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Diversity of Ants (Hymenoptera, Formicidae) in Two Forest Sites from Kabylia of Djurdjura, Northern Algeria

Sadou Sid-Ali[1], Sadoudi Ali-hmed Djamila[1], Metna Ali-Ahmed Fatiha[1], Ourrad Ouiza[1], Slimani Said[2]

1 - Laboratoire Protection, Sauvegarde des Espèces Menacées et des Récoltes, influence des Variables Climatiques. Université Mouloud Mammeri de Tizi-Ouzou, Algérie
2 - Laboratoire de Production, Amelioration et Protection des Végétaux et des Denerées Alimentaires. Université Mouloud Mammeri de Tizi-Ouzou, Algérie

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Corresponding author
Sadou Sid-Ali
Laboratoire Protection, Sauvegarde des Espèces Menacées et des Récoltes, influence des Variables Climatiques. Université Mouloud Mammeri de Tizi-Ouzou, Algérie.
E-Mail: sidali.sadou@ummto.dz

Abstract

The current study deals with the diversity of ants (Hymenoptera, Formicidae) in Kabylia of Djurdjura. It has been carried out in two forest sites from the localities of Azeffoun and Assi-Youcef, Tizi Ouzou (northern Algeria). Two sampling methods were adopted: manual capture and pitfall traps. Various community metrics were used as key elements to assess ant biodiversity within the two study sites. They included the species richness, the relative abundance, the constancy, and the Shannon-Weaver and equitability indices. Our inventory allowed identifying 24 species belonging to 12 genera and three subfamilies, which are the Myrmicinae (58%), the Formicinae (34%), and the Dolichoderinae (08%). The highest species richness was registered for the two first subfamilies, while the subfamily *Dolichoderinae* dominated numerically. The Site of Azeffoun, which is more submitted to human activities, recorded higher values in the number of individuals, the species richness, and the Shannon-Weaver diversity index. However, the difference between the two sites consisted mainly of the rare species, such as *Crematogaster laestrygon*, *Goniomma* sp. and *Palagiolepis* sp., which were present in the Azeffoun site. The local site conditions certainly have played a key role in ant species occurrence within the two study areas. Azeffoun is more disturbed than Assi-Youcef, resulting in the recruitment of much more rare and accidental species in the first site. In contrast, the rate of accessory to omnipresent species is substantially higher in Assi-Youcef, which recorded a high species evenness. To the best of our knowledge, this is the first study to report the ant genus *Formica* in Kabylia of Djurdjura.

Introduction

Ants are social insects of the family Formicidae in the order Hymenoptera. They account for 15% of the world's animal biomass (Passera, 2016). More than 13,922 species are identified in the world (Bolton, 2021). They are widely distributed over different latitudes and biotopes: underground, on the soil surface, in the air, and on plants and animals.

Throughout the ages, ants have been able to survive thanks to unique self-adapting and organizing mechanisms. As biological indicators of environmental quality, insects play a key role in ecosystem functioning (Alonso, 2000). However, their identification remains complex, which constitutes a major problem for their use in environmental studies (New, 1996).

Ants have attracted the attention of many researchers since the last century. The Formicidae have been documented in several studies all over the world, with a focus on their biology and ecology.

From the 1970, many myrmecofauna inventories were carried out through project aimed at strengthening our understanding of biodiversity (Bernard, 1973, 1976; Passera, 1984; Jolivet, 1986; Longino & Colwell, 1997; Delabie et al.,

2000; Marinho et al., 2002; Vasconcelos et al., 2003; Hites et al., 2004; Lepounce et al., 2004; Lappola et al., 2006).

The earliest studies on ants in North Africa were those of Emery (1914) in Tunisia, Dartigues (1988), Doumandji et Doumandji (1988), and Barech et al. (2016, 2018) in Algeria, and Cagniant (2005) and Taheri (2014) in Morocco. It is noteworthy that since the first publications dedicated to the order Hymenoptera in Algeria, few studies have been dedicated to the family Formicidae.

Many authors reported that data on ants in Algeria in general and in the region of Tizi Ouzou, in particular, is scarce, old and fragmentary and that many sites remain unexplored and their fauna unknown (Bernard, 1982, 1983; Belkadi, 1990; Cagniant, 1997, 2005; Djioua & Sadoudi-Ali Ahmed, 2015).

The current study reports the first findings on ants (Hymenoptera, Formicidae) diversity in two forest sites from Tizi Ouzou (Kabylia of Djurdjura, northern Algeria). These results provide relevant elements on the fauna in the study area and constitute vital information to support ongoing forest ecosystem management efforts in the region.

Material and methods

Study area

The current study was carried out in two forest sites located at the extremities north and south of the wilaya of Tizi Ouzou (northern Algeria) (Fig 1). The two forested areas are situated some 50.5 km from one another. The site of Azeffoun is situated on the northern slope, while Assi-Youcef is situated on the southern slope of the Djurdjura mountain chain. The two study areas present important differences as regards their vegetation-soil-topography-climate association.

The first site is located in the coastal zone of Azeffoun (northern Kabylia of Djurdjura), at about 56 km north-east to Tizi Ouzou, at the geographical coordinates 36° 53’ 35” N and 4° 25’ 12” E. The sampled area is situated over an altitudinal gradient ranging from 50 to 300 m. It is characterized by a maritime Mediterranean climate, wet and cool winter and a dry and warm summer. The total annual precipitation varies from 500 to 700 mm. The soil is derived from sandstone.

