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On the Golden Jackal's (Canis aureus Linnaeus, 1758) Distribution During Snow Period in the Central Part of Stara Planina Mts, Bulgaria

Krasimir B. Kirilov*, Stanislava P. Peeva

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 aim of the present study was to determine the frequency of occurrence of the Golden jackal according to snow cover changes in different elevations and slope exposure in the central parts of Stara Planina Mts, Bulgaria. To achieve the purpose, 15 camera traps were used, at both, south and north slopes of the mountain on 5 different elevations. The data revealed a significant difference in the number of jackals detected between the southern and the northern slopes as well as at different elevation of the Central Stara Planina Mts. The largest number of jackals was found at the lowest level (up to 600 m a.s.l.). With elevation increasing, the number of detected individuals decreased. The jackal presence at 1000 - 1200 m a.s.l. in both studied areas was sporadic, and over 1200 m a.s.l. the species was not detected. The Golden jackal from the region of Central Stara Planina Mts demonstrated clear preferences to the southern slopes up to 800 m a.s.l.

Key words: camera traps, elevation, snow, slopes, mountain, jackal.

Introduction

The Golden jackal (*Canis aureus* Linnaeus, 1758) is one of the most widespread canid species in Central and Southern Europe. It is numerous in the Balkan Peninsula, in Bulgaria particularly (Kryštufek et al., 1997). After the 1980s, the species' expansion began from Balkan Peninsula to the north and west, and nowadays it is found in Austria, Hungary, Italy, Ukraine, Poland, Belarus, Estonia, Latvia and Lithuania (Arnold et al., 2012; Trouwborst et al., 2015). Of all occupied European countries, however, the highest jackal population density remained in Bulgaria (Markov, 2012). There, the Golden jackal has a big economic impact (Stoyanov, 2012) and it is hunting object in order to regulate its number (SG, 2000). The species occupies almost the entire territory of the country, appearing sporadically in the highest parts of the mountains (Markov et al., 2018). The present study could clarify the Stara Planina Mts importance as a partial barrier for the jackal's spread which started from Strandzha Mountains to the north in the 1970s (Markov, 2012). The Stara Planina Mts has been overcome by the jackal in its lowest parts along the Black Sea coast (personal observation). It can be assumed that nowadays this long mountain chain isolates partially the jackal populations from Northern and Southern Bulgaria. During winter the conditions in the mountain

habitats change drastically, especially after a snowfall. The behavioral response of the Golden jackal to the severe winter conditions is not studied in details, and the data on its distribution in Bulgaria according to different altitudes is scarce. The only information on its number in the highest parts of the Stara Planina Mts is obtained from the local hunters and from forestry officials. The aim of the present study was to determine the frequency of occurrence of the Golden jackal according to snow cover changes in different elevations and slope exposure in the central parts of Stara Planina Mts, Bulgaria.

Study Area

To reveal the Golden jackal's distribution related to the altitude in winter in the Balkan Mountains and to establish the influence of snow cover on its number, two areas with different exposure (southern and northern) were selected (Fig. 1). The first region is a part of the southern slopes of the Central Stara Planina Mts. The terrain is steep, difficult to access, with low anthropogenic influence (mainly hunting). The average January temperatures for the region range from - 1° C to + 1° C (Nikolova, 2002).

The second region is a part of the northern slopes of the Central Stara Planina Mts, more sloping and smoothly passing in hilly terrain to the north. The climate in this part of the Stara Planina Mts is harsher, compared to the first region, with an average air temperature in January varying from - 1 ° C to - 4 ° C (Nikolova, 2002), and the snow cover preserves longer. With altitude increasing, the snow cover in the highest parts of the region lasts up to 190 - 200 days a year (Mateeva, 2002). The anthropogenic influence is weak, as in the first region.

