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Collection of Ground Beetles (Coleoptera: Carabidae) in Two Types of Arboreal Terrain in the Natural Park of Belezma Batna (North-Eastern Algeria)

COLLECTION OF GROUND BEETLES (COLEOPTERA: CARABIDAE) IN TWO TYPES OF ARBOREAL TERRAIN IN THE NATURAL PARK OF BELEZMA BATNA (NORTH-EASTERN ALGERIA)

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ABSTRACT

The inventory of the carabid family at two forest sites in the Belezma national park namely an oak grove site and a cedar site during a period ranging from May 2017 to April 2018, has shown the counting of 27 taxa that have been inventoried by Barber pitfall traps. The results showed that the *Quercus ilex* site has slightly more species (25 species) compared to the *Cedrus atlantica* one (23 species). However, the *Harpalinae* subfamily is quantitatively the better one represented at both sites. The Shannon and Simpson indices report slightly higher figures in the *Cedrus atlantica* site with respectively (2.38) and (0.87), which explains the higher Jaccard index of similarity (78 %). The boxplot analysis of the two sites shows better representation in the *Cedrus atlantica* site although there are more outliers in the *Quercus ilex* site.

Keywords: Inventory, carabidae, *Cedrus atlantica*, *Quercus ilex*, belezma.

INTRODUCTION

Ground beetles (Coleoptera, *Carabidae*) are one of the most common and numerous families of beetles, with over 40,000 species worldwide (Dajoz 2002; Lövei and Sunderland 1996) Ground beetles are biological indicators and are widely used in biodiversity conservation research (Thiele 1977; Szyszko 1983; Desender and Turin 1989; Luff 1996; Eyre and Luff 2002; Rainjo and Niemelä 2003; Günther and Assmann 2005; Brandmayr et al., 2005; Lövei et al., 2006).

They seem to be sensitive to habitat changes and in this way great markers of environmental alteration, they are also abundant in most habitable land. (Thiele 1977; Ings and Harley 1999; Magura et al., 2000; Melnychuk et al., 2003) and therefore many researchers are interested in this family to test many different hypotheses (Kotze et al., 2011).

The carabids of the ecosystems of North Africa, that is to say of the subtropical regions, are rarely studied whereas elsewhere they are very well documented, such as the extratropical regions. (Dajoz, 2002). There are very few studies carried out in this region, especially in Algeria. Such as Kocher and Reymond (1954), Pierre (1958), Fiori (1972) and Dajoz (1982).

Recent studies are available but nonspecific such as Le Cœur et al., (2002) who studied the biodiversity in the margin of agrarian fields, Griffiths et al., (2007) who studied the representation and functional composition of carabid and staphylinid beetles and Eyre et al., (2009) who studied ground beetles in eastern England but the fact remains that the studies are rare and the carabid family are poorly studied in the region.

This study is focused on the identification and comparison of population, this to know the different

species that can exist while comparing the populations of beetles in two different types of natural habitats for the purpose of having a first glimpse of the annual presence of the different ground beetles in different biotopes.

It will allow us to present a preliminary inventory of the ground beetles in an otherwise never before studied region and to know how vegetation affects their population. We aim to be a study that makes a foothold in this region in this regard.

MATERIALS AND METHODS

Study Area

The study was conducted between May 2017 and April 2018 and the site is present in the confines of the Belezma National Park (35°35′N 6°02′E), located in the Wilaya of Batna in northeastern Algeria, it is 7 kilometers from the city and is home to a rich fauna and flora biodiversity. According to the Ain Soukhna meteorological station, the site receives 211.45 mm of rainfall in the sampling year (May 2017 to April 2018) and has an average temperature of 15.8°C.

