ECOLOGIA BALKANICA
2020, Vol. 12, Issue 2 December 2020 pp. 77-86

Study on Carrion Sharing Between the Golden Jackal (Canis aureus Linnaeus, 1758) and Sympatric Scavengers Over the Winter Period in Central Bulgaria using Camera Trapping

Krasimir B. Kirilov*

Trakia University, Faculty of Agriculture, Department of Animal Production – Non-ruminants and Other Animals, Stara Zagora 6000, BULGARIA
*Corresponding author: krasi9288@abv.bg

Abstract. The position of the Golden jackal (*Canis aureus* Linnaeus, 1758) within scavenger society in three Central Bulgaria habitats of different anthropogenic impact was investigated using camera trapping during the winter period of 2019-2020. Three different types of carrion (jackal carcass, wild boar and cattle skin) were used as lures. The scavenger society was represented by 15 vertebrates, including 8 bird and 7 mammal species, in these habitats. The study found that avian scavengers had an advantage over mammals in detecting carrion in open habitats due to their greater visibility. In mountainous forest habitats the scavenger community consisted mainly of mammals, with the jackal reliably detecting and using carrion as a food source. The study also found that an observational period greater than 25 days is required to attract all potential scavengers.

Key words: carrion, avian scavenger, lures, Red fox, Wild boar, habitats.

Introduction

Soft tissues, as well as bones of animal carcasses, contain energy and nutrients that in one way or another are involved in the cycle of the ecosystem. This process is critical for the function of the ecosystem (Barton et al., 2013; Moore et al., 2004; Parmentes & MacMahon, 2009). Dead large ungulates represent an abundant nutritional resource for medium-sized predators that would otherwise not be able to hunt them. No matter what the cause of their death (road accidents, illnesses, victims of larger predators or poaching), they represent a valuable nutritional resource that supports the survival of all predators during periods of food shortage. The wild boars, red deers and roe deers serve as such a resource in Bulgaria. Occasionally corpses of farm animals such as horses, cattle, sheep and goats are left in the wild. Almost all mammalian carnivores use to scavange frequently. Upon detecting a carcass, they take advantage of it by switching from active predation to carrion eating (Moleon et al., 2014). On this basis, commensal communities consisting mainly of birds and mammals are formed in different latitudes across the land. Their composition, as well as the relationships between the species, have been the subject of numerous studies (Inagaki et al., 2020; Kane & Kendall, 2017; Sebastian–Gonzales et al., 2013; Selva & Fortuna, 2007; Selva et al., 2005; Turner et al., 2017; Wilson & Wolkovich, 2011).

In Bulgaria, the scavenger guild has not been studied yet. The Golden jackal is well known as a scavenger species. Its diet includes remains of wild ungulates and farm animals (Raichev et al., 2013; Stoyanov, 2012). The position of the Golden jackal in the scavenging community has not been studied in the country.

Material and Methods

In order to reveal the potential specification of the facultative scavenger community according to habitat type and to get a full picture of its composition in Central Bulgaria, three different habitats were selected. One of the studied areas is located on the southern slopes of the central part of the Balkan Mountains. It is a steep and wooded, inaccessible terrain with low anthropogenic influence (mainly hunting), with an average altitude of 750-800 m (Fig. 1).

