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A preliminary list of the Ant Fauna in Northeastern Sahara of Algeria (Hymenoptera: Formicidae)

A Chemala[1*], M Benhamacha[1], DM Ould El Hadj[2], F Marniche[3], S Daoudi[1]

1 - Department of Forest and Agricultural Zoology, National High School of Agricultural Sciences, Algiers, Algeria
2 - Department of Naturel science, Kasdi Merbah University, Ouargla, Algeria
3 - Laboratory of Zoology, National High School of Veterinary, Algiers, Algeria

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Corresponding author
Abdellatif Chemala
Departement of Forest and Agricultural Zoology
National High School of Agricultural Sciences
Avenue Hassan Badi, El Harrach
Algiers, ES1603, Algeria.
E-Mail: a.chemala@yahoo.fr

Abstract

We present here a preliminary list of ant fauna of some study sites in the northeastern Sahara of Algeria using two methodologies, quadrat and pitfall traps (Barber-pots) methods. This work was conducted in wild and agricultural ecosystems in the basin of Ouargla, El-Oued region and Djamaa region. We record a total of 26 species of 12 genera belonging to three subfamilies Dolichoderinae, Formicinae, and Myrmicinae. Species of the Myrmicinae and Formicinae were the most abundant with 62.96% and 29.63% respectively. The most diverse genus was *Monomorium* Mayr, 1855 (6 species), followed by *Messor* Forel, 1890 (5). The highest diversity of ants was in Djamaa region (24 species), followed by Ouargla (18) and El-Oued (13). Moreover, this work shows the first record of the species *Strumigenys membranifera* Emery, 1869 for the Country. Finally, we observed a variation in the distribution of ant species between study sites, for why, ecological determinants such as soil need to be studied deeply to explain their influence on the repartition and richness of the Saharan myrmycofauna of Algeria.

Introduction

In Algeria, as in countries where it is not too cold, the ants have the advantage of being abundant. They exist everywhere, in the forest as in open areas, along the water as in dry areas, on clay as on rocks (Cagniant, 1973). Comparing with other countries of the North of Africa, Cagniant (2009) evaluate the Moroccan myrmecofauna approximately to 220 species, while both of Algeria and Tunisia include 180 in Total (Cagniant, 2006). The myrmecofauna of Algeria is known through some fragmentary studies done by: (*e.g.* Forel, 1890; 1894; 1902; Sanchi, 1915; 1929a; 1929b; Bernard, 1955; 1963; 1973; 1977; 1982; Cagniant, 1966a; 1966b; 1967; 1968a; 1968b; 1969; 1970a; Barech et al., 2011; 2015). Unfortunately, no serious studies have been made on repartition of these microfauna in the Algerian territory, excepting those of (Cagniant, 1968c; 1970b; 1970c) who have established a list of the forest ants of Algeria with a total of 120 species. Recently, Djioua and Sadoudi-ali Ahmed (2015) listed the richness of ant fauna in some forest and agricultural areas of Kabylia. Barech et al. (2016) added a checklist of the myrmecological fauna of a saline lake area, Chott El Hodna. In northern Sahara of Algeria, the ant fauna has a significant percentage among the arthropods that inhabit this region by adapting to the conditions of the arid environment. However, the Saharan species were poorly studied. The objective of this study is to evaluate the diversity of myrmecofauna in wild and agricultural ecosystems of the northeastern Sahara of Algeria.

Material and Methods

Study sites

This study was conducted in wild and agricultural ecosystems owns of several areas of the northeastern Sahara of Algeria. For that, three study sites were selected because of the high variation in their flora (appendix I), represented by the basin of Ouargla, El-Oued region and Djamaa region (Table 1). To represent the physiognomy of the vegetation of each study site, a transect of 500 m2 (10m x 50m) was carried out. It consists to produce an inventory of plant species found there and represent them graphically next two figures, one in vertical projection onto a plane and the other in profile. The projected orthogonally on a plane representation allows specifying the structure of the plant community and the recovery rate. However, the profile representation provides indications on physiognomy of the milieu, showing if it is open, semi-open or closed.