This Mediterranean coastal site is close to the urban area of Azffoun, which makes it subjected to strong anthropic pressure, especially to grazing and forest fires. It consists of a reforested area of about 7,718 ha, dominated by a variety of introduced tree species of *Eucalyptus* (*E. globulus*, *E. sideroxylon*, *E. gomphocephala*, *E. cladocalyx*, *E. botryoides*, *E. occidentalis*, *E. maideni*) and *Pinus* (*P. pinaster*, *P. pinea*, *P. canariensis*). Furthermore, there is a notable presence of the native and spontaneous oak species *Quercus suber*. Main understorey vegetation consists of *Pistacia lentiscus*, *Daphne gnidium*, *Erica arborea*, *Cistus monspenliensis,* and *Calycotome spinosa*.

The second site is located in a mountainous area belonging to the municipality of Assi-Youcef (southern Kabylia of Djurdjura), at about 50 km southwest to Tizi Ouzou, at the geographical coordinates 36° 27’ 54” N and 4° 05’ 47” E.

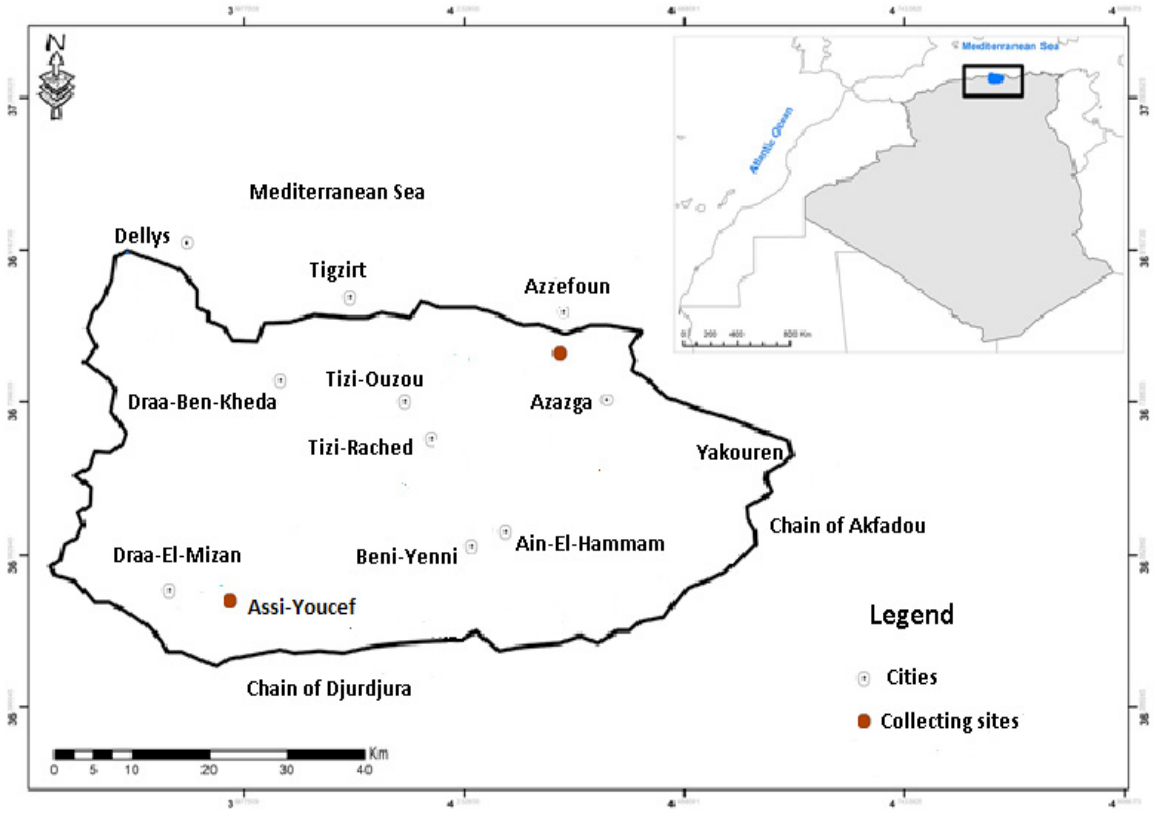

Fig 1. Location of the study sites.

The sampled campaign was performed over an altitudinal gradient ranging from 600 to 950 m. It is characterized by a Mediterranean climate, wet and cold winter and dry and warm summer. The total annual precipitation exceeds 900 mm. The soil is derived from limestone.

This site is situated within the National Park of Djurdjura. Intensive grazing and forest fires are observed, but anthropic activities are much lower than in the first site. This study area consists of a mixed *Cedrus atlantica* and *Quercus ilex* forest with a very low density of the understory, mainly represented by *Juniperus oxycedrus*, *Calycotome spinosa, Erica arborea*, *Cytisus triflorus, Ampelodesma mauritanicum,* and *Asphodelus microcarpus*.

Sampling procedure

Myrmecofauna sampling campaigns were carried out within the two study sites during the years 2018 and 2019. The samples were collected from March to July, every ten days, three times a month.

Two sampling methods were applied in the current study: the Barber pots and the manual capture.

pitfall traps

The first adopted method consisted of using pitfall traps. This technique allows capturing many walking arthropods and flying insects, which land on the surface of the trap or are driven to it by the wind (Benkhelil, 1991).

