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ABUNDANCE AND DISTRIBUTION OF THE FOREST COCKROACHES IN DIFFERENT ALGERIAN ECOSYSTEMS

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ABSTRACT

Forests have many insect species that are unique to biodiversity and play a crucial role in the functioning of ecosystems. Forest cockroaches are the best example of forest litter insects, which also help decompose fallen leaves. The composition of the Blattoptera fauna can vary from one region to another, depending on the habitat and numerous biotic and abiotic factors. In order to study the diversity, abundance, and distribution of forest cockroaches in different Algeria ecosystems, we have selected four sites from three Wilayas: Senalba (Djelfa), Ain achir (Annaba), Seraidi (Annaba), and Lehnaya (El-taref). These sites are classified into two distinct forest groups (*Pinus halepensis* and *Quercus canariensis*). In all areas, the samples were collected each month manually, starting from April 2019 until March 2020. We have collected 1231 individuals of cockroaches and describe eight species from all locations: *Loboptera ovolobata* (Bohn, 1991), *Loboptera decipiens* (Germar, 1817), *Ectobius kervillei* (Bolivar, 1907), *Dziriblatia nigriventris* (Chopard, 1936), *Dziriblatia stenoptera* (Chopard, 1937), *Phyllodromica zebra* (Rhen, 1903), *Dziriblatia sp.* (Chopard, 1936) and some *Ectobius* (Stephens, 1835) specimens have not yet been identified. With 51% *L. decipiens* was the most abundant species, followed by *L. ovolobata* with 27%. Despite that, the number of larvae was substantially higher than the number of adults in all forests examined. However, the abundance and biodiversity of cockroaches in the Djelfa forest were greater than those of the other woods. This study made it possible to characterize the diversity and dynamics of cockroach species populations in different Algerian ecosystems according to diverse Mediterranean forests.

Keywords: Biodiversity, abundance, distribution, forest cockroaches, Algerian forests.

INTRODUCTION

Biodiversity is proposed to be necessary for the rate of ecosystem functions (Gamfeldt, 2008). A critical feature of biodiversity that regulates ecological processes and properties is the abundance of organisms, functional classes, and genotypes (Chapin et al., 1997).

Insects are arguably the most diverse animal taxon, with an estimated 5-10 million species (Odegaard, 2000; Niven et al., 2008). Forests have many insect species that are unique to biodiversity and play a crucial role in the functioning of ecosystems (Sekour et al., 2010). Insects

living in the forest have ecological need, and a wide variety of organisms play a vital role in organic matter decomposition. (leaves, twigs, roots, etc.). They recycle dead organic matter and recreate the cycle of the material necessary for the forest's existence (Habbachi, 2013).

Among these insects, cockroaches, which constitute the oldest group of insects, have existed since the Carboniferous period. Cockroaches were too abundant during the Carboniferous Period (Koehler and Patterson, 1987) and considered the most primitive of the Pterygotes. This fauna varies in the hot and humid regions of Africa and tropical America (Guthrie and Tindall, 1968; Grandcolas, 1998). Forest cockroaches are the best example of forest litter insects, which also help decompose fallen leaves. The composition of the Blattoptera fauna can vary from one region to another, depending on the habitat and numerous biotic and abiotic factors (Rust et al., 1995). Variability of habitats and adaptation to climatic factors cause considerable variation (Cornwell, 1968).

The African species inventory is far from complete. Few researches have been conducted on the fauna of Orthopteroids, especially Dictyoptera, in North Africa. Chopard (1929; 1943) describes and identifies the fauna of Orthopteroids, including cockroaches. In Algeria, little work has been done on this subject. In order to compile a list of woodland cockroaches, we cite the work of Cherairia (2004), Habbachi (2013) in the northeastern region of Algeria, Masna (2016) in the semi-arid regions of Aflou (Laghout) and Djelfa, and that of Azoui (2017) in the region of Batna. Due to a lack of knowledge on cockroach populations in Algerian forest habitats, we decided to perform this survey to estimate species occurrence and biodiversity. Therefore, the aim of this research is to establish the composition

and diversity of forest cockroach species in various locations across Algeria.

MATERIAL AND METHODS

Study Area

To study cockroach's biological diversity in different ecosystems in Algeria, we have chosen four sites distributed over three states, each containing a particular type of trees and plant varieties (Figure 1).