Table 1. Sites where ants were sampled in the northern-east Sahara of Algeria.

Sampling sites	Environment	Type of areas	Geographic coordinates provided in the study
Djamaa region	Agricultural ecosystems	Market gardening: semi- open	33º28'85'' N, 6º03'75'' E
		Palmary: semi- open	33º38'45'' N, 5º59'36'' E
	Wild ecosystem	Open and exposed	33º33'92'' N, 5º59'78'' E
El-Oued region	Agricultural ecosystems	Market gardening : semi- open and sunny	33º26'48'' N, 6º57'42'' E
		Palmary: Open and exposed	33º26'93'' N, 6º57'70'' E
	Wild ecosystem	Open and exposed	32º26'85'' N, 6º57'59'' E
Ouargla region	Agricultural ecosystems	Market gardening: Open	32º02'54'' N, 5º21'42'' E
		Palmary: semi- open and sunny	31°58'16'' N, 5º20'96'' E
	Wild ecosystem	Open and exposed	32º02'66'' N, 5º19'81'' E

Sampling methods

Data sampling was carried out on a monthly basis, between April 2012 and March 2013. For that, two standard ant collecting methods were used. Ants for quantitative study were collected using quadrat methods which consist to a manual capture onto a delimited surface, during a known time interval. In this study, ants were sampled from a surface of 10 m x 10 m, during 3min. This method allows the observation of nests and the enumeration of population of each ant species (Berville et al., 2015). A second method was added for complementary data on ant diversity by using pitfall trap (Barber pots). These interceptions traps consisted of a metallic container (7.4 cm diameter × 10.5 cm long), placed at the same level as the surrounding ground, filled one-third with a solution of water and a drop of liquid dishwashing soap to break the surface tension. Each pitfall trap distant from the other by 5 m along a transect of 50 m^2 (10 traps) for each study site. The pitfall traps were left running during 24 hours before being gathered and emptied of their contents. This method was used by several authors such as (Hernández-Ruiz & Castaño-Meneses, 2006; Berville et al., 2015).

Data analysis

Ant diversity in the study sites was expressed as species richness, Abundance and proportion. Moreover, Factorial Correspondence Analysis (FCA) was carried out using XLSTAT in order to provide a factorial map of the repartition of ant species between the three regions. Hoffman and Franke (1986) defined the Correspondence analysis as an exploratory data analysis technique for the graphical display of contingency tables and multivariate categorical data.

Results and Discussion

Richness and abundance

We recorded 26 ant species of 12 genera and three subfamilies. Myrmicinae was the most abundant subfamily (62.96 %), followed by Formicinae (29.63%) and Dolichoderinae (7.41%). The most diverse genus was *Monomorium* and *Messor* (5 species each ones), followed by *Cataglyphis* (4). *Tapinoma*, *Componotus* and *Tetramorium*, each is represented by two species. However, the genera *Lepisiota*, *Plagiolepis*, *Cardiocandyla*, *Crematogaster*, *Pheidole* and *Strumigenys* are presented by one species each one. The genus *Strumigenys* is recorded for the first time from Algeria by the species *S. membranifera* EMERY, 1869. The region of Djamaa was the most diversify with 24 ant species, followed by Ouargla (18) and El-Oued (13). Similarly, Djamaa region included the high number of restricted ant species, which are represented by: *Tapinoma simrothi*, *Cataglyphis albicans*, *Plagiolepis barbara*, *Crematogaster inermis*, *Messor sanctus* and *Tetramorium sericeiventre*. Nevertheless, both of El-Oued region and Ouargla region include one restricted ant species each ones, represented by *Messor aegyptiacus tunetinus* and *S. membranifera* respectively. According to Deyrup (1997), this species often occurs in disturbed open areas, such as lawns and pastures. Effectively, one sample of this species, identified as a queen was collected from the wild ecosystem of

Table 2. Occurrence and distribution of ant species collected in the northeastern Sahara of Algeria.

