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Seasonal Differences in Howling Response of Golden Jackals *Canis aureus* L., 1758 (Mammalia: Canidae) in Eastern Bulgaria

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Abstract: The howling in golden 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 article describes changes in golden jackal response to a pre-recorded howl on a monthly basis throughout a monitoring period of one year. The study area was set in Eastern Bulgaria, in regions with already known high jackal population density. Data were collected from two transects located in different areas (Northeast and Southeast Bulgaria). The highest number of answers to the broadcasted howls was detected during June and July in Southeast Bulgaria and during July and August in Northeast Bulgaria. During these peaks, group-answers were registered mainly and the single individual-answers were very few or lacking. Based on jackal's ecology and biology, the results suggest that the howling response corresponds more to interactions between territorial groups rather than to communication signals during the breading season.

Key words: *Canis aureus*, golden jackal survey, howling, seasonality, Bulgaria

Introduction

The golden jackal *Canis aureus* L., 1758 had a restricted distribution in Europe between Southeast (Balkans) and Central Europe (Hungary) in the end of the 19th and the first half of 20th Century (Atanassov 1953, Corbet 1978, Spassov 1989, 2007, Demeter & Spassov 1993, Arnold et al. 2012). The increase of the geographical range of this species to the Northern and Western Europe is considered a new phenomenon that has become an important issue in the recent decades (Kryštufek et al. 1997, Herzig-Straschil 2008, Krofel 2009, Arnold et al. 2012, Trouwborst et al. 2015). The jackals' vocalization is one of the most important and exciting ecological features of this carnivore species; various authors have indicated that the howling sound of jackals is used in social interactions but mostly as a signal for marking territories within their groups distributions (van Lawick & van Lawick-Goodall 1970, Golani & Mendelsson 1971, Golani & Keller 1975, Nikolskij & Pojarkov 1981, Demeter & Spassov 1993, Comazzi et al. 2016). In Northern Bulgaria, Kolar et al. (2005) have detected by using sound recording analyses that the howl of the golden jackal has a complex structure, identifying three long distant vocalizations with several harmonics, two long calls (flat howl and warble howl) and one short call (yip); in addition, jackals have been found to respond to a recorded and broadcasted howl.

The implementation of bioacoustic approach in Europe has become a common method for data collection related to the jackal population density (Giannatos et al. 2005, Lapini et al. 2009, Banea et al. 2012, Mihelič & Krofel 2012, Comazzi et al. 2016). Atanassov (1953) identified a relationship between the howling occurrence and the sea-

son, reporting the highest period of howling between September and December in Bulgaria. In Caucasus, jackals howl more during the paring period (Dinnik 1914). However, there were no data on the howling response to playbacks in Bulgaria and the Balkans across the year. Such kind of data were available in Bangladesh (although in different climatic and seasonal conditions) referring to howl response in regards to the annual reproductive cycle of the species (Jaeger et al. 1996).

The spontaneous jackal howling is not the same as the howling response but the relationship between them could be supposed. The present study analyses differences in the answer rate to the broadcasted playback and their seasonal dependence.

Materials and Methods

This study was conducted in East Bulgaria near the coast of the Black Sea where the prevailing habitats are characterised by a mosaic landscape including woodlands, shrublands and extensive agricultural fields. Two areas were chosen (Fig. 1). The first one was in Northeast Bulgaria (Varna Region) near Kamchia River where shrublands and extensive agricultural fields prevail. The second one was in Southeast Bulgaria (Strandzha Mountains region) near Veleka River where woodlands predominate. The climate in Varna Region is temperate continental with Black Sea influence; in Strandzha, the climate is Transitional Mediterranean. The regions used for fieldwork are known as medium to high-density jackal population areas (Spassov 2007, Arnold et al. 2011, Acosta-Pankov, unpubl. data). There are no actual data for jackals' abundance as well as on the density of other carnivores that may compete for resources in the studied areas; however, the hunting statistics for 2015 provide an estimate of the abundance of other canids in the studied areas (Table 1). Our observations do not support the supposition that the jackal howling response is affected by the strong presence of other canids: jackal howls were regularly registered close to barking dogs and even with howling wolfs (Acosta-Pankov, unpublished data).