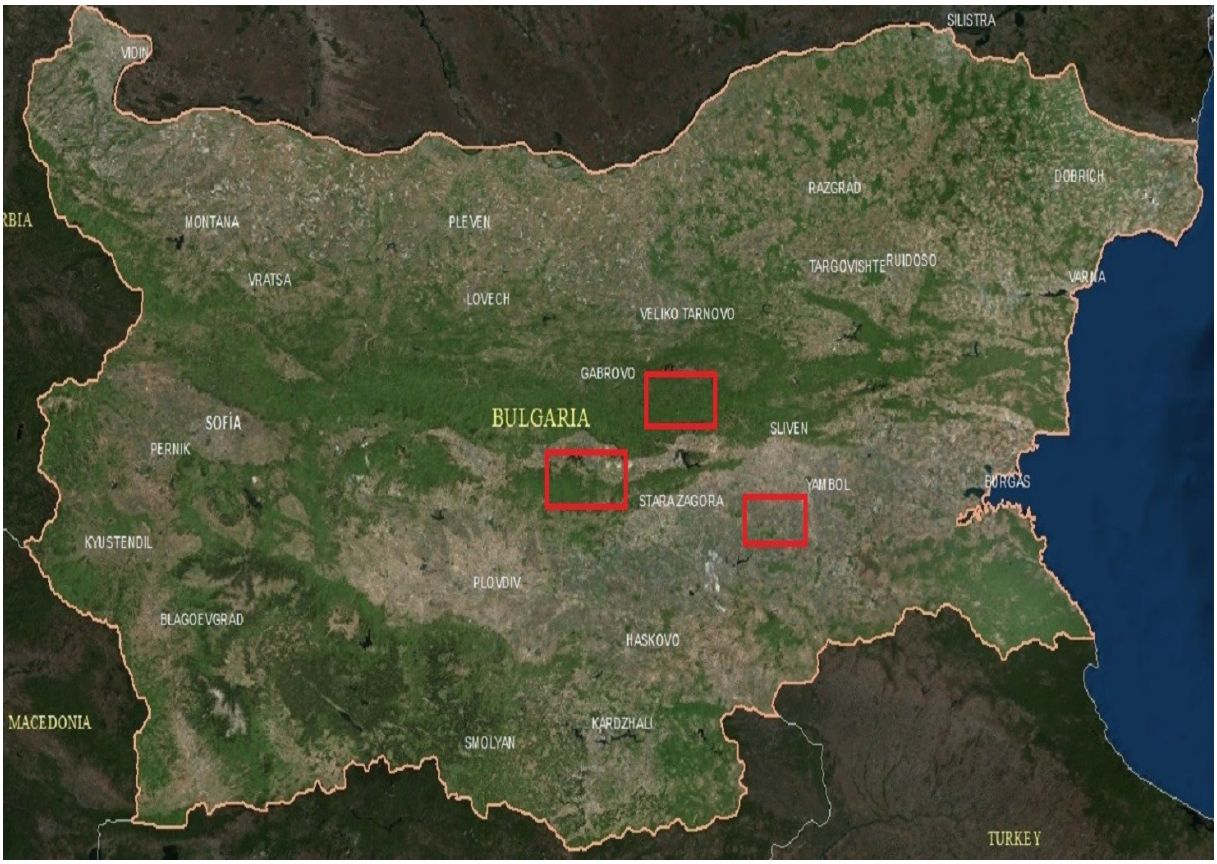

Fig. 1. The location of the three studied areas in Central Bulgaria.

The second area is a part of the territory of Sarnena Sredna gora Mts. The terrain is hilly with villages located at a distance of 5-6 km from each other which leads to stronger anthropogenic influence (agricultural activities, hunting, tourism) compared to the Balkan Mountains. The third study area is a part of the Upper Thracian plain, an open landscape with many arable lands, deserted lands and ponds. The lowland forests occupy insignificant areas and the anthropogenic impact is stronger than in the previous 2 areas. Agricultural activity is intensive, although in some places the area has become depopulated.

With the assistance of forest officials, as well as local hunters, some of the wild boar and jackal shooting sites were found in the study areas. After processing a wild boar carcass, a piece of skin weighing about 10 kg was placed in the area while a whole jackal carcass was left in the jackal shooting

location. This simulated the most common practice in our country. With the same idea, a piece of bovine leather, again weighing about 10 kg, was placed in the forest or in the field. Three types of lures were placed of equal weight to eliminate the influence of carcass size on the composition of the scavenger community (Turner, 2017). The bait was fixed to the base of a tree or shrub. The three types of lures were laid out in the three regions consecutively, in December, January and February of 2019-2020. The places were chosen according to the following rules:

- The lure must be situated away from animal paths so that passing animals are not captured by the cameras. The purpose was to capture only those animals that were attracted to the bait.
- The sites must be away from hunter or tourist trails (minimum 100 m) to minimize the impact of the anthropogenic factor.
- Each month, 9 new different carrion sites were selected to prevent creating a habit in wild animals to look for food in the same place. The goal was the bait to be found again every time. Thus 27 different sites were observed (9 cameras in three consecutive trials).

Three different models of infrared cameras were used: Keep guard Cam (KG690NV), Ltl Acorn (6310 – 3G) and HD camera with Black IR (SG56OK – 14 m). They were all set to take 2 pictures after triggering with followed one-minute interval. The devices were attached to trees at a height of 1.5 - 1.8 m from the ground, at a distance of 5 - 8 m from the laid bait. In this way, the lure was at the center of the resulting photo. Photos from a period of 25 days after the bait laying were used for the study. During this time the sites were not visited by the researcher to avoid the modification of wild animals' behavior. When reporting the results, the photos from consecutive and prolonged capturing of an individual within an hour, were counted as one event. A list of all species detected (birds and mammals altogether and separately for the three regions) was made. The relative order of their appearance was calculated; as well as the number of places visited by each species.

