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Ants' diversity (Hymenoptera: Formicidae) in the Algeria's humid forests, case of the Gerrouche forest massif (Taza National Park)

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Abstract

In order to contribute to the myrmecological fauna knowledge of the Guerrouche forest massif based in northeastern Algeria. A study was conducted on three oak groves (*Quercussuber, Q. canariensis* and *Q. afares*). A total of 60 plots were surveyed by using four sampling methods (manual capture, bait, pitfall and Winkler). The inventory revealed 34 ants species belonging to 15 genus and 4 sub-families; Dolichoderinae, Formicinae, Myrmicinae and Ponerinae. Dispatche as follow, 22 species for Cork oak, 14 for Algerian oak and 17 for Afares oak. Myrmicinae dominate in Cork oakand in Algerian oak (82.83 and 81.23% respectively) while in the Afares oak, Formicinae are largely in the lead (68.54%). This study revealed an endemic species to Algeria (*Aphaenogaster testaceo-pilosa* ssp *canescens*), three endemic' species to Algeria and Morocco (*Camponotus laurenti, Messor antennatus* and *Aphaenogaster foreli*) and one endemic to Algeria and Tunisia (*Bothriomyrmex decapitans*). Comparison of the four sampling methods effectiveness, used reveals that it's the bait (80.7% of the species total number harvested in the all stations) and manual capture (49.69% of the species total number harvested in the all stations), which allowed the capture of the largest number of species followed by pitfalls traps (31.64% of the species total number harvested in the all stations). The Winkler was much less effective (5.55% of the species total number harvested in the all stations).

Introduction

Northern Algeria is a forest-based country; despite the damage caused by humans and herds, beautiful stands are still in place (Cagniant, 1968).

The National Forest Inventory of Northern Algeria (established in 1983) confirms that the *Quercus suber* forests cover an area of 2,000,000 ha totaling 34,000,000,000 trees (all strata combined). Cork oak is strongly represented in the country's east, rare and scattered in the west.

The deciduous oak forests are represented by the Algerian oak (*Q. canariensis*) and the Afares oak (*Q. afares*) both of which thrive from 800 mm of rain. Often in mixture with the Corkoak they invade at some fresh stations. It should be noted that the Afares oak is a species endemic to Great Kabylia and Babor Kabylia (Louni, 1994).

Among the most preserved and beautiful oak forests in Algeria, the forest massif of Guerrouche shelters to pure and mixed oak forests (Algerian Oak, Afares Oak and Cork Oak) of which Algerian oak is the main species (A.S.A., 2006). This forest is home to the Magot Monkey (*Macaca sylvanus*) and the Algreian nuthatch (*Sitta ledanti*) a strict endemic bird of Algeria (Bounar, 2014).

The Guerrouche forest fauna is much diversified but, unlike the flora, we know little about the subject, due to the lack of specific studies. Faunal studies carried out in this forest are more concerned with mammals and birds. Entomological studies, particularly myrmecological studies, are almost non-existent (the best known being that of Cagniant, (1968) on forest ants in Algeria).

In Algeria, myrmecofaune is only known through the work of Bernard (1958, 1968 and 1976) and Cagniant (1968,

1970 et 1973). Since then, the Formicidae's systematics and diversity in Algeria has not been revised except recently with the work of Barechet al. (2011, 2015, 2016 and 2017); Chemala et al. (2017).

The lack of knowledge of the Guerrouche forest myrmecofauna creates an attraction that justifies the choice of this work, whose main objective is to carry out an analysis of the diversity of ants in Guerrouche and as a second objective to compare the effectiveness of sampling methods.

From a methodological point of view, the majority of authors who have worked on ants have used two sampling methods: quadrats, pifalls or both (Cagniant, 1968; Barech, 2016).

In terms of sampling, this study presents a novelty by using four sampling methods: the Winkler method (harvesting by extracting individuals from leaf litter), pitfall trap, bait and manual capture (Agosti & Alonso, 2000; Bestelmeyer et al., 2000). A study using these four sampling methods has already been carried out in Causses Aveyronnais (France) (Groc, 2006) and has given good results.

Methodology

Covering 10859.7 hectares and located 30km southwest of Jijel in northeast Algeria, The national forest of Guerrouche is 19 km long from east to west and 13 km wide from north to south. This forest is characterized by some of the best preserved oak formations in Algeria with an afforestation rate of 44%. The species distribution is as follows: Corkoak: 4568 ha, Algerian oak: 1026 ha (in pure stands up to 700 m altitude) and in association with Cork oak at low altitude and Afares oak, respectively: 1977 ha in pure stands (at high altitudes, above the Algerian oak, from 900 m) (Ziane, 1979).

