use and movement behaviour of the coyote (American jackal; *Canis latrans*) along an urbanization gradient in the Chicago metropolitan area, USA. We estimated home range size and complexity, and characteristics of three movement behaviours (encamped, foraging, and traveling) using Hidden Markov movement models. We found evidence of misanthropy as urbanization increased from moderate to high levels: coyote home range size and complexity increased, and both time spent encamped and time spent traveling increased relative to foraging. Conversely, we found evidence of both synanthropy and misanthropy as urbanization increased from low to moderate levels: coyote home range size decreased, home range complexity increased, and time spent encamped did not change. Although the spatial and behavioural responses of coyotes to urbanization became increasingly misanthropic as urbanization increased, coyotes successfully occupied core urban landscapes. Our study demonstrates that wildlife responses to urbanization can be dynamic relative to the degree of urbanization and represents one of the first descriptions of large carnivore space use and movement in a core urban landscape.

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W14C10

Social learning in coyotes: the role of neophobia, social rank and reward.

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Social learning has important ecological and evolutionary consequences but the role of certain factors, such as social rank, neophobia (i.e., avoidance of novel stimuli), persistence, and task-reward association or type, remain poorly understood. We used five tasks to examine the role of these factors, especially social rank and object neophobia, in social learning by captive coyotes (*Canis latrans*). Task 1 involved individual animals and eliminated object neophobia by familiarizing the subjects to the testing apparatus prior to testing. Tasks 2 and 3 used mated pairs to assess social rank, and included object neophobia, but differed in that task 3 decoupled the food reward from the testing apparatus. Tasks 4 and 5 tested the ability of coyotes to learn from a negative experience. In Task 4, a coyote was captured in a leghold trap, while 6 non-related coyotes observed and were then presented with a trap and compared to control coyotes that did not observe a conspecific get trapped. In task 5, the trap was placed with a mated male-female pair of coyotes. Once one was caught, the mate became the observer and tested with another trap. For Tasks 1-4 we compared performance between coyotes that received a demonstration from a conspecific to control animals with no demonstration prior to testing. Coyotes displayed social learning during Tasks 1, 2, and 5, with persistence being important to individual success in Tasks 1-3. Coyotes that observed a demonstrator perform Tasks 1 and 2 were more successful and persistent than control coyotes. Most coyotes were unable to perform Task 3, including those with demonstrators. Neophobia, measured as latency to approach the object, did no vary by treatment group or social rank. Social rank did not influence success at Tasks 2 or 3 but dominant individuals were the only individuals we observed to succeed and were more persistent at Task 3. Observer and control coyotes were equally likely to set off a trap in Task 4, but observers in task 5 were more likely to avoid traps. These results suggest coyotes use social learning of food-based tasks or when the demonstrator is socially related, but decoupling of the food reward or social relationship reduces their social learning capabilities. This study contributes to understanding the mechanisms underlying how animals gain information about their environment.

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W15C10

Social ecology of the African golden wolf in north-west Senegal: insights from field and molecular non-invasive tools.

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Introduction

The African golden wolf (*Canis anthus*) has recently been recognized as a separate canid species, occurring within the previously considered north African range of the Eurasian golden jackal (*Canis aureus*). Mostly related to the remoteness of its range and lack of scientific interest, there is poor knowledge of basic ecological traits of this new taxonomic entity, namely density of territorial groups, group size and social structure.

Methods

In this study, we investigate the social ecology of *Canis anthus* in north-west Africa (Senegal) using a multi-method approach based on acoustic surveys, direct observations, camera trapping and genetic identification of non-invasive samples (scats, urine and saliva) collected throughout the study area, including active den sites. Field sampling was conducted during 12 days in two areas: a protected wetland (Djoudj National Park) and a contiguous area dominated by human settlements and agricultural fields.

Results

Sixty different individuals genetically assigned to African golden wolves were identified using a set of 15 microsatellite loci. A total of 30 territorial groups were detected by acoustic and visual detection and camera trapping, with an estimated density of 1.5 – 1.7 groups/10 km^2. Mean group size was 4.1±1.8 (SD, range: 2-7) individuals with breeding groups showing a mean number of 2.9±0.7 pups (range: 2-4). Territorial groups (n=4) showed high relatedness estimates (0.44±0.0) among pack members and were composed by an unrelated breeding couple, their respective offspring and one or two helpers (Figure W15C10.1). Genealogies of two family groups inferred from non-invasive genetics revealed that helpers were closely related to the breeding female (siblings or offspring from previous years). The agricultural area located outside the national park showed lower estimates of group density but similar values of group size, possibly related to higher levels of human disturbance and persecution and/or lower abundance of resources.

Conclusion

This study provided a better understanding of the intriguing social life of this new canid species, and highlighted the relevance of short but intensive field surveys based on the combination of different methods, including non-invasive molecular tools for investigating social systems in elusive species.

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Table W15C10.1: Number and estimated density of detected territorial groups of African golden wolves in two sampling areas in north-west Senegal: "Outside NP" area (dominated by villages and agricultural fields) and "Inside NP" area (dominated by wetlands and natural vegetation in Djoudj National Park). Territorial groups were identified based on systematic acoustic surveys and complemented with opportunistic detection from camera trapping, direct observations and spontaneous howling.

	"Outside NP" sampling area	"Inside NP" sampling area	Total
Number territorial groups	9	21	30
Group density(/ 10 km^2)	1.0 – 1.1	2.0 – 2.2	1.5 – 1.7

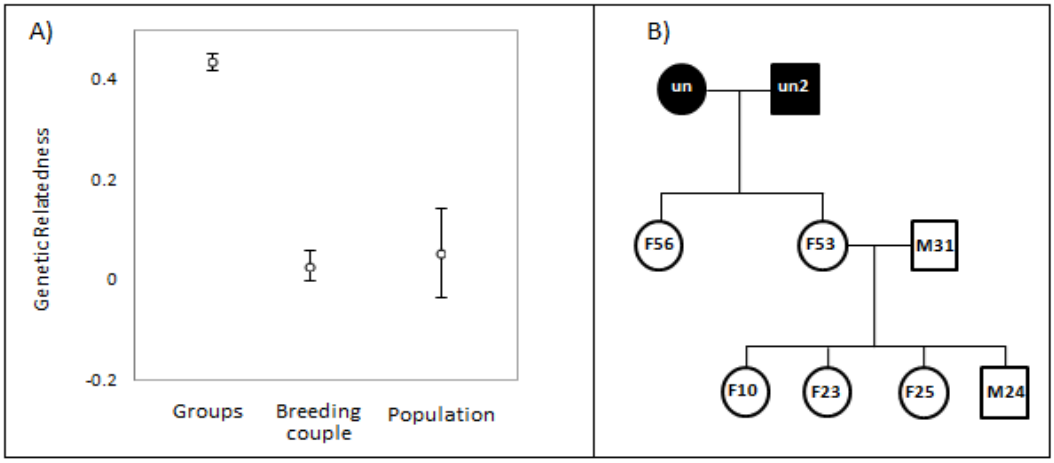

Figure W15C10.1: Genetic relatedness estimates and inferred genealogy of a family group in African golden wolves in north-west Senegal. A) Mean relatedness estimates within groups (Groups, n=4), between breeding couple in each group (Breeding Couple, n=3) and within population considering all individuals except the sampled offspring (Population, n=50). Error bars (line) represent standard deviation from the mean value (circle). B) Genealogy of an inferred family group. Circles represent females and squares represent males. Black squares/circles indicate unsampled individuals.

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W16C10

Some aspects of the golden jackal invasion in the south of Ukraine.

Mykola ROZHENKO * and Vadym KORMYZHENKO

Introduction

Since golden jackals colonised southern Ukraine in 1998, significant ecological changes have occurred. These include the redistribution of other predators, particularly the red fox (*Vulpes vulpes*) and the raccoon dog (*Nyctereutes procyonoides*). This study investigates the dynamics of jackal colonization, the influence of jackals on other local fauna, and the ways in which jackals use their territories. This helps to shed light on ecological changes that have occurred as golden jackals have expanded into southern Ukraine.

Methods

The study was conducted from 1998 until 2018. During this period 318 golden jackals were killed by hunters. Three standardised transects in the Dniester river delta resulted in 507 observations of golden jackals during the winter when snow cover was present. Members of the public provided 120 responses from on golden jackal observations and interactions. Five golden jackals were marked with coloured tags to study individual behaviour. Stomach contents of 54 specimens were analysed. Two specimens killed by hunters were inspected in the laboratory for the presence of rabies.

Results

Separate golden jackal group formation began in March 1998. Group founders were two pairs of jackals, which settled along the lower reaches of the Dniester river. They came naturally to this region, probably from the Romanian side of the Danube, and were the source of further expansion into the area. Research on home ranges provided data on their daily movements foraging and the role played by presence and quantity of food. When there is enough food in an area, animals not only visit it regularly, but also move around it in a routine fashion, with only slight deviations in movements. Transect data in the winter indicated that in the years following the initial jackal colonization, numbers of mesopredators – especially red fox and raccoon dog – decreased sharply or disappeared for 3-5 years.

Analysis of jackal stomach contents (n=48) showed that food collection (e.g. of carrion, berries) may be more frequent than active hunting. Analysing public reports revealed that, when colonizing, jackals use ecological corridors in common with raccoon dogs. Within the research area, these corridors extended south to north along the coast and linked up river basins. Vocal communication was also investigated. Differences were found between voice signals of lone animals and those in packs. Lone animals add a distinct and characteristic sound, unlike the rest of the howl, to the end of the howl.
Jackals do not show anxiety when 150-200 m from the observer, but they try to avoid encounters when humans move towards them. If the approaching human moves at a tangent to the animal, the jackal may not consider it a risk even at distances of 15-20 m. Laboratory examination of two individuals for rabies in February 2018 gave positive results.

Conclusions

Jackal colonization of natural ecosystems in southern Ukraine has significant influences on the native predator guild, leading to redistribution of red foxes and racoon dogs to alternative habitats. Predictable routines are an important component of jackal behaviour and could be used to organize activities aiming to control jackal numbers. The golden jackal was identified as a rabies carrier.

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W17C10

An apex urban predator: the coyote establishes predator functions in Chicago, USA.

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In recent years, coyotes (*Canis latrans*) have colonized major metropolitan areas across North America. For the past 17 years, we have captured and marked over>1,000 individuals in the Chicago area to determine how coyotes function in the urban system. Stable isotope analysis revealed substantial inter- and intra-individual variation in diet, although most coyotes continued to consume natural prey, even in the most developed parts of the city. In addition to coyotes, we have explored predator effects on prey, including Canada geese (*Branta canadensis*) and white-tailed deer (*Odocoileus virginianus*), and potential competitors such as raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), grey foxes (*Urocyon cinereoargenteus*), and feral cats (*Felis catus*). Coyotes represent the primary predator on goose nests (97% of nests monitored), such that they reduce the population growth rate of the resident goose population, from 15% to <5%. We are currently measuring white-tailed deer fawn survival within urban parks. During 2013-15, 29 of 45 fawns died in their first year (S=0.34, SE=0.06). Predation by coyotes was responsible for >80% of mortalities, all of which occurred in the first 30 days following birth. Predation rate varied across years, possibly influenced by availability of alternative prey. Concurrent monitoring of other mesopredators revealed that coyotes have little direct or indirect effects on raccoons and skunks (no predation), but strong intraguild effects on foxes and cats, usually through avoidance rather than direct mortality. It appears coyotes influence these species through direct predation (e.g., at the nest or neonatal stage for geese and deer) and intraguild competition (foxes, cats). Predation by mammalian carnivores had been lacking from urban landscapes across North America. The colonization of Chicago by coyotes illustrates their importance at influencing community structure through their role as an apex predator.

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W18P

Resource partitioning and social behaviour of sympatric African wolves and side-striped jackals in Senegal (north-west Africa): an approach using camera trapping.

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The recently recognized African wolf (*Canis anthus*) and the side-striped jackal (*Canis adustus*) are two canid species with limited knowledge on their biology and ecological interactions when in sympatry. Using camera-trapping data, this study aims to evaluate the social behaviour and patterns in the use of a limited resource by these two canid species in Ferlo Nord Wildlife Reserve (Senegal, north-west Africa), included in the Sahel ecoclimatic zone. As these sympatric canids were monitored near artificial water holes in a semi-arid environment, we hypothesize that species coexistence might be facilitated by temporal segregation as a way of minimizing potentially agonistic encounters to a limited resource. Nine cameras were deployed at artificial water holes from May 2011 to March 2012 to evaluate the number of individuals, their age and patterns of resource use. The most commonly detected carnivore species were African wolves (N= 104 detections comprising 49% of all carnivore records) and side-striped jackals (N= 71 detections comprising 34% of all carnivore records). Both canid species tend to forage alone, as detections of only one individual comprised over 70% of all independent events (N= 82 detections for *C. anthus* and 52 detections for *C. adustus*). However, both species also exhibited social behaviour, with African wolves reaching larger group sizes (up to 5 individuals) than side-striped jackals (up to 2 individuals). Both species showed an evident monthly variation in group size, with detection rates of single animals being higher in November for *C. anthus* and in December for *C. adustus*. Presence of pups was only detected in African wolves, with births estimated to have occurred in November/December. Both species used waterholes more intensively during nocturnal and crepuscular periods, with side-striped jackals showing a more intensive use during night than African wolves. There was some temporal segregation between these two canid species (index of activity overlap = 0.77), possibly in order to avoid agonistic interactions. This study provides relevant data on social behaviour and partitioning of a limited and highly valuable resource (e.g. water) for both species in a semi-arid environment. Furthermore, camera-trapping allowed the detection of several endangered carnivores in West Africa, such as serval (*Leptailurus serval*), caracal (*Caracal caracal*) and striped hyena (*Hyaena hyaena*), reflecting the relevance of Ferlo region for wildlife conservation.

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Picture W18P.1: Video frames of side-striped jackals (left) and African wolves (right) obtained by camera-trapping at artificial water holes in Ferlo region (Senegal, north-west Africa).

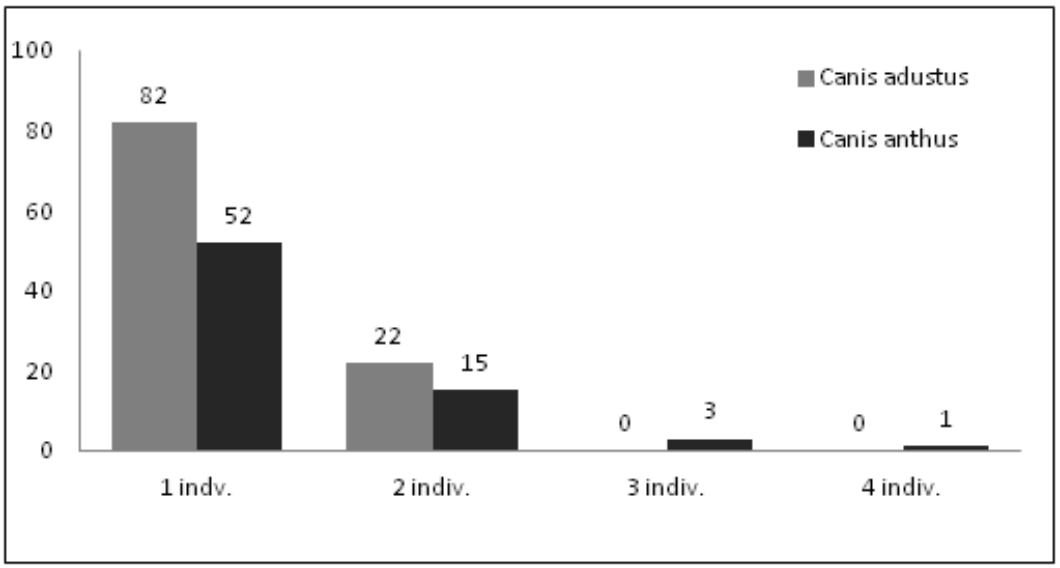

Figure W18P.1: Detected group size of side-striped jackal (grey bar) and African wolves (black bar), based on number of detections by camera-trapping in Ferlo region (Senegal, north-west Africa).

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W19C10

Toward a better definition of territoriality: objective classification of coyote spatial behaviour.

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Many carnivores exclude conspecifics from well-defined areas, resulting in the formation of territories. Such territoriality may confer an advantage for breeding and nutritional resources, outweighing the costs of defence. Current understanding of coyote (*Canis latrans*) spatial ecology and management assumes that individuals belong to either transient or territorial behaviour classes, though some studies acknowledge the existence of additional classes, such as dispersers. Despite recognition in the scientific community as a basic aspect of coyote ecology, a review of the literature reveals no rigorous basis for bimodal assumptions and other ecologically significant behaviours may exist. An objective evaluation of coyote space use and movement behaviour is needed to substantiate or refine our understanding of canid behaviour. Although one study described differences between territorial and transient behavioural groups, their conclusions assumed a bimodal territorial class paradigm, which was not based on an objective analysis of behaviours. We posit that an objective classification of coyote space use must be developed. To achieve this goal, we apply a recently proposed analytic framework that provides a robust and objective means of classifying spatial behaviour using telemetry data from diverse taxa. In essence, the data generate their own classes of behaviour independent of human assumptions. We applied this framework to gain an understanding of the types and characteristics of behavioural classes exhibited by coyotes. We deployed GPS locating collars on coyotes from an unharassed population in southern Texas in 2016, 2017, and 2018. Results reveal considerable variation in coyote spatial behaviour that suggests multiple behaviour modes. While intense site fidelity consistent with territorial behaviour is clearly evident, alternative "transient" strategies exist. Our results provide an objective basis for further studies of coyotes, as well as for comparisons to similar taxa. We encourage ecologists studying species that engage in territorial behaviour to consider concepts beyond the bimodal territorial class paradigm. Other behaviours are evident that carry distinct ecological implications. We encourage canid ecologists to consider alternative behaviour modes, and suggest this framework not only for describing variation within a species, but also as a means of providing novel comparisons between species.

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W110C5

Golden jackals in relation to the density of the human population in Bosnia and Herzegovina.

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Although the presence of golden jackals (*Canis aureus*) in Bosnia and Herzegovina (B&H) has been recorded since the 1970s, significant increase has been noted only during the last ten years, as indicated by the increased number of shot jackals. In the past, only the southern parts of the country were inhabited, while today the core area appears to be in the north of the country (0.33 groups/10 km² in northern B&H and 0.10 groups/10 km² in central B&H). This is likely connected to lower altitudes and lower abundance of gray wolves in this part of the country. An additional potential factor that could affect jackal distribution is human density. We provide new data based on legally harvested jackals and howling surveys. In total, we collected 176 records of occurrence, i.e. the places where the golden jackals were observed across the B&H, from 2006 to 2018 (86 jackal groups detected during acoustic survey, 85 hunting records and five historical records). We used official statistical data from the last census of the B&H population in 2013 and compared it with occurrence of jackals across the entire territory of B&H (143 municipalities). Jackals were registered in 48 (33.6%) municipalities. The most frequent observations of jackals (n= 34) was recorded in the area where human population density was 46-60 persons/km^2 (in eight municipalities or 5.6% of the total number of municipalities). The rarest observations of jackals (n= 4) was recorded in the area where human population density was 76-90 persons/km^2 (in two municipalities or 1.4%) and six observations of jackals in municipalities with human population density from 151-165 persons/km^2 (in two municipalities). In the other 38 municipalities the number of observations of jackals ranged from 12 to 29. Without the observations of jackals were municipalities with 121-135 persons/km^2 (three municipalities or 2.1% of the total number of municipalities) and over the 165 persons/km^2 (21 or 14.7% of the total number of municipalities).

The results suggest that human density affects jackal abundance, most likely through higher availability of anthropogenic food sources. Generally, higher proportion of municipalities with jackals presence as well as higher number of jackal records were in areas with intermediated in higher human densities, although they were absent in the most urban municipalities.

Keywords: Golden jackal, *Canis aureus*, Bosnia and Herzegovina, human density, municipalities

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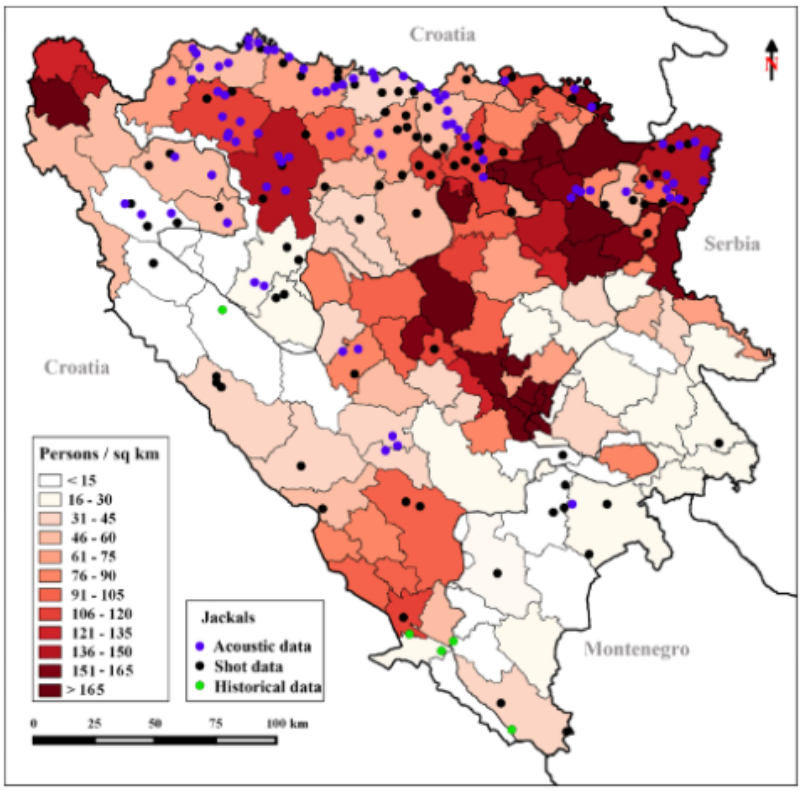

Figure W110C5.1: Observations of jackals in relation to the density of the human population in Bosnia and Herzegovina.

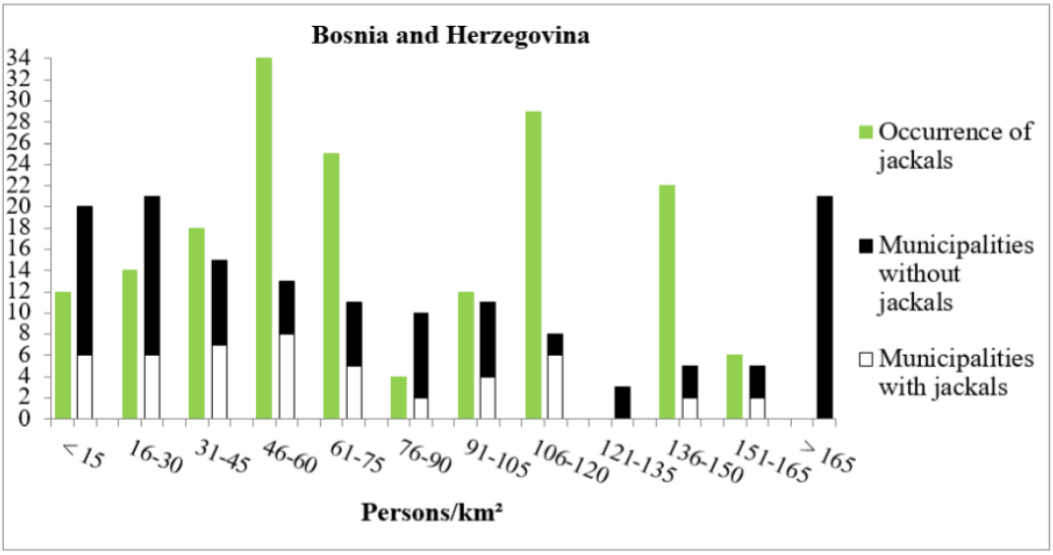

Figure W110C5.2: Occurrence of jackals in relation to the municipalities in Bosnia and Herzegovina.

Chapter 2: Population Ecology and Monitoring

W21K30

Canid co-existence in a densely-settled and human-dominated peri-urban environment. A characterisation of populations and of habitat use among jackals, foxes and wolves in the vicinity of the Athens Metro area.

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Introduction

Like other parts of Europe, Greece was a country of declining populations of both the wolf (*Canis lupus*) and the golden jackal (*C. aureus*) until some 30-40 years ago. Indeed, all three wild canids (i.e. the wolf, the golden jackal, and the red fox *Vulpes Vulpes*) occurring in Greece had the legal status of "vermin" through to the mid-1980s and early 1990s, and were ruthlessly persecuted by all means, including systematic poisoning. However, following the lifting of the aforementioned "vermin" status, the populations of these canids start to rebound, if at differing pace. The wolf population had started to expand by the mid-1980s, while that of the jackal only began to grow again in the late 1990s and early 21st century. Today, both wolves and jackals have experienced a population recovery in Greece and are even expanding their ranges into where they were not present historically. In contrast, the fox always remained widespread, with a continuous population across continental Greece, and even on the larger islands closer to the coast. One area experiencing major population recoveries is the Attiki region, in which wolves are increasing in numbers rapidly at present, while the population of jackals is "reappearing", and that of the fox is large and widely distributed within a continuous and universal range. The aim of the research detailed here was to detect the presence of established territories of wolves and golden jackals, relating these to the presence of the red fox in the Attiki region in general, and the Athens Metro area in particular. The research is ongoing.

Methods

- searching for signs of wolves, jackals and foxes (tracks, marking areas, kills, dead animals, etc); and collecting scats along established transects for the purposes of genetic analysis and an assessment of food preferences;
- intensive camera trapping in three periods (winter – spring 2017, autumn 2017, spring 2018) in selected areas (Parnitha National Park);

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- bioacoustic monitoring for the detection of established groups of jackals;
- filtering of sightings and reports on all three wild canids from hikers, hunters, shepherds and researchers, personnel from two National Parks, and forestry service information on signs of presence, particularly wolf kills.

During the study a large network of reporters was developed, and over 15 volunteers participated actively on field expeditions.

Results

Until summer 2018, 2039 camera trap days were deployed, while there were also 15 sign transects, 16 bio-acoustic calling stations, 84 scat samples analysed genetically, and 150 scats checked. Ultimately, numerous sightings and reports were made available for analysis in regard to western, northern and eastern parts of Athens Metro area.

The wolf reappeared in the area in question after being absent for almost 60 years. The first reliable signs of its presence in the area was a deer kill made in 2011, as followed by a camera-trap photo in 2012. Thereafter, the population expanded rapidly, with high population totals achieved to the north-west of Athens, in a range centred on Parnitha NP, where at least two large packs were detected. Work with the cameras was then able to suggest that their relative abundance is quite great. The main prey species for wolves in this area is the red deer, of which individuals killed are usually consumed very rapidly, given the large sizes of packs. Scavengers at these and other kills were mainly red foxes. However, other scavengers at wolf kills were – in order of decreasing frequency – ravens (*Corvus corax*) and crows (*C. corone*), beech martens (*Martes foina*), feral dogs and common buzzards (*Buteo buteo*). The presence of the wolves changed the abundance, movements and concentrations of the local autochthonous deer herd – the largest in the country, reduced numbers of feral dogs dramatically, increased the number of sightings of ravens, and most probably benefited the fox population. It has also raised concerns within the National Park Management Authority, in regard to the long-term impact on the area's herd of red deer. Concerns were also raised in respect of sightings of wolf-dog hybrids, as well as and the presence of wolves in suburban parts of Athens close to the National Park.

The golden jackal seems to have reappeared in this area in the early 2000s. The last reliable sighting before that (in a nearby area) came from the early 1990s. At least two groups of jackals were detected via bioacoustic surveys in a coastal area of eastern Attiki, in which there is small-scale agricultural activity and limited raising of stock. It is in fact quite possible that the jackal never disappeared completely from this area, but rather survived in low numbers, remaining undetected until family groups were established. The groups of jackals recorded had ranges distinct from those of wolves, though there was co-existence with the ubiquitous red fox.

Conclusions

The rapid increase in the population of wolves was facilitated by the abundant base of a large wild prey species, even if concerns have already been raised as regards long-term imbalance in the predator (wolf) – prey (red deer) system, given that red deer are already in decline. Wolves have been co-existing with foxes, and have controlled feral dogs, while not generating many complaints regarding livestock losses, despite their having reached quite a high population density. However, issues as regards hybridisation with dogs and public safety are raised.

The population trend for the small numbers of jackals re-established in the eastern agro-pastural coastal area is unknown. However, increase in the near future is not anticipated, as the anthropogenic food supply will most probably decrease, due to changes in pastoral activities that produce less husbandry-related waste, as well as in line with the imposition of stricter regulations regarding disposal.

The species is sympatric with foxes and feral/stray dogs, but is clearly excluded from areas nearby in which the large population of wolves is present.

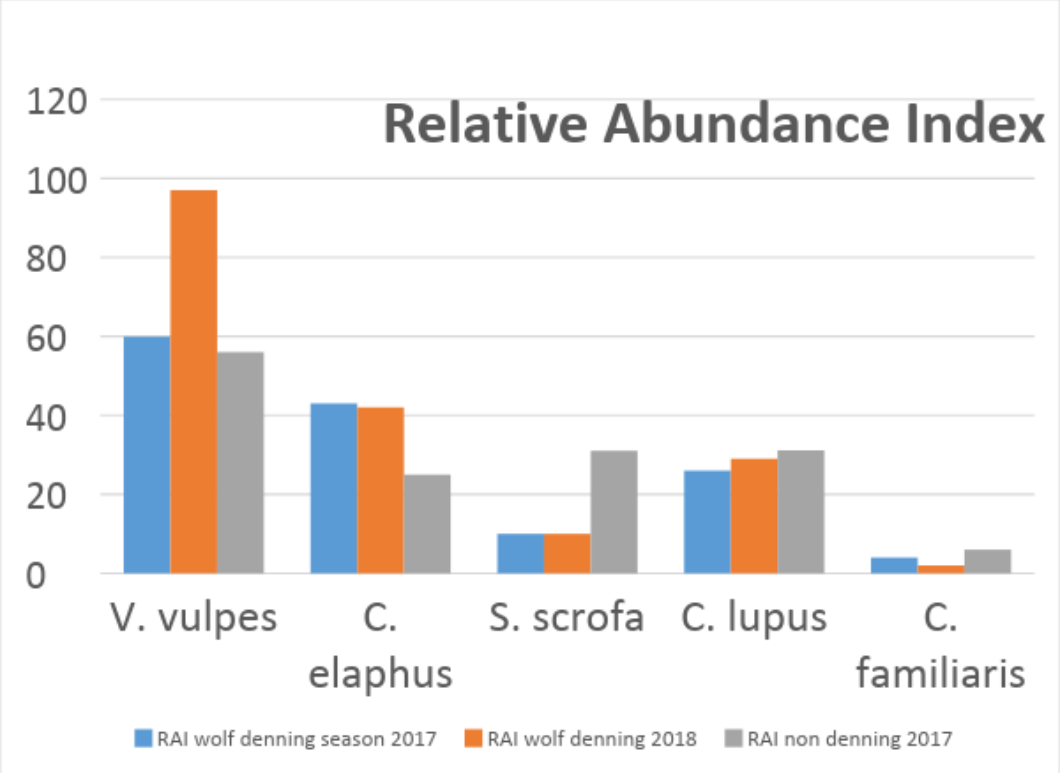

Figure W21K30.1: Camera trapping detection rates of the 2 most abundant carnivores, ungulates and stray dogs in Parnitha National Park during 3 sampling periods.

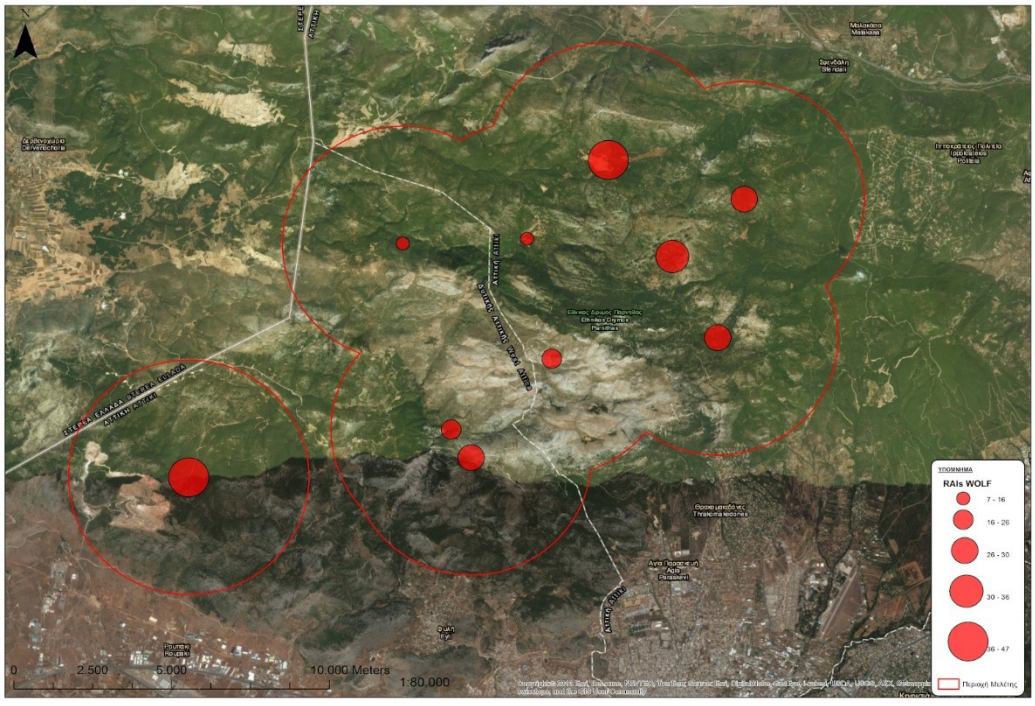

Figure W21K30.2: *Canis lupus* camera trap detection rate in Parnitha National Park.

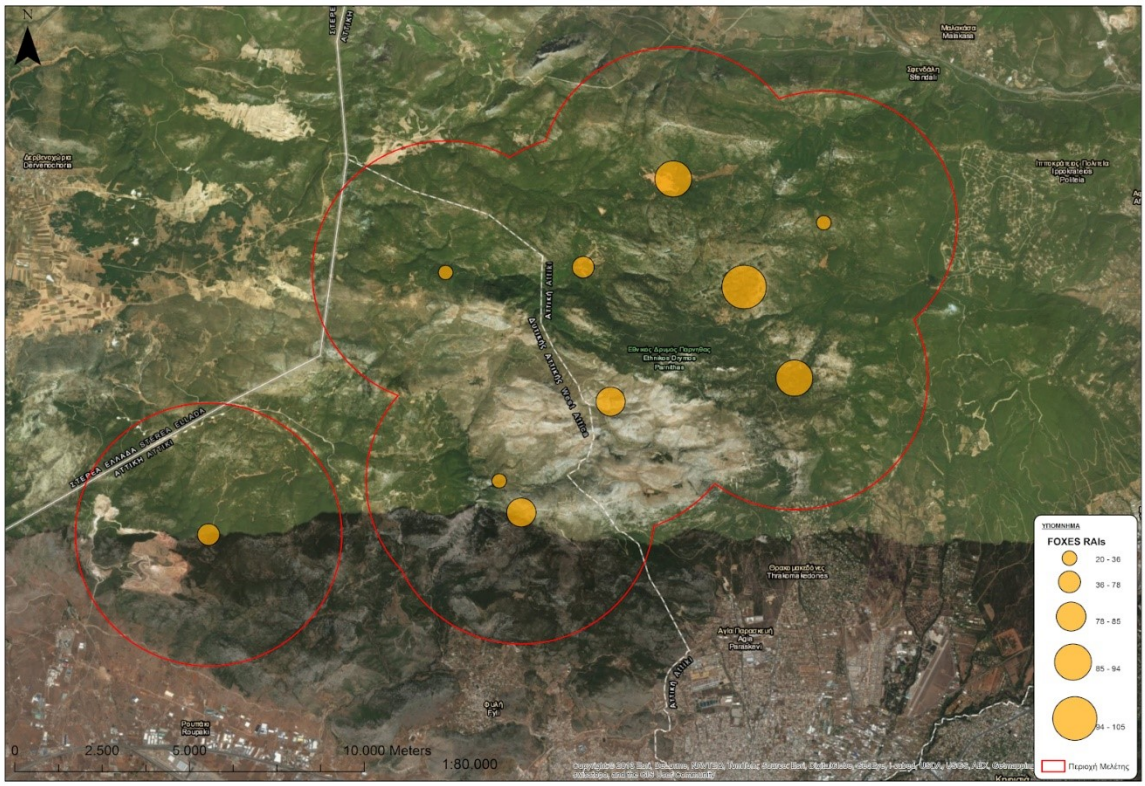

Figure W21K30.3: *Vulpes vulpes* camera trap detection rate in Parnitha National Park.

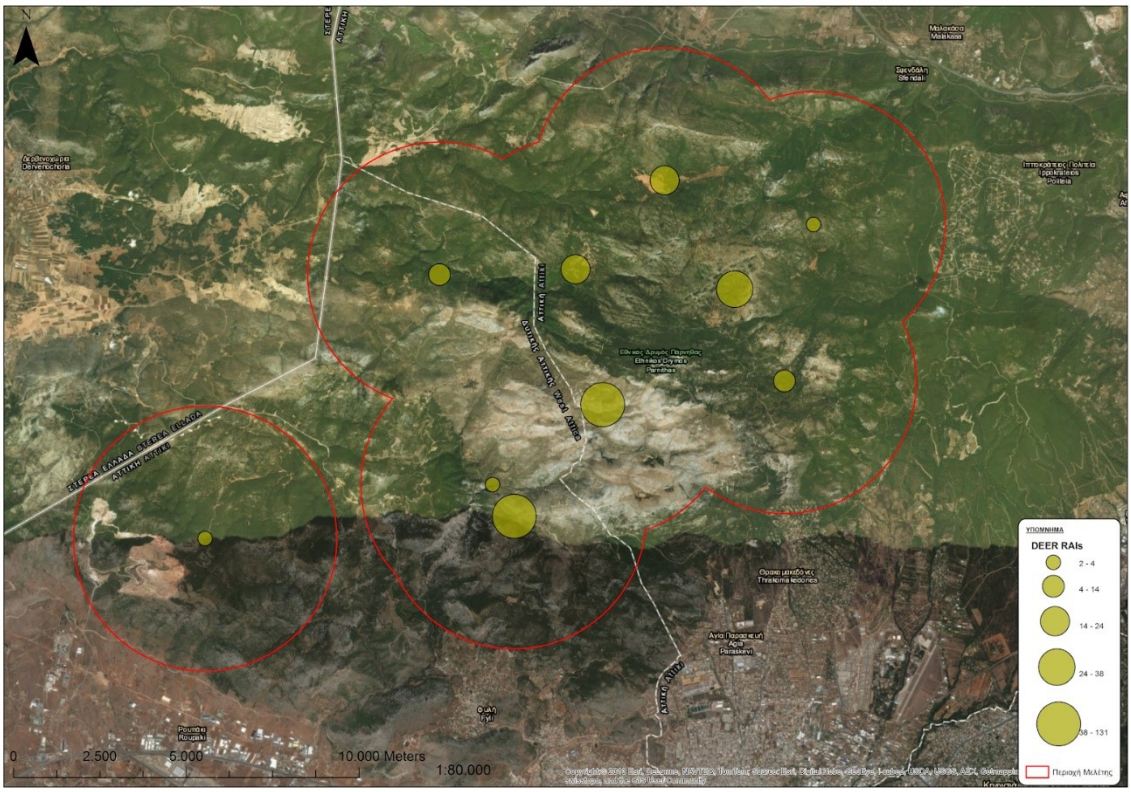

Figure W21K30.4: *Cervus elaphus* camera trap detection rate in Parnitha National Park.

