

# Species diversity of myrmecofauna (Hymenoptera, Formicidae) on the southern slope of Djurdjura National Park (Northern Algeria)

A. Labbaci, F. Marniche, S. Daoudi–Hacini, R. Boulay, A. Milla

Labbaci, A., Marniche, F., Daoudi–Hacini, S., Boulay, R., Milla, A., 2019. Species diversity of myrmecofauna (Hymenoptera, Formicidae) on the southern slope of Djurdjura National Park (Northern Algeria). *Arxius de Miscel·lània Zoològica*, 17: 219–229, Doi: <https://doi.org/10.32800/amz.2019.17.0219>

## Abstract

*Species diversity of myrmecofauna (Hymenoptera, Formicidae) on the southern slope of Djurdjura National Park (Northern Algeria).* This study was carried out at three study sites in the forests of the southern part of Djurdjura National Park. We found a high variety of ants, with 2,651 individuals belonging to 25 species and three subfamilies, Dolichoderinae, Myrmicinae and Formicinae. Sampling methods used were pitfall traps and hand collection. The dominant subfamily was Formicinae, representing 48% of individuals collected. Seven species belonged to this subfamily, 31% of which were *Camponotus cruentatus*. The second most common species found (18%) was *Tapinoma magnum*, an invasive species in many countries. Relative abundance, frequency of occurrence, and diversity varied across the three study sites. Site 1, a black pine forest, had higher species richness (20 species) than site 2, a cedar strip (15 species), and site 3, a mixed holm oak forest (16 species). Our study area has a diverse fauna of ants and distribution of their populations is wide.

Data published in GBIF ([Doi: 10.15470/htbs0q](https://doi.org/10.15470/htbs0q))

Key words: Formicidae, Algeria, Djurdjura National Park

## Resumen

*Diversidad de especies de mirmecofauna (Hymenoptera, Formicidae) en la vertiente sur del Parque Nacional de Djurdjura (norte de Argelia).* Nuestro estudio se desarrolló en tres emplazamientos situados en los bosques de la parte sur del Parque Nacional de Djurdjura. Los resultados revelaron una abundante presencia de hormigas con 2.651 individuos pertenecientes a 25 especies y tres subfamilias: Dolichoderinae, Myrmicinae y Formicinae. Se utilizaron dos métodos de muestreo: trampas de caída y recolección manual. La subfamilia Formicinae es la dominante, con el 48% de los individuos recolectados. Siete especies pertenecen a esta subfamilia, en la que *Camponotus cruentatus* representa el 31%. Otra especie muy común es *Tapinoma magnum*, una especie invasiva en muchos países, con el 18%. La abundancia relativa, frecuencia de hallazgos y diversidad varían en los tres emplazamientos de estudio. El emplazamiento 1, un bosque de pino negro, tiene una elevada riqueza de especies (20 especies), mientras que en el emplazamiento 2, una franja de cedros, contabilizamos 15 especies

y en el emplazamiento 3, un bosque mezclado de encinas, 16 especies. Nuestra área de estudio presenta una diversidad de hormigas y una buena distribución de sus poblaciones.

Datos publicados en GBIF ([Doi: 10.15470/htbs0q](https://doi.org/10.15470/htbs0q))

Palabras clave: Formicidae, Argelia, Parque Nacional de Djurdjura

---

## Resum

*Diversitat d'espècies de mirmecofauna (Hymenoptera, Formicidae) al vessant sud del Parc Nacional de Djurdjura (nord d'Algèria)*. El nostre estudi es va portar a terme en tres emplaçaments situats als boscos de la part sud del Parc Nacional de Djurdjura. Els resultats van revelar una abundant presència de formigues amb 2.651 individus pertanyents a 25 espècies i tres subfamílies: Dolichoderinae, Myrmicinae i Formicinae. Es van utilitzar dos mètodes de mostreig: paranys de caiguda i recol·lecció manual. La subfamília Formicinae és la dominant, amb el 48 % dels individus recol·lectats. Set espècies pertanyen a aquesta subfamília, en la qual *Camponotus cruentatus* en representa el 31 %. Una altra espècie molt comuna és *Tapinoma magnum*, una espècie invasiva en molts països, amb el 18 %. L'abundància relativa, freqüència de troballes i diversitat varien en els tres emplaçaments d'estudi. L'emplaçament 1, un bosc de pi negre, té una riquesa d'espècies elevada (20 espècies), mentre que a l'emplaçament 2, una franja de cedres, vam comptabilitzar 15 espècies i a l'emplaçament 3, un bosc barrejat d'alzines, en vam registrar 16. La nostra àrea d'estudi presenta una diversitat de formigues i una bona distribució de les seves poblacions.

