

A first checklist and diversity of ants (Hymenoptera: Formicidae) of the saline dry lake Chott El Hodna in Algeria, a Ramsar Conservation Wetland

G. Barech^{1,2*}, M. Khaldi^{1,2}, S. Ziane¹, A. Zedam¹, S. Doumandji²,
M. Sharaf³ & X. Espadaler⁴

¹Département d'Agronomie, Faculté des Sciences, Université Mohamed Boudiaf de M'sila, 28000, Algeria

²Département de Zoologie Agricole et Forestière, Ecole Nationale Supérieure Agronomique (ENSA), El-Harrach, Alger, 16200, Algeria

³Plant Protection Department, College of Food Sciences and Agriculture, King Saud University, P.O. Box 2460, Riyadh 11451, Saudi Arabia

⁴Ecology Unit and CREAF, Autonomous University of Barcelona, Bellaterra 08193, Spain

In the first study of its kind, ants (Hymenoptera: Formicidae) were sampled near a unique natural environment, a large saline lake, Chott El Hodna, a Ramsar Conservation Wetland in eastern Algeria. The species of ants were determined at two sites, Medbah and Birkraa in spring (March–April) 2011 using pitfall trapping and hand collecting. We provide a checklist and some observations on 24 species belonging to 14 genera and four subfamilies (Dolichoderinae, Dorylinae, Formicinae and Myrmicinae). To evaluate the ant diversity, we used data from pitfall traps for calculating ecological indexes.

Key words: Formicidae, Algeria, chott, checklist, diversity.

INTRODUCTION

The natural landscapes of Algeria include a diversity of wetlands which are important staging habitats and wintering grounds for migrating Palearctic birds (Samraoui & Samraoui 2008). Chott El Hodna is one of a series of wetland complexes composed of vast and shallow dry saline lakes often seasonally wet, that occur in the semi-arid 'Algerian Hauts Plateaux' located between the Saharan Atlas and the northern narrow coastal plains (Boulkhssaïm *et al.* 2013). These wetlands are ranked among the best wintering sites in Algeria for water birds in Algeria. Created by waters draining from the Atlas Tellien to the north and the Saharan Atlas to the south, the chotts are typified by having a landscape of vegetated Maghreb steppe with seasonal brackish and saline lakes, pools, marshes, and freshwater springs (Ramsar 2011).

Chott El Hodna is supplied by at least 22 main streams and freshwater springs and is covered with water only in winter. In summer it is dry and salty, with a salt crust covering the whole area (Ladgham-Chicouche & Zerguine 2001). The rare ecosystem is of great interest to ecologists and is a site where post-breeding birds congregate (Samraoui & Samraoui 2008; Boulkhssaïm *et al.*

2013). The fauna of Chott El Hodna is rich and diverse but, in contrast to the flora, little is known due to a lack of specific studies, especially of the arthropods, among them the myrmecofauna (Ladgham-Chicouche & Zerguine 2001).

There are a few studies of the ants of dry saline lake areas (chott) of North Africa, notably from Tunisia, particularly Chott El Jerid and Maharès, but those primarily report visual navigation behaviours, such as the mechanisms of navigation, orientation and distance estimation of the desert ants *Cataglyphis fortis* (Forel, 1902) and *Cataglyphis bicolor* (Roger, 1859) (Müller & Wehner 1994; Horváth & Wehner 1999; Meyer & Domanico 1999; Wolf & Wehner 2000; Wohlgemuth *et al.* 2002; Dillier & Wehner 2004; Cheng *et al.* 2006). Those studies, however, have not provided a checklist of ant species. Most studies of ant occurrence and distribution in Algeria are historical and mainly concern the taxa of the Sahara and forest ecosystems (*e.g.* Forel 1890, 1894; Lameere 1902; Stitz 1917; Santschi 1924, 1934; Bernard 1953, 1960; Délye 1968; Cagniant 1973). Barech *et al.* (2011), Barech (2014) and Barech *et al.* (2015) have added more information about ants from Algeria. Here we provide the first investigation of the myrmecological fauna of a saline lake area, Chott El Hodna.

