Diet of hedgehogs (*Atelerix algirus*) in Kabylia, Algeria

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ABSTRACT
In the present study, we provide the first qualitative and quantitative analysis of the diet of Algerian hedgehogs (*Atelerix algirus*) in Kabylia, Algeria. The study carried out between May and October of 2014 covered two different sites Yakouren (forestry environment) and Tizi-Rached (agricultural environment). Sixty droppings were collected at each site. In Yakouren, the analysis of droppings allows us to identify 12050 items grouped in 16 categories of eaten preys while in Tizi-Rached, 13543 items grouped in 13 categories of preys are identified. In both two stations, the Hymenoptera category is the most eaten prey with a percentage of 93% in Yakouren and 98% in Tizi-Rached. Moreover, a comparative study of the consumed categories between the two stations as well as the seasonal variation are carried out. For each category, a quantitative analysis of food selectivity is provided. In the Hymenoptera category, 99% of the consumed preys in both stations belongs to the Formicidae family. A deeper investigation of this family revealed 13 species in Yakouren and 11 species in Tizi-Rached. T he species most consumed by the hedgehog in both stations is *Messor sp* with a percentage of 49% in Yakouren and 91% in Tizi-Rached. A biochemical analysis of this species is performed.

KEYWORDS
Diet; hedgehog; *Atelerix algirus*;Food selection; seasonal variations; Hymenoptera; biochemical analysis

1. Introduction

Understanding the trophic behavior of a given species is essential as it constitutes the first principle of animal ecology, Salas and Fuller (1996). Many reasons cause the study of diet to be of the utmost importance : it brings a better understanding on the nature of potential competitive interactions between sympatric species (Jaksic, Feinsinger, and Jimenez (1992), Wiens (1993)), as well as on how a species food profiles influence the environment.

The hedgehogs (*Atelerix algirus*) diet has been the subject of numerous studies worldwide. In New Zealand, several studies have been conducted on the effect of hedgehog predation on the endemic fauna of the islands ecosystems in which they were introduced, (Jones and Norbury (2011), Chris, Kisten, and Mark (2005), Brockie (1959) and Campbell (1973)). We have also gathered information from a few studies from Europe pertaining to the diet of the European hedgehog (Wroot (1984),Yalden (1976)).

In Algeria, some works have been dedicated to the study of the hedgehog. The

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diet has not been thoroughly investigated. For instance, in (Doumandji and Doumandji (1992)), the authors studied the hedgehogs diet in the region of Algiers. However, other aspects were discussed. Parasitological analysis was discussed in (Khaldi, Socolovschi, Benyettou, Barech, Biche, Kernif, Raoult and Parola (2012)), (Khaldi, Torres, SamsÃ^3, $Miquel, Biche, Benyettou, Barech, BenelkadiandRibas$ (2012)) and (Sakraoui, Boukheroufa, Sakraoui, and Mouiz Bachir El Madoui (2017)). In (Khaldi, Ribas, Barech, Hugot, Benyettou, Albane, Arrizabalaga and Nicolas (2016)), recent anthropogenic introduction of the Algerian hedgehog *Atelerix algirus* in Europe was highlighted by molecular evidence supports. The authors in (Derouiche, Bouhadad and Fernandes (2016)) investigated the genetic and phenotypic variation of the two North African hedgehog *Atelerix algirus* and the desert hedgehog *Paraechinus aethiopicusspecies* in Algeria using mitochondrial DNA and external morphological characters. Road mortality of the Algerian Hedgehog *Atelerix algirus* in the Soummam valley, Algeria is studied in (Mouhoub-Sayah, Robin, PÃ©vet, Moneke, Doumandji and Saboureau (2009)).

To the best of our knowledge, there is no published work dealing with the diet of the hedgehog of Kabylia. The goal of our research is to enrich the Algerian hedgehog ecology corpus, particularly by bringing to light new elements pertaining to the diet of the hedgehog in Kabylia. Our research was conducted in two different locations in Kabylia. This study also aims at providing a quantitative analysis of food selectivity. The variations in the hedgehogs diet according to the locations and according to seasons will also be discussed. According to (Doumandji and Doumandji (1992)), the Algerian hedgehog has a preference for Hymenoptera insects, and particularly, ants. Along with gathering data on the rate at which a certain type of food appears, we will look at the energy value of a few species of Formicidae, namely *Messor sp*, which appears to be preferred by the hedgehog. This constitute the second part of our work.

