

Biodiversity of the Blattopteran Fauna in the Chelia Cedar Forest (the Aures - Eastern Algeria)

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BIODIVERSITY OF THE BLATTOPTERAN FAUNA IN THE CHELIA CEDAR FOREST (THE AURES - EASTERN ALGERIA)

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ABSTRACT

The cedar forests in Algeria represent a model of forests very rich in entomological fauna and especially dictyopterans, notably blattopterans. In the cedar forest of Chelia in the Aurès Mountains, we chose three different sites according to altitude (2020 m, 1920 m, 1820 m) in order to collect existing cockroaches using the sight-hunting method (twice a month). The inventory allowed us to capture more than 1220 cockroaches and we were able to identify three genus (*Dziriblatia*, *Phyllodromica*, *Loboptera*) and seven species: *Dziriblatia stenoptera*, *Dziriblatia nigrivintris*, *Phyllodromica zebra*, *Phyllodromica trivittata*, *Phyllodromica sp*, *Loboptera angulata*, *Loboptera alluaudi*, of which *Dziriblatia nigrivintris* is the most abundant species with a rate of 52.05 %. The results show that the distribution of these species in the different sites in Chelia cedar is controlled by a several natural factors such as (temperature, altitude ...etc) .

.Key words: Blattoptera, biodiversity, chelia cedar forest, dictyoptera, entomology.

INTRODUCTION

Natural forests are important for the conservation of terrestrial biodiversity (Yekwayo, 2016), which requires a perfect knowledge of the distribution of fauna and flora (Azoui, 2017).

The entomological fauna is an essential element in the dynamics and functioning of forest ecosystems (Daas, 2016). It is an integral part of the natural resources that nature conservationists must take into consideration after the large fauna and flora (Tchibozo, 2004). The ecological role as well as the bio-indicator character of some insect species can indicate the health status of forests and determine some factors related to forest degradation; forest cockroaches are among the bio-indicator insects (Habbachi et al., 2014, Habbachi et al., 2016, Daas, 2016).

Cockroaches are a distinct order of insects called Blattodea (or Blattariae) and are often considered to be one of the oldest groups of living insects, first appearing in the Upper Carbon (Jarzembowski, 1994). Cockroaches are found in many tropical, subtropical and temperate habitats around the world.

Many inventories have been carried out on the blattopteran fauna in Algeria from east to west (Habbachi et al., 2016; Azoui et al., 2016, Masna 2016); and despite this, Algeria remains a vast country containing many rich and diverse forests such as the forests of the Aures, notably the pine and cedar forests. In this region (Aurès) only one inventory has been carried out on this type of insect, that of Azoui (2017) in the forests of the Belzema National Park (Batna, Algeria). We are interested in completing this inventory by collecting and identifying the different species of cockroaches that colonise the

Chelia forest (North-East Algeria) and to get an idea of the factors related to their distribution.

MATERIALS AND METHODS

Presentation of the Biological Model

Cockroaches are abundant in forests, of very varied forms and widely wide spread throughout the world (Grandcolas, 1998) and are considered bio-indicator species of the health of the forest ecosystem (Chopard, 1943) where they play important ecological roles as detritivores, folivores, xylophagous and even pollinators (Schapheer, 2017). The lack of information on these species in the forests of the Aurès, in particular the Chelia forest, led us to establish an inventory of the most common species that can be found in this forest.

Presentation of the Study Area

The study was undertaken on forest cockroaches in the Chelia cedar forest Located in the south-east of the city of Batna, at (lat: 35° 23'-35° 17' N; long: 06°33'- 6° 45'E) (Northeast Aurès Mountains, Algeria) (Figure1), north of the massif of Beni Imloul. It is limited in the

north by forest plots and the boundary farm of Oued Tahla, in the south by Oued El Asker and the road linking Bouhmama to Medina, on the west by high lawns and to the east by the Cantina series (Belloula, 2018). this cedar grove covers nearly 7,000 ha, it is here that the highest peak of Aurès culminates at 2328 m altitude (Abdessemed,1981) representing not only the highest peak of this mountain, but also of all northern Algeria (Bouam, 2017) .The climate is semi-arid Mediterranean, characterised by a hot, dry summer and a cold, wet winter. The coldest month is January with a mean minimum temperature of -1°C, while July is the hottest month with a mean maximum temperature of +35°C (Kherchouche, 2019).