Dades publicades a GBIF ([Doi: 10.15470/htbs0q](https://doi.org/10.15470/htbs0q))

Paraules clau: Formicidae, Algèria, Parc Nacional de Djurdjura

*Received: 25/06/2019; Conditional acceptance: 25/09/2019; Final acceptance: 05/12/2019*

*Asma Labbaci, Samia Daoudi-Hacini, Plant Protection Research Laboratory, Department of Agricultural and Forest Zoology, National High School of Agricultural Sciences, Algiers, Algeria.– Faiza Marniche, Amel Milla, Laboratory of Zoology, National High School of Veterinary, Algiers, Algeria.– Raphaël Boulay, Research Institute of Insect Biology, University of Tours, Tours, France.*

Corresponding author: A. Labbaci. E-mail: [asmalabbaci412@gmail.com](mailto:asmalabbaci412@gmail.com)

ORCID: <https://orcid.org/0000-0002-6680-9676>

---

## Introduction

Algeria is a forest-oriented country (Cagniant, 1968). Since the 1970s, Algeria has paid particular attention to natural environments by classifying these ecosystems as protected areas. The Algerian government has created ten national parks, eight of which are located in the north of the country and have a total area of 165,362 ha. One of these parks, the Djurdjura National Park, covers 18,550 ha (11.19 %) (DGF, 2013) and contains a rich diversity of wildlife with 145 animal species (Mousslim and Nouel-Kheiter, 2017).

Ants are abundant in most terrestrial ecosystems. They are found most anywhere, in forests and in the open, at the water's edge and in dry places, underground, and on rocks, (Cagniant, 1973). The most recent classification of Formicidae (Bolton, 2003) consists of 21 sub-families worldwide. In Algeria, six sub-families have been reported: Formicinae, Myrmicinae, Dolichoderinae, Ponerinae, Dorylinae, and Proceratiinae (Cagniant, 1968, 1970a; Dehina et al., 2013). Several authors have studied myrmecofauna in Algeria: Cagniant (1966, 1968, 1969,

1970a, 1970b, 1973), Dehina et al. (2013), Bouzekri et al. (2014), Djioa and Sadoudi–Ali Ahmed (2015), Barrech et al. (2016), and Chemala et al. (2017).

As few studies have been carried out to date in forests areas in Algeria we conducted the present study in the southern part of the Djurdjura National Park to classify Formicidae across three sites that differ in the types of trees therein. The only study conducted previously in this region was that by Cagniant, between 1963 and 1966. However, the area has since undergone changes and disturbances due to anthropization. The objective of this study was to update and complete the list of myrmecological diversity in the southern part of Djurdjura National Park (Northern Algeria).

---

## Material and methods

### Site description

The National Park of Djurdjura is located in the northern–central part of Algeria (36° 27' 47" N, 4° 10' 41" E), covering an area of 185 km<sup>2</sup> (Mousslim and Nouel–Kheiter, 2017). The altitude of the Djurdjura chain averages 2,000 meters and has all the typical characteristics of high mountains.

The Park is divided into four sectors. Three are located on the northern slope. Our work was conducted in the fourth sector, located in the southern part and known for the Tikjda mountain pass. This region has a humid, cool bio–climate characterized by four months of drought (June to September) and an estimated average rainfall of 1,258 mm/year. The monthly temperatures range from 18°C to 23.4°C (Derridj, 1990; Asmani, 1993). The snowfall period may last up to four months in the best years (Derridj, 1990). Being on the southern side of Djurdjura, this sector is directly influenced by hot winds (sirocco).

