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Ecological Data on the Completion of Hibernation in the Algerian Hedgehog *Atelerix algirus*(Lereboullet, 1842) in El Kala National Park (North- East Algeria)

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ABSTRACT

An exploratory and empirical study of the hibernation phenomenon, one of the adaptive strategies used by a population of *Atelerix algirus* to adapt to seasonal conditions, is presented in this work. The research was carried out between 2011 and 2019. A total of 231 hedgehogs were captured and weighed in the El Kala National Park localities of Raml Souk, El Aioun, Berrihane, El Kala, and Bougous in northeastern Algeria. Localities are distinguished by their useful surface area (forests and farmland) and degree of urbanization. The findings highlight the significance of environmental temperature in the onset of hibernation in Algerian hedgehogs. Furthermore, like the European species, hibernation in *Atelerix algirus* is brief, lasting no more than two months. Monthly weight status analysis of captured hedgehogs revealed no significant difference in this parameter before and after the ostensible hibernation period, implying that hedgehogs do not fatten up and thus do not prepare for hibernation.

KEYWORDS: Hibernation, Algerian hedgehog, Climate adaptation, Mediterranean ecosystems

INTRODUCTION

Hibernation in hedgehogs is a type of physiological adaptation to environmental conditions manifested by a slowing of the biological rhythm to conserve energy during periods of trophic resource scarcity (Bourliere, 1951; Fischesser, 1982; Jarry et al., 1989; Vignault et al., 1996). This slowing is characterized by a decrease in activity (cardiac, respiratory, and digestive rhythms), changes in endocrine functions (adrenal, pituitary, and gonadal), and the initiation of the reproductive cycle (ovulation and spermatogenesis) (Andrews et al., 1998; Carrey et al., 2003; Milsom, 1992; Wang et al., 2002). While hibernation in the European species *Erinaceus europeus* has been extensively studied throughout its range, this is not the case for the Algerian hedgehog *Atelerix algirus*, which is the most common species in Algeria, followed by the desert hedgehog *Paraechinus aethiopicus* (Kowalski and Rzebik-Kowalska, 1991). The Algerian hedgehog is thought to have originated in Ethiopia (Heim de Balsac, 1936). It can be found in the Pyrénées-Orientales region of southern France, the Spanish Mediterranean coast, the Canary Islands, the Balearic Islands, and Malta. Algeria, Mauritania, Morocco, Libya, and Tunisia are among the African countries where it can be found (Saint Giron, 1973; Kock, 1980; Corbet, 1978; Aulagnier and Thevenot, 1986; Reeve, 1994). In Algerian regulations, *Atelerix algirus* is included in the provisional list of protected non-domestic animal species, published on June 10, 2012, in Issue 35 of the Official Journal of the Algerian Republic. The few studies carried out on *Atelerix algirus* have mainly focused on estimating its density (Mouhoub - Sayah, 2009), its preferred habitat (Sakraoui et al., 2022), its diet (Ouarab and Doumandji, 2010; Derdoukh et al., 2012), its reproduction (Mouhoub - Sayah, 2009; Boukheroufa et al., 2015), and its parasitic ecophysiology (Khaldi et al., 2012; Sakraoui et al., 2014; Madoui et al., 2014; Boukheroufa, 2017; Senaoui et al., 2020). In contrast, the only study on hibernation was conducted on hedgehogs in semi-captivity, establishing it as a potential hibernator (Mouhoub-Sayah et al., 2006; Mouhoub-Sayah et al., 2017). We wanted to share our field findings about hibernation in the Algerian hedgehog *Atelerix algirus* and its duration in a Mediterranean environment rich in trophic resources and conducive to the species' proper development and reproduction.

MATERIAL AND METHODS

Study area

This research was conducted in the El Kala National Park in Algeria's extreme northeast (36°50 latitude north and 8°27 longitude east) from 2011 to 2019. We sampled five El Kala National Park communities Raml Souk, El Aioun, Berrihane, El Kala, and Bougous). (Figure 1).