2. Materials and methods

2.1. *Study sites*

Fieldwork was carried out in two sites located in Kabylia, which is in the northern part of Algeria. The first site, Yakouren, is a forest type location (called the Beni-Ghobri forest). The second site, named Tizi-Rached, is agricultural ecosystem. Yakouren is located $46km$ east of the Tizi-Ouzou wilaya ($36^o45^{'}N, 4^o23^{'}E$). The altitude of this hardly anthropized forest varies from $512m$ to $657m$ although several roads go though it. The site is also characterized by ravines and streams. *Quercus suber* is the dominant species of the forests flora. We collected our samples in the southern portion of the forest, whose undergrowth is made up of several species such as *Myrtis communis*, *Genista tricuspidata*, *Pistacia lenthiscu*, *Arbustus unedo*, *Calycotoma spinosa*, *Alnus glutinosa*, and *Salix pedicellata*. The shrub layer is predominently composed of *Ilex aquifolium* and *Rubus ulmifolius*. Tizi-Rached is located $13km$ east of Tizi-Ouzou ($36^o40^{'}N, 4^o11^{'}E$), at an average altitude of $300m$. The site is heavily visited by humans. Crops, ranging from, among others, wheat, potatoes, beans, maize, and turnip, depending on the season, are abundant there. There are also other perennial crops such as the fig tree and the olive tree, as well as other naturally occurring varieties of vegetation, namely *Rubus ulmifolius* , *Fraximus sp* , *Rosa sempervireuse* , and *Genista tricuspidata*. The two sites possess a Mediterranean climate. During the study period (from May to October 2014), the temperature, in the two sites, varies between 13^oC and 25^oC in May, between 20^oC and 33^oC in August and between 10^oC and 21^oC in November.

2.2. *Preys availibility*

The estimate of the hedgehogs preys availability in both locations were determined by the pitfall traps distributed in a straight line. The traps are $15cm$ deep and their diameter is of $10cm$. Each trap is set in a hole in the ground in such a way that its opening is at ground level, and the traps are at a $5m$ distance from one another. They are filed to the third with soapy water, which allows for insects to get trapped in them. After 24 hours, the contents of the traps is retrieved and poured in plastic bottle filed with 70% alcohol., which is used to preserve the insects. All the insects captured were identified and a representative sample was kept to be used as reference collection. The traps are inserted during the droppings collection period, i.e., from May to October 2014. They represent the average preys availability.

2.3. *The hedgehogs diet*

The hedgehods diet is analyzed by studying the composition of its droppings. Faecal analysis was the preferred method as it would not require for animals to be sacrificed. Also, its an easier method of gathering larger samples as opposed to that of animal slaughter or collecting carcasses, (Fedriani and Kohn (2001)). In order to distinguish between the composition of the faecal matter samples, we use a fieldwork guide which references the size, shape and color of the feces according to their composition. We have analyzed 120 samples of Algerian hedgehogss droppings, 60 of them collected in Yakouren and the other 60 in Tizi-Rached. The samples were gathered between May and October of 2014. Each sample is stored in a Petri dish with ethanol which rids the droppings of any pathogenic germs. We use a binocular microscope with a 10×40 magnification to analyze the insects ingested by the hedgehog. The identification is done using diverse insect fragments (head, thorax, elytra, femurs, tibiae and mandibles) which were retrieved from the droppings. The determination of the various fragments was carried out at the lowest possible taxonomic level. These fragments are classified, first, by orders, then by families, and finally by genres when possible, using the different keys of determination.

2.4. *Biochemical composition*

The nutritional value of proteins, lipids and sugars and the estimation of energy intake are determined by analyzing the biochemical composition of the ants. This analysis consists of measuring the level of proteins, lipids and carbohydrates for each species of ants consumed by the hedgehog. Three methods are used for this purpose.

- *Proteins content (nitrogen level)*: The total nitrogen is determined by the Kjeldhal's method. The organic nitrogen of the element to be analyzed is mineralized by concentrated sulphuric acid in the presence of a catalyst. The ammoniacal nitrogen formed is displaced by sodium hydroxid and then dosed by titrimetry, (Jarrige (1989)).
- *Lipids content (fat matter)*: The fat matter is determined by the Soxhlet's method. The crude fats correspond to the substances extracted under reflux by a solvent (light petroleum) (Jarrige (1989))
- *Total Sugars content*: The total sugars is determined by the Bertrand's method. Sugar proportion is made after defecation and hydrolysis by reduction of alkalino-cupic liqueur and valuation of cooper oxide formed, according cupric-metrical. (Lecoq (1965))

The energy intake is computed from the fact that $1g$ of protein is equivalent to $4Kcal$, $1g$ of sugar is equivalent to $4Kcla$ and $1g$ of lipid is equivalent to $9Kcal$.

2.5. *Data analysis*

In order to characterize the diet of hedgehog on the basis of all collected droppings, we determinate the number N of items for each identified category ingested by the hedgehog. To estimate the taxonomic diversity, we use the following indices

- The Relative Abundance ($AR(\%)$), computed by the following formula: $AR(\%) = \frac{n_i}{N} * 100$, where n_i is the number of individuals of species i taken into account and N is the total number of individuals of all species (Ramade (2008)).