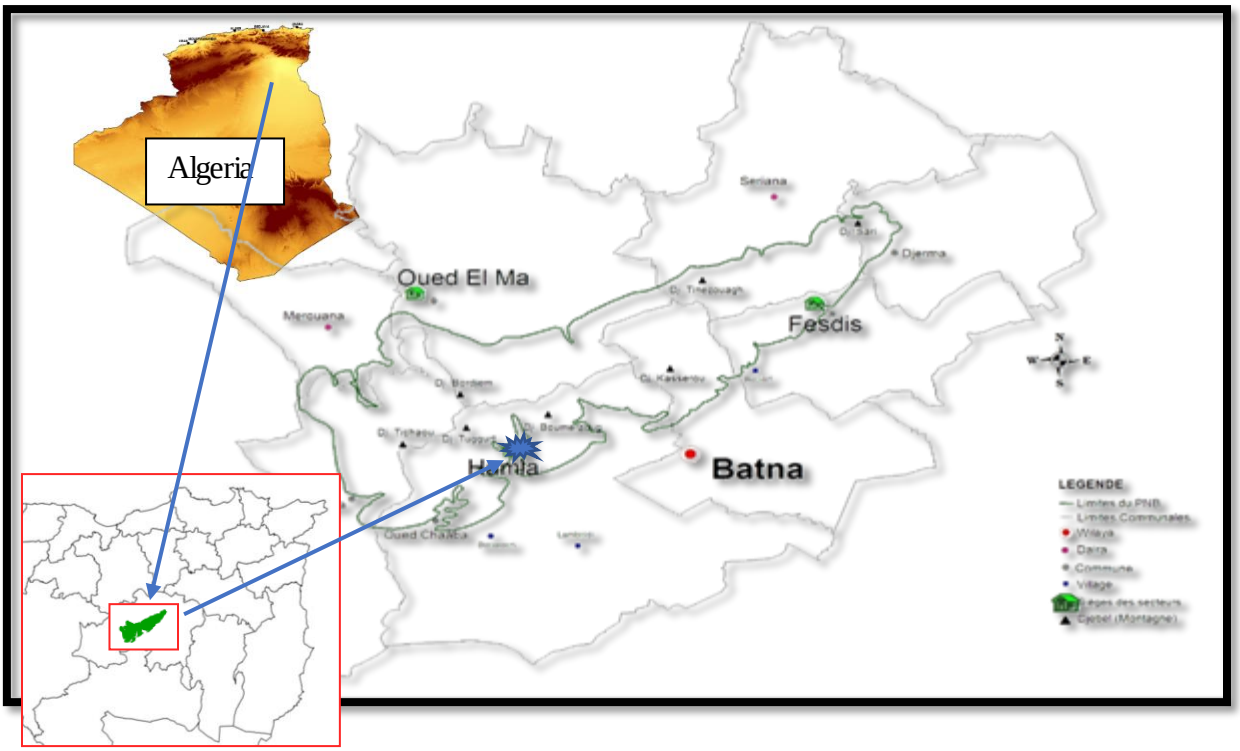

Figure 1: Geographical location of the study area.

Study Sites

The study was conducted on two sites with an area of one hectare for each of them due to the limitation of tree purity of the site meaning any bigger surface will see the mixing of other tree species which renders the comparison between the sites difficult. The two sites are near the town of Hamla in the Belezma National Park, the two sites are located close to each other to minimize the difference in ecological factors between the two, the only noticeable difference being different vegetation:

-First site: Atlas cedars (*Cedrus atlantica*) with dry, dark soil.

-Second site: holm oaks (*Quercus ilex*) with well-drained soil.

Insect Sampling

The method used is simple random sampling and that was achieved by using five pitfall traps per site separated by

twenty-five meters between each two traps to prevent any overlap of the crawling fauna, the traps were set firmly in the ground until the rim was level with the surface and filled to about half with water and acetic acid and drops of laundry detergent to prevent the climb of insects that fall inside.

The traps were checked weekly in periods of high activity and bimonthly or monthly in periods of low activity, the duration of which is twelve months from May 2017 to April 2018. The traps were collected in vials and test tubes that were labeled with the date and the site of collection. Vandalized traps were noted and then discarded.

The insects were taken into the lab and observed under a binocular magnifier to properly identify the insects.

Statistical Analysis

To qualitatively compare the two sites, we used the calculation of the Jaccard index of similarity:

$$J(A,B) = \frac{|A \cap B|}{|A \cup B|} = \frac{|A \cap B|}{|A| + |B| - |A \cap B|}$$

A and B are the number of species in the first and second site respectively. Jaccard, Paul (February, 1912).

To compare quantitatively, i.e., the abundance of species, we calculated the Shannon diversity index:

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

S is the number of different species at each site.
Pi is the number of individual insects. Shannon, C. E. (1948). And Simpson's diversity index:

$$D = 1 - (\sum n(n-1)/N(N-1))$$

n is the number of individuals of the same species. N is the number of individuals in the total population, Simpson (1949).

To find out how to categorize the sampled insects, a factorial map was drawn using the R software, which is commonly called the factorial correspondence analysis test, which makes it possible to analyze and prioritize the data according to Beh and Lombardo, (2014).