Three sites were chosen according to their landscape type:

Site 1, located in the Tigounatine region (fig. 1) at an altitude of 1,480 m and it has a southern exposure (36° 27' 10.55" N 4° 06' 22.37" E). It is covered by black pine forest with a diversified floral assemblage (*Ilex aquifolium* L., 1753, *Daphne laureola* L., 1753, *Berberis vulgaris* L., 1753, *Rosa canina* L., 1753, *Anthyllis montana* L. 1753, *Juniperus communis* L., 1753).

Site 2, located in the Taghzarth region at an altitude of 1,510 m with a north–west exposure (36° 27' 31.66" N 4° 06' 38.86" E) (fig. 2). It is rocky with considerable floral diversity, including *Genista* spp. L., 1753, *Crataegus monogyna* L., 1753, *Astragalus* spp. L., 1753, and *Juniperus communis* L., 1753. The site sampled was situated on the edge of a cedar forest.

Site 3, located in the Tawyalt region at an altitude of 1,490 m with a northeastern exposure (36° 26' 28.40" N 4° 06' 57.16" E) (fig. 3). It is a mixed holm oak forest *Quercus ilex* L., 1753 with cedar, *Cedrus atlantica* Carrière, 1855, *Cytisus scoparius* L., 1822, and *Sambucus nigra* L., 1753, *Acer campestre* L., 1753, *Ilex aquifolium* L., 1753, *Juniperus oxycedrus* L., 1753. This site has suffered from fires on several occasions.

### Ant collection

The study was conducted during spring and summer in March 2016 and July 2017, in accordance with the recommendations of Cagniant (1973) and Barech et al. (2016).

Ants were sampled using two methods, visual detection and direct hand collection (Romero and Jaffe, 1989), and the Barber pots method (Campos et al., 2011). Hand collection was performed when the pots were placed; two researchers actively searched for ants in the vegetation and under stones and rocks for 60'. The ants were then preserved in 70° ethanol.

The Barber pots consisted of metallic containers (7.4 cm diameter × 10.5 cm long), placed at ground level. They were filled to one–third with a solution of water and a drop of liquid dishwashing soap to break the surface tension. For each study site, we selected a 100 m



Fig. 1. The Tigounatine region (site 1).

Fig. 1. Zona de Tigounatine (emplazamiento 1).

---

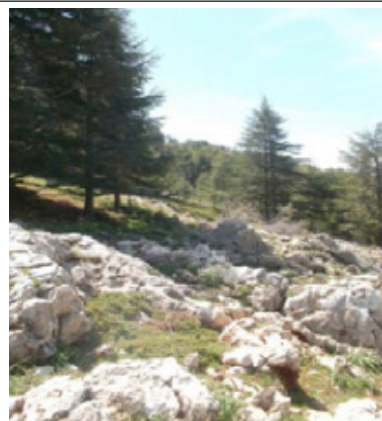


Fig. 2. The Taghzarth region (site 2).

Fig. 2. Zona de Taghzarth (emplazamiento 2).

---

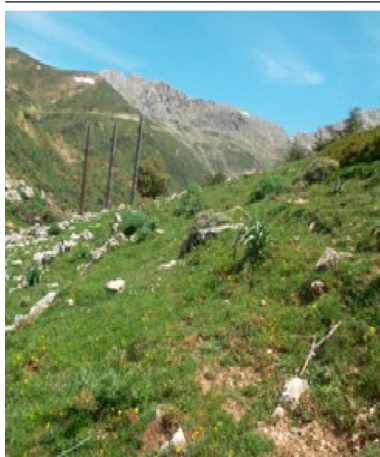


Fig. 3. The Tigounatine region (site 3).

Fig. 3. Zona de Tigounatine (emplazamiento 3).

---

transect and positioned a pitfall trap every 5 m (20 traps). The pitfall traps were left in place for 48 h. Their contents were then collected using a strainer and placed in Petri dishes where the date and place of collection were recorded. Ants were identified based on the determination keys found in AntWeb and AntCat. Concerning the identification of *Tapinoma* genus, species level was determined by Pr. Seifert Bernhard, Senckenberg Museum für Naturkunde Görlitz, Am Museum 1, 02826 Görlitz, Germany. The samples are deposited in the Collection Insectarium at the National High School of Agricultural Sciences, Algiers, Algeria.