- The frequency of occurrence defined by the following formula, (Dajoz (2006)): $C(\%) = \frac{n_{fi}}{N_f} * 100$, where n_i where n_{fi} is the number of faeces containing species i, and $N_f$is the total number of faeces analyzed. Depending on the value of C, a species i can be defined as: ubiquitous if $75\% \leq C(\%) \leq 100\%$, regular $25\% \leq C(\%) \leq 74\%$, accessory $5\% \leq C(\%) \leq 24\%$ and rare if $C(\%) < 5\%$.
(Bigot and Bodot (1973)).
- The Shannon-Weaver diversity index ($H^{'}$) is the measure of species diversity in a given community, (Daget (1976)). The species diversity $H^{'}$ is computed by the following formula, (Dajoz (1975)) $H^{'} = -\Sigma_{i=1}^{N} \frac{n_i}{N} Log_2 \left(\frac{n_i}{N}\right)$ where N is the sum of species numbers and n_i is the population size of species i.

- The equitability index (E) is calculated as the ratio $E = \frac{H^{'}}{H^{'}_{max}}$ between the observed diversity $H^{'}$ and the maximum diversity $H^{'}_{max}$ which is the diversity observed in the theoretical case where all the species have the same number of items, (Ramade (2008)). The used formula is $H^{'}_{max} = Log_2(S)$ where S denotes the total wealth (Blondel (1979)). The equability index E varies from 0 to 1. When E is near 0, i.e., $E < 0.5$, this means that almost all the numbers tend to be concentrated on a single species. When E tends towards 1, it means that all species have the same abundance (Barbault (1981)).

- The Ivlev's(1961) index is used to measure the food choice. In literature, several index were proposed to measure the food choice of predatory animal species by comparing, using different indices, the use and availability of prey. In this study, we used the IVLEV selection or electivity index. Symbolized by (I), this index makes it possible to compare the relative abundance of prey available in the environment and the choice of prey consumed by the predator. It is calculated by the following formula: $I = \frac{(r-p)}{(r+p-2rp)}$ where r represents the frequency of an item in the food spectrum of a species and p the frequency of the same item in the surrounding environment. I varies from -1 to 0 for negative selection and from 0 to $+1$ for positive selection (Jacobs (1974)). For both two stations, we compare the relative proportions of orders in the medium with those observed in the diet study.

To analyze the correlation between the relative abundance and the relative occurrence, we used the Spearman rank correlation. Moreover, we also used the chi squared test (χ_2) to study the seasonal variation and the Mann-Whitney test to compare the two sites results.

3. Results

3.1. *Diet*

The analysis of the 120 droppings collected in the two sites allows us to list 18 food categories. In the region of Yakouren, 12050 preys were identified from 60 droppings. These items are classified into 16 categories. In the region of Tizi-Rached, 13543 preys grouped into 13 categories were identified from 60 droppings. The most frequently observed category is the Hymenoptera occured in 93% in Yakouren and in 98% in Tizi-Rached. The second most commonly consumed category is the Coloptera but with very low percentages of 4% in Yakouren and of 1% in Tizi-Rached. The other categories identified are negligible and their total percentage does not exceed 1% in the two study regions (Table 1).

The number of preys consumed by the hedgehog by dropping between the two study stations is not significantly different. The obtained results of the Mann-Whitney test are $z = -0.145, p = 0.884$.

Table 1. N and $AR\%$ of the different food categories identified in the diet of the Algerian hedgehog (*Atelerix algirus*).

	Yakouren		Tizi-Rached	
Orders	N	AR(%)	N	AR(%)
Aranea	30	0%	11	0%
Opiliones	41	0%	1	0%
Geophilomorpha	2	0%	0	0%
Julida	5	0%	27	0%
Pulmonata	2	0%	0	0%
Stylommatophora	3	0%	0	0%
Coleoptera	532	4%	149	1%
Dermaptera	2	0%	25	0%
Dictyoptera	34	0%	3	0%
Hemiptera	4	0%	26	0%
Heteroptera	9	0%	2	0%
Homoptera	87	1%	9	0%
Hymenoptera	11249	93%	13215	98%
Lepidoptera	1	0%	1	0%
Neuroptera	4	0%	0	0%
Orthoptera	45	0%	9	0%
Blattodea	0	0%	64	0%
Isopoda	0	0%	1	0%
Total	12050	100%	13543	100%

N: Number of identified items, $AR\%$: Relative abundance

The Shanon-Weaver index $H^{'}$ was calculated for the two study regions. The obtained values are low as well at Yakouren ($H^{'} = 0.48$) as at Tizi-Rached ($H^{'} = 0.22$). The equitability values $J^{'}$ are less than 0.5 for the two study regions, $J^{'} = 0.12$ in Yakouren and $J^{'} = 0.05$ in Tizi-Rached. These values reflect an imbalance between the numbers of preys consumed by the Hedgehog of Algeria.