The annual rainfall in this massif varies between 700 and 1000 mm depending on altitude and exposure; this is the domain of the cold subhumid (mainly) and humid bioclimatic stages .

Cockroaches were collected from three selected sites with similar vegetation cover (cedar) and at different altitudes to determine the altitudinal effect on cockroach distribution. The selected sites are divided according to their location in (Table 1).

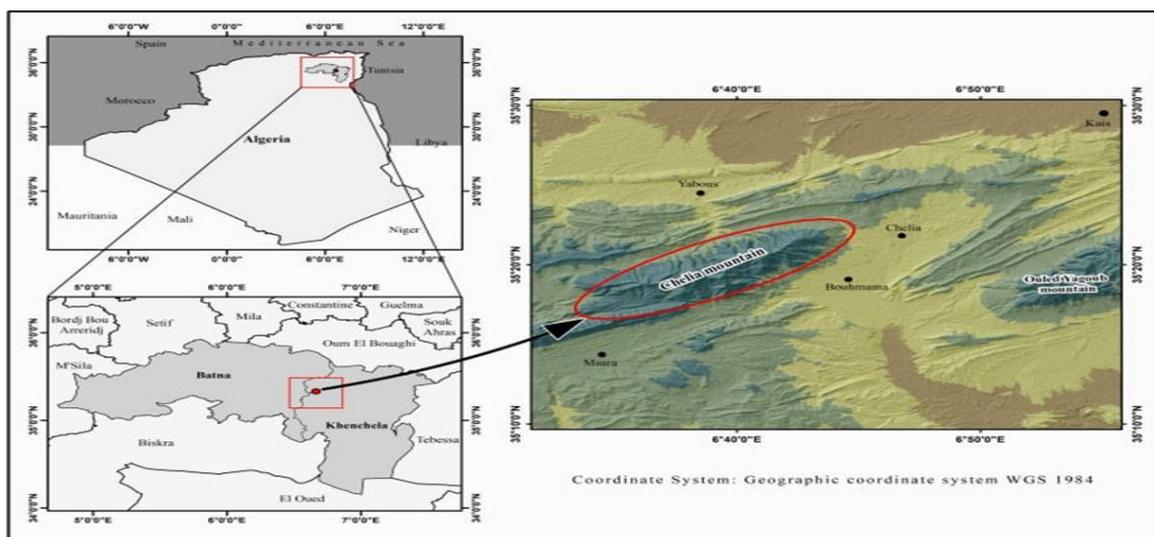


Figure 1: Geographical location of the study sites

Table 1: Geographical characteristics of the study sites

Sites	Altitude	Geographic coordinates	Settlement
Site1	2020m	35°18'54.1''N 6°37'40.5''E	<i>Cedrus atlantica</i>
Site2	1920m	35°18'36.3''N 6°37'37'.2''E	
Site3	1820m	35°18'15.3''N 6°37'28.2'' E	

Harvesting and Identification

The collection of cockroaches was done by sight hunting in the litter, under stones and trunks. The captures were conducted during the period from August 2017 to August 2018, in the morning. In three sites in the Chelia cedar forest, the cockroaches collected over time were kept separately in plastic boxes containing ethyl alcohol and labeled for identification.

The identification of the different species of cockroaches collected is based on the criteria of Chopard (1951).