The traps are vertically buried, with the opening adjusted to the ground surface. To avoid any effect due to barriers towards the traps for tiny insects, the area around the placed Barber pots was cleaned. A total of ten traps were placed in each site along a sampled transect determined by a twine (a trap every five meters). The traps were filled to 1/3 of their height with water, and a detergent is added to facilitate entrapment of attracted insects. The traps' content was collected after 48 hours and stored in plastic tubes with a data tag.

Manual capture

The manual capture method was performed from late April to late July, as described by Mc Gavin (2000). During this period of the year, the capture is easy, as ants are very active and occupy the superficial chambers of their nets.

Species identification

The collected ants were preserved in 75% ethyl alcohol. Their identification was performed using the taxonomic keys of Bernard (1968) and Cagniant (1968, 1970, 1997, 2005, 2006, 2009).

Statistical analyses

A variety of statistical parameters were used to describe the biodiversity of ants in our study areas. The species richness (S) represents the total number of ant species collected at each site. The relative abundance (RA) is the percent composition of a given ant species relative to the total number of individuals collected in a given site. The species constancy (C), or the frequency of occurrence, is the number of samples in which a given species is found relative to the total number of samples. Six constancy classes were considered: the species is rare if $C \leq 17\%$, accidental if $17\% < C \leq 34\%$, accessory if $34\% < C \leq 51\%$, regular is $51\% < C \leq 68\%$, constant if $68\% < C \leq 85\%$ and omnipresent if $C > 85\%$. The Shannon–Weaver diversity index (H') was applied, using the following equation:

$$H' = -\Sigma P_i \log_2 P_i$$

where $P_i = n_i / N$; n_i being the total number of the species i and N is the total number of individuals. The equitability or evenness index (E) was estimated according to Pielou as follows:

$$E = H'/H_{max}$$

where H' is the Shannon–Weaver diversity index and $H_{max} = \log_2 S$, S being the species richness.

In addition, sampling effort is assessed using the nonparametric species richness estimators of Chao, jackknife 1, jackknife 2 and bootstrap, which calculate the number of cumulative observed and expected species in the study sites with 100 randomizations.

Fig 2. Pitfall traps.

Results

Our sampling campaigns allowed collecting 641 ant individuals: 454 in Azeffoun and 187 in Assi-Youcef. Ant species richness (S) within the two study sites is reported in Table 1.

A total of 24 species were identified. They belong to 12 genera and three subfamilies: Myrmicinae (58%), the Formicinae (34%) and the Dolichoderinae (8%). All 24 species were present in Azeffoun, while only 13 were found in Assi-Youcef.

With seven genera and 13 species, the subfamily Myrmicinae was the most diversified. Each of the genera *Crematogaster, Aphaenogaster,* and *Messor* were represented by three species. Only one species represented the other genera (*Tetramorium*, *Pheidole, Goniomma* and *Temmothorax*). The subfamily Formicinae registered ten species belonging to four genera. The genera *Cataglyphis* and *Formica* were represented by one single species, the genus *Plagiolepis* recorded two species, and the *Camponotus* was the richest genus, with six species. The least diversified subfamily was the Dolichoderinae, which registered only one genus (*Tapinoma*) and one species (*Tapinoma simrothi*) (Fig 3).

Table 1. Ant species richness in the two study sites.

Subfamily	Species	Site	
		Azeffoun	Assi-Youcef
	Camponotus toracicus	+	+
	Camponotus spissinodis	+	-
	Camponotus ruber	+	-
	Camponotus latiralis	+	+
Formicinae	*Camponotus alii*	+	+
	Camponotus barbarous	+	+
	Cataglyphis viaticus	+	+
	Formica sp.	+	-
	Palagiolepis schmitzi	+	+
	Palagiolepis sp.	+	-
Myrmicinae	*Crematogaster sticularis*	+	+
	Crematogaster auberti	+	-
	Crematogaster laestrygon	+	-
	Aphaenogaster testaceopilosa	+	+
	Aphaenogaster senilis	+	+
	Aphaenogaster sardoa	+	-
	Messor barbarous	+	+
	Messor lobicornis	+	-
	Messor capitus	+	-
	Pheidole pallidula	+	+
	Goniomma sp.	+	-
	Temnothorax sp.	+	-
	Tetramorium bisekrens	+	+
Dolichoderinae	*Tapinoma simorthi*	+	+

From a quantitative perspective, the ant relative abundance (RA) varied between the two sites according to the species rank (Fig 4 and 5).

In Azeffoun, *Tapinoma simorthi* was the most abundant species (RA = 13.22%). It was followed by *Pheidole pallidula* (RA = 12.56%), and *Cataglyphis viaticus,* and *Crematogaster sticularis* (RA = 11.01% for both).

The most abundant species in Assi-Youcef was *Pheidole pallidula* (RA = 22.32%). It was followed by *Tapinoma simorthi, Palageolipis schmitzi,* and *Cataglyphis viactus,* with RA values of 16.04%, 11.76%, and 10.70%, respectively.

All six considered constancy classes were observed while considering the two study areas (Table 2).

Table 2. Constancy values (C) and their corresponding categories for the two study sites.