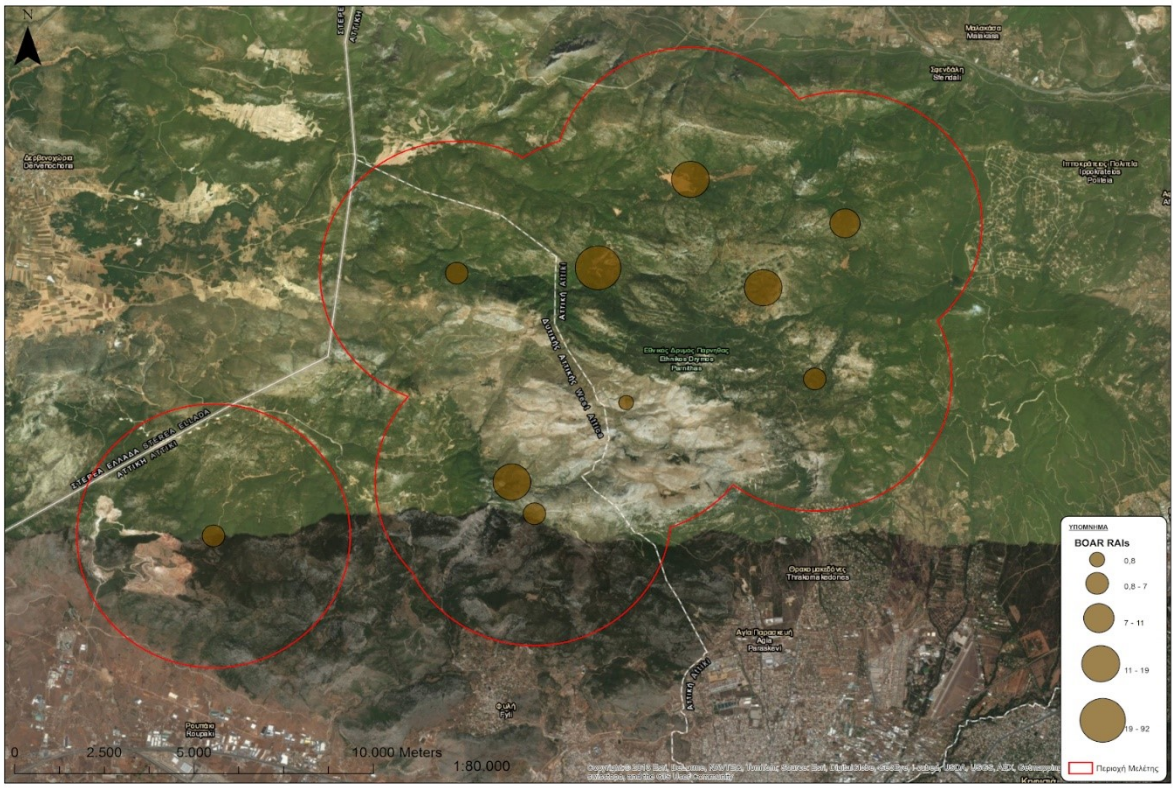

Figure W21K30.5: *Sus scrofa* camera trap detection rate in Parnitha National Park.

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W22K30

Ecology of the golden jackal and wolves in India.

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Three wild species of *Canis* and one *Cuon* exist in India. The golden jackal (*Canis aureus*) is medium sized (6-10 kg) and a typical representative of the genus *Canis*. Based on mt-DNA analysis the golden jackal seems to have originated from the Indian region and spread westward during the late Pleistocene. Due to its adaptive nature and omnivorous diet, the golden jackal occurs across all habitats in India except the higher Himalayas, Sundarban mangroves and extreme parts of the Thar desert. The jackal often occurs in suburban areas, across rural India, and is encountered as one of the most frequent road killed mammal. The jackal subsists primarily on meat obtained through scavenging on livestock carcasses, kills of other predators and from garbage dumps. The jackal is also an effective predator primarily targeting young of ungulates, ground birds, reptiles and insects. It often uses strategy and cooperative hunting to bring down prey 3 to 5 times its size. The jackals' diet also includes a variety of plant matter including fruits, berries, and vegetables. It is often considered a pest to certain crops like melons, grapes, and small livestock as well as poultry. Jackals usually live as pairs but often form groups that can be as large as 5 to 6 individuals. Aggregations of up to 15 individuals can be seen on large carcasses. Jackals typically traverse 6.2 (range 0.4-12) km daily in search of food primarily during the night. The breeding pairs (and helpers) have home-ranges of 29.8 km^2 (S.E. 11 km^2). The outer ranges of neighbouring pairs overlap while core areas are exclusive. Territoriality is often advertised by howling during twilight and early night when all a single howl induces all neighbours to howl. The howl is a complex repertoire ending in a high-pitched staccato. Howls can be used to ascertain occupancy and can serve as a crude estimate of jackal density. In times of high resource availability (calving peak of blackbuck) territoriality breaks down and jackals aggregate at high densities (1.01 per km^2; S.E. 0.21 per km^2). High predation rates by jackals on young can potentially control populations of some wild ungulates. Breeding and then excavation begins February end to March, whelping is usually observed between May-June with an average litter size of 3.6 (range 2-5). Typically, both parents, and often one or rarely two helpers, care for pups by food provisioning. Jackals live in harmony with most large predators and are often observed in the proximity of kills by tigers, lions and wolves, with little aggression expressed towards them. However, striped hyenas predate on jackals, while village dogs often kill them. A high-density jackal population in Velavadar National Park was likely exterminated when newly colonized by striped hyenas within the past 15 years. The golden jackal is on the Schedule 3 of the Wildlife Protection Act as it is common and not under any commercial threat. Rapid development of linear infrastructure, change in land use from traditional farming and livestock rearing to intensive agriculture and industry, diseases like rabies, distemper and parvovirus are major threats to jackals in India.

There are three extant genetic lineages of wolves in India. Two of them the Himalayan lineage (*Canis lupus himalayensis*) and the peninsular lineage (*C. l. pallipes*) are ancient. The third lineage (*C. l. chanco*) is found in the western trans-Himalayas and extends into Tibet, China and Mongolia. It is

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similar to the wolf-dog clade. Both wolf subspecies are on Schedule I and involve the highest protection by law in India.

The peninsular Indian wolf is a small weighing between 17 to 24 kg, with a sandy brown coat and occurs exclusively in India and parts of Pakistan. The Indian wolf though found in varied climatic regions prefers semi-arid grassland and scrub habitats. It avoids thick forests and high rainfall regions, probably out competed by dhole, leopard, and tigers. Indian wolves are primarily found in agro-pastoral landscapes. Their numbers are estimated to be between 2000-3000. Their diet consists primarily of small livestock (goats and sheep) while in wilderness areas they predate on blackbuck, chinkara, hare, and rodents. Scavenging on livestock carcasses is also common. Pack size ranges from two to 14, with breeding in October-November and whelping in late December-January. Territory size was resource dependent ranging between 100-300 km2. Wolves are in direct conflict with humans due to predation on livestock and there are rare attacks on children. Major threats to Indian wolves are anthropogenic, killing pups in dens and poisoning adults were common. Habitat loss due to intensive agriculture, industrialization and linear infrastructure. Hybridization with dogs and diseases like rabies, parvovirus and distemper is increasing.

The Himalayan wolf is larger with adults weighing around 20-35 kg, though coat colour is primarily grey to brown, black wolves are also seen in the region. The range of the Himalayan wolves extends as a narrow, trans-Himalayan belt from eastern Ladakh/Himachal Pradesh across Nepal, parts of Tibet, Sikkim and likely into Bhutan. No population estimates exist as ecological studies have just begun, but an educated guess puts their numbers to be <800 individuals, making them one of the most endangered canids in the world. Himalayan wolves predate livestock (yak, horses, cattle, xo, goats and sheep) as well as wild ass, blue sheep, argali, marmots, and voles. Pack sizes are smaller ranging from two to eight. Breeding occurs in winter with whelping timed for spring (Late February to March end). Home ranges are large >300 km^2 with profound seasonal variation. Major threats are persecution by humans including traditional “wolf pits”, poisoning, and killing of pups during the den stage. Recent threats are hybridization with dogs that are increasing in wolf habitats and diseases associated with them.

All the three wild *Canis* are in need of active conservation measures, the wolves more so than jackals.

Picture W22K30.1: Golden jackal in India. Photos: Yadvendradev Jhala.

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W23C10

Movement ecology of the golden jackal in Europe: first insights from GPS telemetry.

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The golden jackal (*Canis aureus*) is expanding very rapidly from its historic strongholds in south-eastern Europe. The species now reproduces in many central European countries e.g., Austria, Czech Republic, Hungary, Slovakia and Slovenia. Furthermore, dispersing individuals are being recorded throughout the continent and as far north and west as Denmark, Estonia, France and The Netherlands. This phenomenon is triggering sustained interest from ecologists, stakeholders and the wider public. However, future predictions are hampered by a critical lack of knowledge of the species spatial and movement ecology in Europe. In this study, we aimed at providing a first insight into the movement behaviour and space use of golden jackals.

In 2013-2015, we attempted to fit golden jackals with GPS collars in south-western Hungary. Captures were conducted using baited box traps. The GPS collars were programmed to acquire seven relocations per day (00:00, 03:00, 06:00, 12:00, 18:00, 21:00 and 22:00). We subsampled the movement trajectories to a homogeneous fix interval of 6 hr (00:00, 06:00, 12:00, 18:00) in order to investigate the movement behaviour of the species. Specifically, we evaluated the seasonal and daily variations in movement step length and turning angle. Furthermore, we used a spatiotemporal clustering-based segmentation algorithm (MigrO) to identify jackal space use patterns at different scales – from activity cores to home range. Finally, we conducted a step selection function to investigate habitat preferences within the home range.

We successfully GPS-tagged two female jackals – a yearling and a subadult – and acquired 1298 and 2447 relocations, respectively. The average 6 hr step length was approximately 700 m. Most of the variance in step length was explained by the daily circadian rhythm: movement distances were significantly longer during the night. During the monitoring, one of the two individuals dispersed at an average speed of 3.24 km every 6 hr (SD = 3.94, n = 38), which was significantly higher than during the home ranging phases (mean = 0.63 km, SD = 0.72, n = 554). Turning angle distributions were characterized a bias towards pi and –pi, suggesting important backtracking movements. The density-based clustering algorithm estimated the home range size at c. 12 km^2 and suggested a very heterogeneous space use with high concentration around a single location (most likely the den) during the spring and summer. Habitat preferences of both individuals were strongly affected by the time of day. For instance, daylight selection was marked for vegetation cover and distance from roads and settlements.

This study provides the first evidence for movement behaviour and space use of golden jackal in Europe based on GPS telemetry. In particular, it suggests that the propensity of golden jackal to adjust its daily movement behaviour and habitat selection allows the species to persist and be successful in human-dominated landscapes.

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W24CK30

Golden jackals in Iran: distribution, population genetics and ecology.

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Golden jackals were originally described by Carl Linnaeus in 1758, based on a specimen collected in south Persia, presently Iran. Despite being the type locality for this canid, knowledge on Iranian golden jackals is very scarce. There are few presence records available to map precisely the regional distribution area and no data available on ecological traits and genetic variation. This study aims to provide the first-time data on distribution, population genetics and ecology of golden jackals in Iran, at national and local spatial scales.

At a national level, a total of 245 georeferenced presence records of golden jackals in Iran (collected from the period 1865-2017) were compiled from an extensive literature review, on-line databases and unpublished data. The resulting distribution area shows an extensive range throughout the country and across a wide variety of topographic, climatic and habitat conditions. A total of 24 samples of golden jackals covering the entire country were genotyped for 43 microsatellites. Only one genetic group was found with no evidences of population structure exhibiting geographical coherence. Overall, Iranian jackals showed the highest levels of genetic diversity reported so far for populations of this species, with the highest values of expected heterozygosity and mean number of private alleles found in Baluchistan (SE Iran).

At a local level, a survey was conducted in the semi-arid environments of Bidooyieh Protected Area (Kerman, SE Iran). Acoustic surveys, camera trapping and ecological modelling were used to identify territorial groups, estimate group size, and evaluate habitat selection. A total of 16 territorial groups were detected, with an estimated density of 0.14-0.18 territorial groups/10 km^2. Based on camera trapping, the size of one territorial group was estimated in 2 adults and 3 pups, with inferred birth season during late April/early May. Two melanistic individuals were detected: one with a completely black coat and another only with a small white patch in the right paw and chest. Ecological modelling based on the detected territorial groups showed selection of areas with high vegetation productivity, close to small villages but avoiding large settlements with more than 500 inhabitants. Suitable areas predicted by the models were restricted to the bordering areas of Bidooyieh Protected Area, with high water and vegetation availability and small human settlements. Results suggest the species to behave as a local specialist, as they only use 8% of the all available habitats. Additionally, a total of 30 semi-structured interviews to local people were conducted covering 12 villages inside the study area, in order to evaluate the local ecological knowledge and levels of conflict concerning golden jackals. Interviewees reported accurate and valuable information on perceived biological traits of golden jackals, such as distribution, diet, group size and coat pattern. Among local voices, the majority (90%) considered jackals to be

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responsible for damages to agriculture, poultry and livestock. Although local people reported to use damage prevention measures, such as fences and dogs, they still recognize high levels of persecution towards jackals by poisoning, shooting and trapping.

This study supports previous evidences that golden jackals in Iran are widespread and live in close proximity to humans, leading to high levels of conflict and direct persecution. Obtained results also reveal patterns of extended gene flow between populations at a country level but restricted suitable habitats at a local level, particularly in arid environments. These findings provide valuable insights to planning conservation of golden jackals, a species with low social acceptance and widely persecuted.

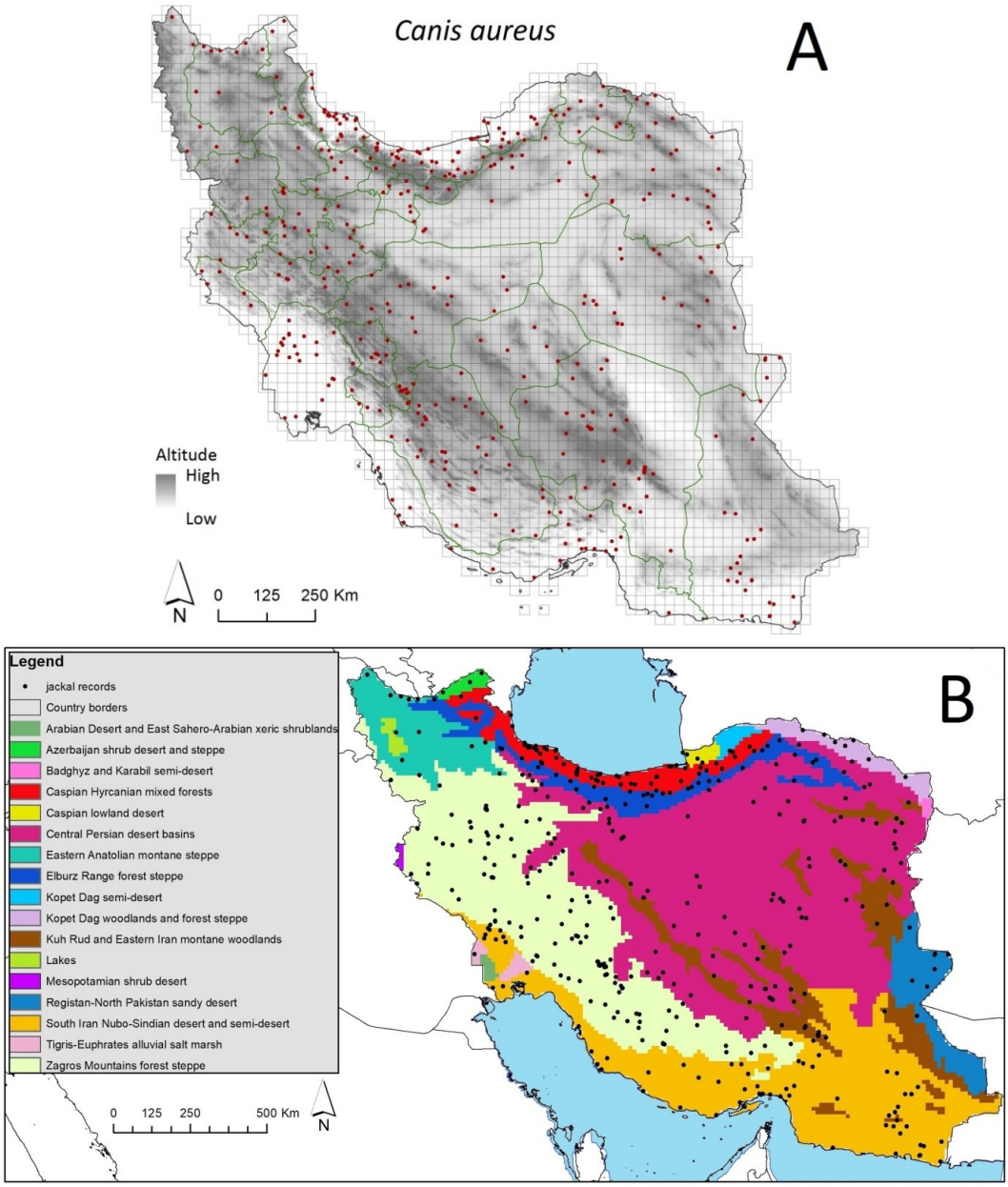
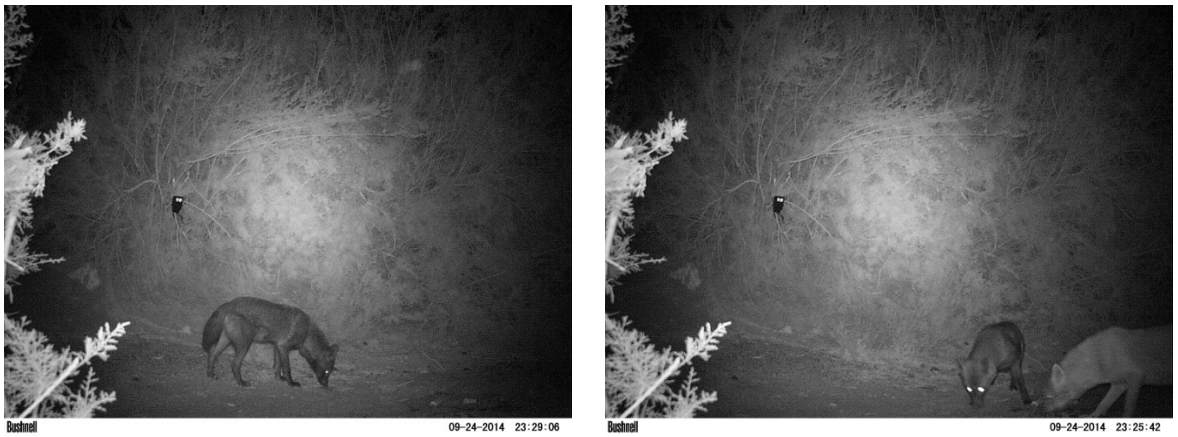


Figure W24CK30.1: A - Distribution of georeferenced presence records (red dots) of golden jackals in Iran from the period 1865-2017, compiled from an extensive literature review, on-line databases and unpublished data (from Yusefi et al., in prep.); B - Location of compiled presence records (black dots) according to the 17 terrestrial ecoregions of Iran (adapted from Dinerstein et al., 2017. *BioScience*, 67, 534-545).



Picture W24CK30.2: Photographic records of melanistic and normal coat individuals of golden jackals obtained by camera-trapping in Bidooyieh Protected Area (Kerman, SE Iran).

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W25C10

Acoustic monitoring and behavioural analysis of the golden jackal: development of new methods for non-invasive monitoring using vocalizations, chorus size analysis, direct and indirect visual observations.

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The golden jackal (*Canis aureus*), although in many respects understudied, is one of the most widely distributed canid species. Its vocalization can be used to monitor their population density and distribution. However, little is known of the behaviour and communication of this species. We aimed to understand whether we could contribute to the development of new methods for the non-invasive monitoring of wild populations and their census.

We observed and recorded the golden jackals in the private reserve of Ultima Frontiera, Tulcea, Romania, during 2016. We estimated the number of vocalizing animals by screening the fundamental frequency of each howl and compared this estimate with the number of potential individuals indicated by the operator in the field. We then performed a similarity analysis of the vocal responses to the jackal howling, which we compared with other howls of jackals and wolves. We then focalized our attention on the fundamental frequency of the first and second howl given by the golden jackals of Ultima Frontiera, with the frequencies of the same howls given by black-backed jackal (*Canis mesomelas*), side-striped jackal (*Canis adustus*) and the gray wolf (*Canis lupus*). We collected 30 files of the first howl and 32 files of the second howl. We calculated the acoustic distances, which we then submitted to a clustering algorithm. We collected videos at particular feeding points for a total amount of 3h 42min of recordings. We documented six behaviours already present in the ethogram of captive individuals, and seven new behaviours.

The results for the evaluation of the number of callers showed that when the number of vocalizing animals was higher than two, the sonogram counts underestimated the number of individuals compared to the estimate in the field. The similarity analysis allowed to identify six and eight clusters depending on the clustering solution chosen. We found a difference in the first and second howls of conspecifics but also found that the golden jackals did not possess utterly distinct howls when compared to other species. Finally, the video analyses showed that body bent down (cautious approach with unknown objects and animals) and vigilance were the most common behaviours. Intimidating and threatening behaviours directed towards conspecifics or other animals (e.g. birds) were the most common sequences of behaviours.

The difference between the estimates by the sonographic inspection and the indication of the observers may be due to the characteristics of the howl and the distance from the vocalizer. The video analyses showed that vigilance is possibly so frequent because of the intraspecific and interspecific competition for food. The results of our study suggest the need for integration between jackal howling,

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acoustics and behavioural analysis. Further studies using the approach we applied could play a role in the development of new methods of non-invasive monitoring of natural populations.

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W26C5

Comparison between acoustic monitoring response rates of the golden jackal in two locations in Italy and Romania.

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Introduction

With the data collected from acoustic stimulation, it is possible to develop a Distance Sampling model in order to estimate the density and the number of individuals. We have tested a three-days stimulation protocol in order to collect a sufficient number (80-90) of responses. We have compared the difference in response rate between the two-study areas to evaluate the efficiency of our protocols. An overstimulation protocol was tested in Romania to collect responses from silent jackals.

Material and methods

In the Italian study area, located in Friuli Venezia Giulia on the Karst near Gorizia, we set up 4 calling stations over a surface of about 1700ha. Here the jackal population is steady since 1996 with a density of 1.1 individuals/100ha. In the Romanian study area, located in the private reserve of Ultima Frontiera (Danube Delta Biosphere Reserve), we set up 3 calling stations over a surface of about 1000ha. The jackal population has a density of about 1.5 individuals/100ha.

In both protocols, for every survey session, a maximum of 5 emissions (trials) with a duration of 30 seconds, alternating with 3 minutes of listening, were employed. In the standard protocol, stimulation session terminates when a jackal or a group of jackals respond. In the over-stimulation protocol, all 5 emissions are performed even if the animals respond.

Results

In Italy (IT) the standard protocol allowed to collect 91 responses in 23 days for a total of 286 emissions in 2015, and 93 responses in 25 days for a total of 307 emissions in 2017. In Romania (RO) the standard protocol allowed to collect 72 responses in 9 days for a total of 84 emissions in 2015 while in 2016 the over-stimulation protocol allowed to collect 49 responses in 8 days for 115 emissions. For the overstimulation data, only the first response was considered to compare the results from the different study area (67 emission, 33 responses).

For all protocols, most of the responses were collected between the first and second trials (I 61.2%, II 19.1%, III 9.3%, IV 9.8%, V 0.54% in IT; I 42.8%, II 9.5%, III 7.1%, IV 11.9% V 28.5% in RO). The average response rate (percentage of the number of responses on the number of trials executed) and the average duration for each of the three days, did not show a statistically significant decrement of the response rate both for Italy (I 33.33% 11.7s, II 31.82% 12.6s, III 25.67% 13.0s) and Romania (I 30.61% 27.2s, II 33.33% 15.8s, III 30.43% 21.1s).

Conclusions

The standard stimulation protocol can provide a sufficient number of responses for the distance sampling analysis for the density estimation of the animals. The response rate is not significantly

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reduced in the three repetition days. The over-stimulation protocol allowed to collect 24.38% more responses than the standard protocol but 46% of animals did not respond to further stimulation if already howled. The stimulation success is higher in Romania than in Italy and the responses length are longer on average.

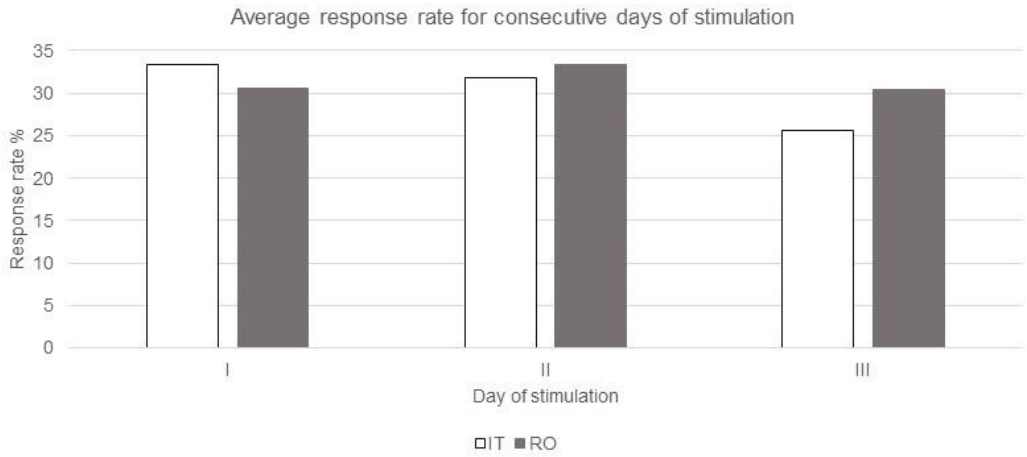

Figure W26C5.1: The average response rate (percentage of the number of responses on the number of trials executed) for the three days of stimulation, did not show a statistically significant decrement of the response rate both for Italy (I 33.33%, II 31.82%, III 25.67%) and Romania (I 30.61%, II 33.33%, III 30.43%).

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W27P

Preliminary results of the study on the distribution of the golden jackal in western Greece: an update.

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Greece is one of golden jackal's historical strongholds in Europe, although its range and populations have notably declined over the last 25 years. Until recently, the species has been reported to survive in discontinuous, isolated population clusters in southern Greece (Peloponnese), in central Greece (Fokida), in northern Greece (Chalkidiki) and in north-eastern Greece (parts of Eastern Macedonia and Thrace) and on the island of Samos in the eastern Aegean Sea.

The present study provides an update of the golden jackal distribution in western Greece. Authors combined the review of different sources of information (published data, unpublished technical reports, interviews and personal communications) with field observations in order to assess the occurrence of the species in western Greece. Data collection covered a time period from 2002 until 2018. Field research was conducted on the Epirus and Western Greece administrative regions (i.e. Thesprotia, Preveza, Ioannina, Arta, Aitoloakarnania regional units), covering an area of ca. 300,000 ha, both in lowlands and semi-mountainous areas.

The results of the study revealed that the golden jackal is present in the whole western Greece and the species' range is currently much larger than it was previously reported for the region. This population appears to be isolated from the rest of the species populations in northern Greece, in central Macedonia and Thrace, while it is fairly close to a known population in southern Albania, as well as to the southern populations of central Greece and Peloponnese.

The golden jackal was believed to have disappeared from western Greece in the 1970s, while in the late 1980s, it was thought to be rare compared to other canids in Greece, with only occasional presence in western Greece, especially in northern coastal zone of Amvrakikos Gulf. Although the occurrence of a population in western Greece has been confirmed based on this study, yet, further investigation would be needed to establish the actual status and distribution of the golden jackal in the area.

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W28C10

Altitudinal patterns of golden jackal distribution in northern Anatolia.

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Golden jackal (*Canis aureus*) is one of the three species belonging to the Canidae family together with gray wolf (*Canis lupus*) and red fox (*Vulpes vulpes*) in Turkey. The population of the species has a wide distribution throughout the country that mostly colonized in coastal regions lower than 800 m altitude. Despite of the fact that golden jackals are known to occupy mostly wolf-free regions in Anatolia, it is necessary to carry out detailed studies for the species, to reveal distribution patterns and co-existence with other canids. In this aspect, we have been conducting systematic camera-trapping surveys in the Western Black Sea Region of Anatolia since 2007 in 12 different study sites, including protected areas as five wildlife reserves and a national park. This ongoing monitoring study reveals significant information about the population, such as current distribution, activity patterns and population trends. During the surveys, 201 systematic camera-trap stations were placed at different habitats and altitudes, with ~2 km distance between them and the total effort reached over 80,000 camera-trap nights. In addition, 58 opportunistic stations were also placed to gather information especially at lower elevations. Data analysis using the obtained records shows that the activity pattern of the golden jackal is mostly nocturnal in the study region, and the positive stations for the species indicate an inclusion of some new regions of higher altitude than the known upper limit for the population in Turkey. Nevertheless, the majority of the population still has a distribution at lower altitudes in the study region; we may conclude that golden jackal population is colonizing new habitats over 900 m that have been already occupied by gray wolf, and establishing permanent populations at above expected elevation limits.

Picture W28C10.1: Golden jackal record obtained at 997 m a.s.l., December 2008, north-western Anatolia.

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W29C10

Preliminary results on population density of golden jackals in Bulgaria.

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Golden jackal's distribution was historically limited to south-east Europe, especially to the Balkans. There is a growing interest on the species due to the dramatic expansion to the west and north of Europe, trying to understand how this process occurs. Although there have been works on habitat preference, there is a lack of knowledge on how habitat affect local population densities. This study aims to estimate the golden jackal population density and relate it with the habitat characteristics variation. In order to determine the presence of territorial jackal groups, the play-back bioacoustic method was used. We carried out a survey of golden jackal density between 2014 and 2017 at 621 calling stations located across all Bulgaria. Every broadcasted howl was followed by a 3-minute pause and repeated five times for each calling station. When a response was registered, the direction from which it originated was determined by using a compass, and the distance roughly estimated as close (0-500 m), medium (500-1000 m) or far (1000-1500 m). Every answer was distinguished between single-answer (1 individual) and group-answer (two or more individuals). The total survey area (4389 km^2) was calculated using GIS software (QGIS 2.18.2). The results show that the areas with highest jackal densities in the country are the north-west (Danube plain), eastern Bulgaria (Kamchia plain) and the eastern Rodope mountains. The estimated densities were organized into three categories, between 1.41 to 2.83 territorial groups/10 km^2 (low density areas); 2.83 to 5.66 territorial groups/10 km^2 (medium density areas) and 5.66 to 7.08 territorial groups/10 km^2 (high density areas). One single answer (individual) was registered at 1161 m altitude. Low and medium density areas were recorded in the range altitude between 500 and 1000 m. Besides low and medium, high density areas were estimated in altitudes less than 500 m. Low and medium density areas were registered in some places inside wolf range distribution. Medium and high densities areas were common in mixed landscapes (agriculture-lands, scrublands) and livestock farming areas. The dataset suggests that the variation in population density is related to different factors like habitat preference, human activity and topography.

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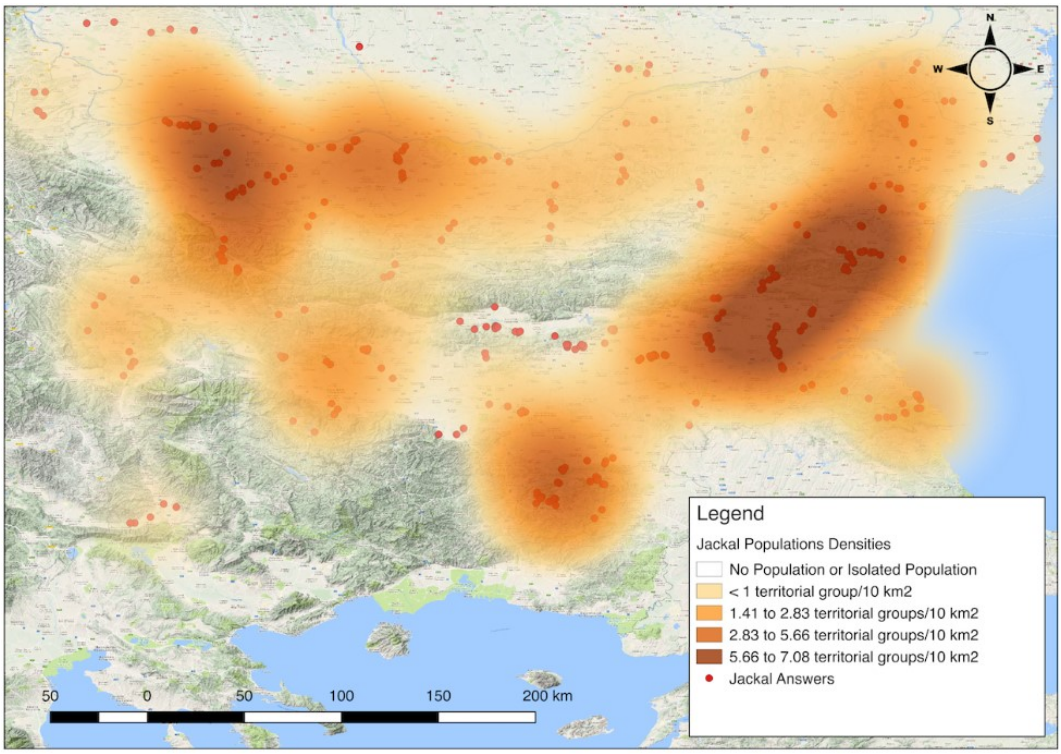

Figure W29C10.1: Jackal population densities based on kernel function, using the location of positive answers during the bioacoustics monitoring in Bulgaria.

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W210P

Testing camera trapping method for monitoring golden jackal population trends in Bulgaria.

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At the end of the 19th and the beginning of the 20th century, the golden jackal occurred at low densities and restricted range in Bulgaria. Over the last two decades it has increased its distribution and currently covers almost 80000 km^2 of Bulgaria. It prefers lower altitudes (mainly up to about 400m), near water sources and wetlands with enough coverings for hiding place.

The present research took place in 2013 and 2014. The method used was camera trapping to assess the status of the species. Parameters of the population that were expected to be evaluated were occurrence and relative numbers. The study season, from May to July, coincides with both of the biological characteristics (the species and the intensity of human activities in the habitat suitable for the golden jackal). In each station a camera trap was active in the field for 30 days. Six study areas were selected in different parts of the country, with different density of the species according to the literature. Three were located in the continental, two in the Black Sea and one in the Alpine biogeographical region. In each study area, five fixed test areas were randomly selected and to each of these, six camera traps were placed. In order to achieve a uniform distribution of the camera trap stations within a fixed test area, a grid with a cell size of 2X2 km was used, generated by the algorithm of ETRS grids of the European Environment Agency. This distance was chosen according to the size of the smallest territory of a breeding female, according to the literature. In order to increase the attraction of the target species to the camera trap stations, lure was placed in front of each camera trap. The bait consisted of valerian tunic (*Valeriana officinalis* L. & Maillefer) mixed with fat (vegetable oil) in a ratio of 3:1, in order to reduce the volatility of the alcoholic extract and extend the effect.

The occurrence of the golden jackal was calculated as part of the test areas, from their overall number within a study area with an established species presence. Confidence intervals were calculated using the Clopper-Pearson Exact method, based on binomial distribution, using MS Excel software. The relative number is calculated as the mean value of the minimum number of recognizable individuals registered for 100 camera trap-days in camera traps in the study areas. We calculated as individuals all the individually recognized animals. We recognized specific face masks, different tail shape and thickness, nursing females, individuals marking with straight leg urination (males), other individual features like part of ear missing, etc. A very small percent of the recordings was not "individualized", even with our numerous population, and they were not included in the calculation of the relative number.

The results from this study are in accord to the previous literature on the distribution of the species and its density, in different regions of the country. Camera-trapping method could be useful to determine the relative abundance of golden jackals, most appropriately to be used in order to monitor small populations.

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Table W210P.1: Estimated occurrence rate of the golden jackals in Bulgaria.

Period (Year)	Unit	Sample size (N)	Value (x)	95% Confidence intervals ($CL_1 \div CL_2$)
2014	Frequency (%)	30	80	61÷92

Table W210P.2: Relative abundance of the golden jackals at national level.

Period (Year)	Unit	Sample size (N)	min÷ max	Mean ($\bar{X}$)	Standard error ($S_{\bar{X}}$)	Standard deviation (STD)	95% Confidence intervals ($\bar{X}$±CL)	% Relative precision (PRP)
2014	Minimal number of individuals/100 trap-days	30	0÷3.3	1.03	0.12	0.82	1.03±0.31	30

Picture W210P.1: Identification of different individuals, registered by 2 neighboring camera traps (in the particular case at 3 km distance): 1. Nursing female; 2. Non-nursing individual.

Picture W210P.2: Identification of different individuals, registered by a single camera trap: 1. Nursing female; 2. Male (raise-leg urination); 3. 2 pups.

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W211C5

Invasibility study on golden jackal suitable habitats from the Danube Delta using bioacoustic monitoring and camera trapping methods.

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Introduction

The invasibility is defined as the susceptibility of a community or ecosystem to the establishment or spread of one or more introduced species while species invasiveness is the ability of a species to reproduce, spread and establish in new location away from the places where it was introduced (Simberloff & Rejmánek, 2011). Both are concepts that deserve a holistic approach in the case of the golden jackal.

The golden jackal (*Canis aureus*) territorial howls can be used to monitor the population density and distribution of the species family groups in a specific area (Comazzi et al. 2016). The bioacoustic monitoring method has its limitations since negative stations area don't necessarily imply absence of jackals. Camera-trapping seems to give important information, particularly as it's monitoring reproduction, daily activity budget, habitat utilization and in the definition of the ecological niche of the species within the local community of carnivores (Pecorella & Lapini, 2014).

We aimed to understand the invasibility of specific natural areas in Danube Delta Biosphere Reserve (DDBR) and Brasov county using repetitive bioacoustic stimulation and camera trapping.

Methods

We performed 1-night bioacoustic monitoring surveys in Oct 2011, Oct 2012, May 2015, April 2017, August 2017 and August 2018 in different calling stations as they initially established during the 2010-2011 surveys (Banea et al. 2012). We analysed responses using the playback bioacoustic stimulation technique in 25 stations across Danube delta "ROSPA0031 Delta Dunării și Complexul Razim - Sinoie", region with known high density of jackals and during the last two years we included in the survey 10 stations from central Romania "ROSPA0099 Podișul Hârtibaciului" (Figure W211C5.1) where 5 jackals were harvested for first time in 2016. Camera-trapping was conducted during one single night as follows: 2010 in Caraorman, 2012 in Lupilor, 2015 in Sahalin-Zatoane or continuously from 29th April to 3rd of August 2017 in Sahalin-Zatoane strictly protected natural reserve.

Results

A- Bioacoustic monitoring. The number of recorded territorial groups in Lupilor natural reserve decreased from 5 in 2011 to 1 in 2017, in Caraorman from 11 in 2012 to 5 in 2015, 3 in 2017 spring, 5

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autumn and 1 in 2018, while in Letea the number of territorial groups decreased from 6 in 2017 to 1 in 2018 (Table W211C5.1). As in previous studies we observed that bioacoustic stimulation was negative in one calling station from Sinoe village (AAA4) where we were able to take a picture of a running jackal in the morning just after the bioacoustic stimulation. Another limitation is the timing of survey. In one calling station (223) near the Letea village we obtained responses from 1 territorial group at 23:30H and after 4 hours at 03:30H when we finished the survey we obtained responses from 4 different territorial groups. In central Romania all stations showed negative results.

B- Camera trapping. Jackal presence was recorded with single spontaneous photo-trap in Caraorman forest in 2010 and 2012, with single video event in Lupilor nature reserve in 2012 and with two events in Sahalin-Zatoane in 2015. In 2017, during the continuous 3 months invasibility video assessment performed in Sahalin-Zatoane area, from 1200 video events more than 500 were false while other 560 recorded cattle and horses (an estimated number of 35 cattle and 40 horses). 240 events showed wild boar, badger, roe-deer, pheasant and one pair of golden jackals were recorded in 3 events (Video W211C5.1).

Conclusions

We observed that jackal territorial group numbers decreased in specific natural areas from the Danube Delta during the last 8 years. The bioacoustic stimulation method showed limitations when the results are negative. Timing, season and weather seem to affect jackal responsivity to bioacoustic stimulation. The invasibility of Danube delta specific habitats by jackal species was not proved. Combined bioacoustic stimulation and camera trapping is an effective method to assess jackal invasiveness and habitat invasibility.