Data Analysis

Calculations of parameters of ecological indices of composition (centesimal frequency (relative abundance) f_i %, frequency of occurrence or centesimal) C %), and of structure (Shannon index H' (Magurran, 1988) and equitability E'). These are used to analyse

and interpret the importance of the species counted and to justify their distribution in the Chelia forest during the working period.

RESULTS

Inventory of Species Collected

A total of 1220 individuals were counted in the inventory, of which 238 individuals were found in site1 (2020 m), 549 in site2 (1920 m) and 433 in site3 (1820 m) (table2). The individuals collected belonged mainly to the three different genera: *Dziriblatla*, *Phyllodromica*, *Loboptera* and seven species: *Dziriblatla stenoptera*, *Dziriblatla nigriventris*, *Phyllodromica zebra*, *Phyllodromica trivittata*, *Phyllodromica sp*, *Loboptera angulata*, *Loboptera alliaudi*) or the species *Dziriblatla nigriventris* is the most abundant in terms of individuals.

Table 2: Systematic list of inventoried cockroach species in the study sites of the Chelia cedar forest, (S=Site).

Sub-family	order	Genus	specie	S1 (2020m)	S2 (1920m)	S3 (1820m)
Ectobiinae	Dictyoptera	<i>Dziriblatla</i>	<i>D.nigriventris</i>	149	275	211
			<i>D.stenoptera</i>	46	115	129
		<i>phyllodromica</i>	<i>P,zebra</i>	17	71	50
			<i>P,trivittata</i>	2	31	8
			<i>P,sp</i>	19	10	19
		<i>Lobopera</i>	<i>L.angulata</i>	4	46	16
			<i>L.alliaudi</i>	1	1	-

Monthly Population Dynamics

The increase in the number of cockroaches in the three sites at the level of the forest of Chelia differs according to the species of which (*D. nigriventris*, *D. stenoptera*) to begin their increase starting from the autumn precisely the month of September and October and that what one noticed in the three sites of study this increase reaches its peak in spring, for the species *P. zebra* and *L. angulata* their generation starts to appear at the end of autumn and the beginning of winter notably at the end of November and the beginning of December, the peak of their generation starts in March and ends in June for *P. zebra* and the month of August for *L. angulata* where most of the species traded in these months will be carried from oothecae and start to release them so that a new generation starts to appear, for *P. trivittata* its monthly dynamics indicated a single generation which starts at the end of spring and ends at the beginning of autumn (approximately 5 months of activity) and it is what it appears well at the level of site 2 where the number of traded is considerable, on what concerns *P. sp* has an irregular monthly pattern that starts in December and lasts until the beginning of the summer, as is evident in site 1, while the pattern of *L. alluaudi* is unknown due to the low numbers of specimens in the adult stage (Figure 2).

Phylogenetic Distribution of Cockroaches

According to their phylogenetic distribution, the collected species are divided into three developmental stages (adult, old larva and young larva) (Figure 3). Adults are most abundant in S2 and S3 with a rate of (49.72%, 40.18%) successively, while young larvae represent the highest rate in S1 with 40.33%. Old larvae represented the lowest percentage at site 2 with 15.66%, and for S1 and S3 were successively 26.47% and 24.24%. The

distribution of cockroaches according to the phylogenetic stage differs according to the season and the number of generations of each species.