This study was conducted in three oak formations in the Guerrouche forest more precisely in the Taza national Park and at different altitudes (Fig 1):

1. The Cork oak station is located in the Jijelian cornice heart in the Taza National Park western limit (which is located inside the national forest of Guerrouche) (36°42'26.46"N 5°32'57.264" E) at an altitude of 95m. The pure Cork oak formation represents an open forest characterized by a shrub stratum as *Erica arborea, Cytisus villosus, Pistacia lentiscus, Cistus monspelliensis, Rubus ulmifolius, Myrtus communis* and *Calycotom espinosa.*

2. The Algerian oak station is located in the Guerrouche forest heart at an altitude of 800 metres, the coordinates of which are: 36°41'45.62"N 5°38'27.36"E. This is a regular pure forest station (Boudy, 1954) with a very dense canopy where grows only a much undeveloped undergrowth (Bellatrèche, 1994). We can distinguish *Hedera helix* which suffocates a certain amount of Algerian oak. The shrub stratum consists of *Crataegus monogyna, Laurus nobilis, Cytisus villosus* and *Rubus ulmifolius.* The herbaceous stratum is dominated by *Vinca major* and *Viola munbyana*.

3. The Afares oak station is located at the Guerrouche forest top, at an altitude of 950 metres (36°41'34.10 "N 5°39'3.77 "E). It is a gardened forest of pure Afares oak. We notice the rare Algerian oak individual's presence and the undergrowth are characterized by *Cytisus villosus, Drimia maritima, Ampelodesmos mauritanicus Erica arborea* and *Rubus ulmifolius*.

The myrmecological inventory carried out at these different stations took place from April to June 2018, twice a month.

In this study, four sampling methods were applied to these environments: the Winkler method (harvesting by extracting individuals from leaf litter), pitfall trap, bait and manual capture, as described by Agosti and Alonso (2000), Bestelmeyer et al. (2000) and Brinkman et al. (2001).

1. Manual capure: During prospecting, manual capture is the appropriate. This is a random capture, pending 4 to 5 hours, using a mouth aspirator. All species seen with the unaided eye are sampled.

Fig 1. The three study stations location in Taza National Park (Algeria).

2. Bait: It is possible to actively attract ants with different baits placed in all areas. The bait used is pieces of oil's sardines placed on an absorbent paper piece on the ground for three hours.

3. Pitfall traps: The traps we used were 11 cm deep and 10 cm in diameter cans buried vertically, so that the opening was flush with the ground, to avoid the barrier effect for small species. Each pitfall was filled to 5% with soapy water, which, in principle, is neither attractive nor repellent for ants. After 48 hours of continuous sampling, the traps were removed and the ants harvested.

4.Winkler method: In each plot, the litter from a 1m² quadratand 15 cm of depth was collected in a numbered bag for later extraction in the laboratory. In the laboratory, a Berlèse device was developed.

The area total sampling for each environnent is 0.2 hectares. Each area was divided into 5 transects to 40m long and 10m wide. Each transect was then divided into four 10m square plots where each sampling method was applied. Thus, for each environment, we obtained 20 samples of each method (Fig 2).

The standard protocol for myrmecofauna sampling proposed by Agosti and Alonso, (2000) and Fisher et al. (2000) suggests a minimum 20 separate sampling points 10m apart to capture at least 70 % of a site's myrmecofauna.

After display and drying, ants are identified after examining some each species systematic criteria specific. The determination always takes place under the binocular loupe.

The most species identification is carried out by referring to various guides and identification keys such as those of Bernard (1968) and Cagniant (1968, 1970, 1997, 2005, 2006, 2009). Professor Henri Cagniant has also contributed to the identification of some species.

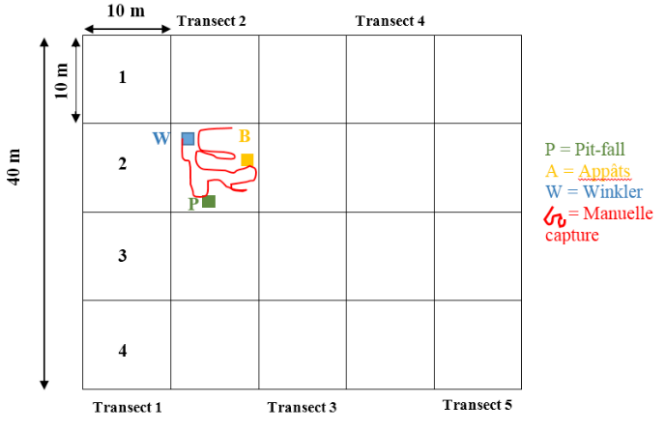

Fig 2. Experimental protocol for each sampled environment (Groc, 2006).

Once the ants have been sorted, determined and counted, we measured them with a strip of graph paper in order to know their sizes.

In order to exploit the results obtained from the study of the myrmecofauna of three humid forests, we used ecological indices such as specific richness, centesimal frequency, Shannon-Weaver diversity index, Evenness index, Sorensen coefficient and Chao formula (Ramade, 1984; Chao, 1987). Variance analysis (Anova) is used to compare the diversity between stations.