Species	Azeffoun		Assi-Youcef	
	C	Category	C	Category
Camponotus toracicus	25.00	Ac	33.33	Ac
Camponotus spissinodis	04.76	Ra	00.00	Absent
Camponotus ruber	04.76	Ra	00.00	Absent
Camponotus latiralis	06.66	Ra	06.66	Ra
Camponotus alii	28.33	Ac	16.66	Ra
Camponotus barbarous	08.33	Ra	13.33	Ra
Cataglyphis viaticus	66.66	Reg	60.00	Reg
Formica sp.	16.66	Ra	0.00	Absent
Palagiolepis schmitzi	66.66	Reg	66.66	Reg
Palagiolepis sp.	03.33	Ra	00.00	Absent
Crematogaster sticularis	75.00	Con	40	Acc
Crematogaster auberti	30.00	Ac	00.00	Absent
Crematogaster laestrygon	01.66	Ra	00.00	Absent
Aphaenogaster testaceopilosa	10.00	Ra	06.66	Ra
Aphaenogaster senilis	75.00	Con	50.00	Acc
Aphaenogaster sardoa	08.33	Ra	00.00	Absent
Messor barbarous	58.33	Reg	50.00	Acc
Messor lobicornis	05.00	Ra	00.00	Absent
Messor capitus	06.66	Ra	00.00	Absent
Pheidole pallidula	91.66	Omn	93.33	Omn
Goniomma sp.	01.66	Ra	00.00	Absent
Temnothorax sp.	05.00	Ra	00.00	Absent
Tetramorium bisekrens	08.33	Ra	40.00	Acc.
Tapinoma simorthi	93.33	Omn	93.33	Omn.

Five constancy classes were identified in Azeffoun. Accessory species were absent. A total of 14 species were rare. The rarest ones were *Goniomma* sp. (C = 01.66%), *Crematogaster laestrygon* (C = 01.66%) and *Palagiolepis* sp. (C = 03.33%). Three species were accidental: *Crematogaster auberti* (C = 30.00%), *Camponotus alii* (C = 28.33%) and *Camponotus toracicus* (C = 25.00%). Likewise the regular ones were represented by three species, which were *Palagiolepis schmitzi* (C = 66.66%), *Cataglyphis viaticus* (C = 66.66%) and *Messor barbarus* (C = 58.33%). Two species

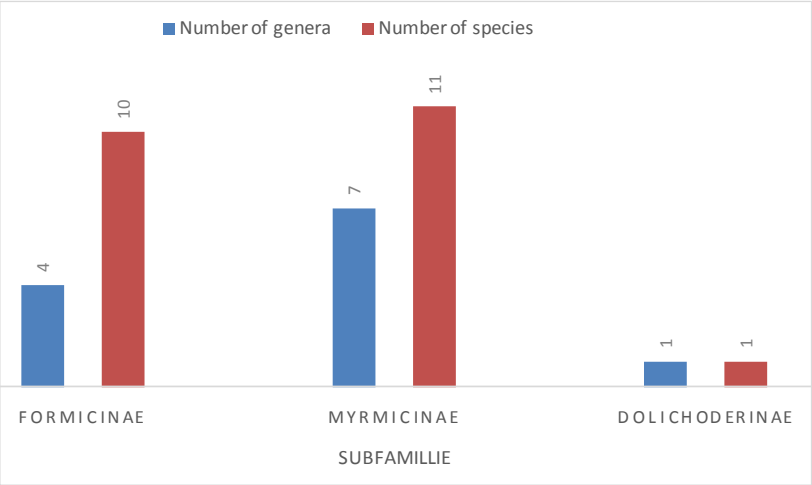

Fig 3. Number of genera and species for each subfamily in the two study sites.

were constant: *Crematogaster sticularis* (C = 75.00%) and *Aphaenogaster senilis* (C = 75.00%). Two other species were omnipresent: *Tapinoma simorthi* (C = 93.33%) and *Pheidole pallidula* (C = 93.33%).

Five constancy classes were also identified in Assi-Youcef. In this site, no ant species was identified as constant. Four species were considered rare: *Camponotus alii* (C = 16.66%), *Camponotus barbarus* (C = 13.33%), *Camponotus latiralis* (C = 06.66%) and *Aphaenogaster testaceopilosa* (C = 06.66%). The class accidental was represented by only one species, *Camponotus toracicus* (C = 33.33%). Four accessory species were recorded: *Aphaenogaster senilis* (C = 50.00%), *Messor barbarus* (C = 50.00%), *Crematogaster sticularis* (C = 40.00%) and *Tetramorium bisekrens* (C = 40.00%). Regular and omnipresent species were both represented by two species, which are *Palagiolepis schmitzi* (C = 66.66%) and *Cataglyphis viaticus* (C = 60.00%), and *Pheidole pallidula* (C = 93.33%) and *Tapinoma simorthi* (C = 93.33%) respectively.

The majority of the species identified in Azeffoun were rare (58.33%). They are followed by the accidental and the regular and species (12.50% for each category), and the least represented were the omnipresent (08.33%).

In Assi-Youcef, the most present species belonged to the categories rare and accessory (30.77% for each class). They are followed by the regular and omnipresent species (15.38% for each of the classes), and the accidental ones came last (07.69%).

