

Environmental and Habitat Preferences of the Algerian Hedgehog *Atelerix Algirus*(Lereboullet, 1842) in El Kala National Park (North-East Algeria)

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ENVIRONMENTAL AND HABITAT PREFERENCES OF THE ALGERIAN HEDGEHOG *ATELERIX ALGIRUS*(LEREBoullet, 1842) IN EL KALA NATIONAL PARK (NORTH-EAST ALGERIA)

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ABSTRACT

We conducted this study to identify the preferred habitat of *Atelerix algirus* in the National Park of El Kala (PNEK), through the analysis of the catches rates of the species combined to an ethno zoological survey carried out among the residents. The study was conducted between January 2010 and December 2011, in five localities of the Park, different by their useful areas (forests and agricultural land) and their degree of urbanization: Raml Souk, El Aioun, Berrihane, El Kala and Bougous. We also surveyed 57 residents of Berrihane locality. Our results identified the locality of Berrihane as the preferred area of life for the species within the PNEK. This area, which has the highest abundance, is rather semi-urban and as much forest as agricultural, meeting the different needs of the species in terms of survival, sustainability and reproduction. This study provided fundamental data on the bio-ecology of this urban adapt species in Mediterranean environments.

Keywords: *Atelerix algirus*, habitat, Berrihane, hedgehog, PNEK.

Abbreviations: ACP: Principal Component's Analysis, PNEK: National Park of El Kala.

INTRODUCTION

Like all living organisms, hedgehogs acquire resources in their environment and allocate them to their reproduction (search for a partner, production of gametes, parental care...) their development (growth, moult...) and their survival (immune defence and defense against predators or parasites)(Stearns, 1992; Michalakis, 2007). However, in a stochastic environment where the available natural resources vary unpredictably, these organisms will have to face a compromise in the resources allocation between the different functions (Stearns, 1976; Ricklefs, 1991). In

addition to seasonal variability, the spatial variations induced by human activities (agriculture, urbanization, etc.), can force natural populations to disperse in new environments to survive, to maximise their reproductive success and escape the degradation of their natural environment. This spatial variability may therefore influence the adaptive potential of populations (Kokko et al., 2004; Ewers and Didham, 2006). As a typical urban adapter, the Algerian hedgehog is an excellent tool for monitoring the health status of ecosystems (Boukheroufa et al., 2015), especially as the species tends to become increasingly urbanized, because of the significant fragmentation of its natural habitats (Boukheroufa, 2017). In Algeria,

the Algerian Hedgehog was particularly studies in these last years (Sakraoui et al., 2014; Boukheroufa et al., 2015; Khaldi et al., 2016; Mouhoub-Sayah et al., 2018; Guerzouetal.,2019; Senaoui et al.,2020). Even if *Atelerix algirus* protected by the Algerian law (text appearing on 10 June 2012 in the 35 edition of the Official Journal of the Algerian Republic) in Boukheroufa (2017), the species is increasingly confronted with negative anthropogenic actions (fragmentation of habitats, intensive agriculture, urbanization...)(Sakraoui et al., 2014; Madoui et al., 2014., Boukheroufa, 2017; Senaoui et al., 2020; Senaoui, 2021). In this study, we wanted to identify the preferred habitat of *Atelerix algirus* in the national park of El Kala, through the measurement and analysis of the catches number, combined with an ethno-zoological survey of residents on the analysis of some bio-ecological data.

MATERIAL AND METHODS

The Study was carried out in the National Park of El Kala (PNEK) located at the extreme north – eastern Algeria (36°50 north latitude and 8°27 east longitude) between January 2010 and December 2011(Figure 1).

Catch campaigns were carried out in 5 different localities: Raml Souk, Berrihane, El Kala and Bougous. These localities differ by agricultural and forestry area and also in terms of degree of urbanization (Table 1).

We conducted one field trip per locality and per month (from 24 to 48 hours interval), a total of 60 field trips. Since the animal is nocturnal, the search begins at dusk. For two hours of time (19:00 to 21:00 pm), we actively searched for individuals while walking at a constant speed (2 km/h on average). The captured specimens were sexed, weighed and then released into their natural environment. We also conducted an ethno-zoological survey of 57 residents of the Berrihane locality, which was distinguished from other localities by the abundance of the species. We tried to measure their level of knowledge and their perception about the Algerian hedgehog. The questionnaires include multiple-choice and open-ended questions. We have noted basic information on age, sex and occupation of the target population to analyze the relevance of responses to the ecology of *Atelerix algirus* (Table 2).

