



RESEARCH ARTICLE - ANTS

Ant community diversity in two agrosystems in Bejaia wilaya (Northern Algeria)

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Abstract

The present work studied the diversity of Formicidae in two agrosystems of Bejaia, a lemon orchard located at INRAA and an orange orchard located at Amizour. We used the transect method by combining three (3) sampling methods: Barber Pots or Pitfall, Bait, and manual capture. We identified 18 ant species representing 11 genera and three subfamilies: Dolichoderinae (*Tapinoma magnum*), Formicinae (*Cataglyphis*, *Camponotus*, *Lasius*, and *Plagiolepis*), and Myrmicinae (*Messor*, *Aphaenogaster*, *Crematogaster*, *Pheidole*, *Tetramorium*, and *Temnothorax*). The species richness was 13 species in the Oued Ghir's site and 12 species in Amizour's site. At INRAA, Dolichoderinae and Myrmicinae have the same proportions (43.95 and 43.17%, respectively) followed by Formicinae (12.88%). In Amizour, Formicinae showed the higher frequency (40.28%), followed by Dolichoderinae and Myrmicinae (30.47 and 29.25%, respectively). In the INRAA lemon orchard *Tapinoma magnum* was the dominant species with a relative abundance of 43.95%, whereas in Amizour the predominance is attributed to the *Cataglyphis viatica* with a relative abundance of 39.05%.

Introduction

Formicidae is the major living group in many habitats, accounting for up to 15% of the total animal biomass, 94% of the individuals, and 50% of the arthropod biomass in the tropical forest canopy (Hölldobler & Wilson, 1990). Ants play a diverse role in terrestrial ecosystems acting as predators, scavengers, herbivores, detritivores, and granivores (Hölldobler & Wilson, 1990) and participate in an astonishing array of associations with plants and other insects (Hölldobler & Wilson, 1990; Jolivet, 1996). Their ubiquity and importance in the ecosystems explain the repeated evolution of many types of interactions, sometimes very specific and specialized (Lebas et al., 2016).

Some ant species are useful and play an important role in maintaining a certain biological balance as predators or parasites, while other species are considered pests, especially in agriculture (Bernard, 1968). Ants play a crucial ecological role in agrosystems through their regulatory action of phytophagous insects, seed dispersal, and symbiosis with

plants and are at the same time accidental pollinators (Ramón & Donoso, 2015; Diame et al., 2015).

They also play an important role in soil enrichment and aeration, thus improving the soil quality by mixing it and accelerating the transport and recycling of organic matter (Lyford, 1963; Wagner & Jones, 2006).

In Algeria, the Formicidae family is only known from the works of Bernard (1968, 1976, and 1983) and Cagniant (1966, 1968, 1969, 1970, and 1973). Since then, the systematics and diversity of this taxonomic group have not undergone any major revision except recently with the works of Barech et al. (2011, 2014, 2015, 2016, and 2017), Chemala et al. (2017), Henine-Maouche et al. (2019), Henine-Maouche et al. (2020) and Henine-Maouche (2020).

Information on ant community structure in agrosystems is still unknown in Algeria, except for the works such as Dehina (2004). Seeking to fill in this information gap, the objective of our study was to analyze antcommunity diversity in two agrosystems in Bejaia's wilaya.



Methods

The investigations were carried out in Bejaia's northern region (north-east of Algeria) where two experimental stations were chosen. These are a lemon orchard located at INRAA in Oued Ghir (Fig 1) and an orange orchard located in Amizour (Fig 2).

The National Institute of Agronomic Research of Algeria in Oued Ghir ($36^{\circ}42'22.03''$ N $4^{\circ}57'23.66''$ E) is located on the RN 12, 10 km southwest of Bejaia's main town. The INRAA station covers a total land area of 22.06 ha of which: 15.50 ha of useful agricultural area, 5.50 ha are uncultivated

land, and 1.5 ha has built areas. The studied station vegetation is composed of *Citrus × limon* trees regularly spaced and weeds such as *Scolymus hispanicus*, *Sonchus asper*, *Cynodon dactylon*, and *Lolium perenne*.

The Amizour station ($36^{\circ}40'9.76''$ N $4^{\circ}54'58.55''$ E) is located 24 km southwest of Bejaia. It is a citrus agrosystem "young orange orchard" where the vegetation is composed of (*Citrus × sinensis*) regularly spaced weeds such as *Lolium perenne*. Next to this orchard is a vineyard (*Vitis vinifera*) where the soil is well worked. The station is bordered by *Arundo donax* windbreaks.



Fig 1. Geographical location of the INRAA's station (Google Earth).