### Data analysis

The results of the myrmecological diversity of this study are expressed by ecological indices: species richness (S), relative abundance (AR), frequency of occurrence (O), Shannon diversity index (H), equitability (E), and Simpson's diversity index and evenness (E) using PAST software (Paleontological STatistics) Version 2.17. Correspondence factor analysis (CFA) was conducted using XLStat software (Copyright © 2017 Addinsoft).

---

## Results

We collected a total of 2,651 individuals belonging to three subfamilies, Dolichodorinae, Myrmicinae and Formicinae, across the three sampled sites in the National Park of Djurdjura (see table 1). The number of ants collected in the pitfall traps (1,499 individuals belonging to 25 species and 13 genera, see [dataset published in GBIF, doi: 10.15470/htbs0q](https://doi.org/10.15470/htbs0q)) was slightly higher than the number collected by hand (1,152 individuals belonging to 16 species and 11 genera). The most common species found in the Barber pots was *Camponotus cruentatus* (469 individuals, 31 %) although *Tapinoma magnum* was the species most commonly caught by the hand method (385 individuals, 32.5 %).

Among the three subfamilies present, Formicinae was the most abundant in the pitfall traps (48 %), followed by Myrmicinae (34 %) and Dolichoderinae (18 %). The most abundant subfamily with the hand collection was Myrmicinae (35 %) followed by Dolichoderinae (33 %) and Formicinae (32 %). Because pitfall traps allowed the collection of a larger numbers of species than hand collection, we based our subsequent analyses on this method. The most common species found in the Barber pots was *Camponotus cruentatus* (469 individuals: 31 %) whereas *Tapinoma magnum* was the most common species caught by hand collection (385 individuals: 32 %).

The highest relative abundance was represented by *Tapinoma magnum* at site 1 and by *Camponotus cruentatus* at sites 2 and 3. With regard to frequency of occurrence and consistency, *Aphaenogaster testaceopilosa* was fairly constant in site 1 (40 %) and site 2 (45 %), while in site 3, it was *Camponotus cruentatus*, which is fairly constant (40 %). Most of other species were rare, very rare, accidental, or incidental (table 2).

Table 3 shows the diversity parameters at the three study sites. Wealth and numbers were highest at site 1 (20 species). Dominance tended towards 0 at all three sites, indicating no one species dominated over the others. The Shannon index measures the regularity with which individuals are divided among the taxa present. It revealed values close to two at the three sites, explaining why the southern part of Djurdjura National Park is diversified in ants. The Simpson values (1–D) tended towards one, showing that the diversity was maximal. The flatness values for the three sites were similar.

The distribution of numbers among ant species was not uniform.

The graphical representation of the correspondence factor analysis indicates a good distribution of ant species in the three study sites in the southern part of Djurdjura National Park (fig. 4), with a 100 % contribution rate for both axes 1 and 2. Three groups (A, B and C) emerge from the cloud and each represents the ant species that exist at site 1, 2 and 3, or represent a strong dominance.

Table 1. Relative abundance of ant species sampled at three different sites according to pitfall trapping (PT) and hand collecting (HC) methods: N, number of individuals; RA%, relative abundance in percentage.

Tabla 1. Abundancia relativa de especies de hormigas en tres emplazamientos diferentes, de acuerdo con las capturas realizadas mediante trampas de caída (PT) y recolección manual (HC): N, número de individuos; RA%, abundancia relativa en porcentaje.