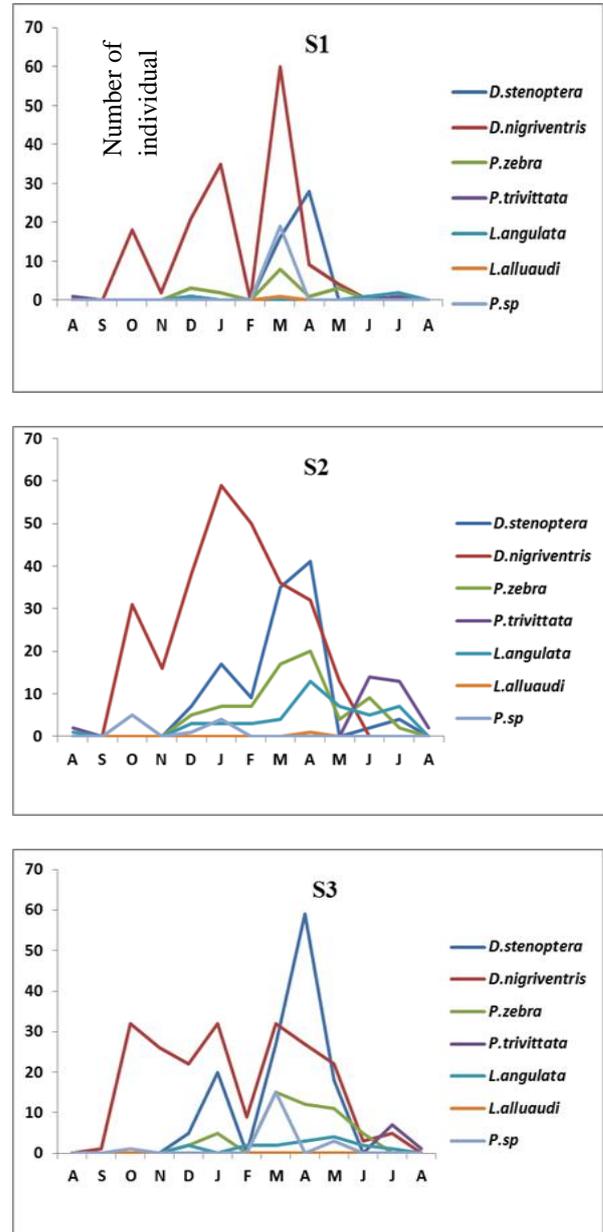


Figure 2: Monthly population dynamics of forest cockroach species sampled between August 2017 and August 2018 in the three sites at the Chelia cedar forest (north-east Algeria), S1 (2020m), S2 (1920m), S3 (1820m).

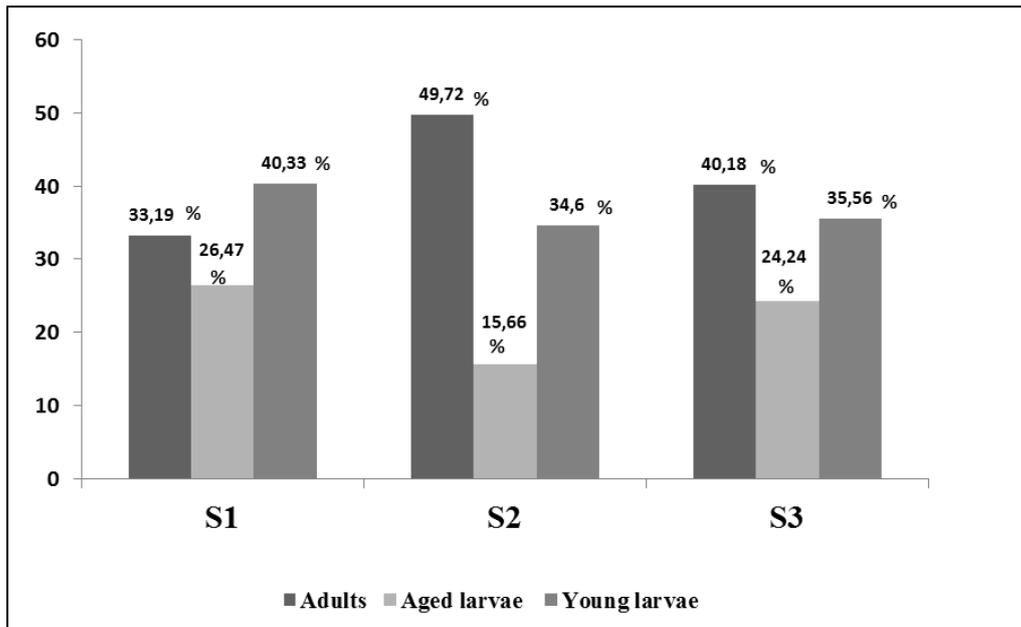


Figure 3: Phylogenetic distribution of cockroaches in the cedar forest of Chelia (Eastern Algeria), S1 (2020m).S2 (1920m).S3 (1820m).