Results

Our study identified 34 ant species representing 15 genus and 4 subfamilies; Formicinae, Myrmicinae, Dolichoderinae and Ponerinae. 22 species have been recorded in the Cork oak, 14 species in the Algerian oak and 17 species in the Afares oak. (Table 1).

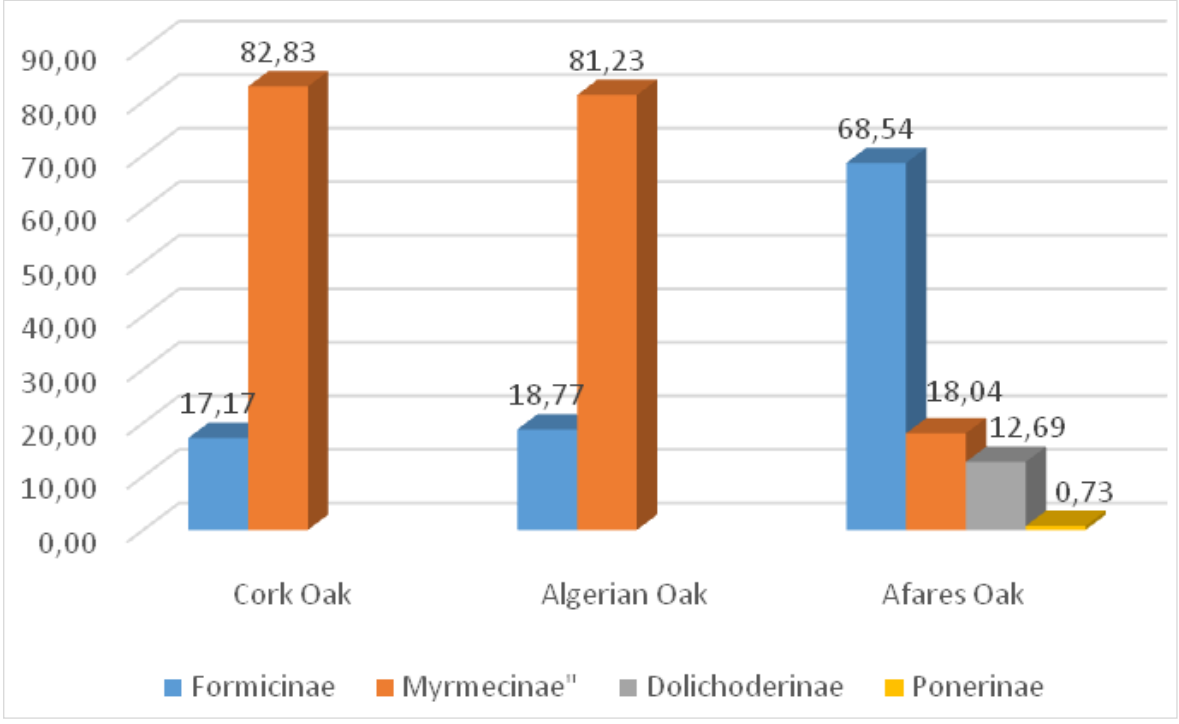

Fig 3. Formicidae centesimal frequencies of grouped by sub-family in the three study stations (Guerrouche).

Table 1. Formicidae listed's percentage and occurrence frequencies of at the three study stations in the Guerrouche forest (Algeria) (Fc: percentage frequency, Fo: occurrence frequency) (*Endemic species).

Species	Cork Oak		Algerian Oak		Afares Oak	
	Fc	Fo	Fc	Fo	Fc	Fo
Cataglyphis bicolor	0,36	5	-	-	-	-
Cataglyphis viatica	0,12	5	0,29	10	0,18	10
Camponotus spissinodis	1,92	25	-	-	-	-
Camponotus cruentatus	1,32	10	-	-	-	-
**Camponotus laurenti*	0,36	10	0,29	5	0,59	15
Camponotus lateralis	1,32	25	-	-	-	-
Camponotus piceus	0,24	10	-	-	-	-
Camponotus micans	2,88	55	0,88	25	2,36	60
Camponotus gestroi	-	-	-	-	0,14	5
Formica cunicularia	-	-	1,47	5	1,59	20
Formica fusca	-	-	3,08	10	-	-
Lasius niger	-	-	7,04	20	3,67	50
Plagiolepis schmitzii	8,64	35	5,72	10	59,88	100
Plagiolepis pallescens	-	-	-	-	0,14	10
Aphaenogaster testaceopilosa	12,61	85	12,46	35	0,95	15
**Aphaenogaster testaceo-pilosa ssp canescens*	0,48	10	1,61	35	4,40	85
Aphaenogaster gibbosa	4,32	25	-	-	-	-
**Aphanogaster foreli*	2,04	25	-	-	-	-
Aphaenogaster depilis	0,12	5	-	-	-	-
Aphaenogaster crocea	-	-	38,27	85	1,81	40
Messor straticeps	0,24	10	-	-	-	-
**Messor antennatus*	0,12	5	-	-	-	-
Crematogaster scutellaris	45,62	75	28,15	40	6,98	80
Crematogaster auberti	0,12	5	-	-	-	-
Crematogaster auberti laevithorax	2,88	10	-	-	-	-
Crematogaster sordidula	1,80	15	-	-	-	
Pheidole pallidula	4,40	15	-	-	-	-
Oxyopomyrmex emeryi	-	-	0,15	5	-	-
Solenopsis occipitalis	-	-	-	-	3,54	5
Tetramorium forte	8,04	15	0,44	5	0,09	10
Temnothorax curtulus	-	-	0,15	10	-	-
Temnothorax rottenbergii scabriosus	-	-	-	-	0,27	10
**Bothriomyrmex decapitans*	-	-	-	-	12,69	40
Ponera coarctata	-	-	-	-	0,73	10
Individuals number	833		682		2206	
Richness	22		14		17	