(S1): Senalba forest, 34°39'44" N; 3°09'38" E, adjacent in the wilaya of Djelfa, situated at an altitude of 1140 meters, is a picturesque natural site attracts many eyes. This forest occupies 19,800 hectares and comprises 95% of Aleppo's pine trees and other plant varieties and characterized with a semi-arid climate.

(S2): Seraidi forest, 36°54'29" N; 7°41'11" E, located in the city of Saraidi (Annaba), on Mount Edog (850 meters above sea level) in a forested area surrounded by an intense mountain range that covers the entire eastern side of the country, where oak, oak, and Aleppo pine trees abound and it belongs to the humid climate stage.

(S3): Ain Achir forest, 36°57'21" N; 7°46'31" E, it is a forest near the beach of Ain Achir, at an altitude of 50 meters from the sea level, and it belongs to the wilaya of Annaba. This forest is covered with clusters of oak and oak trees and it's characterized by a humid climate.

(S4): Lehnaya forest, 36°51'26" N; 8°12'01" E, a forest located in the municipality of Berrihane (El-Tarf wilaya), which is situated at an altitude of 54 meters from the sea level and characterized by the diversity of the environment and forest and animal components density and beautiful stretches of forests made of cork, pine and oak trees. this forest is part of a humid climate.

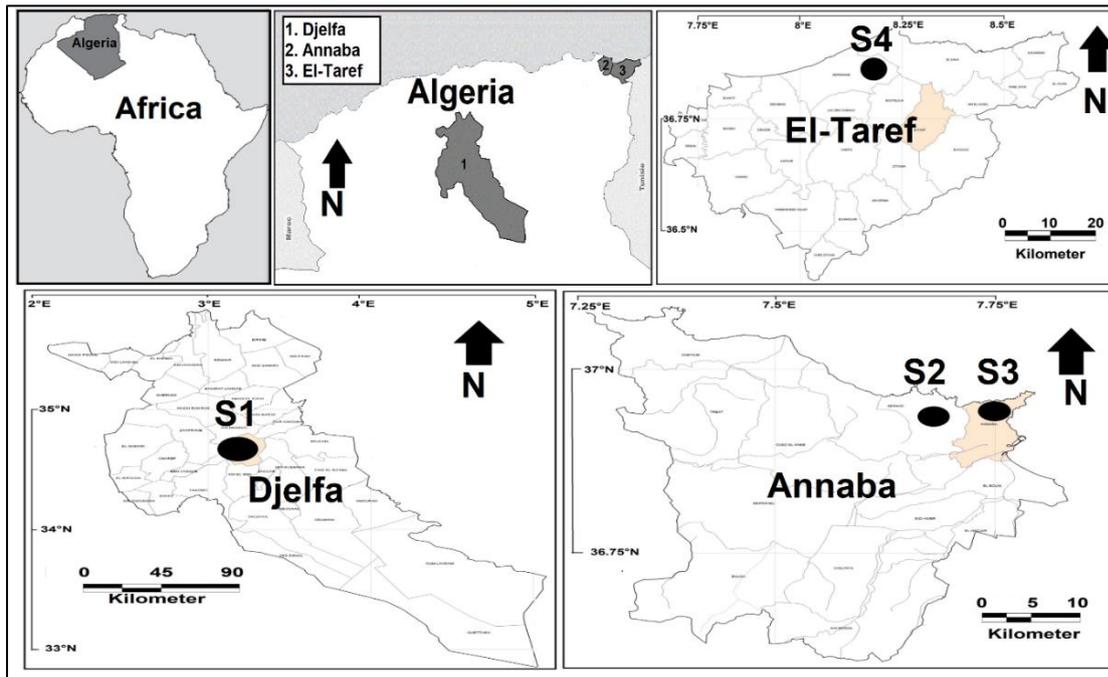


Figure 1: Location of the four forest sites studied.

(S1: Senalba, S2: Seraidi, S3: Ain Achir, S4: Lehnaya).

Cockroaches Sampling

The cockroaches were hand-gathered inside the litter and searched under the stones and on the branches. Captures were made in four plots of 1 m² each, for 2 hours in the morning. Monthly captures were made from April 2019 to March 2020.

The specimens were stored in alcohol (70%) and later returned for identification to the laboratory. Every sample consisted of oothecae, young larvae (YL) containing the first two larvae, aged larvae (AL) represented by the rest of larvae, and the adults (AD). Chopard (1951) guidelines were used for the identification of various cockroach species captured.