To provoke jackals' response in the study area, a playback acoustic method was used (Giannatos et al. 2005). Different points or calling station (CS) were selected for broadcasting, using the pre-recorded jackal howl with a 60 Watts power megaphone, which includes USB, SD inputs and MP3 player software. The vocalization type used in the recording for stimulation was a long-distance call (Kolar et al. 2005), with two jackals. It was recorded in June 2014 near town of Chernevo in Northeast Bulgaria (Varna Region) and had duration of 30 seconds. The same record was always used throughout the year in all the points.

Data were obtained from two transects. The first (Transect 1) consisted of 14 CS located in the area of Strandzha Region with an estimated density of 1.41 territorial groups/10 km^2. The second (Transect 2) had 10 calling stations in the area of Varna Region, with an estimated density of 2.83 territorial groups/10 km^2 (Fig. 1). All data were collected in 2015 on a monthly basis (January to December) for each transect, performing the fieldwork in the second half of the respective month.

Giannatos et al. (2005) experimentally tested and determined the maximum human hearing distance at 1.8 – 2 km. Due to the morphology of the terrain in the study area, we reduced the listening radius to a 1.5 km; subsequently, the calling stations were set at a distance of at least 3 km to each other to avoid counting answers of the same territorial group from two different calling stations. Every broadcasted howl was followed by a 3-minute pause. In lack of response, the procedure was 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 approx.), medium (500-1000 m approx.) or far (1000-1500 m approx.) (Banea et al. 2012).

Table 1. Canids harvest rate in the study area hunting preserves in 2015. Territory size: Strandzha Mountains region 1215.85 km^2; Varna region 1097.69 km^2 (Official data of the Union of Hunters and Anglers in Bulgaria).

Species of Canids	Animals harvested (Strandzha Mountains)	Animals harvested (Varna Region)	Animals harvested / km^2 (Strandzha Mountains)	Animals harvested / km^2 (Varna Region)
Stray dogs (*Canis familiaris*)	0	41	0.00	0.037
Red fox (*Vulpes vulpes*)	138	64	0.114	0.058
Gray wolf (*Canis lupus*)	2	0	0.002	0.000
Golden jackal (*Canis aureus*)	139	299	0.114	0.272