In the Cork oak and Algerian oak stations, Myrmicinae are largely in the lead (with respectively 82.83 and 81.23%) followed by Formicinae with respectively 17.17 and 18.77%. In the Afares oak station, the opposite is true, Formicinae were the most captured (68.54%) followed by Myrmicinae (18.04%) and Dolichoderniae (12.69%). Ponerinae are far behind with 0.73% (Fig 3).

Among the Cork oak's ants found, the species; *Crematogaster scutellaris* et *Aphaenogaster testaceo-pilosa* are the most frequent with rates of 45.62 and 12.61% respectively followed by *Tetramorium forte* and *Plagiolepis schmitzii* (with 8.04 and 8.64%, respectively). The other species have frequencies ranging from 0.12 to 4.44% (Table 1).

In Algerian oak, *Aphaenogaster crocea, Crematogaster scutellaris* and *Aphaenogaster testaceo-pilosa* were the most captured (all methods combined) with 38.27; 28.15 and 12.46% respectively. The other species have frequencies that range from 0.29 to 7.04% (Table 1).

In Afares oak, *Plagiolepis schmitzii* is the most common with a rate of 59.88%. It is followed by the species and *Bothriomyrmex decapitans* and *Crematogaster scutellaris* (with 12.69 and 6.98%, respectively) (Table 1).

The species number per plot varies between 2 and 8 in Cork oak, 1 and 6 in Algerian oak and finally 4 and 9 in Afares oak. The average richness (Sm) per plot is higher in the Cork oak and Afares oak (respectively 5.05 and 5.7) (Table 2).

The calculated Shannon-weaver diversity index indicates good specific diversity at all stations (Table 2).

The Evenness values indicate that the species numbers in the Cork and Algerian oak stations tend to be in equilibrium (E = 0.64), while at the Afares oak, species numbers are less balanced.

To determine if the three studies are different in terms of richness, we used the analysis of variance (Anova). The latter revealed significant differences between the three stations for a threshold-specific richness parameter ($P < 0.05$).

Table 2. Specific and average richness, Shannon-Weaver diversity index and Evenness distribution of ants recorded in three study stations in the Guerrouche forest (Algeria)

Stations	Cork Oak	Algerian Oak	Afares Oak
Specific richness	22	14	17
Average richness	5,05	3	5,7
Shonnon-Weather (H)	2,86	2,44	2,19
Maximum diversity (Hmax)	4,46	3,81	4,09
Evenness	0,64	0,64	0,54

According to Sorensen's index, the species communities in each environment are neither identical nor totally different. Despite this, they share a fairly large common characters number. The greatest similarity was found between Algerian oak and Afares oak (70.96%) (Table 3).

Table 3. Sorensen similarity index values calculated for the two-to-one comparison of sampled environments in the Guerrouche forest (Algeria)

Sorensen index	Cork Oak	Algerian Oak	Afares Oak
Cork Oak	100%	44,44%	41,02%
Algerian Oak		100%	70,96%
Afares Oak			100%

The four sampling methods used allowed us to identify a significant species number, however, manual capture and bait were the most effective in this study (Table 4). Manual capture, baits and pitfalls harvested the most ant species in the oak; the Winkler was relatively effective (22.72% % of the total number of species) (Table 4).

Regarding Algerian oak, the manual capture allowed the largest species number catching (85.71 % of the total number of species); followed by bait (35.71 % of the total number of species). Pitfalls and Winkler were much less effective (21.42 for each method) (Table 4).

For Afares oak, manual capture and bait made it possible to sample the largest species number (88.23 and 58.82 % of the total species number); followed by pitfall and Winkler method (Table 4).