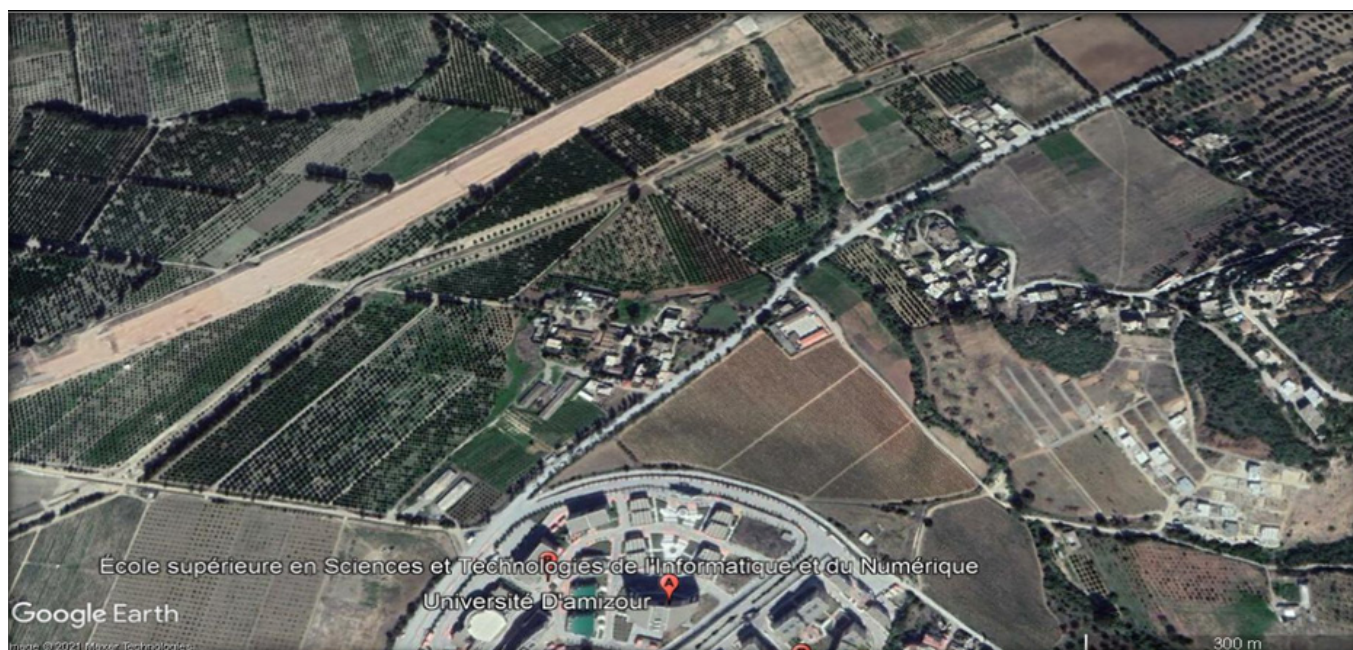


Fig 2. Geographical location of the Amizour's station (Google Earth).

The simultaneous use of several sampling methods and their combination is the best approach to biodiversity assessment (Marshall et al., 1994). The sampling took place during the ants' activity period. The first field work took place on 19 May 2021 for Amizour and on 24 May 2021 for INRAA. The second field work took place on 1 July 2021 for Amizour and on 13 July 2021 for INRAA.

A well-defined protocol was followed combining three sampling methods which are Pitfall Traps or Barber Pots, Baiting, and manual capture for a complete sampling.

We followed the sampling plan of Abdi-Hamecha et al. (2021) (Fig 3): we subdivided the ten (10) barber pots into two transects, each segment consisting of five (5) trap pots spaced at 15 meters. Each barberpot is surrounded by four baits at a distance of 5 meters, making a total of forty (40) baits. An area of 1750 m² was covered.

The baits consisted of tuna oil, honey, and jam, and were left in place for 3 hours, but probes were made every 30 minutes to collect the ants. The Barber pots were left for

24 hours during the first visit and 48 hours during the second. The manual capture lasted 4 hours, from 9 am to 1 pm.

The identification of collected ants was made by referring to various identification guides (Bernard, 1968; Cagniant, 1968; 1970; 1997; 2005; 2006 and 2009) and reference websites (www.antarea.com and www.antweb.com). Diversity indices were calculated, and parametric statistics (Student test) were used to evaluate the results of the two communities.

The assessment of the sampling effort was obtained by calculating non-parametric diversity estimators (Jackknife 1, Jackknife 2, and Bootstrap) using the EstimateS Version 9.1.0 software.

The observed species richness (S_{obs}) and the estimated species richness (S_{est}) are used to produce the accumulation curve.

The ratio of observed species richness and estimated species richness allows the calculation of the sampling completeness rate by the following formula:

$$\text{Sampling efforts} = \frac{S_{obs}}{S_{est}} \times 100$$

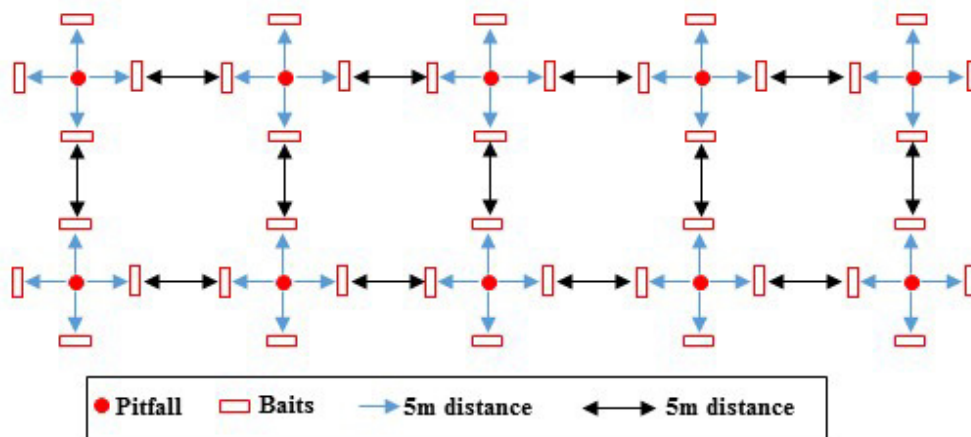


Fig 3. Sampling plan developed for the two sites at Amizour and Oued Ghir according to Abdi-Hamecha et al. (2021).