Finally, to make an exploratory analysis of the statistical data of each site and give them a graphical representation, we made boxplots and compared them.

RESULTS

Inventory

The number of species inventoried was 27 divided into 7 carabid subfamilies according to the classification of Ball et al., (1998) as indicated in table 1. The number of individuals captured amounts to 1172 individuals, including 704 counted at the level of the Atlas cedars and 468 for the holm oaks.

We note that the number of individuals is much higher in the site of the Atlas cedars even if some species are missing there. The most represented subfamily in the two sites is the subfamily *Harpalinae* figures (1 and 2) and the most abundant species in the two sites are *Calathus fuscipes* (cedar) and *Licinus punctatulus* (oak).

For all the subfamily of the cedar forest, the number of individuals is significantly higher Figure (1) compared to the oak forest:

Diversity and Similarity

We can appreciate the diversity of the carabid family by the different indices mentioned above, we notice that the

Shannon and Simpson indices as well as the zone of specific richness are a little bit higher in the oak forest which means a greater diversity among the species, as shown in Table 2.

Table 1: List of carabid subfamilies and species present in the two study sites

Subfamily	Species	*Cedrus atlantica*	*Quercus ilex*
Brachininae	*Brachinus sclopeta* Fabricius, 1792	57	30
	Brachinus immaculicornis Dejean, 1825	31	37
	Brachinus crepitans Linné, 1758	8	2
Broscinae	*Broscus politus* Dejean, 1828	53	35
Carabinae	*Macrothorax morbillosus* Fabricius, 1792	62	50
	Campalita maderae Fabricius, 1775	8	3
Trechinae	*Mettalina Ambiguum* Dejean,1831	20	17
Nebrinae	*Nebria andalusia* Rambur, 1837	24	10
Pterostichinae	*Zabrus tenebrioides* Goeze, 1777	7	4
Harpalinae	*Calathus fuscipes* Goeze, 1777	206	109
	Calathus circumseptus Germar, 1824	5	2
	Calathus melanocephalus Linné, 1758	4	0
	Calathus mollis Marshamm, 1802	3	2
	Laemostenus algerinus Gory, 1833	0	2
	Poecilus purpurascens Dejean, 1828	1	0
	Poecilus vicinus Levrat, 1859	0	1
	Angoleus crenatus Dejean, 1828	0	1
	Odontocarus tricuspidatus Fabricius, 1792	1	4
	Acinopus megacephalus Rossi, 1794	25	11
	Licinus punctatulus Fabricius, 1792	139	105
	Pseudophonus rufipes De Geer, 1774	4	3
	Harpalus fuscipalpis Sturm, 1818	10	3
	Harpalus distinguendus Duftschmidt, 1812	0	2
	Harpalus rufitarsis Duftschmidt, 1812	2	2
	Harpalus tenebrosus Dejean, 1829	7	2
	Harpalus lethierryi Reiche, 1859	12	10
	Harpalus attenuatus Stephens, 1828	15	13

Compared to other studies like the one done in Tebessa by Ouchtati et al., (2012) they found strong differences between the habitats studied there.

The Shannon index is slightly higher in the *Quercus ilex* site which means higher entropy and randomness in that site,

Simpson's index is also higher in the same site meaning that the site has the most dominant species. The similarity between the two sites is high as shown in the table 2 which means that the difference in vegetation is a minor factor of differentiation of different ground beetle species.

We can hypothesize that the reason for the slight elevation of the indices in the oak forest even if the number of individuals is high in the cedar forest being the nature of the pH of the soil since the soil of the cedars is always acidic which inhibits the extended presence of certain species of carabids and according to Boivin and Hance (2003), the texture of the soil can affect different groups of ground beetles.

We can hypothesize that the reason for the slight elevation of the indices in the oak forest even if the number of individuals is high in the cedar forest being the nature of the pH of the soil since the soil of the cedars is always acidic which inhibits the extended presence of certain species of carabids and according to Boivin and Hance (2003), the texture of the soil can affect different groups of ground beetles.

The study is limited spatially because of the conditions applied at the beginning of the study consisting of choosing two adjacent sites to minimize the difference in other factors such as altitude, and applying the difference only to the tree species.