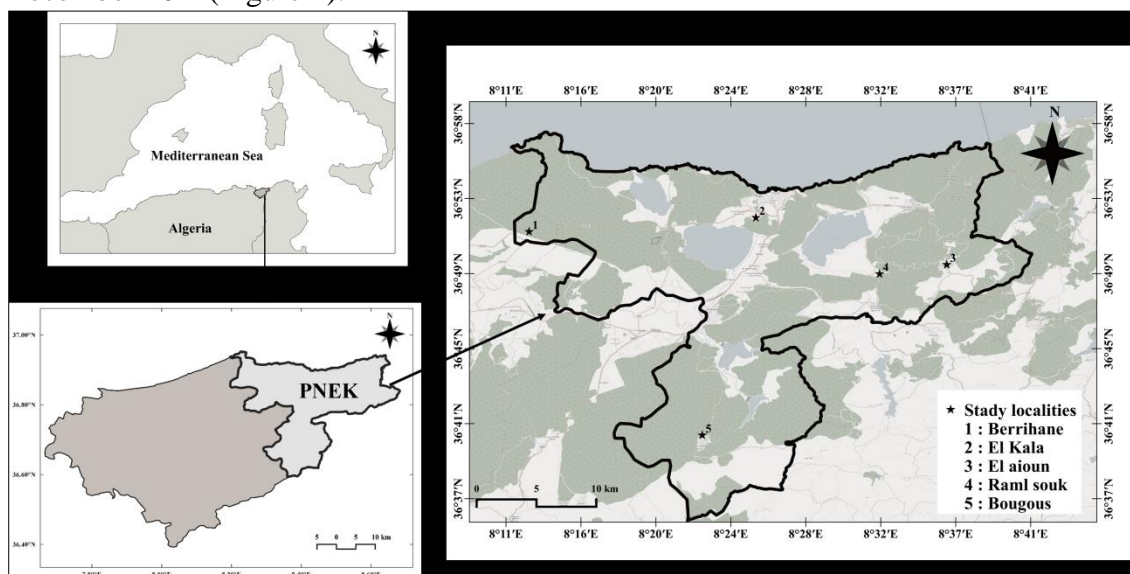


Figure 1. Location of study sites in National Park of El kala.

Table 1: Some characteristics of the study sites (in Bouazouni, 2004).

Studylocality	RAML SOUK	EL AIOUN	BERRIHANE	EL KALA	BOUGOUS	
Geographic coordinates	36°47'10" North / 8°32'08" East	36°52'15" North / 8°35'47" East	36°53'60" North / 08°19'60" East	36°53'44" North / 8°26'36" East	36°39'34" North / 8°22'10" East	
Area (ha)	6215	4585	20250	29200	21580	
Agricultural area (ha)	800	720	4765	1040	860	
Forest area (ha)	3700	3159	3159	20184	16140	
Altitude (m)(study station)	150	280	37	80	180	
Density (people/km2)	60	117	47	440	52	
Distribution of the resident population by residential area (%)	Urban area	52.24	79.08	37.34	85.84	8.61
	Semi-urban area	28.71	12.78	51.19	3.69	17.16
	Rural area	19.05	8.14	11.47	10.47	74.23

Table 2: Some aspects of the survey questionnaires.

Name of animal	Vernacularname
	Synonyms
	Significance
Description	Category (<i>Insectivorous, mammal</i>)
	Morphology <ul style="list-style-type: none"> • Dimensions • Colors • Sexualattributes • Remarkable particularities regardless of sex (<i>Tusks, leg shape, behaviour, posture...</i>).
	Custum <ul style="list-style-type: none"> • Activity (<i>Diurne, nocturne,...</i>) • Habitat (<i>Burrows, gites, others</i>) • Diet (<i>Animals [worms, insects...]/Plants [seeds, fruits, etc.]/Other</i>)
	Sociability <ul style="list-style-type: none"> • <i>Shy, familiar, ...</i> • <i>Rare, quitefrequent, frequent....</i>
	Repartition (<i>Plains, forests, irrigated lands, riverbanks..</i>).
Status	<ul style="list-style-type: none"> • <i>Wild, domestic...</i> • <i>Ignored, systematically exterminated, hunted, harmful, threatened, to be protected ...</i>
Exploitation	<i>Regular, periodic, occasional</i>
Hibernation	<i>Period, conditions</i>
Reproduction	<i>Period, number of litters/year, number of youth/litter</i>

The statistical analysis of the data was done using the software “Minitab 17” (eds, 2015) and R (eds, 2016). The results are expressed as a standard average error. We used Student’s T-tests and variance

analysis (ANOVA) for mean comparison, and a principle component analysis (ACP) to interpret the role of the different measured variables. The graphical representation of the data was based on the development of histograms, sectors and

rings produced under Microsoft Office Excel 2007.