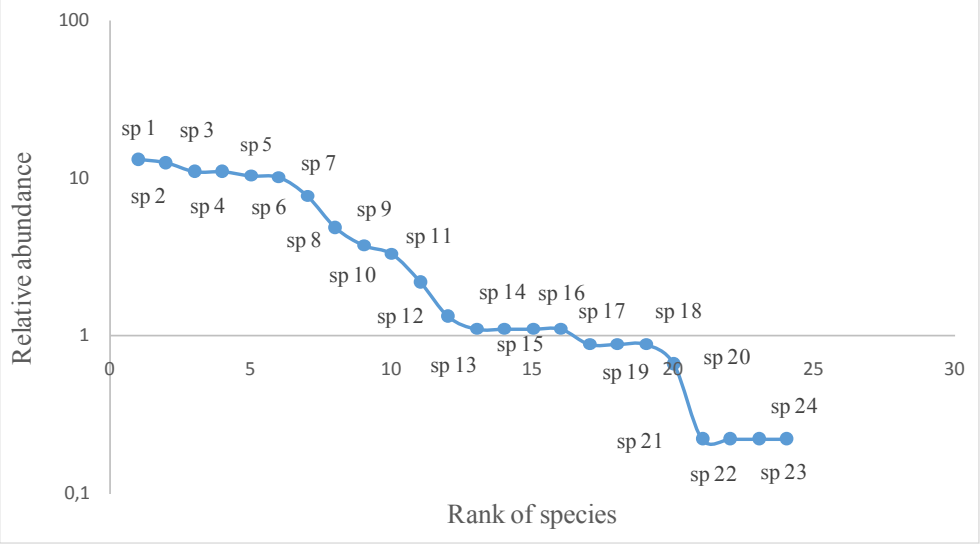

Fig 4. Rank-abundance curve for the relative abundance (Log10ni/N) of ant species collected in Azeffoun. sp 1 : *Tapinoma simorthi;* sp 2: *Pheidole pallidula;* sp 3: *Cataglyphis viaticus;* sp 4: *Crematogaster sticularis;* sp 5: *Aphaenogaster senilis;* sp 6: *Palagiolepis schmitzi;* sp 7: *Messor barbarus;* sp 8: *Crematogaster auberti;* sp 9: *Camponotus alii;* sp 10: *Camponotus toracicus;* sp 11: *Formica sp;* sp 12: *Aphaenogaster testaceopilosa;* sp 13: *Camponotus barbarus;* sp 14: *Aphaenogaster sardoa;* sp 15: *Temnothorax sp;* sp 16: *Tetramorium bisekrens;* sp 17: *Camponotus latiralis;* sp 18: *Palagiolepis sp;* sp 19: *Messor capitus;* sp 20: *Messor lobicornis ;* sp 21: *Camponotus spissinodis ;* sp 22: *Camponotus ruber ;* sp 23: *Crematogaster laestrygon;* sp 24: *Goniomma sp*.

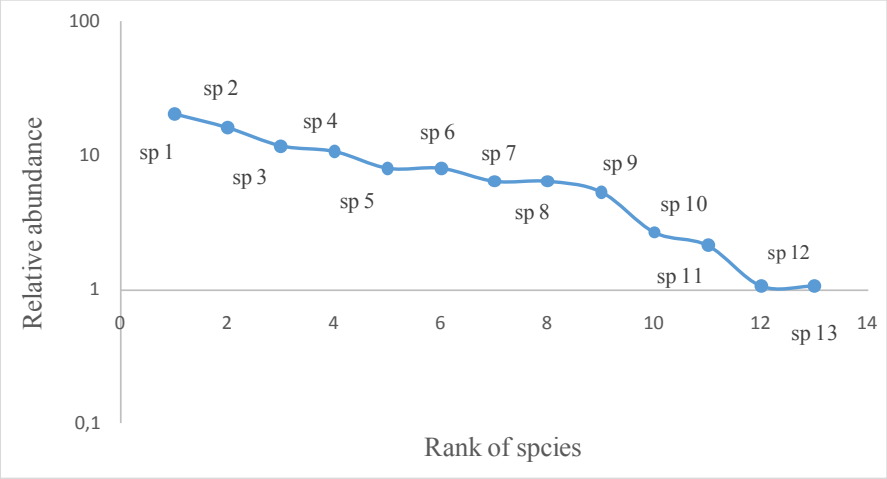

Fig 5. Rank-abundance curve for the relative abundance (Log10ni/N) of ant species collected in Assi-youcef.
sp 1: *Pheidole pallidula;* sp 2: *Tapinoma simorthi;* sp 3: *Palagiolepis schmitzi;* sp 4: *Cataglyphis viaticus;* sp 5: *Aphaenogaster senilis;* sp 6: *Messor barbarus;* sp 7: *Crematogaster sticularis;* sp 8: *Tetramorium bisekrens;* sp 9: *Camponotus toracicus;* sp 10: *Camponotus alii;* sp 11: *Camponotus barbarus;* sp 12: *Camponotus latiralis;* sp 13: *Aphaenogaster testaceopilosa*.

It is worth mentioning that the absent species in Assi-Youcef registered a low presence in Azeffoun: ten species out of 11 were rare, and one was accidental. Moreover, the rare species in Azeffoun were absent (ten species), rare (three species), or accessory (one species) in Assi-Youcef. On the contrary, the rare species in Assi-Youcef were rare (three species) or accessory (one species) in Azeffoun. In addition, the two sites registered the same omnipresent species, which are *Tapinoma simorthi* and *Pheidole pallidula*. However, we notice that the rates of the rare and the accidental species were lower and that of the omnipresent species was higher in Assi-Youcef than in Azeffoun.