Results and Discussion

In winter, the scavenger community included 15 vertebrates (8 bird and 7 mammal species), throughout the study area. During the 25 monitored days, most of the mammals and birds attracted to the bait were detected by the cameras prior to the 5th day (Fig. 2).

However, the whole 25-day period is not sufficient to establish the full composition of the probable compatriots. In the three study areas, representing a diversity of habitats: forest (semi-mountainous and mountainous) and open (lowland), some differences in the composition of scavenging communities were found (Table 1). The least numerous community consisting of one bird (Eurasian jay) and 7 mammal species (Domestic dog, Golden jackal, Red fox, European wildcat, Eurasian badger, Stone marten and Wild boar) was found in the Balkan Mountains.

Despite the presence of the Grey wolf (*Canis lupus*) in the area, it was not detected by the cameras. The probable reasons for its absence were: its population density was low; it was suspicious to human smell and the investigated winter season was unusually warm. What is striking, was the low presence of birds, even though the golden eagle and the common raven were typical inhabitants of the mountainous area. In previous years, however, they took advantage of the wild boar carcass provided (personal observation).

The scavenger guild in the semi-mountainous region of Sarnena Sredna gora Mts. was represented by 2 bird species (Common buzzard, Eurasian jay) and 7 mammal species (Golden jackal, Red fox, Domestic dog, European wildcat, Stone marten, Eurasian badger and Wild boar). The

