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A comparative study of the reproductive activities of European hare (*Lepus europaeus*) populations in Turkey

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Abstract: To explore whether the reproductive cycle of *Lepus europaeus* differs within Turkey, a total of 182 hares from Turkish Thrace (transition climate), Central Anatolia (continental climate), the Black Sea (oceanic climate), and the Turkish Mediterranean (Mediterranean climate) were collected between June 2006 and September 2014. We present the length of breeding season, sex ratio, mean litter size, and testicle position of European hares distributed in Turkey for the first time. Among these features, length of breeding season and mean litter size of European hares showed moderate variation in Turkey.

Key words: European hare, breeding season, mean litter size, Turkey

Reproductive patterns of hares vary depending on latitude, with a positive correlation between latitude and litter size. Hare species also have smaller litters but produce more litters per year in warmer climates; there is plasticity within species due to changes in climate and latitude as revealed by numerous studies on the reproduction of *Lepus europaeus* (Raczyński, 1964; Antoniou et al., 2008; Chapman and Flux, 2008; Hackländer et al., 2011). With the exception of Mediterranean ecosystems, most European hare populations generally reproduce from early February until September, and no juvenile females breed during the season of their birth (Holley, 1992; Norbury, 2001; Antoniou et al., 2008). As a consequence, one might expect that *L. europaeus* would have a longer reproductive break in cold winters due to the continental climate and a shorter reproduction period at higher latitudes. However, Hackländer et al. (2011) revealed that the reproductive pattern of European hares is affected by actual winter temperatures regardless of latitude, and hence, European hares in regions with mean annual temperatures above 0 °C breed throughout the year. Simeunovic et al. (2000) discussed the change in the testicle position of European hares in Slovakia by month.

Until now, knowledge of the reproductive activities of this species, which has a continuous distribution in Turkey, has not been known. The aim of this study was to find out whether the reproductive activities of *Lepus europaeus* are different among the various climatological regions of Turkey.

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We sampled 182 European hare specimens from Turkish Thrace, which has a transitional climate (Edirne, Kırklareli, and Tekirdağ); Central Anatolia, which has a continental climate (Kırşehir, Kırıkkale, and Ankara); the Black Sea, which has an oceanic climate (Bolu, Kastamonu, Trabzon, and Artvin); and the Turkish Mediterranean, which has a Mediterranean climate (Manisa, Isparta, Burdur, and Antalya) between June 2006 and September 2014. Most specimens were obtained from hunters during hunting season and some from traffic accidents during the months outside hunting season. The age determinations were made according to both Stroh (1931) and field notes. Only the adult groups (68 ♂, 81 ♀) from Turkish Thrace (20 ♂, 22 ♀), Central Anatolia (25 ♂, 30 ♀), the Black Sea (14 ♂, 18 ♀), and the Turkish Mediterranean (9 ♂, 11 ♀) were used for evaluations of reproductive activity. Testicle position was recorded as external or in the abdominal cavity. Females were classified as pregnant, lactating, or inactive based on Alves et al. (2002).

We tested whether the data were normally distributed using the Shapiro–Wilk normality test. An ANOVA test was employed to determine the effects of regional differences on reproductive traits of the species. Statistical analyses were conducted using PASW Statistics 18 (SPSS 2010).

Data in this study exhibited normal distribution ($P > 0.05$) in all regions. The differences among mean litter sizes observed in the four different regions were statistically significant ($P < 0.05$). In order to determine the differences

among regions, the LSD test was performed post hoc, and it was concluded that female hares from the Turkish Mediterranean had a significantly smaller mean litter size (2.13 ± 0.50, range between 1 and 3) compared to Turkish Thrace and Central Anatolia (2.90 ± 0.63, range between 2 and 4; 3.08 ± 0.66, range between 2 and 4, respectively) ($P < 0.05$, LSD test). In addition, the mean litter size of females from the Black Sea region (2.46 ± 0.42, range between 2 and 3) was larger than that in the Turkish Mediterranean, although this difference was not significant ($P > 0.05$).

Hares inhabiting the continental climate region exhibit a short reproductive period (between February and September), and hares inhabiting the Mediterranean climate region have a small reproduction break in November. Hares in the Black Sea region have a small reproduction break in November and December. Compared to hares from Turkish Thrace, those from other regions had a breeding season ranging from January to September. The breeding season of specimens from Thrace was shorter than that in the Black Sea and Turkish Mediterranean specimens and longer than that in the Central Anatolian specimens.

The proportions of pregnant, lactating, and inactive females throughout October to January are presented in Figure 1.

Except during the breeding period testicle position was generally (87.1%) inguinal, but the testicles descended during the breeding period. In this study, sex ratios for European hares were 1:1.1 in Turkish Thrace, 1:1.2 in Central Anatolia, 1:1.3 in the Black Sea, and 1:1.2 in the Turkish Mediterranean in favor of females.