The results of the Shannon-Weaver (H') and equitability (E) indices are presented in Table 3. H' recorded a higher value in Azzefoun (2.61) than in Assi-Youcef (2.29). This also coincides with higher values in S and H'_{max}. We notice that H' is relatively close to H'_{max} in Assi-Youcef, while in Azeffoun, the difference between the two parameters is huge. On the contrary, Assi-Youcef registered a slightly higher value in E.

Table 3. Shannon-Weaver (H') and equitability (E) indices for the two study sites.

Parameter	Site	
	Azeffoun	Assi-Youcef
H'	2.61	2.29
S	24	13
H'_{max}	4.585	3.70
E	0.56	0.62

In Azeffoun, the estimated total species richness was higher than the observed value ($S_{obs.}$ = 24). According to the different used estimators, the number of new species to be found in this site is 16 to 20 with the Chao 1 and jackknife 1 indices, 9 with the jackknife 2 index and four with the bootstrap index (Table 4). In contrast, in Assi-Youcef, the estimated values are close to the observed, with a minimal estimate of one to three more species to be found in this site: $S_{obs.}$ = 13, Chao = 15.93 ± 3.63, jackkniefe 1 = 15.93 ± 1.37, jackknife 2 = 16.90 and bootstrap = 14.86 ± 0.77). In addition, the inventory completeness rate reached a value of 67.09% in Azeffoun and 81.90 in Assi-Youcef. Moreover, the inadequacy of the sampling effort within the two sites is confirmed by the difference between the species accumulation curves ($S_{obs.}$) and those obtained using the adopted estimators (Fig 6 and 7).

Table 4. Estimation of the total richness of the ants.

Estimators	Sites					
	Azeffoun	Assi-Youcef	Azeffoun		Assi-Youcef	
	Value		Completen-ess	Average completeness	Completeness	Average completeness
Observed richness	24	13				
Chao	44,63 ± 19.59	15,93 ± 3,63	53,77 %		81,60 %	
Jackknife 1	33,72 ± 4,07	15,93 ± 1,37	71,17 %		81,60 %	
Jackknife 2	40,36	16,90	59,46%	67,09 %	76,92 %	81,90 %
Bootstrap	28.58 ± 2,06	14,86 ± 0,77	83,97 %		87,48 %	