Table 4. Total number of species and species percentage according to sampling methods in the Guerrouche forest (Algeria)

Environment	Sampling method	Species number	species percentage (%)
Cork Oak	Manual Capture	15	68,18
	Baits	12	54,54
	Pitfall	11	50,00
	Winkler	5	22,72
Algerian Oak	Manual capture	12	85,71
	Baits	5	35,71
	Pitfall	3	21,42
	Winkler	3	21,42
Afares Oak	Manual Capture	15	88,23
	Baits	10	58,82
	Pitfall	4	23,52
	Winkler	1	5,88

To determine if the sampling of the three oak forests' myrmecofauna of Guerrouche forest was effective, we used Chao's formula. The latter estimates the total of Cork oak's specific richness at 26 species, which indicates that with our 80 samples (all methods combined), 84.61% of the area' s specific richness was observed. For Algerian oak, formula Chao estimates the total specific richness at 15, indicating that 93.33% of the station was correctly sampled. For Afares oak, the inventory can be considered complete because all species are represented by at least two individuals.

The four sampling methods used allowed the capture variable-sizes workers (from 2 to 10 mm long) the respective distribution is shown in Figure 4. The latter clearly shows us that the 2 mm class is the most represented in our inventory (Fc=43.99%), followed by the 3, 4, 5 and 7 mm classes with frequencies respectively 14.81 ; 14.03 ; 12.98 and 8.22% . The species frequencies according to the workers size collected using the four sampling methods on Guerrouche forest are shown in Figure 5. Pitfall mainly trapped medium sized ants (between 5 and 7mm) while the winkler has been used to catch mostly small ants (2 mm). The baits mainly caught small species (between 2 and 4mm) as well as medium-sized species of 5 to 7mm. As for manual capture, it allowed a complete species harvest the regardless of the workers' size.

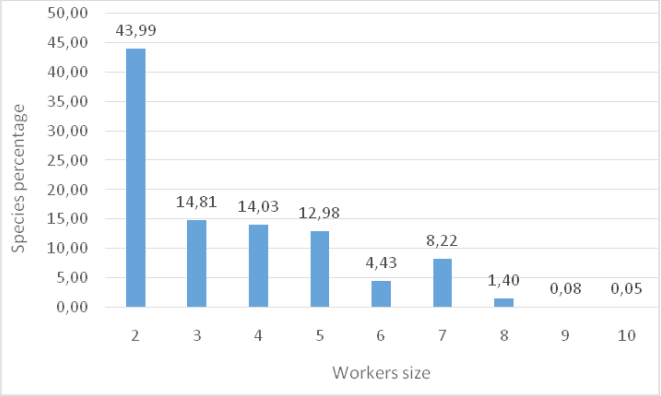

Fig 4. The species percentages's representation according to the workers size harvested by all sampling methods used (Winkler, pitfall, baits and manual capture) and in the three study stations of the Guerrouche forest (Algeria).

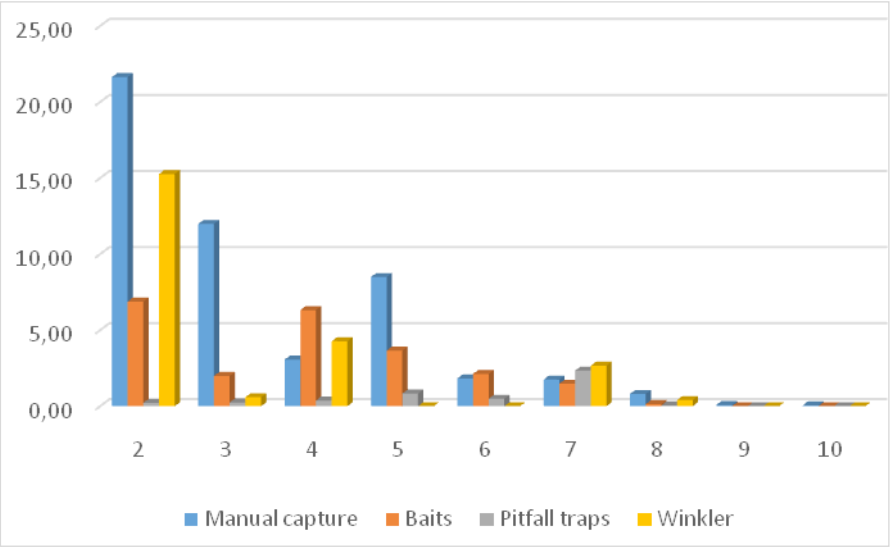

Fig 5. Species frequencies's representation according to the workers size harvested using the four sampling methods of the Guerrouche forest (Algeria).