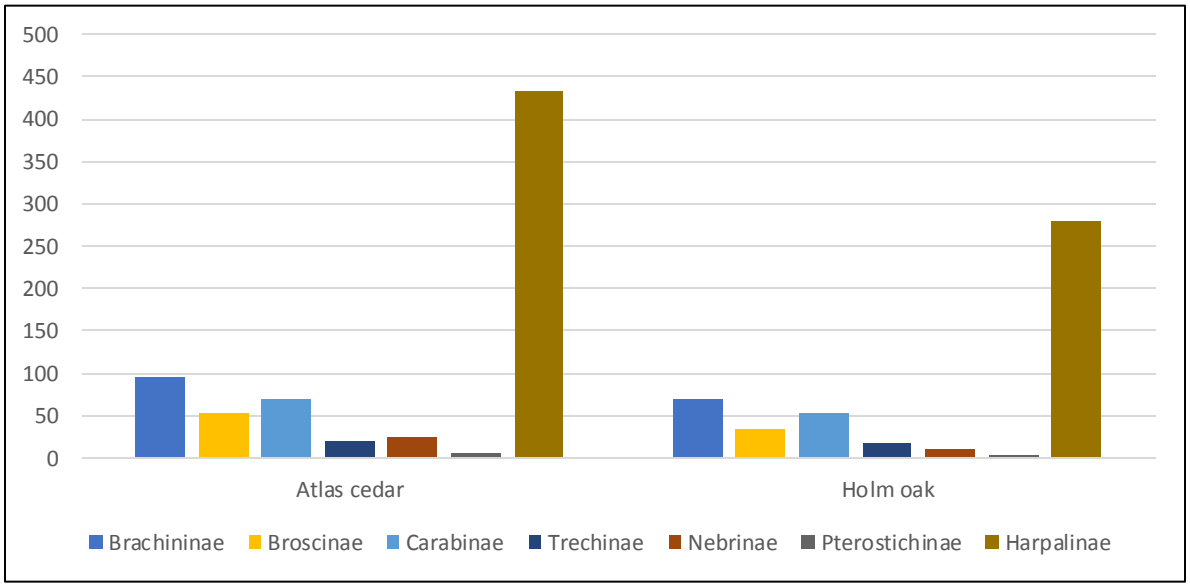

Figure 1: Number of individuals of the different subfamilies identified from the two sites.

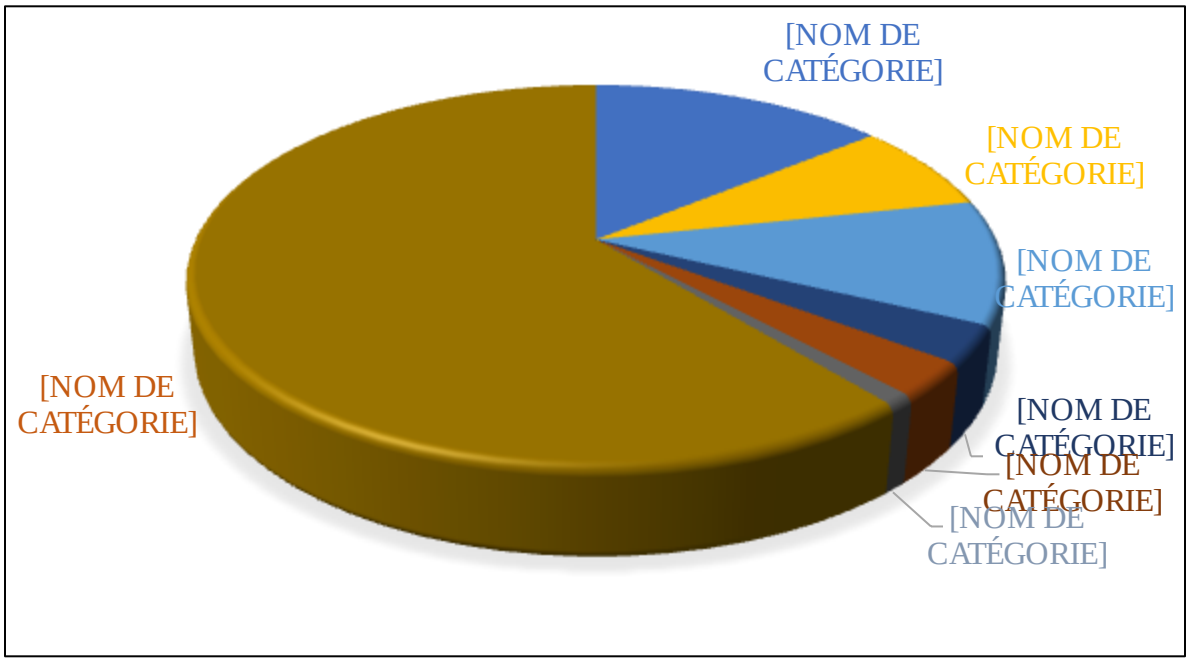

Figure 2: Pie chart showing the proportion of subfamilies at the two sites.