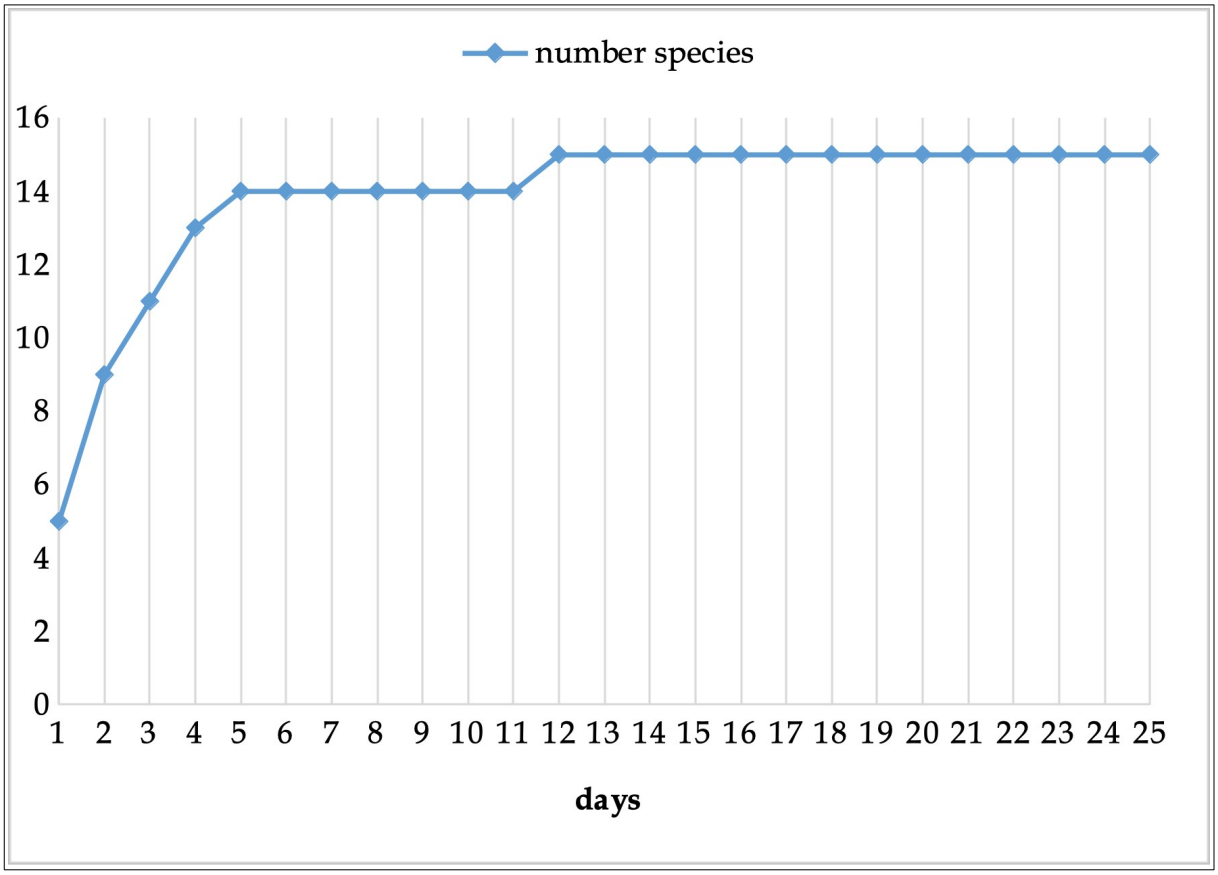

Fig. 2. Accumulation of the detected species number during investigated period.

Table 1. The list of scavenger community established in three different habitats in Central Bulgaria.

№	Species	Balkan Mountains	Sarnena Sredna gora Mts.	Upper Thrakian Plain	Mean value of order of appearance (MOA)
1	Magpie *Pica pica*			+	1.5
2	Common buzzard *Buteo buteo*		+	+	1.8
3	Eurasian jay *Garrulus glandarius*	+	+	+	1.86
4	Eastern Imperial Eagle *Acuila heliaca*			+	2
5	Golden jackal *Canis aureus*	+	+	+	2.68
6	Stone marten *Martes foina*	+	+	+	2.8
7	Eurasian Badger *Meles meles*	+	+		2.83
8	Domestic dog *Canis lupus familiaris*	+	+	+	2.83

9	Grey heron *Ardea cinerea*			+	3
10	Wild boar *Sus scrofa*	+	+	+	3.44
11	Red fox *Vulpes vulpes*	+	+	+	3.54
12	Western Marsh harrier *Circus aeruginosus*			+	4
13	Hooded crow *Corvus cornix*			+	4
14	Common raven *Corvus corax*		+		4
15	European wildcat *Felis silvestris*	+	+	+	4.5

birds contributed to the largest number of established species, detected in the Upper Thracian plain. This high detectability of birds can probably be due to good visibility in the open habitat (Turner, 2017), which facilitates the detection of carcasses from the air (Selva et al., 2005). The lures were visited by 6 species of mammals and 7 species of birds, which is the almost complete list presented in Table 1. Thus, the jackal's competition for carrion in open habitat is higher than in the other studied areas. However, in the lowland the jackal attracted by the presence and sounds of the Corvids could reach the carrion faster. The presence of the Eastern Imperial eagle and birds of the wetlands, such as Western Marsh harrier and Grey heron, is noteworthy. Vultures (*Gyps fulvus*) were absent in all three surveyed areas. After the extinction of the species from the territory of the country in the 60's, nowadays it is found in a small area along the Arda River (Stoyanov et al., 2018). It could be assumed that if the vultures were present, their role in the scavengers' guild would be palpable. The vultures play a crucial role in the ecosystem as the best cleaners (Mann & Banks, 2017). In the present study, their role is distributed to other species of birds and mammals found in the study areas.

According to the order of detection of the carcass calculated by the Mean value of the Order of Appearance (MOA) in front of the camera traps, the species can be divided into several groups. Part of the birds respond rapidly (MOA - 1.5-2) to the bait: Magpie, Common buzzard, Eurasian jay, Eastern Imperial eagle (Table 1). Although magpies hunt close to their resting places (Vines, 1981), in most of the cases they found the lure first. This is probably due to their large number and the detection of human presence when placing the carrion. Most of the mammals formed the second group of visitors (MOA - 2.68-3.54) as follow as: Golden jackal, Stone marten, Domestic dog, Eurasian badger, Wild boar and Red fox. The accidental appearance of a grey heron disrupted this sequence. Since this species appeared only once, it can be considered as a result of curiosity. However, it has been described as an element of the avian scavenger society in Spain (Hiraldo et al., 1991).

The Hooded crow, the Common raven, and the Western Marsh harrier appeared later (MOA - 4). The delay in the appearance of typical carrion-eating species such as the Common raven and the Hooded crow (Hiraldo et al., 1991) was probably due to their suspicion towards human presence. The European wildcat was the last (MOA – 4.5; Table 1), which is consistent with the claim that it rarely feeds on carrion (Hewson, 1983; Moleon & Gill-Sanchez, 2003).