The analysis of frequency of occurrence is performed and is illustrated by Figure 1. For both two stations, the obtained results show that the category of Hymenoptera is present in all analyzed droppings. The second most dominant category in the two stations is that of the Coloptera with a percentage of 88% in Yakouren and 80% in Tizi-Rached. For the following categories, a difference between the two stations is noted. Indeed, in Yakouren, the present category are: Orthopera (52%), Aranea, Opiliones and Homoptera (between 28% and 27%), Dyctyopera (23%). The other categories do not exceed the 10% of analyzed droppings. In Tizi-Rached, the present categories are successively: Hemiptera 25%, Dermaptera (23%), then by Blattodea, Aranea Orthoptera, Julida (between 18% and 13%). The other categories do not exceed the 10% of faeces analyzed. The correlation between the relative abundance and the frequency of occurrence of the different food categories consumed by the hedgehog is significant according to the Speerman's correlation test ($r_s = 0.977, p - value < 0.0001$), in Yakouren; ($r_s = 0.966, p - value < 0.0001$) in Tizi-Rached. Then, we have proceeded an

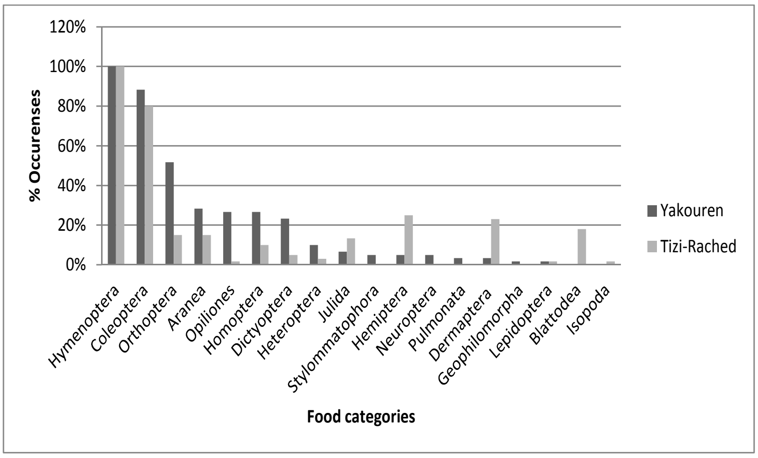

Figure 1. Occurrence of food categories consumed by the Algerian Hedgehog in Yakouren and in Tizi-Rached.

in-depth determinationin. In the Hymenoptera category, 99% of the consumed preys in both stations belongs to the Formicidae family. In the Yakouren, 13 species belonging to this family were identified, including *Messor sp* (49%), *Camponotus sp* (31%), *Crematogaster sp* (14%), *Aphaenogaster sp1* (3%), *Tetramorium sp* (1%) and other species are very weakly represented with a percentage much lower than 1%. In the Tizi-Rached, the family of Fourmicidae is represented by 11 species which are *Messor sp* (91%), *Camponotus sp* (4%), *Aphaenogaster sp1* and *Tapinoma sp* (2%), *Tetramorium sp* (1%) and other species which are very poorly consumed by the Algerian hedgehog with a percentage not exceeding 1%.(Figure 2).

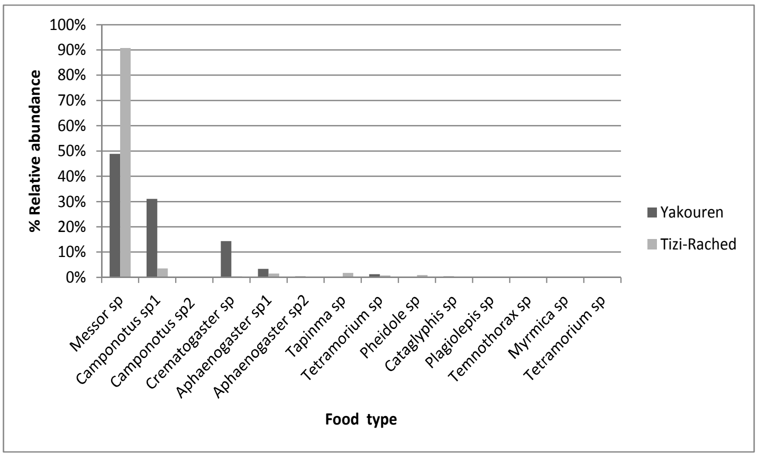

Figure 2. Relative abundance of Fourmicidae species consumed by the Algerian hedgehog in Yakouren and in Tizi-Rached.

3.2. *Seasonal variation*

There is no significant difference in the different dietary categories identified in the hedgehog diet between seasons in the two regions ($\chi_2 = 3.008, ddl = 32, p - value = 1$ in Yakouren and $\chi_2 = 3.220$, $ddl = 26$, $p - value = 1$ in Tizi-Rached). The Hymenoptera dominated during the three seasons in spring, summer and autumn with a percentage between 93% and 94% in Yakouren and a percentage between 97% and 98% in Tizi-Rached (Figures 3 and 4).