*Author for correspondence. E-mail: barechghania@gmail.com

MATERIAL AND METHODS

Study area

The Chott El Hodna is a dry saline lake in eastern Algeria (35°18' to 35°32'N and 04°15' to 05°06'E) with an area of about 362 000 ha, and set at 392 m mean altitude. The local climate is classified as arid with a cold winter. Precipitation is variable, with a mean of 128.9 mm and ranging between 150 and 200 mm/year. Annual mean temperatures are 20.6 °C (minima: -0.6 °C to 6.2 °C; maxima: 33.0 °C to 37.9 °C). Drought can last 11 to 12 months. Most of the plants in the landscape consist of steppe formations dominated by halophytes such as *Salsola vermiculata* L., *Atriplex halimus* L., *Limonium pruinosum* (L.) Chaz., *Suaeda fruticosa* (L.) Forrsk and *Frankenia thymifolia* Desf. (Kaabeche 1995).

Two sites (Medbah and Birkraa) were chosen close to the saline lake, both situated in the southern part of the Chott. Medbah is located 75 km from the centre of M'Sila (35°21'09"N 4°33'45"E) (Fig. 1). The soil has a sandy texture, medium salinity, and contains little organic matter. Salt crusts usually cover the soil surface. At this site, the vegetation coverage is approximately 20 %. Plant communities are primarily composed of 10 plant families: Asteraceae (*Atractylis flava* Desf.), Chenopodiaceae (*Atriplex halimus* L. and *Halocnemum strobilaceum* (Pall.) M.B.), Brassicaceae (*Ammosperma* sp.), Poaceae (*Oropetium africanum* Coss. & Dur.) Chiov. and *Aeluropus littoralis* (Gouan) Parl.), Geraniaceae (*Erodium* sp.), Plantaginaceae (*Plantago albicans* L.), Plumbaginaceae (*Limonium pruinosum* (L.) Chaz. and *Limoniastrum* sp.), Fabaceae (*Retama retam* Webb.), Terebinthaceae (*Frankenia thymifolia* Desf.) and Thymelaeaceae (*Thymelaea microphylla* Coss. & Dur.). There is a strong dominance of the Chenopodiaceae, represented by halophytic species. The second site, Birkraa is located 90 km from the town of M'Sila (35°21'16"N 4°38'40"E) (Fig. 2). This sampling site has a slope of 10 %. Ants were sampled about 20 m near the dry lake. The vegetation grows in distinct bands along a toposequence, orienting from south to north with an overall 20 % coverage. The most dominant species are the halophytes *Atriplex halimus* L. and *Salsola vermiculata* L. with five other species, *Suaeda fruticosa* (L.) Forrsk, *Halocnemum strobilaceum* (Pall.) M.B., *Limonium pruinosum* (L.) Chaz., *Juncus* spp. and *Frankenia thymifolia* Desf. Some palm trees (*Phoenix dactylifera* L.) are interspersed at both sites. Many rodent holes were seen in the soil with the fat sand rat *Psammomys obesus* Cretzschmar dominating.

Sampling methods

To inventory the ants at the two sites, we employed two standard ant collecting techniques – pitfall trapping (Campos *et al.* 2011) and hand collecting (Romero & Jaffe 1989). All sampling occurred during March and April 2011, the spring season in the region. This followed other myrmecologists, such as Bernard (1945) and Athias-Henriot (1946), who preferred sampling ants in the Maghreb in spring (April and May). Likewise Cagniant (1973) mentioned that the most favourable period for sampling ants in Algeria ranges from late April to late July. Any myrmecological research outside of this period is useless, as was confirmed by Barech (2014) working on the ants of North Algeria and steppe.

At each site 20 pitfall traps were placed in transect within the halophilic plant communities 30 m from the Chott. The grid was set as two parallel transects with the pitfall traps spaced 10 m apart. Pitfall traps consisted of a metallic container (7.4 cm diameter × 10.5 cm long) two-thirds filled with soapy water and left open for 3–4 days. Hand collecting also was done during this time. As many microhabitats types as possibly favoured by ants were examined, such as among vegetation, under rocks, in fallen woody debris, palm trees, etc. All ants were placed in vials, preserved in 70 % ethanol and labelled for type of collecting, trap number, and any ecological information. Voucher specimens of all ant species were identified by X.E. at the Universitat Autònoma de Barcelona (UAB) and are deposited in his collection.