Data Analyses

To understand how cockroach's biodiversity is spread throughout the different woods, with

descriptive variables used for data interpretation being the structural and operational indexes of stands. Relative frequency (Dajoz, 1971), frequency of occurrence (Dajoz, 1982) and density (Shannon, 1963), and nonparametric indices of biodiversity description, species richness (Ramade, 1984), Shannon index (Daget, 1976), and evenness (Ramade, 1984).

RESULTS

The catches performed over 12 months from April 2019 to March 2020 resulted in a collection of 1231 individuals, including 140 adults, 692 young larvae, and 399 older larvae, as well as 27 oothecae (Table 2). The specimens gathered all belongs to the subfamily Ectobiinae (Order: Dictyoptera, Suborder: Blattodea, Family: Blattellidae), with four genus (*L. Ectobius*, *Dziriblatta*, and *Phyllodromica*) and eight species: *L. decipiens* (Germar, 1817), *L. ovolobata* (Bohn, 1991), *E. kervillei* (Bolivar, 1907),

Ectobius sp (Stephens, 1835), *D. stenoptera* (Chopard, 1937), *D. nigriventris* (Chopard, 1936), *Dziriblatta sp.* (Chopard, 1936) and *P. zebra* (Rhen, 1903). Generally, catches were more abundant in the Senalba forest, with a total

of 431 individuals, followed by the forest of Ain Achir (359 individuals). Then the forest of Seraidi (246 individuals), and finally the forest of Lahnaya with 195 individuals.

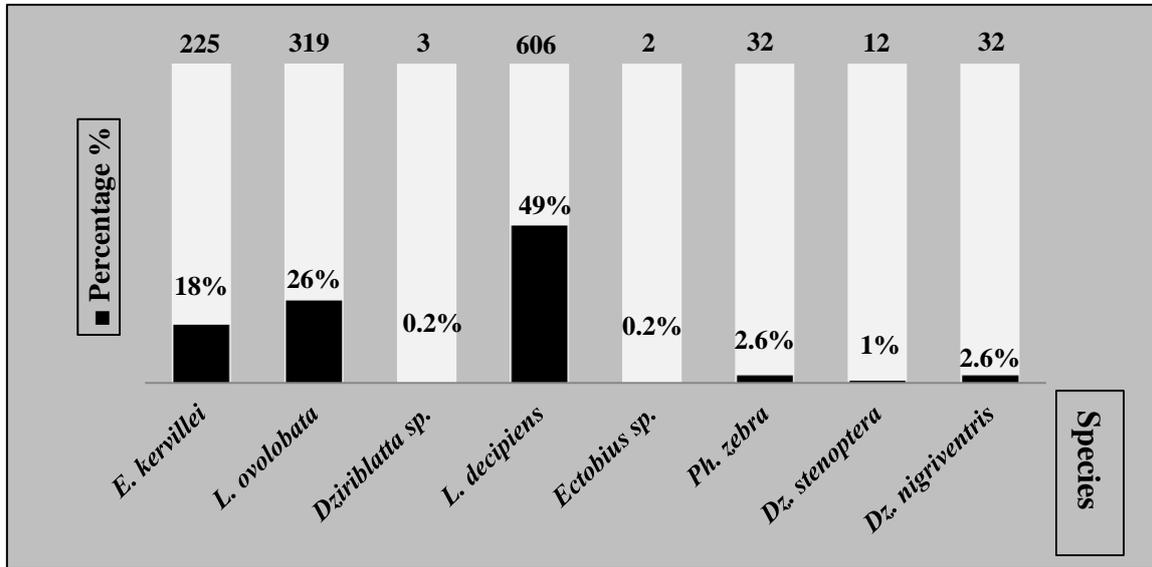


Figure 2: Percentages and the total number of species captured in the different forests.

The abundance of species in all forests was for *L. decipiens*, followed by *E. kervillei*. Except for the Senalba forest, *L. ovolobata* was the most abundant species, followed by *L. decipiens*, then *Ph. Zebra*. However, the abundance of all the studied areas shows that *L. decipiens* was the most abundant species with 49 % of the populating, followed by *L. ovolobata* (26 %) than *E. kervillei* with an abundance of 18 % (Figure 2).

The phenogram of the species inventoried in the Senalba forest, revealed that most of the species (*Dz. stenoptera*, *D. nigriventris* and *Ph. zebra*) have an annual activity and the majority disappear from July-December. Only *L. ovolobata* is present in the forest throughout the year. The phenogram also shows that *Ectobius sp.* only appeared during the month of February. For the East forests, Lehnaya shows that *L. decipiens* and *E. kervillei* were present most of the months while

Dziriblatta sp. Appeared only during February and March. For the forest of Seraidi, both species were active most of the year. Simultaneously, the species of Ain Achir forest were involved throughout the year (Table 1).