The number of visited baited sites indicates the importance of the carrion for the species' diet (Selva & Fortuna, 2007). The

presence of jackals was reported in 22 of the 27 baited places. In India, the jackal scavenges on cattle carcasses because of the taboo to eat calves (Yunman et al., 2015). In Israel, the jackal not only scavenges on cattle carcasses but also attacks newborn calves (Yom-Tov et al., 1995). In the Ngorongoro Crater, the jackal scavenges opportunistically (Temu et al., 2016). In Serbia, this species is estimated to remove about 3,700 tons of animal waste per year, and in Europe, this amount consists of more than 13,000 tons per year (Cirovic et al., 2016). The jackal's dependency on carrion consumption is documented in this study. Other authors in Bulgaria found a significant presence of remains from domestic and wild mammals, as well as closely related species (Domestic dog, Golden jackal, Red fox) in the jackal's diet in the areas of this study (Vlasseva et al., 2013; Raichev et al., 2013; Tsunoda et al., 2017) and in other regions of the country (Atanasov, 1953; Genov, 1989; Stoyanov, 2012). Founding a large ungulate carcass, the jackals may form clusters of up to 14 individuals (Moehlman & Hayssen, 2018; Van Lawick & Van Lawick-Goodal, 1970). In the present study, no more than 3 individuals were captured together at one baited place. In these cases, the jackals were standing next to each other feeding in succession.

The Red fox was observed at 14 sites and the Stone marten at 10. In Spain, these two species are defined as meso-facultative scavengers. Together with the vultures, they are the main contributors for the nestedness of scavenging society (Sebastian-Gonzales et al., 2016). The Red fox is one of the major facultative scavengers in the world (Henry, 1977; Mateo-Tomas et al., 2015; Young et al., 2014). The presence of the Eurasian badger at 9 sites was observed but without consumption. That fact doesn't exclude it from the scavenger guild in the studied area, as it is a proven competitor to the Red fox for this nutritional resource (Young et al., 2014). The Wild boar, the same as an Eurasian badger, ranked fourth according to the number of visited places with bait (9 sites). As an omnivorous species, it consumes carrion (Wilson & Wolkovich, 2011) and also exhibits cannibalism (Cukor et al., 2019; Taylor & Helgren, 1997). The group nature of Wild boar visits was documented in this study.

The photographed dogs were difficult to define as feral or stray. The first group is defined as dogs gone wild, which hunt their prey and live away from humans. The second group consists of animals that live in dumps and hunt for fun, rather than passion, but not for food (Scot & Causey, 1973). Among the dogs captured in this study (6 sites), there were individuals with ear tags, i.e. neutered and fled far from settlements. Whichever category they belonged to, it was obvious that they took advantage of the carrion, which was their typical behavioral feature. (Macdonald & Carr, 1995; Selva et al., 2005). Stray dogs are less afraid of humans and can be active both during the day and at night (Zanin et al., 2019), which gives them some advantage over wild carnivores in detecting and consuming carrion.

The Magpie and the European wildcat exhibited the same level of visitation (6 sites each), and 5 places were visited by Common buzzard. The Eastern Imperial eagle, the Hooded crow, the Common raven, the Western Marsh harrier and the Grey heron visited each by one place out of the possible 27. Under the conditions of the experiment: warm and short winter period, low amount of carrion and intense competition among predatory mammals, these species behaved as sporadic scavengers. It could be assumed that their role as carrion consumers would be changed under different conditions. For example, the Common raven could be a companion of the Grey wolf, willing to take advantage of its prey (Stahler et al., 2002; Vucetich et al., 2004). In addition, Corvids are known to be mostly looking for fresh food avoiding eating poor quality carcasses. It matters to them how fresh the carrion is and what nutritional value it brings (Gomo

et al., 2017). In the present study, wild boar and cattle skins had almost no nutritional value for these bird species and this should be taken into account.

Conclusions

During winter in Central Bulgaria, the Golden jackal shares carrion as a food resource with 14 other vertebrate species. A 25-day study period is not sufficient to attract all potential compatriots. Open areas provide some advantage to birds over mammals in detecting a dead animal. In the highlands, the facultative scavenger guild consists mainly of mammals. The Golden jackal is the main species that reliably detects and certainly uses carrion as a food resource.