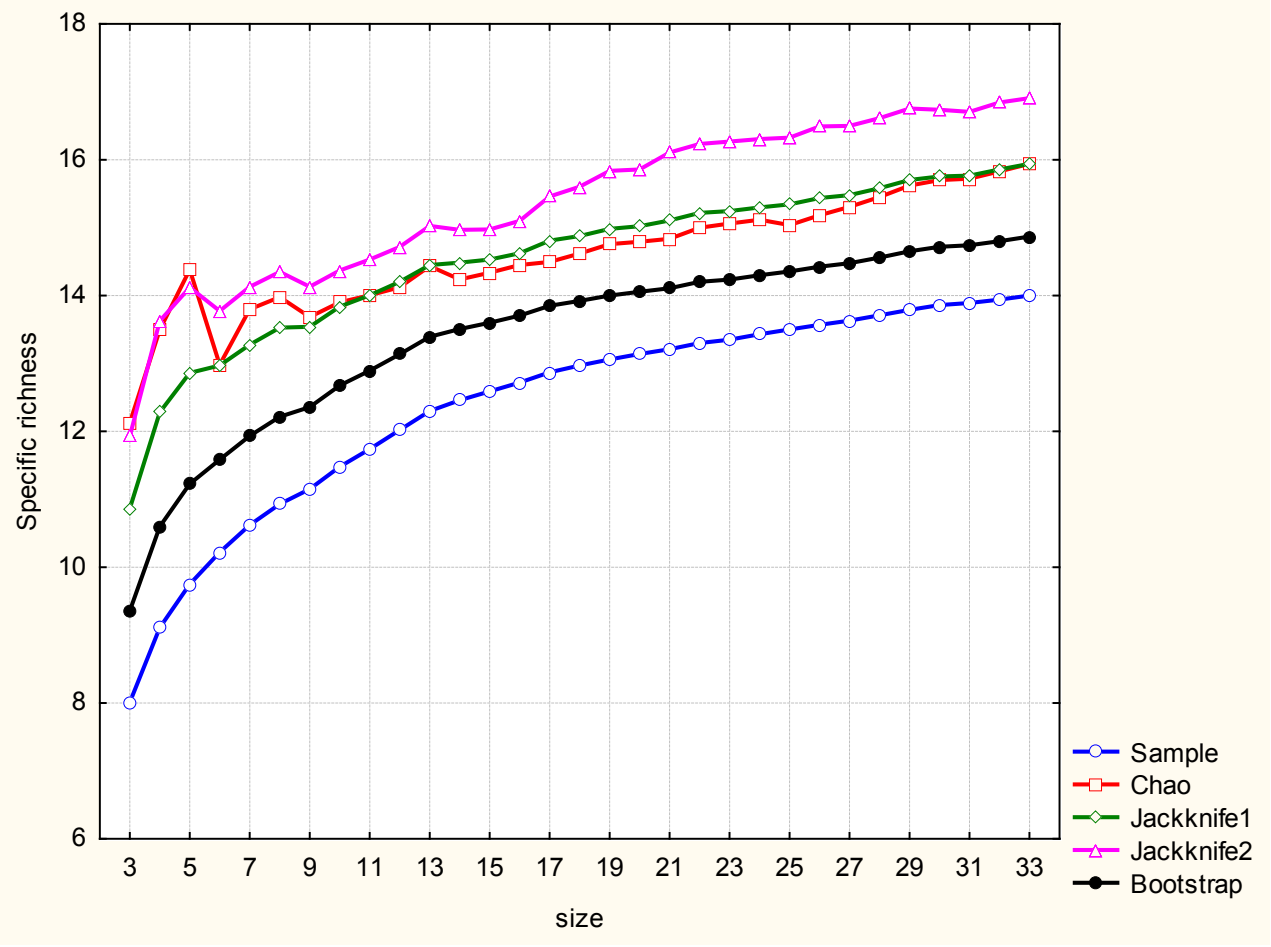

Fig 6.Curves of accumulation of the species, estimators of the richness in Azeffoun.

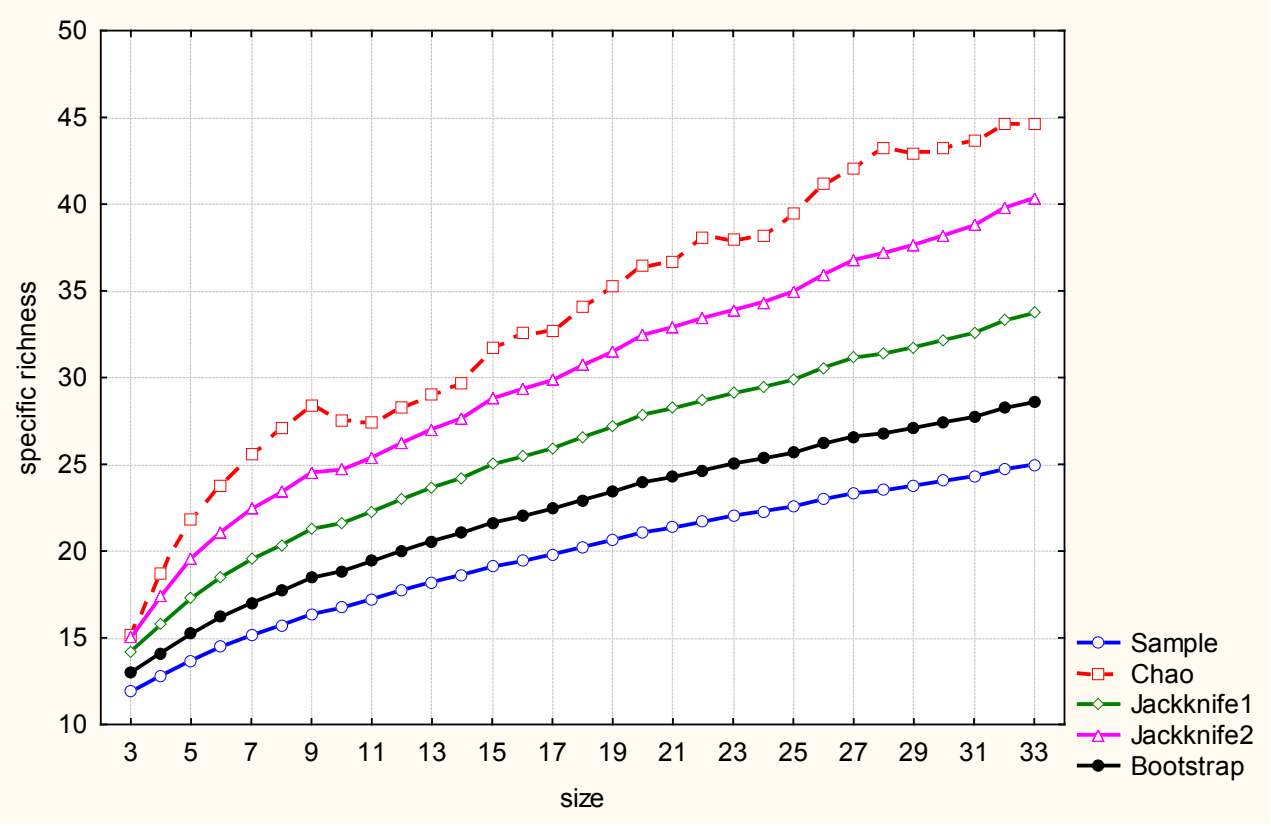

Fig 7.Curves of accumulation of the species, estimators of the richness in Assi-Youcef.

Discussion

The current investigation on the myrmecological fauna allowed identifying 24 species in the two studied sites. They belong to three subfamilies, which are: the Myrmicinae, the Formicinae, and the Dolichoderinae. Our findings showed that the species richness was much higher in Azeffoun (24 species) than in Assi-Youcef (13 species). This difference may be due to the differences in ecological conditions within the two studied areas. The close relationship between ants and the type of habitats has been reported by Agosti et al. (2000). Indeed, the site of Azeffoun is coastal and is located on the northern slope of the Djurdjura mountain chain. On the contrary, Assi-Youcef is mountainous and is situated on the southern slope of the Djurdjura massif.