With elevation changing, the vegetation in both studied areas formes belts, that are same for both, the southern and northern slopes. The two studied areas in the Central Balkan Mountains comprise 5 vegetation belts, developed in all Bulgarian mountains: Mediterranean vegetation (up to 300 - 400 / 500 m a.s.l.); xerothermic oak forests (up to 600 - 700 m a.s.l.); hornbeam-gorun forests (from 600 - 700 to 900 - 1000 m a.s.l.); common beech forests (from 900 - 1000 to 1300 - 1500 m a.s.l.) and coniferous forests (from 1300 - 1500 to 2000 - 2100 m a.s.l.) (Velchev, 2002).

Material and Methods

For the purpose camera trapping was used which excludes modifying typical species behavior. To reveal the Jackal distribution depending on elevation, the devices were placed in 5 different levels: level A (up to 600 m above sea levels (a.s.l.); level B (600 - 800 m a.s.l.); level C (800 - 1000 m a.s.l.); level D (1000 - 1200 m a.s.l.) and level E (above 1200 m a.s.l.). After a preliminary investigation of the terrain, the most suitable places for setting the cameras were selected. The devices were mounted near the most useful predator trails. The criteria for their selection were: they need to be well trodden and with presence of predators' traces and feces. A total of 15 camera traps (Keep guard Cam, KG690NV) were set in each investigated area in two winter seasons (2016 - 2017 and 2018 - 2019). The devices were distributed in 3 at each elevational level. Each camera was mounted near a suitable animal path at an angle ranging from 45° to 90° to the leight of the trail. The devices were attached to a tree at 1.5 - 1.8 m height and at 3 - 5 m distance from the path, according to the instructions (Ancrenaz et al., 2012). The cameras were set to take 3 photos after triggering with 5 minutes delay. For each elevational zone, the days with and without snow cover were estimated within the studied period, from the obtained photos basis. Than the frequency of occurrence of the jackal was calculated according to the following equation:

$$F = \frac{number\ of\ jackals}{camera\ days} x\,100.$$

Results and Discussion

Taking into account the first and the last snow day detected by the cameras, two periods: of 143 days (29.11.2016 - 20.04.2017), 2 145 camera days respectively for the southern slope and of 142 days (17.11.2018 - 07.04.2019), 2

130 camera days respectively for the northern one, were estimated (Table 1).

Data from the survey showed a significant difference in the number of jackals between the southern and northern slopes of Stara Planina Mts (179 photos for the southern slope against 39 - for the northern one). The largest number of jackals was registered at the lowest level (up to 600 m a.s.l.). For the same elevation range the big difference between the number of jackals detected in the two studied areas was found (152 for the southern slope and 14 - for the northern one). At this altitude the habitat type is determined by the main vegetation, typical for the xerothermic oak forests (Velchev, 2002). It provides various food base and shelters for jackals.

The jackal occurrence at 600 - 800 m a.s.l. was lower with more individuals detected on the southern slopes again. As a rule, the number of jackals registered decreased with an elevation increasing. The jackal presence from 1000 to 1200 m a.s.l. in the both studied areas was sporadic, and above 1200 m a.s.l. the species was not detected.