Data analysis

To evaluate the species abundance and species diversity at each site and the differences in community composition, data of pitfall traps was analysed using PAST software (PALEontological STatistics) Version 2.17.

The indexes used to examine ant community composition and structure at the two sites at Chott El Hodna, were species richness (S), relative abundance (RA), occurrence frequency (O), dominance (D), Shannon's diversity index (H), Simpson's diversity index and evenness (E).

RESULTS

Myrmecofauna

A total of 928 ant individuals were collected (682 by pitfalls, 246 by hand) representing 24 species



Fig. 1. Medbah sampling site.



Fig. 2. Birkraa sampling site.

from 14 genera and four subfamilies (Dolichoderinae, Dorylinae, Formicinae, Myrmicinae) (Fig. 3, Table 1). More species of ants were collected by pitfall trapping (20) than hand sampling (15). Taxa of two subfamilies dominated the ant fauna. Myrmicinae were the most frequently collected and included 14 species representing seven genera accounting for 58 % of the total number collected. The other was the Formicinae, with eight species in five genera representing 33 % of the total. Dolichoderinae and Dorylinae were each represented by a single taxon comprising 4 % each of the total surveyed ants. The number of species collected, using pitfall traps, was almost identical at both sites: 14 at Medbah and 13 at Birkraa (Table 2). Seven species were found at both sites (*Tapinoma simrothi* Krausse, 1911; *Messor arenarius* (Fabricius, 1787); *Messor* sp. 1; *Monomorium* sp. 2; *Tetramorium biskrense* Forel, 1904; *Goniomma* cf. *barbaricum* Santschi, 1929, *Cataglyphis savignyi*

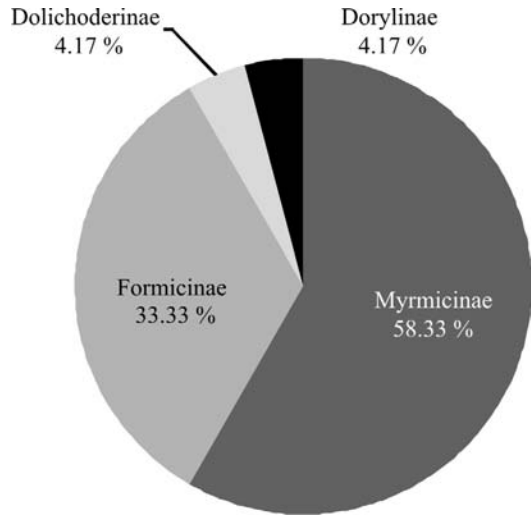


Fig. 3. Species-richness pattern of subfamilies at Chott El Hodna (pitfalls and hand sampling).

Table 1. Ant species collected at Chott El Hodna, Algeria from March–April 2011 by two sampling methods.

Subfamily	Species	Pitfall	Hand
Dolichoderinae	<i>Tapinoma simrothi</i> Krausse, 1911	15	16
Myrmicinae	<i>Messor medioruber</i> Santschi, 1910	10	0
	<i>Messor arenarius</i> (Fabricius, 1787)	19	38
	<i>Messor striatulus</i> Emery, 1891	0	11
	<i>Messor</i> sp. 1	58	23
	<i>Messor</i> sp. 2	0	19
	<i>Monomorium salomonis</i> (Linnaeus, 1758)	12	23
	<i>Monomorium</i> sp. 1	1	0
	<i>Monomorium</i> sp. 2	346	41
	<i>Cardiocondyla nigra</i> Forel, 1905	2	0
	<i>Tetramorium biskrense</i> Forel, 1904	118	0
	<i>Goniomma</i> cf. <i>thoracica</i> Santschi, 1907 (1)	6	4
	<i>Goniomma</i> cf. <i>barbaricum</i> Santschi, 1929 (1)	6	1
	<i>Pheidole pallidula</i> (Nylander, 1848)	37	0
	<i>Aphaenogaster</i> sp.	1	1
Dorylinae	<i>Dorylus fulvus</i> (Westwood, 1840)	0	6
Formicinae	<i>Plagiolepis</i> sp.	2	0
	<i>Lepisiota frauenfeldi</i> Mayr, 1855	19	49
	<i>Cataglyphis bicolor</i> (Fabricius, 1793)	3	0
	<i>Cataglyphis savignyi</i> (Dufour, 1862)	21	7
	<i>Cataglyphis bombycinus</i> (Roger, 1859)	3	2
	<i>Cataglyphis albicans</i> (Roger, 1859)	0	5
	<i>Bajcaridris</i> sp.	2	0
	<i>Camponotus atlantis</i> Forel, 1890	1	0
Total individuals	928	682	246
Total richness	24	20	15

(1) The names cf. *thoracica* and cf. *barbaricum* used here do not reflect a taxonomic decision. Both are unavailable names (Bolton 2012). Formal taxonomic decision is pending.