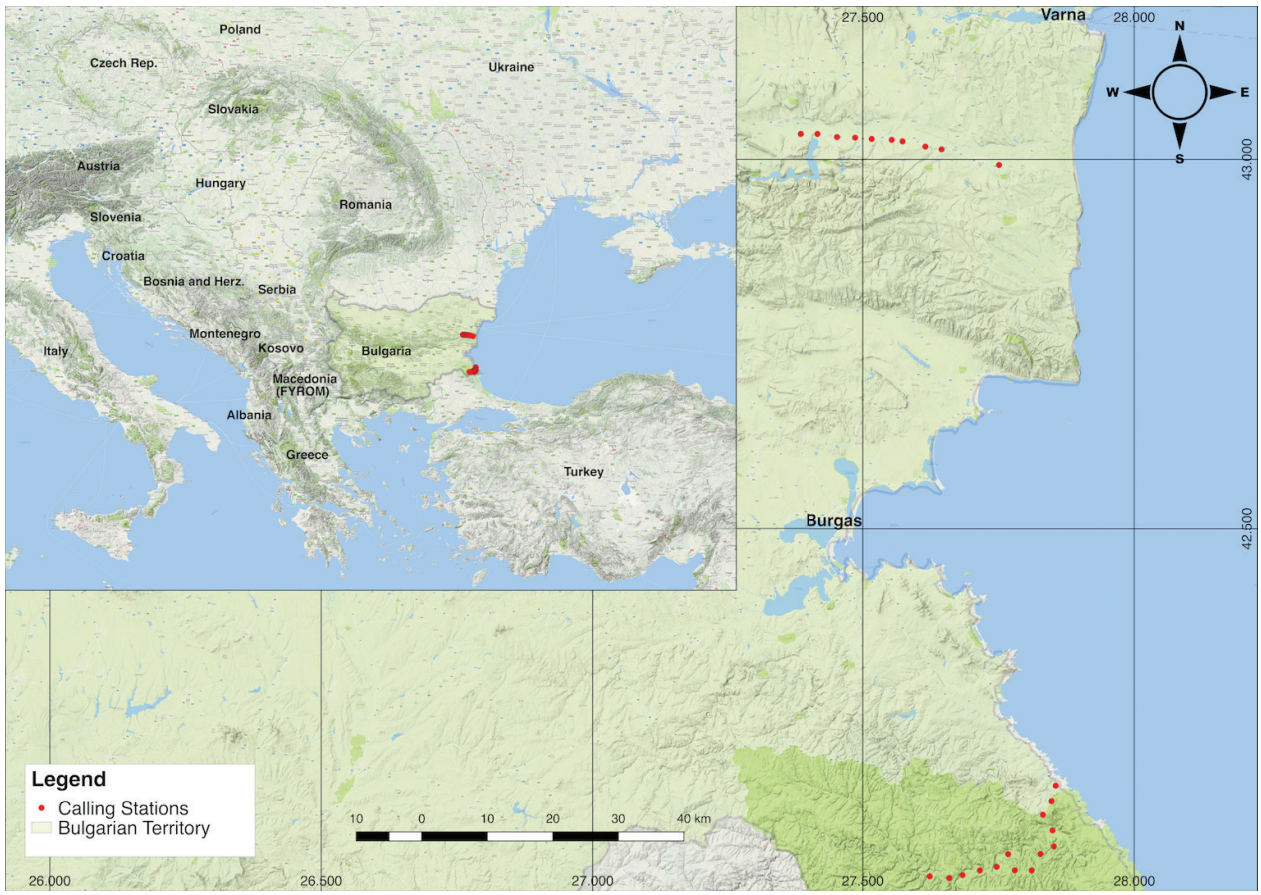

Fig. 1. Map of the calling stations location where the howling broadcast was performed (QGIS Development Team 2015).

The calling stations with positive responses were mapped using the software QGIS 2.18.2 (QGIS Development Team 2016). A buffer for each distance was considered (close – 500 m, medium – 1000 m and far – 1500 m) in all calling stations. The compass data indicating the direction for each answer and the estimated distances in the field (close, medium and far) were used for mapping the point where the response came in each calling station using the azimuth and distance plug-in of the GIS Software. This location approach helped to avoid data duplication. Additionally, the registered answers were counted for a second time in the GIS processing in order to confirm that jackals' answers of the same family group were not counted twice.

The broadcast was played during the night at selected CS in calm and dry nights, except the month of October when, due to logistic problems, the survey was carried out during light rains. The data for this month were not taken into the analysis.

Every answer was differentiated between single-answer (1 individual) and group-answer (two or more individuals).

The data were set as one variable for each transect (total number of answers detected per month). The software used for the basic statistics was R 3.3.2 (R Core Team 2013). To avoid type I and type II errors, a data exploration protocol was followed (Zuur et al. 2010); outliers and normal distribution were tested. Concerning the dataset, outliers were identified with a Cleveland dotplot and a box plot for both transects showed that the data were skewed. A histogram and qq-line plot showed that the data did not have normal distribution. Based on the above, non-parametric statistics were used and a chi square test was made for both transects' dataset. This test helped to understand if the number of answers' differences detected in-between months were statistically significant.

Results

The number of the responses per month varied between 2 and 22, being between 2 and 10 for Transect 1 and between 3 and 22 for Transect 2 (Fig. 2). Both single answers and group answers were detected in each of the two transects (Fig. 3). The answers differences detected across months were statistically significant only for Transect 2 ($\chi^2 = 35.271$, $p < 0.001$) but not for Transect 1 (χ^2