The Shanon-Weaver index $H^{'}$ was calculated for each season and for each study region. In Yakouren, the highest value of this index is in spring $H^{'} = 0.52$. On the other hand, in autumn, this index has the lowest value $H^{'} = 0.41$. The values of the equitability index $J^{'}$ are low for all seasons, the maximum obtained is in spring $J^{'} = 0.12$ and the minimum is in autumn with $J^{'} = 0.10$. At Tizi-Rached, the values of the Shanon-Weaver index are lower. The highest value is obtained in summer with $H^{'} = 0.30$ and the lowest value is observed in autumn with $H^{'} = 0.1$. The values of the indices obtained are less than 0.5; The maximum obtained is in summer with $J^{'} = 0.07$ and the minimum is obtained in autumn with $J^{'} = 0.03$.

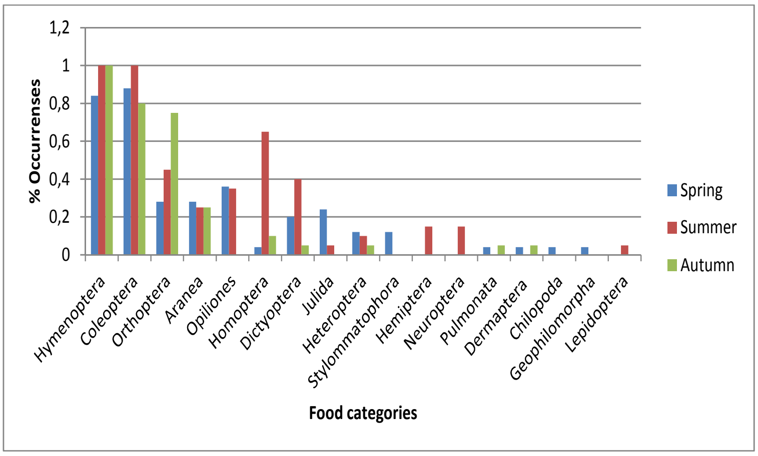

Figure 3. Seasonal variation among the different food categories of the Algerian hedgehog in Yakouren

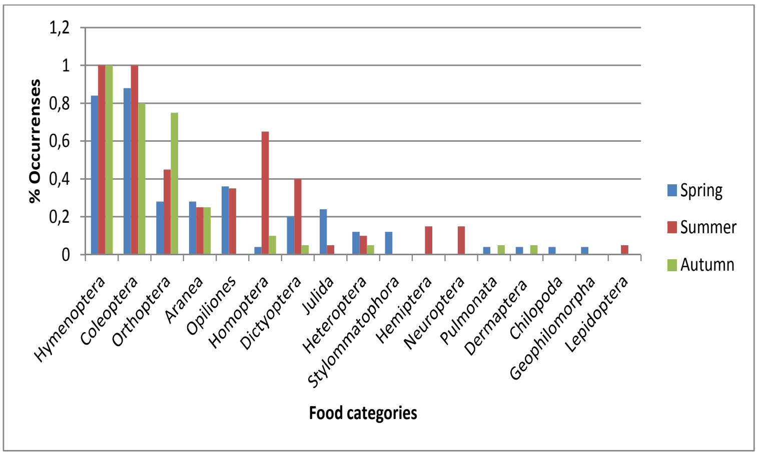

Figure 4. Seasonal variation among the different food categories of the Algerian hedgehog in Tizi-Rached

3.3. *Food availability*

(The inventory of food availability at both stations was completed during the study period.

At Yakouren, 3 classes were identified: Arachnida (3%), Insecta (94%) and Collembola (3%). These classes were divided into 14 orders. Hymenoptara is the most dominant order with a percentage of 92%. Other orders are present with low percentages between 1% and 3% (Aranea, Opiliones, Prostigmata, Trombidiformes, Coleoptera, Dictyoptera, Diptera, Hemiptera, Homoptera, Lepidoptera, Montodea, Orthoptera and Entomobryomorpha.) The order of Hymenoptera is divided into 4 families. The Formicidae family is the most dominant with a percentage of 99%. Other families are weakly represented with a single individual. In the dominant family of Formicidae, we identified 11 species: *Cataglyphis viaticus* which is the most dominant species (68%), *Crematogaster laestrygon* (12%). Other species do not exceed 10% (*Aphaenogaster dipilis*, *Aphaenogaster sardoa*, *Camponotus alii*, *Crematogaster scutellaris*, *Crematogaster sp*, *Messor barbara*, *Plagiolepis barbara*, *Tetramorium sericeiventris* and *Tetramorium sumiliev*. The values of the Shanon-Weaver diversity and the equitability indices are $H^{'} = 2.34$ and $J^{'} = 0.43$, respectively.