Despite the snow cover presence, in the highest parts of the studied areas, jackals have never been detected, and at lower altitudes individuals were registered. In the mountain basis, the snow cover did not negatively affect the jackals, as the number of individuals photographed on snow was significantly higher compared to those on snowless conditions. Snow influences animal behavior not only because its presence, but also via its characteristics (Novikov, 1981). Although the snow cover depth in different levels was not measured in the present study, it is well known that the snow at the mountain base, especially on the southern side, is shallow due to its frequent melting. It can be assumed that the shallow snow cover does not hinder the animals' movement. The dynamics in changes of snow periods with snowless ones at the lowest elevations, as well as the lesser number of snow days, compared to the other levels in the studied areas, are the probable reasons for the increased jackals presence at lowest places with snow cover. It can be assumed that such variable weather conditions facilitate the jackal in its vital functions (searching food and finding shelter). Among the medium-sized predators in Bulgaria, the Golden jackal is the least adapted for locomotion in deep snow (Raichev, 2010), which is a prerequisite for avoiding the high parts of the studied areas. The jackal has relatively short legs with narrow paws, which hinder its moving in deep snow. In addition, its fur is not adapted to severe winter conditions (Aliev, 1968; Taryannikov, 1974; Vereshchagin, 1959; Heptner & Naumov, 1998), typical for the high parts of the mountains. There are no researches on the critical snow depth for the jackal. For the fox, which has a similar anatomy, this depth is 30 - 40 cm (Formozov, 1946). It is very likely that the jackal will have difficulty even at less than the mentioned depth (Fig. 2), as the weight load of its paws is greater than that of the fox (Raichev, 2010). In addition, studies on the jackal's distribution revealed that the snow cover duration significantly affects its selection of new habitats (Ranc et al., 2017). Coyotes in North America, which occupy the same ecological niche as jackals in Europe, are most numerous in areas with low elevation and shallow snow cover (Murray & Boutin, 1991). The same as the Golden jackal, they have difficulties when moving in deep snow. They often move on trails left by snowmobiles, taking advantage of the pressed snow (Crete & Lariviere, 2003). High mountainous areas with deep and permanent snow cover, extremely low temperatures and steep terrain are not suitable for the Golden jackal (Spassov, 1989; Demeter & Spassov, 1993). Such conditions cause energy losses when moving, finding food and thermoregulating (Pacer et al., 1984; Root, 1988). Energy consumption increases with snow depth and density increasing (Withers et al., 2016). In domestic dogs, sinking of the limbs when moving on deep snow was found to accelerate heart rate more than accelerating movement does itself (Crete & Lariviere, 2003).

Fig. 1. Study areas located in the Central Stara Planina Mts, Bulgaria.

Table 1. Number of registered golden jackals during snow period according to elevation in northern and southern slopes of the Central Stara Planina Mts, Bulgaria.

Level	Southern slope			Northern slope		
	Detected jackals / camera days with snow	**Detected jackals / camera days without snow**	**Total**	**Detected jackals / camera days with snow**	**Detected jackals / camera days without snow**	**Total**
E	0 / 354	0 / 75	0 / 429	0 / 426	0 / 0	0 / 426
D	1 / 300	1 / 129	2 / 429	1 / 342	1 / 84	2 / 426
C	0 /204	1 / 225	1 / 429	2 / 324	8 / 102	10 / 426
B	10 / 159	14 / 270	24 / 429	8 / 204	5 / 222	13 / 426
A	117 / 153	35 / 276	152 /429	7 / 168	7 / 258	14 / 426

Fig. 2. Golden jackals detected moving in deep snow cover.

The declining jackal's presence with elevation rising (Fig. 3) underlines its preference towards the lowest levels (below 800 m a.s.l.) in the study areas.

The species prefers lowlands which are the natural habitats for its main prey (Nievergelt, 1981) avoiding the vast forest areas in the highest mountainous levels, described as a barrier for its distribution (Negi, 2014). In Greece, the Jackal inhabits mainly areas below 600 m a.s.l., being most numerous in wetlands overgrown with dense vegetation and at about 10 m a.s.l. (Giannatos et al., 2005). The small number of individuals photographed during the entire study period at levels of 800 - 1200 m a.s.l. (C and D) suggests the idea that this part of Stara Planina Mts is not preferred by jackals in winter. Habitats above 800 m a.s.l. comprise the beech forest belt (Velchev, 2002), offering limited food resources and scarce shelters for jackals.