Ecological Composition Index

The results of the relative abundance % of blattopteran species encountered in the three sites are represented in figure 4. The genus *D. ziriblatta* is the most abundant in the three sites of which *D.nigriventris* species representing the first class in S1, S2 and S3 with a rate of 62.60%, 50.09% and 48.73% followed by *D. stenopera* with a rate of 19.32% (S1) 20.94% (S2), 29.79% (S3). For the species of *P. zebra* was less abundant than previous species with a rate of 7.14 in S1, 12.93 in S2 and 11, 54 in S3 while the other species of *L.angulata* , *P. sp* and *P. trivitatta* represent low percentages in the three study plots, for *L. alluaudi* was a rare species represented by only a few specimens in S1 and S2 . According to their frequency of occurrence C% the species *D. nigriventris*, are classified as regular species ($50\% \leq F < 75\%$) in S2, S3 and incidental in S1. While *P. zebra* and *L. angulata* are classified as regular species ($50\% \leq F < 75\%$) in S2 and classified as incidental species in S1 and

S3. For *P. trivitatta*, *P. sp* and *D. stenoptera* species were reported as incidental species ($F < 25\%$), in all three study sites. With regard to *L. alluaudi* it exists only in S1, S2 and classified as a rare species (Table 3).

The Biodiversity Index

Sites 1 and 2 represent the most diverse sites in terms of species with a total richness of seven species in each site, followed by S3 which has a total richness of six species. The total diversity of the harvested stand is 1.13 in S3 and 1.39 in S2 and 1.29 in S1, these high diversity values allow the richness and complexity of the stand studied in the Chelia cedar forest to evolve. Equitability is almost equal in sites 2 and 1, it was respectively 0.71, 0.72 indicating an equilibrium in the distribution of abundance of the species recorded in these two sites, whereas in site 1 it is 0.58, far from 1, indicating an imbalance in the distribution of abundance of the species recorded (Table 4).