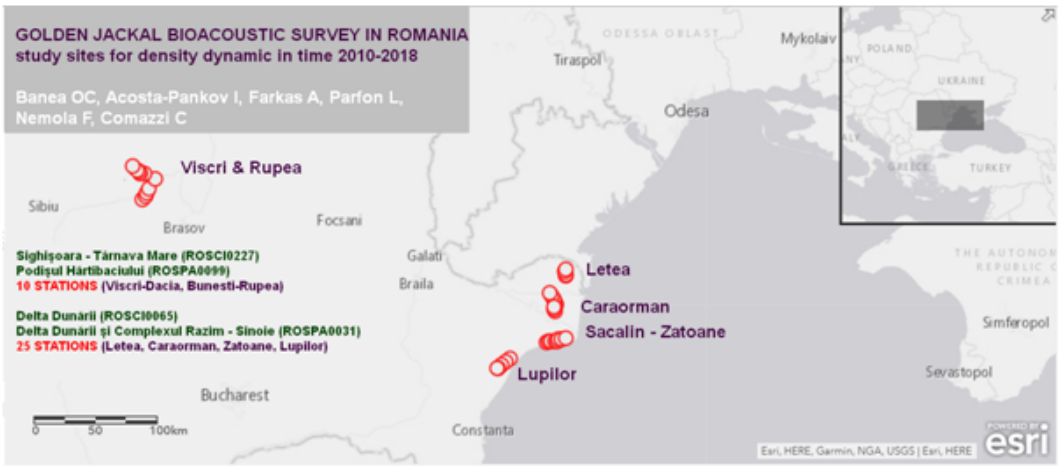

Figure W211C5.1: Study sites and calling stations from Romania used to assess the local dynamic of the golden jackal territorial groups.

Table W211C5.1: Preliminary results of golden jackal territorial group number evolution recorded with bioacoustic method in 25 calling stations across Danube Delta (2011-2018).

Year / Location	2011	2012	2015	2017	2018
Letea				6 TG	1 TG
Caraorman Ch		11 TG	5 TG	3 TG	1 TG
Sacalin-Zatoane				1 TG	
Lupitor	5 TG			1 TG	

Video W211C5.1: https://youtu.be/zL24r7PVJdU

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W212C5 W212P

Monitoring of a *Canis aureus* population living in the airport area of Samos Island, Greece

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The golden jackal (*Canis aureus*) population that lives within the area of Samos International Airport and the surrounding area has been characterized during the past years as a potential risk for passenger and flight safety. For this reason, its exclusion from the airport installations and runorth-westays has become a priority adopting practices that do not affect the welfare of this population. The gradual exclusion process began in May 2017 and is ongoing involving monitoring of the airport population, using camera traps. Camera traps were deployed in locations known to be frequented by jackals. These locations were identified by the presence of tracks, scats, fur hairs and holes in the airport fencing that were used to gain access to habitat inside the airport. The first stages of the exclusion process were initiated in March 2018, when the holes in the airport fencing and other entrance points were identified. All entrance points were closed apart from one where a controlled gate was placed that can be closed as required. An attempt to herd the jackals out of the airport took place. The dense vegetation consisting of reeds, thorns and long grass concealed the jackals in inaccessible, for the herding team, areas. Population monitoring is ongoing with camera trapping and bioacoustics while the exclusion process will take place over the following months in parallel to the vegetation removal works. The post-exclusion behaviour and distribution of this population will be studied further in detail following the fitting of Global Positioning System collars to some individuals. The GPS collars will provide the precise locations of individuals. This dataset provides an insight into the jackals' spatial and temporal use of the habitat and help to show an activity budget from which a number of analyses will be conducted.

Figure W212C5.1: Location of the Samos International Airport, Samos Island –Greece.

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W213C10

Golden jackal population dynamics in certain study areas of Hungary – examples for hectic population change and invasion.

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The golden jackal is currently the most successful carnivore species of the continent with a continuously expanding population and distributional area. In our research, we monitored the changes of the number of breeding families in four study areas in Hungary with the aid of bio-acoustic survey. In Kétújfalu (examinations were carried out between 2004 and 2015), Hajósszentgyörgy (2004-2010) and Császártöltés (2004-2014) the survey was started when the population of the golden jackal had already been considerably stable. Near Lake Velence (2007-2015), however, investigations started at the time of the first appearances of the species. In the abovementioned three areas with stable populations, further expansion of the golden jackal population was not proven. The number of jackal families in these areas changed hectically during the survey period, or even showed systematic decrease. In contrast, in the case of the examinations we started at the time of the first appearances near Lake Velence both the proportion of the positive points and the number of responding families were continuously increasing. This population growth of this region is also supported by the detailed hunting bag data of Fejér County. This increase is persistent in both the number of wildlife management units concerned and the number of estimated and hunted animals, while in the case of the hunting bag this trend shows an exponential growth. Our results suggest that golden jackals indeed are capable of rapidly colonising and populating new habitats, almost similarly to an invasive spreading. This process becomes stabilised within a relatively short period of time, which eventually leads to stable populations despite sometimes significant year to year fluctuations.

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W214P

Results from the first systematic field survey of golden jackal in Lake Kerkini National Park, Northern Greece.

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During 2010 to 2013, monthly acoustic surveys to evaluate the population of golden jackal were carried out at 15 call stations around Kerkini Lake and along the Strymon River in Lake Kerkini National Park, Northern Greece. During dusk and early night hours, a megaphone was used to broadcast a 1-minute recording of golden jackal howling, and we counted the responding animals within the first 10 minutes. We did not differentiate between single animals or groups. Best results were achieved during autumn months, in winter and in early spring. Golden jackals were recorded at ten of 15 call stations during the 4 years of monitoring, and in total, 145 responses from animals or groups were registered. The call stations with the highest response were in the northern shore area of the lake, near the incoming Strymon River and near the north-eastern dyke, areas with very diverse biotope structure with small forest patches, poplar plantations, open fields and grazing land, hedges and ditches with reed beds. The calling station with the most frequent responses (36) was near the river exit of the lake in an area with diversified biotope structure. At the southern forested slopes of Krousia Mountain and on the western dyke area, almost no jackals were noticed. In 2010, a minimum of 3 to maximum 14 animals responded, while in 2013 at least 12 to a maximum of 46 animals answered to the playback, showing a clear increase of responding animals over the 4 years. An exceptionally high number of 40 animals (at 7 different stations) were recorded in April 2011. The population increase might be connected with the increase of grazing buffalo herds in the same period, giving better food resources for jackals with a higher number of carcasses.

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Chapter 3: Feeding ecology and Physiology

W31K30

Prey preferences of the jackals – critical resources to explain their range expansion.

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Prey selection by carnivores can be affected by top-down and bottom-up factors. For example, large carnivores may facilitate food resources for mesocarnivores by providing carcasses to scavenge, however mesocarnivores may hunt large prey themselves, and their diets might be affected by prey size and behaviour. We reviewed jackal dietary studies to determine how the presence of large carnivores and various bottom-up factors affected jackal prey selection. We found 20 studies of black-backed jackals (*Canis mesomelas*) from 43 different times or places, and 13 studies of Eurasian golden jackals (*Canis aureus*) from 23 different times or places reporting on 3900 and 2440 dietary records (i.e. scats or stomach contents), respectively. Black-backed jackals significantly preferred small (<30 kg) ungulate species that hide their young (duiker *Sylvicapra grimmia*, bushbuck *Tragelaphus scriptus* and springbok *Antidorcas marsupialis*), and avoided large (>120 kg) hider species and follower species of any body size. They had a preferred and accessible prey weight range of 14–26 kg, and a predator to ideal prey mass ratio of 1:3.1. Eurasian golden jackal significantly prefers to prey on brown hare (*Lepus europaeus*; 4 kg), yielding a predator to preferred prey mass ratio of 1:0.6, and a preferred and accessible prey weight range of 0–4 kg and 0–15 kg, respectively. Prey preferences of jackals differed significantly in the presence of apex predators, but it was not entirely due to carrion availability of larger prey species. Our results show that jackal diets are affected by both top-down and bottom-up factors, because apex predator presence, as well as prey size and birthing behaviour, affected prey preferences of jackals. A better understanding of the factors affecting jackal prey preferences, as presented here, could lead to

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greater acceptance of mesocarnivores and reduced human-wildlife conflict. These results may also explain the rapid range expansion of golden jackals throughout continental Europe as the presence of hares appears to be a fundamental resource requirement.

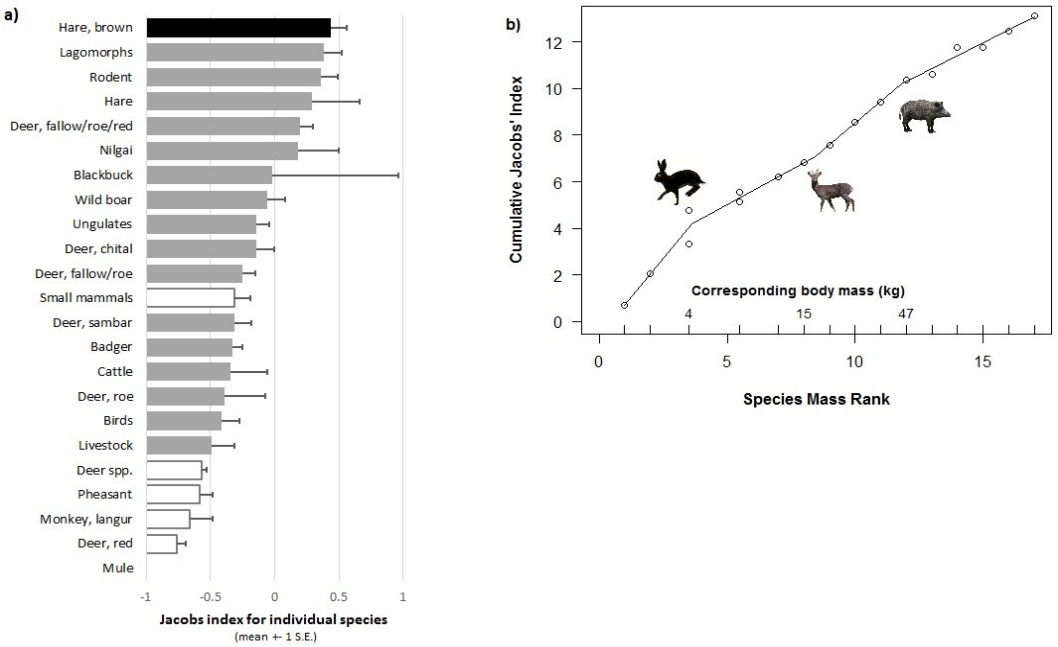

Figure W31K30.1: Prey preferences of the golden jackal (a) showing brown hares are the preferred prey species; and (b) a segmented model plot for the preferred weight range of golden jackal showing peak preference below 4kg and prey being accessible below 15kg (Hayward et al. 2017 *Mammalian Biology* 85, 70-82).

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W32K30

Feeding ecology of the golden jackal: knowledge and limitations.

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The golden jackal (*Canis aureus*) inhabits a wide variety of habitats in different climatic areas of Eurasia, where the abundance of food greatly varies. Little is known about the resources limiting or supporting the rapidly expanding jackal population in Europe. In order to understand which factors affect the feeding habits of the jackal, we analysed biogeographical variation in the diet and trophic niche breadth, based on literature data from Eurasia.

We reviewed 41 published studies and unpublished data sets described diet of golden jackals in Europe (7 countries) and Asia (10 countries). We considered 13 food categories, two types of analysed material (stomach and scat content), two methods of diet composition calculation (relative frequency of occurrence i.e., RFO, and frequency of occurrence i.e., FO), annual and seasonal data (cold and warm periods), geographical location, and different environmental (or regional) characteristics.

In preliminary analyses, we recorded 259 different food species (or taxa): 81 mammals, 31 birds, 8 reptiles, 3 amphibians, 5 fish, 50 invertebrates and 81 plants, including 7 species of conservation concern (IUCN Red List). The main foods of jackals were plants (mainly fruits, RFO: 22.8%, FO: 35.1%), small mammals (mainly rodents, RFO: 21.0%, FO: 41.8%) and domestic animals (RFO: 20.0%, FO: 31.5%). Proportion of wild ungulates (mainly from viscera eating and scavenging), domestic animals (mainly from scavenging), small mammals and invertebrates were significantly different in relation to type of analysed material (stomach and scat; Figure W32K30.1). The diet composition of jackal varied with season and geographic location. Jackals consumed invertebrates and plants more frequently in warm than in cold periods. The small mammal consumption increased, while consumption of birds and invertebrates decreased along a latitudinal gradient from southern to northern Eurasia. The consumption of small mammals increased, while invertebrate consumption decreased along a longitude gradient from western to eastern Eurasia. These relationships were generally non-linear (Figure W32K30.2). The proportion of domestic animals did not vary with either latitude or longitude. Consumption of small mammals negatively correlated with plants and inorganic materials, while we found positive correlation between consumption of lagomorphs and wild ungulates, birds and reptiles, bird eggs and amphibians, amphibians and fish, amphibians and invertebrates. The golden jackal trophic niche breadth increased from South to North across the species range (Figure W32K30.3) and was also higher in warm than cold seasons. Trophic niche breadth positively correlated with consumption of birds, fish and invertebrates.

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Our analysis showed, that each food type has a wide range of consumption values. For instance, mall mammals, wild ungulates, domestic animals, invertebrates and plants range from 0 to 50-90%. This pattern highlights the opportunistic and plastic nature of golden jackal. This dietary flexibility illustrates why jackals have been able to expand their distribution so rapidly and successfully. However, this pattern makes predictions of diet in newly colonized areas difficult and prone to errors. A more mechanistic approach is required to investigate how local resource availability and trophic interactions influence resource selection in golden jackals.

In most European countries, the jackal is considered a pest for game management and grazing livestock, however there is a gap between experiences from practice and dietary studies. The reason for this is that the real predation impact (and its causes) are largely unknown. To better understand the ecological role of the jackal, and to reduce the human-predator conflicts, further studies are needed, especially in newly colonised areas.

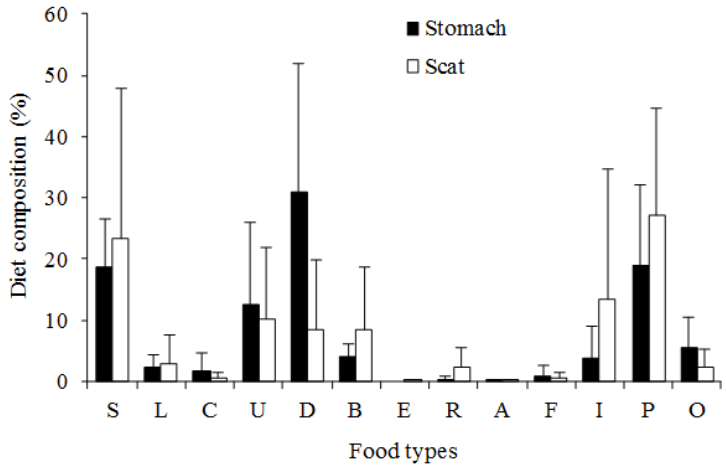

Figure W32K30.1: Diet composition (RFO, mean ± SD) of the golden jackal (Canis aureus) from the reviewed studies across Eurasia. Sample types: stomach content (n = 18 study sites) and scat (n = 17 study sites). Food types: S – small mammals, L – lagomorphs (medium sized mammals), C – carnivores, U – ungulates (wild), D – domestic animals, B – birds, E – eggs (bird), R – reptiles, A – amphibians, F – fish, I – invertebrates, P – plants and O – others (inorganic materials).

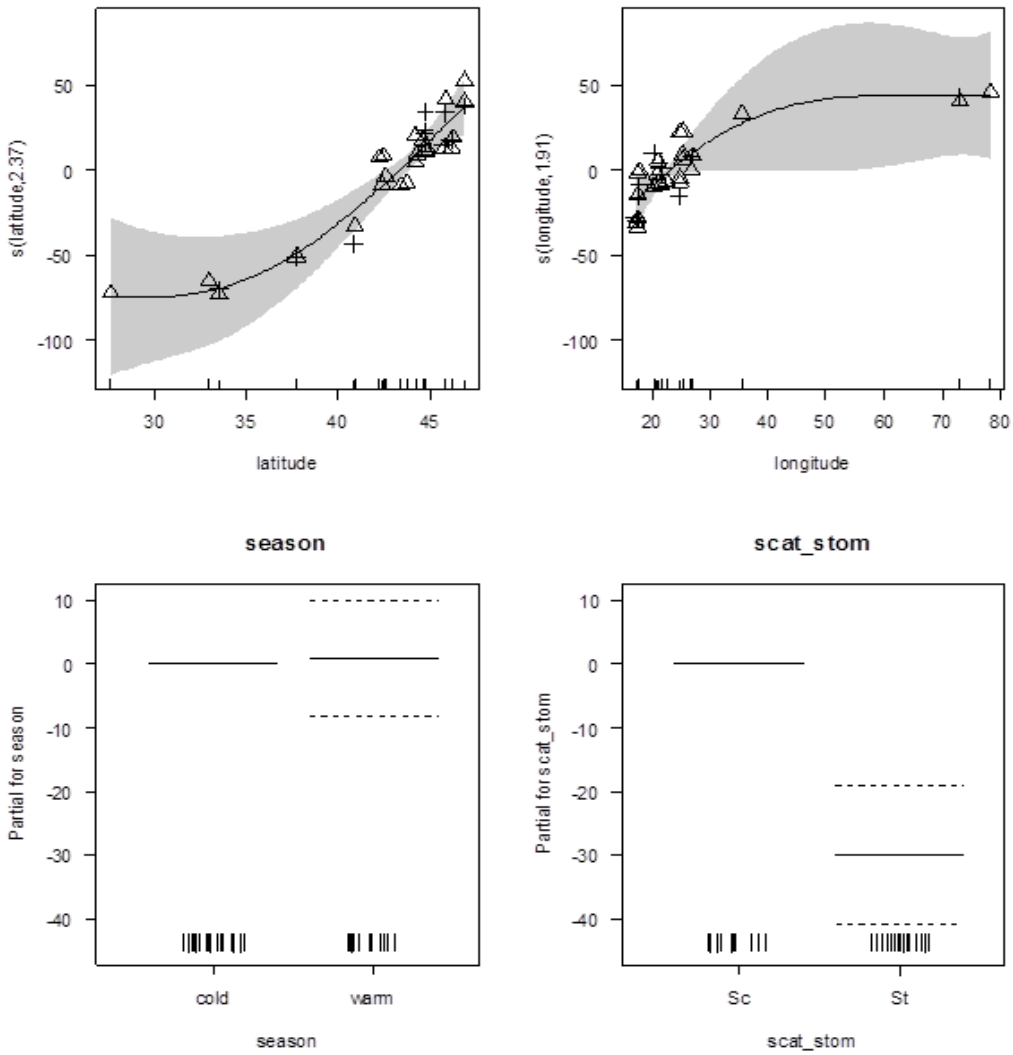

Figure W32K30.2: An example: partial effects of variables in the generalized additive mixed model (GAMM) explaining the small mammal consumption of the golden jackal (Canis aureus) from the reviewed studies across Eurasia. The above panels show the effect of latitude and longitude. Solid lines represent the estimated smooth function and shading denotes 95% confidence intervals around the smooth function. The number in the y-axis caption is the effective degree of freedom for smooth term. The rug plots along the x-axis show the values of the covariates. The below panels show the estimated effect for two seasons and two sample types (stomach and scat). Seasons: + - warm, Δ - cold. (Latitude: $P < 0.001$, longitude: $P < 0.05$, season: NS, sample type: $P < 0.001$; Radj2 = 0.67).

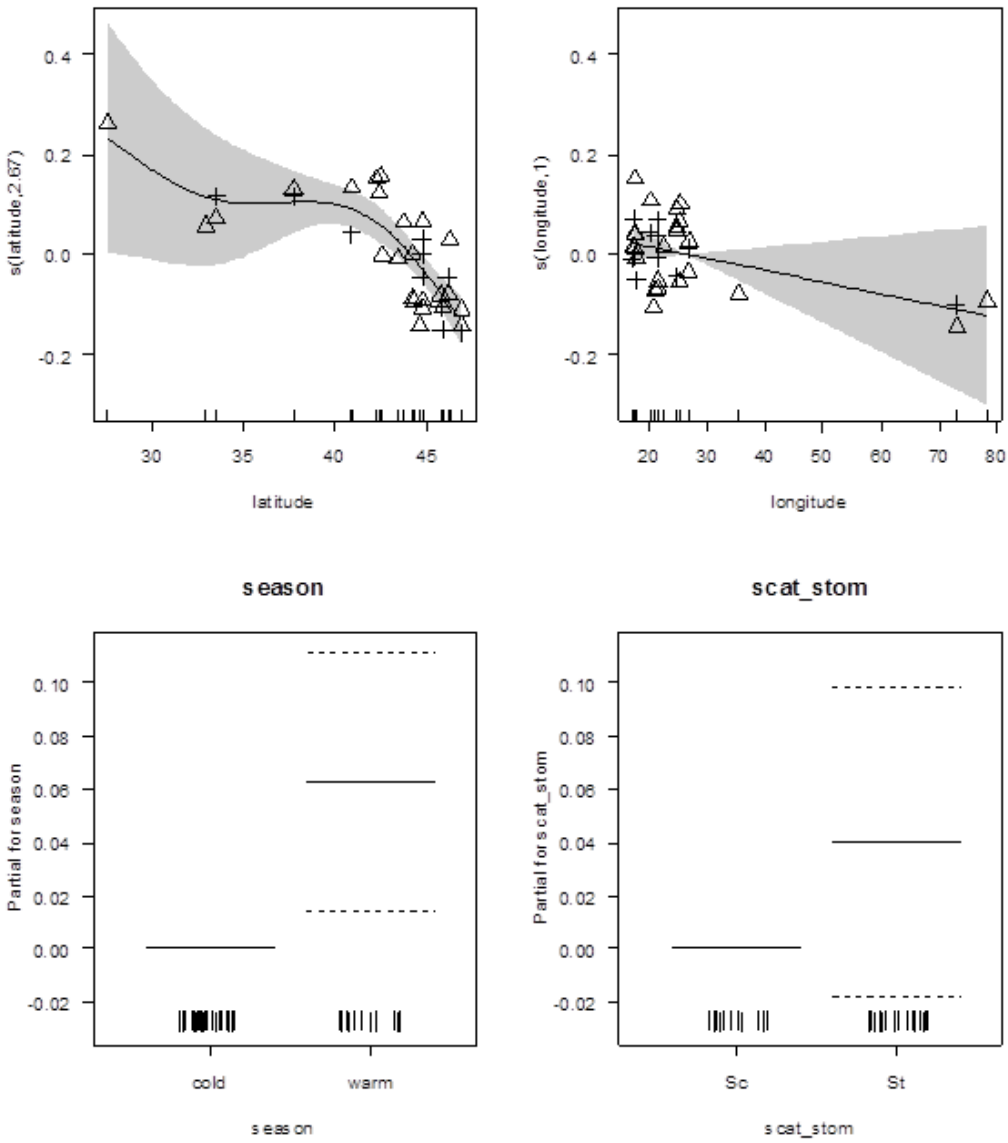

Figure W32K30.3: Relationship between standardized trophic niche breadth and different variables in golden jackal (*Canis aureus*) from the reviewed studies across Eurasia. Seasons: + - warm, Δ - cold. (Latitude: $P < 0.001$, longitude: NS, season: $P < 0.05$, sample type: NS; Radj2 = 0.52). For other details, see Figure W32K30.2.

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W32P

Feeding ecology of the golden jackal: knowledge and limitations.

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Little is known of the resources that limit or promote the rapidly expanding golden jackal (*Canis aureus*) population in Europe. We hypothesised that in an area of intensive big game hunting, a reduction of the main food resource (human subsidised big game viscera) would result in dietary switching.

We used multivariate analyses to test whether the dietary composition of 200 jackal stomachs varied between two 2-yearly survey occasions, the first without big game viscera removal (availability of 68 kg viscera/year/km^2) followed by a period with viscera removal (minimum of 50 kg of viscera/year/km^2 removed).

The proportion of empty stomachs and the stomach wet content weight did not differ between the two periods. Even after the reduction of food subsidies, the primary food of jackals was viscera and carrion from wild ungulates (frequency of occurrence: 45% vs. 30%; wet weight: 55% vs. 29%, respectively), and scavenging was not affected by season or sex. Log-linear analysis of frequency data revealed no significant differences between survey occasions in consumption of either food type. MANCOVA of wet weight data revealed that in the first period with food subsidies jackals consumed a higher proportion of adult wild boar (11.6% vs. 1.3%; from predation or scavenging), while juvenile wild boar (0 vs. 11.8%; from predation or scavenging), domestic animals (0.8% vs. 6.2%; mostly from scavenging) and invertebrates (2.6% vs. 4.1%) increased in the second period. The stomachs in the second survey occasion contained more varied food items, but the trophic niche was not significantly wider.

The feeding responses of this mesopredator to the reduction of food subsidies were less pronounced than expected. Because in high big game density areas, wild ungulate carrion from different mortality causes are available in high quantities throughout the year, predator populations can be maintained despite the high amount of viscera removal.

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W33P

Preliminary assessment of feeding ecology of a golden jackal population in south-eastern Samos Island, Greece, through post mortem examination and scat analysis.

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Diet composition of the only population of *Canis aureus* living on a Greek island was investigated based on post mortem analysis of digestive system contents. The study is carried out in SE Samos, an agricultural area consisting of valleys, small-scale cultivated fields (olive orchards, vineyards, etc.), herbaceous and low-lying shrub undergrowth. The contents of 41 stomachs of Golden jackals found dead between 2010 and 2018 were analysed together with 30 scat samples collected between 2017 and 2018. Post mortem analyses focused on a determined area where animals are often victims of car accidents. The samples collected during the necropsy demonstrate that the diet of *Canis aureus* is highly diverse. Diet composition shows seasonal variations associated with the availability of different prey and food sources. During the summer season, when most of the road killings occurred, the diet was mostly composed by fruits (i.e. figs, carobs, grapes, berry, olives, etc.) while in the winter season the composition showed presence of bones belonging to small mammals (rodents, birds, etc.). The scat analysis showed similar results and allowed the coverage of a more extended sampling area even if due to the weather conditions of the winter season it was more difficult to find valuable samples to be analysed. The preliminary results showed that the studied population is composed of opportunistic omnivores. The samples collected have shown the preference for natural food sources instead of anthropogenic food subsidies, even when the population is living in a synanthropic environment. Further analyses including higher sampling numbers and systematic surveys are underway to assess the feeding ecology of the overall population living on the island and make comparisons based on seasonal and geographical variations.

Picture W33P.1: *C. aureus* scat sample.

Picture W33P.2: *C. aureus* necropsy.

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W34C10

Feeding habits of the golden jackal based on stomach analyses: Do they really cause damage to wildlife management and animal husbandry?

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According to the hunters, the golden jackal population largely affected the game reserve species like roe deer (*Capreolus capreolus*) and fallow deer (*Dama dama*) populations. Besides this assumption, several stakeholders, including gamekeepers and sport hunters as well as the cattle, sheep and poultry farmers also support this statement. The results of scat analysis were not accepted by the stakeholders. The aim of this study was to analyse the feeding ecology of golden jackals (*Canis aureus*) in Hungary, based on stomach analyses, using samples collected by hunters at the beginning of the re-colonization (1997 - 2017; n=40). To analyse the feeding preferences of the golden jackals, it was necessary to conduct a more precise study on the diet analysis of this species which would be acceptable by the stakeholders. As, based on the hunter's opinion, the golden jackal has got serious influence on the ungulate species population. However, the official country wide hunting bag and the estimated spring population data does not significantly support this fact, as per the following data: fallow deer hunting bag 1997: 4.389, 2016: 14.346; roe deer: 34.481(1997); 113.658 (2016). Nevertheless, the hunting bag data does not clarify that the jackal cannot or might not have caused any measurable damage on the local hunting ground; hence stomach analysis is the only appropriate method that can be used to establish the real scenario.

Besides, the majority of the feeding habits studied are based on faeces analyses. Although the two methods (stomach vs. faeces analyses) have got several well-known advantages and disadvantages, the stakeholders (like hunters, farmers) seems to prefer the stomach analysis method over the scat analysis and accept the results.

The methodology used was based on wet techniques where the samples were collected and preserved in freezer; they were further defrosted at room temperature and weighed. The stomach contents are classified into different categories namely, plant parts, seeds, fruits insects, organs/meat, feathers, hair, bones/nails, and unknown parts. The contents were then allowed to dry at room temperature, weighed and further preserved in plastic bags in the freezer.

We have a variety of interesting data obtained from the dissected stomachs, some of them include the skin from the head/skull of a mammal species, probably a herbivore, however we also predict that it is nearly impossible for a Jackal to skin a mammal's head, thus we believe that it might have found the remains somewhere, hence, we conclude the scavenger behaviour of the species from this observation. We also found large amounts of the coleopteran *Polyphylla fullo* remains from one of the stomachs, which constitute the majority of the contents found. Several remains of wild plum fruits and seeds are often found from the dissected stomachs. We also found remains of small rodents; sometimes wholly swallowed rodents like mole (*Talpa europea*) and voles (*Microtus arvalis*); which establishes the predatory behaviour of the golden jackals.

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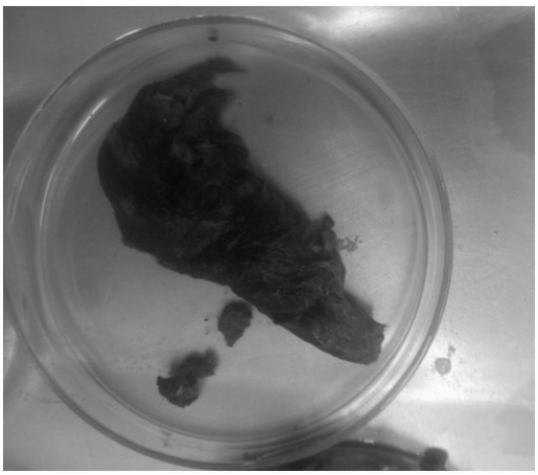
We expect this research work to provide and unveil the real scenario of the feeding preference and ecology of the golden jackals in Hungary.

Table W34C10.1: Dry weight stomach contents of 17 dissected stomach samples.

Stomach sample number	Weight of the stomach contents (dry weight in grams)	Categories in grams (dry weight)									Remarks
		Plant materials	Seeds	Fruits	Hair	Insects	Organs/meat	Feathers	Unknown	Bones and Nails	
1. 2519	30.8	2.5	10	0.4	0.2	0.5	4.7	1.9	5.0	0.0	
2. 2527	41.5	0.3	0.0	0.0	31.7	0.3	5.8	0.1	0.0	0.5	
3. 2512	109.0	0.5	0.0	0.0	15.2	0.0	78.0	1.9	0.0	3.7	
4. 2534	150.8	1.8	0.0	0.0	70.3	0.0	71.7	0.0	0.0	0.0	Tail parts of some rodents are found
5. 2557		19.4	0.0	0.0	8.4	0.3	0.0	0.0	5.0	0.0	Plastic material of 0.3 gm is found
6. 2566	20.0	0.3	0.0	0.0	3.6	0.0	9.0	0.1	0.0	0.0	
7. 2529	136.8	1.0	0.9	0.0	0.6	0.0	129.8	0.8	2.3	0.0	
8. 2545	3.6	0.1	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	
9. 2524	70.8	0.2	0.0	0.0	0.0	0.0	67.3	26.2	0.0	0.0	
10. 2528	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Empty stomach
11. 2550	74.3	0.7	0.0	42.8	14.8	0.1	6.3	0.0	0.0	6.7	
12. 2565	131.0	1.3	0.0	0.0	0.0	128.3	0.6	0.0	0.0	0.0	A large amount of *Polyphylla fullo* remains are found
13. 2645	16.9	0.0	13.1	2.7	0.0	0.0	0.0	0.0	0.0	0.0	
14. 2623	184.0	0.1	0.0	0.0	57.7	0.0	120.8	0.0	0.0	4.6	Teeth remains are found
15. 2633	34.8	0.1	0.0	0.0	0.0	3.0	29.6	0.0	0.0	1.4	
16. 2542	450.7	0.3	0.0	0.0	0.1	0.0	441.2	0.0	0.0	0.1	Large chunks of meat are found
17. 2647	17.6	2.8	0.0	0.0	0.0	0.0	8.2	0.0	6.3	4.8	



Picture W34C10.1: Wholly swallowed small rodent.

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W35P

Competition between sympatric wolves: an example involving African and Ethiopian wolves.

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Carnivore populations are declining globally due to range contraction, persecution and prey depletion. One consequence of these patterns is increased range and niche overlap with other carnivores, and thus an elevated potential for competitive exclusion. Here we document competition between an endangered canid, the Ethiopian wolves (*Canis simensis*: hereafter EW) and the newly discovered African wolves (*Canis lupaster*: hereafter AW) which was until recently incorrectly regarded as a golden jackal, in central Ethiopia. Seven AWs from four packs were captured using rubber-padded leg-hold traps and fitted with very high frequency collars (VHF). We recorded the nature of the interaction (neutral, aggression and aggression with bite), the number of individuals of each species present, and the duration and location of the interaction (core area or buffer zone). We collected 175 scats during the wet season (June–November) of 2015 and 175 scats during the dry season (December–May) of 2016. The scats were dried and broken into pieces, and prey remains were identified via comparison with reference samples. The diet of the ecological specialist EW was dominated by rodents (e.g. *Arvicanthis abyssinicus* , *Lophuromys flavopunctatus*) whereas the AW consumed a more diverse diet also including insects (mostly grass hopper) and non-rodent mammals (Sheep, livestock carcasses, insects). EWs used predominantly natural habitat whereas AWs used mostly areas disturbed by humans and their livestock. We observed encounters between the two species, of which 94% were agonistic. The outcomes of agonistic encounters followed a territory-specific dominance pattern, with EWs dominating in intact habitat and AWs in human-disturbed areas. For AWs, the likelihood of winning encounters also increased with group size. Rodent species consumed by EWs were also available in the human-disturbed areas, suggesting that these areas could be suitable habitats for EWs if AWs were not present. Increasing human encroachment not only affects the prey base of EWs, but also may impact their survival by intensifying competition with sympatric AWs.

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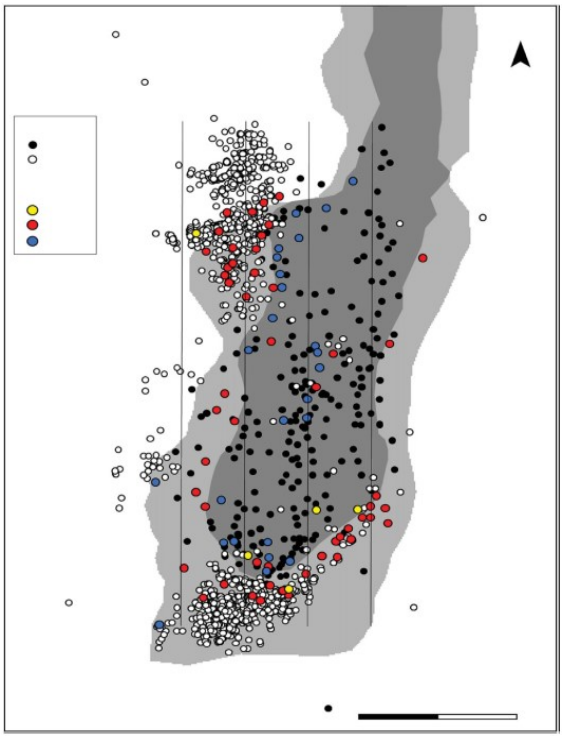

Figure W35P.1: The study area in the southern section of the Guassa Community Conservation Area, including transects (vertical lines) and sighting locations of AWs and EWs. The locations and outcomes of AW–EW encounters are also depicted. The dark grey area indicates the core area, the light grey area indicates the buffer zone and the white area indicates the matrix.

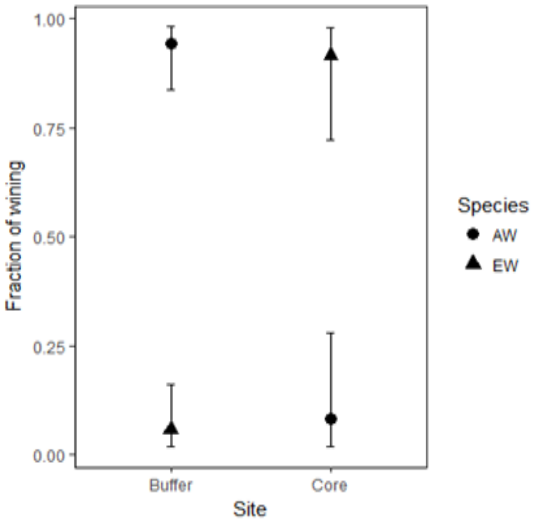

Figure W35P.2: Fraction of winning in the antagonistic interaction of African wolf and Ethiopian wolf in relation to sites (buffer vs. core), analysed separately for each species using binomial logistic regression.

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W36P

Hair cortisol level in the golden jackal (*Canis aureus moreoticus* I. Geoffroy Saint Hilaire, 1835) in relation to different factors.

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Introduction

Hair glucocorticoid metabolite quantification is a non-invasive tool that provides important information about endocrine status of the animal and is a valuable method for studying potential stressors that may affect some species under natural conditions. Hair cortisol analysis is a method for studying systemic cortisol exposure over longer periods of time. We have measured the cortisol level accumulated in hair of golden jackal (Canis aureus) to assess how sample conservation methods, sex and ecological factors could lead to stressful events and, consequently, to an increase in hair cortisol accumulation.

Material and methods

We have tested the hair cortisol concentration on 16 specimens of golden jackal: 5 from frozen animals, 10 from stuffed animals and 1 taken from injured animal during recovery in an Animal Care Center. The samples came from Italy (Friuli Venezia Giulia and Veneto Region) and Croatia (Istria and Dalmatian region). We have studied the hair cortisol concentration by RIA method in respect to conservation method, sex and origin areas (dispersal and core areas), with non-parametric and parametric tests and mixed model.

Results

The hair cortisol concentration (values expressed in pg/mg) from the frozen animals (mean=3.38, median =2,44, SD=3.13, n=5) was not significantly higher than the stuffed samples (mean=2.81, median =1,95, SD=2.72, n=9), also the sex has not showed any statistical effect (males, mean=1.96, median=1,79, SD=0.63, n=9; females, mean=4.56, median=3,01, SD=3.99, n=6) but with higher level for females. The hair cortisol concentration in respect to the sites of origin of samples, dispersal and core areas was not statistically different (dispersal areas: mean=1.57, median=1,19, SD=0.77, n=5; core areas: mean=3,72, median =2,38, SD=3.14, n=10) but with higher level for the samples from core areas. The use of mixed model to detect the effect of areas (core and dispersal areas) and interaction between sex and areas has showed the presence of significantly higher hair concentrations of cortisol for the females (mean=6.27, median 6,28, SD=3.84, n=4) in the core areas in respect to the males (mean=2.02, median=1,95, SD=0.52, n=6). The concentration of hair cortisol of sick and injured animal recovered in the Animal Care Center was higher (> 12 pg/mg) in respect to the other samples (mean=3.00, median=2.11, SD=2,77, n=15).

Conclusion

Cortisol analysis from hair samples seems to be a promising technique to understanding the interrelationship of health and physiology, mobility and social behaviour of jackal, anyway further analysis should be performed on large samples of hair and with robust schemes.

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W37C10

Comparing widely used methods for assessing body condition in golden jackals.

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Body condition of an animal can be quantified by many different approaches such as morphometrics or physiological metrics. The outputs of these analyses can not only give information about the physiological status of an individual but it can also offer potential insights into its habitat and its quality or suitability. In this study we compared some of the methods widely used to assess body condition in mammals with "Body Condition Score" (BCS) that we have specifically developed in 42 legally shot golden jackals (*Canis aureus* L., 1758) from Bosnia and Herzegovina. BCS was calculated as the sum of visual valuations of fat depots on the back, sternum and heart, each having a possible value from 0 to 3. Kidney Fat Index (KFI) was calculated as the proportion of fat dissected from each kidney in the weight of the fatless kidney. Bone Marrow Fat was extracted with Soxhlet-Method and calculated as the proportion of extracted fat in the weight of dry marrow sample. Our 4 hypotheses were: (1) BMF content is better in assessing body condition than the KFI; (2) the visual valuations of fat depots correlate positively with both KFI and marrow fat content, (3) visual valuations of visceral fat depots correlate positively with BCS; (4) weights of inner organs are of no importance for assessing body condition. Our statistical results showed a significant positive correlation between KFI and BCS ($F=29.56$, $p<0.001$ for left and $F=30.82$, $p<0.001$ for right kidney), but no correlation between BCS and bone marrow fat. All fat depots showed significant positive correlation with KFI. Both visceral fat depots (retroperitoneal and mesenteric & omental fat) correlated strongly positively with BCS. Except for kidneys and liver, the other organs studied (heart, lungs, spleen) showed no significant correlation with BCS. We conclude that body condition can be potentially assessed by evaluating single fat depots. This could be very useful in cases where the full necropsy is not possible, the carcass was damaged (bad shot placement, road kills, scavengers) or in remote areas where only the basic equipment is available.