Above 1200 m a.s.l., (level E) no jackals were detected in both areas throughout the studied periods. There, the snow cover was the most abundant and continuous, suggesting difficulties in finding food for the medium sized predators such as the Golden jackal. Many authors reported the jackal as a typical polyphagous species, feeding mainly on small prey (mostly rodents), plants (mostly fruit), carrion from wild and domestic animals and artificials (Cirovic et al., 2014; Markov & Lanszki, 2012; Tsunoda et al., 2017; Jaeger et al., 2007). Thus, it can be assumed that the limited food base in the highest parts of the studied areas is one of the main reasons for the small jackal number reported there. In the temperate latitudes of Europe, cervids make vertical migrations towards the lower parts of the mountains, as typical movement pattern (Mysterud et al., 2001). It is considered that the triggering mechanism for this behavior is the snow cover depth retention over 20 - 25 cm for a long time period (Schmidt & Gossow, 1991). Thus the hunting efforts in the lower parts of the mountain occur, ensuring additional food source for predators. The jackal was found to be an opportunistic species that feeds on leftovers from hunted animals (Lanszki et al., 2015). The presence of wolves in the higher parts of Stara Planina Mts (Fig. 4) could affect negatively the jackals' number at the levels C, D and E. The Grey wolf is one of the factors limiting jackal's distribution (Spassov & Acosta-Pankov, 2019; Ranc et al., 2017).

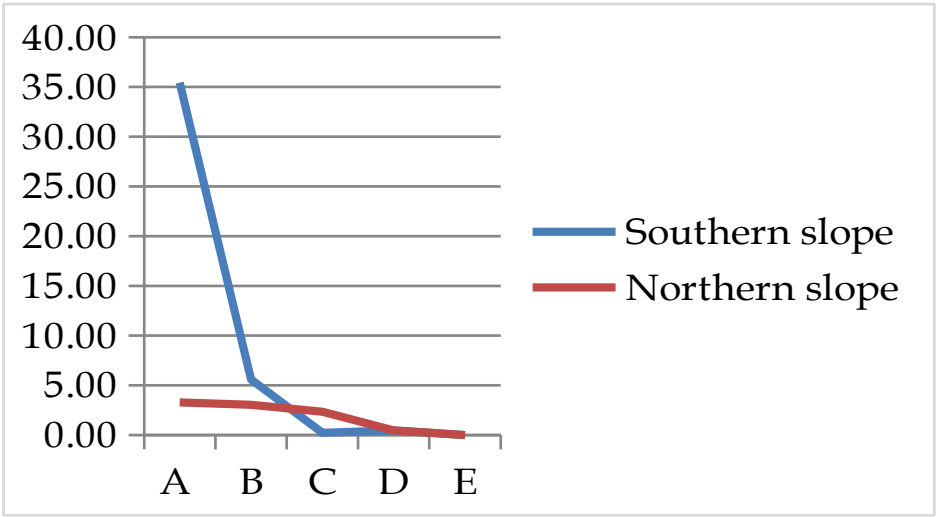

Fig. 3. Frequency of occurrence of the Golden jackal during snow period according to elevation (A - up to 600 m a.s.l.; B – 600 - 800 m a.s.l.; C – 800 - 1000 m a.s.l.; D – 1000 - 1200 m a.s.l.; E - above 1200 m a.s.l.) in northern and southern slopes of the Central Stara Planina Mts, Bulgaria, in %.

Fig. 4. Grey wolves detected at 1000 - 1200 m above sea level.

In order to clarify the influence of the factors mentioned above on the Golden jackal behavior and distribution in the mountains, detailed researches are needed.

Conclusions

During snow period, the Golden jackal from the region of Central Stara Planina Mts demonstrated clear preferences to the southern slope up to 800 m a.s.l. The elevation from 800 to 1000 m a.s.l. could be considered as a conditional border for the jackal's distribution in the Central Stara Planina Mts.

The following factors could be pointed out as probable reasons for the Golden jackal's uneven distribution in the Central Stara Planina Mts during snow period: the terrain exposure and elevation, the snow cover depth and the Grey wolf's presence.

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