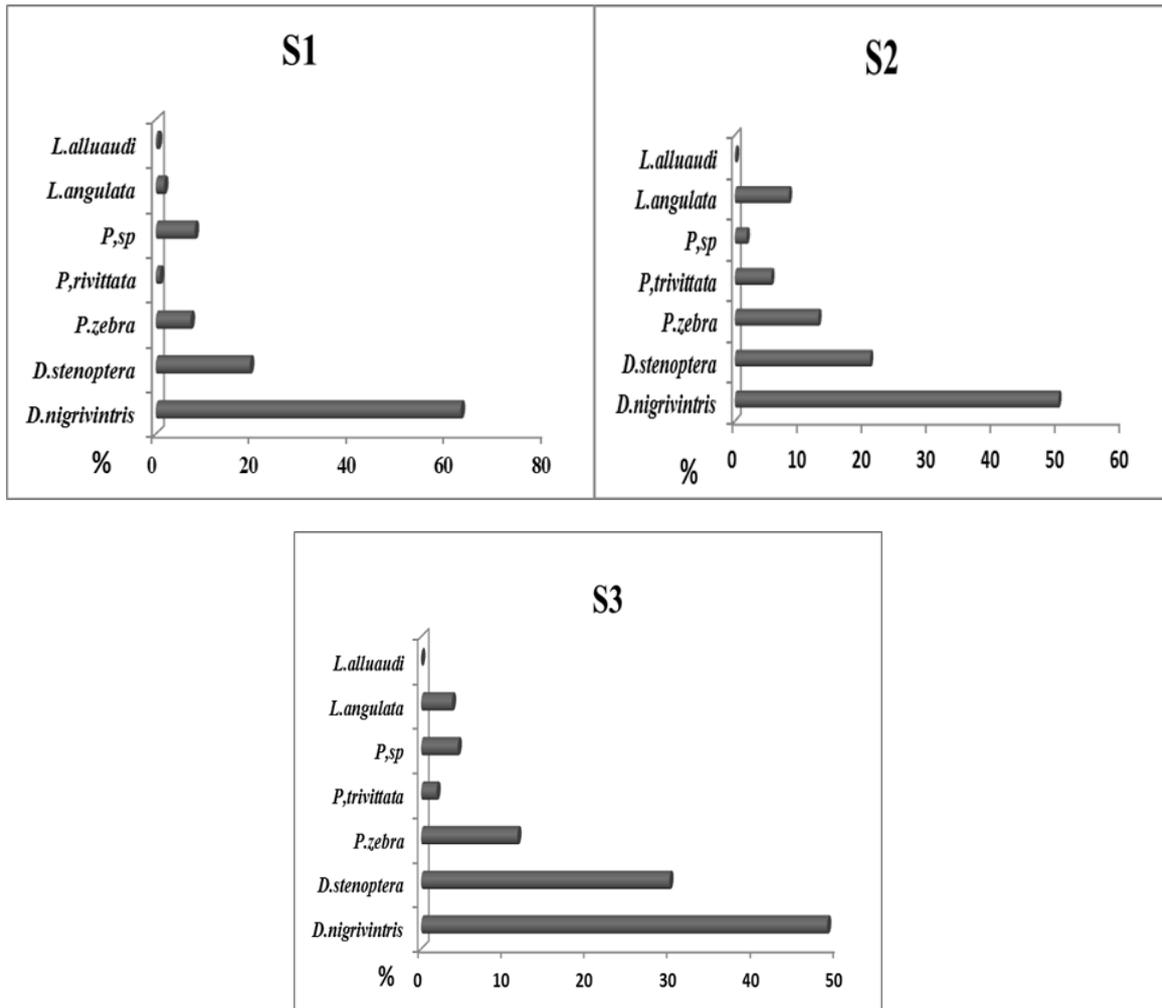


Figure 4. Relative importance of species collected in the study sites, S1 (2020m), S2 (1920m), and S3 (1820m) in the Chelia cedar forest

Table 3. Occurrence (C %), and density (D %) of blattopteran species collected in each study site in the Chelia cedar forest

Cockroach species	study sites					
	1820m		1920m		2020m	
	C%	D%	C%	D%	C%	D%
<i>D.nigrivintris</i>	73,07	8,11	61,53	10,57	42,3	5,73
<i>D.stenoptera</i>	38,46	4,96	46,15	4,42	23,07	1,76
<i>P.zebra</i>	38,46	1,92	53,84	2,73	23,07	0,65
<i>P.trivittata</i>	11,53	0,3	23,07	1,19	3,84	0,076
<i>Phyllodromica .sp</i>	15,38	0,73	19,23	0,38	3,84	0,73
<i>L.angulata</i>	34,61	0,61	61,53	1,76	11,53	0,15
<i>L.alluaudi</i>	/	/	3,84	0,038	3,84	0,038

Table 4: Structural parameters of cockroach species populations in the three sites of the Chelia cedar forest.

	Site 1 (2020m)	Site2 (1920m)	Site3 (1920m)
Shannon index	H'=1.29	H'=1.39	H'=1.13
faimess	E= 0.72	E=0.71	E=0.58

Phenogram of Collected Cockroaches

The determination of the phenogram of blattopteran species was established according to monthly observations during one year (August 2017-August 2018). The species *Dziriblatta nigriventris* is present in the litter almost throughout the year, while the species *Dziriblatta stenoptera*, *phyllodromica zebra* and *Loboptera angulata* present a similar activity they

appear in the forest at the beginning of winter until the end of summer, while *phyllodromica trivittata* appears only in the summer season, where the temperature is high (Table 5). As far as *P.sp* is concerned its activity is irregular during winter, autumn and spring and it disappears during summer. *Loboptera alluaudi* is concerned, it remains a rare species that is seen two or three times.