Code Species	PT		HC	
	N	RA%	N	RA%
Subfamily Dolichoderinae (Forel, 1878)				
001 <i>Tapinoma magnum</i> Mayr, 1861	276	18.41	385	32.6
Subfamily Myrmicinae (Lepelletier de Saint Fargeau, 1835)				
002 <i>Aphaenogaster testaceopilosa</i> (Lucas, 1849)	114	7.61	52	4.38
003 <i>Aphaenogaster depilis</i> Santschi, 1911	92	6.14	106	8.94
004 <i>Aphaenogaster crocea</i> André, 1881	1	0.08	0	0.00
005 <i>Messor sanctus</i> Emery, 1921	2	0.13	0	0.00
006 <i>Messor barbaru</i> (Linnaeus, 1767)	125	8.34	62	5.23
007 <i>Messor capitatus</i> (Latreille, 1798)	2	0.13	0	0.00
008 <i>Messor foreli</i> Santschi, 1923	2	0.13	0	0.00
009 <i>Crematogaster scutellaris</i> (Olivier, 1792)	13	0.88	27	2.28
010 <i>Crematogaster</i> sp.	2	0.13	3	0.25
011 <i>Monomorium salomonis</i> (Linnaeus, 1758)	1	0.08	1	0.08
012 <i>Pheidole pallidula</i> (Nylander, 1849)	69	4.60	43	3.63
013 <i>Pheidole</i> sp.	4	0.28	2	0.17
014 <i>Solenopsis</i> sp.	3	0.20	0	0.00
015 <i>Tetramorium caespitum</i> (Linnaeus, 1758)	40	2.67	0	0.00
016 <i>Tetramorium biskrense</i> Forel, 1904	17	1.13	90	7.59
017 <i>Tetramorium semilaeve</i> André, 1883	8	0.53	5	0.42
018 <i>Temnothorax</i> sp.	15	1.00	12	1.01
Subfamily Formicinae (Latreille, 1809)				
019 <i>Cataglyphis viatica</i> (Fabricius, 1787)	181	12.08	83	7.00
020 <i>Camponotus cruentatus</i> (Latreille, 1802)	469	31.29	236	19.90
021 <i>Camponotus alii</i> Forel, 1890	32	2.14	43	3.63
022 <i>Camponotus erigens subconcolor</i> Emery, 1920	1	0.07	0	0.00
023 <i>Camponotus piceus</i> (Leach, 1825)	12	0.80	0	0.00
024 <i>Lasius</i> sp.	8	0.53	0	0.00
025 <i>Plagiolepis schmitzii</i> Forel, 1895	10	0.67	2	0.17
Total	1,499	100	1,152	100



Table 2. Relative abundances, occurrence and categories of ants according to the study sites collected by pitfall: RA%, relative abundance; O%, occurrence frequency; Cat, constant category (VR, very rare; R, rare; Ac, accidental; Acc, accessory; Ac, quite constant).

Tabla 2. Abundancia relativa, frecuencia y categorías de hormigas según las capturas realizadas con trampas de caída en los tres emplazamientos de estudio: RA%, abundancia relativa; O%, frecuencia; Cat, categoría constante (VR, muy rara; R, rara; Ac, accidental; Acc, accesoria; Ac, bastante constante).

Species / Parameter	Sites								
	Site 1			Site 2			Site 3		
	RA%	O%	Cat	RA%	O%	Cat	RA%	O%	Cat
<i>Tapinoma magnum</i>	30.52	10	R	7.71	15	R	7.25	20	Ac
<i>Aphaenogaster testaceopilosa</i>	5.91	40	Ac	11.94	45	Ac	6.22	20	Ac
<i>Aphaenogaster depilis</i>	8.30	10	R	1.74	10	R	6.74	15	R
<i>Aphaenogaster crocea</i>	0.00	0	VR	0.00	0	VR	0.26	5	VR
<i>Messor sanctus</i>	0.28	5	VR	0.00	0	VR	0.00	0	VR
<i>Messor barbarus</i>	16.46	10	R	0.00	0	VR	2.07	10	R
<i>Messor capitatus</i>	0.14	5	VR	0.25	5	VR	0.00	0	VR
<i>Messor forelii</i>	0.00	0	VR	0.50	5	VR	0.00	0	VR
<i>Crematogaster scutellaris</i>	0.56	5	VR	2.24	5	VR	0.00	0	VR
<i>Crematogaster</i> sp.	0.28	5	VR	0.00	0	VR	0.00	0	VR
<i>Monomorium salomonis</i>	0.14	5	VR	0.00	0	VR	0.00	0	VR
<i>Pheidole pallidula</i>	3.80	25	Ac	3.48	25	Ac	7.25	35	Acc
<i>Pheidole</i> sp.	0.00	0	VR	0.75	10	R	0.26	5	VR
<i>Solenopsis</i> sp.	0.42	10	R	0.00	0	VR	0.00	0	VR
<i>Tetramorium caespitum</i>	1.97	15	R	5.22	15	R	1.30	15	R
<i>Tetramorium biskrense</i>	0.00	0	VR	1.24	15	R	3.11	15	R
<i>Tetramorium semilavae</i>	1.13	0	VR	0.00	0	VR	0.00	0	VR
<i>Temnothorax</i> sp.	0.56	5	VR	1.99	10	R	0.78	5	VR
<i>Cataglyphis viatica</i>	11.67	10	R	12.44	20	Ac	12.44	20	Ac
<i>Componotus cruentatus</i>	12.80	25	Ac	48.51	45	Ac	47.41	40	Ac
<i>Componotus alii</i>	4.22	10	R	0.00	0	VR	0.52	5	VR
<i>Componotus erigens subconcolor</i>	0.14	5	VR	0.00	0	VR	0.00	0	VR
<i>Componotus piceus</i>	0.56	5	VR	0.75	10	R	1.30	10	R
<i>Lasius</i> sp.	0.00	0	VR	0.00	0	VR	2.07	5	VR
<i>Plageolepis schmitzii</i>	0.14	5	VR	1.24	10	R	1.04	5	VR