Subfamilies	Species	Djamaa region		El-Oued region		Ouargla region	
		WE	AE	WE	AE	WE	AE
Dolichoderinae	*Tapinoma nigerrimum* (Nylander, 1856)	-	+	-	-	-	+
	Tapinoma simrothi (Krausse, 1911)	-	+	-	-	-	-
Formicinae	*Camponotus barbaricus* (Emery, 1905)	-	+	-	+	+	+
	Camponotus thoracicus (Fabricius, 1804)	+	+	-	+	+	+
	Cataglyphis albicans (Roger, 1859)	-	+	-	-	-	-
	Cataglyphis bicolor (Fabricius, 1793)	+	+	-	+	+	+
	Cataglyphis bombycina (Roger, 1859)	+	-	+	+	+	-
	Cataglyphis rubra (Forel, 1903)	+	-	-	-	+	-
	Lepisiota frauenfeldi atlantis (Santschi, 1917)	+	+	-	-	+	+
	Plagiolepis barbara (Santschi, 1911)	+	+	-	-	-	-
	Cardiocondyla batesii (Forel, 1894)	+	+	-	+	+	+
	Crematogaster inermis (Mayr, 1862)	-	+	-	-	-	-
	Messor arenarius (Fabricius, 1787)	+	-	+	+	+	-
	Messor aegyptiacus tunetinus (Santschi, 1923)	-	-	+	+	-	-
	Messor foreli (Santschi, 1923)	+	-	-	+	+	-
	Messor medioruber sublaeviceps (Santschi, 1910)	+	+	-	-	+	-
	Messor sanctus (Emery, 1921)	+	+	-	-	-	-
Myrmicinae	*Monomorium areniphilum* (Santschi, 1911)	+	+	+	+	-	+
	Monomorium destructor (Jerdon, 1851)	+	-	-	-	+	+
	Monomorium salomonis obscuratum (Linnaeus, 1758)	+	+	-	-	-	+
	Monomorium salomonis obscuriceps (Santschi, 1921)	+	+	+	+	+	+
	Monomorium subopacum (Smith, 1858)	+	+	+	-	+	-
	Pheidole pallidula (Nylander, 1849)	+	+	+	+	+	+
	Strumigenys membranifera (Emery, 1869)	-	-	-	-	+	-
	Tetramorium biskrense (Forel, 1904)	+	+	-	+	-	-
	Tetramorium sericeiventre (Emery, 1877)	+	-	-	-	-	-
	Total/area	19	18	7	12	15	11
	Total/ region	24		13		18	

WE: wild ecosystem; AE: agricultural ecosystem

Ouargla region. In Saudi Arabia, it was recorded from an area of date palm trees cultivation (Sharaf et al., 2014). Wetterer (2011) considered *S. membranifera* as a cosmopolitan ant species which has spread around the world through human commerce, in all zoogeographical regions (Bolton, 1983; Bolton, 2000). But it was probably suggested that it has an African origin (Brown & Wilson, 1959). In the Mediterranean region, it occurs in: France, Greece, Italy, Malta, Spain, Egypt and Tunisia (Wetterer, 2011). The absence of record of this species in the adjacent countries such as Morocco, Libya, Niger and Mali allowed us to suggest a hypothesis of being introduced from Tunisia because of its localization near El Oued region and their similar ecosystems. Although its known that *S. membranifera* and *S.emmae* are a successful invasive species (Wetterer 2011), Sharaf et al. (2014) thought that *S. membranifera* reaches more temperate areas. So, the Sahara of Algeria presents a good area for their invasion.

The analyze of the data of table 2 shows that some ant species are common in all study sites. For example: *Monomorium salomonis obscuriceps* and *Pheidole pallidula* are the only species which occurred in all study stations. This result confirms the view of (Hernández-Ruiz & Castaño-Meneses, 2006) which stated that populations of the genus *Monomorium* are frequent and occupy environments with different conditions of soil (humid or dry), because they are not so highly affected by micro weather changes. In other hand, the species *P. pallidula* has spread through the Mediterranean regions (Bernard, 1956). The study of the abundance of ant species in different ecosystems of the northeastern Sahara of Algeria is given for the first time. Among the identified species, the most abundant ant species was *Lepisiota frauenfeldi atlantis* (34.02%) for Djamaa region, *Messor aegyptiacus tunetinus* (28.24%) for El-Oued region and *Tapinoma nigerrimum* (23.58%) for Ouargla region (Tables 3, 4, 5). By analyzing