Table 5: Phenogram of species collected in the Chelia cedar forest during the study period.

	Aug-2017	Sep-2017	Oct-2017	Nov-2017	Dec-2017	Jan-2018	Feb-2018	Mar-2018	Apr-2018	May-2018	Jun-2018	Jul-2018	Aug-2018
<i>D.nigriventris</i>													
<i>D.stenoptera</i>													
<i>P,zebra</i>													
<i>P,trivittata</i>													
<i>P,sp</i>													
<i>L.angulata</i>													
<i>L.alliaudi</i>													

DISCUSSION

Due to the surprisingly high diversity of cockroaches, most of them are useful insects for their ecosystems. Some cockroaches act as scavengers to consume dead plants, dead leaves and other organic matter in forests and other places (Liang, 2019), our study sheds light on this type of insect in the Chelia forest, This forest has a semi-arid Mediterranean climate. (Kherchouche, 2019) characterised by its dominant plant cover of the atlas cedar (*Cedrus atlantica*), its elevation which exceeds 2000 m and which represents a model of virgin forests for the study of entomofauna.

The inventory carried out in the Chelia forest on the blattopteran fauna revealed a relative diversity dominated by the genus *Phyllodromica* (Chopard, 1943) with three different species *Phyllodromica Zebra*, *Phyllodromica trivittata* and *Phyllodromica sp*, followed by the genus *Dziriblatta* (Chopard, 1937) which was the most dominant in the Chelia cedar forest in terms of individuals and the genus

loboptera (Brunner, 1865) which present a similar diversity with two species each (*Dziriblatta nigriventris*, *Dziriblatta stenoptera*) and (*loboptera angulata*, *loboptera alluaudi*), two new species *Phyllodromica. sp*, *loboptera alluaudi* are identified to be added to the total inventory of forest cockroaches in Algeria, with regard to *Phyllodromica Zebra*, *Phyllodromica trivittata*, *loboptera angulata*, *Dziriblatta stenoptera* and *Dziriblatta nigriventris* are already reported from Algerian forests, in particular the Djelfa forest (Masna et al., 2014), and the Batna forest (Azoui, 2017) where the climate is semi-arid.

The composition of the Blattoptera fauna can vary from one region of the globe to another and habitat suitability depends on many biotic and abiotic factors (Rust et al., 1995) and the most important factors involved in the speciation of the ecological niches of these insects are climatic parameters (Kambhampati and Peterson, 2007) such as temperature or temperature range (Wagner et al., 1984). Among the limiting factors of

cockroach distribution are also the characteristics of the vegetation and the characteristics of its litter (Antunes et al., 2008; Schal et al., 2008). In our study we chose a forest with a homogeneous vegetation cover to eliminate the effect of the latter on the distribution of cockroaches and we focused much more on the altitudinal effect. The diversity and abundance distribution of species surveyed in Chelia forest varied in the three sites studied of which (S1, S2) were the most diverse in terms of species while the sites (S2, S3) were the most abundant in terms of individuals. These results show that the altitude factor together with other climatic factors such as high and low temperatures play a fundamental role on the distribution of cockroaches.

CONCLUSION

The inventory carried out in the three sites in the cedar grove of Chelia (North-East Algeria) identified seven species (*Dziriblatia stenoptera*, *Dziriblatia nigriventris*, *Phyllodromica zebra*, *Phyllodromica trivittata*, *Phyllodromica sp*, *Loboptera angulata*, *Loboptera alluaudi*) their distribution in the cedar forest varies according to altitude, season and the species itself.

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