Results

Our study identified 18 ant species representing 11 genera and three subfamilies:

Dolichoderinae (*Tapinoma magnum*), Formicinae (*Cataglyphis*, *Camponotus*, *Lasius* and *Plagiolepis*) and Myrmicinae (*Messor*, *Aphaenogaster*, *Crematogaster*, *Pheidole*, *Tetramorium*, and *Temnothorax*) (Table 1).

The sampling result allowed us to note that the INRAA site is slightly richer in species (13 species) than the Amizour site (12 species).

Some species are only present in one of the two agrosystems, such as *Lasius flavus*, *Plagiolepis atlantis*, *Crematogaster scutellaris*, *Temnothorax sp.*, *Tetramorium maurum*, and *Tetramorium semilaeve*, which were only found at INRAA. While *Camponotus ruber*, *Cataglyphis diehlii*, *Tetramorium biskrense*, *Tetramorium forte* and *Aphaenogaster subterranea* were only sampled in Amizour. *Tapinoma magnum*,

Camponotus spissinodis, *Cataglyphis viatica*, *Aphenogaster sardoa*, *Aphenogaster testaceo-pilosa*, *Messor barbarus*, and *Pheidole pallidula* belong to both agrosystems.

At the INRAA, the frequencies of Dolichoderinae and Myrmicinae subfamilies are quite identical (43.95 and 43.17%, respectively) followed by the Formicinae with a frequency of 12.88% (Fig 4). In Amizour, the Formicinae are in the lead with a frequency of 40.28%. Dolichoderinae and Myrmicinae follow with frequencies of 30.47 and 29.25%, respectively (Fig 4).

The histogram below (Fig 5) shows the proportions of the seven genera of Formicidae recorded during the sampling of the two agricultural environments (INRAA and Amizour). These genera are: *Tapinoma*, *Plagiolepis*, *Lasius*, *Camponotus*, *Cataglyphis*, *Tetramorium*, *Aphaenogaster*, *Messor*, *Pheidole*, *Crematogaster* and *Temnothorax*.

It can be observed that at INRAA the genera *Tapinoma* is largely dominant with a frequency of 43.95% followed by *Aphaenogaster* with a frequency of 31.49%. *Lasius* is far

Table 1. Number and relative abundance (RA%) of Formicidae sampled in the two study stations (Amizour and INRAA Oued Ghir).

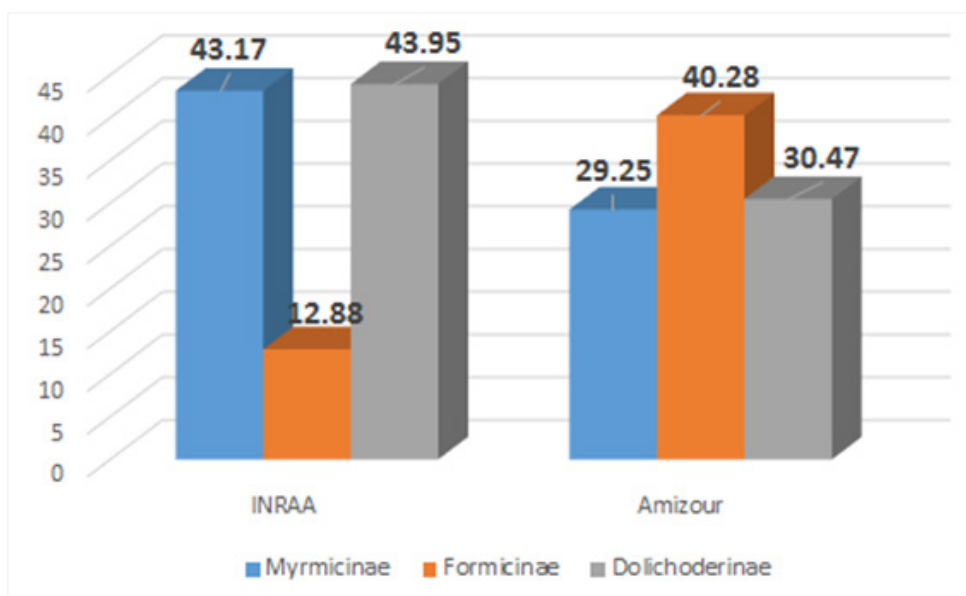
Subfamilies	Species	Amizour		INRAA	
		N _i	RA%	N _i	RA%
Dolichoderinae	<i>Tapinoma magnum</i> Mayr	174	30.473	730	43.95
	<i>Plagiolepis atlantis</i> Santschi	-	-	29	1.75
	<i>Lasius flavus</i> (Fabricius)	-	-	170	10.23
	<i>Camponotus spissinodis</i> Forel	2	0.35	1	0.06
Formicinae	<i>Camponotus ruber</i> Emery	1	0.18	-	-
	<i>Cataglyphis diehlii</i> (Forel)	4	0.70	-	-
	<i>Cataglyphis viatica</i> (Fabricius)	223	39.05	14	0.84
	<i>Tetramorium biskrense</i> Forel	3	0.53	-	-
	<i>Tetramorium forte</i> Forel	10	1.75	-	-
	<i>Tetramorium aurum</i> Santschi	-	-	1	0.06
	<i>Tetramorium semilaeve</i> André	-	-	15	0.90
	<i>Aphaenogaster subterranea</i> (Latreille)	4	0.70	-	-
	<i>Aphaenogaster sardoa</i> Mayr	10	1.75	28	1.69
	Myrmicinae	<i>Aphaenogaster testaceopilosa</i> (Lucas)	32	5.60	495
<i>Messor barbarus</i> (Linnaeus)		82	14.36	41	2.47
<i>Pheidole pallidula</i> (Nylander)		26	4.55	100	6.02
<i>Crematogaster scutellaris</i> (Olivier)		-	-	25	1.51
<i>Temnothorax</i> sp		-	-	12	0.72
Total	18	571	100	1661	100