In Tizi-Rached, we determined 5 classes. Insecta is the most dominant class (97%) followed by the Arachnida (2%). Other classes have very low percentages. The five classes are divided into 20 orders. The order of Hymenoptera is the most dominant (95%). The orders of the Diptera and Aranea are present with percentages of 2% and 1%, respectively. Other orders are present with low frequencies (Acari, Mesostigmata, Opiliones, Sarcoptiformes , Trombidiformes, Scolopendres Scutigeromorpha, Blattodea, Hemiptera, Heteroptera, Homoptera, Orthoptera, Psocoptera, Thysanoptera, Isopoda, Entomobryomorpha and Poduromorpha). The order of Hymenoptera is devided into 7 families. The Formicidae family is the most dominant (99%). Other orders are represented with very low frequencies. The Formicidae family includes 20 species. *Messor barbara* is the most dominant species with 38% followed by *Pheidole pllidula* (35%), *Tetramorium sumiliev* (8%), *Plagiolepis barbara* (5%), *Tapinoma nigerrimum* (4%), *Aphaenogaster sardoa* (3%), *Aphaenogaster dipili*, *Aphaenogaster testaceo pilosa* (2%), *Cataglyphis viaticus* and *Tetramorium caespitium* (1%). Other species are very poorly represented (*Aphaenogaster sp*, *Crematogaster auberti*,*Crematogaster laestrygon*, *Crematogaster scutellaris*, *Crematogaster sp*, *Messor sp*, *Plagiolepis sp*, *Temnothorax sp*, *Tetramorium sericeiventris* and *Monomorium salomonis*. The values of the Shanon-Weaver diversity and the equitability indices are $H^{'} = 2.83$ and $J^{'} = 0.41$, respectively.

3.4. *Food selectivity*

For both two stations, the selectivity index values are reported in Table 2. In Yakouren, we recorded 7 orders in faeces but were not caught by traps. The value of the corresponding Ivlev index is +1. These orders are: Geophilomorpha, Julida, Pulmonata, Stylommatophora, Dermaptera, Heteroptera and Neuroptera. Four identified orders are present both in droppings and in the environment and have positive Ivlev index value varying between 0.04 and 0.074. These orders are Coleoptera ($I = 0.74$), Dictyoptera ($I = 0.53$), Homoptera ($I = 0.73$), Hymenoptera ($I = 0.11$), Orthoptera ($I = 0.04$).

In Tizi-Rached, we found 5 orders consumed by the hedgehog but absent in the environment. The corresponding Ivlev index value is therefore equal to +1. These orders are: Coleoptera, Dermaptera, Dictyoptera, Julida and Lepidoptera. Three identified orders have a positive Ivlev index value. These orders are: Blattodea ($I = 0.18$), Hemiptera ($I = 0.66$) and Hymenoptera ($I = 0.39$).

3.5. *Biochemical characteristics of some ant species*

As we have seen in the previous results, the study reveals that Formicidae have the first place in the diet of the hedgehog. In order to understand the hedgehog's preference for Formicidae, we considered it important to carry out an analysis of the biochemical components in order

Table 2. Ivlev's (I) electivity values for food categories consummed by the Algerian hedgehog in Yakouren and in Tizi-Rached.

Orders	Yakouren	Tizi-Rached
Aranea	-0.7249	-0.8448
Acari	–	-1
Mesostigmata	–	-1
Opiliones	-0.4333	-0.9258
Prostigmata	-1	–
Sarcoptiformes	–	-1
Trombidiformes	-1	-1
Geophilomorpha	1	–
Scolopendres	–	-1
Julida	1	1
Pulmonata	1	–
Scutigeromorpha	–	-1
Stylommatophora	1	–
Blattodea	–	0.1851
Coleoptera	0.7401	1
Dermaptera	1	1
Dictyoptera	0.5351	1
Diptera	-1	-1
Hemiptera	-0.6756	0.6678
Heteroptera	1	-0.5910
Homoptera	0.7891	-0.0707
Hymenoptera	0.1084	0.3873
Lepidoptera	-0.8233	-0.4433
Montodea	-1	–
Neuroptera	1	–
Lepidoptera		1 –
Orthoptera	0.0434	-0.5790
Psocoptera	–	-1
Thysanoptera	–	-1
Entomobryomorpha	-1	-1
Poduromorpha	–	-1

"–": Not found

to demonstrate the nutritive qualities of some species of ants. To perform this study, we have analyzed a few species of ants, in particular the *Messor sp* species, which is the most dominant, by a set of biochemical methods. This analysis makes it possible to demonstrate the different nutritive values of proteins, lipids and carbohydrate. The results obtained show that this species is very rich in protein (72.74%),low in lipid (5.05%) and with no carbohydrate. For the other species *Cataglyphis sp*, *Tapinoma sp* and *Pheidol sp*, due to small amount of samples, only their protein levels were determined. The obtained results show that *Pheidole sp* contains the most protein in 77%, followed by *Ctaglyphis sp* in 73.18% and *Tapinoma sp* in 48.31%. The results of the energy intake of the different biochemical components of the species *Messor sp* are as follows: the protein energy intake is $290.96Kcal/\%DryMatter$, the lipid energy intake is $45.45Kcal/\%DryMatter$ and the carbohydrate energy intake is zero. Therefore, the total energy intake Thus, the total energy intake of the three biochemical components for the *Messor sp* species is $336.41Kcal/\%DryMatter$.