Since March, the increase of cockroaches among all species in the forests of Senalba began, this forest revealed high individuals' density during April of May compared to the other months. In the summer (June–August) and early autumn (September), there was a marked drop in the abundance, from which there was a second rises in the number of individuals. However, it is not the same case as the other forest species, which increased from April and reached its climax during May and June. And decrease starting from July to grow for the second time from September (Figure 3,4, 5, 6).

Table 1: Phenogram of cockroaches collected in the Algerian forests during the study period.

Forests		Species	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
Semi-arid region	S (1)	<i>L. decipiens</i>	+	+	+		+					+	+	+	
		<i>L. ovolobata</i>	+	+	+	+	+	+	+	+	+	+	+	+	
		<i>Dz. Stenoptera</i>	+	+											
		<i>Dz. nigriventris</i>	+	+											+
		<i>Ph. zebra</i>	+	+											+
		<i>Ectobius sp.</i>												+	
Humid region	S (2)	<i>L. decipiens</i>	+	+	+	+	+	+	+	+	+	+	+		
		<i>E. kervillei</i>		+	+	+	+	+	+	+	+				
	S (3)	<i>L. decipiens</i>	+	+	+	+	+	+	+	+	+	+	+	+	
		<i>E. kervillei</i>	+	+	+	+	+	+	+	+	+	+	+	+	
	S (4)	<i>L. decipiens</i>	+	+	+	+	+	+	+	+	+	+	+		
		<i>E. kervillei</i>	+	+		+	+			+	+	+	+		
		<i>Dziriblatia sp.</i>											+	+	

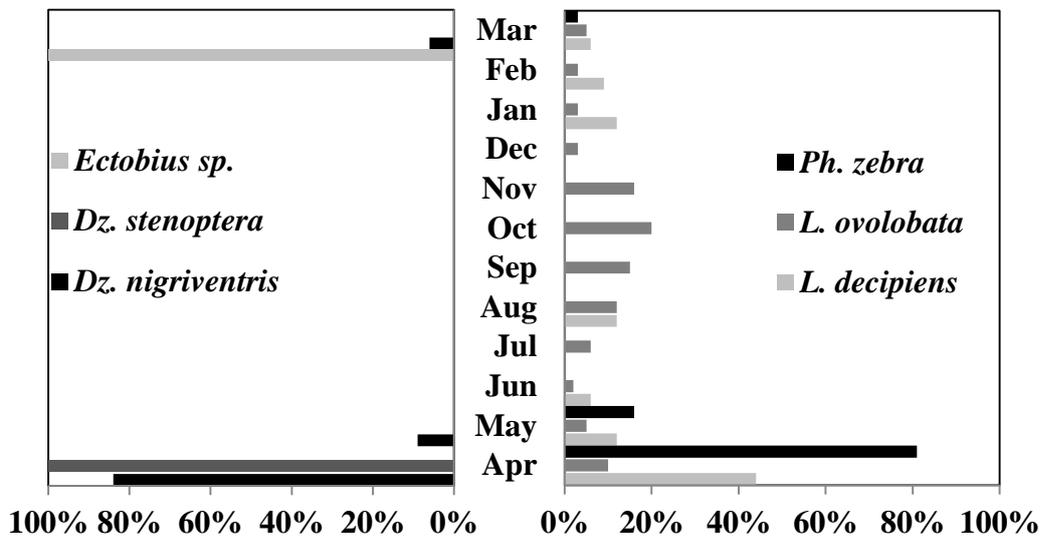


Figure 3: Monthly population dynamics of cockroach species sampled in the Senalba forest between April 2019 and March 2020.