behind with a frequency of 10.23%. On the other hand, in Amizour it is the *Cataglyphis* genera which was the most recorded with a frequency of 39.75%, followed by *Tapinoma* with a frequency of 30.45%. *Messor* only represents 14.36%.

In Amizour orange orchard, the *Cataglyphis viatica* species was dominant with a relative abundance of 39.05% followed by *Tapinoma magnum* with 30.47%. These are the two most abundant species on this site. *Messor barbarus*

follows far behind with 14.36%. *Aphaenogaster testaceopilosa* and *Pheidole pallidula* do not exceed 6% (5.60 and 4.55%, respectively).

In the INRAA lemon orchard, *Tapinoma magnum* is the most abundant species with 43.95%, followed by *Aphaenogaster testaceopilosa*, *Lasius flavus*, and *Pheidole pallidula* with relative abundances of 29.80, 10.23, and 6.02%, respectively. The other species do not exceed 3%.

**Fig 4.** Frequency (%) by subfamily for each study station.

Comparison of the two outputs of each station

The two histograms below (Fig 6) represent the numbers of each species for each station and each trap. It is noted that for the Amizour site, some species are present in the first sampling and not in the second and vice versa. Other species are present in both samplings. Ten species were recorded in the first sampling and eight species in the second. The same was true at the INRAA site, where 10 species were sampled on the first sampling and 11 on the second.

At Amizour, the *Tapinoma magnum* and *Cataglyphis viatica* species were less present in the first sampling with 59 individuals each, whereas in the second sampling they were more abundant (155 and 158 individuals, respectively). In contrast, *Messor barbarus* was more abundant in the first sampling with 73 individuals sampled compared to only nine individuals in the second sampling. *Camponotus spissinodis*, *Tetramorium forte*, and *Pheidole pallidula* were only sampled on the first sampling with 2, 10, and 26 individuals,

respectively. While *Camponotus ruber* and *Tetramorium biskrense* were only caught on the second sampling with only one and three individuals.

To find out if there is a significant difference between the abundance of each species over the two sampling periods (May and July), we used Student's t-test, which confirmed that the species numbers between the two periods are different ($t = 0.46$, $df = 11$, $P = 0.6515$). At INRAA, we find species present during both periods such as *Tapinoma magnum* present in large numbers, 368 and 362 individuals, respectively. On the first sampling, the *Plagiolepis atlantis* and *Aphaenogaster sardoa* numbers were 27 individuals per species compared to two and one individuals on the second sampling. *Aphaenogaster testaceopilosa* was represented by 310 individuals in the first sampling compared to 185 individuals in the last. We used the same Student's t-test to compare the abundance of each species over the two sampling periods and the result of the test shows us that, again, the two samplings are different ($t = 0.17$, $df = 13$ et $P = 0.8662$).

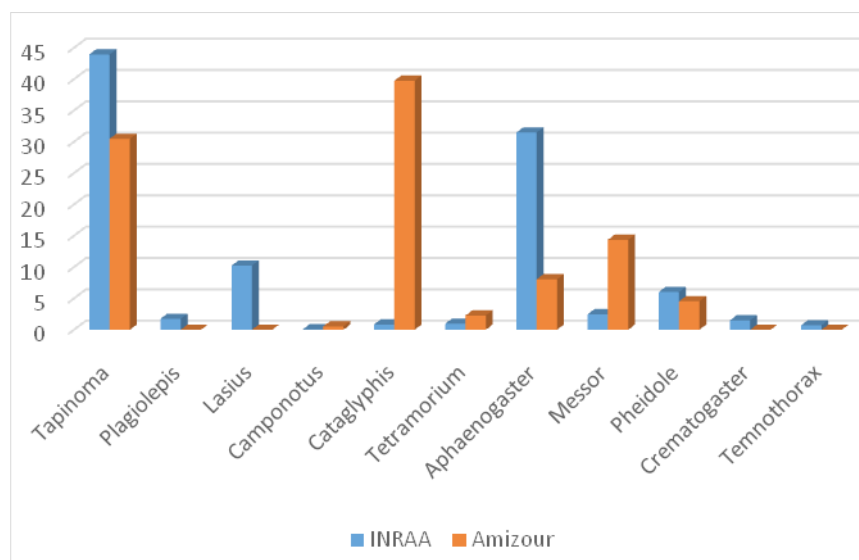


Fig 5. Frequency (%) by Formicidae's genera recorded in the two study stations.

Other species were only found on the first sampling such as *Tetramorium semilaeve* with 15 individuals and *Temnothorax sp* with 12 individuals. Others were found in the second sampling such as *Lasius flavus* with 170 individuals, *Camponotus spissinodis*, and *Tetramorium maurum* with only one individual each.