the data of tables (3, 4, 5), we observe that most species of the genus *Cataglyphis* was found more abundant in the wild ecosystems. However, *C. albicans* was restricted to the agricultural areas. This genus is occured in open areas such as clearing and steppe in the north of Africa from the seaside to 2800m in Hoggar (Cagniant, 2009). Also, *Cataglyphis bombycina* was the most abundant. Its high abundance is explained by their common existence in sand-dune and other sandy areas of the south of Morocco and Algeria (Cagniant, 2009). Similarly, *L. frauenfeldi atlantis* occured greatly on arid zone (Cagniant, 2006). The lowest abundance is reported in the genus *Cardiocondyla*. According to (Cagniant, 2009), this genus appears discretely in open habitat. Generally, there is a difference and variation in the proportion of each ant species between different study sites and habitats. Some species are found in wild and agricultural ecosystems. In other hand, some species are collected just from the wild ecosystem such as, *Cataglyphis rubra, Tetramorium sericeiventre* and *S. membranifera.* Cagniant (1997) confirmed the presence of the species *T. sericeiventre* in the region of Biskra which is located near the region of Djamaa. In opposition, the species, *Tapinoma nigerrimum*, *T. simrothi* and *Crematogaster inermis* were collected only from agricultural areas. *T. nigerrimum* was found in pasturage milieu from the north of Algeria into the Saharan Atlas (Cagniant, 1970b). Whereas, *T. simrothi* is more common in pasture areas but it suffers if exposed to cold. The same author confirmed its presence in the Saharan Atlas of Algeria above 1300 m. This variation in abundance and distribution between the two species is explained by (Cagniant, 1966a) who wrote that *T. nigerrimum* resists better cold, this capacity allowed it to be maintained in the north of Algeria. For the *Crematogaster* genus, Cagniant (2005) found *C. inermis* on tree (fruit and Tamarix) in Morocco and include the other species of this group to the arboreal insect, most of the time.

Table 3. Abundance and proportion of ant species recorded in Djamaa region.

Species	Wild ecosystem		Agricultural ecosystem		Total	
	A	P (%)	A	P (%)	A	P (%)
Tapinoma nigerrimum (Nylander, 1856)	0	0	1779	18.26	1779	11.92
Tapinoma simrothi (Krausse, 1911)	0	0	76	0.78	76	0.51
Camponotus barbaricus (Emery, 1905)	0	0	43	0.44	43	0.29
Camponotus thoracicus (Fabricius, 1804)	40	0.77	16	0.16	56	0.38
Cataglyphis albicans (Roger, 1859)	0	0	27	0.28	27	0.18
Cataglyphis bicolor (Fabricius, 1793)	81	1.56	651	6.68	732	4.90
Cataglyphis bombycina (Roger, 1859)	80	1.54	0	0.00	80	0.54
Cataglyphis rubra (Forel, 1903)	15	0.29	0	0.00	15	0.10
Lepisiota frauenfeldi atlantis (Santschi, 1917)	3110	59.96	1968	20.21	5078	34.02
Plagiolepis barbara (Santschi, 1911)	18	0.35	26	0.27	44	0.29
Cardiocondyla batesii (Forel, 1894)	16	0.31	20	0.21	36	0.24
Crematogaster inermis (Mayr, 1862)	0	0	40	0.41	40	0.27
Messor arenarius (Fabricius, 1787)	9	0.17	0	0.00	9	0.06
Messor foreli (Santschi, 1923)	972	18.74	0	0.00	972	6.51
Messor medioruber sublaeviceps (Santschi, 1910)	6	0.12	2020	20.74	2026	13.57
Messor sanctus (Emery, 1921)	30	0.58	44	0.45	74	0.50
Monomorium areniphilum (Santschi, 1911)	268	5.17	843	8.66	1111	7.44
Monomorium destructor (Jerdon, 1851)	13	0.25	0	0.00	13	0.09
Monomorium salomonis obscuratum (Linnaeus, 1758)	10	0.19	2	0.02	12	0.08
Monomorium salomonis obscuriceps (Santschi, 1921)	57	1.10	1354	13.90	1411	9.45
Monomorium subopacum (Smith, 1858)	42	0.81	338	3.47	380	2.55
Pheidole pallidula (Nylander, 1849)	394	7.60	438	4.50	832	5.57
Tetramorium biskrense (Forel, 1904)	1	0.02	55	0.56	56	0.38
Tetramorium sericeiventre (Emery, 1877)	25	0.48	0	0.00	25	0.17
Total	5187	100	9740	100	14927	100