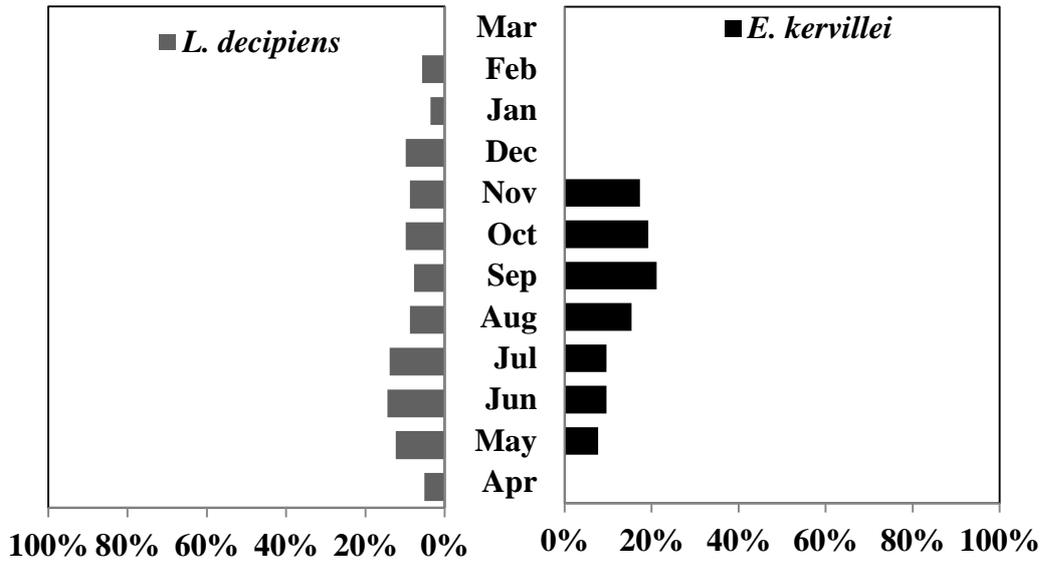


Figure 4: Monthly population dynamics of cockroach species sampled in the Seraidi forest between April 2019 and March 2020.

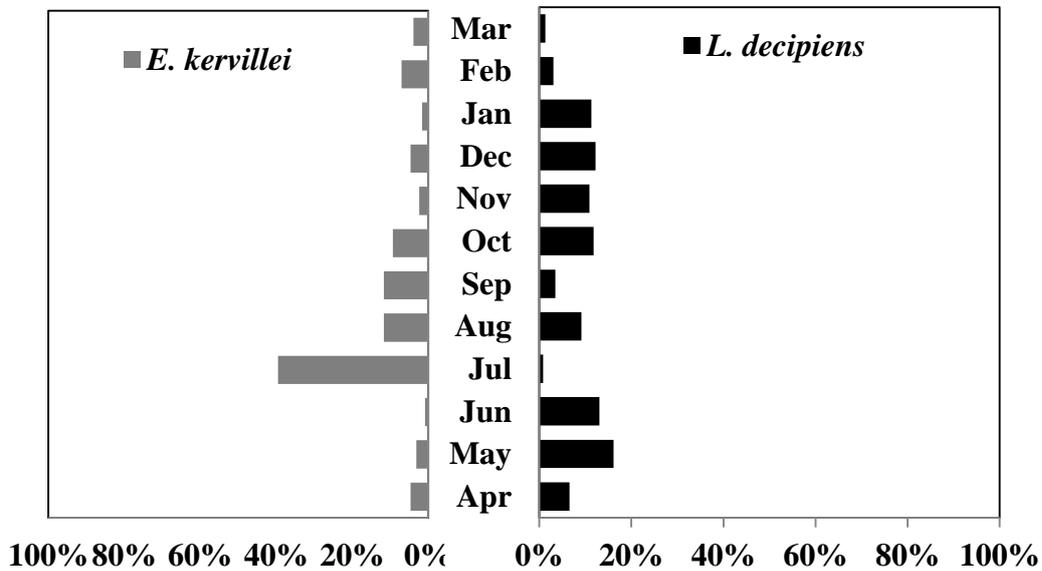


Figure 5: Monthly population dynamics of cockroach species sampled in the Ain Achir Forest between April 2019 and March 2020.