Discussion

The myrmecological inventory carried out in three forests, of the Guerrouche massif in Algeria, allowed us to identify 34 species from 4 sub-families; Formicinae, Myrmicinae, Dolichoderinae and Ponerinae. At the Cork and Algerian oak stations, Myrmicinae frequencies exceed 80%, followed by Formicinae with frequencies ranging from 17.17 to 18.77%. While in Afares oak, Formicinae were the most captured (68.54%) followed by Myrmicinae (18.04%) and Dolichoderniae (12.69%). Ponerinae are far behind with 0.73%. These last two sub-families have only been recorded in this last station.

In a study on the the ant richness in the Ermenonville forest in Oise (France), Formicinae slightly dominate Myrmicinae in terms of species (16 and 14 taxa respectively). They are also the two richest subfamilies of the myrmecological fauna of these regions. The Ponerinae and Dolichoderinae represent only 1% for each one (Colindre, 2017).

Among the 15 genus recorded, three genus were particularly well represented among the harvested ants: the genus *Camponotus* (7 species), *Aphaenogaster* (6 species) and *Crematogaster* (4 species).

Commented list of harvested species

The species's classification is based on the systematic order adopted in the work of Cagniant (2006) and Taheri et al. (2014). For each species, its distribution in the Algerian forests and its distribution in the Guerrouche forest are presented, according to the three forest habitats surveyed.

Subfamily of Dolichoderinae

Bothriomyrmex decapitans (Santschi, 1911) was inventoried by Cagniant (1968), in his preliminary list of forest ants in Algeria, in the forest of Guerrouche (Jijel, Algeria). According to Borowiec (2014), this species is endemic to Algeria and Tunisia. In this study, it was sampled only in the Afares oak.

Subfamily of Formicinae

Genus *Plagiolepis* Mayr, 1861

Plagiolepis schmitzii (Forel, 1895) was captured in all study stations but it is better represented in Afares oak because the heavy humus is very favourable to it (Bernard, 1973). Indeed, the largest workers numbers were found in the Winkler. Cagniant (1968) found that the species is extremely common when there is an onset of deforestation. It is a species common to all environments, from the coast to the Saharan Atlas, with a clear preference for open forests, brush and clearings (up to 2000m) (Cagniant, 1970).

Genus *Lasius* Fabricius, 1804

Lasius niger (Linnaeus, 1758) is common in the open forests of Pine, Oak and humid areas and at all altitudes (Cagniant, 1968, 1970). In this study, it was observed in Algerian oak and Afares oak.

Genus *Camponotus* Mayr, 1861

C. micans (Nylander, 1856) is found throughout northern Algeria, from coastal plains to mountains, up to 1200 m in the Tell and 1700 m in the Aurès (Cagniant, 1970). He noted that this species is associated with the holm oak, kermesse and Algerian oaks of the Blida's Atlas, Tala Guilef, Djurdjura and the Beni-Imbul forest (Cagniant, 1968).

C. laurenti (Santschi, 1939) is a common underground species in the Ouarsenis, in particular in a pine forest mixed with holm oak (900 m) and a cedar forest mixed with Algerian oak (1500 m) from Algiers (Cagniant, 1970).

C. micans and *C. laurenti*were found in large numbers in the Afares oak station and are not very abundant in the other stations.

C. lateralis (Olivier, 1791) is a fresh forests and mountain ant from 800 to 1900 m. The species has been observed in the Hafir forest in Oranie (a mixture of holm, Cork and Algerian oak), in Algiers, in Theniet-el-had forest (cedar grove mixed with Algerian oak) and in Blida holm oak groves and Kabylia and Numidia atlases (southern flank of Djurdjura). But also, in a Cork forest of the Edough forest (between Annaba and El-Marsa) and at the calle (now El Kala) (Cagniant, 1970). *C. laurenti* is endemic to Algeria and Morocco, (Borowiec, 2014).

C. spissinodis (Forel, 1909) is an open and clear forests species (Cagniant, 1968).

C. cruentatus (Latreille, 1802) is found mainly in Tellian Atlas holm oak forests between 800 and 1200 m and along the edges of clearings (Cagniant, 1968).

C. gestroi (Emery, 1878) is a Tyrrhenian distribution species and rare one in Algeria, it has been observed in Algiers and Kabylia in Algerian oak stations. It nests are located at the oaks's foot.

C. lateralis, C. spissinodis, C. cruentatus and *C. piceus* were only caught in the Cork oak while C. gestroi was only observed in the Afares oak.

It should be noted that the *Camponotus* mentioned above were not sampled by Cagniant (1968, 1970) in the Guerrouche forest.

Genus *Cataglyphis* Foerster, 1850

Cataglyphis bicolor (Fabricius, 1793) is found in all open and sunny places from the seaside to the mountains tops (Cagniant, 1968). It has been found in the diets of two insectivorous Babors birds (Henine-Maouche et al., 2017; Belkacem et al., 2019). In this study, the species is only included in the Cork oak list.