Acknowledgements

I am thankful to my scientific supervisor, Dr. E. Raichev from Trakia University as well as to the hunters and forestry officers from Stara Zagora region for the support at the time of hunting season in finding proper places for setting cameras. I further appreciate Dr. H. Tsunoda from Center for Environmental Science in Saitama and Dr. Y. Kaneko from Tokyo University of Agriculture and Technology for the technical support and also Ms Christina Mihaylova for her help in the English expression. The study was partly supported by a Grant-in-Aid for Scientific Research (No. 22405003 and 26257404) from the Japan Society for Promotion of Science.

References

Atanassov, N. (1953). Jackal researchers (*Canis aureus L*, 1758) in Bulgaria. *Notification of the Zoological Institute and Museum, 2*, 189-207. (In Bulgarian)

Barton, P., Gunningham, S., Lindermayer, D., & Manning, A. (2013). The role of carrion in maintaining biodiversity and ecological processes in terrestrial ecosystems. *Oecologia, 171*(4), 761–772. doi: 10.1007/s00442-012-2460-3.

Borkowski, J., Zalewski, A., & Manor, R. (2007). Diet composition of golden jackal in Israel. *Annales Zoologici Fennici, 48*(2), 108-118. doi: 10.5735/086.048.0203.

Cirovic, D., Penezic, A., & Krofel, M. (2016). Jackals as cleaners: Ecosystem services provided by a mesocarnivore in human-dominated landscapes. *Biological Conservation, 199*, 51–55. doi: 10.1016/j.biocon.2016.04.027.

Cukor, J., Linda, R., Vaclavek, P., Mahlerova, K., Satran, P., & Havranek, F. (2019). Confirmed cannibalism in wild boar and its possible role in African swine fever transmission. *Transboundary and Emerging Diseases, 67*(3), 1068-1073. doi: 10.1111/tbed.13468.

Henry, J. D. (1977). The Use of Urine Marking in the Scavenging Behavior of the Red Fox (*Vulpes vulpes*). *Behaviour, 61*(1-2), 82-105. doi: 10.1163/156853977X00496.

Genov, P., & Wassilev, St. (1989). Der Schakal (*Canis aureus L.*) in Bulgarien. Ein Beitrag zu seiner Verbreitung und Biologie. *Zeitschrift für Jagdwissenschaft, 35*, 145–150.

Gomo, G., Mattison,Y., Hagen, B., Moa, P., & Willebrand, T. (2017). Scavenging on a pulsed resource: quality matters for corvids but density for mammals. *BMC Ecology, 17*(1), article 22. doi: 10.1186/s12898-017-0132-1.

Henrich, M., Tietze, D.T., & Wink, M. (2016). Scavenging of small bird carrion in southwestern Germany by beetles, birds and mammals. *Journal of Ornithology, 158*, 287-295. doi: 10.1007/s10336-016-1363-1.

Hewson, R. (1983). The food of Wild cats (*Felis Silvestris*) and Red foxes (*Vulpes vulpes*) in west and north-east Scotland. *Journal of Zoology, 200*(2), 283-289. doi: 10.1111/j.1469-7998.1983.tb05790.x.

Hiraldo, F., Blanco, J., & Bustamante, Y. (1991). Unspecialized exploitation of small carcasses by birds. *Bird Study, 38*, 200-207.

Hisano, M., Raichev, E., Peeva, S., Georgiev, D., Tsunoda, H., Masuda, R., & Kaneko, Y. (2014). Notes on autumn-

winter stomach contents of the Stone Marten (*Martes foina*) in the Balkan Mountains, Central Bulgaria. *ZooNotes, 56*, 1-6.

Inagaki, A., Allen, M., Maruyama, T., Yamazaki, K., Tochigi, K., Nagenuma, T., & Koike, S. (2020). Vertebrate scavenger guild composition and utilization of carrion in an East Asian temperate forest. *Ecology and Evolution, 10*(3), 1223-1232. doi: 10.1002/ece3.5976.

Kane, A., & Kendall, C. (2017). Understanding how mammalian scavengers use information from avian scavengers: Cue from above. *Journal of Animal Ecology, 86*(4), 837-846. doi: 10.1111/1365-2656.12663.

Lanszki, J., Kurys, A., Heltai, M., Csanyi, S., & Acs, K. (2015). Diet composition of the golden jackal in an area of intensive big game management. *Annales Zoologici Fennici, 52*(4), 243-255. doi: 10.5735/086.052.0403.

Macdonald, D., & Carr, D. (1995). Variation in dog society: between resource dispersion and social flux. In: J. Serpell (Ed.). *The domestic dog: its evolution, behaviour, and interactions with people.* (1st Edition, pp. 199-216) Cambridge, United Kingdom, Cambridge University Press.