The Shannon-Weaver index shows that both orchards have relatively good myrmecological diversity with almost identical values, 2.28 Bits for Amizour and 2.23 Bits for INRAA. The Piélou's equitability index's values were very close for the two stations: 0.64 at Amizour and 0.60 at INRAA. This indicates that the species frequency (number of individuals) at these stations tends to be relatively similar to each other (Table 2).

The calculated Jaccard index reveals a difference in species composition between the two stations. These stations (Amizour and INRAA) together share up to 0.39 of the common species. This makes these agrosystems different in terms of species composition.

Table 2. Species richness, Shannon-Weaver diversity index, Maximum diversity index and Piélou equitability index for comparing the ant communities recorded at two study stations.

Stations	Amizour	INRAA
Species Richness	12	13
Shannon-Weaver diversity index	2.28	2.23
Maximum diversity index	3.58	3.70
Piélou equitability Index	0.64	0.60

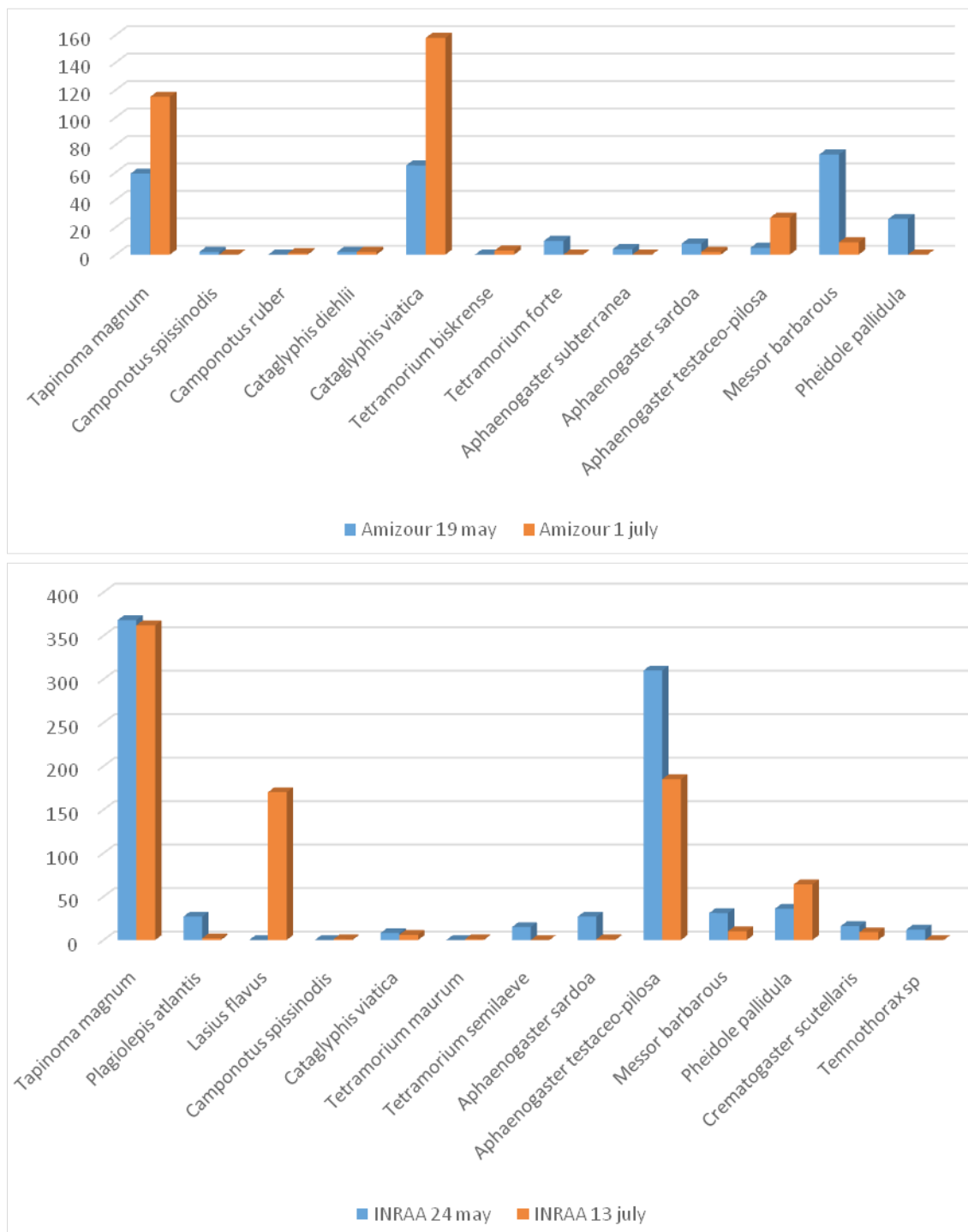


Fig 6. Number of individuals collected per species during the two sampling periods in the two study stations.

Richness estimation

For the orange orchard, the Jackknife 1, Jackknife 2, and Bootstrap indices predict higher specific richness (13.99, 14.97 and 12.99, respectively).

This means that there would be an average of 2 to 3 species of ants left to discover at the site.

The completeness rate of the inventory calculated based on the average of these three estimators is 85.9%, which suggests that the sampling effort was satisfactory and this is

confirmed by the growth of the species accumulation curve (Sobs) and its convergence with those of the estimators (Fig 7).