Table 2: Values of species richness and the indices of Shannon, Simpson and Jaccard in the populations of ground beetles in the two sites of study.

	Cedrus atlantica	*Quercus ilex*
Species richness	23	25
Shannon index	2.32224924	2.38051653
Simpson's index	0.84990463	0.865425795
Similarity (Jaccard's index)	0.777777778	

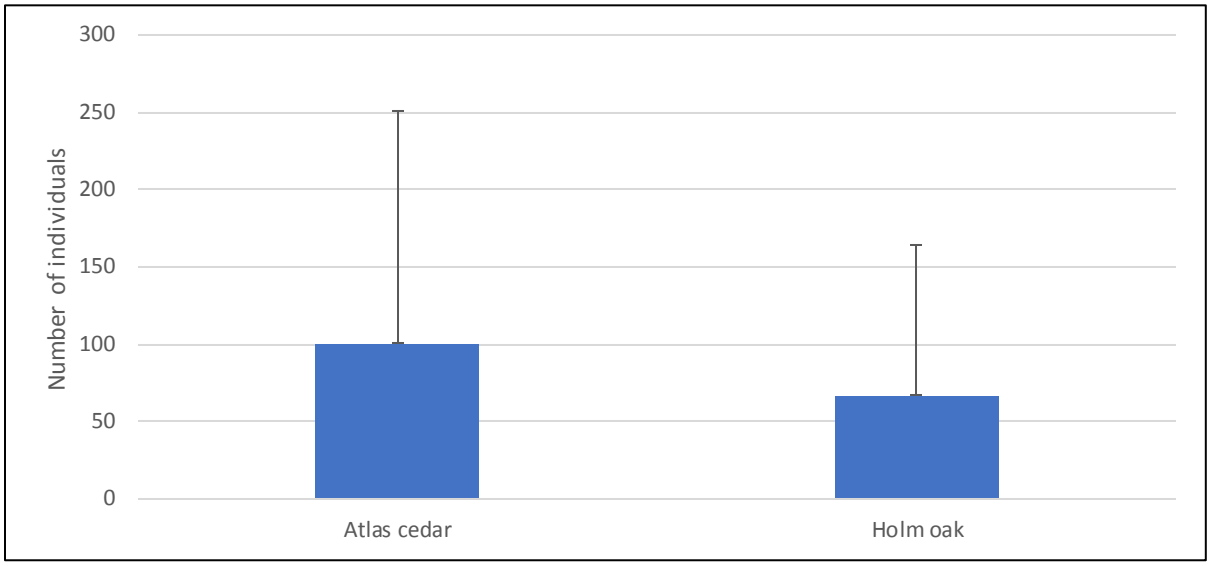

Figure 3: Variation in the number of individuals between the two sites. Bars indicate standard deviation.