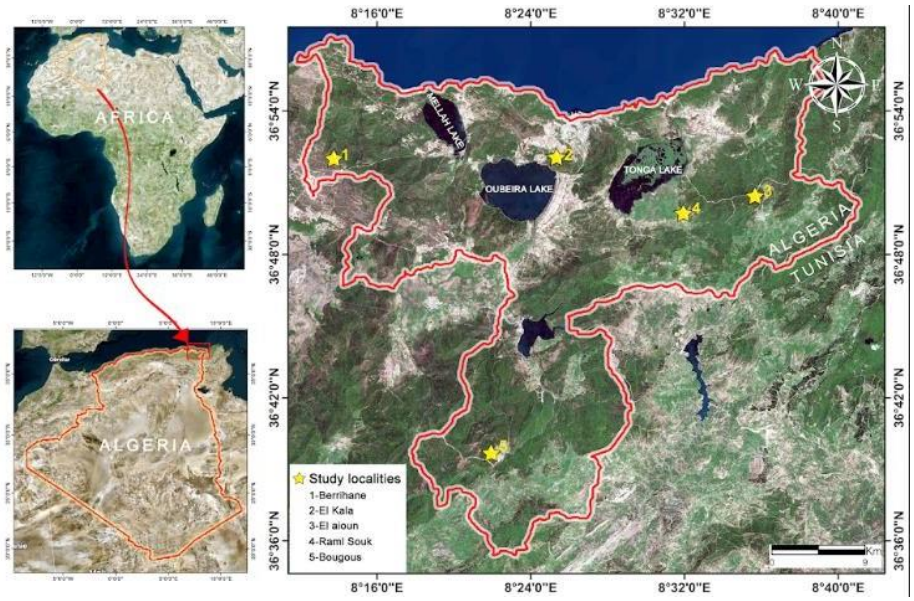
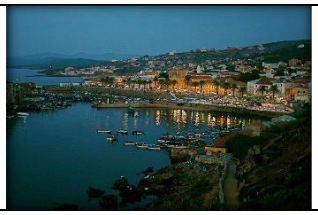
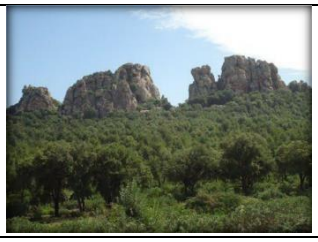


Figure 1: Location of study area and sample localities

We relied on various administrative documents to provide information for each locality regarding coordinates, population density and distribution, land area, and the degree of urbanization (Table. 1).

Table 1: Study areas description. Sources : Direction of Planning and Land Management, Agricultural Services Department, Forestry Directorate, National Statistics Office, Bouazouni, 2004.

Study Area	Characteristics	
RAML SOUK	31°47'10" N/ 8°32'08" E	
	Area	6215 hectares
	Population Density	60 inhabitants/km²
	It includes: Urbanized areas (52.24%); semi-urban areas (28.71%) and rural areas (19.05%)	
EL AIOUN	31°52'15" N / 8°35'47" E	
	Area	4585 hectares
	Population Density	117 inhabitants/km²
	It includes: Urbanized areas (79.08%); semi-urban areas (12.78%) and rural areas (8.14%)	
BERRIHANE	36°53'60'' N / 08°19'60'' E	
	Area	20250 hectares
	Population Density	47 inhabitants/km²
	It includes: Urbanized areas (37.34%); semi-urban areas (51.19%) and rural areas (11.47%)	

EL KALA	31°53’44” N / 8°21’31” E	
	Area	29200 hectares
	Population Density	440 inhabitants/km²
	It includes: Urbanized areas (85.84%); semi-urban areas (3.69%) and rural areas (10.47%)	
BOUGOUS	31°39’34” N / 8°22’10” E	
	Area	21580 hectares
	Population Density	52 inhabitants/km²
	It includes: Urbanized areas (8.61%); semi-urban areas (17.16%) and rural areas (74.23%)	

Methodology

We studied two aspects of the species' bioecology that could be directly related to the completion of hibernation: the monthly capture rates and the weight of individuals captured before and after the hibernation period. Capture campaigns were conducted, with one trip per locality per month. Because the animal is nocturnal, the active search began at dusk and lasted two hours (from 7:00 p.m. to 9:00 p.m.) while walking at a constant speed of two kilometers per hour on average. Captured specimens were weighted (using a PESOLA Medio-Line 41000 / 1000 g spring balance), and released back into the wild. We also collected the temperature data from the national weather office, and linked to the number of captures throughout the study period. The results are expressed as means standard error, and the data was statistically analyzed using Minitab 17 software (eds, 2015). We used variance analysis (ANOVA) to compare average monthly weights. The graphical representation of the data was based on the development of histograms produced under Microsoft Office Excel 2007.