Table 2. Ant species collected by pitfall trapping March–April 2011 at two sites at Chott El Hodna, Algeria.

Subfamily	Species	Medbah		Birkraa	
		N	RA %	N	RA %
Dolichoderinae	<i>Tapinoma simrothi</i> Krausse, 1911	11	2.32	4	1.93
Myrmicinae	<i>Messor medioruber</i> Santschi, 1910	10	2.11	0	0
	<i>Messor arenarius</i> (Fabricius, 1787)	18	3.79	1	0.48
	<i>Messor</i> sp. 1	58	12.21	0	0
	<i>Monomorium salomonis</i> (Linnaeus, 1758)	0	0	12	5.8
	<i>Monomorium</i> sp. 1	0	0	1	0.48
	<i>Monomorium</i> sp. 2	304	64	42	20.29
	<i>Cardiocondyla nigra</i> Forel, 1905	0	0	2	0.97
	<i>Tetramorium biskrense</i> Forel, 1904	5	1.05	113	54.59
	<i>Goniomma</i> cf. <i>thoracica</i> Santschi, 1907 (1)	6	1.26	0	0
	<i>Goniomma</i> cf. <i>barbaricum</i> Santschi, 1929 (1)	1	0.21	5	2.42
	<i>Pheidole pallidula</i> (Nylander, 1848)	37	7.79	0	0
	<i>Aphaenogaster</i> sp.	1	0.21	0	0
	Formicinae	<i>Plagiolepis</i> sp.	0	0	2
<i>Lepisiota frauenfeldi</i> Mayr, 1855		0	0	19	9.18
<i>Cataglyphis bicolor</i> (Fabricius, 1793)		0	0	3	1.45
<i>Cataglyphis savignyi</i> (Dufour, 1862)		19	4	2	0.97
<i>Cataglyphis bombycinus</i> (Roger, 1859)		3	0.63	0	0
<i>Bajcaridris</i> sp.		1	0.21	1	0.48
<i>Camponotus atlantis</i> Forel, 1890		1	0.21	0	0
Total individuals	682	475	207		
Total species richness	20	14	13		

(1) The names cf. *thoracica* and cf. *barbaricum* used here do not reflect a taxonomic decision. Both are unavailable names (Bolton, 2012). Formal taxonomic decision is pending.

(Dufour, 1862); *Bajcaridris* sp.) *Dorylus fulvus* (Westwood, 1840) was collected only at Birkraa and *Aphaenogaster* sp. only at the Medbah site. *Aphaenogaster* sp. is probably specific to chott. This species is characterised by its globular petiole node, small to non-existent metasternal process, presence of gular ammochetae and elongated head (head width/head length 0.85). More specimens are needed for a formal description as a new species.

The species that were collected occurred in the highest abundance during March–April at Birkraa were *T. biskrense*, comprising 55 % of the total abundance and *Monomorium* sp. 2 comprising 19.81 %. At this site *Monomorium* sp. 2 occurred in 54 % of pit trap samples followed by *T. biskrense* with 46.15 %. Other species of ants were collected in low numbers (Fig. 4). At the second site, Medbah, *Monomorium* sp. 2 dominated (64 %) and was collected during each sampling event (Fig. 5). *Cataglyphis savignyi* occurred in almost 62 % of pit traps, but in low abundance (4 %). *Messor arenarius* also was collected in low abundance (4 %) but

occurred in 54 % of the pit trap samples. All other species were trapped in low abundances (Fig. 5).

Species diversity

Dominance (D) at both sites is rather small (0.4 vs 0.35), respectively at Medbah and Birkraa given that this index varies from 0 to 1. The Simpson (1-D) Index illustrates medium values. For the Shannon index the values are generally small with 1.35 bits in Medbah and 1.47 bits in Birkraa which reflect a moderate diversity of ants at these two sites in Chott El Hodna. The evenness values at both sites are similar (0.51 in Medbah vs 0.57 in Birkraa) (Table 3).