4. Discussion

It is clear from these results that the main prey of the Algerian hedgehog (Atelerix algirus) are the Arthropods. In Yakouren, among the five classes of identified arthropods, the class of insects is predominant. The same observation is true in Tizi-Rached, where this class is predominant over the four identified classes. These results generally correspond to those reported by (Doumandji and Doumandji (1992)), (Mouhoub-Sayah (2009)) and (Khaldi (2014)). The hedgehog presents a very restricted food spectrum. The Algerian hedgehog presents mainly predominantly insectivorous habit.

The order of the insects most consumed by the Algerian hedgehog is the Hymenoptera as well in Yakouren as in Tizi-Rached. The Coleoptera order is the second consumed and is weakly represented in both two sites. These results are in agreement with those reported in some works carried out in Algeria on the diet of the Algerian hedgehog (Doumandji and Doumandji (1992), Mouhoub-Sayah (2009) and Khaldi (2014)). In (Mouhoub-Sayah (2009)) and in (Khaldi (2014)), the authors have asserted that Hymenoptera are the most frequently observed item occurred in 69% in the Djurdjura National Park, in 72% in the Soumame Valley and in 94% in the Algiers region.

Most of the investigations on the diet of the European hedgehog (Erinaceus europaeus) show that Coleoptera are dominant. (Chris, Kisten, and Mark (2005)) noted that Coleoptera are present in 81% of the 192 analyzed intestines in a range of wetland habitats in New Zealand. The results of (Jones and Norbury (2011)) showed that the Coleoptera are found in 94% of the analyzed faeces, in New Zealand in an arid environment. In England, studies concluded that Coleoptera is the most eaten order by the European hedgehog (Reeve (1994)) and (Yalden (1976)) noted that 73% of the Coleoptera are present in 137 analyzed stomachs. The results obtained on the composition of the food spectrum of the Algerian hedgehog are different from those of the European hedgehog. The Hedgehog of Algeria shows a heavy reliance on Hymenoptera. Indeed, we noted a large consumption by the hedgehog for Hymenoptera in both two regions. However, we noted a high frequency of occurence of Coleoptera in the droppings with few items in each droppings. We can conclude that the dominance of Hymenoptera is due to the high availability of this order in the environment compared to the availability of Coleoptera which is very low in Yakouren and almost zero in Tizi-Rached. We also found that the Formicidae is the most consumed family by the hedgehog. The difference in the trophic regime between the hedgehog of Europe and the hedgehog of Algeria may be explained by the availability or the richness of formicidae. In New Zealand, only 37 species of ants have been recorded. (Don (2007)). In the Tizi-Rached region alone, we have already identified 20 species of ants, nearly 50% of the species found throughout New Zealand. This indicates that the richness of ant species in Algeria may be another explanation for the hedgehogs consumes a lot of Hymenoptera.

Remarkably, ants are very much appreciated by the Hedgehog of Algeria as observed in the two sites. The hedgehog of Algeria consumes several species of ants. In Yakouren we noted 13 species while in Tizi-Rached 11 species has been listed. *Messor sp* is the most consumed species in both sites. According to (Doumandji and Doumandji (1992)), this species is considered to be detrimental to cereal. The *Messor sp* is found in all known environments, including crops, gardens, pasture and forest clearings, but virtually never under vegetation cover (Cagniant and Espadaler (1998)). The high consumption of the *Messor sp* species in Tizi-Rached is due to the fact that this species is very abundant in this agricultural zone, which is characterized by the various crops according to the seasons. In Yakouren, in addition to *Messor sp*, *Camponotus sp* were eaten. This is due by the fact that Yakouren is a forest region and according to (Cagniant (1970)), the *Camponotus sp* is a rather forest ant.