RESULTS AND DISCUSSION

We focused on two clues from our capture campaigns and field observations to demonstrate hibernation completion, regardless of the environment in which it is found. The variation in capture rates as a function of temperature throughout the study period is one of the most striking clues. The results clearly show that activity peaks in December and particularly in April. In contrast, it is low in August and extremely low in February. Temperature influences the onset, duration, and termination of hibernation (Dechert-Cadre, 1986; Herter, 1975). The arrival of the first cold spells, linked to a lack of food resources, induces the autumn-winter period's lethargic sleep (Herter, 1975; Wroot, 1986). According to Morris and Berthoud (1992), a key factor is the scarcity of food resources, which is caused by the drop in outside temperature. Hedgehogs can sleep when the temperature falls below 15 to 17°C (Dechert-Cadre, 1986). It is semi-awakening at first, then sinks deeper into lethargy.

We analyzed the average temperature data for our study period (2011 - 2019) based on all of these bibliographical elements to highlight the key features. Overall, the findings highlight that 9 of the 12 months have temperatures above 15°C and that the temperature stays below 13°C in January and February, with the latter being the coldest month with a temperature not exceeding 12°C. These data were then combined with monthly catch rates in El Kala National Park's various localities. We discovered that *Atelerix algirus* hibernates, but only for a short time (maximum 2 months, from January to February) compared to the European species (Figure 2).

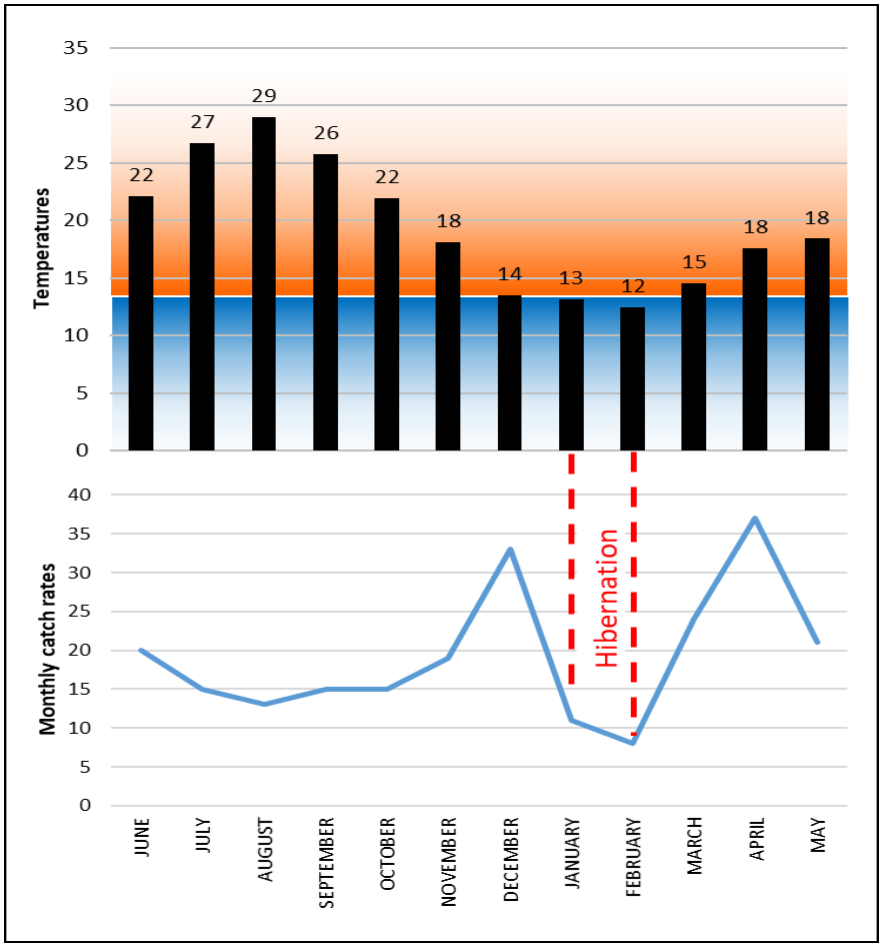


Figure 2: Monthly variation in mean temperature over the study period (2011 - 2019) and monthly catch rates of *Atelerix algirus*