RESULTS

Abundance Analysis

A total of 82 hedgehogs (46 males and 36 females) were captured at all locations. The results obtained in the 5 localities clearly showed that *Atelerix algirus* is more abundant in Berrihane (50% of catches). The sites of El Aioun and especially Bougous represent the lowest catch rates (9 and 6 % respectively) (Figure 2). However, 48 % of capture campaigns (29/60) were unsuccessful (no captures).

i. Seasonal Analysis

The results showed a seasonal fluctuation in abundance across sites. At berrihane and Raml Souk, the presence of *Atelerix algirus* is constant throughout the year, with the highest abundances for the first site. The results also reveal the presence of hedgehogs at all sites in the spring (breeding season). In contrast, we captured 25% of the hedgehogs in the urban area (El Kala) during the winter period. In the fall, hedgehogs were only

captured at the Berrihane (69%) and Raml Souk (31%) sites (Figure 3).

*i. Inter-Site Analysis of the Weight Status of *Atelerix algirus**

The one-criterion variance analysis, supported by the Tukey test, allowed us to compare the average weight of hedgehogs caught at the five sites. It shows that the hedgehogs of El Kala are the heaviest (705 ± 96.9 g) with a very significant difference ($F= 6, 07$; $P = 0,000^{***}$) (Figure 4).

By carrying out an analysis in main components (ACP), and by correlating some variables such as: abundance and weight of *Atelerix algirus* with some parameters described in the analysis of Bouazouni (2004) on the different localities (degrees of urbanization, areas of forests and agricultural land), we were able to demonstrate that the highest catch rates are in semi-urban areas with an agricultural vocation (in the semi-urban area, Berrihane consists of 4765 ha of agricultural land). We have also found that hedgehogs in urban areas tend to become fatter, taking advantage of an easily accessible food resource and the absence of predation pressure (Table 4 and Figure 5).