Table 3. Diversity indexes and Evenness of the three sites in the southern part of Djurdjura National Park by pitfall.

Tabla 3. Índices de diversidad y regularidad de las capturas mediante trampas de caída en los tres emplazamientos de la parte sur del Parque Nacional de Djurdjura.

Parameters	Sites		
	Site 1	Site 2	Site 3
Taxa_S	20	15	16
Individuals	711	402	386
Dominance_D	0.1645	0.2766	0.2615
Shannon_H	2.11	1.79	1.87
Simpson_1-D	0.8355	0.7234	0.7385
Evenness_e^H/S	0.4136	0.3992	0.4066

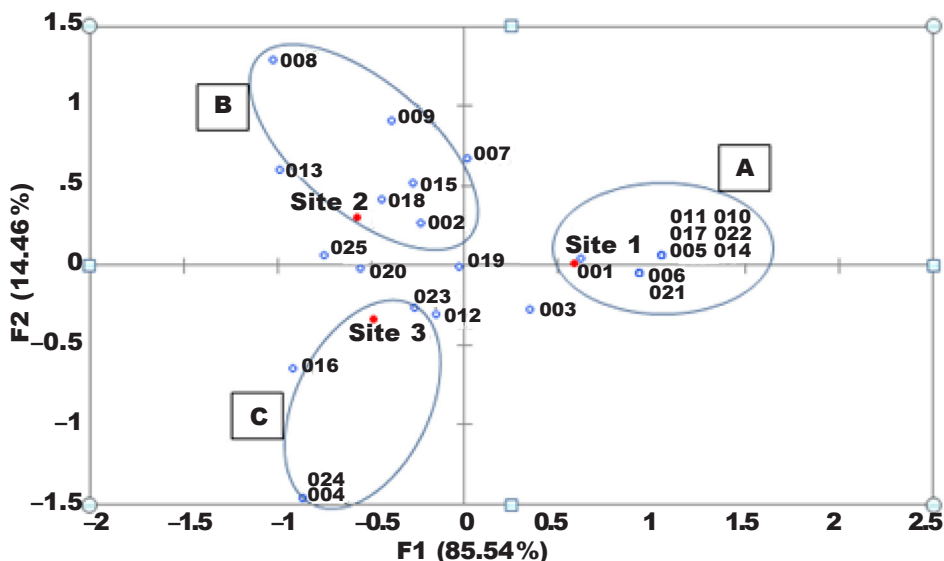


Fig. 4. Graphical representation of the correspondence factor analysis of ant species in Djurdjura National Park.

Fig. 4. Representación geográfica del análisis de factor de correspondencia en el Parque Nacional de Djurdjura.



---

## Discussion

The southern part of Djurdjura National Park is rich in ants. We identified 25 species in the three selected sites (table 1). Cagniant (1968) worked in 30 forest regions of Algeria and identified 90 species, only 55% of which were North African. In another study on ant populations in some forest and agricultural environments in Kabylia, Djioua and Sadoudi–Ali Ahmed (2015), 15 species were identified, including 8 species found in a forest at 1,200 m of altitude.