A: abundance, P: proportion

Table 4. Abundance and proportion of ant species recorded in El-Oued region.

Species	Wild ecosystem		Agricultural ecosystem		Total	
	A	P (%)	A	P (%)	A	P (%)
Camponotus barbaricus (Emery, 1905)	0	0.00	93	2.60	93	2.25
Camponotus thoracicus (Fabricius, 1804)	0	0.00	3	0.08	3	0.07
Cataglyphis bicolor (Fabricius, 1793)	0	0.00	13	0.36	13	0.32
Cataglyphis bombycina (Roger, 1859)	163	29.80	277	7.74	440	10.67
Cardiocondyla batesii (Forel, 1894)	0	0.00	98	2.74	98	2.38
Messor arenarius (Fabricius, 1787)	157	28.70	569	15.90	726	17.60
Messor aegyptiacus tunetinus (Santschi, 1923)	98	17.92	1067	29.82	1165	28.24
Messor foreli (Santschi, 1923)	0	0	190	5.31	190	4.61
Monomorium areniphilum (Santschi, 1911)	53	9.69	512	14.31	565	13.70
Monomorium salomonis obscuriceps (Santschi, 1921)	20	3.66	16	0.45	36	0.87
Monomorium subopacum (Smith, 1858)	4	0.73	0	0.00	4	0.10
Pheidole pallidula (Nylander, 1849)	52	9.51	698	19.51	750	18.18
Tetramorium biskrense (Forel, 1904)	0	0.00	42	1.17	42	1 .02
Total	547	100	3578	100	4125	100

Factorial Correspondence Analysis (FCA)

The factorial map displays a total inertia of 100 % for both axes, F1 (60. 62%) and F2 (39. 38%) (Fig 1). The chart shows the existence of six grouping (A, B, C, D, E, F) distribute between the study regions. The groups A, C and E contain exclusive species for Djamaa, El-Oued and Ouargla region respectively, which are already mentioned in the text above. The group B contains one species shared between Djamaa and El-Oued region, represented by *T. biskrense*. The group D contains 11 species shared between the three regions represented by: *Camponotus barbaricus, Camponotus thoracicus*, *Cataglyphis bicolor*, *C. bombycina*, *Cardiocondyla batesii*, *Messor arenarius*, *Messor foreli*, *Monomorium areniphilum*, *M. salomonis obscuriceps*, *Monomorium subopacum*, *P. pallidula*. The last group F contains 6 species shared between the region of Ouargla and the region of Djamaa. This group groups the species *T. nigerrimum*, *C. rubra*, *L. frauenfeldi atlantis*, *Messor medioruber sublaeviceps*, *Monomorium destructor*, *Monomorium salomonis obscuratum*.

Table 5. Abundance and proportion of ant species recorded in Ouargla region.