DISCUSSION

Ant diversity and richness

This study is the first evaluation of the ants occurring near a unique North African habitat, a large saline lake, by using pitfall trap and hand sampling.

The 24 ant species were divided primarily into

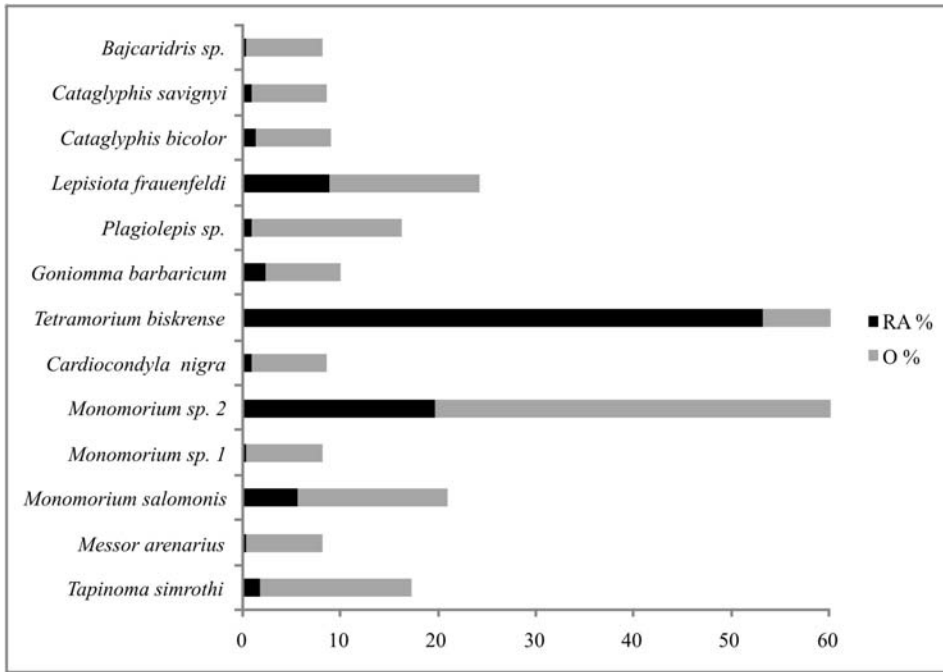


Fig. 4. Relative abundance (RA %) and occurrence frequency (O %) of ant species in Birkraa. Total specimens, 207; number of pitfalls, 20.