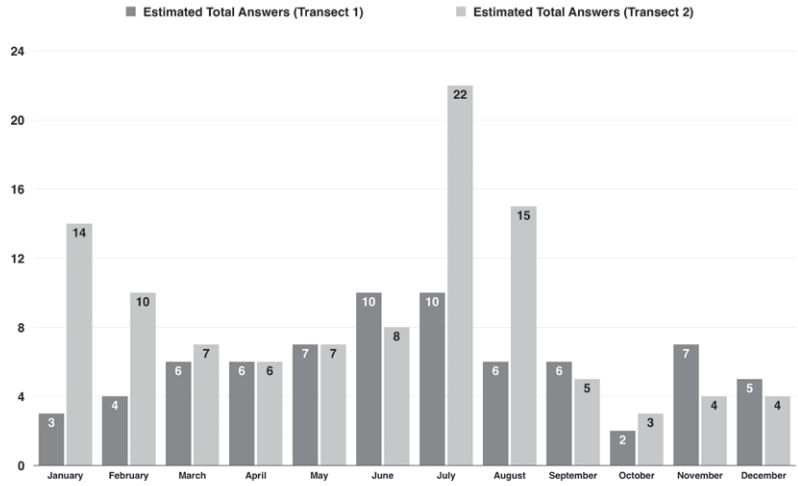

Fig. 2. Number of detected answers per month in all calling stations of each transect.

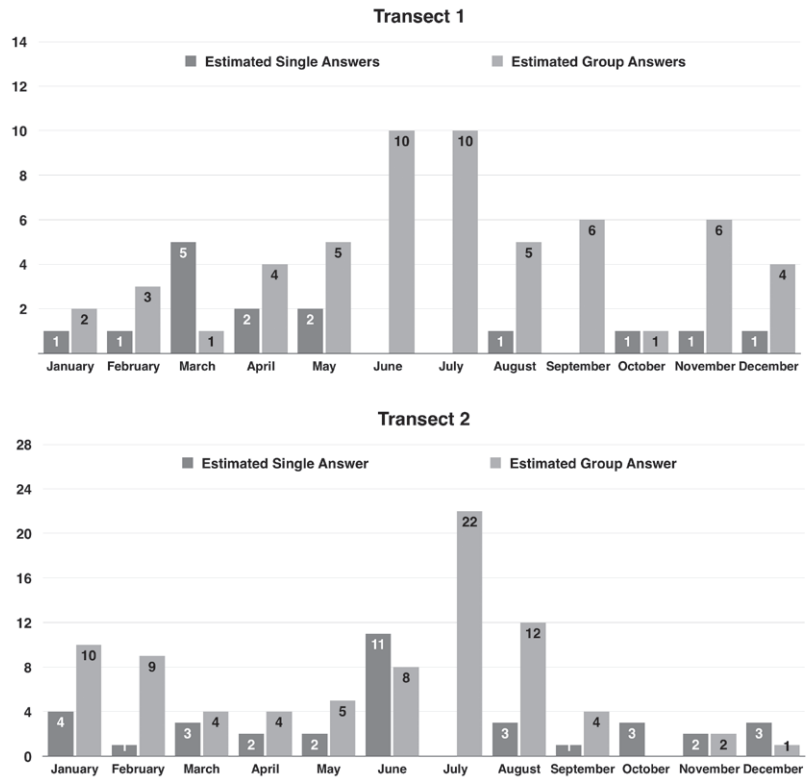

Fig. 3. Number of single and group answer for both transects.

= 12.1053, p = 0.471). The highest detected number of responses to the broadcasted howls was in June and July for Southeast Bulgaria and in July and August for Northeast Bulgaria. The lowest response occurrence was registered in October and was due to bad weather (low wind and light rain) in the field, which affected the hearing ability.

Discussion

The collected data suggest differences in the jackals' responsiveness to a broadcasted howl. The jackal biology data during its breading period, individual growth and social dynamics, reported in other studies, allowed better understanding of the relationship between the biological cycle (seasonality) and the response to howling interactions. Reproductive activity

begins in February and continues through March in India and Turkmenistan and since October through March in Israel (Golani & Keller 1975, Ginsberg & MacDonald 1990). In Bulgaria, the mating period occurs also between February and March and the pups are born in April – May (Atanassov 1953, Demeter & Spassov 1993). Vassilev & Genov (2002) have shown that the birth of pups in southern Bulgaria occurs earlier (April 10 – May 5) and later in the northern parts of the country (April 25 – May 20). We assume that this could be one of the reasons explaining the difference in the peaks of responsiveness between the two transects, being in June in Transect 1 and in July in Transect 2 (Fig. 2).