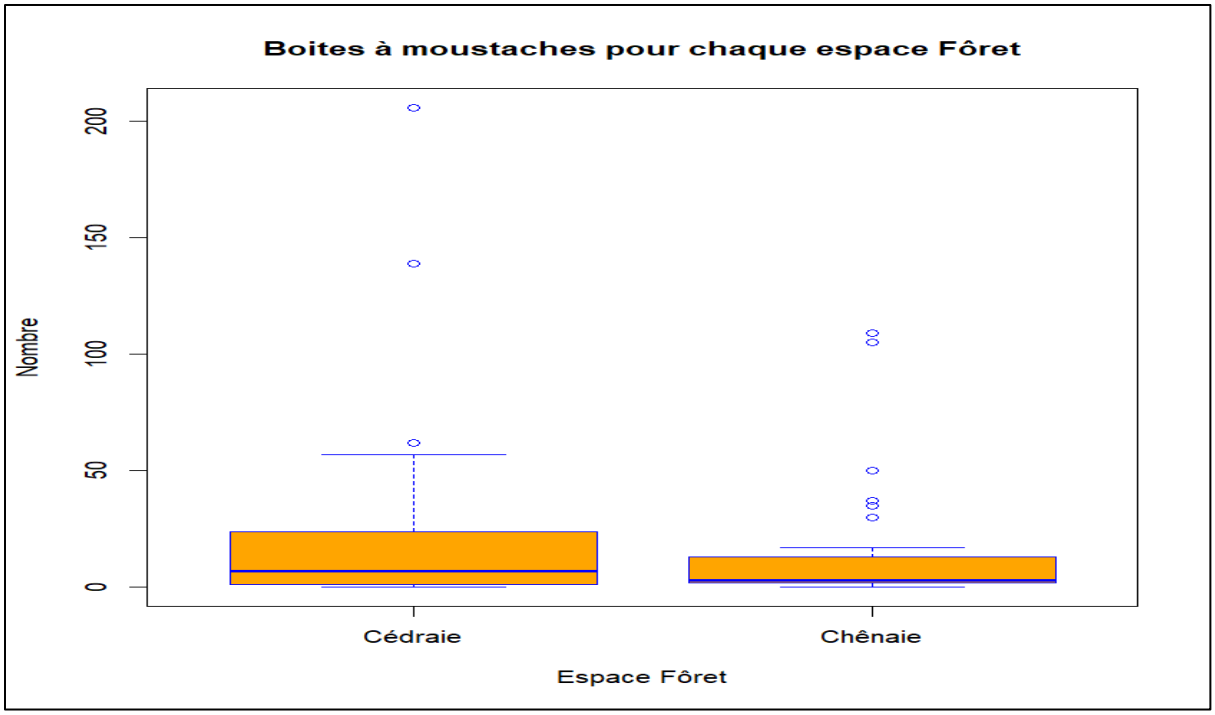

Figure 4: Boxplots representing the analysis values of each site.

Individuals collected in the two sites have displayed light difference between their numbers, although the mean number of individuals in the Atlas cedar site is greater than the holm oak site but the standard deviation differs with the same amount which makes the presence of an overlap between the bars representing it understandable.

By comparing the boxplots of the two sites one can note large differences in the values. The median, the third quartile, the maximum sample and the atypical values (outliers) have much larger values in the cedar forest than in the oak forest, the oak forest has more outliers (perhaps due to the greater disparity in this site), the minimum sample is practically the same between the two sites.

The whole statistical approach is to produce a working link between the subfamilies of ground beetles and the type of vegetation, we can surmise the presence of a weak link that needs to be further studied.

DISCUSSION

The *carabidae* family is well known taxonomically and ecologically, and many of its members are good bio-indicators (Lövei and Sunderland, 1996). The inventory in the two sites has shown a good diversity of carabid beetles which the majority of is endemic to the region, the *Harpalinae* subfamily is the most represented by number of individuals and by number of species (Figure 1 and Figure 2) and a large number of inventory studies in the area have a big number of species while the species themselves contain just an individual or two (Saoueche et al., 2014).

The use of carabid beetles as a taxonomic study group is growing in biodiversity research, and they are also being used as bio-indicators in site assessment studies for nature conservation (Luff et al., 1989, 1992; Luff, 1990; Erwin, 1991; Desender et al., 1991, 1992; Loreau, 1994; Heijerman and Turin, 1995). Carabid beetles have been estimated at 40000 species (Brezina, 2013) and that is an important reason in the recent interest in studying this family.

The diversity indices show that both sites enjoy a mild diversity even though the individual numbers are higher in the Atlas cedar site (Table 2) and that might be because of the nature of the soil surrounding trees but that remains to be proven in a future study. The overlap in the standard deviation bars of the two sites means that the difference in numbers or diversity between them is not significant (Figure 3).

CONCLUSION

The site of the holm oaks has the advantage in terms of the number of carabid species, while the site of the Atlas cedar has the advantage in terms of the number of individuals. The boxplot analysis shows better dispersion in the Atlas cedar site between the different species while the holm oaks site has a number of outliers, meaning non-uniform distribution, natural landscapes need more studies to investigate the natural variation of species and number of individuals across different sites with different factors ranging from altitude, soil type, vegetation type and anthropogenic disturbances.

CONFLICT OF INTEREST

We have no conflicts of interest to disclose. All authors declare that they have no conflicts of interest.

AUTHORS' CONTRIBUTION

Authors agree that they have met the criteria for authorship, agree to the conclusions of the study, and that no individual meeting the criteria for authorship has been omitted.

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