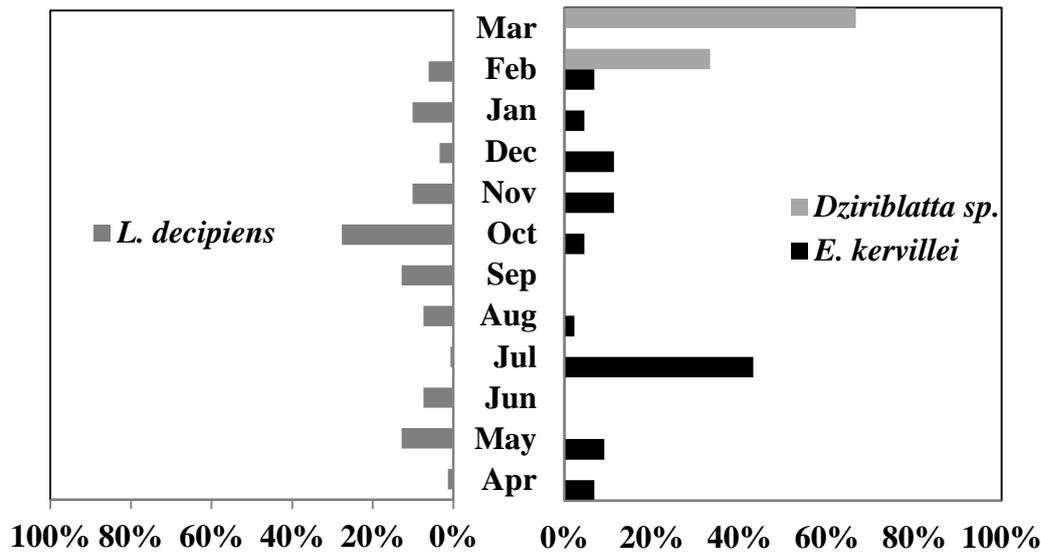


Figure 6: Monthly population dynamics of cockroach species sampled in the Lehnaya forest between April 2019 and March 2020.

Table 2: Phenological stages distribution of the cockroach's species individuals captured in the different forests of Algeria.

Sites	Cockroach species	Phenological stage				Overall
		Ootheca	YL	AL	AD	
Semi-arid region Senalba	<i>L. decipiens</i>	1	1	27	6	35
	<i>L. ovobata</i>	7	161	132	26	326
	<i>Dz. Nigriventris</i>	5	9	15	8	37
	<i>Dz. Stenoptera</i>	-	2	7	3	12
	<i>Ph. Zebra</i>	3	5	16	11	35
	<i>Ectobius sp.</i>	-	-	-	2	12
Humid region Lehnaya Ain Achir Seraidi	<i>L. decipiens</i>	1	104	37	7	149
	<i>E. kervillei</i>	2	14	23	7	46
	<i>Dziriblatta sp.</i>	2	3	-	-	5
	<i>L. decipiens</i>	3	148	67	17	235
	<i>E. kervillei</i>	3	83	22	22	130
	<i>L. decipiens</i>	-	119	43	14	176
	<i>E. kervillei</i>	-	43	10	17	70
All species combined		27	692	399	140	1258

The difference in the number of individuals caught by forest types at each phenological level and studied

months varied according to species. About the forest of Senalba the aged larvae were the most abundant in the number of the

individual with 197, followed by the young larvae (178 individuals) then the adults with 56 individuals. While the forest of Lehnaya the highest number of individuals was for the young larvae followed by aged larvae (121 and 60 individuals respectively). However, the forest of Ain Achir contained 231 individuals of young larvae, 89 aged larvae and 39 adults. Nevertheless, in the forest of Seraidi the young larvae were also abundant in number with 162 individuals and 53 aged larvae (Table 2).

Which concern the relative frequency in the Senalba forest, *L. decipiens* was the only regular species in samples (C = 58%). Two species were considered an accessory (*Ph. Zebra* and *Dz. nigriventris*), where *L. ovolobata* presented the highest occurrence frequency (C=100%). They are classified as a constant species, while the two last species (*Dz. stenoptera*, *Ectobius sp.*) with the lowest occurrence frequency C >25% are

considered accidental species. But regarding the seraidi forest *L. decipiens* was a constant species (C=91.67%), and *E. kervillei* was a regular one with (C%= 58.33%). Concerning the two other forests, the species was considered as constant species except for *Dziriblatta sp.* In the forest of Lehnaya was it an accidental species. In general, in the four forests, over 50% of species were constant (Table 3). Regarding the relative frequency (F%) and density (D), the most abundant species in the first forest was *L. ovolobatta* with F% = 74.01% and a large density (D = 26.58 individuals per sample). *L. decipiens* was the most abundant species in the other three forests with a relative abundance of F% = 78.86% in Seraidi, F% = 75.9% in Lehnaya, and 63.79 in Ain achir . The density of this species was also important in these three forests with 16.17, 12.33 and 19.08 individuals/sample, respectively (Table 3).

Table 3: Occurrence (C %), relative frequency (F %), and density (D) of cockroaches species caught in the different forests of Algeria.