Table W37C10.1: Results from Spearman rank correlation with BCS and visceral fat depots. Both depots valuated with values ranging from 0 to 3 in 0.5 steps.

Variable	Spearman rho	p-value
Retroperitoneal fat (valuation)	0.846	<0.001
Mesenterium & Omentum fat (valuation)	0.707	<0.001

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Figure W37C10.1: Valuation of the back fat depot by analysing the fat coverage and layer thickness. Noticeable bad shot placement in this case resulting with massive damage on both kidneys.

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W38C10

Diet composition of golden jackal in an urban landscape of Kolkata, India.

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Introduction

Golden jackals around the world are known for their opportunistic feeding habits. The present study conducted on an old resident jackal population of long-time residents within the 108-acre confines of a social club in southern Kolkata, aims at finding out their diet composition and comparing it with previously existing data on the species' diet in the wild. The findings would help confirm the theory attributing their survival and adaptation in an urban environment without any human-wildlife conflict to their feeding habits.

Materials and Methodology

The present study was conducted on a population of 45 golden jackals long confined to the premises of the Tollygunge Club (Figure W38C10.1), very close to human proximity in the southern fringes of the Kolkata Metropolitan area (N22º29'42'' and E88º20'42''). Some of the Club areas in the city are rich in biodiversity and harbour a number of small mammals, including a healthy population of golden jackal.

Figure W38C10.1: Tollygunge Club area (Source: Google Earth).

Empirical studies show a preponderance of "prey-remains in faeces" analysis to assess carnivore diets, golden jackals' in particular. The scats were collected in plastic bags and labelled with the date, time and location of collection (areas frequented by jackals or only after direct observation of

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defaecation). The scats were sun dried and stored to prevent further fungal growth, soaked in water for approximately 30 minutes, placed in a fine sieve (mesh size: 0.5mm) and washed in tap water. The remains were dried on absorbent paper, separated to prepare slides, cleaned again in an alcohol-ether mixture (1:1), and dried. Observations were made under microscope. Hair, bones and plant materials were identified by comparing them with reference slides.

Results

The identified food items were classified into vegetative matters (fruits, seeds, grass and plant debris), vertebrates (rodents, frogs), invertebrates (arthropods, molluscs), garbage (plastic, foil paper, paper, metal remains of canned food, etc.). The details are depicted in the table and pie chart below (Table W38C10.1, Figure W38C10.2). SD and CV of different types of food Items is shown in Table W38C10.2.

Table W38C10.1: Percentage frequency (N%) Relative percentage occurrence (R%) and Percentage of Biomass consumed (B%) of different food items by golden jackal in the Tollygunge Club, Kolkata.

Prey items	Winter (N=101)			Summer (N=112)			Monsoon (N=91)			Autumn (N=105)		
	N%	R%	B%	N%	R%	B%	N%	R%	B%	N%	R%	B%
Vegetation	56.25	36.99	41.43	51.33	31.42	38.62	59.42	39.11	41.01	61.75	41.3	46.21
Arthropods	36.45	23.97	18.45	38.84	26.36	24.45	34.42	29.43	27.1	35.23	22.12	20.13
Frogs	14.58	9.59	9.43	13.23	10.55	7.24	16.53	8.24	10.11	14.28	8.92	7.83
Molluscs	9.38	6.36	7.13	8.51	7.42	7.73	9.11	6.79	6.2	7.42	5.94	7.75
Rodents	13.5	18.68	12.33	16.77	16.68	14.62	10.14	10.24	9.11	13.91	14.45	11.86
Garbage	6.25	4.41	11.23	5.22	7.57	7.34	4.11	6.19	6.47	4.39	7.27	6.22

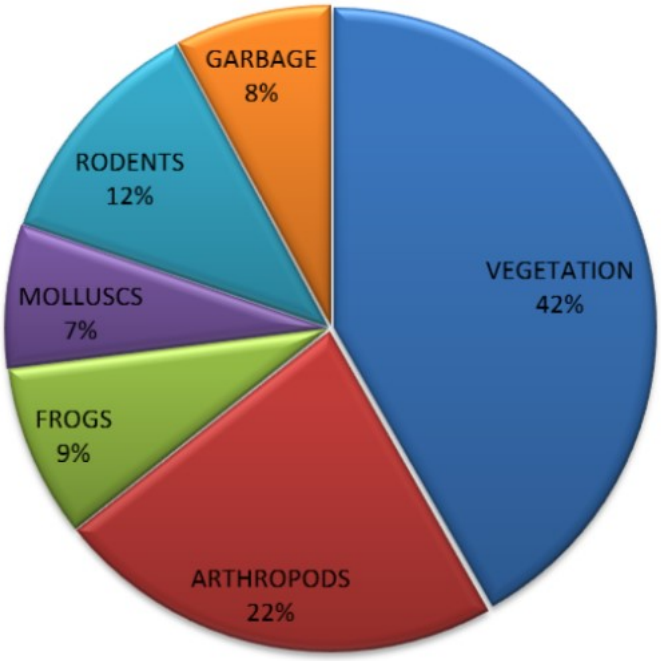

Figure W38C10.2: Overall distribution of different kinds of prey items throughout all the seasons (% Biomass).

Table W38C10.2: Calculations of Standard Deviation (SD) and Coefficient of Variation (CV) of different types of prey.

Prey items	S.D.	C.V.
Vegetation	2.7532	6.5838
Arthropods	3.4270	15.2092
Frogs	1.1619	13.4290
Molluscs	0.6301	8.7488
Rodents	1.9585	16.3484
Garbage	2.015	25.7837

Conclusions

Presence of artificial materials (garbage) indicates the jackals' dependence on human refuse in the Club area. Scavenging is highest in winter as proved by peaking of percentage biomass of artificial matter (11.23%), in line with behaviour in human-dominated agricultural landscapes. The percentage biomass of such artificial matter was the highest (11.23%) during winter indicating highest rate of scavenging on Club refuse, as also observed elsewhere in human dominated agricultural landscapes. However, vegetable matter formed predominant biomass in all seasons – 41.43% in winter, 38.62% in summer, 41.01% in monsoon and 46.21% in autumn – followed by insects, rodents and garbage, proving the jackals' dependence on vegetation and disinclination towards hunting despite access to prey. Notably, no hunting activity was observed in the entire study period. Since in the present study area, food in the form of vegetative matter and human refuse was easily available, hunting became redundant. This is reinforced by the complete absence of bird remains in the present study, although birds constitute a major portion of jackals' diet around the world.

The highest percentage biomass of arthropods, especially insects was in summer (27.1%) followed by monsoon (24.45%), autumn (20.13%) and winter (18.45%). In the present study, insects formed 36.45% of the scats in winter, 38.84% summer, 34.42% in monsoon and 35.23% in autumn. Although evidently there is no significant variation in percentage frequency, the percentage biomass consumed varies considerably due to the abundance of insects during summer and monsoon in comparison to winter.

Interestingly, the jackals are regularly fed by compassionate Club members. No conflict was recorded between the jackals and the dogs in the Club premises regarding food capture or food choice. This can be attributed to regular feeding and maintenance of the dogs by the Club. Although carcasses of crows, mole rats and jackals were noticed in the study area, the jackals under study showed no inclination to consuming the carcasses; rather they were found to be playful with them.

Conclusion can therefore be drawn that in a human-dominated landscape, the golden jackals have adapted to ready food availability by depending on vegetation as their major source of food along with the food provided by Club members. They do not exhibit their natural hunting instinct and live in harmony with the ground birds, accepting food from human beings in close quarters, confirming that golden jackals are opportunistic feeders, and can hence exist even in such a highly populated urban area.

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Chapter 4: Taxonomy and Morphology

T41K30

Golden jackal and wolf-jackal: taxonomic and paleozoological aspects. Appearance and factors of dispersal of the golden jackal in Europe.

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Known until last decades almost from the south-eastern "corner" of Europe, *Canis aureus* registers now a somewhat inexplicable boom of expansion, conquering (perhaps for the first time in its existence in Europe) large parts of the continent reaching Estonia (Trouwborst et al. 2015) and Denmark, thus becoming a subject of great zoological interest. The time of its emergence in Europe, however, remains a mystery. It could be reasonable to suppose that this may have happened at the end of the Pleistocene or at the Holocene beginning, before the Bosporus opening. There are some assertions for subfossil remains found, but the revisions give negative results and there is no reliable indication of the jackal presence on the continent (incl. the Balkans) before historical time – the Middle ages (Spassov 1989; 2007). The probable centres of origin and for dispersal of the population (the last 100-150 y.) to the west, north and north-east (Ukraine) in Europe are: 1. A basic one: south-eastern Bulgaria (Strandzha coast, Eastern Rhodopes, Upper Thracian lowland south of Yambol,); 2. Part of the Dalmatian coast; 3. possibly also a part of Aegean Macedonia (mainly the lower stream of Struma / Strimon). From there, probably mostly from Strandja and Kurdjali region (E. Rhodopes) started, at the end of the seventies/eighties the jackal expansion, after the ban on toxic baits (in the sixties). The species gradually occupy considerable territories on the Balkans and Romania (Demeter, Spassov 1993), from where it spreads to the west (Arnold et al. 2012) and probably the east along the Black Sea coast (see: Zagorodniuk 2014; Musabekov et al. 2016). The astonishingly high current number (ca. 30,000 ind.: Stoyanov 2013) and average density (2.83 to 5.66 territorial groups per 10 km^2: Acosta et al. 2018) show once again that the territory of Bulgaria is related to the core area of the population dispersal in Europe. The good hunting farming in Bulgaria and the artificial afforestation leading to the creation of impassable pine plantations in the 70s and 80s are the reasons for the initial population boom in Eastern Bulgaria. Further expansion is related to the anthropogenic changes - felling of forests, pave roads, accumulation of food waste near the villages, reduction of the wolf population and eventually to the climate warming. The factors limiting the spread of the species are the step terrains, large forest massifs, deep snow, extremely low temperatures, the presence of the wolf (but jackals also co-exist with wolves in several habitats).

Despite some intra-micropopulation body differences (Bošković et al. 2016) the Caucasian-South-eastern European population is genetically rather homogenous (Rutkowsky et al. 2015), and the coloration and size similarities between the jackals from Europe (the Balkans), A. Minor and the Caucasus are very strong and they must represent a single subspecies *C. a. moreoticus* (Demeter, Spassov 1993).

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The taxonomy of the African wolf-jackal (*Canis* "*lupaster*") today provokes great interest but also considerable controversy. Last studies take this taxon not as a jackal or wolf subspecies, but as a separate species (Koepfli et al., 2015, Viranta et al., 2017, Bertè 2017), an opinion expressed long ago (Spassov 1989). This species appears to exist in N. Africa since the late Pleistocene (Figure T41K30.1). However, there remains the question (see Gaubert et al., 2012, Stoyanov 2013, Bertè 2017: Is there a golden jackal (*C. aureus* or a specific African jackal "*C. anthus*"?) in Africa together with it?

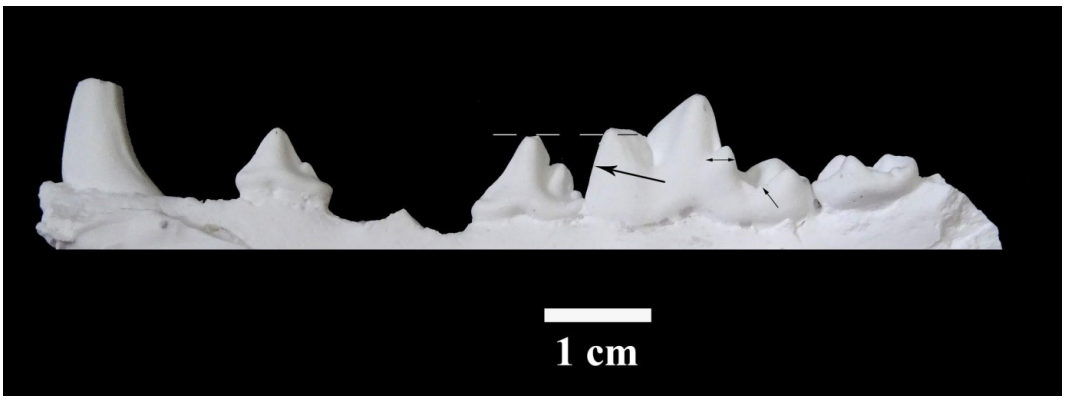

Figure T41K30.1: Fossil "jackal" lower teeth from the Late Pleistocene of Tamar Hat, Algeria (cast). (in: Arambourg et al. 1934, In: Archives de l'Institut de Paléontologie humaine, vol. 13, 242 pp.). M2 is primitive; the carnassial tooth shows a set of plesiomorphic (jackal) features: presence of pre-entodonid, large talonid, large metaconid, and apomorphic (wolf) ones: a high paraconid with slanting mesial edge, large size. All this is characteristic of the wolf- jackal.

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T42K30

Population phenetic and epigenetic distinctiveness and developmental stability of Eurasian golden jackals in a south-east European area.

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This study describes the cranial population phenetic and epigenetic identity and developmental stability of the golden jackal (*Canis aureus moreoticus* Geoffrey 1835) populations in the core area of its expanding south-east European range.

The population phenetic craniometric analysis of golden jackal was carried out using 18 linear skull and dental parameters. The analysis included 167 adult individuals (78 males and 89 females), originating from five populations inhabiting Bulgaria, Serbia and Hungary.

It confirmed the high degree of craniometric sexual dimorphism of the skull. The general pattern of craniometrical likeness of the golden jackals in investigated European area is not strongly bound to their population geographic origin neither in males, nor in females and their craniometric dissimilarity is not too high.

We studied variations in 13 craniometric non-metric traits in skulls of 202 adult specimens of golden jackal collected from six populations in Bulgaria, Serbia and Hungary. The recorded epigenetic variation and epigenetic uniqueness in the populations were low.

The low epigenetic diversity of the studied European populations of the golden jackal was probably caused by the recent expansion of species range into the continent because of immigration from the Balkan Peninsula and the long-distance expansion strategy followed by this species.

The population levels of developmental stability of European golden jackal was estimated in three populations inhabiting Bulgaria (104 specimens), Serbia (76 specimens) and Hungary (20 specimens). The population levels were assessed through the fluctuating asymmetry determined as minor non-directional deviations from bilateral symmetry in 10 morphological non-metric skull characters.

Looking at the fluctuating asymmetry as an indicator of environmental as well as genetic stress, there is no evidence of genetic depression by reproductive isolation in the studied populations. Moreover, there is no indication of relatively reduced developmental stability in any of the analysed populations.

Our data outline an integral picture of the geographic variation of the golden jackal natural populations in south-eastern Europe and help to establish a biological basis of rational management or conservation of this species, as the population approach is one of the leading principles of research and managing the wildlife.

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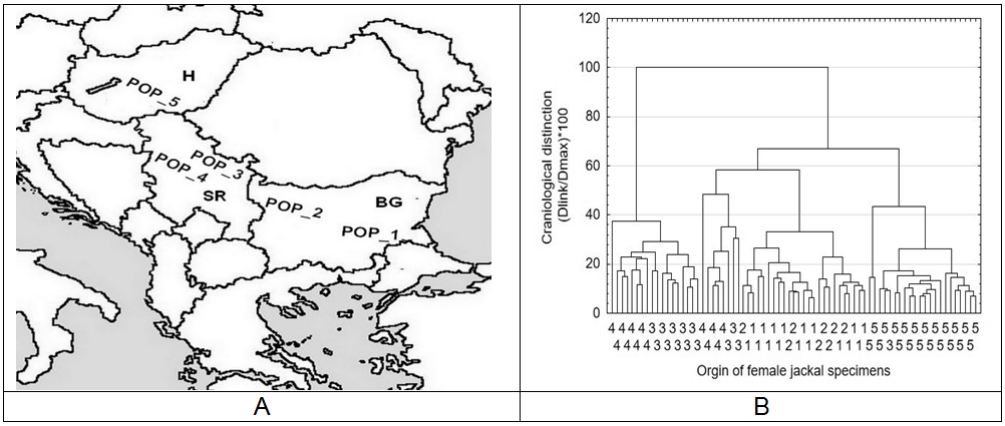

Figure T42K30.1: Map of localities of the studied golden jackal populations: Population POP_1, inhabiting Upper Thracian and Thracian-Strandja region in Bulgaria; Population POP_2, inhabiting the western part of the Sub-Balkan valleys in Bulgaria; Population POP_3, inhabiting the north-eastern part of Serbia; Population POP_4, inhabiting the central part of Serbia; Population POP_5, inhabiting South Hungary (A) and phenotypic craniometric similarity of the females specimens of European golden jackals (*Canis aureus moreoticus*) in his investigated South-east European populations (B).

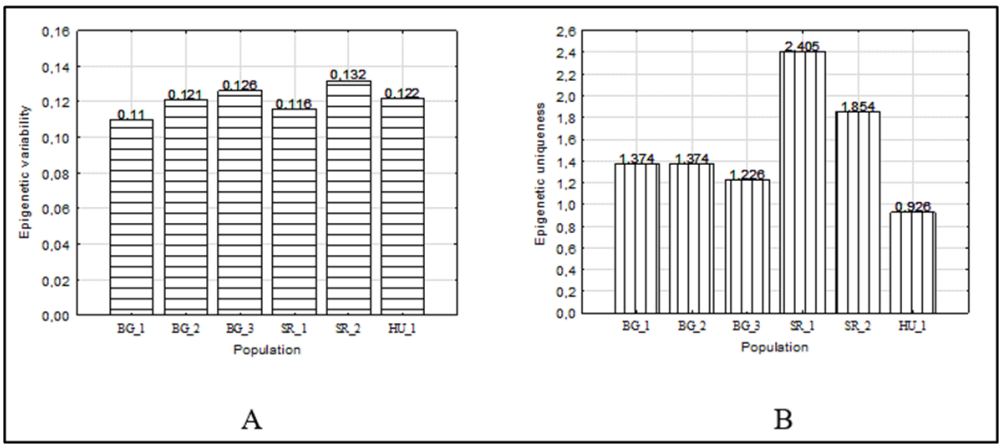

Figure T42K30.2: Epigenetic variability (A) and epigenetic uniqueness (B) of the populations of the golden jackal (*Canis aureus* L.) from: Bulgaria - BG_1; BG_2 and BG_3; Serbia - SR_1 and SR_2, and Hungary - HU_1. The geographic localities of the investigated populations are the same as described in Figure T42K30.1.

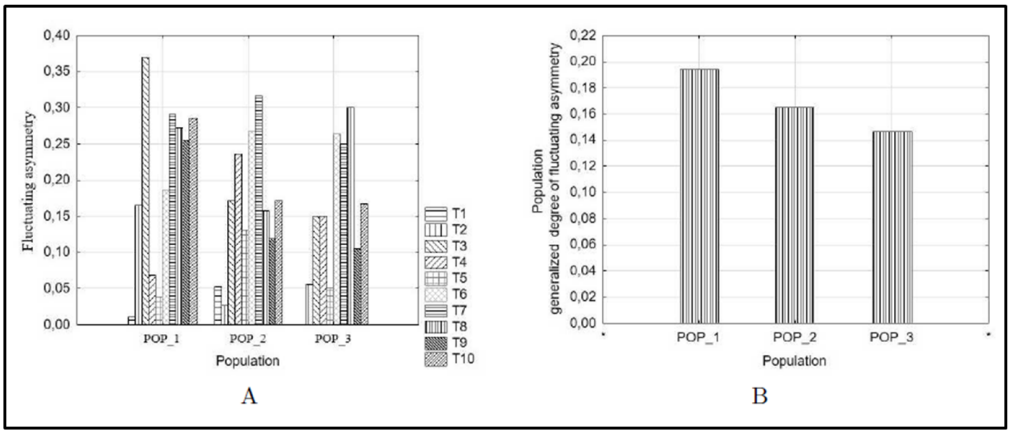

Figure T42K30.3: Values of the fluctuating asymmetry in the investigated 10 non-metric skull characters (A) and (B) mean values of the generalized degree of fluctuating asymmetry of each population expressed as the unscaled mean of fluctuating asymmetry of all investigated characters. POP_1 originates from Bulgaria, POP_2 is located on the territory of Serbia and POP_3 includes golden jackals from South Hungary.

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T43P

Morphometry of the mature *os penis* of the European jackal (*Canis aureus moreoticus*)

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The study presents the morphological variation in 9 linear traits of the baculum (*os penis*) in European jackal (*Canis aureus moreoticus*), based on an analysis of 18 adult males (between 3-and 4 years) collected in north-west Balkan Peninsula. The linear size of these parameters was measured precise to the 0.1mm.

The values of all investigated bacular parameters were calculated using a non-parametrical percentile method and are described by their basic descriptive statistics and characterized by their 25,00 and 75,00 Percentile intervals for the mean (Table T43P.1).

Table T43P.1: Descriptive Statistics of linear traits: LBa (length of the baculum without a cartilaginous end); DvThd (dorsoventral thickness - distal), DvThm (dorsoventral thickness - middle), DvThp (dorsoventral thickness -proximal); LSU (length of sulcus urethralis), WSU (width of sulcus urethralis); LtThd (laterolateral thickness - distal); LtThm (laterolateral thickness - middle); LtThp (laterolateral thickness -proximal) of the baculum (*os penis*) in European jackal (*Canis aureus moreoticus*).

Parameter	Mean	Median	Min.	Max.	25,0 Perc.	75,0 Perc.	Std. Dev.	Range	Quartile Range
LBa	54.77	55.02	43.43	64.25	49.04	60.65	6.99	20.82	11.61
DvThd	2.18	2.23	1.58	2.69	2.01	2.45	0.33	1.11	0.44
DvThm	4.45	4.47	3.24	5.80	4.03	4.81	0.70	2.56	0.78
DvThp	4.81	4.71	3.80	6.28	4.28	5.28	0.68	2.48	1.00
LSU	36.14	35.50	30.74	45.08	32.22	38.86	4.26	14.34	6.64
WSU	3.39	3.40	2.72	3.86	3.22	3.68	0.33	1.14	0.46
LtThd	2.17	2.30	1.54	2.72	1.85	2.44	0.35	1.18	0.59
LtThm	4.66	4.77	3.09	5.42	4.33	5.07	0.60	2.33	0.75
LtThp	4.72	4.71	3.68	5.80	4.13	5.25	0.72	2.11	1.12

The present examination and statistical analysis of the defined bacular parameters has established the initial norm of their variation in *C. a. moreoticus* and can be used not only to evaluate the males' quality and viability but also these patterns of variability have led to their use as a taxonomic characters in determining the taxonomic status of a number of *Canis aureus* populations inhabiting its Euro-Asian area.

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T44P

Phenetic diversity across gray wolf in Bulgaria: a focus on craniological population description and identification.

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The craniometrical analysis of population diversity of the gray wolf (*Canis lupus* L. 1758) from Bulgaria was carried out using 15 linear skull parameters. The analysis included 86 adult individuals (41 males and 45 females), originating from the most preferred habitat of this species in the country: mountains regions – Population_1 from Stara Planina; Population_ 2 from Rila; and Population_3 from Rhodope Mountains (Figure T44P.1). The univariate and multivariate statistical assessment of the skull features of Bulgarian gray wolf, performed separately by sex, demonstrated its degree of the phenotypic craniological similarity between the adult specimens of the same sex from the main populations in Bulgaria (Figure T44P.2).

These results create a baseline for estimation of current craniology-morphological features in gray wolf from Bulgaria and provide an opportunity to use them as an indicator tool for disclosure of future potential anthropogenic negative influence on the gray wolf population in the country, under the conditions of modern industrial, agricultural and truism activities.

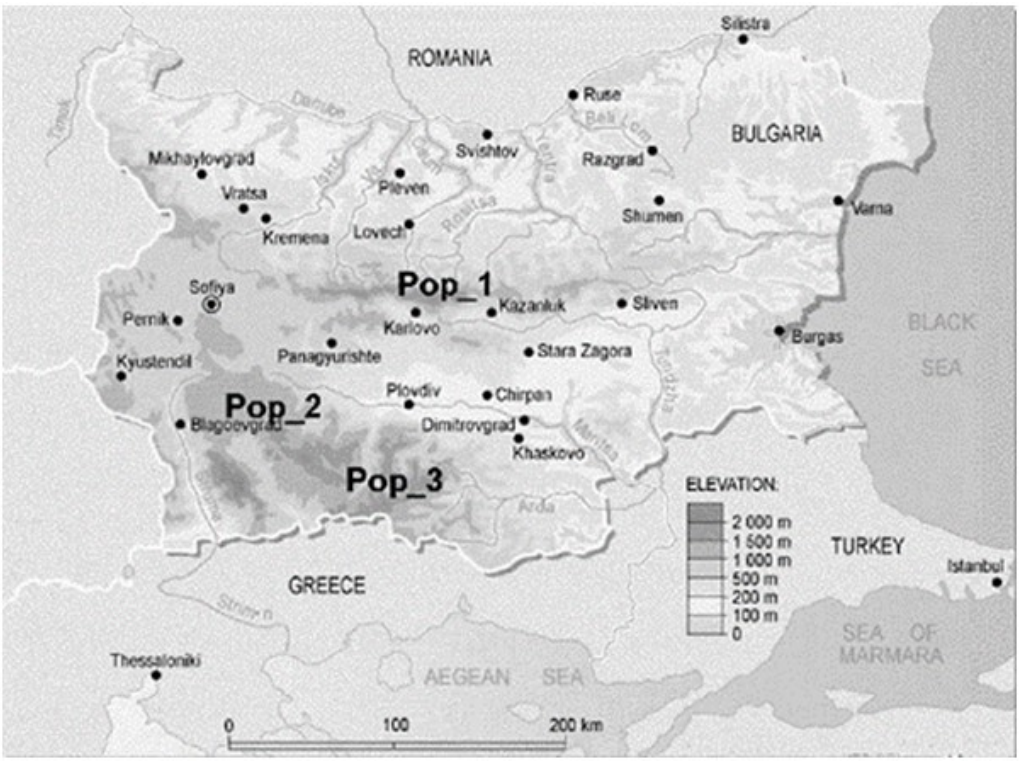

Figure T44P.1: Geographic location of the study for craniometric diversity wolf (Canis lupus) population in Bulgaria: Pop_1 – Stara Planina Mountain; Pop_2 – Rila Mountains; Pop_3 – Rhodope Mountain (A) and phenotypic craniological similarity in the male specimens originating from them (B).

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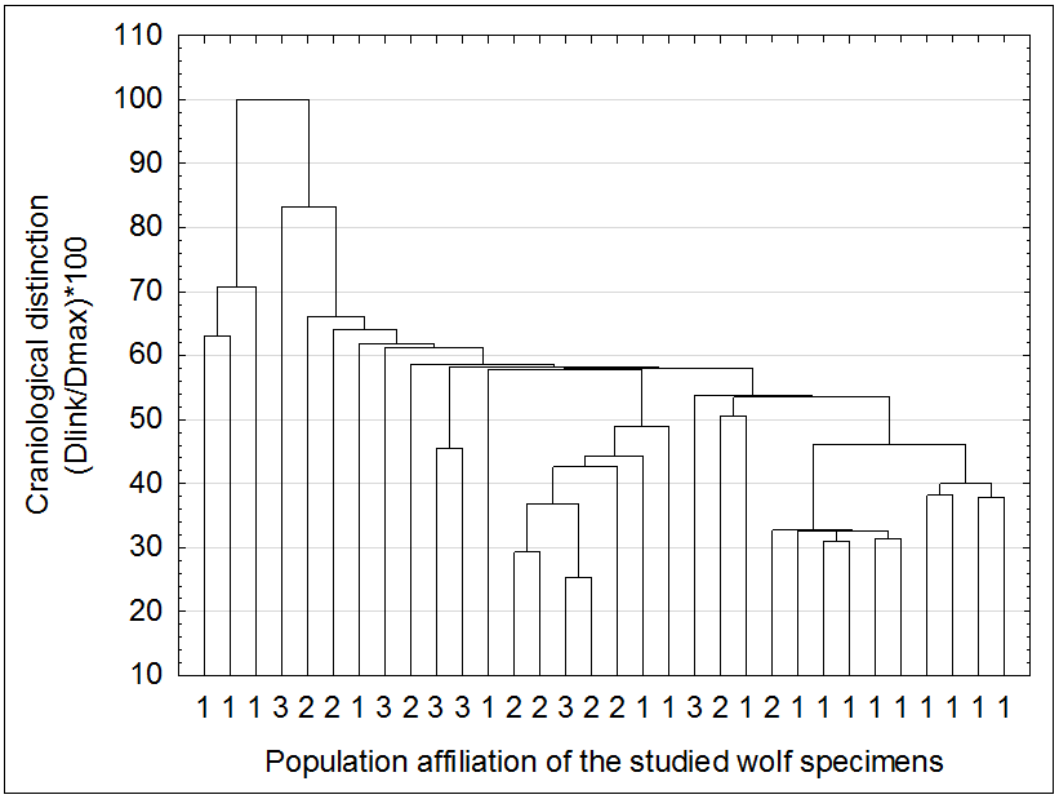

Figure T44P.2: Phenotypic craniological similarity in the male wolf (Canis lupus) specimens originating from Popopulations;1 – Stara Planina Mountain; 2 – Rila Mountains; 3 – Rhodope Mountain (A).

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T45P

Craniometrical distinction: a comparison of Pannonian and Balkan golden jackal skulls.

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Recent studies investigated craniometrical relationship patterns of different golden jackal (*Canis aureus* Linnaeus, 1758) populations in Hungary, Bulgaria, and Serbia. These studies showed differences between subadults of distinct populations and sexual dimorphism in adult individuals for certain craniometric characteristics. In Austria, the golden jackal is considered as an allochthonous species and the first record was documented in 1987. In this research, we examined skulls from golden jackals collected in Austria, Hungary and Bulgaria (Figure T45P.1). Following previous studies, the aim of this craniometrical analysis was to define certain measurements that possibly distinguish 1) populations, 2) age classes, and 3) sex respectively.

We measured a total of 112 skulls of subadult and adult golden jackals, i.e. with complete second dentition. Age was determined in consideration of tooth wear and the degree of fusion of cranial sutures. Subadult specimen were defined as individuals with fully developed second dentition, but less than two years of age. Hence, adults are characterized to be two years and older. We took 25 measurements (Figure T45P.2) from cranium and mandibles, including dental parameters, using a digital sliding calliper.

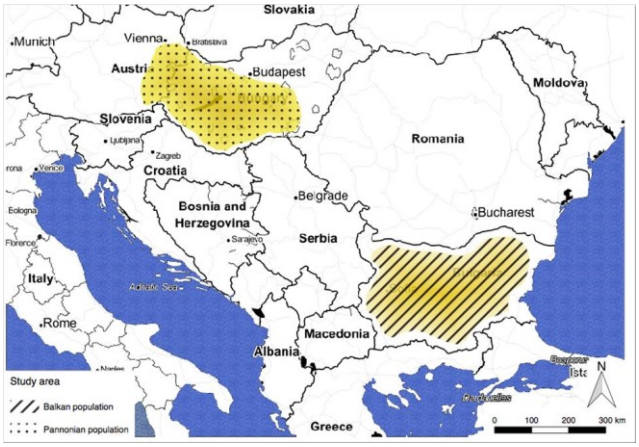

Figure T45P.1: Areas of origin for studied skulls.

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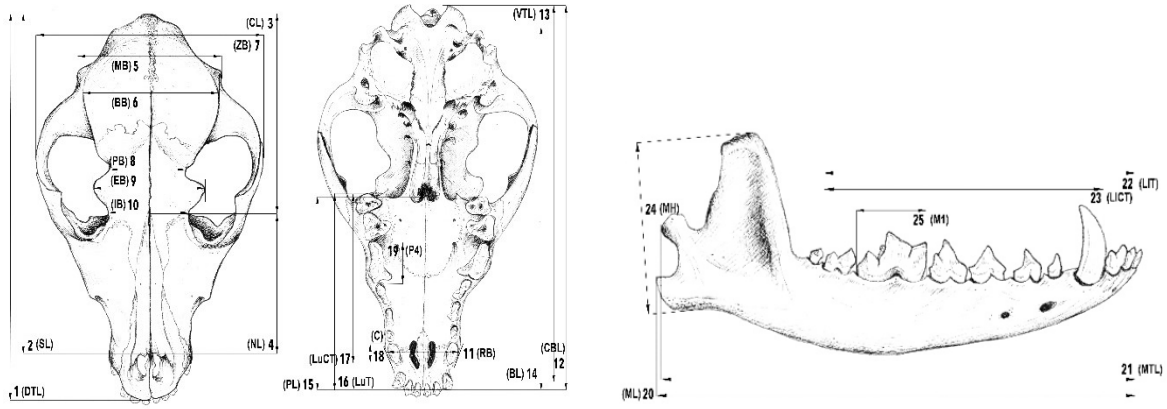

Figure T45P.2: Measurements taken on golden jackal skulls: dorsal total length (1), skull length (2), cranial length (3), nasal length (4), mastoid breadth (5), braincase breadth (6), zygomatic breadth (7), postorbital breadth (8), ectorbital breadth (9), interorbital breadth (10), rostral breadth (11), condylobasal length (12), ventral total length (13), basal length (14), palatal length (15), upper tooth row (16), upper cheek tooth row (17), diameter of canine (18), length of P4 (19), mandible length (20), mandible total length (21), lower tooth row (22), lower cheek tooth row (23), mandible height (24), length of M1 (25) (drawings: Jasmin Barl).

Skulls from Austria and Hungary were combined to one group (Pannonia) consisting of 52 specimens, 22 of them were adults (seven females, 15 males) and 30 were subadults (nine females, 21 males). The second group (Balkan) comprised a total of 60 samples from Bulgaria, including 17 adults (four females, 13 males) and 43 subadults (14 females and 29 males).

For statistical analysis, confidential inference trees (CIT) were run with R (R Core Team 2017) by using the package "party". First results from the CIT show the following:

1) The analysis of populations (Balkan/Pannonia) displayed no significant differences between the groups, except in subadult females (with interorbital constriction (IB) ($p = 0.008$) as a distinctive feature).

2) A partition between age classes (adult and subadult, n=112) was demonstrated through the ectorbital breadth (EB) ($p < 0.001$) segregating at a value of 40.82 mm: skulls with smaller values derived from subadults (86%), those with values larger than 40.82 mm were adults (63% Figure T45P.3).

3) In terms of differentiating sexes of adult individuals (n = 39) the diameter of the canine tooth (C) was the most important segregation ($p = 0.006$) (Figure T45P.4). All adult males showed a canine diameter greater than 7.87 mm, whereas seven females exhibited a canine diameter less or equal than 7.87mm; in four females, C exceeded 7.87 mm.

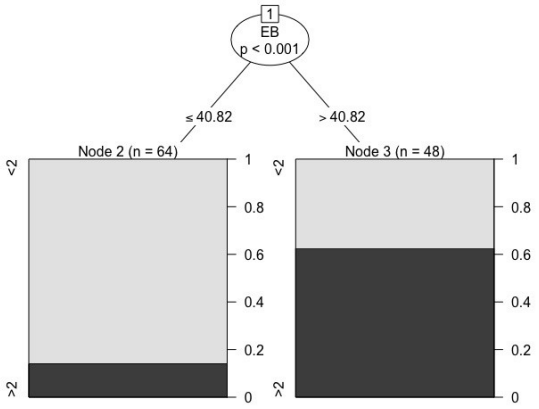

Figure T45P.3: CIT for all individuals showing a segregation between adults and subadults being the EB.

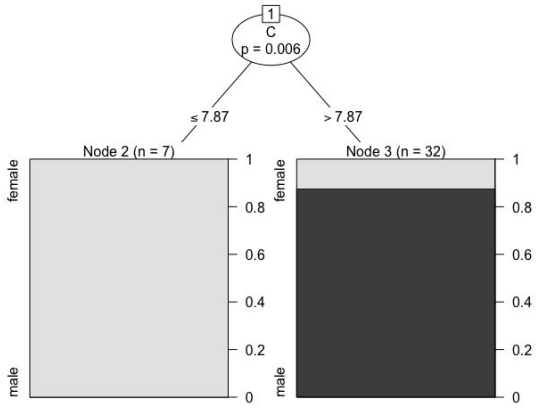

Figure T45P.4: CIT for a subset of the data (adult males and females) showing a significant distinction at the value 7.87 mm for the measurement of the canine diameter (C).

With adding confidential inference trees to the analysis, these results present a new way to display craniometric measurements. The distinction between sexes shows that 100% of adult males (n=28) and 64% of the adult females (seven from n=11) could be determined by means of only one measurement (C) in our samples. The segregation of populations and of age classes through cranial measurements still needs further investigation and a larger sample size. Furthermore, skulls from other parts of Europe can be included in the analysis for a broader view on one hand and a more detailed look at differentiating measurements on the other hand.

Key words: Canidae, skull measurements, geographic differentiation, sexual dimorphism

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Chapter 5: Phylogeography, Genetics and Biogeography

T51K30

Re-discovering the African wolf.

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Swedish Museum of Natural History, Sweden

Introduction

We have re-described the African wolf as a distinct species, *Canis lupaster*. The species was first discovered and identified in 1832 by German naturalists F. G. Hemprich and C. G. Ehrenberg, but in the 20th century was synonymized with the golden jackal (*Canis aureus*). In recent years, several authors have indicated the unique genetic composition of the African wolf as well as the possibility that morphological similarity between the golden jackal and African wolf is due to convergent evolution rather than a close phylogenetic relationship.

Our study showed that all the African specimens previously labelled as *C. aureus* are representatives of the African wolf and confirmed that the African wolf is more closely related to the Eurasian wolf (*Canis lupus*) than the golden jackal. It is still unclear how far the distribution of the African wolf spans beyond the African continent.

Methods

African wolf and golden jackal skulls housed in the natural history museums in Stockholm, Berlin, Copenhagen, and Helsinki, as well as recent road kills from Ethiopia, were studied. Skulls and dentitions were measured and the measurements were compared using bivariate diagrams and Simpsonian ratio-diagrams. Analyses of measurement data were carried out using the PAST software.

Results

As shown by us and elsewhere, the African wolf differs from the Eurasian golden jackal both nuclear and mitochondrial DNA sequences. Morphologically, it differs in shape the of the palate and in canine cross-sectional geometry. Samples from Oman, Iraq and Syria show affinities with the golden jackal, whereas samples from Israel and Palestine are more equivocal.

Conclusions

Several studies have confirmed the presence of the African wolf in Africa. The geographic range of the African wolf is that previously described for the African golden jackal. It ranges from the Ethiopian highlands to the Rift Valley, across North Africa and Saharan desert to the west coast of Africa.

Whether the distribution of the African wolf extends beyond Africa requires additional study. It may overlap with the golden jackal in the Sinai Peninsula, and may also be sympatric with the Arabian wolf (*C. lupus arabs*) in Israel, where there is some evidence for hybridization between the species.

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Recent literature of the records of *Canis aureus* and *C. lupaster* in the Middle East.

Ferguson WW. 1981. The systematic position of *Canis aureus lupaster* (Carnivora: Canidae) and the occurrence of *Canis lupus* in North Africa, Egypt and Sinai. *Mammalia* **45:** 460-465.

Koepfli KP, Pollinger J, Godinho R, Robinson J, Lea A, Hendricks S, Schweizer RM, Thalmann O, Silva P, Fan Z et al. 2015. Genome-wide evidence reveals that African and Eurasian golden jackals are distinct species. *Current Biology* **25:** 2158-65.

Saleh M & Basuony M. 2014. Mammals of the genus *Canis* Linnaeus 1758 (Carnivora Canidae) in Egypt. *Egyptian Journal of Zoology* **62:** 49-92.

Viranta S, Atickem A, Werdelin L. & Stenseth, NC. 2017. Rediscovering a forgotten canid species. *BMC Biology* **2:** 6.

Reference	*C. lupaster*	*C. aureus*
Ferguson, 1981	Sinai Peninsula	
Saleh & Basuony, 2014	Sinai Peninsula	Sinai Peninsula
Koepfli et al., 2015	Sinai Peninsula	Sinai Peninsula
Viranta et al., 2017	Sinai Peninsula	Arabian Peninsula

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T52K30

Complex genetic structure of the expanding golden jackal populations in Europe.