In the southern part of Djurdjura National Park, the subfamily Formicinae dominates in Barber pots with a portion of 48% and Myrmicinae dominates in direct collection with 35%. While in the northern part of the same park, precisely in the forests of Tizi Ouzou, Djioua and Sadoudi–Ali Ahmed (2015), Myrmicinae dominates with 57% at all stations. In another type of landscape, in the northeastern Sahara, Chemala et al. (2017) reported the dominance of Myrmicinae (62%). In Chott El Hodna, Barech et al. (2016), four subfamilies (Dolichoderinae, Formicinae, Myrmicinae and Dorylinae) have been highlighted. Myrmicinae also dominates in this region (58.3%).

In our study *T. magnum* represents a little more than a third of the specimens (30.5%) found at the first site and less than 10% at the other two sites. This species, previously determined as *Tapinoma nigerrimum*, is found at up to 1,800 m above sea level with grazing in wetlands (Cagniant, 1968). It is well adapted to survive in cold regions (Noordijk, 2016). This supports its presence in our study area at 1,490 m. In addition, the current name *T. magnum* of this invasive ant was used by Seifert et al. (2017) and Lenoir and Galkowski (2017).

About half of the ant population are represented by *C. cruentatus* at site 2 (48.5%) and site 3 (47.4%). According to Cagniant (1968), it is mainly found in the holm oak woods of the Tellian Atlas, at an altitude between 800 and 1,200 m. Indeed, the third site of our study is a mixed forest with holm oak. In addition, *C. viatica* is moderately abundant in all three sites (above 10%). It is a so-called common species on the edge of forests, cited by Cagniant (1968) in the preliminary list of forest ants in Algeria. In 2009, Cagniant reported that species of the genus *Cataglyphis* are found in North Africa from the seaside to the Hoggar (the case of the *targuia* form). It can reach an altitude of 2,800 m and seems to nest in open areas. The *A. crocea* ant was only found on one occasion at site 1, which explains why it is very rare outside Numidia and Aurès (Cagniant, 1968). On the other hand, *A. testaceopilosa* is fairly constant in Djurdjura National Park, with a rate varying between 6 and 12%. Six species are present in all surveyed areas in the northern part of Djurdjura National Park (Djioua and Sadoudi–Ali Ahmed, 2015). These are *C. bicolor*, *A. testaceopilosa*, *P. pallidula*, *T. biskrense*, *T. nigerrimum* and *M. barbara*. These authors also point out that *A. testaceopilosa* is the most constant ant in the region. In the northeastern Sahara, Chemala et al. (2017) note that the two species *M. salomonis obscuriceps* and *P. pallidula* are common in the region. According to Barech et al. (2016), in Chotte El Hodna there are two dominant species, *Monomorium* sp. and *T. biskrense*. In our study, *M. salomonis*, *Crematogaster* sp., *Pheidole* sp., *T. semilavae*, and *Temnothorax* sp. were poorly represented at all three sites.

The various diversity indices used indicate that the diversity of ants in the southern part of Djurdjura National Park is significant, and that there is a good distribution of ants in the environments surveyed. According to Hölldobler and Wilson (1990), the ant community is dominated by a few species that also contribute to reducing the presence of subordinate or opportunistic ants. And according to Heip et al. (1998), a diversity index summarizes the structure and not the functioning of a community and that regularity is independent of species richness. It is argued that the calculation of diversity or regularity indices should simply serve as descriptors of the community structure and be complemented by information on ecological functioning.

---

## Acknowledgements

The authors are grateful to the Editor and the three anonymous referees for their constructive comments and valuable suggestions. We thank my dad Labbaci Belkacem for his help during the sampling process and Claudie Doums for help with the English correction.