The biochemical analysis carried out on the most dominant *Messor sp* species shows that this species is very rich in protein, low in lipid and with no carbohydrate. These results are in agreement with those of (Rothman, Raubenheimer, Bryer, Takahashi and Gilbert (2014)), on the study of the average nutrient concentration of different orders of insects. The concentration of proteins is higher than those of lipids at all levels. The obtained energy intake of *Messor sp* is about $336.41 Kcal/\%DryMass$ This result is in agreement with those reported This result is in agreement with those reported in (Rumpold and SchlÃter (2013)) whose energy intake is between $391 Kcal/100g$ and $566.36 Kcal/100g$. The hedgehog's preference for it Messor sp may be due to the relatively high energy intake even though other species have more and also because this species has a high frequency of availability in the environment. Moreover, the choice of itMessor sp may be linked to the activity of the ants. (Delalande (1985)) observed the activity rate of some species of ants in the Mediterranean region, *Messor sp* observed a peak activity from 19H to 2H in the morning and another peak from 8h to $10h$ in the morning. We note that the protein intake of *Pheidole sp* and *Cataglyphis sp* is also high. *Cataglyphis sp* is a diurnal species (Delalande (1985)). This explains the fact that it is not eaten by the hedgehog. On the other hand, *Pheidole sp* is active even during the night (Delalande (1985)). The fact that it is not preferred by the hedgehog remains unclear. Abundance, quality and ease of capture are the determining factors for hedgehog prey selection. The preference of the Algerian hedgehog for a given prey indicates an adaptation to the variation in environmental conditions. The study of the seasonal variation of the prey consumed by the hedgehog is therefore essential during the three seasons of spring, summer and autumn. This can also lead to a response to seasonal variations in prey availability. Note that in winter, the hedgehog would be hibernating. At the best of our knowledge, there is no study concerning the seasonal variation of the diet of the Algerian hedgehogs.

Overall, for the three seasons studied, spring, summer and autumn in which the hedgehog is active, there is no net variation in the diet as shown by the test of χ_2. This is due to the fact that the two orders Hymenoptera and Coleoptera are almost dominant for the three study seasons as well at Yakouren as at Tizi-Rached. Nevertheless, it should be noted differences between the seasons of certain orders consumed by the hedgehog. Changes in the food supply of the environment are linked to climatic variations in the environment, namely a fall in temperature and an increase in rainfall, leading to major changes in feeding behavior (Mouhoub-Sayah (2009)). In Yakouren, we noticed that the Orthoptera are much consumed in autumn just after Hymenoptera and Coleoptera. The reason for this is that the rhythm activity of Orthoptera decreases in this period because of unfavorable climatic conditions; they become an easy prey for the hedgehog (Moussi (2012)). On the other hand, in summer, the Homoptera order comes just after Hymenoptera and Coleoptera. Indeed, this order is very abundant in this season. The diversification of consumed orders is greater in the spring when almost all the identified orders are consumed In Tizi-Rached, summer is the most diversified season. Blattodea is eaten only in summer with a relatively high rate but below those of Hymenoptera and Coleoptera. Conversely, Dermaptera is much consumed in spring but little consumed in summer. This reflects the hedgehog's ability to adapt its food requirements to the prey availability in the environment.

The results show that, in Yakouren, there are 12 orders with positive value of the selectivity index and, in Tizi-Rached, there are 8 orders with positive value of the selectivity index. This difference is due to the availability of the orders in the environment. Note that the majority of orders in Tizi-Rached with positive selectivity index are also present in Yakouren. However, there are some differences between the two sites. Some orders with a positive selectivity index in one site are assigned by a negative index in the other site and vice versa.

The orders which have the maximum selectivity index $(+1)$ in the two sites are Dermaptera and Julida. After that, orders with an important index are Coleoptera and Dictyoptera. The work carried out on the selectivity of the European hedgehog by (Jones and Norbury (2011)) shows that the preys most sought after by the hedgehog belong to the orders of Dermapteres and Coleoptera. This is in line with our results. According to (Wroot (1984)),(Reeve (1994)) , the reason for the European hedgehog's dietary preference for Dermapteres is unclear, as this order has a relatively low energy content compared to other foods. Indeed, (Rumpold and SchlÃter (2013)) have shown that Lepidopteres which is the least preferred food possesses the highest energy intake ($508.89 Kacl/100g$) and those of Coleoptera and Hymenoptera are significant ($490.30 Kcal/100g$) and ($484.45 Kcal/100g$), respectively. The order of the Hymenoptera has a positive index but relatively very low in both sites although it is most consumed the order by the hedgehog. This can be explained by their high abundance in the environment. In other words, the Hedgehog of Algeria in this environment consumes foods in relation to their abundances. It should also be recognized that availability and use measures are subject to biasses. Indeed, Pitfall traps remain insufficient for a more coherent measure of availability due to the fact that surface fauna in motion, as Hymenoptera, has a higher probability of capture than other less active or flying forms. The performed study allowed us to highlight a part of the ecology of the Algerian hedgehog. In spite of limitations due to a lack of data on prey availability, some robust conclusion can be drawn. The diet of Algerian hedgehogs depends mainly on Hymenoptera, particularly on ants. However, the hedgehog of Algeria does not hesitate to consume other categories such as Coleoptera, according to the availability. This is valid for the two studied sites. We also noticed that the diet of the hedgehog according to the seasons depends mainly on the availability of the preys. Further research should therefore be directed at improving the availability data by diversifying the types of traps. Another research direction we are suggesting is biochemical analysis of all prey consumed by the hedgehog. This will make it possible to understand the preference, if any, of the hedgehog for certain preys according to their energy contribution.

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