Winter sleep duration varies with latitude, according to Heim de Balsac and Bourlière (1955). The impact of climate is obvious in this case. Northern Italy hibernates from October to April, while southern Italy hibernates for a shorter period. Hibernation can be greatly reduced or non-existent on Mediterranean islands and at low altitudes (Aubert, 2002; 2005; Toschi and Lanza, 1959). Hedgehogs are said to not hibernate in Transcaucasia (Aubert, 2001). Erinaceids in warm regions, according to Wroot (1986), do not enter winter lethargy because food is available all year. According to the same author, *Erinaceus europaeus* introduced to, and perfectly adapted to, New Zealand hibernates during the austral winter, which occurs six months

later than the boreal winter in their home country. Hedgehogs do not hibernate in the southern latitudes of the northern hemisphere, according to Clothier (1961). Berthoud (1982) mentions the case of Switzerland, which is particularly interesting because it emphasizes the role of altitude and climate. Hedgehogs hibernate on the plains from mid-November to the end of March. They hibernate from October to the end of April in the Jura region, which is known for its cold winters.

The analysis of hedgehog body mass before and after hibernation is the second indicator of hibernation completion. According to Page (2001), one of the factors determining hibernation duration is body mass prior to hibernation. In our study, an analysis of variance comparison of the hedgehogs' average monthly body weights revealed no significant differences (F= 1.18 et P = 0.30) (Figure 3).

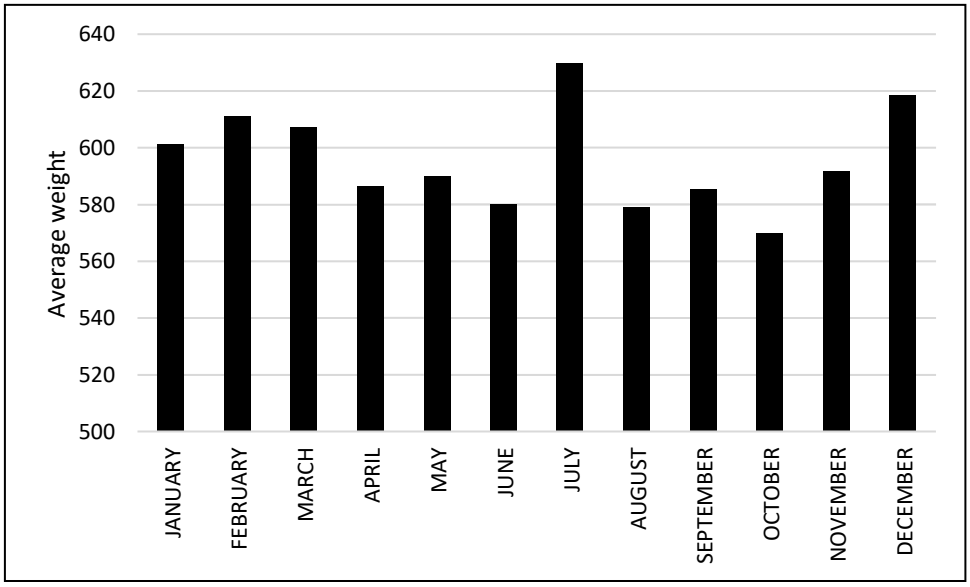


Figure 3: Monthly variation in the average weight of captured hedgehogs

In temperate Europe, where hibernation can last up to six months (Mac Donald and Barrett, 1995; Aubert, 2005), large adults sleep longer than smaller or younger individuals (Berthoud, 1982). By the end of summer, these large adults will have consumed massive amounts of food, preparing them for hibernation (Aubert, 2002; Cherel et al., 1955; Jarry et al., 1989; Nixon, 1982). They arrive with a third of their body weight in excess, represented by fat, which serves as the primary fuel source during this sleep period (Lagrange, 1994). This fat can account for up to 40% of the animal's weight (Tähti and Soivio, 1978) and can even double in two weeks (Wroot, 1986). In our case, if hedgehog weight remains constant throughout the year, it implies that *Atelerix algirus* does not build up fat reserves in preparation for hibernation during the summer. This finding suggests that hibernation is either absent or brief (in our case) and does not necessitate fattening.

CONCLUSION

Preliminary ecological data on hibernation in *Atelerix algirus* in the northest of Algeria, based on environmental temperature analysis, catch rates in the field, and weight of captured individuals, revealed a short hibernation period not exceeding two months.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon request from the authors.

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