Species	Wild ecosystem		Agricultural ecosystem		Total	
	A	P (%)	A	P (%)	A	P (%)
Tapinoma nigerrimum (Nylander, 1856)	0	0.00	1142	34.04	1142	23.58
Camponotus barbaricus (Emery, 1905)	3	0.20	7	0.21	10	0.21
Camponotus thoracicus (Fabricius, 1804)	3	0.20	71	2.12	74	1.53
Cataglyphis bicolor (Fabricius, 1793)	50	3.36	200	5.96	250	5.16
Cataglyphis bombycina (Roger, 1859)	683	45.87	0	0.00	683	14.10
Cataglyphis rubra (Forel, 1903)	20	1.34	0	0.00	20	0.41
Lepisiota frauenfeldi atlantis (Santschi, 1917)	24	1.61	953	28.41	977	20.17
Cardiocondyla batesii (Forel, 1894)	2	0.13	29	0.86	31	0.64
Messor arenarius (Fabricius, 1787)	3	0.20	0	0.00	3	0.06
Messor foreli (Santschi, 1923)	482	32.37	0	0.00	482	9.95
Messor medioruber sublaeviceps (Santschi, 1910)	2	0.13	0	0.00	2	0.04
Monomorium areniphilum (Santschi, 1911)	0.00	0	217	6.47	217	4.48
Monomorium destructor (Jerdon, 1851)	10	0.67	9	0.27	19	0.39
Monomorium salomonis obscuratum (Linnaeus, 1758)	0	0.00	9	0.27	9	0.19
Monomorium salomonis obscuriceps (Santschi, 1921)	129	8.66	31	0.92	160	3.30
Monomorium subopacum (Smith, 1858)	1	0.07	0	0.00	1	0.02
Pheidole pallidula (Nylander, 1849)	76	5.10	687	20.48	763	15.75
Strumigenys membranifera (Emery, 1869)	1	0.07	0	0.00	1	0.02
Total	1489	100	3355	100	4844	100