Considering territoriality as a part of the jackals' social behavior (Demeter & Spassov 1993, Giannatos 2004, Spassov 2007, Acosta-Pankov, unpubl. data), this study suggests that the highest howling response reported in June and July could be related to the beginning of the renewal of territorial family group formation, when the new litters emerge of the den and start also to howl (personal observation). In central North Bulgaria, near the Danube River, pups also howl in July (Acosta-Pankov, unpublished data). Tracks of young and adult individuals were observed together (Ivanov, personal communication) in several regions, e.g. in Sevlievo area of North Bulgaria at the very end of August. We assume that in the second half of June and in July the jackals of the same family group start to communicate intensively among them and in July – August the renewed family group is organised in order to start moving together.

Gaines et al. (1995) suggest that howling response surveys for coyotes and wolves could be effectively conducted between June and October. Particularly to grey wolves, spontaneous howling frequency is high in summer and early autumn, suggesting that high howling activity is related to the period when the pups begin to participate in the howling (Ivanov 1988, Kusak et al. 2005, Nowak 2007). Similar behaviour has the reply rate to human-simulated wolf-howl (Harrington & Mech 1982) and the reply to playbacks of pre-recorded wolf-howl (Gazzola et al. 2002).

Differing from our results, in coyotes, the highest howling rate is during the breading season (Laundré 1981, Walsh & Inglis 1989). Okoniewski & Chambers (1984) have similar results with responses to an electric siren and human howl. However, seasonal changes in howling rates among alpha animals may be related to increased pair-bond behaviour and also territorial maintenance (Gese & Ruff 1998).

According to the only available data on seasonal jackal howling response (Jaeger et al. 1996), howl responses occurred in the same proportion during both the pairing-mating (winter) and denning seasons (spring); the seasonal pattern in Bangladesh is consistent with the hypothesis of a territorial function for howling in these two seasons. The differentiation between single-answer and group-answer is important in terms of claiming territory, since group howls carry more authority than howls by individuals (Harrington & Mech 1979). The detected domination of group-answers in the peak of the howling response (Fig. 3) suggest that, during the mentioned period (June – August), the jackals' response is related to the formation of the renewed family group (together with the pups) and to a higher territoriality behaviour.

We do not know for sure if jackals' answers are influenced by the hunting pressure. Several authors describe the impacts of breeder loss by human kills in populations of wolves and other social canids (Brainerd et al. 2008, Borg et al. 2014). It could be assumed that this pressure and not only the seasonality could affect the howling response in jackals in Bulgaria, though the seasonality in the social life of the golden jackal could be the most important factor. However, we need further studies to resolve this question.

Conclusion

The detected number of answers to the broadcasted howls was higher in June – July in Southeast Bulgaria and in July – August in Northeast Bulgaria. We assume that the late birth of the cubs in northern Bulgaria might be one of the reasons that suggest why in Transect 1 the peak of responsiveness increases in June and in the Transect 2 in July.

The results of this study suggest that the vocalization response behaviour is used more intensively when the new-born members start to move with the family group defining boundaries between different territorial family groups in order to defend their territory more intensely. This supports the statement (van Lawick-Goodall 1970, Golani & Keller 1971, Nikolskij & Pojarkov 1981) that the howl in jackals is a signal for territorial borders, family group identification and distribution. Further studies are needed to understand if the howling frequency is directly related to the biological cycle of the species.

Based on the number of answers to playback in our field study and data of more than 600 CS carried out in the last 3.5 years in Bulgaria (Acosta-Pankov, unpublished data), we suggest that the best possi-

ble survey periods are January – March and June – August. These are the months with higher numbers of answers, making the survey more efficient. However, it is important to note that golden jackals respond to playback howl throughout all the year.

Additional studies such as sampling more years and analyzing jackals' answer recordings in the wild will help to understand better the golden jackal vocalization behaviour, which show distinct seasonal changes. The bioacoustic method appears to be very useful in studies on jackal population dynamics and the monitoring of the population (especially for golden jackal conservation and management).

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