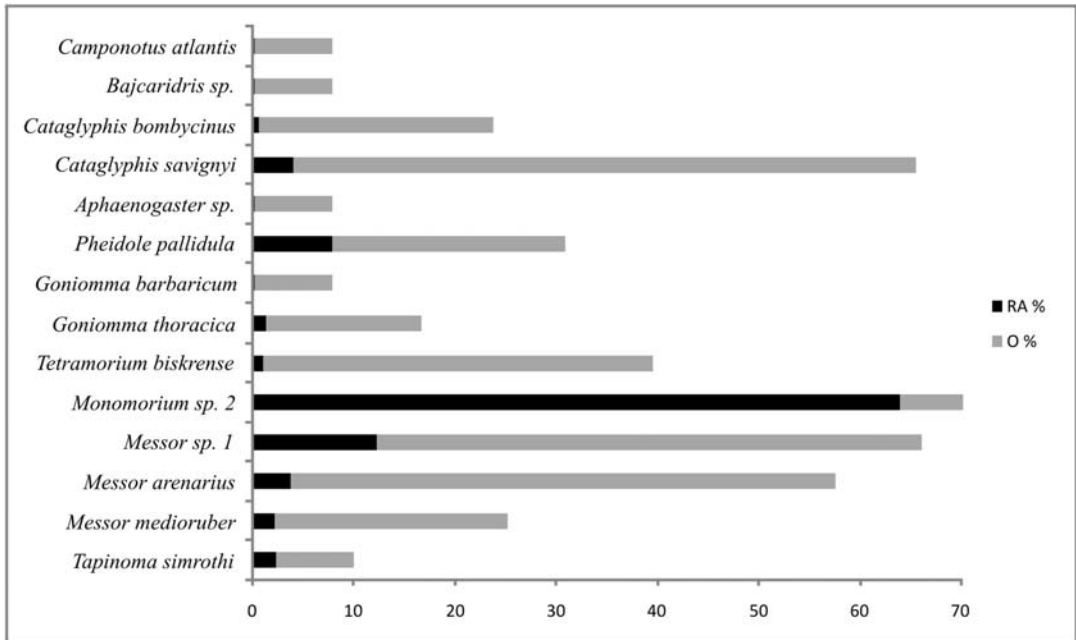


Fig. 5. Relative abundance (RA %) and occurrence frequency (O %) of ant species in Medbah. Total specimens, 475; number of pitfalls, 20.

Table 3. Diversity indexes and Evenness for the two sites at Chott El Hodna, Algeria during March–April 2011.

	Medbah	Birkraa
Taxa (S)	14	13
Individuals	475	207
Dominance (D)	0.4349	0.3525
Simpson (1-D)	0.5651	0.6475
Shannon (H)	1.35	1.478
Evenness (E)	0.5114	0.5761

Myrmicinae (14 species) and Formicinae (eight species). Dolichoderinae and Dorylinae each were represented by one species. The most abundant species was *T. biskrense* in Birkraa, found in 50 % of all traps. *Monomorium* sp. 2 was the most abundant taxon in the pitfall traps at Medbah. The desert ant *C. savignyi* was the most frequently trapped ant, being found in 62 % of all pitfall traps, likely due to differences in catchability. The harvester ants, *M. arenarius* and *Messor* sp. 1, occurred in 54 % of pitfall traps but they were less abundant at this site. However, the frequency of individual workers in pitfall traps may be related to the relative density of nearby nests (Schlick-Steiner *et al.* 2006) or wider foraging ranges (B. Taylor, pers. comm.). Our results of richness at Chott El Hodna (24 spp.) are similar to those found by Campbell *et al.* (2015) in a Namibian salt pan (23 spp.).

Diversity indices provide more information than simply the number of species present (*i.e.* they account for some species being rare and others being common), they serve as valuable tools that enable biologists to quantify diversity in a community and describe its numerical structure (Magurran 1988). The most commonly used indices are based on the estimation of relative abundance of species in samples (Heip *et al.* 1998).

The Simpson index and Shannon index values indicate a moderate diversity of ants at these two sites in Chott El Hodna and the distribution of individuals over species is equitable (see Table 3). Since D takes on values between zero and one, 1-D provides an intuitive proportional measure of diversity that is much less sensitive to species richness (Magurran 2004).

Ant species collected at Chott El Hodna include taxa that are considered in the literature as rare or have a restricted geographical distribution such as: *G. cf. thoracica*, *G. cf. barbaricum* and *Cardio-*

condyla nigra. The male and queen of the two *Goniomma* species are undescribed (Bolton 2012). *Cardiocondyla* and *Goniomma* are genera that are difficult to collect (Cagniant 2009); yet two species of *Cardiocondyla* are listed as cosmopolitan by Cagniant (2006) in his list of Moroccan ants. *Goniomma* known as the Mediterranean harvester ants (Wheeler 1907; Espadaler 1981) are rare in collections because of their nocturnal habits and narrow burrows making them difficult to find (Bernard 1968; Blatrix *et al.* 2013). They inhabit open and flat hot areas and sandy zones (Blatrix *et al.* 2013).

At the Birkraa site two individuals of *C. nigra*, were collected by pitfall traps. This is the second record of this species from Algeria. Seifert (2003) noted that the first record of *C. nigra* in Algeria was in 1934 at Biskra but gave no other information. The report, however, was by Forel (1909) where two workers (one in El Kantara and one in the dunes of Biskra) were named as *C. batesii* var. *nigra* Forel, 1905. Schembri & Collingwood (1981) elevated *C. nigra* to species status. Three species of *Cardiocondyla*, *C. batesii* Forel, 1894, *C. nuda* (Mayr, 1866) and *C. jacquemini* Bernard, 1953 are known from the Saharan region of Algeria (Délye 1968). *Cardiocondyla batesii* was rediscovered by Cagniant (1968) in western Algeria (Oranie).