Cataglyphis viatica (Fabricius, 1787) is common to forest edges (Cagniant, 1968). It does not appear in the preliminary list of ants in the Algerian forests of Cagniant in Guerrouche (1968, 1970). In our study, it was sampled in all environments but with low densities.

Genus *Formica* Linnaeus, 1758

Formica fusca (Linnaeus, 1758) is an introduced ant from Europe (Cagniant, 1968). It is a well temperate forests species. It has been observed in Akfadou (Algerian oak and afares between 900 and 1300 m) (Cagniant, 1970). In Guerrouche, it was only captured in Algerian oak.

Formica cunicularia (Latreille, 1798) is an edges species of cedar forests. It was observed in an Algerian oak in Theniet-el-had forest and Tala-guilef cedar forest (Cagniant, 1968; 1970). In Guerrouche forest, it was located in the Algerian oak and Afares oak.

Subfamily Ponerinae

Ponera coarctata (Latreille, 1802) is a species widespread throughout the Mediterranean region and humid forests in good condition (Cagniant, 1968). It was observed in a Blida atlas holm oak forest, in Yakouren (Cork, Algerian and Afares oak), in Akfadou (Algerian and Afares oak) as well as a Algerian of Guerrouche forest and Djebel El Ghoufi (Cagniant, 1970). In this study, the ant was only observed in the Afares oak.

Subfamily Myrmicinae

Solenopsis occipitalis (Santschi, 1911) is common in Cedar glades or pastures pseudo-alpine in Djurdjura and Aurès (Cagniant, 1966). The latter did not record this ant at Guerrouche. The species is fond of wetlands (Bernard, 1968). In this study, it was collected at the Afares oak.

Genus *Tetramorium* Mayr, 1855

Tetramorium forte (Forel, 1904) was sampled at all environments with greater abundance at the Cork oak.

Genus *Aphaenogaster* Mayr, 1853

A. gibbosa (Latreille, 1798) is a forest species in Algeria (Bernard, 1968) and is common to open forests near wadis (Cagniant, 1968).

A. foreli (Cagniant, 1996) is an Algerian-Moroccan species of the Middle and High Atlas, between 1300 and 1800 m (Cagniant, 1996; Borowiec, 2014). It prefers the lawns, pastures, clearings, coppices and maquis of the holm oak floor. In this study, it appeared only in Cork oak.

A. depilis (Santschi, 1911) is a species of high mountain on shallow ground. It was seen in a cedar grove in the Blida Atlas and Telmet Pass (Belezma and Aurès), in Tikjda and Jebel Chelia as well as in a Djurdjura pseudo alpine pasture (Cagniant, 1968).

A. gibbosa, A. depilis and *A. foreli* have only been found in Guerrouche Cork oak. *A. foreli* is endemic to Algeria and Morocco (Cagniant, 1996; Borowiec, 2014).

A. testaceo-pilosa (Lucas, 1849) was collected from all study stations but its number is declining in the Algerianoak and Afares oak. It has been identified in the Western Babors by Henine-Maouche et al. (2017) and Belkacem et al. (2019). According to Cagniant (1968), it is very common in Algiers.

A. testaceo-pilosa ssp canescens (Lucas, 1849) is a Kabylia and Numidia subspecies on humus soil (Cagniant, 1968). These taxa are limited to Algeria while it is also found in Europe (Borowiec, 2014). In Guerrouche, it was sampled in all stations with a higher abundance in the Afares oak.

A. crocea (André, 1881) is commonplace in Numidia and Aurès but more uncommon elsewhere (Cagniant, 1966). This autor found it in the Cork, Algerian oak and Afares oak formations of Kabylia and Numidia as well as in the forests

of Mizrana, Yakouren, Akfadou and Guerrouche, on the Jebel Babor and El Ghoufi or even the Melab pass (Cagniant, 1968).

Genus *Messor* Forel, 1890

M. striaticeps (André, 1883) is a mountain species. In Algeria, Cagniant (1968, 1970) observed it only in Djurdjura pseudo-alpine pasture.

M. antennatus (Emery, 1908) is endemic to Algeria and Morocco (Borowiec, 2014). It does not appear in the Cagniant's preliminary list of ants in Algerian forests (1968 and 1970). In a study on the young *Picus vaillantii* diet in Western Babors, Henine-Maouche et al. (2017) found this species in the young woodpeckers faecal bags. Our investigations in Guerrouche, allowed us to capture only one individual at the Cork oak.

Genus *Oxyopomyrmex* André, 1881

Oxyopomyrmex emeryi (Santschi, 1908) is a new species in Algeria (Cagniant, 1968), it was observed in Ghardaia. It is steppe and not forest (Delye, 1971). According to Bernard (1973), this species is rarely forested. In this study, only one individual was captured at the Algerian oak.

Genus *Pheidole* Westwood, 1839

Pheidole pallidula (Nylander, 1849) is a common species, found everywhere (Cagniant, 1968). In this study, it was only captured in the Cork oak.