For the lemon orchard, the Jackknife 1, Jackknife 2, and Bootstrap indices predict higher specific richness (16.31; 19.55 and 14.38, respectively). This means that there would be an average of 2-6 species of ants left to discover at the site.

The completeness rate of the inventory calculated based on the average of these three estimators is 78.86%, which means that only three-quarters of the species were sampled.

The lowest completeness rate was recorded with the Jackknife 2 estimator (66.49%) and this can be seen in Figure 7 where the species growth curve (S_{obs}) diverges from that of the estimator.

The efficiency comparison of the three sampling methods used

In myrmecology, no sampling method allows the collection of all species in an environment. In our study, the number and percentage of species sampled by the three sampling methods used are listed in Table 3.

For Amizour, the highest number of ant species were collected by manual capture (75 % of the total number of species sampled); bait and pitfall traps were relatively effective (50 and 58.33% of the species' total number, respectively).

Concerning the INRAA station, pitfall traps were the most efficient and captured 76.92% of the species's total number; followed by baiting (69.23 % of the species' total number) and hand catching (46.15 % of the total number of species sampled).

Table 3. Number of species and percentage of total species according to sampling methods.

Environments	Sampling methods	Species's numbers	Species's percentage
Amizour	Capture manual	9	75%
	Baits	6	50%
	Pitfall traps	7	58.33%
INRAA	Capture manual	6	46.15%
	Baits	9	69.23%
	Pitfall traps	10	79.92%

In this study, we decided to improve the pitfall protocol by leaving the traps in the field for additional 24 hours (i.e. 48 hours) as recommended in the protocol of Bestelmeyer et al. (2000).

To know if the change of protocol was effective, we used the Student's t-test and the results show that for the INRAA station, the increase in pitfall trap duration was effective ($t=0,3$; $df=9$ et $P=0,7699$). Indeed, five-fold more ant species were caught compared to the first sampling.

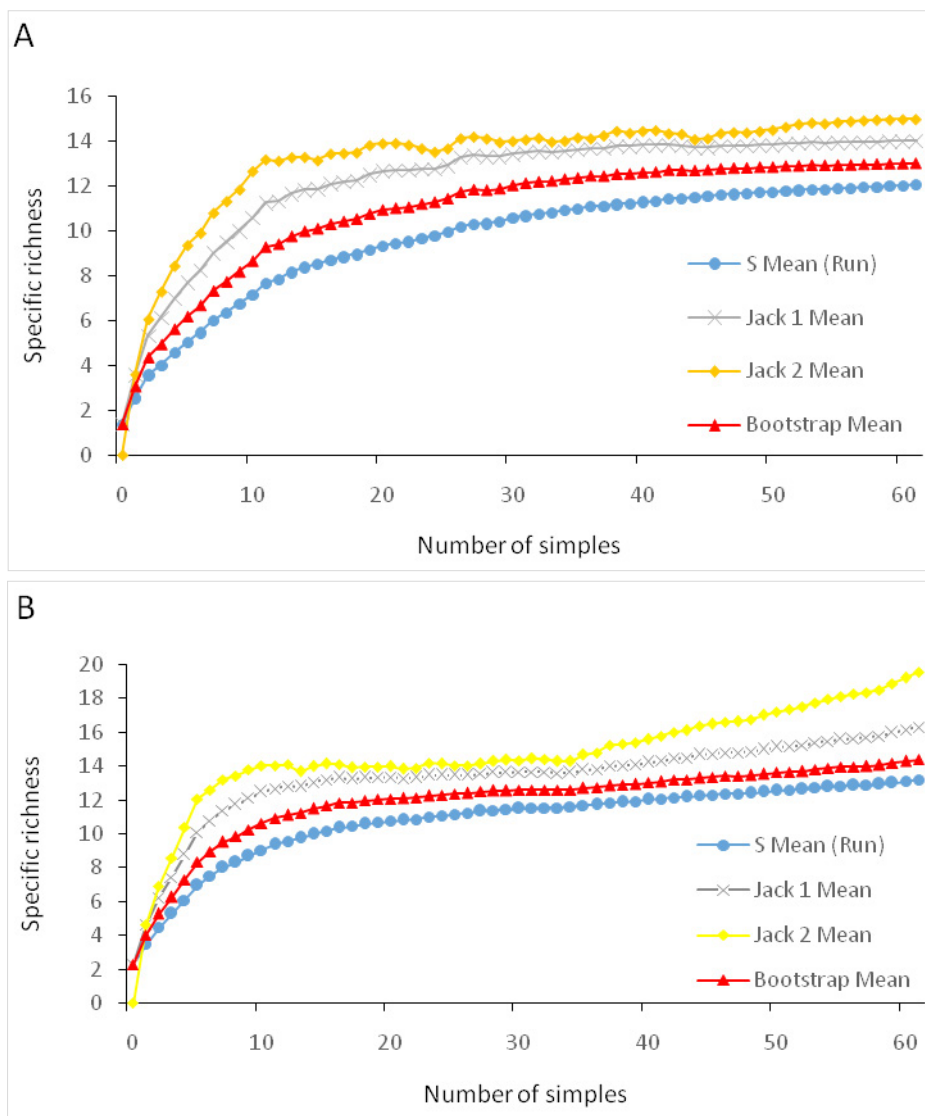


Fig 7. Species accumulation curves, richness estimators with all sampling methods combined. A: Orange orchard, B: Lemon orchard.