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Golden jackals (*Canis aureus*) are expanding their range as shown by the increasing number of individuals recorded far outside their known breeding area. Here we analyse the genetic structure of golden jackals from core areas of their distribution to identify the origin of dispersing individuals recently observed in central, north-eastern and northern Europe. We obtained 399 tissue samples from the current range of the species: the Balkans (including continental Greece and Samos Island, Serbia, Croatia), Slovenia, Hungary, Romania, Ukraine, and Caucasus, as well as from central, north and north-eastern Europe (Germany, Poland, Czech Republic, Slovakia, Belarus, Lithuania, and Estonia), where isolated individuals have been sporadically observed. Each individual was genotyped for 15 microsatellite loci. We used Bayesian clustering approaches to determine genetic structure and genetic ancestry of particular individuals. The analyses indicated three distinct genetic groups. It was confirmed that, concurring with previous findings, individuals from Estonia and some from the Ukraine grouped together with the Caucasian population. This genetic cluster also comprised golden jackals from Samos Island, but not from continental Greece. In Hungary and Romania, we found two genetic clusters: one which dominated in Hungary, and the other in Romania. In both, however, individuals from either Romania or Hungary were recorded, as well as a small portion of genetically admixed jackals. Samples from the Balkans were mainly included in the Romanian cluster. Jackals sampled in Germany, Poland, the Czech Republic, Slovakia, Belarus, and Lithuania were of diverse origins, including one individual of admixed origin from the Caucasian and Romanian clusters. Our results support the hypotheses that: 1) golden jackals reached the Baltic States via different routes, including long-range dispersal from both

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the Caucasus Mountains (and Asia), and from the Balkans; 2) a possible source of the spreading outside Bulgaria and Greece was/were small breeding population(s) that persisted at the Balkans. They also suggest that dispersal is female- rather than male-mediated in this species.

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T53P

Possible fitness advantage of one MHC class II DQA genotype in subadult golden jackals expanding towards central Europe.

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In Europe, golden jackals have continuously been expanding their distributional range from the southern and south-eastern Balkans towards central Europe since the 1960ies. Given the high diversity of pathogens reported in those expanding populations, we hypothesized 1) geographic immunogenetic variation despite high gene flow due to adaptation to regional pathogenic landscapes, 2) a potential effect of climatic parameters on DQA alleles or genotypes, independent from geographic variation, as climatic parameters may indicate favourable or unfavourable conditions for pathogens, and 3) a potential allele/genotype effect on body weights, due to a better growth rate of jackals with "optimal alleles/genotypes" to fight pathogens, indicating higher fitness. We have studied DQA exon 2 polymorphism in 157 individuals from Serbia (n=90), Bulgaria (n=33) and Hungary (n=34) by direct sequencing and obtained individual genotypes by phasing, including all available canid sequences from GenBank. Among all four alleles detected presently (DQA1*00402, DQA1*03001, DQA1*00101, DQA1*01401, with frequencies of 0.704, 0.290, 0.003, and 0.003, respectively), DQA1*00402 and DQA1*03001 occurred with similar frequencies across our study area, whereas DQA1*00101 and DQA1*01401 were found in single individuals from Serbia only. Multinomial linear modelling and model averaging on the R platform, with genotypes of the two most frequent proteins as response variable and latitude/longitude as well as a locality-specific climate factor (mean and annual temperature and precipitation of the coldest quarter of the year) as explanatory variables, indicated significant geographical variation (longitude and latitude). Independently, a significant climatic effect was found as well, favouring DQA1*03001-homozygotes at locations with increased climate factor scores. Our body weight models indicated a significant effect of the DQA1*03001/03001 genotype on body weight in subadult jackals of either sex, independent of their body size (i.e., head body length) that also affected body weight. Despite no marked geographic variation of DQA1 allele frequencies, genotype frequencies of the two most prevalent proteins varied significantly geographically and independently also among local climate: DQA1*03001 homozygotes were found more often at locations of higher mean annual temperature and higher precipitation during the coldest quarter of the year. Seemingly, this genotype confers a fitness advantage in terms of higher body weights in subadults, independent of the currently studied climatic conditions and geographical position.

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T54P

Identification of golden jackal in Belarus with the help of mitochondrial genetic markers.

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Introduction

The golden jackal (*Canis aureus* Linnaeus, 1758) is a mammal species of the Canidae family that has been characterized by a rapid expansion of the range in recent decades. In Belarus, the first report of the jackal appeared in 2012 and concerned an animal that was found in the south-east of the Brest region at the end of 2011. However, this finding was not scientifically confirmed hitherto. The purpose of this work was to establish by means of molecular genetic methods the species affiliation of "jackal-like" individuals hunted at different times on the territory of Belarus.

Methods

DNA extraction was performed using the NucleoSpin Tissue kit (Macherey-Nagel, Germany) according to the manufacturer's protocol.

A part of the cytochrome b gene (about 500 bp) was amplified using the universal primers MVZ04 (5'-GCAGCCCCTCAGAATGATATTTGTCCTC-3') and MVZ05 (5'-CGAAGCTTGATATGAAAAACCATCGTTG-3') (Smith and Patton, 1992), according to the protocol, described by Hulva et al. 2004.

The primers WDLOOPL (5'-TCCCTGACACCCCTACATTC-3') and H576 (5'-CGTTGCGGTCATAGGTGAG-3') were used for the amplification of the mitochondrial DNA (mtDNA) control-region (protocol: Rutkowski et al. 2015).

The PCR product was sequenced with both primer sets using the CFX96 Touch Real-Time PCR Detection System (Bio-Rad Laboratories, Inc.). The sequencing reactions were run with GenomeLAB GEXP Genetic Analysis System (Beckman Coulter). The standard commercial protocol was used for sequencing. The sequences were aligned by eye using MEGA 6.0. The resulting sequences were processed using the BLAST program for species identification.

Based on mitochondrial D-loop and cytb sequences, phylogenetic dendrograms of C. aureus were revealed using Neighbour-Joining (NJ) and Maximum Likelihood (ML) methods with MEGA6 (bootstrap value for each branch on the ML and NJ trees was 500 pseudoreplicates).

Results

Our research confirmed the fact of the first registration of golden jackal in Belarus in December 2011. According to the results of our genetic analysis, *C. aureus* registered in the Brest region in 2011 has a connection with the Balkan and Caucasian distribution center. Thus, relying on the experimental and literature data, we assume, that the invasion of P. ? golden jackal into Belarus occurred from both centres of its distribution.

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T55P

The presence and the extinction of the golden jackal from the island of Corfu, north-western Greece.

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The golden jackal, *Canis aureus*, was the major terrestrial predator and carcass cleaner on Corfu island. We tried to find out the pattern of its extinction and every possible information, by personal experience and by questioning people from the countryside, farmers, hunters, foresters, locals and visitors etc, directly, with questionnaires or through social networks. We also examined several written sources. It first appeared clearly in literature in 19th century, when Europeans started describing the natural resources of their occupations. Since golden jackals vocalize a lot compared to other mammals, it's easy even for laymen to know when they are present in an area. Till the early 1960s they used to be very common almost all over Corfu, but then they started declining and the few remaining animals of the 1980s, were not able to keep up for long and so they disappeared in the 1990s. They were mostly common in the lowlands of Corfu, in hilly terrain, in valleys, near wetlands and streams. They avoided the higher altitudes above 500-600m. Their interaction with human was varying, as many people were afraid of them during night-time, but their howling was an amusing attraction in some cases and even sometimes locals were provoking it. Small damage to livestock and crops was reported. Some were hunted for fur in the 1950s-70s and some were hunted for the bounty. It seems that when still common, the numerous jackals were keeping red foxes in low numbers. As to the reason of their extinction we have to mention that in the 1960s and 1970s the lowlands of Corfu started getting overbuilt for infrastructure for tourism. In the same period reduced farming led to a drop of food abundance. Also, the state decided to eliminate wild canids by putting poison baits and traps and by paying hunters for every killed one. Many blame disease or/and pesticides for the extinction. There is still suitable habitat for them in places like Poulades, Korission-Messonghi Valley, Tiflos Valley etc, but it is quite impossible for them to cross the channel between Corfu and the mainland (~2,5km) and recolonize the island.

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T56P

Exploring the ancestry of golden jackals from Hungary.

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In Europe, golden jackals have continuously been expanding their distributional range from the southern and south-eastern Balkans north and north-westward towards central Europe since the 1960s and have meanwhile, established a vital population in Hungary. Based on earlier genetic data and landscape characteristics, we hypothesized that the recent colonization of Hungary by golden jackals has resulted from a northward expansion from Serbia and Slavonia (NE Croatia). Here, we genotyped 81 individuals from the border region of eastern Slavonia (NE Croatia) and northern Bosnia & Herzegovina (n= 41) and Hungary (n= 40) at seven microsatellite loci and combined the obtained genotypes with an earlier dataset (n = 279) from Bulgaria, Serbia, and Hungary. Allele composition and allelic richness did not vary significantly across the study area, and relative and absolute genetic differentiation (F-statistics, Cavalli-Sforza & Edwards genetic distances) between the regions studied were all very low. Nevertheless, a significant (FIS = 0.082; 99% confidence interval: 0.045 – 0.127) deviation from Hardy-Weinberg expectations was found for the composite dataset (n = 360). Our geographical cluster analyses of individual genotypes using various Bayesian algorithms (STRUCTURE, BAPS, GENELAND) concordantly indicated highest gene pool similarity between jackals from Hungary and those from the border region of NE Croatia/northern Bosnia & Herzegovina, whereas genetic characteristics of jackals from Serbia were clearly different from those of Hungarian jackals. Despite rather uniform genetic characteristics of Hungarian jackals, some individuals from Hungary exhibited genetic signals of possible descendants from northern Bulgaria. In conclusion, our present findings surprisingly did not suggest a considerable northward expansion of the gene pool of Serbian jackals into Hungary; rather, NE Croatia and northern Bosnia appear to be the most important source population for the jackals currently roaming Hungary. Further analyses should include samples from Romania, Ukraine, but also from north-west Croatia and Slovenia to obtain a more comprehensive model of the colonization of the eastern part of central Europe.

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T57C10

Non-invasive genetic assessment provides evidence of extensive gene flow and possible high movement ability in the African golden wolf.

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The African golden wolf, *Canis anthus*, is a newly recognized medium-sized canid species from North Africa, which has remained poorly studied to date. We applied genetic methods for individual identification of non-invasively collected samples (n=93) of the African golden wolf in Tunisia, assessing their genetic diversity and structure. The mitochondrial control region exhibited high haplotype diversity (Hd = 0.907 ± 0.018) with 15 haplotypes detected among 28 individuals. Similarly, a set of 15 microsatellite loci revealed high genetic diversity at the nuclear level (expected heterozygosity = 0.83±0.04; average number of alleles = 8.30±0.99). The Bayesian model-based clustering method implemented in STRUCTURE did not reveal population structure in African golden wolves within Tunisia. This result was corroborated by the Discriminant Analysis of Principal Components where no clear clusters were observed. Based on seven individuals that were found multiple times among samples, we estimated straight distance movements up to 230 km. Our results provide movement lengths for the species and no evidence for biogeographical structure of genetic diversity within Tunisian golden wolves, probably related to the high dispersal ability of the species, facilitating high gene flow. The evaluation of population diversity and the first information on movement ability provided in this study should be considered as baseline information in the development of a management plan for African golden wolf in Tunisia.

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Chapter 6: Disease, Toxicology and Human-wildlife conflict

T61K30

Overview of golden jackal parasites and zoonotic diseases.

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The golden jackal (*Canis aureus*) is a species under significant and fast geographic expansion. Various parasites are known for golden jackals across their geographic range, and certain groups can be spread during their expansion, increasing the risk of cross-infection with other carnivores or even humans. The list of the golden jackal parasites includes 194 species; among these, 21 protists species, 119 helminths and 54 arthropods have been identified in golden jackal. This large variety of parasites is related to the extensive geographic range, territorial mobility and a very unselective diet. The vast majority of these parasites are shared with domestic dogs or cats. The zoonotic potential is the most important aspect of species reported in the golden jackal, some of them, such as *Echinococcus* spp., hookworms, *Toxocara* spp., or *Trichinella* spp., having a great public health impact. Our review brings overwhelming evidence on the importance of *Canis aureus* as a wild reservoir of human and animal parasites.

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T62K30

Home range and movement of golden jackal pair in human dominated landscape.

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Golden jackal (*Canis aureus*) is a native canid species in Europe and it is nowadays expanding its distribution range across the continent. Although the species is in focus of many studies in Europe, data about the movement and home range size of jackals is very limited. The aim of this ongoing study is to give an insight in seasonal home ranges, movement habits and habitat preferences of a golden jackal pair in a suburban area in the Balkans, Southern Europe.

A pair of golden jackals was collared with GPS/GSM (male) and GPS/radio (female) collars in the suburb area of Belgrade (Serbia). The area is dominated by agricultural land (84%) with little semi-natural habitats (12%) mostly consisting of vegetation around irrigation canals, fallows and hedges. We collected data from collars during vegetation season 2017 (March – October for male, March – June for female). We calculated home ranges and distance travelled for each sex and month separately and produced heat map of spatial density for each month using ArcMap (ESRI, 2015). We also established relationship between jackal presence and vegetation type using buffers of various sizes around semi-natural vegetation. Differences between sexes in home range size and distance travelled were tested with paired t-test using Real Statistics Resource Pack software (Zaiontz, 2017).

Male and female did not differ significantly in their calculated home ranges ($t(3)=-1.306$, $p=0.283$) or distances travelled ($t(3)=-1.042$, $p=0.374$), though female had markedly smaller home range during April than male (1.73 km2 and 9.62 km2,respectively). There is also a trend of increase of distance travelled from early to mid-season with sharp decrease for males in late season. Heat maps showed several clusters that changed during season. Earlier in the season clusters were inside larger patches of semi natural habitats on the edge of agricultural area while later in the season they moved to smaller semi-natural patches deeper into crop land. Analysis of buffers of different sizes around semi-natural habitats showed that earlier in the season both male and female stay within 20 m of semi-natural habitat (March: 93%, 92%, respectively), that they venture further out into the crop fields in the mid of the season (June: 50%, 43%, respectively), and even more so later in the season (October: 17%, male only). However, both male and female rarely venture more than 60 m from semi-natural habitats (averaged across season: 14% and 10%, respectively). Results of the heat map and buffer analyses indicate that jackals use semi-natural vegetation as cover earlier in the season while later in the season they venture more into agricultural land.

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T63C10

Influences of anthropogenic food resources on coyote space use.

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Food resource availability structures space use for most wildlife species. The availability of carrion can strongly influence space use decisions of mesomammals which are its intense consumers. In North America, coyotes (*Canis latrans*) exist in landscapes where carrion from other wildlife and livestock is present, as well as placental expulsions. Although these resources provide energetically efficient nutritional supplementation, they occur randomly except for rare mass mortality events, thus cannot serve as a reliable nutritional feature. Anthropogenic food sources, however, may influence use of space by coyotes by providing regularly occurring large depositions of carrion, sometimes in predictable locations. Indeed, normal livestock and wildlife management practices in many regions of North America involve the deposition of carcasses *en masse* at regular intervals.

We examined the influence of (1) carcass disposal facilities, and (2) mass mortality events of feral swine occurring as part of removal efforts on coyote space use and structure of territories in southern Texas, USA on a ~63,000 ha property that prohibits harvest or harassment of native wildlife. We deployed GPS locating collars on 24 coyotes in January 2018, and monitored their behaviour for several months to establish baseline behaviour and space use. We then experimentally conducted removal of feral swine to detect changes in space use over time as a result of carrion deposition. We continued to monitor activity to determine the longevity of the effects.

We determined that these depositions increased frequency of extra-territorial movements of coyotes, distance travelled, time spent at destination, and that these effects persisted over time. The amount of carrion influenced the longevity of effect, where coyotes visited resource sites after the resource depletion.

The ability of anthropogenic carrion resources to alter structures in coyote populations, including territoriality and space use, may artificially disrupt ecological systems. Coyotes consume herbivores, such as lagomorphs and cervids, and also vector several infectious diseases and parasites. An artificially increased density of coyotes due to anthropogenic carrion deposition bodes ill for herbivore populations, disease risks, and other increasingly critical aspects of ecological systems. We recommend a closer investigation of human activities that alter the nutritional landscape for such species.

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T64CK30

What does science and history tell us about black-backed jackals and their conflict with sheep farmers in South Africa?

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There is a debate in South Africa over how best to prevent predation of small livestock by black-backed jackal (*Canis mesomelas*). When black-backed jackals re-emerged in the 1990s and 2000s as a serious predator on sheep farms in South Africa's dry interior Karoo, many farmers resorted to lethal control. Conservation authorities warned that culling was likely to be counterproductive (because dispersing juveniles could quickly recolonise vacant territories) but farmers argued that in the absence of apex predators and in the presence of a large food supply (sheep) black-backed jackal numbers would expand if not culled. This review is about the history of the conflict between small livestock farmers and black-backed jackals and the available scientific evidence on black-backed jackal ecology.

The historic record shows that with sufficient resources (government subsidies for fencing and predator control), it is possible to exclude black-backed jackals from fenced camps. Lethal control worked for the forefathers of today's Karoo sheep farmers. However, government no longer provides such resources and there are fewer full-time sheep farmers and more nature reserves and part-time (so-called 'weekend') farmers. A survey of Karoo sheep farmers reveals that they attribute the return of the black-backed jackal to deteriorated fences, falling employment and to insufficient effort on the part of remaining farmers to cull jackals. A minority of farmers accept that culling jackals might exacerbate the problem, but most argue that the 'fence-and-clean-up' approach of their forefathers is still the best way forward. There is some evidence that culling meso-predators like black-backed jackals and caracals (*Caracal caracal*) increases livestock losses the following year (suggesting source-sink dynamics). Farmers, however, remain suspicious of the notion that they should 'live with' the jackal. This view is supported by scientific studies linking black-backed jackal reproduction to food and showing that black-backed jackals share territories in the presence of 'clumped' resources.

Conservationists and ecologists are calling for more research on black-backed jackal ecology, especially on farmlands where studies are limited. More studies would be helpful although they will at best provide context-specific information about black-backed jackal diet and impact on livestock. We already know from existing studies that black-backed jackal diet is opportunistic and flexible and that their behaviour responds to persecution and adapts to culling techniques. This suggests that 'one-size-fits-all' solutions are unlikely to work everywhere or consistently.

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T65C5

Golden jackal (*Canis aureus moreoticus* Geoffroy, 1835) predatory behaviour and carcass consumption of livestock in north-east Italy.

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Introduction

The Italian Karst hills in the south-eastern part of Friuli Venezia Giulia is home of a consolidated population of golden jackal since 1996 (estimated density in 2017: 1.1 heads/100ha). From the 2013 jackals sporadically attacked two flocks. During 2015-2016, was started a collaboration with a local breeder to monitor predations on his flock. The flock, with 40 sheep, grazed on pastures of 25 ha, fenced with metal wire mesh, with semi extensive management, without the presence of the shepherd at night

Methods

During the studies, 18 carcasses of sheep were analysed, presumably preyed by the golden jackals. After the findings, the carcasses were necropsied to evaluate pathological features, the causes of death and the amount of consumption. Moreover 15 carcasses were monitored with camera traps to study the consumption behaviour.

Results

Predation took place from summer to autumn, mainly at night or at dawn (6.25% May, 12.5% July, 12.5% September, 68,75% October). Predated animals were mainly weak condition, subjects such as lambs (less than one year old, n=8), elderly (n=5) and sick. The sheep were immobilized by single or several bites in front area of body (neck, forelimbs) or in hind limbs. Death came due to the bites in the ventral area of neck. Bites were often evident in carcasses skin, the distance between the two teeth holes were from 3 to 3.5 cm. After the flatting the neck showed: haemorrhages, lacerations of soft tissues (muscles, big vessels), while the tracheas were rarely lacerated with only signs of compression. The consumption took place mainly at night or at dawn with a constant distribution per hour (18-21: 23%, 21-24: 24%, 24-3:26% 3-6: 27%). On average, for adult sheep, consumption lasted for 7-10 days, but often returned also after 20 days or more. The average total daily consumption duration was 28 minutes (1-85). Factors affecting permanence were related to the disturbance and the carcass consumption rate. Feeding behaviour was often alternate with vigilance behaviour (about 42% of the time spent). The consumption was beginning from removing the rumen and intestine from the abdominal cavity and moved it to a few meters from the carcass, to avoid the dispersion of faecal material. Feeding began from the muscular part of the back limbs, then passing to the heart and lungs.

Conclusions

The macroscopical lesions observed on the carcasses and the photographic material collected confirm the active predatory behaviour of golden jackals. From the analysis of the video emerge that the predation has probably occurred by two or more jackals in the 61% of cases. In the remaining 39% cases, a single animal made the predation. The anatomopathological features observed in sheep killed by golden jackal appears very similar to the wolf approach. The jackal is the first consumer of the

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carcass but the kleptoparasitism by wild boar and fox makes difficult to estimate the amount of consumption by the predator. Livestock predations are the main sources of conflict between jackals and breeders.

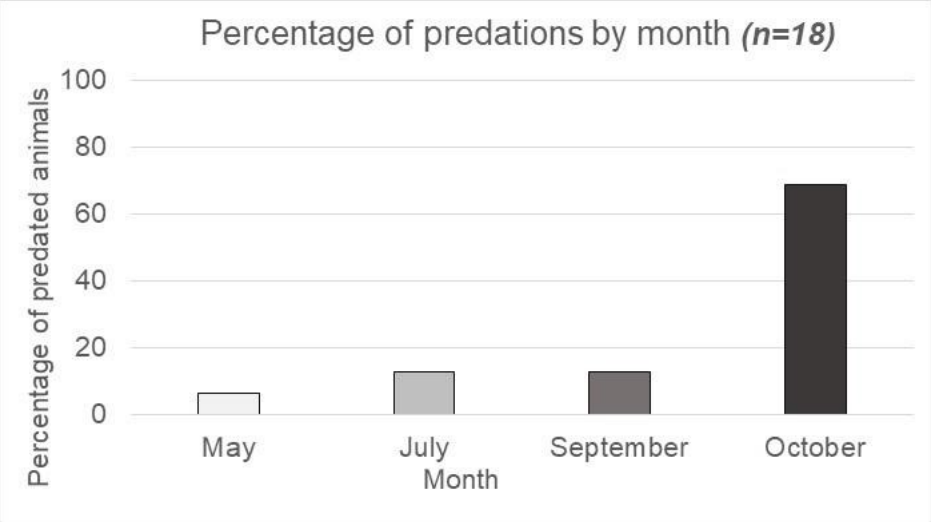

Figure T65C5.1: 68% of predations occurred in October, 12.5% in September, 12.5% in July and 6.25% in May.

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T66C5

Thanatological and necroscopic remarks about two suspected poisoned golden jackals (*Canis aureus moreoticus*) from north-eastern Italy.

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Introduction

In the last decade golden jackal (*Canis aureus moreoticus*) distribution indicates an ongoing expansion in Europe. The species can live under a wide variety of natural conditions and this ecological plasticity allows it to settle large geographic range. Increased presence is recorded in the European area northwards and westwards, including Italy. Italy provides an important habitat for wildlife. Anthropogenic activities threaten many species, as accidental or deliberate poisoning, documented over many years in European countries.

Methods

During the spring of 2018 two golden jackals were found dead in Gorizia province in Friuli Venezia Giulia (FVG) region (north-eastern Italy). Different reproductive packs of golden jackal inhabit this area and the neighbouring north-west Slovenia, where sheep farms are quite widespread.

Two carcasses were found at a distance of about 150 meters from each other within 5 days. In that area, during the week before the findings, the temperature range was 8-29°C with sunny weather. The dead animals, a male and a female both of about one year old, were located in area partially shaded and externally infested by different necrophagous Diptera and Coleoptera species. The insects on carcasses were in different development stages and they were dead or showed nervous symptoms. The animals were submitted to the laboratory for gross pathological analysis; brain, lungs, stomach content, liver, spleen and kidney were sampled for Canine Distemper Virus, Rabies Virus and toxicological investigations; lungs and gastrointestinal tract were collected for parasitological analysis.

Provisional results

The collected carcasses were moderately decomposed at the moment of the necropsy and their body condition score was good. Moderate haemorrhagic effusion in the thoracic cavity and lung parenchyma congestion were predominant pathological features; no lesions were observed in visceral organs but diffuse liver necrosis. The gastric content in one carcass was represented by only five partially digested birds with legs tied by wires (identified as *Coturnix* sp.), while in the other there were some bird portions (the same bird species), broken bones and hair of a scavenged mammal, at present still under study.

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Body condition score, post mortem findings, entomological features and gastric content aroused the suspect of poisoning. While toxicological analysis is in progress (not yet available for this abstract), preliminary microbiological and parasitological results would support the hypothesis. Furthermore, thanatological and necroscopic findings allowed the recruitment of an anti-poison dog team which found baits consisting in quails hanging on shrubs, at 20-150 meters from the carcasses respectively.

Provisional conclusions

This occurrence is the first description of poisoning as potential mortality cause in Italian golden jackal. The adequate evaluation of the suspected crime scene and the necropsy procedures adopted have been essential for the present hypothesis suggestion. Moreover, the data collected will be very useful for the correct management of this spreading carnivore in Italy and Western Europe.

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T67C10

Fear of the unknown: are carnivores terrorizing the Netherlands?

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The Netherlands is the most densely populated country of Europe. In 33,893 square kilometres of land surface live over 17 million people, more than 500 people per square kilometre on average. Also, the history of the Netherlands is not carnivore-friendly; they eradicated every carnivore larger than a red fox in the 19th century.

Still, large carnivores such as wolves and golden jackals are popping up in the Netherlands. Since 2015, wolves have been visiting the Netherlands on regular basis, with potentially the first wolf territory for over 200 years. Even the golden jackal has paid the Netherlands a visit in 2016, one individual was photographed twice by camera traps on different wildlife crossings.

In the oral communication I will give more insight in the public opinion and the actions of key stakeholders, organisations and government on this delicate and extremely controversial topic for a country where everything is regulated, contained and 'safe'.

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T68P

The background of human-wildlife conflicts in connection with the golden jackal.

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The golden jackal (*Canis aureus*) is a native carnivore species to Hungary but disappeared from the country by the middle of the 20th century. In the 1990s, breeding pairs were observed in the southern counties, and for today, the carnivore is present in all Hungarian counties.

During the explosive spread of the golden jackal, human-wildlife conflicts have been occurred gradually. Hunters claim that the jackal has a significant effect on wildlife management, especially on big game, while herders connect the suffered damages in their livestock with the species. The general judgment of the jackal is extremely divisive in the country and there are many contradictions related to the topic. To elicit different phenomena of conflicts and to get acquainted with the affected people's point of view, we made semi-structured interviews with hunters, herders and other local people in Somogy (15 interviews) and Bács-Kiskun (10 interviews) counties. At the beginning the interviewees were selected on the basis of the local ranger's suggestions. Later we reached additional people with snowball method. We used 11 main questions: morphological questions; local changes since the carnivore has reappeared; questions about putative diet composition; concrete depredations on livestock; future visions; etc.

Our interviewees reported about the effect of the jackal on local roe deer, fallow deer and red fox population. Most of the opinions were based on personal experiences, but besides that we also acquired relevant amount of information which was second-hand and originated from different kinds of media. The golden jackal's negative effect on roe deer was mentioned with the highest frequency (60-60%) in both areas. In Bács-Kiskun county, the interviewees assumed higher impact on small mammal populations (22%), while in Somogy county people found the carnivore's effect on fallow deer more significant (53%). The jackal's effect on red fox was reported by the 33% (Somogy) and 60% (Bács-Kiskun) of the interviewees.

There were many emotion-based opinions and there were people who doubted the results of scientific publications related to the diet composition of the jackal and its impact on big game. Nature conservation, just like media followed by hunters have a high responsibility in dissemination of knowledge. Mutual communication can serve as a base for a more effective and regular cooperation with local herders and hunters.

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T69C10

Compensatory life-history responses of black-backed jackals undermine population reduction efforts.

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Lethal carnivore management, aimed at reducing carnivore impacts, is a global phenomenon threatening the persistence of many carnivores. In South Africa, carnivore persecution escalated during the expansion of pastoralism and the introduction of modern technology. Consequently, most large carnivores have been extirpated from much of their historic ranges (e.g. lion, hyaena, and leopard); yet black-backed jackals (*Canis mesomelas*, hereafter jackals) persist despite centuries of lethal management. This begs the question; why do jackals survive when other predators have been extirpated? Jackals are the dominant cause of livestock predation in South Africa, causing financial losses reputed to be in excess of USD 90 million per year. Consequently, many managers still kill jackals to reduce densities, and presumably livestock mortality. Smaller canids, like jackals, are highly adaptable and display variable responses to these mortality sources, which may affect management outcomes. As yet, the effects of lethal management on jackal populations have not been fully investigated. Here, we compared reproduction and dispersal between jackal populations subjected to different intensities of lethal control (farms – heavily hunted; reserves – lightly hunted and unhunted) to determine if compensatory reproduction and compensatory immigration contribute to population persistence. We predicted that: 1) hunted jackals will increase reproductive output to compensate for increased mortality; and 2) lightly hunted/unhunted reserves will act as source populations, exporting individuals to heavily hunted farms that act as sink populations. We collected demographic (age and sex) and reproductive (uterine scars) information, as well as tissue samples (DNA analysis to estimate dispersal) from harvested jackals. We analysed 12 microsatellite loci from 554 individuals. Multilocus Bayesian genetic techniques were used to estimate dispersal between jackal populations associated with these distinct land-uses. As predicted, jackals on farms compensated for increased mortality by increasing the pregnancy rate of young individuals and increasing the litter size at younger ages, thereby increasing reproductive output (compensatory reproduction). This may be ascribed to anthropogenic mortality which reduces the density of conspecifics allowing younger individuals that would be socially precluded from reproducing to reproduce. Further, spatial variation in hunting intensity induced source-sink dynamics through net dispersal from lightly hunted/unhunted reserves (sources) into heavily hunted farms (sinks). Heterogeneous hunting intensities facilitated the dispersal of jackals from reserves by reducing the density of conspecifics on farms (compensatory immigration). The lethal management of predators is the prevailing strategy to reduce livestock predation. However, the highly adaptable nature of jackals and the combination of compensatory mechanisms such as increased reproduction and

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immigration allow these predators to persist in the face of severe anthropogenic mortality, through the formation of a source–sink system. These compensatory processes will continue to counter population reduction efforts as long as recruitment from refuges persists. Thus, lethal management of jackals may not be an effective long-term strategy in reducing livestock predation.

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T610P

Management of disease in Ethiopian wolves, Africa's most endangered carnivore.

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The Ethiopian wolf (*Canis simensis*) is one of the most threatened canids species in the world, with fewer than 500 individuals remaining. The wolves are threatened by diseases transmitted from domestic dogs, primarily rabies and canine distemper virus. To protect the wolves there have been trials of preventative vaccination and a long running domestic dog vaccination campaign, however we need to understand how to most effectively apply these interventions. Using custom built GPS collars high resolution data was collected on the domestic dog movements, this is combined with historical observation data on the movements of wolves to parameterise an epidemiological agent-based model (ABM). The ABM is fully GIS integrated meaning individuals are moving through realistic space with movements drawn from real behavioural data. Using this model, we will then simulate various vaccination strategies of both the wolves and the dogs. Using Kernel Density Estimates (KDE) dogs used a central range of ~1km^2 with a further extent of ~4km^2.

Dogs in the range appeared to move slowly, 200m/hour or less in most hours. Dogs were typically out of the village between 07:00 – 15:00h. Individuals showed clear preferences, but activity patterns varied highly between dogs.

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Picture T610P.1: Fifteen-member dhole pack in pre-hunt bonding ritual. Bandipur National Park, Karnataka, India. Credit : Krupakar Senani.

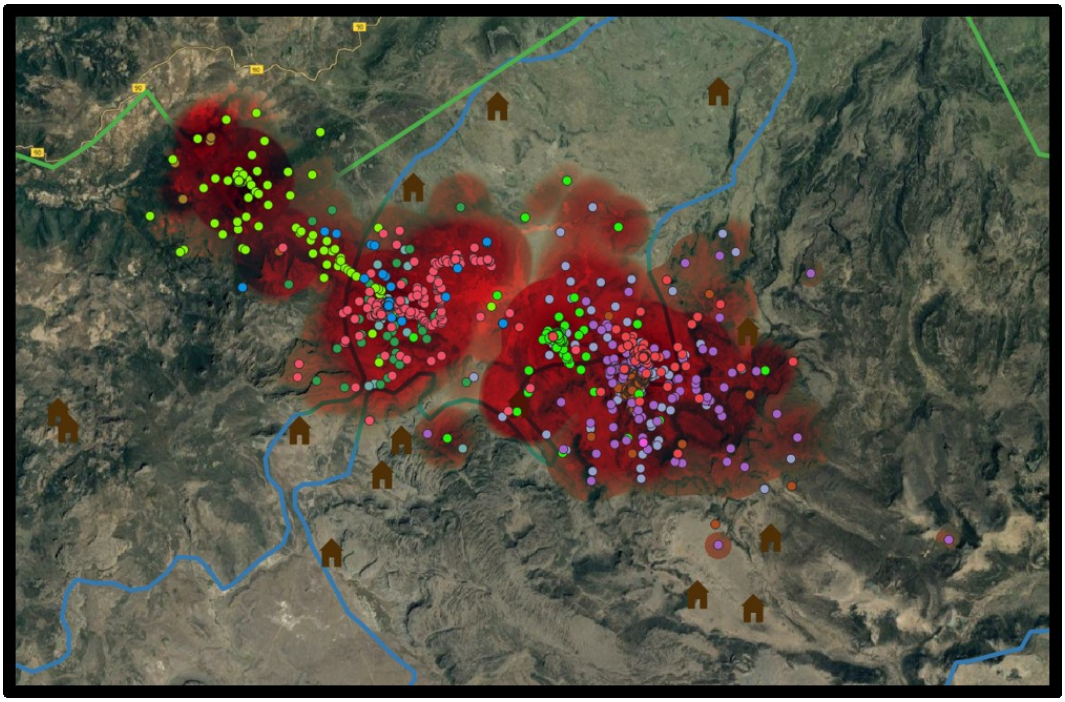

Figure T610P.2: Using Kernel Density Estimates (KDE) dogs used a central range of ~1km^2 with a further extent of ~4km^2.

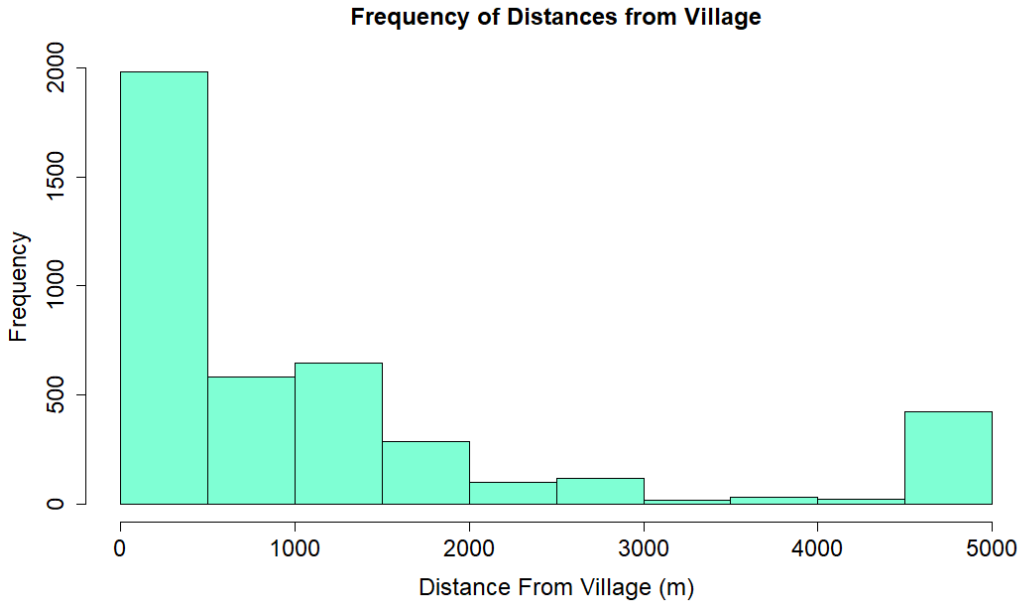

Figure T610P.3: Dogs in the range appeared to move slowly, 200m/hour or less in most hours.

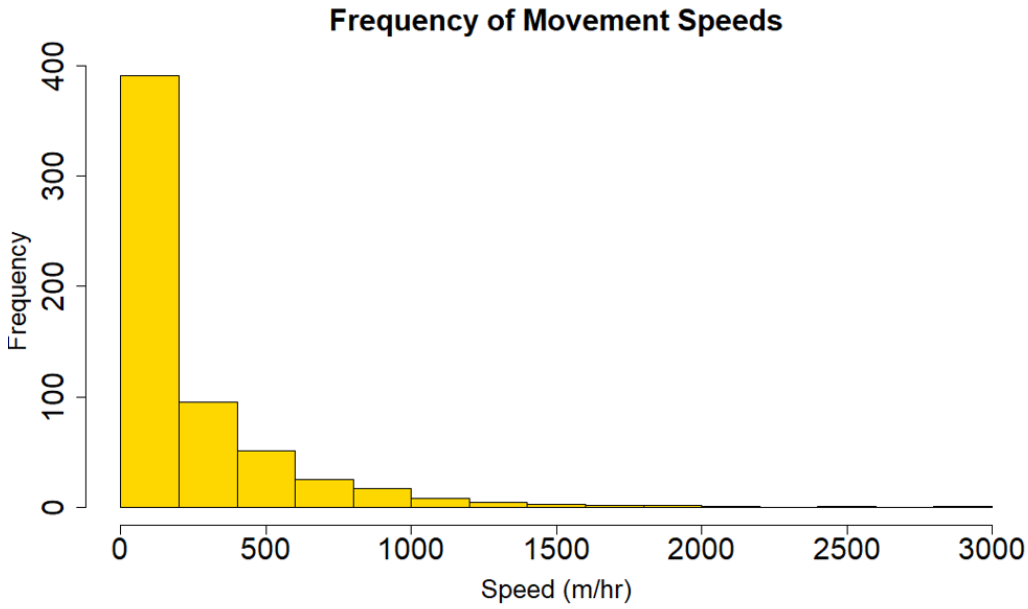

Figure T610P.4: Dogs in the range appeared to move slowly, 200m/hour or less in most hours.

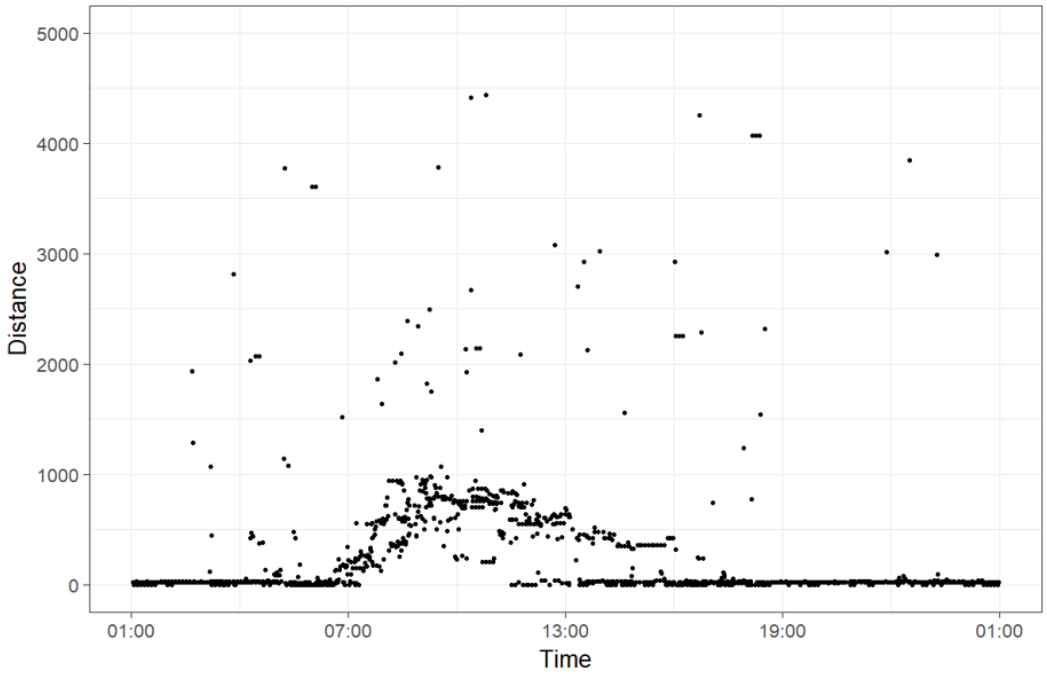

Figure T610P.5: Activity patterns varied throughout the day and between dogs, but they were away from their village and most active between 07:00 – 15:00h.