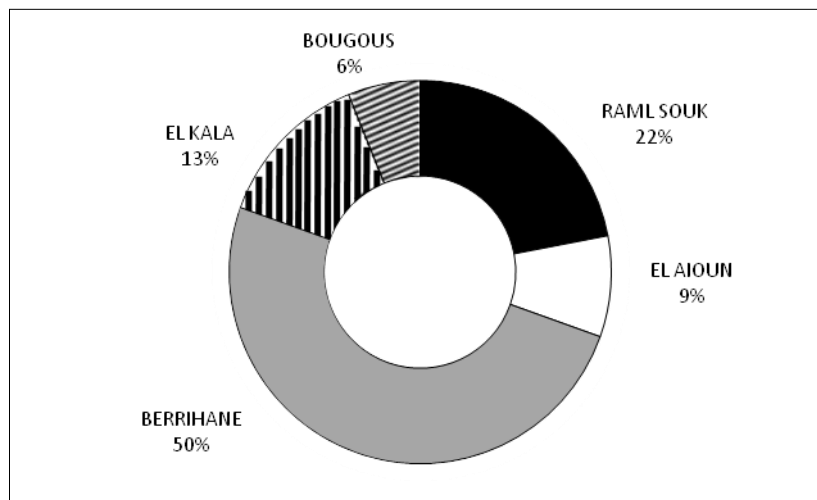


Figure 2: Proportion of catches in the five localities of PNEK

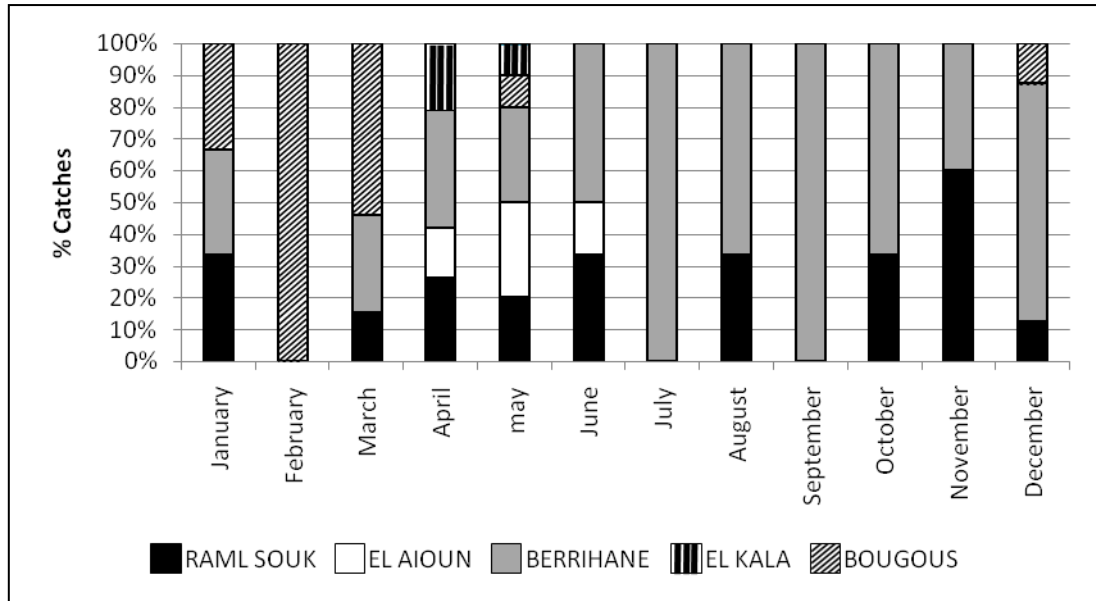


Figure 3: Monthly variation in catch proportions by site.

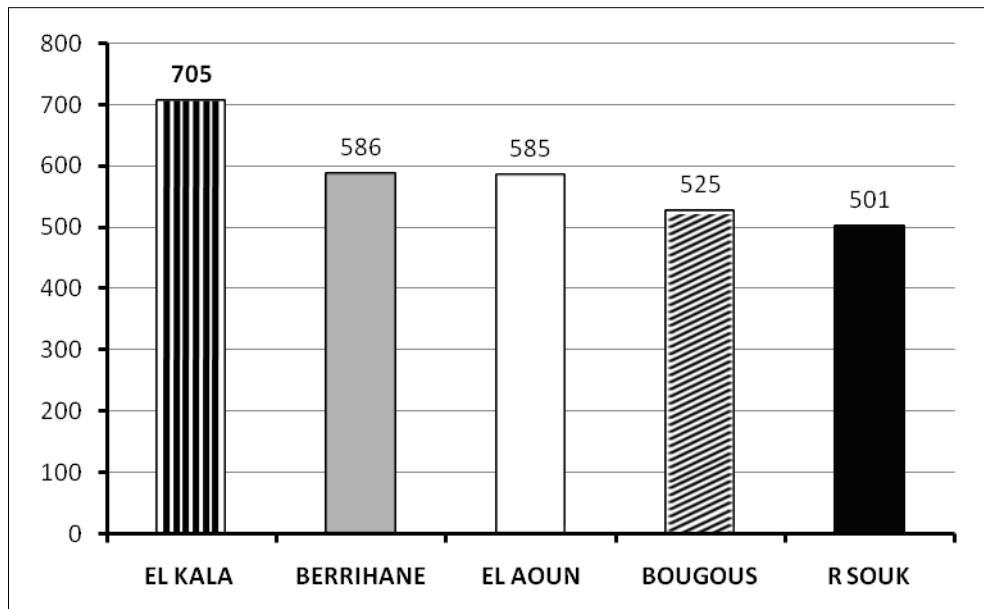


Figure 4: Analysis of the average weight of hedgehogs per site.