Antoniou et al. (2008) stated that the plasticity exhibited in the reproductive cycle of European hares in different regions indicated the adaptation of populations to different conditions (i.e. historic, climatic, and landscape characteristics). The present study revealed that breeding periods of European hares in Turkey changed among all regions with different climatological and phytogeographical characteristics. It is worth noting that Turkish European hares (both female and male) did not exhibit reproductive activity in any localities in November, which has very cold weather conditions. Demirbaş et al. (2012) noted that despite the presence of different phenotypes in Anatolia, genetic exchange is rather low among these hares. Additionally, Demirbaş et al. (2013) found significant differences in some morphometric characters among regional hare samples in Turkey. It was concluded that climatic characteristics, particularly with ambient temperature, cause plasticity in the reproductive cycle of European hare populations distributed in Turkey.

There is a positive correlation between latitude and litter size, with those in the north producing the largest litters during shorter breeding seasons (Chapman and Flux, 2008). Similarly, we found alterations among the reproductive patterns of European hares distributed in Turkey indicating these positive correlations. The birth weight of *L. europaeus* is approximately 100 g (Macdonald and Barrett, 1993). In this study, four fully furred fetuses of a doe were obtained from Central Anatolia in August, and

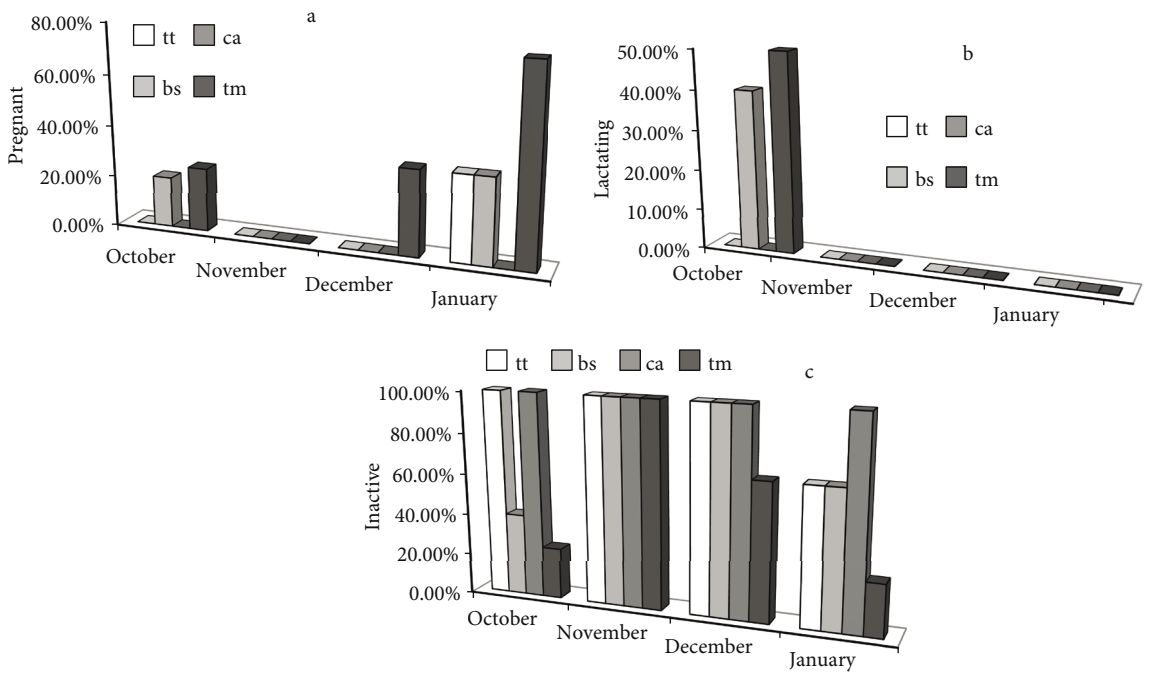

Figure 1. Variation in the proportion of pregnant (a), lactating (b), and inactive (c) females in the Turkish European hare populations (tt: Turkish Thrace, bs: Black Sea, ca: Central Anatolia, tm: Turkish Mediterranean).

Table. Breeding season length and mean litter size of European hares in various countries. The largest number of embryos per litter is presented in brackets.

Country	Breeding season	Mean litter size	References
Canada	January–August	1.6–3.8 (4)	Reynolds and Stinson (1959)
New Zealand	January–September	2.2 (5)	Flux (1967)
England	January–August	3.0	Lincoln (1974)
Poland	January–September	2.0–2.8 (6)	Pielowski (1976)
Argentina	August–March	2.1 (4)	Bonino and Montenegro (1997)
France	January–October	2.7	Marboutin et al. (2003)
Sweden	February–October	2.9 (5)	Frylestam (1980)
Denmark	February–August	2.6 (5)	Hansen (1992)
Greece (Crete)	January–December	1.5 (3)	Antoniou et al. (2008)
Turkey	December–October	2.1–3.1 (4)	This study

their body weights were 93, 97, 99, and 106 g. Additionally, the seasonal changes in testicle position of the European hares in our study were consistent with findings given by Simeunovic et al. (2000).