Mann, R., & Banks, D. 2017. *Vultures: nature's best scavengers.* Bushwise.

Mateo–Tomás, P., Olea, P., Moleón, M., Vicente, J., Botella, F., Selva, N., Viñuela, J., & Sánchez–Zapata, J. (2015). From regional to global patterns in vertebrate scavenger communities subsidized by big game hunting. *Diversity and Distributions, 21,* 913-924. doi: 10.1111/ddi.12330.

Moehlman, P., & Hayssen, V. (2018). *Canis aureus* (Carnivore: *Canidae*). *Mammalian Species, 50*(957), 14-25. doi: 10.1093/mspecies/sey002.

Moleon, M., & Gill–Sanchez, J. (2003). Food habits of the wildcat (*Felis silvestris*) in a peculiar habitat: the Mediterranean high mountain. *Journal of Zoology, 260,* 17-22. doi: 10.1017/S0952836902003370.

Moleon, M., Sanchez–Zapata, J., Selva, N., Donazar, J., & Owen–Smith, N. (2014). Inter–specific interactions linking predation and scavenging in terrestrial vertebrate assemblages. *Biological Reviews, 89*(4), 1042-1054. doi: 10.1111/brv.12097.

Moore, J., Berlow, E., Coleman, D., Ruiter, P., Dong, Q., Hastings, A., Johnson, N., McCann, K., Melville, K., Morin, P., Nadelhoffer, K., Rosemond, A., Post, D., Sabo, J., Scow, K., Vanni, M., & Wall, D. (2004). Detritus, trophic dynamics and biodiversity. *Ecology Letters, 7*(7), 584-600. doi: 10.1111/j.1461-0248.2004.00606.x.

Munez-Lozano, C., Martin-Vega, D., Plieite, C., Sanchez–Zapata, J., Morales-Reyes, Z., Juan, M., & Moleon, M. (2019) Avoidance of carnivore carcasses by vertebrate scavengers enables colonization by a diverse community of carrion insects. *PLoS ONE, 14*(8), e0221890. doi: 10.1371/journal.pone.0221890.

Parmenter, R., & Macmahon, J. (2009). Carrion decomposition and nutrient cycling in a semiarid shrub–steppe ecosystem. *Ecological Monographs, 79*(4), 637-661. doi: 10.1890/08-0972.1.

Raichev, E., Tsunoda, H., Newman, C., Masuda. R., Georgiev, D., & Kaneko, Y. (2013). The reliance of golden jackal (*Canis aureus*) on anthropogenic foods in winter in Central Bulgaria. *Mammal study, 38*(1), 19-27. doi: 10.3106/041.038.0102.

Scott, M., & Causey, K. (1973). Ecology of Feral Dogs in Alabama. *The Journal of Wildlife Management, 37*(3), 253-265. doi: 10.2307/3800116.

Sebastian–Gonzalez, E., Moleon, M., Gibert, J., Botella, F., Mateo-Tomas, P., Olea, P., Guimaraes, P., & Sanchez-Zapata, J. (2016). Nested species-rich networks of scavenging vertebrates support high levels of interspecific competition.

Ecology, 97(1), 95-105. doi: 10.1890/15-0212.1.

Sebastian–Gonzalez, E., Sanchez–Zapata, J., Donazar, J., Selva, A., Cortes–Avizanda, A., Hiraldo, F., Blazquez, M., Botella, F., & Moleon, M. (2013). Interactive effects of obligate scavengers and scavenger community richness on lagomorph carcass consumption patterns. *Ibis, 155*, 881-885. doi: 10.1111/ibi.12079.

Selva, N., & Fortuna, M. (2007). The nested structure of a scavenger community. *Proceedings. Biological sciences, 274*(1613), 1101–1108. doi: 10.1098/rspb.2006.0232.

Selva, N., Jędrzejewska, B., Jędrzejewski, W., & Wajrak, A. (2005). Factors affecting carcass use by a guild of scavengers in European temperate woodland. *Canadian Journal of Zoology, 83*, 1590–1601. doi: 10.1139/z05-158.

Stahler, D., Heinrich, B., & Smith, O. (2002). Common ravens, *Corvus corax*, preferentially associate with grey wolves, *Canis lupus*, as a foraging strategy in winter. *Animal Behaviour, 64*(2), 283-290. doi: 10.1006/anbe.2002.3047.