Table 4: Variables exploited for ACP (present work vs Bouazouni, 2004)

Location	Catche	Weight (g)	Urban Zone	Semi – urban Zone	Rural Zone	Agriculture	Forest
EL AOUN	7	585	79,08	12,78	8,14	720	12007
BERRIHANE	41	586	37,34	51,19	11,47	4765	12007
BOUGOUS	5	525	8,61	17,16	74,23	860	16140
RAML SOUK	18	501	52,24	28,71	19,05	800	3700
EL KALA	11	705	85,84	3,69	10,47	1040	20184

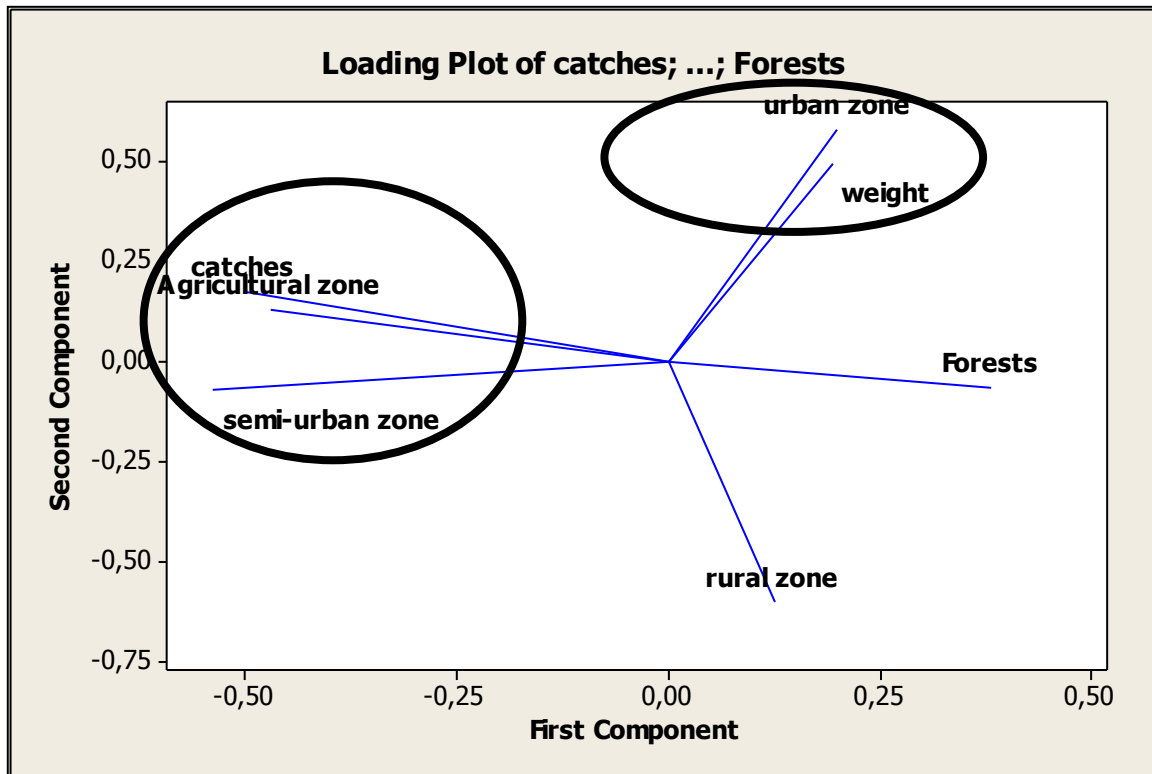


Figure 5: Principle of component analysis (ACP), of abundance and weight of *Atelerix algirus* in the different localities described by Bouazouini (2004)

Analysis of Survey Questionnaires

We interviewed 57 residents in the Berrihane site, on some aspects of the bio ecology of *Atelerix algirus* (Figure 6). Overall, all interviewees, aged between 25 and 70 years, have a good knowledge of our biological model, which allowed us to analyze and consolidate the results of the abundance of the species. Among our target population, 79% were men and 21% were women. The age-group analysis of interviewees showed that 40% of them were between 20 and 40 years of age, 32% were between 40 and 60 years of age, and those between 60 and 80 years of age represent 28% of the surveyed population. The target population has several professional activities; 35% were farmers, 27% were ranchers, 26% unemployed and 12% night watchers.

i. Social Organization of *Atelerix algirus*

All interviewees confirmed the presence of *Atelerix algirus* in Berrihane. The residents observed it moves in solitary (48%), and also in pairs (12%), in families (at least one adult with the young) (37%), and in groups (several adults) (3%). These movements, apart from hibernation, mark different phases of the hedgehog's life cycle. These results clearly showed that they spend through all the phases in Berrihane locality.

ii. Analysis of the Evolution of Hedgehog Abundance

The residents of Berrihane assert to 70% that the numbers of the species are in net increase and even provide elements of explanation on this increase, which would be due, to its trophic opportunism thus exploiting household waste (34%), the intensification of agriculture in the site of