	Forests	Species	C%	F%	D
Semi arid region	Senalba	<i>L. decipiens</i>	58.33	7.89	2.83
		<i>L. ovolobata</i>	100.00	74.01	26.58
		<i>Dz. Nigriventris</i>	25.00	7.42	2.67
		<i>Dz. Stenoptera</i>	8.33	2.78	1.00
		<i>Ph. Zebra</i>	25.00	7.42	2.47
		<i>Ectobius sp.</i>	8.33	0.46	0.17
Humid region	Seraidi	<i>L. decipiens</i>	91.67	78.86	16.17
		<i>E. kervillei</i>	58.33	21.14	4.33
	Lehnaya	<i>L. decipiens</i>	91.67	75.90	12.33
		<i>E. kervillei</i>	75.00	22.56	3.67
		<i>Dziriblatta sp.</i>	16.67	1.54	0.25
	Ain Achir	<i>L. decipiens</i>	100.00	63.79	19.08
		<i>E. kervillei</i>	100.00	35.93	10.75

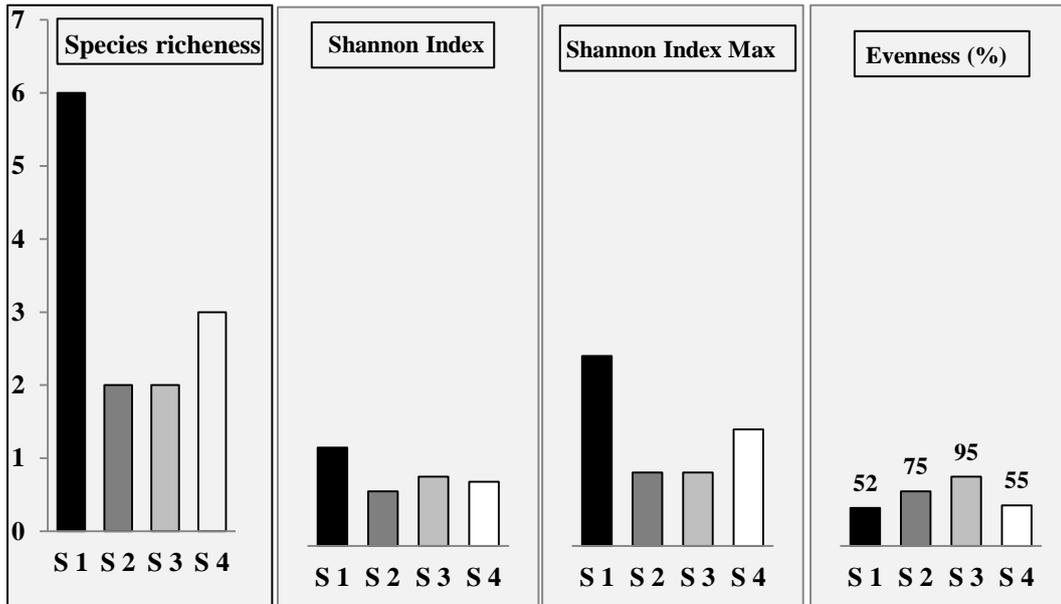


Figure 7: Parameter diversity of cockroach species was captured in Algeria's different forests (S1: Senalba, S2: Seraidi, S3: Ain Achir, S4: Lehnaya).

Concerning the species richness, Senalba's pine forest had the most cockroach varieties of six species, followed by Lehnaya's forest, which had three species. Biodiversity, as measured by Shannon's index, was marginally higher in the Senalba area ($H = 1.35$, $H_{max} = 2.60$), followed by Ain Achir forest ($H = 0.95$, $H_{max} = 1.00$), then Lehnaya forest ($H=0.88$, $H_{max}= 1.59$), while the forest of seraidi showed the lowest values of biodiversity ($S = 2$, $H = 0.75$, $H_{max} = 1.00$). However, the highest value of evenness was for the Ain achir with 94.57 %, while evenness was 74.66 % in the Seraidi forest and only 52 % for Senalba forest. In general, the evenness values ($E > 52$ %) showed that stands were very equal in all forests and populations were distributed fairly evenly. (Figure 7).