In our study, we collected only two workers of the rare genus *Bajcaridris*, but unfortunately the species could not be ascertained because only two heads were recovered from the pitfall. Mandible dentition, with five teeth which do not evenly decrease in size from apex to base, allowed for the generic distinction from *Proformica*. Three species of this genus are known from Algeria, *B. kraussii* (Forel, 1895), *B. menozzii* (Santschi, 1923) and *B. theryi* (Santschi, 1936). All three species have rarely been collected since their description. These ants inhabit oueds or wadis of the northern Sahara in Algeria (Agosti 1994). Forel (1895) recorded and described only one individual of *B. kraussii* (worker) from Algerian Sahara (Oued En Nsa between Tougourt and Ouargla). Emery (1899) also described a male of this species from Ghardaia (southern Algeria). *B. kraussii* is a septentrional species populating the Berberian steppes and occurs in the Tunisian Chott (Délye 1968). The second species, *B. menozzii*, was found by Cagniant (1973) in a forest of Red Juniper.

Four species of *Cataglyphis* were collected at Chott El Hodna, *C. bicolor*, *C. albicans*, *C. savignyi*

and *C. bombycinus*. *C. bicolor* apparently prefers clay soils and is found even in heavy, moist soils close to chotts (Wehner *et al.* 1994). This species has been reported to inhabit low-shrub desert surrounding the salt pans (Dillier & Wehner 2004). Their nests are often found within inundation areas that are flooded once every year, areas where no other *Cataglyphis* species occur (Wehner 1983). Colonies of *C. savignyi* were found by Cagniant (2009) in the salt lake of Oum Dbâ (north of Laâyoune) in Morocco and by Heatwole (1996) in the Chott El Djerid in Tunisia. *Cataglyphis albicans* is usually confined to dry, hard and steppe-like regions (Wehner 1983) while *C. bombycinus* is adapted to sandy habitats (Santschi 1929, Athias-Henriot 1946).

In this study, *Messor* spp. were the most species-rich genus represented by *M. medioruber*, *M. striatulus*, *M. arenarius*, *Messor* sp. 1 and *Messor* sp. 2. The harvester ant *M. arenarius* is a common North African ant (Délye 1971). It is a Saharan species (Délye 1968) inhabiting high plains (*Hauts plateaux*) and the northern borders of the Algerian Sahara (Cagniant 1968). This species was recorded in some arid areas of chotts in Algeria (Forel 1902).

The subfamily Dorylinae with the subterranean *Dorylus fulvus* was collected only at Birkraa, where a few individuals were collected by hand from under rocks beneath palm trees. Santschi (1931) describes *Dorylus* as a curious [meaning strange not inquisitive] genus, which is represented in North Africa by two species: *D. (Alaopone) aethiopicus* Emery, 1895; and *D. (Typhlopone) fulvus*. Santschi (1931) separated the form from Tunisia as

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Dorylus (Typhlopone) fulvus West. *St. juvenculus* (Shuck.) v. *punicus* Sants. (Taylor, pers. comm. believes the North Africa–eastern Mediterranean forms are readily separable from the type *D. fulvus*, which seems likely to be of sub-Saharan origin). Nothing is known of the habits of the first species but the latter is closely adapted to a hypogeal life with a social organisation much like termites, with large queens. The nests are found in damp places under large rocks, also associated with animal manure (Santschi 1931). In a salty coastal plain near Maharès (Tunisia) during the five-year period, Dillier & Wehner (2004) observed several attacks by this species on *C. bicolor* colonies.

Messor sp. 1, *Plagiolepis* sp., *Monomorium* sp. 1, *Monomorium* sp. 2 and *Aphaenogaster* sp. require further identification to species. The *Aphaenogaster* sp. seems most probably an undescribed new species.

ACKNOWLEDGEMENTS

The authors would like to extend their sincere appreciation to the Deanship of Scientific Research at King Saud University for its funding of this Research Group (No. RGP-1436-029). We are grateful to the two reviewers of this paper especially B. Taylor for helpful comments on the manuscript, and for checking the English. Special thanks to B. Kondratieff (Colorado State University) for giving substantial comments on the manuscript. G.B. and M.K. thank the University of M'sila for supporting scientific training in the Autonomous University of Barcelona.

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