Berrihane (54%), or the fact that the hedgehog which was a dish once very appreciated in the region, is less and less consumed.

iii. *The Hedgehog's Diet and Predators*

According to their observations, 31% of the residents of Berrihane describe a very diversified diet mainly consisting of Arthropods, 27 % of them think that the hedgehog feeds from household waste, 22% mentioned the dried fruits and precisely the peanuts, grown in Berrihane, and 20% described the consumption of fruits such as melons, prickly figs or

myrtle, which have also been found in this locality. Asked about the predators of the hedgehog, 36% of Berrihane residents identified wild carnivores such as the african golden wolf (*Canis anthus*) and the red fox (*Vulpes vulpes*), 34% identify the dog as a predator and 30% referred to humans because of its consumption.

iv. *Nest Construction*

Residents observed nests built by the hedgehogs and mentioned at 55%, that the nests built at ground level under the prickly pear snowshoes, 36% described nests in tree trunks and 9% resembled burrows.

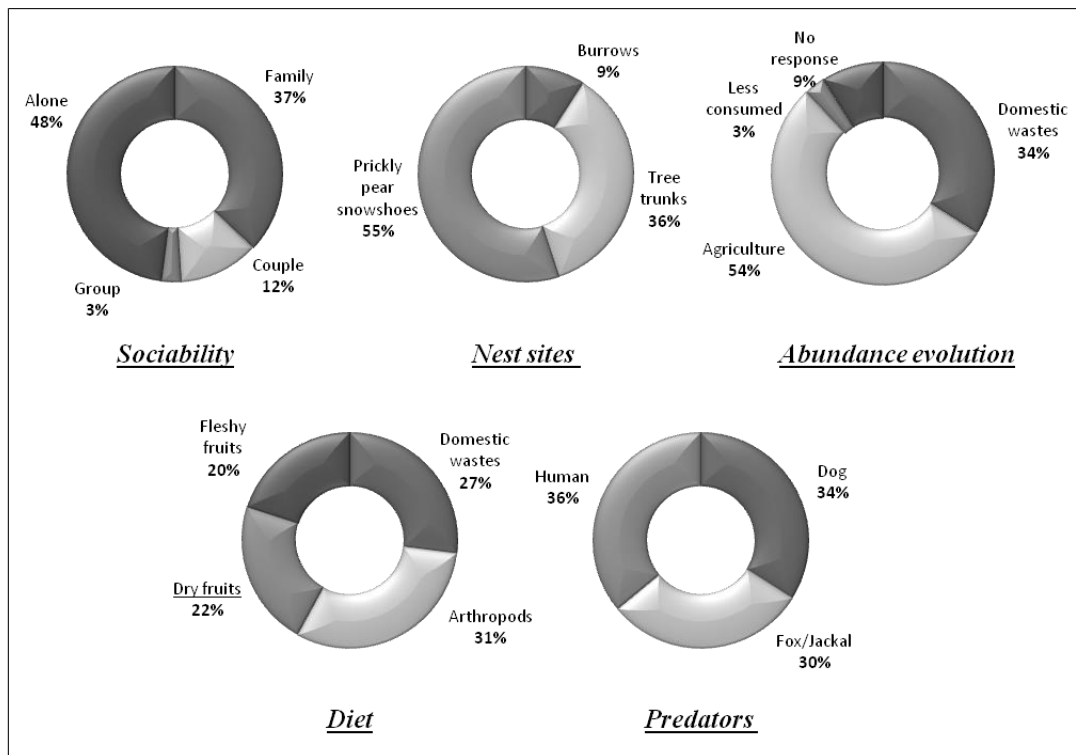


Figure 6: Analysis of Survey Questionnaires about the bio ecology of *Atelerix algirus* in Berrihane locality.

DISCUSSION

Many authors revealed that hedgehogs are present in forest areas, agricultural, wet meadows, edges, but has a preference for forest edges and cultivated lands (Heim de Balsac and Bourlière, 1955; Schwammberger, 1972; Morris, 1986; Aubert, 2002; 2005; Boukheroufa,

2017; Senaoui, 2021). From the meta-analysis of

Jourde (2013), the hedgehog population densities are highly variable depending on the composition of its habitat, with some landscape types being more suitable than others. The ideal habitat for the hedgehog would be mixed; both anthropogenic and natural, with the abundance of food, and refuges against predators (Hof and Bright,