Moreover, even if the two studied sites are forested areas, the site of Azeffoun is a reforested one. It is close to the urban area, so it is more or less artificial and submitted to high anthropogenic pressure (overgrazing, forest fires, illegal loggers), while the site of Assi-Youcef consists of a spontaneous forest located in a protected area, which is the Djurdjura National Park. These differences suggest that the site of Azeffoun is much more disturbed and open, which may play a key role in recruiting much more species than in Assi-Youcef. The soil type could also be a determining factor: in Azeffoun, the soil is siliceous, while in Assi-Youcef, it is calcareous.

A larger-scale study, carried out by Djioua and Sadoudi Ali-Ahmed (2015) in the region of Tizi Ouzou, involving four different sites (Aghrib, Azazga, Ain El Hammam, and Tizi Ouzou), allowed identifying 15 species. This richness is close to the one we found for Assi-Youcef. This result confirms the particular influence of the ecological conditions that prevail in our site of Azeffoun, which recorded much higher species richness (24 species).

The majority of the identified ant species in the two studied sites have already been reported by Cagniant (1968, 1969, 1972, and 1973) and Bouzekri et al. (2013) in their works on Algerian ant populations. However, to the best of our knowledge, the current study is the first to report the genus *Formica* in Kabylia of Djurdjura, occuring in the richest site, Azeffoun.

For both sites, the most abundant species were *Tapinoma simorthi* and *Pheidole pallidula*. Similar results have been reported by Belkadi (1990), Djioua, and Sadoudi Ali-Ahmed (2015) in the region of Tizi Ouzou and Dehina (2009) in two stations in the Algiers region. *Crematogaster scutellaris* was also abundant. Many authors have reported this species in the Mediterranean forests; these results corroborate with those of Janine (1972). Our results are consistent with those reported by Cagniant (2005) in Morocco, who mentioned the genus *Crematogaster* as one of the most abundant among the Formicidae and corroborate those noted by Djioua & Sadoudi Ali-Ahmed (2015) in the region of Tizi Ouzou.

The constancy index, reflecting the frequencies of occurrence, varies considerably among the identified ant species and confirms the difference mentioned between the two sites regarding their species richness. As mentioned above, the site of Azeffoun recorded a higher number of identified species. However, the difference between the two sites was mainly represented by the category of rare species. Consequently, more submitted to anthropogenic disturbances, the site of Azeffoun tends to recruit more non-characteristic species. In contrast, located in a protected area, Assi-Youcef showed a higher rate of omnipresent species, which are characteristic of the forest environment.

The values reported in Table 2 were recorded from May to June. Similar results have been reported in Algeria by Bakiri (2001) in the suburban environment near Algiers and Dehina (2009), who also listed *Tapinoma simrothi* as an omnipresent species. However, different results have been reported concerning the omnipresent species, *Pheidole pallidula*. Hacini (1995) listed it among omnipresent species in Staouali (northern Algeria), while Djioua & Sadoudi-Ali Ahmed (2015) mentioned it as regular within four sites in the region of Tizi Ouzou.

Table 3 revealed that the Shannon-Weaver and equitability indices were high in both sites. However, the most disturbed site (Azeffoun) recorded higher values of S, H', and H'_{max}. In contrast, the most stable one (Assi-Youcef) registered a higher value of E. In addition, this site showed close values of H' and H'_{max}, which suggests that many species have more or less the same abundance. On the contrary, the higher diversity in species of Azeffoun is characterized by a high range of abundances among species.

Our findings stem from a sampling procedure associating manual capture and pitfall trap methods. Other authors adopted this combined technique to assess ant biodiversity in Algeria. Their results showed lower H' values: Barech et al. (2016) noted values ranging from 1.35 bits in Medbah to 1.47 bits in Biskra. Barech et al. (2018) reported an H' value of 1.10 bits at the edges of the dam of El Ksob (M'sila). This difference could be because our study areas are located in different climatic zones: our sites are situated in a humid area, facing the Mediterranean Sea, while the studies of Barech et al. (2016, 2018) were carried out within sub-arid and arid zones, which are characterized by lower fauna biodiversity compared to the northern part of the country.

According to the estimated total specifies richness, the adopted sampling methods allowed capturing two thirds (67.09%) of the ant species that would be present in Azeffoun and over than three quarters (81.90%) of those expected to be found in Assi-Youcef. This justifies the differences exhibited between the accumulation curves of the captured and expected species within the two sites. The accumulation curve did not reach an asymptote for all samples. This suggests that the sampling effort is incomplete. Hence, additional samples would be required in order to capture new species.

Conclusion

A total of 641 ant individuals were collected. They belong to 24 species, 12 genera and three subfamilies, which are: the Myrmicinae, the Formicinae and the Dolichoderinae.

The local site conditions could have played a key role in ant species occurrence within the two study areas. The site of Azeffoun is more submitted to human activities than Assi-Youcef, which is located in a protected area, the Djurdjura National Park. This promoted recruitment of much more rare and accidental species in that disturbed site, while the rate of accessory to omnipresent species is substantially higher in Assi-Youcef. To the best of our knowledge, the current study is the first to identify the genus *Formica* in the region of Tizi Ouzou.

Compared to other works realized on ants since years. Scientific research on this group of bio-indicator insects should be continued in order to better understand the biodiversity levels of these hotspots.

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