Whereas in Amizour, the increase in trap duration was not more effective (just three more species compared to the first sampling).

Discussions

The survey that we performed using the three combined sampling methods (Barber pots, baits, and manual capture), allowed us to record 18 species of Formicidae in the two agrosystems: 13 species in the lemon orchard located at the INRAA of Oued Ghir and 12 species in the “young” orange orchard located at Amizour, divided into three subfamilies, namely; Dolichoderinae, Formicinae, and Myrmicinae.

Our results are superior to Djioua's (2011), where she was able to record 10 species in Oued Aissi (TiziOuzou) in her study on Formicidae from some forest and agricultural environments, those of Dehina et al., (2007) who recorded 11 species during two years (2006 and 2007) at the National Agronomic Institute of El-Harrache and those of Ait Said (2005).

Mohammedi-Boubekka (2006) reports a richness of eight species in his study on the Bioystematics of Aphidae and their place in the orange trees' entomofauna in the Metidja plain. In the same station, Dehina (2004), noted a total species richness of nine species in the Heuraoua region (the Mitidja). She noted seven species in the citrus orchard, and four species in the vegetable crops.

Chemala (2013), in his myrmecological study of The Sahara's areas, reported in the Djamâa area 13 species in the palm grove and 11 species in cultivated areas. The three subfamilies identified during our sampling are represented with different proportions at the two sites. At INRAA, the Dolichoderinae and Myrmicinae dominate over the Formicinae. On the other hand, at Amizour, the subfamily Formicinae dominates, followed by the Dolichoderinae and Myrmicinae.

According to Djioua's study (2011), on the myrmecofauna of some forest environments and two agricultural orchards, the Myrmicinae predominate with more than 50% in the two agricultural environments, followed by the Dolichoderinae with more than 30% and finally the Formicinae with only 20%. Concerning the genera, 11 genera were noted at INRAA, of which only seven are present at Amizour with very distinct frequencies. The *Tapinoma* genus is the best represented at the Oued Ghir site and predominates with a frequency of 43.95%, followed by *Aphaenogaster* with a frequency of 31.49%. At Amizour, it is the *Cataglyphis* and *Tapinoma* genera that dominate (39.79 and 30.47% respectively).

Djioua (2014) recorded 12 genera in his study in the two orchards of Oued Aissi. Nadji et al. (2017) were able to record 11 genera in some *Crescia* orchards in Sidi Slimane in his study on the predation impact by *Cataglyphis viatica* (Insecta, Formicidae) about trophic availability in agricultural and natural environments in the Algerian Sahel. Mohammedi-Boubekka (2006) sampled eight genera in his study on the

Aphidae's biosystematics and their place in the orange trees' entomofauna in the Mitidja plain.

Some common species are not distributed in the same way in the two sites and over the two sampling periods.

➤ *Tapinoma magnum*: This species prefers watered or flooded areas. It is fond of clayey and humid soils on river banks, coastal dunes, and scrubland (Lebas et al., 2016). *T. magnum* is highly adaptable, tolerating both very wet and very dry soils. It maintains aphids and mealy bugs on plants (Bernard, 1968). In this study, the *Tapinoma magnum* is dominant at INRAA. Indeed, we observed in the field that this station's lemon trees are invaded by aphids and this is due to the very rare use of pesticides and insecticides by the managers of the institute (Personal Communication Dr. Boussad B.). In contrast, the Amizour orange trees have been treated with phytosanitary products and are free of all parasites. At INRAA, we noted the same number of individuals during the two samplings (368 individuals and 362 individuals, respectively), whereas at Amizour, the highest number of *T. magnum* was noted in July (155 individuals). This can be explained, probably, by an irrigation system installation by the orchard's owner, which was not present during the May sampling, whereas at INRAA the orchard is permanently irrigated.

➤ *Cataglyphis viatica*: It is more abundant in Amizour because these ants nest in open habitats (large clearings, mountain pastures, and steppes) (Cagniant, 2009). Indeed, the Amizour station is more open than the INRAA station where a lot of vegetation remains in the lemon orchard due to the absence of plowing. At Amizour, the species was more abundant during our second sampling in July with 158 individuals compared to 59 in May. This is explained by its scavenging and thermophilic nature, which collects the corpses of other arthropods that have fallen victim to the heat and stress of their hostile environment (Wehner et al., 1983). The high temperatures in July probably increased the death of arthropods.

➤ *Aphaenogaster testaceo-pilosa*: this species colonizes all environments. Cagniant (1973) considers that this species is indifferent to the vegetation cover. During our sampling at the INRAA lemon orchard, we noted a higher number of individuals in May (310) compared to 158 in July.

➤ *Lasius flavus*: According to Bernard (1968), *L. flavus* prefers cool, moist, open, mostly granitic, gently sloping ground and tolerates swampy facies more than most other ants. Most crops and pastures give an advantage to *Lasius*. The INRAA station is, therefore, favorable to its establishment.

➤ *Messor barbarus*: It is the most spectacular granivorous species. Although it is common in the Mediterranean region, it is adapted to warm and dry environments and is more frequent in open, herbaceous ecosystems such as meadows and scrublands (Lebas et al., 2016). At INRAA, the number of individuals was not very different during the two samplings, whereas at Amizour, the number of individuals decreased from 71 in May to only 9 in July (although this is the period

when it should be present). It is thought that land plowing between the two samplings destroyed the *M. barbarus* nests, reducing their numbers.