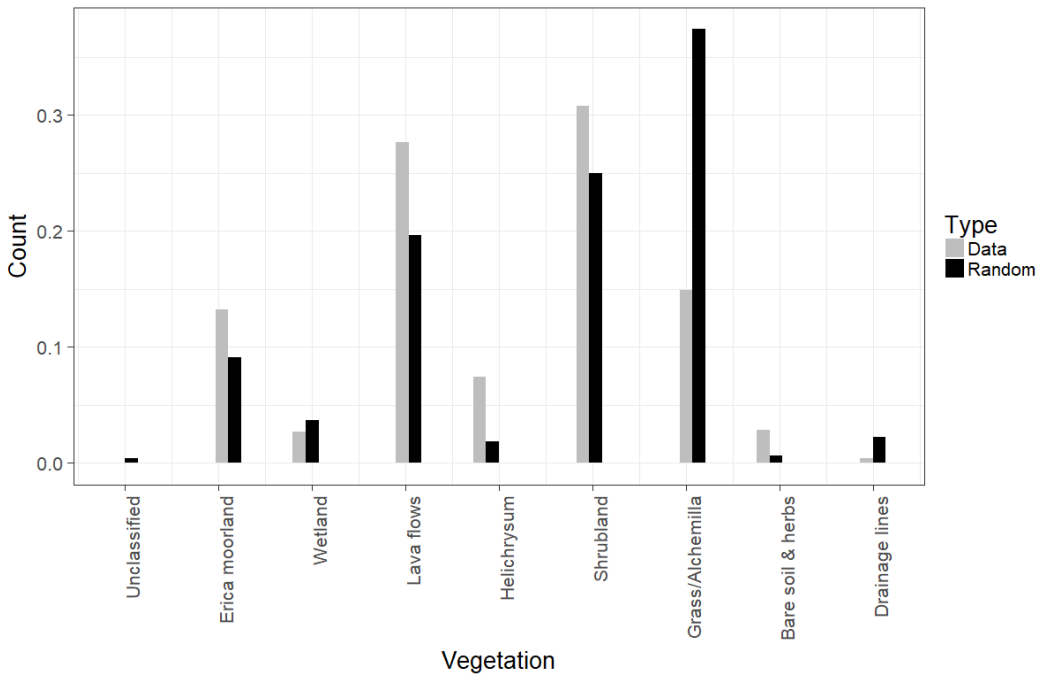

Figure T610P.6: Dogs used most available habitats, but when compared with habitat availability, they showed a preference for grasslands and *Alchemilla* meadows.

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Chapter 7: Applied Ecology and Habitat

T71K30

Golden jackal expansion across Europe: causes and consequences.

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As a generalist and opportunistic species, golden jackal (*Canis aureus*) is capable to colonize wide range of habitats and exploit various food sources. Since the 19th century, jackal increased in its distribution and abundance in Europe in what is arguably the most dramatic recent expansion among the native predators on the continent. Its historic distribution through much of the Holocene was restricted to the south-eastern Europe, mostly along the Mediterranean and Black sea coasts and islands. Later these historic populations merged with the jackals expanding from the Caucasus and especially since the Second World War jackal population has been increasingly spreading throughout Europe. Today reproductive populations are established in Central, East and North Europe with vagrant animals occurring also in parts of Western Europe. Factors affecting the jackal expansion across Europe are not completely understood and several hypotheses have been proposed. Recent studies have suggested that jackal expansion was triggered by intensive persecution and resulting decline of the European apex predator, the gray wolf. Reconstruction of the historic changes in the distribution and abundance of the two canid species on the continental scale, hunting data patterns at regional scale, and local data on jackal persistence in areas that became re-colonized by territorial wolves all seem to support the mesopredator release hypothesis. Recent data suggest that also nowadays top-down suppression may be weakened where wolves are intensively persecuted by humans or occur at reduced densities. Additional factors that have been suggested to influence jackal expansion in Europe include abundant and easily accessible anthropogenic food resources, changes in land use and wildlife management, and climate change. Although still understudied, jackal colonization of new areas has potential to affect other wildlife through a range of interspecific interactions, including predation, competition, kleptoparasitism, and several indirect interactions. Furthermore, due to species' preference for human-dominated landscapes, the jackals can also affect people. Consequences of this interaction can be negative for local inhabitants, such as livestock depredations, or positive due to ecosystem services provided by the jackal. However, further research is required to better understand interactions between golden jackal and other species, including humans, and to guide future management policy.

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T72K30

Structure and dynamic of the coyote population in an urban environment: Lessons from spatial ecology.

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Coyotes (*Canis latrans*) have recently become top predators in most metropolitan areas across North America. Despite their ubiquity, the full extent to which they exploit urban landscapes is still poorly understood, especially within the urban core. As part of a long-term monitoring project, since 2000 we have captured and marked over 1,000 coyotes from the Chicago, Illinois, USA, metropolitan area, an area that includes a population density of over 9 million people. We used the full sample for demographic analyses, which revealed largely consistent survival rates (S = 0.60-0.80) across years and across the landscape, including highly urban territories (570 MCP territories from 288 individuals). Primary cause of mortality was vehicles, and mange was the most important disease. Exclusive territories were maintained regardless of urbanization, but space use within the territory varied. Space use in the most developed areas became linear and followed transportation corridors. Linear corridors also served as foraging areas. Survival was consistent across space, regardless of road or traffic densities, indicating adjustments to traffic patterns. Some disease exposure varied by space. Matrix modelling revealed that the population has maintained a positive growth rate, and represents a source population across the city. Coyotes are now exploiting nearly all areas of the Chicago landscape, including the urban core, and there are now generations of coyotes that have been reared within the metropolitan area. Nevertheless, the frequency of nuisance coyotes has remained low across years regardless of location or length of time near people. This success illustrates that medium-sized predators can be successful in large cities.

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T73C5

Current state and further expansion of the jackal in the Ukrainian Carpathian area.

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First records of the golden jackal in Ukraine belonged to the end of twentieth century. Till the last decades, the species was distributed in Ukraine mainly along the Black-sea coast. However, during the last several years new records of the specimens have been recorded in different parts of Ukraine. The appearance of the golden jackal was expected in the Transcarpathian part of the Ukrainian Carpathians area because the species had observed everywhere in Hungary till the end of the 20th century. The first reliable record of the golden jackal's observation was coming from January 2005 (near Koroleve village, Vynohradiv district). A specimen was caught again in 2006 in the same locality. After that period the specimens were noted almost every year. Majority of records were originally from the bordering area with Hungary. Besides of numerous new records close to the Hungarian border (floodplain of the Tisa river basin), the jackal became to penetrate the sub-mountain and mountain parts of the Carpathians. Since these years we observed an expansion of the species in the Transcarpathian part of the Carpathian Mts.

During the last years, we noted the tendency of expansion of jackal into the mountains. The highest altitude consisted on over 600 m a.s.l. (between villages Lugy and Bohdan, Rakhiv distr.). However, some places, where the jackal s were recorded, were situated relatively deep in mountains. The longest distance was over 100 km. All the mountain records were in autumn and winter, so it can be the dissemination of young specimens. Usually, the golden jackal inhabited ecotones and very mosaic habitats: edges of forest-bushes biotopes, riverine undergrowth, and reed-bed. Sometimes the species may occur in the foothill mountain zones. All the records of the jackal in the mountains showed that animals moved along the rivers. Majority of records of the jackal originated from killed specimens. There were hunted by hunters (shot or trap) or killed by the shepherd or hunting dogs. Usually, the jackal avoids areas settled by wolves. However, the records in mountains were originated from the places inhabited by wolves. Interspecific interaction of jackals and wolves are still not investigated.

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T74C10

The golden jackal in Europe: Where to go next?

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The golden jackal's *Canis aureus* distribution is expanding rapidly and populations are increasing in Europe. Historically restricted to the Mediterranean and Black sea coasts, jackals are now reproducing in most of South-eastern Europe as well as in Central European countries. Current population trends suggest that population expansion is far from complete. The colonization of this new species could have important implications on animal communities and the ecosystems. The presence of this new carnivore is already receiving high interest from wildlife managers, policy makers and the

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public. In this study, we aimed at characterizing the golden jackal habitat preferences, and identifying areas of high habitat suitability, which are likely to be colonized in the future.

We surveyed the presence of golden jackal territorial groups throughout its European range by means of a strict bioacoustic stimulation protocol. We characterized the species environmental niche using snow cover duration and ten land-cover variables extracted from Corine Land Cover, as well as gray wolf presence, treated as a trophic dependency covariate. We modelled jackal probability of occurrence by fitting a generalized linear model (GLM) to our survey presence/non-detection dataset. We evaluated the model predictive performance by means of a repeated split plot. The final model was then projected across the continent.

We performed acoustic stimulations at a total of 8,821 locations in twelve countries. Among these, we recorded the presence of established jackal groups at 1,821 localities. Snow cover duration accounted for the highest variable contribution (mean = 37.2%), followed by wolf presence (mean = 20.8%). Proportion of forest and agricultural land cover, as well as distance from settlements and hydrological features were also selected in the best model. Jackal probability of occurrence was highest in areas with short snow cover duration, heterogeneous land cover and outside the core of the wolf range. Average jackal probability of presence ranged from 0.21 in areas of permanent wolf presence to 0.73 in areas of wolf absence. Although snow cover duration was the most influential variable to predict jackal distribution, the model predictive ability was significantly improved by including the wolf presence covariate.

Besides the clear avoidance of snowy areas, our findings suggest that the species favours mosaic landscapes and avoid areas with permanent gray wolf presence. Furthermore, our modelling results suggest that large parts of Western and Southern Europe may be suitable for golden jackals. Altogether, these results provide managers with relevant information to prepare for the jackal's future colonization of areas where the expansion is most likely.

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T75C10

Jackal´s expansion towards north: Can they survive in boreal ecosystem?

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First evidence of golden jackal (*Canis aureus*) presence and reproduction in Boreal region was recorded in Estonia in 28.02.2013 when young female individual was accidentally hunted in Western Estonia. The species was identified by external and cranial characteristics as well as using mitochondrial DNA analysis. Since then the species was expanded its range and in 2016 and 2017 it was distributed along almost all western coast of Estonia (Baltic Sea) with at least 10 reproductive pairs. While after first records jackal was regarded as alien species in all Baltics, the following evidences expressed in several scientific papers forced the governments to re-evaluate the legal status. For the present, jackal is affirmed as naturally immigrated new species and lies in the lists of game species in all three Baltic countries. In Estonia, jackal was regarded as small game (with just limited hunting season) in 2016, and the hunting bag size in 2016 and 2017 was 32 and 26, respectively (Table T75C10.1).

In Latvia jackal reproductions were observed in 2013 and 2014 in inland habitats of southern part of the country but no more evidences of reproductions are recorded afterwards. In the southernmost Baltic country Lithuania there has been just two evidences of jackal presence without any known reproduction so far.

Hereby we present the habitat preference of recently established jackal population in boreal region, the probable role of human activities and wolf on it, and try to predict the future scenarios of that northernmost small local population.

Table T75C10.1: Hunted and found dead (mainly road kills) jackals in Estonia in 2012-2017 hunting years (March - next year February).

Year	Hunted	Found dead
2012	1	0
2013	3	0
2014	2	3
2015	6	1
2016	31	1
2017	26	3

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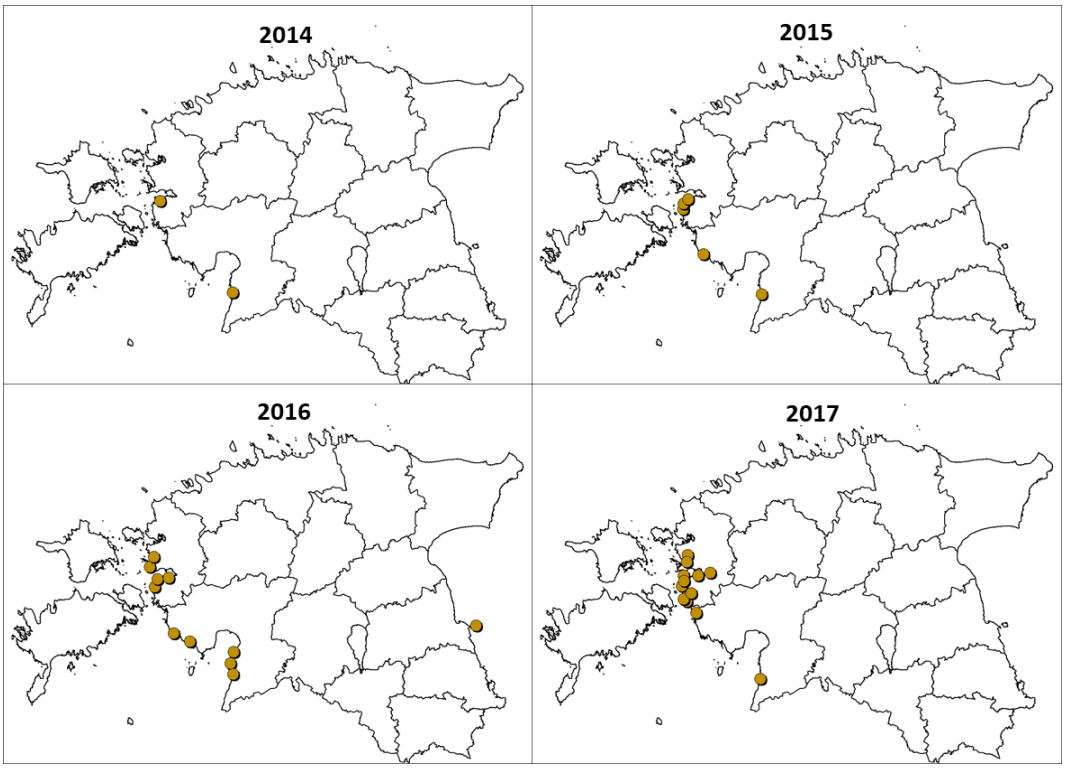

Figure T75C10.1: Reproductions of golden jackal in Estonia in 2014-2017 (from data of hunted individuals).

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T76P

Status update and distribution of the golden jackal in parts of continental Greece.

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Similar to other parts of south-eastern Europe, the golden jackal population (*Canis aureus* L.) suffered a strong decline in Greece till the end of the 20th century. Main causes of decline were the extensive poisoning campaigns till the early nineties when the species was considered "vermin", and the reduction of the species food supply due to changes in human agro-pastoral activities (less husbandry related waste and stricter disposal regulations). Nowadays, it is possible that golden jackals in Greece have recovered and began expanding their range even into areas outside of their historic distribution. The aim of this research was to detect the presence of established golden jackal territories in mainland Greece through bioacoustic monitoring and to produce an updated distribution map of surveyed areas. A total of thirteen transects (139 calling stations) were carried out in six regions of mainland Greece (Attiki, Central Greece, Epirus, Thessaly, Western Macedonia Central and Eastern Macedonia). We recorded five jackal responses at four calling stations in areas next to the coast in Attiki and Epirus; the other 135 calling stations were negative. Two spontaneous golden jackal howling and one jackal pair sighting were also considered in the analysis as jackal territories. Landscape and environmental characteristics were assessed within two different radii (500 m and 1000 m) around all calling stations. Shrub and/or herbaceous vegetation association was the dominant land cover class surrounding both the positive and negative calling stations. However, for the second dominant land cover, the results showed a difference between positive and negative points. The positive calling stations were surrounded by heterogeneous agricultural areas and the negative calling stations were largely characterized by forest. Furthermore, the results support the assumptions, that the golden jackal may not be present in many parts of mainland Greece due to the presence of wolf packs, dense forest cover or human pressure.

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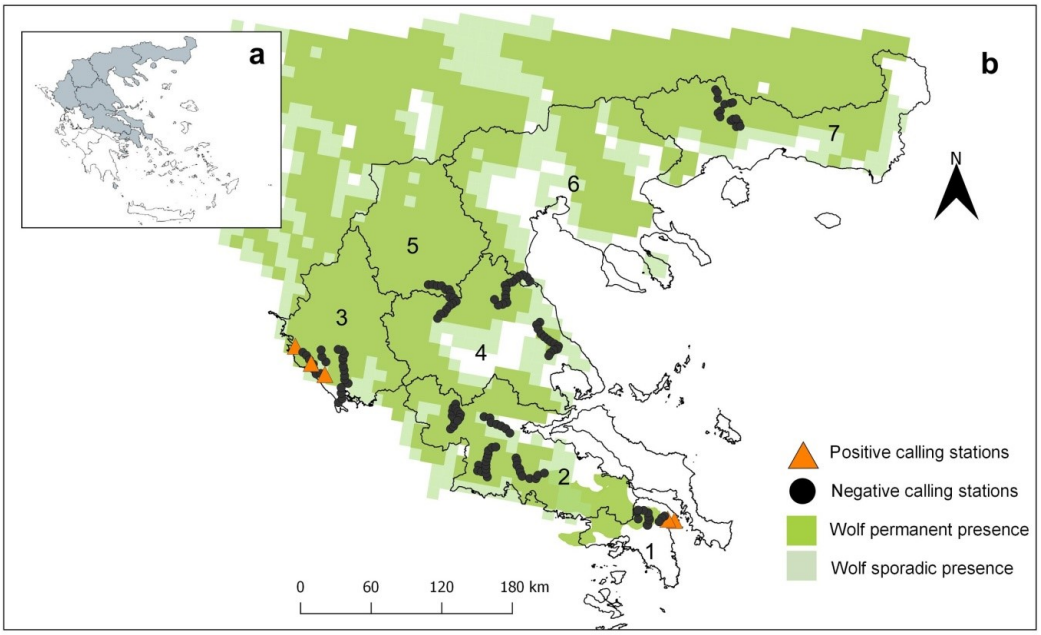

(a) Map of Greece. (b) Location of the 13 transects- 139 stations- in the 7 Regions of continental Greece [Attica (1), Central Greece (2), Epirus (3), Thessaly (4), Western Macedonia (5), Central Macedonia (6) and Eastern Macedonia (7)]. Data source for Wolf distribution: Large Carnivore Initiative for Europe (LCIE) 2006-2011 and Giorgos Giannatos personal communication (data between Attica and Central Greece) 2018.

Figure T76P.1: Map of Greece indicating the presence of wolf as well as the calling experiment results.

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T77C10

Potential versus actual "habitat interference" between expanding golden jackals and wolves in Slovenia.

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Interference competition with wolves (*Canis lupus*) is hypothesized to be one of predominant factors that have limited the distribution and expansion of golden jackals (*Canis aureus*) to Europe since the Holocene. The eradication or reduction of wolves is often invoked to explain the expansion in jackal range throughout a large part of central- and south-eastern Europe in the last 30 years. Spreading of the distribution range is followed by a rapid increase in abundance of jackals. A similar trend is significant also for Slovenia, which has experienced a rapid increase in the jackal distribution range, which however overlaps with the range of wolves. Moreover, during the last decade the abundances of both jackals and wolves have markedly increased in Slovenia putting in question former beliefs on competitive exclusion of these two species when considering long-lasting trends.

The spread of the jackal has raised numerous conservation and management issues, while the emerging ecological role of the species in the areas of recent range expansion is barely known. Competition is a powerful form of interaction that structure animal communities. In competitive interactions, species evolve either to avoid each other, to tolerate the presence of the other, or to aggressively exclude the other.

To explore the hypothesis that jackal abundance/distribution is limited by interactions with wolves, we developed habitat suitability models for each species. All data on wolf's and jackal's distributions in Slovenia were collected from the national monitoring databases (i.e. acoustic surveys, mortality, telemetry, non-invasive genetic samples and other signs of presence). The best models, selected by the Akaike information criterion, of the resource selection function (RSF) by wolves and jackals included percentage cover of forests, meadows, marshes and other co-natural landscapes, forest fragmentation index and settlement density index. For jackals we developed ad-hoc expert habitat suitability model as well as GLM and Maxent models based on presence data only. All jackal habitat suitability models were overlapped with wolf's habitat suitability model to estimate a potential habitat interference between the species. Alternatively, potential interference distribution was compared to actual distributions between the species obtained from the national monitoring in 2016/17 and 2017/18, respectively.

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T78C10

Habitat preferences of golden jackals in northern Bosnia and Herzegovina.

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In this study we investigated the presence and distribution of the golden jackal (*Canis aureus* Linnaeus, 1758) in northern Bosnia and Herzegovina and attempted to discover habitat structures potentially selected by this species. Furthermore, the distance of the detected animals to the nearest human settlement was also measured. Dispersal towards Central Bosnia and Herzegovina was another point of interest in this study and was analysed by measuring the air distance of territorial groups from the northern border of the country, namely the river Sava. Finally, we calculated the density of territorial groups in our survey area. We used acoustic stimulation as non-invasive tool to gather data on jackal presence. Habitat structures were evaluated with GIS software and used as input for our statistical models. Our survey area covered approximately 1150 km². Results showed a minimum density of 3.5 territorial groups per 100 km². Territorial groups were found at distances more than 15 km south of the Sava River with the highest measured distance being 38 km. Habitat analysis identified shrub vegetation and pastures as structures with significant positive influence on the presence of golden jackals (p=0.038, p=0.014 respectively). Distances between jackals detected with this method and the nearest human settlement turned to be small, the nearest one being 75 m. The mentioned structures (transitional woodland-shrubs and pastures) together with other potential influencing factors like local agricultural practices, low hunting pressure, diverse natural and anthropogenic food sources, could have benefited the dispersal of golden jackals in the northern lowlands of Bosnia and Herzegovina.

Keywords: golden jackal, habitat analysis, GIS, Bosnia and Herzegovina, acoustic monitoring

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T79C10

Seasonal differences in golden jackals' howling response in eastern Bulgaria.

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The howling in jackals has a complex structure and is mostly used for territorial interactions. Due to the recent expansion of the golden jackal in Europe and the well-known fact that jackals respond to a playback howl, the bioacoustic stimulation has become an important method for data collection related to the jackal population density. This work describes changes in golden jackal response to a pre-recorded howl on a monthly basis throughout one year of monitoring period. The study area was set in Eastern Bulgaria, in regions with already known high jackal population density. The data were collected from two transects located in different areas (north-east and south-east Bulgaria) (Figure T79C10.1). The highest number of answers to the broadcasted howls was detected during June and July in south-east Bulgaria, and, July and August in north-east Bulgaria. During these peaks, group-answers were registered mainly and the single individual-answers were very few or missing (Figure T79C10.2). Based on jackal's ecology and biology, we assume that the howling response corresponds more to interactions between territorial groups, rather than to communication signals during the breeding season.

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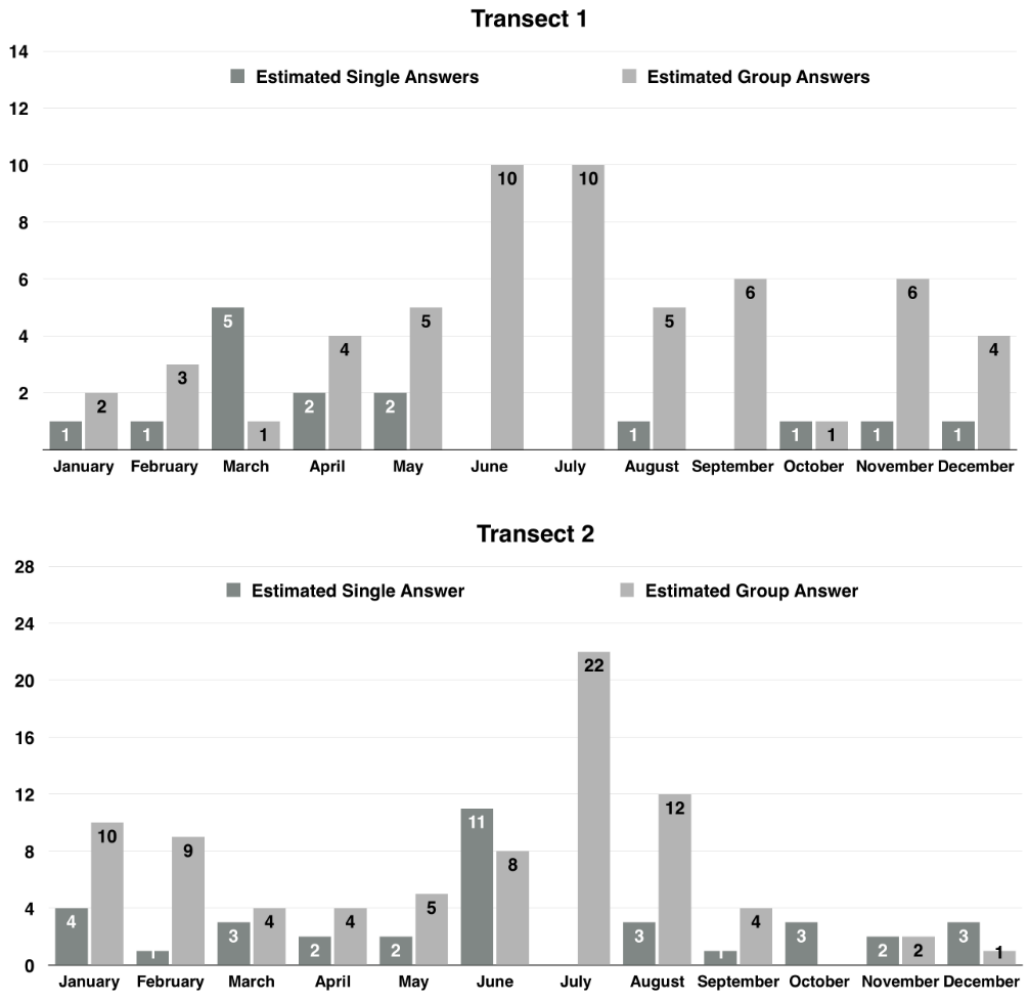

Figure T79C10.1: Golden jackal individual and group responses to bioacoustic stimulation.

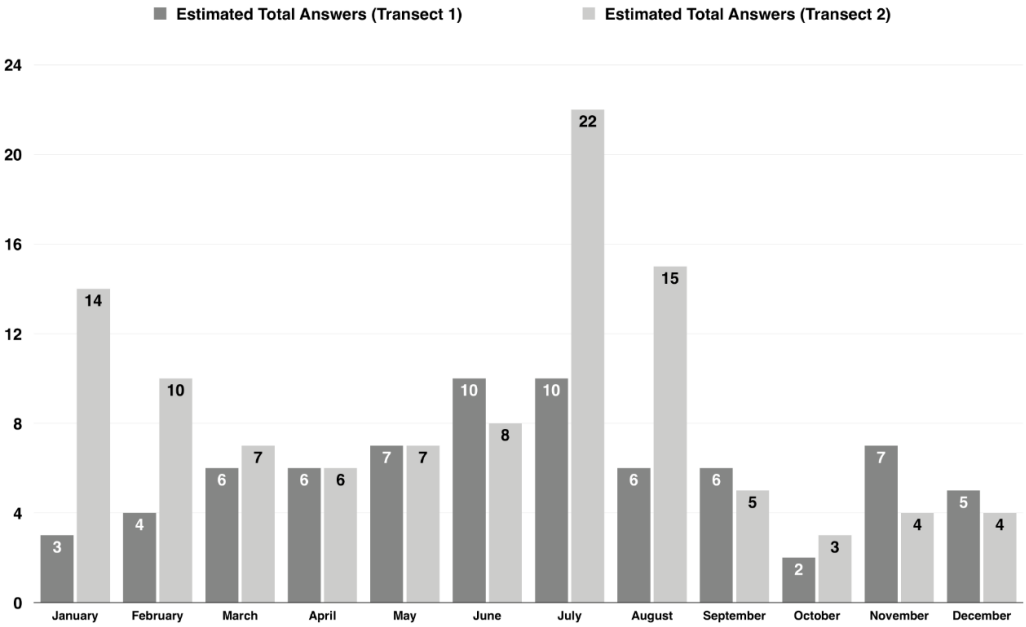

Figure T79C10.2: Seasonal jackal responses to bioacoustic stimulation in two regions from Bulgaria.

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T710C10

Red fox and golden jackal hunting bag differences in countries from central and south-eastern Europe. Population trend and management aspects.

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Red foxes (*Vulpes vulpes*) and golden jackals (*Canis aureus*) are medium sized carnivores with similar ecology in terms of habitat use, food requirements and demographic features. The large-scale spreading and population growth of the golden jackal species, which occurred in central and south-eastern Europe (SEE) during the last years, raised many questions. One of them is how the environmental boards and game hunting authorities would interact for both red foxes and jackal's population conservation action plan within the principles of applied ecology at economic and management levels. We hypothesized that the red fox population in central and SEE would be affected by the larger body size jackal species.

We collected abundance estimations and hunting bag (HB) data of the two species for 2002-2017 period in Bulgaria, Hungary and Romania. We fitted linear and exponential models on distribution of stock assessment (SA) and HB data and assessed red fox and golden jackal management with the control rate (CR), defined as the current ratio between hunting bags and the size of the breeding stock. In addition, we gathered jackal HB from Croatia, jackal and red fox HB from Serbia and red fox HB from Austria. Hunting indicator of red foxes population density (H.I.P.D.) was used to compare red foxes hunting success during 2015/2016 hunting season in Austria, Hungary, Bulgaria and Romania.

The last golden jackal available HB data for the studied countries are: 623 specimens in Croatia (2012), 1403 in Serbia (2008), 3267 in Hungary (2015), 5371 in Romania (2016) and 20179 in Bulgaria (2015). Significant exponential trends of growing are seen for jackal SA data in Hungary, Romania and Bulgaria. In Romania and Hungary there are strong correlations between official jackal HB data and those predicted by fitted exponential models. In Bulgaria, linear correlation coefficient is higher, and their significance is stronger ($r_{lin} = 0.712$, $p = 0.004$; $r_{exp} = 0.652$, $p = 0.011$). In case of the fox, linear growing trend is common for SA and HB data as well. The averaged jackal CR for the studied period was 0.23 in Hungary, 0.47 in Romania and 0.53 in Bulgaria while the average of fox CR was 0.88 in Hungary, 0.43 in Romania and 0.39 in Bulgaria.

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H.I.P.D. was 0.78 foxes / km^2 in Hungary and Austria, 0.1 / km^2 in Romania and 0.17 / km^2 in Bulgaria. In the 2015/2016 hunting season in Austria and Hungary the red fox HB was 136,182 individuals / 176.909 km^2 (7.69 individuals / 10 km^2) in comparison with data obtained from Bulgaria and Romania where the total HB was 45,727 individuals / 349,390 km^2 (1.30 individuals / 10 km^2).

Evidence of the golden jackal competitive exclusion or suppression effect on red foxes referring to the population dynamics has not been found in any of the studied countries. The red fox abundance in countries from Central Europe might be an interesting ecological factor to assess during the limited invasibility of these new suitable habitats by the golden jackal.

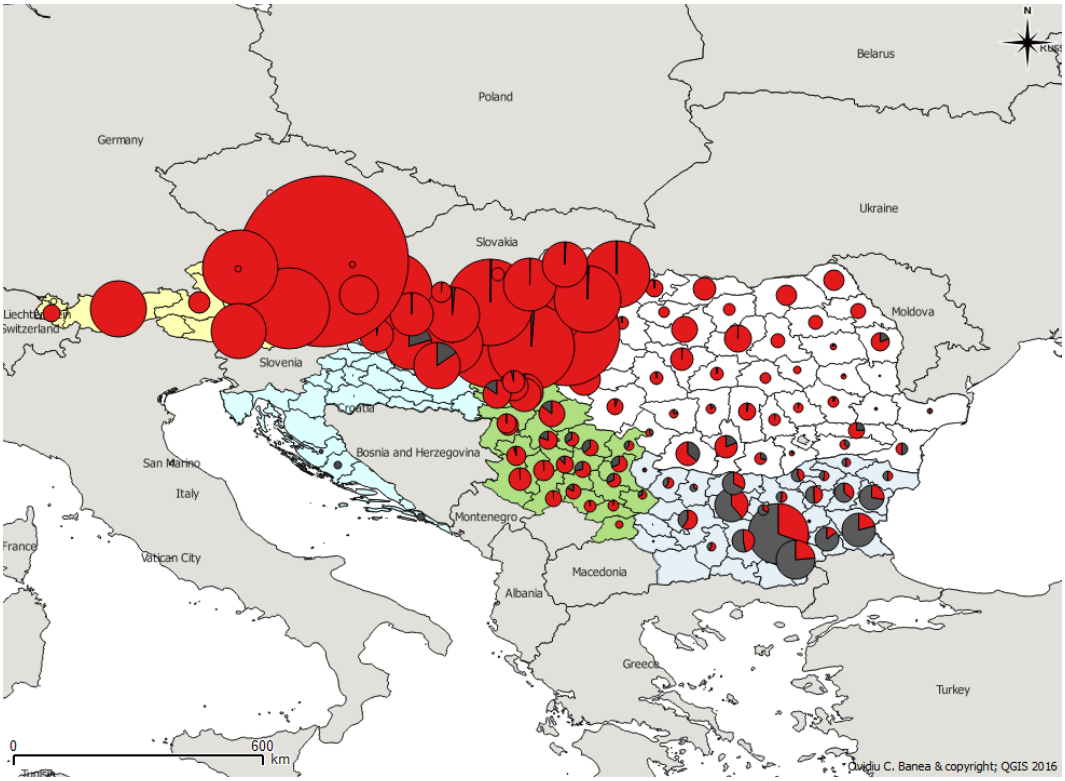

Figure T710C10.1: Red foxes (red) and golden jackal (grey) harvested in 2014 (Central Europe).

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T711C10

Specification of different habitat types that affect the golden jackal spreading.

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Golden jackal (*Canis aureus* L. 1758) is a wide-spread canid. Owing to its excellent adaptability it can occur in various habitats. It is a native species of Hungary but primarily due to habitat changing and destruction it became extinct from the country by the middle of the 20th century. Spontaneous re-colonisation has started in the early '90s, intensive spreading is proven since then not only in the country but over its origin area across Europe. The reason of fast, invasive like spreading and the estimated extremely high population density in some areas is unclear nowadays. Habitat analysis of the golden jackal was based on a long-term bioacoustic study carried out in one core area of the species' distribution area (between River Tisza and Danube, close to Hajós-Szentgyörgy and Császártöltés-Kunfehértó) between 2004-2014. The estimated population density is rather high (up to 2.4 group/1000 hectares, $\bar{X}$=0.99; SD=0.6) in this ~45000 ha study area. Location points where presence of the golden jackal had proven by its response were chosen for analysis. Buffers with 1 km radius were marked to the location points by the maximum hearing distance (thus the covered area was 314 ha in each point) then GIS (QGIS) analysis were done by the Corine (Coordination of Information on the Environment) Land Cover (CLC2012). Frequency and rate of each land cover category were specified. In total 16 habitat types were found from which three were determinative (~20-20%): Mixed forest (3.1.3), Transitional woodland-shrub (3.2.4), Broad-leaved forest (3.1.1). Significant difference wasn't found in habitat use of the jackal by the comparison of study periods (spring-autumn). Results don't show preferred habitat type obviously, but settlements seem avoided and forests are attractive for the jackal. Our results confirm the importance of woody areas (hiding-place) and slight proportion of arable land in high population density areas so far. Previous results give an opportunity to predict further spreading in Hungary by the presence of suitable habitats for the golden jackal.

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T712P

Habitat suitability analysis on the golden jackal for the Netherlands.

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The aim of this study was to investigate how many golden jackals (*Canis aureus*) family groups will be able to live in the Netherlands and where these would be located. First the habitat requirements of the golden jackal were assessed by means of a literature study. This information was used to perform a Habitat Suitability Analysis (HSA). Factors such as diet, roads, habitat size, land use and potential wolf territories were taken into account to assess the quality of the each 25x25 meter area as part of potential habitat for golden jackal. 5 rules were established based on the literature study:

1. Diet is not a limiting factor, but rather a density depending factor.
2. Urban areas are not used as resting spots but will be visited during the night.
3. The territory of a family group in highly suitable areas is 6 km^2 and in suitable areas is 12 km^2.
4. Roads are barriers but these are not insurmountable.
5. Presence of wolves makes an area uninhabitable for the golden jackal.

The main two limiting factors for the golden jackal seem to be urban areas (excluded in this study) and the presence of wolves. Maps were created in which the most likely core areas, highly suitable areas and suitable areas were recognized.

The core areas consisted of high quality areas of at least 6 km^2 consecutive area without any roads. Highly suitable areas were the same as core areas except that primary and secondary roads were allowed. The suitable areas consisted of lower quality area and were therefore at least 12 km^2 of consecutive area. The results showed that core areas can support more than 100 family groups, while the highly suitable areas can support an additional 50 family groups. The remaining suitable areas can support up to around 1200 more family groups. In total the Netherlands could support around 1450 golden jackal family groups. Reestablishment of wolves could decrease these numbers to around 800 golden jackal family groups. This study did consider as many parameters as possible and used conservative parameter settings; therefore it is likely that these estimated suitable areas will be higher in reality.

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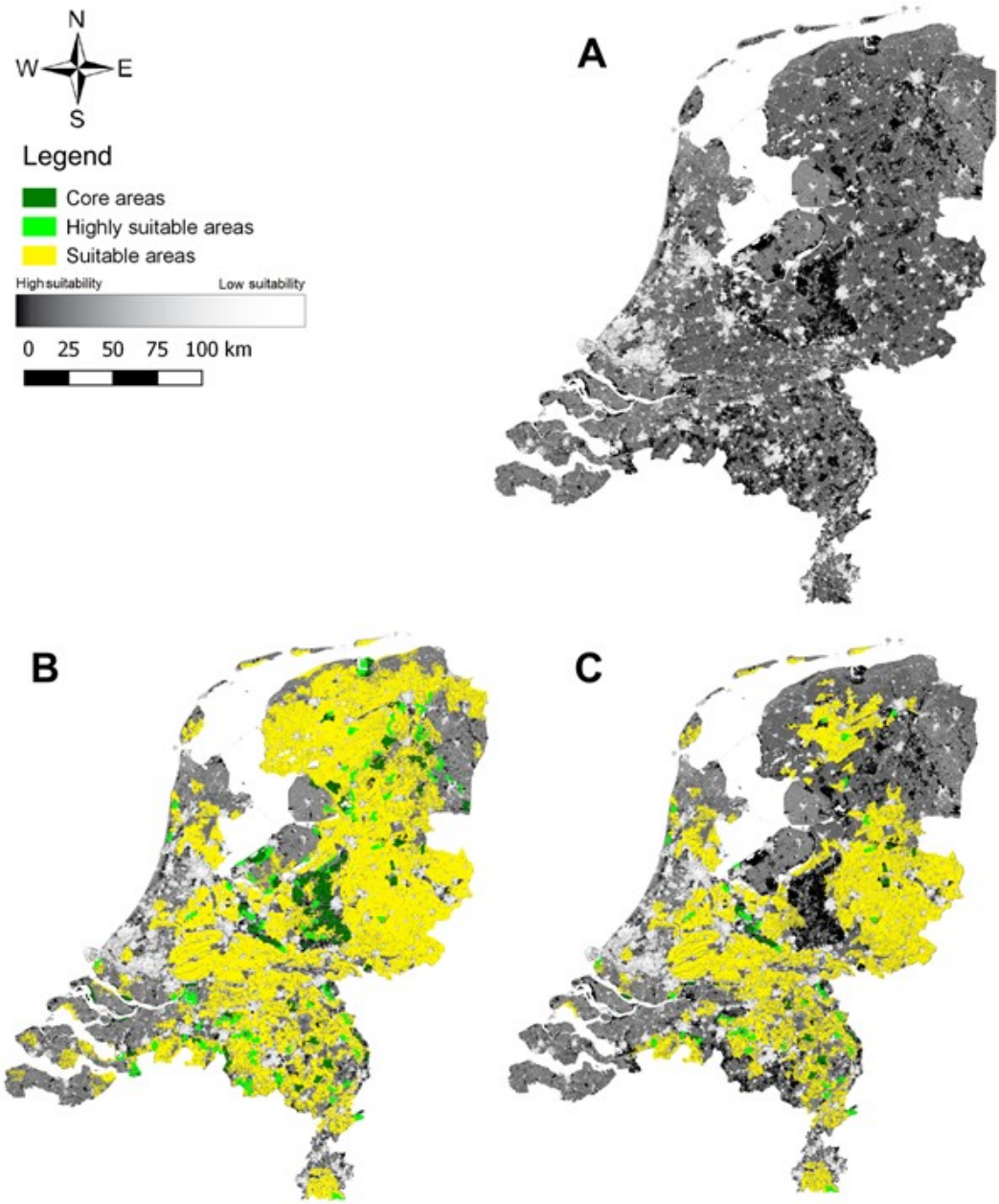

Figure T712P.1: 3 maps of potential golden jackal habitat: **A.** The Netherlands mapped based on habitat suitability. **B.** The Netherlands mapped based on habitat suitability including core areas, highly suitable areas and suitable areas. **C**. The Netherlands mapped as B but excluding potential wolf territories.