2010; Hubert et al., 2011; Chesne, 2012). In our study, we wanted to identify the preferred habitat of Algerian hedgehogs by analyzing the abundance of the species between five localities of the national park of El Kala, combined with the results of ethno zoological survey. The results clearly reveal that Berrihane is the preferred area of *Atelerix algirus*, because this habitat meets different needs of the species (reproduction, feeding, nesting, protection against predators...etc.). Indeed, the results obtained by Senaoui et al., (2020) and Senaoui (2021) confirmed that Berrihane is still the preferred habitat of the species. In addition, the observations of the residents showed that *Atelerix algirus* spend all its life cycle at the Berrihane site. Hedgehogs are generally solitary animals (Morris, 1973; Gaisler and Zejda, 1995; Aubert, 2002), but during their life cycle they go through a phase succession, outside of the hibernation period, where they can be and move as a couple, family or group (Hubert et al., 2011). By carrying out the principal component's analysis, and by correlating some variables such as: the abundance and weight state of *Atelerix algirus* with some parameters described in the analysis of Bouazouni (2004), we were able to highlight that the highest catch rates are in semi-urban agricultural areas (the semi-urban area, Berrihane, consists of 4,765 ha of agricultural land. 50% of hedgehogs captured come from this area). Also, hedgehogs in urban areas tend to fatten up more, taking advantage of an easily accessible trophic resource and the absence of predation pressures (El Kala: 85.84% urbanization). For García-Rodríguez and Puig-Montserrat (2014), these factors would be the cause of the withdrawal of European populations of hedgehogs from their natural environment.

The loss or fragmentation of agricultural habitats and the density of rural traffic are different factors that explain the current apparent preference of the hedgehog for the city (Pettett et al., 2017).

CONCLUSION

We were able to characterize the species preferred life zone in El Kala National Park through the analysis of catch rates, combined with indications from the residents. This area would be rather semi-urban and forestry as well as agricultural. Indeed, the site of Berrihane which displays the highest abundance corresponds best to these characteristics, meeting the different needs of the species in terms of survival, and reproduction. Hedgehogs therefore benefit, in this area, both from the resources related to man and his activity (cultivated plants, household waste...), but also from the absence of predators. The ethno-zoological survey we conducted proved to be an excellent tool in that it allowed us to learn more about the biology of the species, its density and its way of life, and thus contributed to the knowledge of the life history traits of the species.

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ETHICAL STATEMENT

This study was approved by the scientific committee of the Department of Biology (Badji Mokhtar Annaba University).

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

AUTHORS' CONTRIBUTIONS

All authors contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript. All authors read and approved the final version.

REFERENCES

- Aubert A (2002). The Hedgehog. course in the University Temps Libre, Cholet (25 nov.): 1-19.
- Aubert A (2005). Useful and familiar: The Hedgehog. Bull. Soc. Lettres, sciences et arts du Saumurois : Saumur : 86-88.
- Bouazouani O (2004). National Park of El Kala PNEK. Regional project for the development of marine and coastal protected areas in the Mediterranean region (Med MPA).
- Boukheroufa M (2017). Ecophysiology of the Algerian Hedgehog (*Atelerix algirus*) in El Kala National Park. Doctoral thesis. University of Badji Mokhtar, Annaba (Algeria).pp 159.
- Boukheroufa M, Sakraoui F, Bentayeb Y, Nafir A & Benyacoub S (2015). Reproduction monitoring of Algerian hedgehog *Atelerix algirus* (Lereboullet, 1842) (Erinaceidae, Mammalia) during spring, in Righia (National Park of El Kala, northeast Algeria). *Adv. Environ. Biol.*, 9 (14): 97-103.
- Chesne C (2012). The hedgehog. Wild portrait. Artemis Eds. 64p.
- Ewers RM, Didham R (2006). Confounding factors in the detection of species responses to habitat fragmentation. *Biol. Rev. Camb. Philos. Soc.*, 81(1) :117-142
- Gaisler J, Zejda J (1995). The Great Encyclopedia of Mammals. Ed Grand (C. Republic). pp. 496.
- García-Rodríguez S, Puig-Montserrat X (2014). Algerian hedgehog (*Atelerix algirus* Lereboullet, 1842) habitat selection at the northern limit of its range. *Galemys.*, 26: 49-56.
- Guerzou A, Derdoukh W, Guerzou M, Souttou K, Doumandji S (2019). Predation of the Algerian hedgehog *Atelerix algirus* (Insectivora, Erinaceidae) on some organisms harmful to plants in agricultural environments in Djelfa (Algeria). *Bulletin O.E.P.P.*, 49 (1): 152-158.
- Heim de Balsac H, Bourlière F (1955). Order of Insectivores, Systematics. In GRASSE, P.-P. (ed.), *Traité de Zoologie* 17. pp 1653-1712.
- Hof AR, Bright PW (2010). The value of agri-environment schemes for macro-invertebrate feeders: hedgehogs on arable farms in Britain. *Ani Conser.*, 13: 467-473.
- Hubert P (2008). Effets de l'urbanisation sur une population de Hérissons européens (*Erinaceus europaeus*) ». PhD Thesis, Reims : Université de Reims Champagne-Ardenne. 124p.
- Hubert P, Julliard R, Biagiantia S, Poule ML (2011). Ecological factors driving the higher hedgehog (*Erinaceus europeus*) density in an urban area compared to the adjacent rural area. *Land. urb. plan.*, 103: 34-43.
- Jourde P. (2013). The European Hedgehog. Delachaux et Niestlé, Paris. 207p.
- Khalidi M, Ribas A, Barech G, Hugot JP, Benyettou M, Albane L, Arrizabalaga A, Nicolas V (2016). Molecular evidence supports recent anthropogenic introduction of the Algerian hedgehog *Atelerix algirus* in Spain, Balearic and Canary Islands from North Africa. *Mammalia.*, 80(3): 313–320.
- Kokko H, Harris MP, Wanless S (2004). Competition for breeding sites and site-dependent population regulation in a highly colonial seabird, the common guillemot