➤ *Pheidole pallidula*: This is an omnivorous species with a wide distribution in the Mediterranean region (Bernard, 1983). In North Africa, it occupies humid environments, especially in sandy and clayey soils. In Algeria, it prefers flat land (Bernard, 1968). It is the typical interior ant, a generalist species, very common, adaptable, and tolerant to human intervention. At INRAA's sampling, more than 64 individuals were recorded in July compared to 36 in May. In Amizour, however, it was absent from our records during the second sampling without any apparent explanation.

➤ *Crematogaster scutellaris*: The *Crematogaster* are among the most important warm-region genera in the world (Bernard, 1968). It is very common in the Mediterranean and commonly called the cork ant because it establishes its nests in aging oak trees causing their death. It is very flexible in its nesting behavior and can settle in cavities in trees, shrubs, soft wood, or walls, dry stone walls, various cracks, crevices, and cavities in friable rocks (Casevitz-weulersse, 1972). It is a pastoral species that seeks out and exploits arboreal aphids colonies. It can also nest in fruit or ornamental trees and various pines (Villemant & Fraval, 2002; Cagniant, 2005). In this study, its capture at the INRAA station is explained by the fact that the latter remained in its wild state as well as by the presence of aphids on lemon trees (it was on these trees that we captured them).

In Djioua's (2011) study on agricultural environments, she noted that *Tapinoma simrothi* is the most abundant species, in an orchard, with a frequency of 32.24%, followed by *Aphaenogaster testaceo-pilosa* (17.72%), *Pheidole pallidula* (14.90%), *Cataglyphis bicolor* (9.79%), *Tetramorium biskrense* (7.30%), and *Messor barbarus* (5.75%). The same observation was made by the author in a second orchard with a dominance of *Tapinoma simrothi* (AR=30.39%), followed by *Aphaenogaster testaceo-pilosa* (18.38%), *Pheidole pallidula* (16.86%), *Cataglyphis bicolor* (10.61%), *Tetramorium biskrense* (6.62%), and *Messor barbarus* (4.32%).

In northern Algeria, Ait Said (2005) noted that the *Tapinoma simrothi* abundance was 62.3% in Staoueli. Similarly, Dehina (2004) working in the Heuraoua region (Mitidja), noted the dominance of *Tapinoma simrothi* in the citrus orchard (AR% = 41%) and at the market gardening station (AR% = 82.3%). Chemala (2009) mentions the *Monomorium salomonis* dominance at three stations in Djamaa (El-Oued) with an abundance of 68.8% in palm groves, 54.8% in natural environments, and 29.9% in cultivated environments. Guehef et al. (2018) show that in Oued Souf, *Messor arenarius* (AR% = 36.76%) is the most abundant species in the potato station and *Pheidole pallidula* (AR% = 54.17%) in another potato station.

The diversity index carried out for the two orchards (INRAA-lemon and Amizour-orange) gives the following values: 2.23 bits for the first orchard and 2.28 bits for the second.

These values are fairly close and reveal a good Formicidae diversity. These values are higher than those reported by Djoua (2011) ($H' = 0.86$ bits for the orange and peach orchards (Oued Aissi). Chemala (2009) in a study carried out in three stations in Djamaa (El-Oued), diversity indices of 1.62 bits in the palm grove, 2.20 bits in the natural environment, and 2.42 bits in the cultivated environment. Toukali (2016), at the pear orchard in Sidi Embarek, noted that the Shannon diversity index value is very high and equal to 4.64 bits. Guehef et al (2018), recorded in Oued Souf, values of 2.32 bits in two stations.

The equitability index values indicate 0.60 for the INRAA orchard and 0.64 for the Amizour orchard. The values are quite similar and indicate that in both stations, the number of individuals among the species of each community tends to be relatively similar. Our results are lower than those found by Djoua (2011) in Oued Aissi in both orchards (respectively $E = 0.73$ and 0.86) reflecting an equilibrium between the abundance of species sampled. Chemala (2013) noted, in the region of El-Oued, an equitability value of 0.93 for the palm grove, 0.91 for the natural environment, and 0.79 for the cultivated environment. Chemala (2009), noted, in Oued Righ, an equitability value of 0.4 in the palm grove and 0.28 in the cultivated environment.

We also noted that Formicidae nests are very rare in the Amizour station (exception for *Tapinoma magnum* and *Messor barbarus*). The ants collected on this station are only transient (they come to hunt, collect corpses of other insects or collect seeds). In contrast, at INRAA, nests are present in large numbers between the lemon trees.

It seems that the main factors determining ant distribution are firstly insecticide use and secondly the environment nature (absence or not of plowing). Indeed, we found that at INRAA, certain species have higher abundance because it is favorable to their installation, contrary to Amizour where the land is continuously worked, which disturbs the establishment of ant species.

The Formicidae have a significant role in agricultural environments as they are front-line plowmen through their role in the regulation of phytophagous insects, seed dispersal, and symbiosis with plants and sap-sucking insects. In the future, we should be interested in the relationship between plants and ants and the importance of the latter in agricultural environments.

Author's Contributions

Anissa Henine-Maouche conceived the idea presented.

Wissam Guergouz, Thiziri Moudache carried out the sampling and laboratory work, assisted by Anissa Henine-Maouche for the identification.

Anissa Henine-Maouche carried out the calculations and statistical analyses and supervised the results of this work. All authors discussed the results and contributed to the final manuscript.

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