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T713C5

New records and population density of golden jackal in the Danube Delta Biosphere Reserve.

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Introduction

The Danube Delta Biosphere Reserve (DDBR) has been largely studied for decades from biodiversity point of view. However, the golden jackal (*Canis aureus*) population has not been systematically investigated and its distribution and size is still little known.

The golden jackal in the DDBR benefits from favourable habitats and a great variety of food to prosper, which makes the Delta an area with the highest jackal densities in Romania. Thanks to its highly territorial behaviour, the golden jackal can be stimulated to howl under certain conditions. The systematic performance of bioacoustic stimulation can thus be an effective monitoring method. However, for a more comprehensive result it might be supported by methods like camera trapping, snow and/ or mud tracking and interviews with locals.

We aimed to identify the jackal abundance and determine the distribution of golden jackal territorial groups. Further, we recorded changes in population density at local level during three different brief surveys in 2012, 2015 and 2018.

Methods

Our study areas are located in the central part of the DDBR; the Crisan-Caraorman channel and the Puiu Lake area. In August of 2018 we included the so-called "Old-Danube" channel and its surroundings. With overall 27 calling stations, we performed jackal howling for one night in (13/14) October 2012, one night in (16/17) December 2015 and two nights (27/28 and 28/29) at the end of August 2018. We additionally installed eight camera traps and interviewed seven locals. Compared to the first two monitoring sessions (2012 and 2015), the howling survey in 2018 was slightly adapted. The howls played at the individual calling stations were distinct from one another, ranging from a howl of one young individual to a jackal group howl. Up to five playbacks were performed. The pauses between the calls (if no answer occurred) were of 2-2.5 minutes. The camera traps were installed randomly, except during the second survey day of 2018 when they were installed based on either the previous replies, or on tracks found along the shores.

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Results

The identified number of golden jackal groups and the densities calculated vary between the three monitoring sessions. In October 2012 we found 11 jackal groups along the Crisan-Caraorman channel, resulting in a density of 2.2 territorial groups/10 km^2. In December 2015 five distinct groups replied in the same area leading to a calculated density of one territorial group/10 km^2.

At the end of August 2018 we identified 10 territorial groups in Crisan-Caraorman area showing a density of 1.6 groups/10 km^2. The survey in this period was an extended one and included more stations around the Puiu Lake and additionally 10 stations were installed in the Old Danube area. In this extended Crisan-Caraorman area we performed acoustic monitoring from 17 calling stations in total and 32-34 territorial groups replied all in all, showing an average density of 1.8-2 territorial groups/10 km^2. The response rate for all calling stations was over 76% (there were answers from 13 stations out of the 17). Five groups replied at one calling station within Crisan village and seven groups replied at one calling station between Crisan and Sulina, close to the intersection with the Old Danube. In the area of Crisan village – the Old Danube – 22-23 groups replied, resulting in an average density of 2.7-2.8 territorial groups/ 10 km^2. In August 2018 four individuals in three different places were sighted at close distance (20 m) along the Caraorman channel, right after the howls were performed. In addition, the camera traps confirmed the presence of jackals. In total, five events including jackal species were recorded. All seven interviewed people over the three survey sessions confirmed the presence of the golden jackal in the area and reported howls during the nights.

Conclusions

The jackal density observed with bioacoustic method in the central region of Danube delta has decreased from the year 2012 to 2015 but increased again from the year 2015 to 2018. These results show a fluctuation of population density that might be the result of different howling method, suggesting an increased success with a shorter pause of 2-2.5 as of the increased response in the year 2018. However, the locals also confirmed an increase in numbers of jackals compared to the last three years.

The 2.7-2.8 territorial groups/ 10 km^2 identified in Crisan-Old Danube area in August 2018 is the highest ever reported for Romania. Bioacoustic monitoring is a cost-effective method that can provide very good results. The results depend on season and period when the bioacoustic method is performed, weather conditions, and other known or unknown ecological factors (e.g. waste and organic materials of anthropogenic sources, other species behaviour, etc).

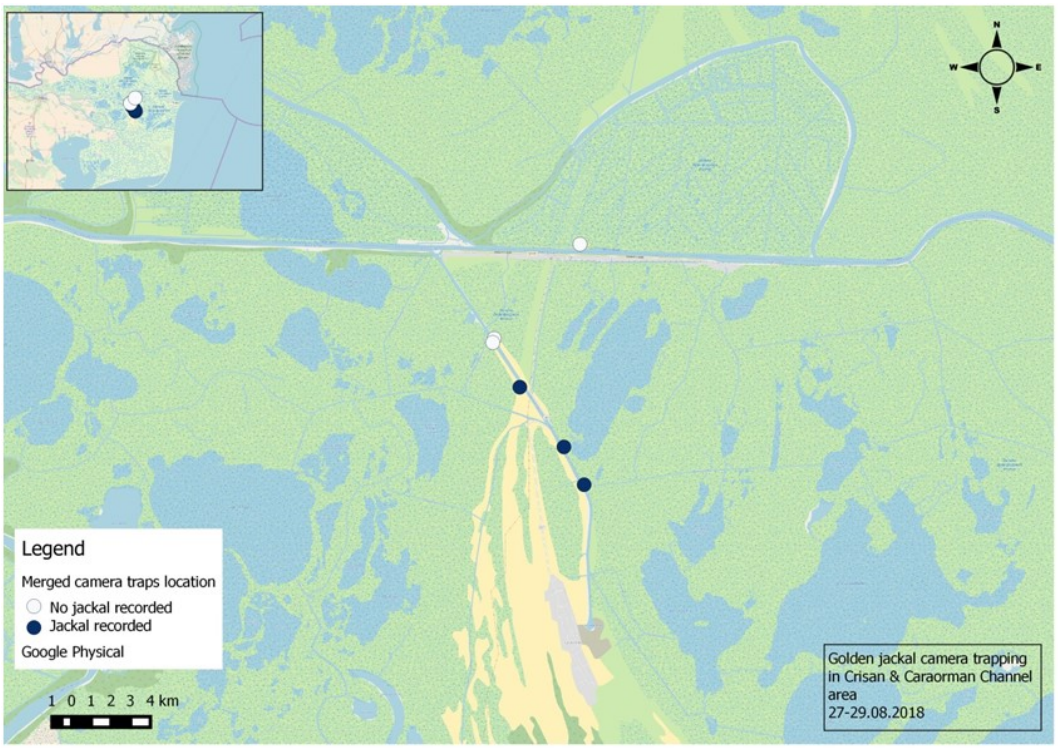

Figure T713C5.1: Camera traps locations, central Danube delta.

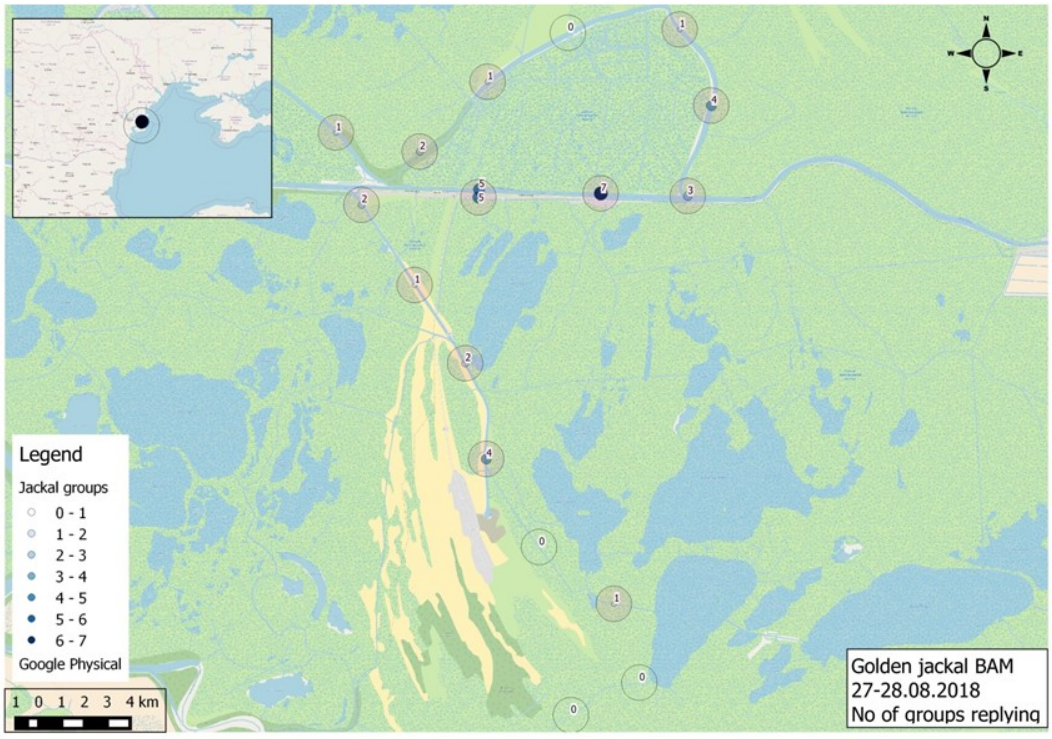

Figure T713C5.2: Calling stations installed during August 2018 survey.

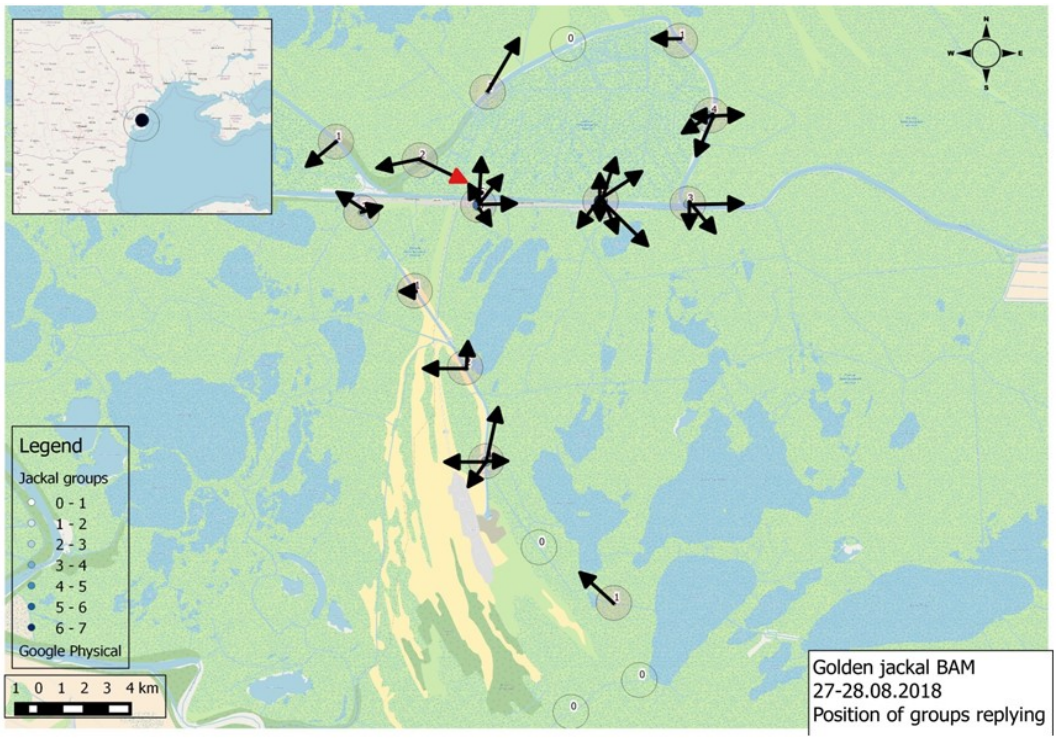

Figure T713C5.3: Golden jackal groups localization (direction and distance from CS). August 2018.

Picture T713C5.4: Golden jackal recorded in central area of the Danube delta.

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Chapter 8: Hunting, Conservation and Economy

F81K30

Lethal management and golden jackal population dynamics. Is hunting effective for jackal expansion suppression?

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The aim of sustainable wildlife management is to maintain wildlife populations at economically, socially and environmentally desirable levels. Central to this aim is the concept of carrying capacity. It is not clear, however, how carrying capacity for jackals should be defined in human-dominated landscapes. Carrying capacity is likely to shift over time, and to be influenced heavily by the densities of wild and domestic prey. Furthermore the desirable population size of golden jackal will be influenced not only by legal and ecological considerations but also by socioeconomic and cultural considerations (Trouwborst et al. 2017). The impact of jackals on wildlife and livestock could be reliable indicator for acceptable density level in human-dominated landscapes. In Bulgaria golden jackal's population density is the highest in Europe and according to national legislation jackals are hunted. This raises some questions. Do we need lethal control of golden jackal population as a wildlife management approach? Is hunting effective to control population size? How the favourable conservation status (FCS) of golden jackal should be determined and how many jackals do we need? Answering these questions is crucial for sustainable management and conservation of golden jackal and requires a better understanding of population demography. The golden jackal's demography and social organization are poorly known in Europe.

Golden jackal's population dynamics was studied by using hunting statistics data. We analysed a big sample of shot jackals to determine the age distribution and to construct the life table of golden jackal's population. The following assumptions were considered to be met: constant population growth, equal catchability, equal hunting effort, and stable age distribution.

Since 1998 golden jackal's population in Bulgaria was constantly growing with finite rate of increase about 13 % per year (Figure F81K30.1). After 2010 the population was stable and probably reached ecological carrying capacity. Population size/Harvest ratio was 1.818 (s = 0.133, 95 % CI: 1.557 – 2.073) for the period of expansion and 1.456 (s = 0.101, 95 % CI: 1.228 – 1.632) given that the population is stable ($\lambda = 1$). Assuming equal sex ratio, we could infer that 2-3 pups (average 2.6) per breeding pair survive to the autumn. About 10 % of jackals from one cohort reached the age of 5 years and more, and jackals above 3 years comprised only 6 % of the population (Figure F81K30.2). The sensitivity and elasticity analyses indicated that survival of subadults had the largest influence on jackal's population size. Mainly 2-years and 3-years old animals took part in the reproduction. Hunting did not affect the core of the population in reproductive age because of high survival of subadults that could already reproduce at the age of 2 years. But it had some impact on the age structure and survival rates causing the main part of mortality.

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Golden jackal's population status has been assessed and reported under Article 17 of Habitats Directive since 2013. All eight criteria according to operational definition of FCS in the "Carnivores Guidelines" (Linnell et al. 2008) are satisfied for Bulgarian golden jackal's population. As a game species jackals are hunted in Bulgaria, but the Habitats Directive and national legislation enforce some limitations on hunting. All studies in Bulgaria and in Europe showed insignificant impact of jackals on livestock and game, since they are not the main prey. Still the public attitudes are controversial. Wildlife managers, gamekeepers, hunters, stakeholders and landowners treat golden jackal as pest species and the public opinion is mostly negative. The present status of golden jackal in Bulgaria does not require any special measures. Furthermore, jackals are currently associated with fewer of the conflicts that characterize the larger species and which motivate the need for specific management approaches. Jackals flourished partly due to low sanitation and improper disposal of carcasses and poultry on the garbage dumps around villages. Ceasing of these practices is more effective than hunting to control jackal's population. Recreational hunting could not affect its population size, but it is preferred wildlife management approach to control population instead of poaching and using poisons. Hunting also could minimize the conflict with gamekeepers and farmers, and would help to improve public perception of jackals. We recommend an adaptable approach when using hunting to control golden jackal's population size in different areas. An efficient monitoring system on population size and hunting bags should be implemented as well.

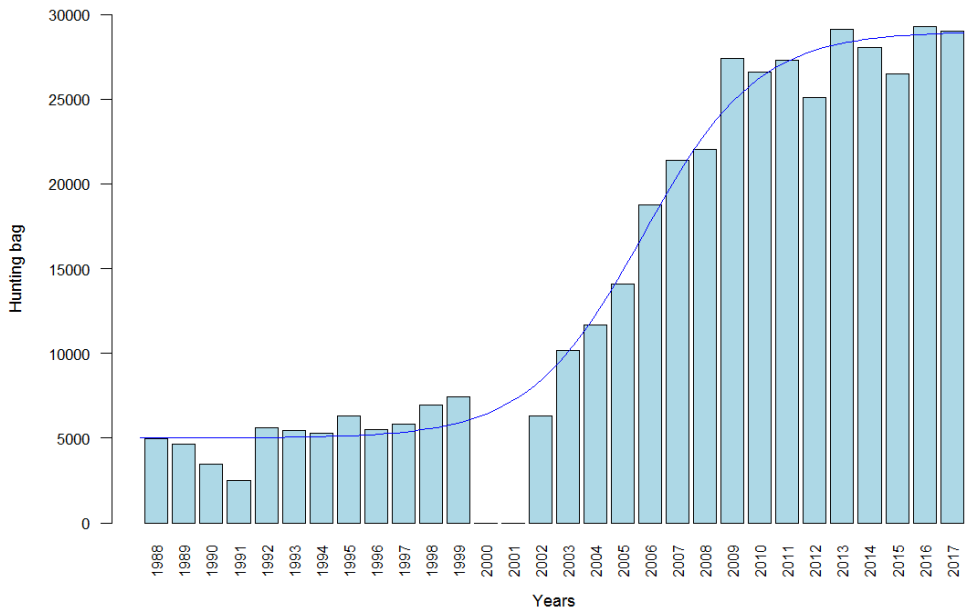

Figure F81K30.1: Golden jackal hunting bags in Bulgaria for the last three decades according to official hunting statistics.

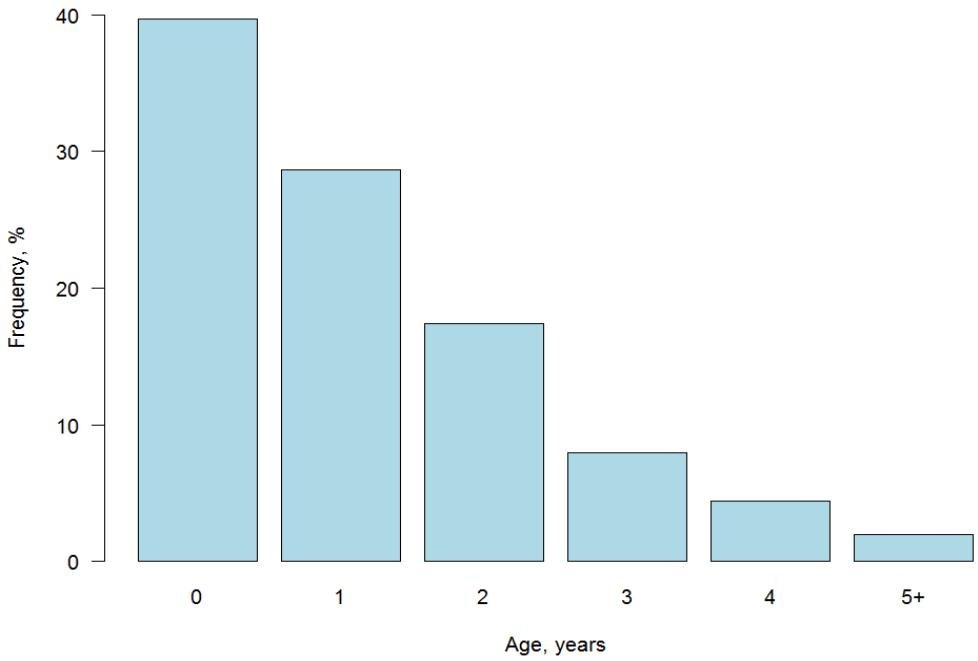

Figure F81K30.2: Stable age distribution of the golden jackal's population in Bulgaria.

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F83C10

Legal status of the golden jackal in relation to confirmed records in Austria´s provinces.

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Due to range expansions across Europe, the golden jackal (*Canis aureus*) gained more importance on a European level in the last decade. Most states in Central Europe previously did not include the golden jackal in their list of species and had no direct obligations under international, European or national law. Recent records of known range imply that those states need to deal with a new situation. One such state is Austria.

Trouwborst et al. (2015) dealt with range expansions of the golden jackal in a broad (wildlife and legal) perspective. They considered several Central and Eastern European states; especially, which international or regional legal instruments are applicable and how this reflects on the golden jackal's national status. As for this broad approach, they did not mention specific differences of the golden jackal's national legal status within a specific State.

Therefore, we focus on the different legislation in Austria´s nine Provinces. We describe and graphically demonstrate the historic and most recent records of the golden jackal in Austria. We analyse whether Austria's Provinces meet the obligations under the CBD, the Bern Convention and the Habitats Directive. Besides discussing improvements for procedures specifically in hunting bag data collection, we address risks that occur on a national level due to unclear legal terms in international or European legal instruments and due to inconsistent legislation from one Province to another.

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F84P

Distribution of the golden jackal in Ukraine and its trophy value.

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After the appearance of the jackal in the Dniester (1998) and the Danube (1999) deltas, in the Crimea (2001), on Biriuchyi Peninsula (2002), and since 2003 - in other places of the south-eastern Ukraine, its distribution in the country has evolved into intense expansion. Currently, four main directions of the jackal immigration to the territory of Ukraine are distinguished: a) from Romania across Odesa and Mikolaiv regions along the Black Sea coast to the east; b) from Romania across the Bârlad river valley into Zakarpattia region to the north; c) from Kuban river delta (Krasnodar Region, Russia) across the Crimea to Kherson Region - to the west, north and east; d) from Rostov Region (Russia) across Lake Manych-Gudilo and the Don river delta to Donetsk and Luhansk regions and further to the north-west of the country. The range of the largest jackal population covers the Danube and Dniester deltas, and southern districts of Odesa and Mykolaiv regions. A slightly smaller group is located at the shores of Lake Syvash (Autonomous Republic of Crimea and Kherson Region). In addition there are small populations on Biriuchyi Peninsula (the Sea of Azov), and on the Dnieper islands near the city of Zaporizhzhia. In 2003-2017, many animals have penetrated from Rostov Region (Russia) to the territory of Donetsk and Luhansk regions and may form a new population in this area.

Given the tendency of the jackal to distant migrations, it is not surprising that the appearance of a few individuals was recorded in such places of the country as a) Zakarpattia Region (N 48.18448; E 22.242524) in 2001-2005 and (48.301547; E 22.115825) in 2011-2017; b) Dnipropetrovsk Region (N 48.201022; E 36.32157) in 2005; c) Khmelnytskyi Region (N 49.272319; E 27.46330) in 2009; d) Poltava Region (N 49.302307; E 35.154941) and (N 49.345227; E 35.164354) in 2012; e) Kharkiv Region (N 49.163259; E 35.124176) in 2013; f) Sumy Region (N 52.154513; E 33.394196) in 2016; g) Chernihiv Region (N 51.42608; E 31.15668) in 2016; h) Kyiv Region (N 50.43465; E 30.314350) in 2017. In Poltava Region, according to our colleagues (Lapini, 2012), no permanent habitats were found. The jackals continue to penetrate to the territory of Ukraine from Romania and Russia, and from Ukrainian habitats – to Belarus, Poland and further inland.

In Ukraine the jackal is a game species. Of the examined skulls of females (n = 24) 2 is worthy of being awarded silver (25.57-25.76) and 3 – bronze (25.00-25.50 points) medals. Of the males (n = 19), 6 can be given gold (26.00-27.10), 3 – silver (25.60-25.70) and 3 – bronze (25.00-25.41 points) medals. Thus, out of 43 investigated jackal skulls, 17 (39.5%) are outstanding hunting trophies.

Keywords: golden jackal, Ukraine, expansion, immigration, population, hunting.

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F85C10

Lust for life: rehabilitation and post-release survival of a severely injured golden jackal pup in Greece.

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Data on survival, social reintegration, habitat use and overall rehabilitation success, after hard releasing severely injured and recovered golden jackals (*Canis aureus*) are scarce. We used VHF telemetry and camera trapping to document long-term survival of a young jackal in northern Greece released back to its natal territory, following a 9-month treatment in captivity to recover from severe traumatic injuries caused by vehicle collision.

In July 2012, a male jackal pup (ca. 2-3 months old) was hit by a vehicle in northeast Chalkidiki, and brought to the "Action for Wildlife" Rehabilitation Centre with severe fractures on all four legs. The animal was successfully operated by veterinary surgeons and started walking again soon after surgery. Shortly after, it was moved to the EKPAZ - Hellenic Wildlife Hospital where it remained for ca. 8 months with minimum human contact to fully recover. In April 2013, the jackal, named "Stavros" was fitted with a low weight custom made VHF collar equipped with cotton spacer and was hard-released close to the area where it was initially injured. "Stavros" just after a few days abandoned the release site, and moved 3 km away, close to the village of Ano Stavros. We monitored his movements and behaviour for a total of 12 months. The approximate location of "Stavros" was estimated with the use of VHF signal triangulation once or twice per month (n= 17 successful relocations). Minimum home range size was 0.18 km^2 (MCP-minimum convex polygon) but should be considered a conservative estimation due to the small sample size of relocations. Camera trapping revealed that "Stavros" shared his home range and interacted with at least one non-tagged jackal. Social interactions were documented at least 4 times (camera captures) and after 2 months post-release.

We used our field data and findings to raise public awareness on the species; we organized a successful local event at the village of Ano Stavros. We presented information on species ecology, focusing on the unique story of "Stavros" and conducted environmental education activities for children and teenagers. Moreover, the story of "Stavros" was followed by the media all the way through; several press releases on at least 16 online and newspaper articles were published.

Our findings suggest that rehabilitated jackals can recover and survive in the wild for at least a year, even after suffering severe injuries at a very young age and spending 9 months in captivity. Moreover, such stories are excellent for public awareness and environmental education initiatives which can change the attitudes towards this misunderstood species.

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F86C10

The adaptable black-backed jackal: re-emergence and survival under heavy persecution in a human-dominated landscape.

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Livestock predation is a pervasive form of human-wildlife conflict on rangelands, particularly in semi-arid regions of Africa where livestock farming is extensive and numerous species of carnivore still occur outside of protected areas. In the Karoo drylands of South Africa, black-backed jackal (*Canis mesomelas*, hereafter jackal) were the scourge of colonial livestock during the 19th century, as wool and mutton production expanded across the region. By the early 1920s, state-sponsored bounty hunting and poisoning assisted farmers in eliminating "the jackal problem" and it appears to have remained at acceptable levels until the 1990's. However, since the onset of the 21st century, jackal predation is reported by Karoo farmers to have re-emerged as a threat to their livelihoods. Despite their previous and current economic importance, the contemporary history and drivers of jackal predation on livestock remain poorly understood. In this study conducted between July 2014 and March 2015, we interviewed 77 small-livestock farmers (20% of all the farms in the central Karoo region) to assess the spatio-temporal distribution and severity of the reported jackal predation problems. We also investigated the farmers' perceived reasons for changes in jackal numbers, their current attitudes towards jackals and their strategies for reducing livestock losses attributed to jackal. Our results show that jackal problems re-emerged in the 1990s and became a serious threat to the livelihoods of many farmers at the onset of the 21st century. Most farmers perceived jackal numbers to be increasing and attributed this trend to declining government support for predator management, changes in livestock husbandry and an increase in "predator-friendly" land use. Attitudes towards jackals in our sample were homogeneous and uniformly negative. Most farmers ranked jackals as either the primary (72% of cases) or secondary (20%) cause of livestock predation, followed by caracal (*Caracal caracal*) and chacma baboon (*Papio ursinus*). 97% of farmers wish to reduce jackal numbers, with 57% wanting to eradicate them completely. 94.7% of respondents use a combination of night hunting, gin traps and cage traps to eliminate jackals from their farms. Night hunting is considered to be the most effective method (mean Likert score for perceived efficiency: 4.3 ± 0.9), followed by gin traps (3.6 ± 1.2) and shooting from a helicopter (3.3 ± 1.7). 53% of farmers also reported using poison to get rid of jackals, despite this method being illegal. We contextualize these findings with the recent research on the diet and ecology of jackals on farmland in this region to explain jackal re-emergence and survival in the semi-arid interior of South Africa, even under heavy persecution.

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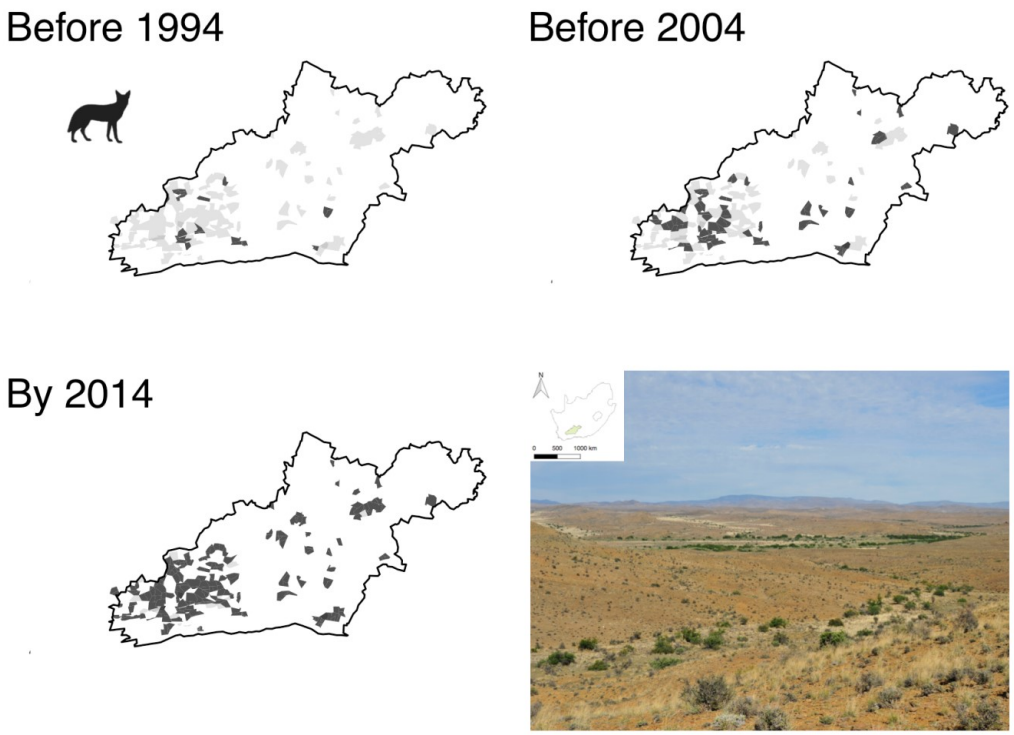

Figure F86C10.1: Panel of maps representing the spatio-temporal patterns of the distribution of reported severe black-backed jackal (*Canis mesomelas*) predation problems in the South African Central Karoo. All farms surveyed in the region are represented in pale grey using the regional cadastral map. Farms reporting severe predation problems, at a level that is perceived to threaten the viability of the farms, are filled with a darker shade of grey. The date of onset of a severe predation problem for a given farm was used to build cumulative maps of conflict with time binned in three categories (i.e. before 1994, before 2004, by 2014). Bottom right: photograph of a typical small-livestock farm landscape in the Central Karoo, South Africa. The insert represents the localisation on the Central Karoo District Municipality inside South Africa.

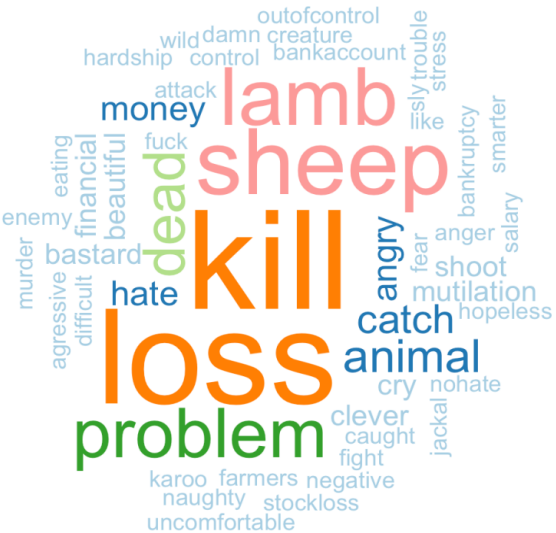

Figure F86C10.2: Word cloud of the small-livestock farmers' answers to the question "What is the first thing you think about when I say jackal?" The sizes of the words are proportional to the number of times they were detected in the answers. Maximum mentions are 21 for "kill". The word "nohate" corresponds to the sentence "I have no hate for the jackal".

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F87C10

Preliminary findings on the impact of dogs on wild canid occupancy in western Greece.

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The presence of dogs *Canis familiaris* in Greek rural landscapes – even far from human settlements – is a well-known but poorly documented and quantified fact. Typically, the dog population consists of resident feral solitary or pack living dogs, permanent or seasonal shepherd dogs (often free ranging near livestock corrals) and a seasonal influx of hunting dogs (September – January). While in some cases dogs exceed wild canid populations by orders of magnitude, no study has examined the potential impact of those dogs on Greece's wild canids (wolf *Canis lupus*, golden jackal *Canis aureus*, and red fox *Vulpes vulpes*). In Western Greece, our study area, the red fox is present throughout, the wolf has sporadic presence across the area but mostly in semi-mountainous landscapes, while the golden jackal's sporadic presence has been recently confirmed. Using data from 237 camera trap stations across 88 10X10 km² grid cells (8800 km²) in western Greece (mean 50 days/site; total 11,850 c-trap nights) collected over 3 years (2016-2018) and opportunistic records of golden jackals (e.g. roadkills, field observations), we present preliminary findings on the impact of dogs on the three native canids' occurrence in the administrative regional units of Ioannina, Thesprotia, Preveza, Arta and Aitoloakarnania using occupancy models. Camera traps were placed in the lowlands and semi-mountainous areas up to 1100 a.s.l., in a variety of natural habitats and areas dominated by human activities such as livestock raising and farming. We discuss our findings and propose management measures to address dog numbers - a largely ignored carnivore conservation challenge – which can impact both the golden jackal's recolonization of western Greece and the perceived role of wild canids' in livestock depredation incidents.

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Figure F87C10.1: Study area (88 - 10X10 km² grid cells) and camera points (n=237).

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F88P

Assessment of methods for age determination based on teeth and skull of the golden jackal.

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The spreading of the golden jackal (*Canis aureus*) within Europe results in a greater interest for the species. According to Appendix V of the EU Habitats Directive its favourable conservation status has to be assured. For the accuracy of studies and sustainable management decisions, it has therefore become even more important to precisely determine the age of individuals in case they are taken from the wild. The aim of this study was to ascertain a guidance in determining the age of golden jackals while inspiring and encouraging scientists not to solely rely on one approach. Beside exact methods such as the counting of cementum annuli or the examination of tooth wear, we included also less exact methods such as canine fissures, pulp cavity, length, width and the basal opening of teeth or certain skull measurements in the decision-making process for evaluating age. Descriptive statistics, as well as a principal component analysis were conducted for the assessment of the results. 84.7% of the total variance can be described with the two components of the PCA. The findings based on 45 analysed golden jackal skulls suggest that alternative techniques such as scanning have the potential to be an effective, less time consuming and less cost-intensive alternative to colouring with chemicals or x-raying. Another advantage is the possibility of compensating for methods that cannot be conducted due to damage on the individual or logistic reasons. Summarizing, a combination of exact methods with less exact methods and an overall impression of the skull can contribute to a more precise age determination.

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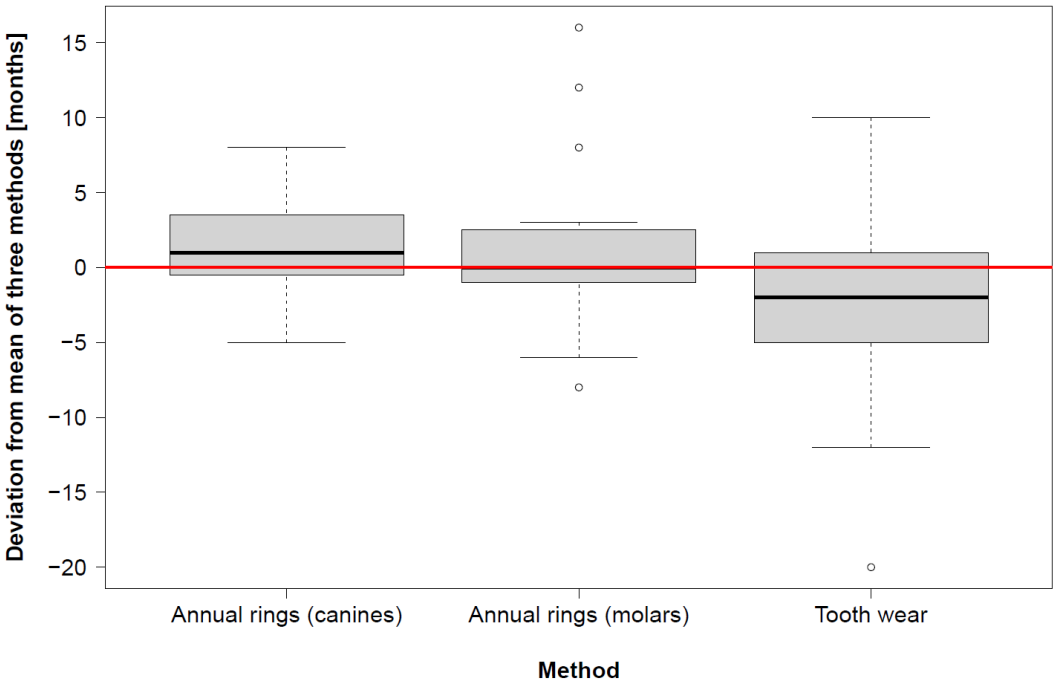

Figure F88P.1: Boxplots of deviation to the mean of three methods for age determination of golden jackals in months: 1) Annual ring count (canines) 2) Annual ring count (molars) 3) Tooth wear. These plots show an overlap of the resulting month counts and support the fact, that not a single method is the most reliable, but a combination of methods.

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F89C10

Gray wolf activity as an apex predator in the protected areas of northern Turkey.

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Constituting the majority part of the designated protected area network in Turkey, wildlife reserves situated throughout the country to increase population size of target species that have conservation priorities globally or nationally. Within this scope, total 81 areas have been established as wildlife reserves and they cover approximately 12000 km^2 surface area, which constitutes the largest category of protected area network of Turkey in terms of land coverage. Although the primary conservation objectives in wildlife reserves generally target the large herbivores, they also became sanctuaries as being valuable areas for carnivore species in the natural habitats of the country. To maintain existence of conservation value in the wildlife reserves, General Directorate of Nature Conservation and National Parks continuously supports the inventory and monitoring projects aiming to help achievement of prioritized conservation goals. In accordance with this purpose, this study was conducted being a part of a long-term monitoring project in four wildlife reserves covering 312 km^2 total area where the red deer (*Cervus elaphus*) has been determined as the target species. These areas are situated in Black Sea Region of Northern Anatolia, regarded as one of the most significant regions in terms of large mammal community in the country. To collect data, camera-trapping surveys were conducted from May 2014 to November 2016 with systematic approach using 57 stations placed in four regions simultaneously targeting gray wolf (*Canis lupus*) packs. Consequently, 606 gray wolf records were obtained in total 30157 camera-trap days. During the survey, 44 camera-trap stations were continuously triggered by gray wolves, revealing that the areas actively occupied by them. In addition to gray wolf records, main potential prey species such as wild boar (*Sus scrofa*), red deer and roe deer (*Capreolus capreolus*) activity were detected in high amounts. For the analysis of collected data, we built linear regression models based on daily activity patterns of wolf records and its three preys. The analysis of collected data shows that, daily activity pattern of gray wolf has significant relationship with red deer and wild boar. However, no significant relationship has been detected with the roe deer. As a conclusion, the significant relationship between red deer and gray wolf activity indicates that these four protected areas are also important for gray wolf as much as red deer which is the target species for conservation goals.

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F810P

Golden jackals and human disturbance: how tolerant can a jackal be?