Stoyanov, E., Kmetova-Biro, E., Stoyanov, G., Peshev, H., Ivanov, I., Stoev, I., Bonchev, L., Vangelova, N., Nikolova, Z., Yankov, L., Parvanov, D., Grozdanov, A., & Angelov, I. 2018. Population Boost of the Griffon Vulture *Gyps fulvus* (Hablizl, 1783) (Accipitridae) in Bulgaria Based on Reintroductions. *Acta zoologica bulgarica, 12*, 59-65.

Stoyanov, S. (2012). Golden jackal (*Canis aureus*) in Bulgaria. Current status, distribution, demography and diet. *Conference: International Symposium on Hunting: Modern aspects of sustainable management of game population. Zemun-Belgrade, Serbia, 22-24 June 2012.*

Taylor, R., & Hellgren, E. (1997). Diet of Feral Hogs in the Western South Texas Plains. *The Southwestern Naturalist, 42*(1), 33-39.

Temu, S., Nahonyo, C., & Moehlman, P. (2016). Comparative Foraging Efficiency of Two Sympatric Jackals, Silver-Backed Jackals (*Canis mesomelas*) and Golden Jackals (*Canis aureus*), in the Ngorongoro Crater, Tanzania. *International Journal of Ecology, Vol. 2016.* doi: 10.1155/2016/6178940.

Tsunoda, H., Raichev, E., Newman, C., Masuda, R., Georgiev, D., & Kaneko, Y. (2017). Food niche segregation between sympatric golden jackals and red foxes in Central Bulgaria. *Journal of Zoology, 303*(1), 64-71. doi: 10.1111/jzo.12464.

Turner, K., Abernethy, E., Conner, L., Rhodes, O., & Beasley, J. (2017). Abiotic and biotic factors modulate carrion fate and vertebrate scavenging communities. *Ecology 98*(9), 2413-2424. doi: 10.1002/ecy.1930.

Van Lawick-Goodall, H., & Van Lawick-Goodall, J. (1970). *Innocent Killers: A Fascinating Journey Through the Worlds of the Hyena, the Jackal, and the Wild Dog*. Houghton Miffin, Boston, 222 p.

Vines, G. (1981). A socio−ecology of magpies *Pica pica*. *Ibis, 129*, 190-202. doi: 10.1111/j.1474-919X.1981.tb00924.x.

Vlasseva, A., Chassovnikarova, T., & Atanassov, N. (2017). Autumn-Winter Diet and Food Niche Overlap between Red Fox (*Vulpes vulpes L.*, 1758) and Golden Jackal (*Canis aureus L.*, 1758) in Two Regions in Bulgaria. *Acta zoologica bulgarica, 8*, 217-220.

Vucetich, Y., Peterson, R., & Waite, T. (2004). Raven scavenging favours group foraging in wolves. *Animal Behaviour, 67*(6), 1117-1126. doi: 10.1016/j.anbehav.2003.06.018.

Wilson, E., & Wolkovich, E. (2011). Scavenging: how carnivores and carrion structure communities. *Trends in Ecology & Evolution, 26*(3), 129–135. doi: 10.1016/j.tree.2010.12.011.

Yom-Tov, Y., Ashkenazi, S., & Viner, O. (1995). Cattle predation by the golden jackal *Canis aureus* in the Golan heights, Israel. *Biological Conservation, 73*(1), 19-22. doi: 10.1016/0006-3207(95)90051-9.

Young, A., Marquez–Grand, N., Stillman, R., Smith, M., & Korstjens, A. (2014). An

investigation of Red Fox (*Vulpes vulpes*) and Eurasian Badger (*Meles meles*) scavenging, scattering, and removal of deer remains: forensic implications and applications. *Journal of Forensic Sciences, 60*(1), 39-55. doi: 10.1111/1556-4029.12554.

Yumnam, B., Negi, T., Maldonado, J., Fleischer, R., & Jhala, Y. (2015). Phylogeography of the Golden Jackal (*Canis aureus*) in India. *PLoS One, 10*(9), e0138497. 10.1016/0006-3207(95)90051-9.

Zanin, M., Bergamaschi, C., Ferreira, Y., Mendes, S., & Moreira, D. (2019). Dog days are just starting: the ecology invasion of free-ranging dogs (*Canis familiaris*) in a protected area of the Atlantic Forest. *European Journal of Wildlife Research, 65*(5), 65. doi: 10.1007/s10344-019-1303-5.

Received: 30.05.2020
Accepted: 24.08.2020