---

## References

- Asmani, A., 1993. Exploration of variability in Black Pine in the Tigounatin forest (Djurdjura–Algeria) in comparison with some Mediterranean Black Pine sources. Magister's memoir, Tizi–Ouzou University.
- Barech, G., Khaldi, M., Ziane, S., Zedam, A., Doumandji, S., Sharaf, M., Espadaler, X., 2016. A first checklist and diversity of ants (Hymenoptera: Formicidae) of the saline dry lake Chott El Hodna in Algeria, a Ramsar Conservation Wetland. *African Entomology*, 24: 143–152.
- Bolton, B., 2003. Synopsis and classification of Formicidae. *Memoirs of the American Entomological Institute*, 71: 1–370.
- Bouzekri, M. A., Daoudi, S., Doumandji, S., 2014. Vegetative Selection of Formicidae Species in Steppe Region (State of Djelfa, Algeria). *International Journal of Zoology and Research*, 4(2): 9–14.
- Cagniant, H., 1966. Clé dichotomique des fourmis de l'Atlas blidéen. *Bulletin de la Société d'Histoire Naturelle d'Afrique du Nord*, 56: 26–40.
- 1968. Liste préliminaire de fourmis forestières d'Algérie. Résultats obtenus de 1963 à 1966. *Bulletin de la Société d'Histoire Naturelle de Toulouse*, 104: 138–147.
- 1969. Note sur deux *Aphaenogaster* rares d'Algérie (Hyménoptères, Formicidae, Myrmicinae). *Insectes Sociaux*, 16: 103–114.
- 1970a. Deuxième liste de fourmis d'Algérie récoltées principalement en forêt (1re partie). *Bulletin de la Société d'Histoire Naturelle de Toulouse*, 105: 405–430.
- 1970b. Deuxième liste de fourmis d'Algérie récoltées principalement en forêt (Deuxième partie). *Bulletin de la Société d'Histoire Naturelle de Toulouse*, 106: 28–40.
- 1973. Note sur les peuplements de fourmis en forêt d'Algérie. *Bulletin de la Société d'Histoire Naturelle de Toulouse*, France, 108: 386–390.
- 2009. Le genre *Cataglyphis* Foerster, 1850 au Maroc (Hyménoptères Formicidae). *Orsis*, 24: 41–71.
- Campos, R. I., Vasconcelos, H. L., Andersen, A. N., Frizzo, T. L. M., Spina, K. C., 2011. Multi-scale ant diversity in savannah woodlands: an intercontinental comparison. *Austral Ecology*, 36: 983–992.
- Chemala, A., Benhamacha, M., Ould El Hadj, D. M., Marniche, F., Daoudi, S., 2017. A preliminary list of the Ant Fauna in Northeastern Sahara of Algeria (Hymenoptera: Formicidae). *Sociobiology, an international journal on social insects*, 64(2): 146–154.
- Dehina, N., Daoudi, S., Doumandji, S., 2013. Effect of Climatic Factors on the Swarming Ants in a Park of El-Hararch (Algeria). *International Journal of Engineering Research and Technology*, 2(1): 2264–2269.
- Derridj, A., 1990. Study of *Cedrus atlantica* populations in Algeria. PhD thesis, Paul Sabatier University, Toulouse, France.
- DGF (Direction General of Forests), 2013. *Djurdjura National Park*. Report of the General Directorate of Forests, Algiers.
- Djioua, O., Sadoudi–Ali Ahmed, D., 2015. The stands of ants (Hymenoptera, Formicidae) in some forest and agricultural areas of Kabylia. *International Journal of Zoological Research*, 5: 15–26.

- Heip, C. H. R., Herman P. M. J., Soetaert, K., 1998. Indices of diversity and evenness. *Oecanis (Paris)*, 24(4): 61–87.
- Hölldobler, B., Wilson, E. O., 1990. *The ants*. Harvard University Press, Cambridge, MA.
- Lenoir, A., Galkowski, C., 2017. Sur la présence d'une fourmi envahissante (*Tapinoma magnum*) dans le Sud-Ouest de la France. *Bulletin de la Société Linnéenne de Bordeaux*, 152, new series 45(4): 449–453.
- Mousslim, B., Nouel-Kheiter, A., 2017. Le Parc national du Djurdjura une biodiversité à mieux faire connaître, *Le courrier de la nature*, 307: 36–40.
- Noordijk, J., 2016. Leefwijze van *Tapinoma nigerrimum* (Hymenoptera: Formicidae), een nieuwe exotische mier in Nederland. *Entomologische Berichten*, 76(3): 86–93
- Romero, H., Jaffe, K., 1989. A comparison of methods for sampling ants (Hymenoptera, Formicidae) in Savannas. *Biotropica*, 21(4): 348–352.
- Seifert, B., D'Eustacchio, D., Kaufmann, B., Centorame, M., Lorite, P., Modica, M. V., 2017. Four species within the supercolonial ants of the *Tapinoma nigerrimum* complex revealed by integrative taxonomy (Hymenoptera: Formicidae). *Myrmecological News, Vienna*, 24: 123–144.