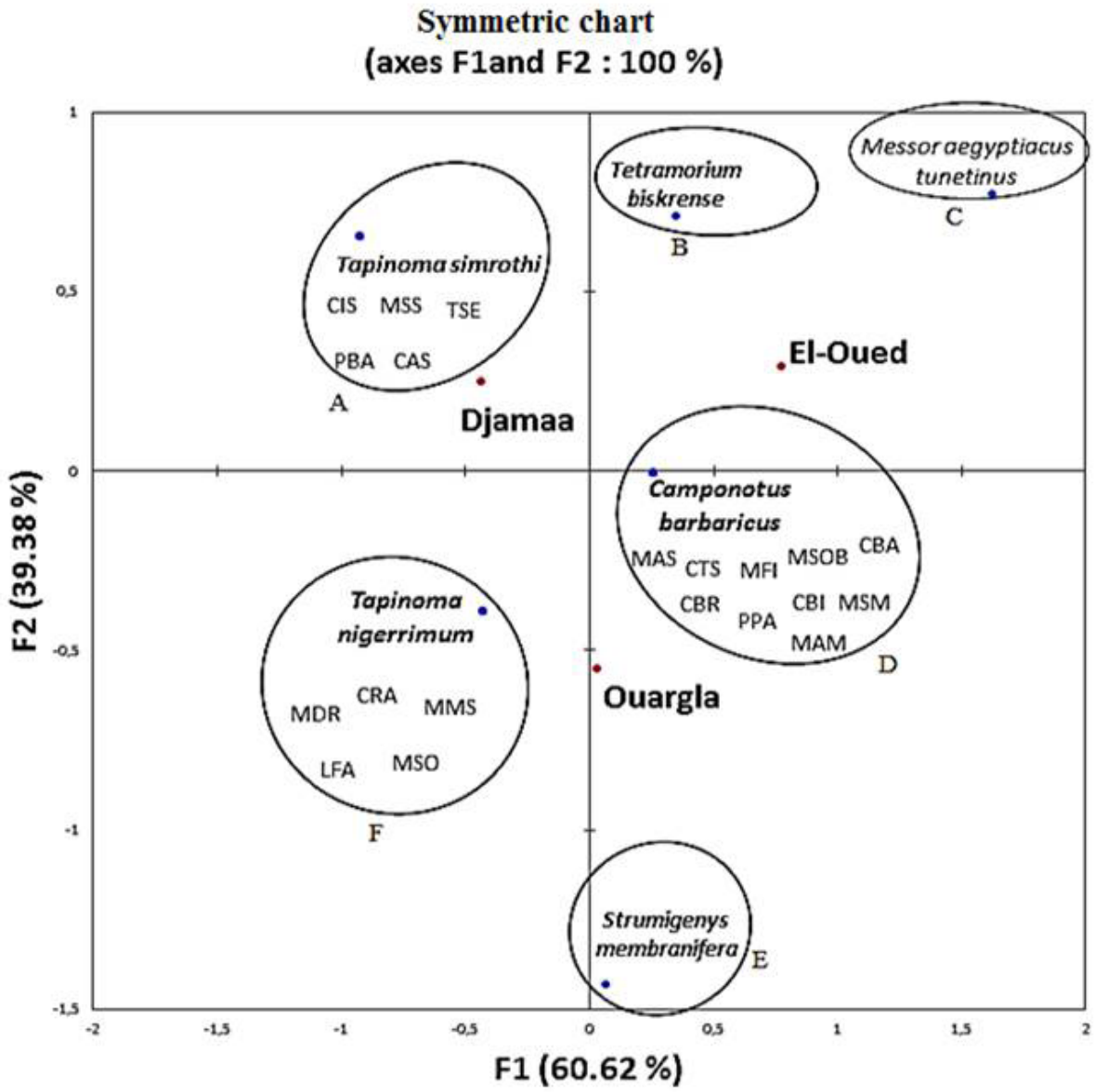

Fig 1. Chart represents factorial map of the repartition of ant species in the study region
CAS: *Cataglyphis albicans*, CBA: *Cataglyphis bombycina*, CBI: *Cardiocondyla batesii*, CBR: *Cataglyphis bicolor*, CIS: *Crematogaster inermis*, CRA: *Cataglyphis rubra*, CTS: *Camponotus thoracicus*, LFA: *Lepisiota frauenfeldi atlantis*, MAM : *Monomorium areniphilum*, MAS: *Messor arenarius,* MDR: *Monomorium destructor*, MFI: *Messor foreli*, MMS: *Messor medioruber sublaeviceps*, MSM: *Monomorium subopacum*, MSO: *Monomorium salomonis obscuratum*, MSOB: *Monomorium salomonis obscuriceps*, MSS: *Messor sanctus*, PBA: *Plagiolepis barbara*, PPA: *Pheidole pallidula*, TSE: *Tetramorium sericeiventre*.

For a better understanding of the variation in the distribution of ants species, others researches must be made in the future. This last is consistent with the study of the influence of ecological determinants such as soil parameters and vegetation cover on ant distribution. Bardgett et al. (2005) wrote that Soil characteristics are well known with their strong effects on spatial distribution of soil communities. Meanwhile, Boulton et al. (2005) concluded that overall ant species richness and abundance are more consistently associated with soil chemistry and texture than plants. Additionally, a particular change in environmental conditions may increase the diversity of one subset of organisms within a community, while decreasing the diversity of a different group of organisms (Semida et al., 2001). Also, there is a relationship between ant community abundance and altitude. Taheri and Reyes-Lo´pez (2015) stated that some approach followed in the study of myrmecofauna such as season, altitude, aridity, geology and vegetation types and animal farming practices give a better picture of the composition and distribution of the species.

This work is a contribution for the study of Algerian myrmecofauna of the northeastern Sahara. Data on ant fauna from the occidental and central Sahara stay unknown and need a great effort in sampling methods to dispatch richness and abundance of species. Finally, it is certain that other survey expanded in space and in time will enrich more this list.

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Appendix I. Vegetation found in different environment of the study sites.

Sampling sites	Environment	vegetation
Djamaa region	Agricultural ecosystem	*Lactuca sativa* L., *Allium cepa* L., *Allium sativum* L., *Mentha pulegium* L., *Phoenix dactylifera* L., *Medicago sativa* L.
El-Oued region	Wild ecosystem	*Zygophyllum album* L., *Tamarix gallica* L.
	Agricultural ecosystem	*Solanum tuberosum* L., *Cynodon glabratus* L., *Phoenix dactylifera*
	Wild ecosystem	*Stipa tenacissima* L.
Ouargla region	Agricultural ecosystem	*Lactuca sativa* L., *Phoenix dactylifera* L., *Prunus armeniaca* L., *Allium sativum* L., *Medicago sativa* L., *Phragmites communis* L.
	Wild ecosystem	*Reseda sp* L., *Zygophyllum album* L.