DISCUSSION

The forest system has continued to attract researchers at the national level, especially foresters for management studies and ecologists for

their various inventories of flora and fauna (Ouelmouhoub, 2005). Algerian forests are

poorly known at the international level, except for a few citations in publications devoted to the Maghreb forests (mainly Morocco and Tunisia) (Berchiche, 1986; Azzoui et al., 2000). In general, the forests of the Mediterranean rim are characterized by an important flora and fauna richness. They cover more than 81 million hectares (9.4 % of the world's forest area) and are made up of a mosaic of forest species, mainly hardwoods (about 60 %). This area's fame is well established because of many natural parks (Houe, 1996).

This study made it possible to characterize the diversity and dynamics of cockroach species populations in different Algerian ecosystems according to diverse Mediterranean forests. It is worth noting the relatively wide ranges of flora and fauna in Algerian forests from which over 200 species of insects have been identified (Zereg, 2010). Nevertheless, not much detail was available on Dictyoptera. Wildlife inventory of woodland habitats continues to excite scientists worldwide. In

different forest management study, they have proved their usefulness (Habbachi, 2013). These seven species listed in this study are already reported in different regions of Algeria, In the coastal region of Annaba with wet climate two species (*L. decipiens*, *E. kervillei*) have been identified (Habbachi, 2013), seven species (*L. decipiens*, *L. ovobata*, *Dz. nigriventris*, *Dz. stenoptera*, *Ph. zebra*, *Ph. trivittata* and *Ectobius sp.*) In the Djelfa region (Masna et al., 2014; Masna, 2016) and six species in Belezma National Park in the area by Batna (Azoui et al., 2016).

The composition of the Blattoptera fauna can vary from region to region of the world, and habitat suitability depends on many biotic and abiotic factors (Rust et al., 1995). the characteristics of the vegetation, the attributes of its litter, and the climatic parameters are the most critical factors involved in specifying these insects' ecological niches (Schal et al., 2008). Besides, the availability of water, i.e., the humidity of the biotope, stimulates the growth of cockroach populations (Boyer, 2004).

Our results are similar to those of Masna et al. (2014) and Azoui et al. (2016), who demonstrated that the variety and distribution of cockroaches was influenced by different vegetation cover. This study also showed that the patterns in the different phenological stages and the dynamics of the identified cockroach population found were very close among the different types of woodland. This represents the strong impact of time shifts in temperature conditions, which have been recorded and known for the direct effects on insects' environment, populations, and their diet (Chafaa et al., 2013).

The great diversity and number of cockroach species in the Senalba forest than other woods are probably linked to this habitat's ecological conditions. Although deciduous forests produce more waste, this environment is

rich in litter and offers a suitable habitat to house a great diversity of microarthropods (Madej et al., 2011).

The insects found in the forest have their ecological requirements, and many species play an essential role in the decomposition of organic matter (leaves, twigs, roots, etc.). They recycle dead organic matter and recreate the cycle of value necessary for the forest to exist. Forest cockroaches are the best example of detritus-eating terrestrial insects that feed on all waste (excrement, corpses, dead leaves, etc.). As a result, they largely colonize the soil (Dajoz, 1998). Aleppo pine forests in the Mediterranean region foster soil properties that make these areas especially capable of containing a diverse range of pathobiotic arthropods (Antunes et al., 2008).

The species diversity in the different forests studied can be confirmed by the results obtained in the Est region of Algeria by Habbachi (2013), who showed that cockroaches prefer eucalyptus litter of an alkaline nature than that of cork forests of an acid nature. Simultaneously, the abundance of cockroaches in the latter type of litter could be explained by the fact that they prefer to live in basic soil. While the results in the south region of Algeria by Masna (2016) also show that the forests are rich in organic matter and organic carbon. On the other hand, the soil rich in mineral matter plays an essential role in distributing cockroaches. Indeed, the soil properties of coniferous forests vary from those of deciduous forest, these ecosystems' litter, which is primarily made up of needles, exhibits distinct dynamic and physicochemical properties (types of humus, humidity, rate of decomposition, acidity, and renewal). Microfauna, types of undergrowth, organic matter, etc (Binkley and Fisher, 2012).

CONCLUSION

We were able to demonstrate in the different Algerian forests the existence of eight species of cockroaches: *L. decipiens*, *L. ovobata*, *Dz. nigriventris*, *Dz. stenoptera*, *Dziriblatia sp.*, *Ph. zebra*, *E. kervillei* et *Ectobius sp.* These cockroaches are present in forest litter for most of the year with fluctuating numbers. During the inventory carried out in the four different forests, we were able to show that the distribution of these cockroaches differs depending on the altitude, the climatic conditions and the predominant plant species. we have also shown that the Senalba forest is the richest in species than the other forests.

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