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In the '70s golden jackals, together with fox, wolf, marten and corvids, were considered as vermin in Greece and almost 7000 jackals have been executed. The species was the first one to be removed from the vermin list in the early '90s, however a crucial damage to the jackal status has been done: National study performed in 2000, showed that only 1000 jackals have been remained in the country. Surveys that followed in the period 2009-2015 showed that total jackals' population has increased to 1500 individuals, showing slight signs of recovery, although the other 'vermin' species have restored their numbers to former levels much faster. The main reasons of the jackal inability to recover seem to be associated with human activities. The Red Data Book of Greece classifies the golden jackal as endangered, underlining a rather sensitive nature of the species.

In this study, several examples of human disturbance are examined, regarding the impact they had on jackal persistence in each area they occurred. In all surveys the same acoustic method involving broadcasted jackal howls from standard calling stations was used before and after the end of disturbance, to determine the presence of resident jackal groups and estimate minimum population. Disturbances varied greatly in intensity and duration, from the most severe one that was an extensive fire within a jackal habitat, to the long-term situation of high sound and light levels of the Customs Area, close to the Greek-Turkish borders. Other intermediate disturbances involved the construction of a gas pipeline that lasted 6 months, heavy agricultural activities performed after dusk until midnight for two months within the summer period and an one-month excavation of a deep but narrow ditch by the Greek army as a measure to prevent refugees passing. Jackals seemed to respond differently in each situation, showing difficulties to get habituated to a disturbance. Their main reaction was to abandon the area and resettle back when conditions were again favourable. Duration, extent and intensity of the disturbance played a very important role, as well as the condition of the area left behind after the end of the disturbance. Jackals appear be tolerant to short-term and light human activities, but not to greater ones. These results aim to contribute in the decision-making procedure, when the environmental impact of a project is discussed.

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F811C5

Upper canine dentine and cementum layers counting as a new age determination method in golden jackals.

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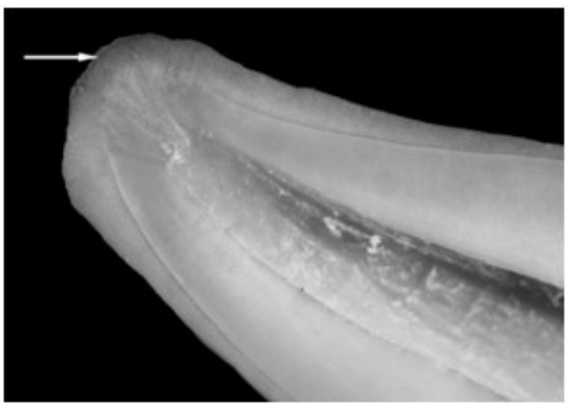
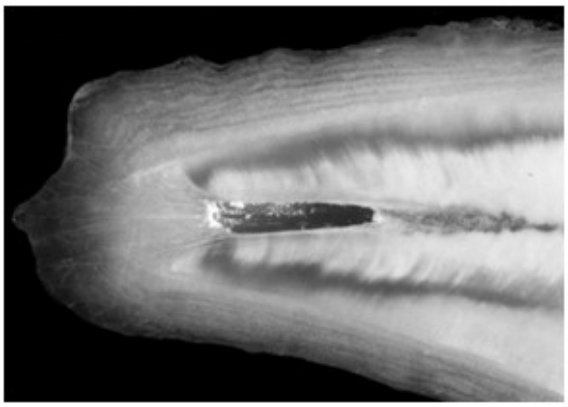
Introduction

Age determination by pulp cavity-tooth width ratio was used successfully to analyse the age of a young jackal female together with zoologist Peep Männil in Matsalu National Park, West Estonia, during Baltica 2013 jackal survey (GOJAGE Letters 23.08.2013). The calculation was done in a transverse section of one canine.

Jackal age determination is actually performed by tooth wear or by assessing the ratio between pulp cavity and tooth width diameters. In wild caught coyotes a pulp cavity-tooth width ratio of 0.45, measured 15 mm from the tip of the root of the canine teeth, seems to reasonably discriminate between juvenile and mature coyote (Knowlton & Whittemore, 2001). Even so, a better method is needed in order to assess jackal population structure.

In red fox population structure studies in Czech Republic, (Roulichová & Anděra, 2007) it was used a much simpler method for counting the increment layers of secondary dental cement, based on longitudinal sanding of dental roots. The dental roots were prepared from one or two upper canines or any of the lower ones.





Pictures F811C5.1. and F811C5.2: First correspond to a 1-year old fox and the 2nd picture to 8-year-old fox (Roulichová & Anděra, 2007 Simple method of age determination in red fox, *Vulpes vulpes*).

The tooth was carefully extracted from the jaw (by hand or with dental forceps). Then its root was reduced to almost half its thickness, using sandpaper coarseness from 80 then 400 and finally polished at very fine coarseness ca 1200 (Roulichová & Anděra, 2007). Jackal is similar with red fox in teeth structure and dentine cementum layers in grounded upper canine of jackal might be visible.

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We aimed to analyse the jackal age using the pulp cavity - outer tooth width ratio and we further investigated the method described by Roulichová & Anděra.

Method

Fourteen (14) jackals were legally shot in southern Romania during January 2016 by members of General Association of Hunters and Sports Fishermen from Romania (AGVPS). Upper canines were carefully extracted using a dental forceps from maxillars and jaws after the muzzles were removed with a hacksaw and then boiled (Figures F811C5.3 and F811C5.4). When the canine was dry it was held in one hand and with the other it was polished on the root level using sandpaper with different coarseness, from 80 to 1200. The age was determined with pulp cavity - tooth width ratio method. The upper canine dentine cementum layers counting was further investigated.

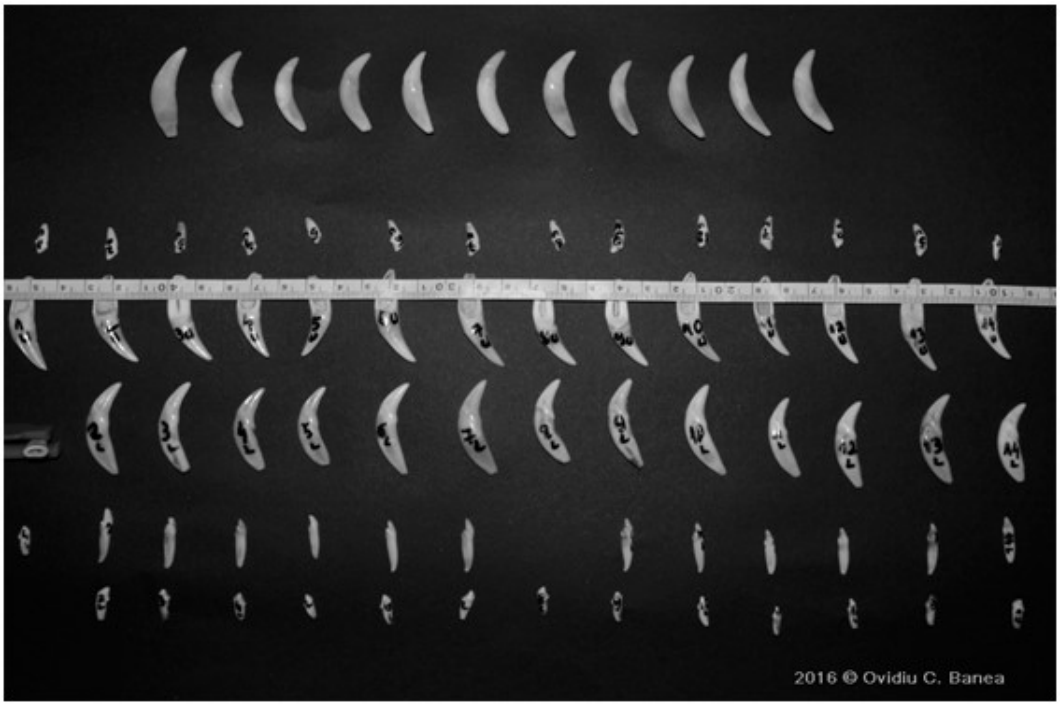
Results

Ten (10) jackals were estimated as being juvenile (9-10 months old) and 4 jackals as mature according to pulp cavity - tooth width ratio method (Figure F811C5.5). We used also the classic method of clovers shape of observed incisives to classify juveniles less than 1 year old. We could then count the dentine growth layers in longitudinal profile for the 4 specimens older than 1 year and we found 2 different annual ages: 2 jackals of 21-22 months old (almost 2 years) and the other 2 were estimated as being 33-34 months old (3 years). Counting of cementum layers on the cortical bone and periosteal apex was not possible in these specimens probably due to the young adult age. The juvenile golden jackals represented 70% of the analysed sample. Further analysis under microscope will include the adult specimens and other older specimens with known age estimated by conventional methods.

Age determination should be considered within the golden jackal management planning to assure homogeneous population age structure in time to avoid the expansive clusters pyramid types like we observe for this sample.

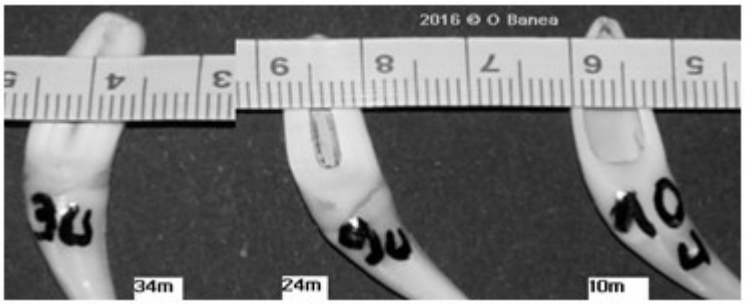
Conclusions

The analysed 14 individuals sample was differentiated in two groups of juvenile and mature jackals using the pulp-cavity tooth width ratio method. The proposed method of longitudinal growth layers counting was useful to differentiate the adult group. The cementum layer counting was not possible in this sample due to the juvenile and young adult structure. We assume that on the hunting terrains where these specimens were collected exists an active and continuous golden jackal population control.



Picture F811C5.3: Golden jackal age determination with pulp cavity - tooth width ratio in Romania.

Picture F811C5.4: Golden jackal.



Picture F811C5.5: Clustering of three different golden jackal specimens.

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F812C10

The evolution of the presence of the golden jackal in Slovakia.

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Canis aureus (L.1758), the golden jackal, is one of the most widespread carnivore of the genus *Canis*. Considered a permanent species from the Slovak fauna, it is becoming more and more popular in the country. Conservation status of the golden jackal was first time determined in Slovakia in 1995, being then categorized as a rare species. Renewed status followed in 1997 and 2001, when the data available was considered inadequate, lacking abundance and distribution for a correct categorization of the species. In the Red list of mammals of Slovakia, it was included in Data Deficient (DD) category. Golden jackal in Slovakia had between 2001 and 2008 full year protection. But from 2009, it became officially a game species, with the establishment of a hunting period from the 1st of September until the 31st of January. The hunting period changed in 2014 and it is nowadays possible to hunt the golden jackal from the 1st of August until the end of February.

Within this work, we aim to review, summarize and evaluate all available data of records of golden jackal's presence in Slovakia. We analyse the distribution of the mortality data and other evidences of presence. We produce a model of the probable range of the population in the country.

In the last 30 years, golden jackal numbers and dispersion range increased throughout the country. The first official evidence is from 1989 originated from south-east of Slovakia close to the border with Hungary and Ukraine. Since then, the number of records of killed and found dead individuals, and the official counts of observed golden jackals increased steadily in the rest of the country with higher incidence in the latest years. Patterns of first migrator individuals presented in this work, confirmed previsions of the direction of the dispersion of this species from the Balkans region to north and the migration much presumably occurred from Hungary or Ukraine, to the south of Slovakia.

The natural expansion, the growing ranges and numbers of the golden jackal in the last decade, enhances the need to elaborate, approve and implement a care program in Slovakia. This plan should include the introduction of a monitoring plan with the support of scientific research, to achieve a more detailed information of the population status of the golden jackal in Slovakia.

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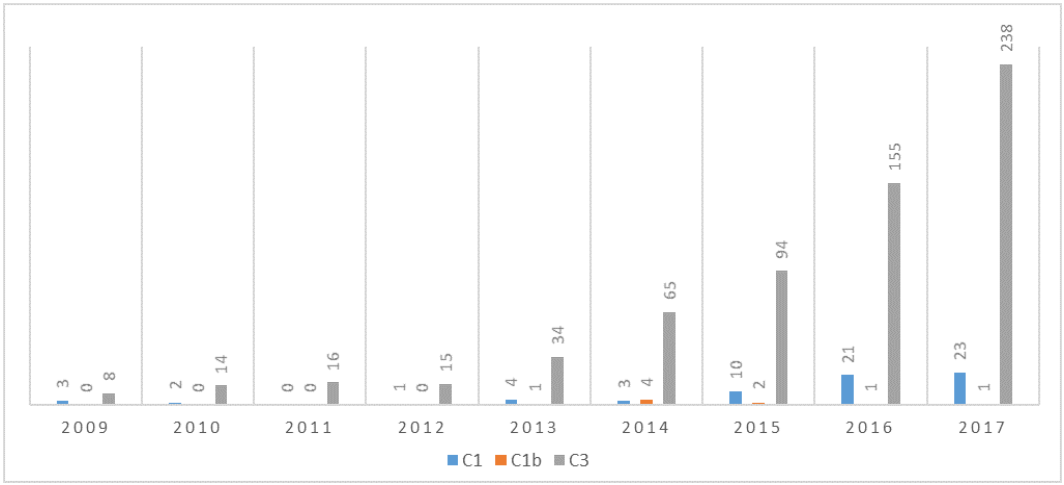

Figure F812C10.1: Evolution of the golden jackal numbers in Slovakia 2009-2017: C1-hunted; C1b-found dead; C3-observed individuals.

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F813C10

Population dynamics and current status of the golden jackal in Romania.

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Introduction

The distribution, population size and dynamics of the golden jackal (*Canis aureus*) in Romania is still unclear and there is no comprehensive national level monitoring programme to determine them. The official statistics regarding the total number of golden jackals per county and at national level is represented by the estimates provided by the hunting grounds administrators. The jackal is considered by hunters as being a pest species which affects hunting economy and thus they proposed all year round harvesting with not justified increased hunting quotas from year to year.

We aimed at reviewing and analysing the official data reported for the golden jackal population in Romania regarding its size, annual growth rate, reduction through culling in the past 10 years, as well as analysing its distribution at national level.

Methods

We analysed the official data reported by the hunters, namely stock assessment and hunting bag in the period 2006 - 2018. A map with the species' population size and distribution has been developed based on this official data by using QGIS software. We included new records from our own data obtained mainly through bio-acoustic monitoring in north-west, west, central, south-west and south-east parts of Romania, but also direct observations, camera trapping, snow and mud tracking, etc. The annual population growth rate has been calculated based on estimates of the population size (stock assessment) from year to year.

Results

A total number of 14,273 golden jackals have been estimated in spring 2018 in Romania. There is a linear growing observed during 2006-2018 period according to the statistics (Figure F813C10.1). Out of the 41 counties of Romania in only 2 there has not been any jackal reported by hunters. Our monitoring data gathered confirms the presence of golden jackals in north-west, west, central, south-west and south-east parts of Romania and in addition, we found jackals in Salaj County in 2015, where no jackal has been reported by hunters yet. Since 2012, we identified jackals in other counties as well where the species has not been reported by that time by hunters (in Hunedoara in 2013 and in Cluj in 2016, Figure F813C10.2).

There are huge discrepancies between the estimates regarding jackals from neighbouring counties. For instance in the Eastern part of the country we can officially find the highest number of jackals in Tulcea county. 2553 individuals were estimated in spring 2018, while in the neighbouring county Galati there were only 182 jackals reported and in Braila 361. High differences in numbers

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compared to their neighbouring counties can also be observed in Vaslui (840 individuals, while in Iasi there are only 21), Buzau (569 individuals, while in Vrancea there are only 97 reported), Mures (268 individuals, compared to Suceava 0 individuals or Cluj with 2), etc.

There are also big differences between the annual growth rates based on the declared number of individuals (Figure F813C10.3). The highest difference is between 2008 (with a growth rate of -16%) and 2009 (with a growth rate of 42.5%) of 58.5%. The average annual growth of the jackal population in Romania between 2006-2018 is 19.3%, based on calculations using the official reported data.

In average 47.21% of the total jackal population has been officially removed every year in the period 2007-2018. The proposed harvest quota for 2018 represents 72,59% of the total population size (Figure F813C10.4).

Conclusions

The golden jackal is widespread in Romania, being found at least in almost every county. There are inconsistencies in terms of the officially declared numbers of jackals over the years, both at the county and national levels. The anomalous population size differences between neighboring counties with more or less similar habitats and the irregular annual population growth rate indicate that either the methodology used for the nationwide monitoring by hunters is wrong, or its implementation is deficient.

There is a clear need for a comprehensive monitoring programme of the golden jackal in Romania. The stock assessment and harvest quota have to be planned based on local population growth rate analysed not only from estimates but including also the hunting bag data.

The average annual growth rate of the golden jackal population in Romania based on the official data is 19.3% (in the period 2006-2018). Considering this rate, the proposed hunting quota for the species for the actual hunting season is high and its realization would negatively affect its population.

Bio-acoustic monitoring might be considered as a complementary tool for a better golden jackal population assessment before any management measures. The use of BAM lead to the identification of jackals in areas/ county where the species have not been reported before (in Hunedoara in 2013, in Salaj in 2015 and in Cluj in 2016).

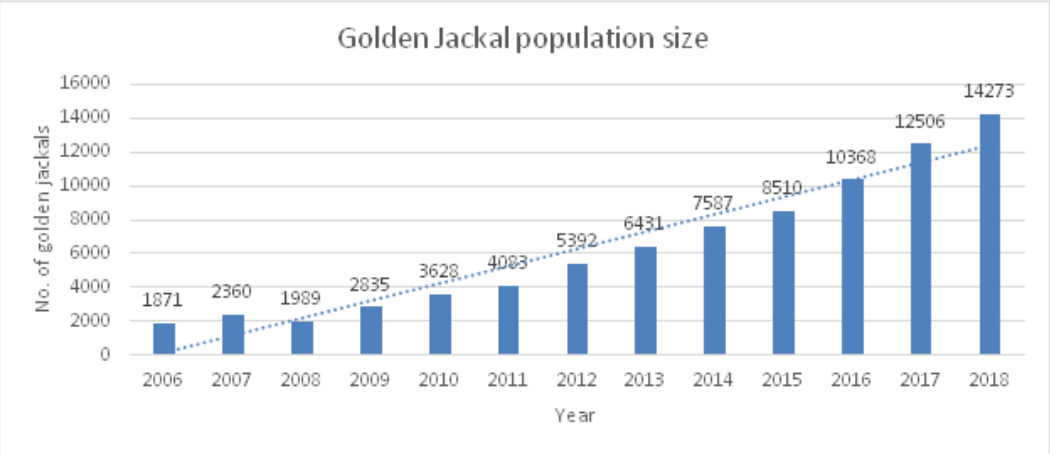

Figure F813C10.1: The evolution of the golden jackal population estimates during 2006-2018 period.

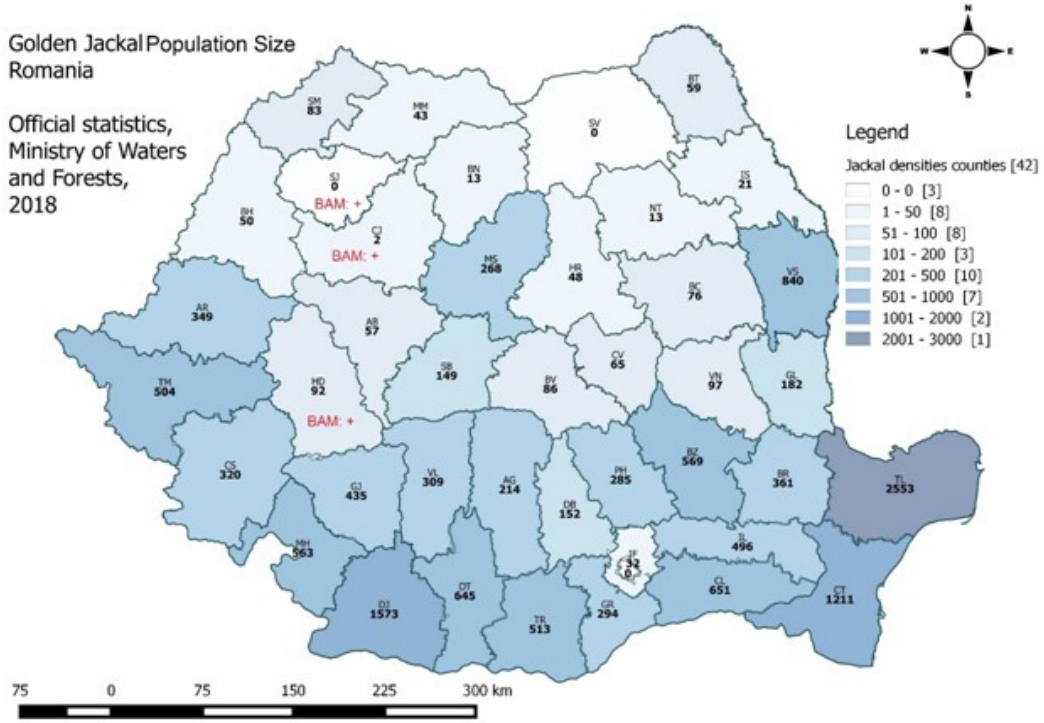

Figure F813C10.2: The golden jackals' distribution in Romania based on county population size estimates (N.B.: BAM + represents the counties where we detected the presence of golden jackals before any official reporting).

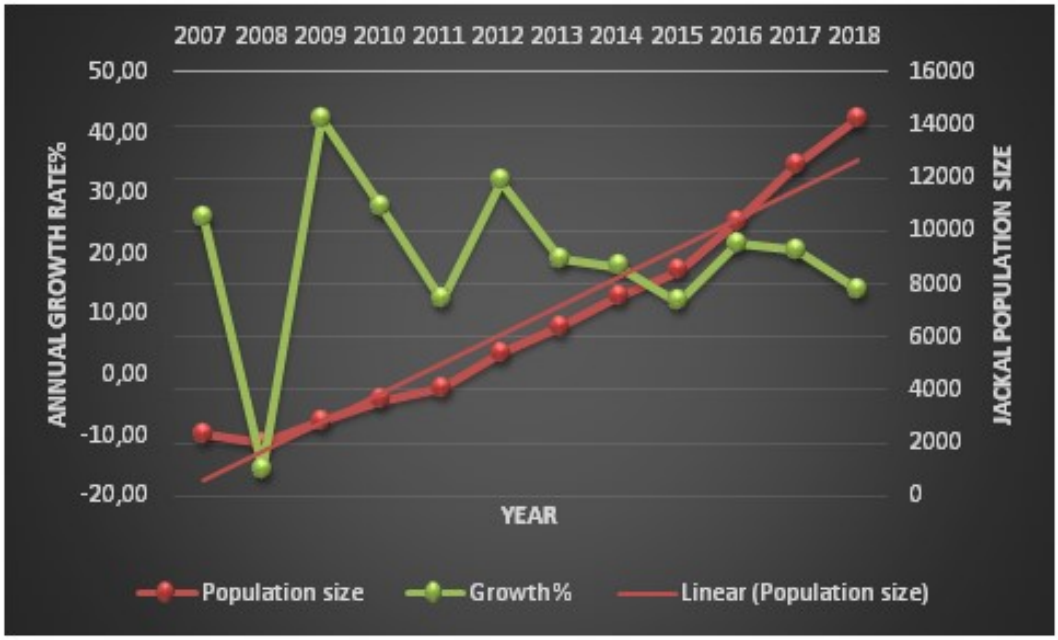

Figure F813C10.3: Comparison between the jackal population size and its annual growth rate.

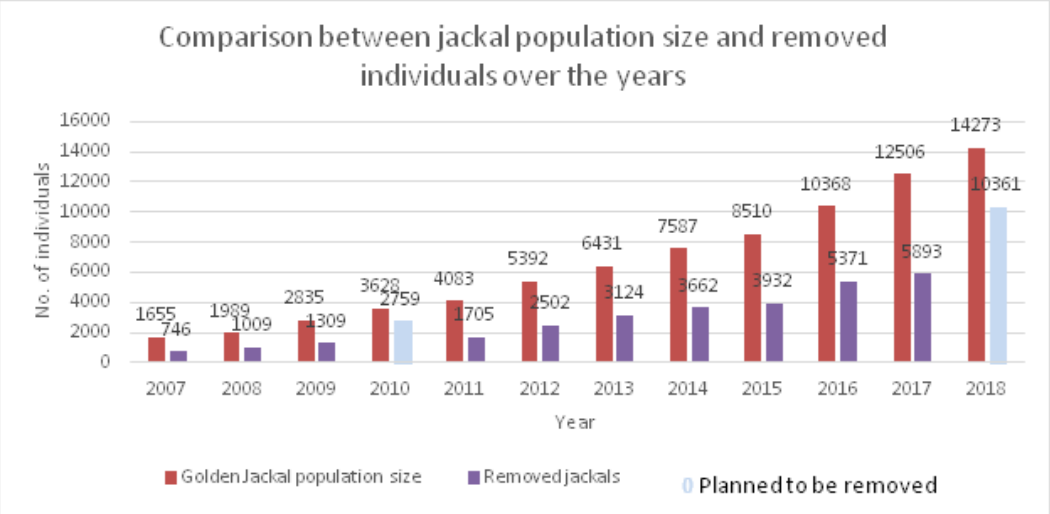

Figure F813C10.4: Comparison between the jackal population size (S.A.) and the removed individuals (H.B.) over the years. Data for 2010/2011 hunting bag was not available.

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F814P

Preliminary data incidents reports of wolf attacks on hunting dogs in Northern Greece.

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The wolf (*Canis lupus*) is one of the large carnivores in Greece. The wolf distribution covers variety of habitats, including areas with several human land uses. It is known that wolf is feeding on wild animals, but also with livestock animals and carcasses of dead animals. This study is trying to present the status of wolf attacks on dogs, particularly hunting dogs. Cases with fights between wolves and dogs have been recorded before, but during the last years new cases have been reported on the web, social media and in hunting magazines about attacks on hunting dogs and their consumption by wolves. We started a preliminary study by recording these incidents also from other sources. This took place through the 63 local hunting associations - members of the Federation. The data were collected from the Regions of Macedonia and Thrace, covering the North Greece from hunters, who owned hunting and sent through local hunting associations. Through prepared forms the owners of the hunting dogs provided information about wolf attacks on hunting dogs: date, location, involved animals, short description of the result (dead or injured), and the name of the owner with contact. The data are collected since 2014 and 321 cases have reported. In these, 309 dogs have been attacked, from which 275 died, 22 were heavy injured and 14 were mildly injured. These data also included reported some cases of attacks on livestock (sheep, goats, cows, pigs and horses) and some cases referring to attacks by bears. These are preliminary data and further detailed study is needed in order to examine parameters affecting these interactions, as well as to verify that these attacks were indeed caused by wolves and not wolf-hybrid or feral dogs. Also, an official protocol by state agencies is needed in order to record future cases of wolf attacks on hunting dogs.

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F815P

Road kills of golden jackals and other small carnivores in south-east Lakonia, South Greece.

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Between February 2018 and August 2018 (7 months), during routine driving (eight times per month), 18 golden jackals (*Canis aureus*) were recorded as road kills, along a distance of 68 km, on the Greek National Road (EO86) of Krokees–Monemvasia, a road network (highway) in south-eastern Lakonia, Southern Greece. On the same motorway, 21 dead red foxes (*Vulpes vulpes*), 11 eurasian badgers (*Meles meles*), 26 beech marten (*Martes foina*) and 13 domestic and/or stray dogs were also recorded at the same period. Most (88%) of the killed animals were recorded in the new parts of the road network (which are very wide and straight) and on which high car speeds can be developed. The construction of new highways in Greece, without any mitigation measures for wildlife, such as fences at roadsides and animal passages, leads to habitat fragmentation for mobile species. This problem, in combination with the expanding touristic activity in Greece, including high vehicle traffic volume, mostly during spring and summer may have played an important role in the increased mortality of the above species in the area.

Figure F815P.1: National Road (EO86) of Krokees–Monemvasia with the points of the killed golden jackals (10X10 km² grid cells).

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F816C10

Time allocation in Ethiopian wolves.

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Animals allocate time to different behaviours in order to fulfil their requirements, and they do so by adopting optimal strategies that maximise their fitness. The Ethiopian wolf (*Canis simensis*), a specialist rodent hunter that lives in groups, provides a suitable case study on time allocation when the needs for solitary foraging and sociality might conflict. We investigated behavioural observations from 46 wolves over 4 years in the Bale Mountains, Ethiopia. We explored time allocation across six main behaviours, namely: foraging, resting, patrol-marking, moving, socializing and others, and according to individual characteristics (age, dominance status, sex), pack-level characteristics (territorial density, family size, whether the dominant female bred or not) and environmental variables (dry and wet seasons). Generalized linear mixed models were fitted to hourly time investment data, with wolf and pack as random factors. Ethiopian wolves spent the majority of daytime foraging, with a peak around noon (when rodent prey is most active), irrespective of age and sex. Subordinate individuals however invested more time foraging than the dominant pairs. The higher the density of wolves within a family's territory the more time the individuals spent foraging, particularly during the dry season. The time invested in foraging however did not depend on whether the pack bred or not, except for females; time spent socializing did not change between breeding and non-breeding years. The larger the packs, the less time individuals spent patrolling the territory. Our results bring light into the costs and benefits associated to group living in a solitary forager. While living in larger packs diminished the costs of territorial defence, wolves living in crowded territories spent more time foraging, presumably due to interference competition. Habitat degradation and disturbances, from example from domestic dogs that roam within wolf habitat at daytime, could break this time-allocation balance, with implications for the survival of Ethiopian wolves and the long-term persistence of endangered populations.

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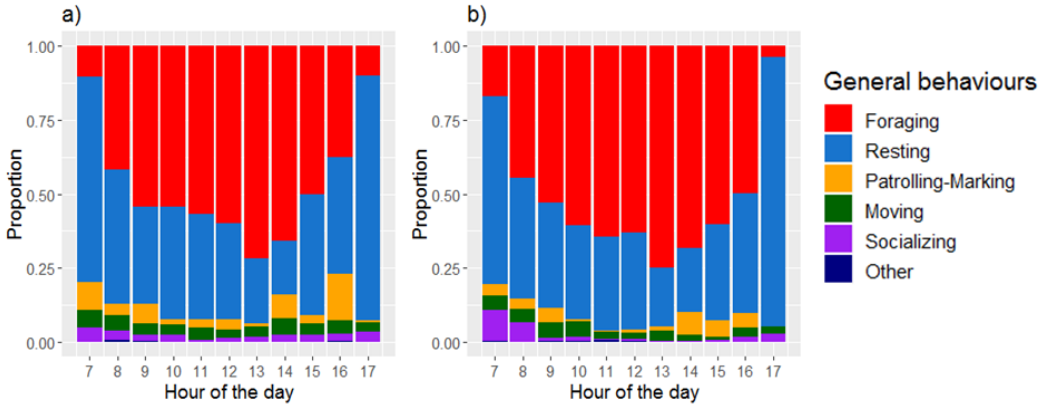

Figure F816C10.1: Daily time allocation by dominant (a) and subordinate (b) Ethiopian wolves among main behavioural categories, expressed as proportions of each behaviour per hour (N= 16 dominant and 33 subordinate wolves).

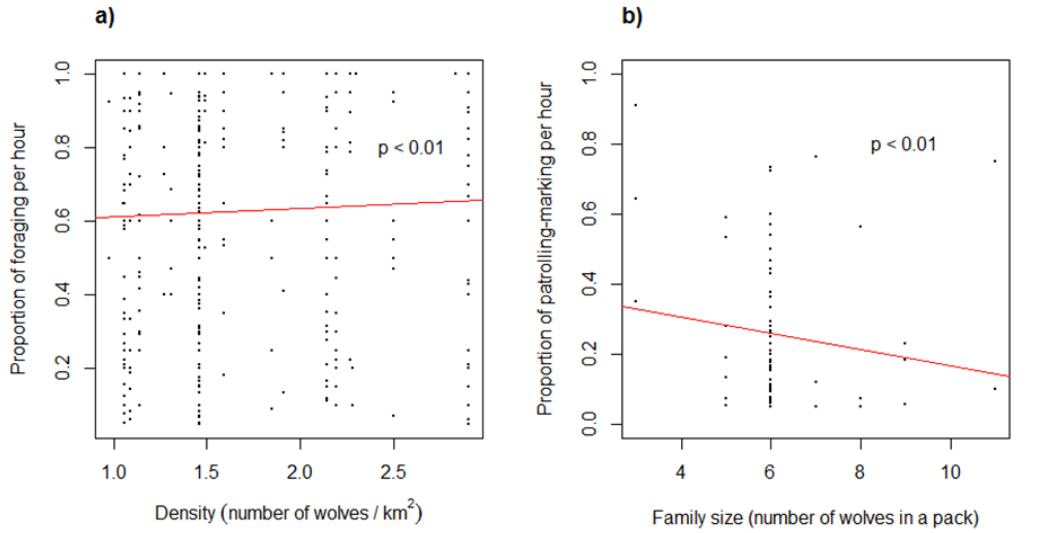

Figure F816C10.2: Time allocation in Ethiopian wolves (N= 47 individuals). a) Proportion of time foraging with respect to pack density (N= 390 observations), b) proportion of time patrolling with respect to group size (number of adult and subadult wolves in the pack) (N= 71 observations).

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F817K10

Research regarding the damages caused by the golden jackal in Danube Delta Biosphere Reserve and in surrounding areas (Romania).

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Introduction

The expansion of the jackal area is a process that we've yet to understand, whether is natural (due to intrinsic or extrinsic factors) or caused by humans (due to wolf elimination, poorly managed animal wastes, increase of protected areas, animal management, etc.). In recent years, many locals from Danube Delta Biosphere Reserve (DDBR) and the surrounding area, claim damages caused by jackals. The jackal is considered a pest and is demonized by the hunters, farmers and even some authorities.

Methods

In this study we documented the origins and trophobiology of the golden jackal in Romania (our data and references). The laboratory analysis on feces was corroborated with field observations concentrated especially on the surrounding of the species dens. We also use questionnaires (n= 155 in 2016) to investigate the damages produces by the jackal in DDBR.

Results

The trophobiology analysis showed that the jackal is a predator that plays an important ecological and sanitary role in agricultural and wet ecosystems in Danube Delta. From the bromatological analysis and field observations from Dobrogea, we documented the following results:

- A large spectrum of trophic components is used by the jackals, both of animal (vertebrates and invertebrates) as well as of plant origins;
- The food origin is uncertain. It could be from predation, scavenged carcasses of household debris.
- The domestic animals consumed by jackals were: pig (*Sus scrofa domesticus*) sheep (*Ovis aries*), dog (*Canis familiaris*), chicken (*Gallus domesticus*), turkey (*Meleagris gallopavo*), and some other unidentified birds.
- Approximately 10% of the samples contain domestic pigs and also 10% mature wild boars (no piglets; this indicates that they died of diseases or were shot, then scavenged, and not killed by the jackals).
- Regarding sheep findings, only one of the three cases was lamb and in other cases only wool bounds were found. These finding don't prove predation.

In February 2016 we questioned the locals regarding the damages produced by wild animals to the agricultural fields and domestic animals. The conclusions of the 155 questionnaires filled are:

- 93% believed that jackals can produce damages, 3% denied, 1% didn't know what to believe and 3% refused to answer.

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- 90 respondents said that they know of 1627 situations in which the jackal produced damages to domestic animals (overestimations, the same situations presented by many responders).
- 71% accused damages caused by the jackals, 24% denied and 5% didn't answer.
- Most claims damages to domestic birds and sheep; the most affected areas are Sălcioara and Maliuc; most attacks are during the night and at Sălcioara and Partisani only during the night.
- A large number of attacks were reported all around the year, with a small increase during the winter.
- Most of the attacks were against unguarded, domestic animals.
- 76% reported jackals inside the villages, 17% denied that.
- 88% reported damages during 2015, 67% reported that damages occur every year.
- 390 attacks were on goats and 355 on sheep.
- 44% of the respondents reported that it is possible that some of the cases attributed to the jackals to be misidentified, and the dogs or foxes could be the predators. 9% stated the same thing with a lower certitude. 30% denied this possibility.

Conclusions

As a main conclusion it should be pointed out that the jackal, as an active predator, has a beneficial role that needs to be popularized. Beside this, minimal protection measures for animal stocks have to be taken. On the other hand, the questionnaires show that the jackal is a voracious predator that decimated the livestock and should be controlled. The Danube Delta is a protected area with important habitats and ecosystem and the jackal is a predator that according to all of the principles of ecology is an important element in the food chain of the DDBR.

This study was financed by Danube Delta Biosphere Reserve Authority (Project title: 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).

F82K10+10

From the first to the second international symposium on jackal and related species: 2IJS outcome. GOJAGE 2011-2018 brief report.

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ΕΛΛΗΝΙΚΗ ΖΩΟΛΟΓΙΚΗ ΕΤΑΙΡΕΙΑ

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Σκοπός της εταιρείας είναι η μελέτη της γεωγραφικής κατανομής (Ζωογεωγραφία), της Οικολογίας και της Συστηματικής των ζώων του ελληνικού χώρου, η προστασία της πανίδας της Ελλάδας καθώς και η μελέτη των συναφών προβλημάτων.

Για την επίτευξη του σκοπού αυτού, οι δραστηριότητες της Εταιρείας είναι η συγκέντρωση της επιστημονικής βιβλιογραφίας της αναφερόμενης στην πανίδα της Ελλάδας, η προώθηση και ο συντονισμός θεμάτων που έχουν σχέση με την πανίδα, η παροχή πληροφοριών στους αρμόδιους για κάθε τι που έχει σχέση με την πανίδα και την προστασία της, η ανταλλαγή πληροφοριών, η διοργάνωση συμποσίων, συνεδρίων, διαλέξεων και συζητήσεων, η έκδοση συγγραμμάτων, μελετών, περιοδικών ή η ενίσχυση για την έκδοση τους, όπως και η υποβοήθηση κάθε άλλου είδους δραστηριότητας που συμβάλλει στην επίτευξη των στόχων της Εταιρείας.

Τομείς δραστηριότητας είναι η διοργάνωση του Διεθνούς Συνεδρίου για τη Ζωογεωγραφία και Οικολογία της Ελλάδας και των Γειτονικών Περιοχών κάθε τρία χρόνια, η έκδοση της σειράς *Fauna Graeciae*, η έκδοση του περιοδικού Ελληνικό Ζωολογικό Αρχείο, η έκδοση του Κόκκινου Βιβλίου για τα Απειλούμενα Σπονδυλόζωα της Ελλάδας, η λειτουργία του Κέντρου Απογραφής της Πανίδας της Ελλάδας για την συγκέντρωση και επεξεργασία των δεδομένων γύρω από την πανίδα της Ελλάδας, η εκτέλεση ερευνητικών προγραμμάτων και η συνεργασία με Ανώτερα Εκπαιδευτικά Ιδρύματα και με άλλες επιστημονικές και περιβαλλοντικές οργανώσεις σε θέματα έρευνας, ενημέρωσης, προστασίας και εκπαίδευσης γύρω από τα ζώα.

HELLENIC ZOOLOGICAL SOCIETY

The Hellenic Zoological Society is a non-profit organization established in 1980 in Athens. Its membership stands at the moment at more than 200 members from Athens, Thessaloniki, Patras, Crete and other parts of Greece as well as from abroad. Members can become all individuals that have a documented scientific activity in zoological subjects. Associate member can become anyone who is interested in the aims of the Society. The electronic address of the Society is www.zoologiki.gr.

The aims of the Society are the study of the geographic distribution (Zoogeography), the Ecology and the Systematics of the animals that live in Greece, the conservation of the fauna of Greece and the study of relevant problems.

In order to achieve these aims, the activities of the Society are the collection of the scientific literature on the fauna of Greece, the promotion and coordination of all matters related to the fauna of Greece, the provision of information to the authorities, the exchange of information, the organization of symposia, congresses, talks and discussions, the publication of books, studies, journals and the assistance of every kind of activity that leads to the achievement of the aims of the Society.

Areas of present activities are the organization of the International Congress on the Zoogeography and Ecology of Greece and the Adjacent Regions every three years, the publication of the series *Fauna Graeciae*, the publication of the journal Hellenic Zoological Archives, the publication of the Red Data Book of the Threatened Vertebrates of Greece, the supervision of the Greek Fauna Documentation Center that collects and processes data on the fauna of Greece, the implementation of research projects and the collaboration with Universities and other scientific and environmental organizations for the promotion of subjects dealing with research, information, conservation and education on the animals of Greece.