The breeding seasons and mean litter sizes of European hares from various countries around the world are presented in the Table.

The sex ratio for hares is subject to fluctuation and is sometimes in favor of females and sometimes males. It is assumed that this is connected with the method of capture and sex status of individuals shot at different periods (Raczyński, 1964; Pielowski, 1969; Bonino and Montenegro, 1997). In this study, sex ratios for European hares favored females in all regions.

In conclusion, this study examined breeding activities including length of breeding season, sex ratio, mean litter size, and seasonal changes in the position of testes of European hares distributed in Turkey. When compared with previously reported data on reproductive biology, the length of breeding season and mean litter size of European hares presented moderate variation in Turkey. These results will contribute to an understanding of the reproductive activity of European hares.

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References

Alves PC, Gonçalves H, Santos M, Rocha A (2002). Reproductive biology of the Iberian hare, *Lepus granatensis*, in Portugal. Mamm Biol 67: 358–371.

Antoniou A, Kotoulas G, Magoulas A, Alves PC (2008). Evidence of autumn reproduction in female European hares (*Lepus europaeus*). Eur J Wildl Res 54: 581–587.

Bonino N, Montenegro A (1997). Reproduction of the European hare in Patagonia, Argentina. Acta Theriol 42: 47–54.

Chapman JA, Flux JEC (2008). Introduction to the Lagomorpha. In: Alves PC, Ferrand N, Hackländer K, editors. Lagomorpha Biology: Evolution, Ecology, and Conservation. Berlin, Germany: Springer-Verlag, pp. 1–9.

Demirbaş Y, Albayrak İ, Suchentrunk F (2012). Population genetics of Turkish hares. In: Hackländer K, Thurner C, editors. 4th World Lagomorph Conference; 23–27 July 2012, Vienna, Austria; Institute of Wildlife Biology and Game Management, BOKU University of Natural Resources and Life Sciences, pp. 1–160.

Demirbaş Y, Albayrak İ, Yılmaz A (2013). Studies of ecomorphological variations of the European hare (*Lepus europaeus*) in Turkey. Arch Biol Sci Belgrade 65: 559–566.

Flux JE (1967). Reproduction and body weights of the hare, *Lepus europaeus* Pallas, in New Zealand. New Zealand J Sci 10: 357–401.

Frylestam B (1980). Reproduction in the European hare in southern Sweden. Holarct Ecol 3: 74–80.

Hackländer K, Zeitlhofer C, Ceulemans T, Suchentrunk F (2011). Continentality affects body condition and size but not yearly reproductive output in female European hares (*Lepus europaeus*). Mamm Biol 76: 662–664.

Hansen K (1992). Reproduction in European hare in a Danish farmland. Acta Theriol 37: 27–40.

Holley AJF (1992). Studies on the biology of the brown hare (*Lepus europaeus*) with particular reference to behaviour. PhD, University of Durham, Durham, UK.

Lincoln GA (1974). Reproduction and March madness in the brown hare, *Lepus europaeus*. J Zool (London) 174: 1–14.

Macdonald D, Barret P (1993). Collins Field Guide: Mammals of Britain and Europe. 3rd ed. London, UK: HarperCollins.

Marboutin E, Bray Y, Péroux P, Mauvy B, Lartiges A (2003). Population dynamics in European hare: breeding parameters and sustainable harvest rates. J Appl Ecol 40: 580–591.

Norbury G (2001). Advances in New Zealand mammalogy 1990–2000: Lagomorphs. J R Soc N Z 31: 83–97.

Pielowski Z (1969). Sex ratio and weight of hares in Poland. Acta Theriol 19: 119–131.

Pielowski Z (1976). Number of young born and dynamics of the European hare populations. In: Pielowski Z, Puvek Z, editors. Ecology and Management of European Hare Populations. Warsaw, Poland: Polish Hunting Association, pp. 75–78.

Raczyński J (1964). Studies on the European hare. V. Reproduction. Acta Theriol 9: 305–352.

Reynolds JK, Stinson RH (1959). Reproduction in the European hare in southern Ontario. Can J Zool 37: 627–631.

Simeunovic B, Strbenc M, Bavdek SV (2000). Position and histological structure of the testis in the brown hare (*Lepus europaeus*) during seasonal regression and recrudescense. Anat Histol Embryol 29: 73–82.

Stroh G (1931). Zwei sichere Altersmerkmale beim Hasen. Berl tierarztl Wschr 12: 180–181.