Genus *Crematogaster* Lund, 1831

C. scutellaris (Olivier, 1791) is present in all study stations of Guerrouche. This species is common especially in Cork oak, it excavates its nests and galleries in the bark of trees. The latter are recognizable by the entry holes dug by these ants. C. scutellaris is a major factor in the deterioration of Cork (Bernard, 1968; Mouro, 2011). It was identified by Henine-Maouche et al. (2017) and Belkacem et al. (2019) in the Algeria's Babors region. In this study, it was observed at all stations with a high presence in the suberaie.

C. sordidula (Nylander, 1848) prefers forests in low-level degradation (Cagniant, 1968).

C. auberti (Emery, 1869) occurs in coastal forests and is less common in the interior (Cagniant, 1968).

The low density of the latter two species in the Cork oak is probably due to the study station relief. Indeed, the slopes are not very populated by these two species (Bernard, 1973).

C. auberti laevithorax (Forel, 1902) is an ant from southwest Algeria (Cagniant, 2005). It was also sampled in the study of Henine-Maouche et al. (2017) at an altitude of 372 m.

C. sordidula, C. auberti and *C. aubertilae vithorax* were only sampled in Cork oak.

Genus *Temnothorax* Mayer, 1861

They are good ecological and biocenotic indicators, are sensitive to environmental disturbances and disappear when deforestation, erosion and overgrazing occur, facilitating the intrusion of anthropophilic ants (Cagniant & Espadaler, 1997).

In Guerrouche Cork oak, the *Temnothorax* are absent. *Temnothorax curtulus* has only been recorded in the Algerian oak and *Temnothorax rottenbergii scabriosus* in the Afares oak.

In specific richness terms, the Guerrouche Cork oak formation is richer with 22 species compared to 17 species for Afares oak and 14 species for Algerian oak.

In the Cork oak forest Mâamora (Morocco), 43 species have been recorded (Bernard, 1945). In Talassemtane National Park (Morocco), Cork oak shelters 25 species of formicidae (Taheri et al. 2014). In Ermenonville forest (Oise-France), the ants species number inventoried is 32 (Colindre, 2017).

The Shannon-weaver diversity index calculated for the all study stations, gave values of 2.86 Bits for the Cork oak, 2.44 Bits for Algerianoak and 2.19 Bits for the Afares oak. This indicates a good specific diversity of all stations.

The Evenness values for two stations (Cork and Algerian oak) are equivalent (E=0.64), it tells us that this stations's individuals are tending to be balanced, The Evennessin the Afares oak (E=0.54) indicates that the individuals are fairly balanced.

In the in Talassemtane National Park's Cork oak (PNTLS) at Rif (Morroco), the diversity index shows that this environment is quite diversified (1.49 Bits). Individuals of various ant species are far from equilibrium (E = 0.46) (Taheri et al. 2014).

Despite their abundance and ease to collect in most ecosystems, several ants' biology characteristics complicate their sampling (Crist & Wiens, 1996; Wiernasz & Cole, 1995). According to Chao formula results; for an equal sampling effort and with identical sampling techniques, each environment appears to have been sampled overall with the same efficiency.

In this study, manual capture and baiting were the most effective, while at the Causses oak grove, it is the Winkler extraction then the baits that allowed the the largest species number capture (81.8 and 63.6 % of the species total number); pitfalls and manual capture were considerably less effective (45.5 and 40.9% of the total number of species) (Groc, 2006).

The use of several sampling methods simultaneously is the best way to assess biodiversity. All methods have their strengths and weaknesses and only a several combination of them will provide a representative sample for most research objectives (Marshall et al. 1996).

Frequency distributions of workers size suggest that each sampling method traps preferentially some species category of given size ants and that the hypothetical completeness of sampling could only be achieved through a different collection methods combination (Groc, 2006).

This list does not claim to represent all the the Guerrouche national forest myrmecofauna because our research was focused exclusively on oak forests. Nevertheless, it results from this study that the inventoried environments have a good myrmecological diversity and that the main factors determining the Formicidae's distribution are altitude and the habitat's type frequented.

Conclusion

Our investigations revealed 34 species and subspecies. 32 species do not appear in the Cagniant inventory (1968 and 1970) carried out in Guerrouche.

Aphaenogaster testaceo-pilosa ssp *canescens* is an endemic species in Algeria. Three species are Algeria and Morocco's endemic (*Camponotus laurenti, Messor antennatus* and *Aphaenogaster foreli*). One species is endemic to Algeria and Tunisia (*Bothriomyrmex decapitans*). Some species have not reappeared in the scientific literature since their description especially in the genus: *Messor*, *Bothriomyrmex*, *Crematogaster* and *Solenopsis*.

In the interest of a better knowledge of the forest ants'current status in Algeria, it would be useful to extend investigations to other Algerian wet forests, especially those found at high altitudes.

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