- Uriaaalge. *J. Ani. Ecol.*, 73: 367-376.
- Madoui BEM, Sakraoui F, Houhamdi M, Bouslama Z (2014). Characterisation and dynamics of wild and domestic flea populations: Impact on health. *Entomol. faun.*, 67:3-13.
- Michalakis Y. (2007). Parasitism and evolution of life history traits. In *Ecology and evolution of parasitic systems*. Eds. Thomas F, Guégan JF & Renaud F. de Boeck, Bruxelles : pp 129-154.
- Morris PA (1973). Winter nests of the hedgehog (*Erinaceus europaeus* L). *Oecologia*, 11: 299-313.
- Morris PA (1986). Nightly movements of hedgehogs (*Erinaceus europaeus*) in forest edge habitat. *Mammalia.*, 50 (3): 395-398.
- Mouhoub-Sayah C, Djoudad-Kadji H, Kletty F, Malan A, Robin JP, Saboureau M (2018). Seasonal variations in the diet and food selection of the Algerian hedgehog *Atelerix algirus*. *Afr. Zool.*, 53: 1-10.
- Pettett CE, Johnson PJ, Moorhouse TP, Hambly C, Speakman JR, Macdonald DW (2017). Daily energy expenditure in the face of predation: hedgehog energetics in rural landscapes. *J. Exp. Biol.*, 1; 220 (Pt 3): 460-468.
- Ricklefs RE (1991). Structures and transformations of life histories. *Funct. Ecol.*, 5:174-183.
- Sakraoui F, Bouheroufa A, Sakraoui W, Madoui M (2014). Ectoparasitic ecology of Algerian hedgehog *Atelerix algirus* (Lereboullet, 1842) (Erinaceidae, Mammalia) in some localities of Edough Mountain (W. Annaba, Northeast Algeria). *Adv. Environ. Biol.*, 8(21): 217-221.
- Schwammberger K (1972). *Colorful world of animals. The native mammals*. Kosmos. Franckh'sche Verlagshandlung. Stuttgart: 10-11.
- Senaoui C (2021). Parasitic ecology of the Algerian Hedgehog (*Atelerix algirus*) in northeastern Algeria. Doctoral thesis, Badji Mokhtar Annaba University, Algeria. pp. 110.
- Senaoui C, Boukheroufa M, Sakraoui F, Sakraoui W (2020). Preferential fixation sites and relative frequencies of ectoparasites at *Atelerix algirus* (Lereboullet, 1842) in a locality on the North East of Algeria. *Eco. Env.& Cons.*, 26 (2): pp. 926-930.
- Stearns SC (1976). Life-history tactics: a review of the ideas. *Q. Rev. Biol.*, 51: 3-47.
- Stearns SC (1992). *The evolution of life histories*. Oxford University Press, Oxford.