Bulletin of Pure and Applied Sciences
Vol.38A (Zoology), No.1, 2019: P.27-39

Print version ISSN 0970 0765
Online version ISSN 2320 3188
DOI 10.5958/2320-3188.2019.00004.4

Original Research Article
Available online at www.bpasjournals.com

Evaluation of the Arthropodological Fauna Associated With the Bean Culture (*Viciafaba* Minor L.) in the Naciria Region (Boumerdes, Algeria)

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Received: Jan 21, 2019
Revised: Mar 22, 2019
Accepted: Jun 10, 2019
Published: Jun 20, 2019

Abstract

The bean is a plant belonging to the Fabaceae family, it is one of the most important legumes in view of its importance in the human diet and its richness in various proteins, as well as its role in the contribution of atmospheric nitrogen in the soil. However this crop is subject to various attacks of diseases and pests, altering the good production of beans. In this context, several studies have been undertaken to study the main pests of the bean as well as the auxiliary insects. The objective of our study is to carry out an exaustive inventory of arthropods present on faba bean cultivation in the region of Naciria (Boumerdes), in order to understand the existing host-pest relations, and to evaluate the number of auxiliary insects that can intervene in a reasoned biological fight, thus respecting the balance of the environment. Sampling of arthropod populations was done using three trapping techniques, namely Barber pots, colored traps, and the sweep net. The results obtained express a richness of 79 species, belonging to 40 families, divided into 11 orders and 5 classes.

Keywords: arthropods, inventory, bean, Boumerdes, fababeans, traps.

1. INTRODUCTION

The bean is an annual diploid plant (2n = 12chromosomes) (Wang et *al*., 2012). Among legumes produced in Algeria, the bean represents about 50% of the local reproduction (Belkhodja et *al*.,1992), its cultivation would cover in the world 4.7 million hectares (Chaux and Foury, 1994). The bean is a good source of protein and energy, and plays a role in crop rotation, nitrogen fixation and soil fertilization (Wang et *al*., 2012). Nevertheless, the bean crop is under attack from several factors, including various pests causing considerable losses in the fields, and during stocks.

In Algeria, arthropods inventories have been carried out. We quote the work of Mezani et *al*. (2016), who evaluated the diversity of invertebrates in a bean plot (*Viciafaba* major) in the Tizi-Ouzou region. Work of Nuessly et *al.* (2004) who studied the insects associated with the cultivation of leprosy (*Viciafaba*) in South Florida. The objective of the present study is to establish a qualitative and quantitative inventory of arthropodological fauna on bean, faba bean variety culture in the Naciria region and to evaluate the total richness of the listed species, as well as to estimate the percentage of pests and auxiliary insects present in the region of Naciria, wilaya of Boumerdes.

2. MATERIALS AND METHODS

2.1 Description of the study area

The study plot is located in the region of Naciria (36 ° 44 '51'North, 3 ° 49'44'east, 158m altitude), part of the wilaya of Boumerdes, 80 km from East of Algiers and 30 km from the wilaya of Boumerdes (Figure 1). The region of Naciria belongs to the Mediterranean climate, characterized by a rainy and mild winter and a dry and hot summer.

Figure 1: **Location of the study area (Google maps, 2019)**

2.2 Methodology

Weekly field trips are conducted for sampling arthropod populations once a week. We divided the study plot into 9 homogeneous quadrats, at the center of each quadra a yellow trap and a barber pot are deposited, the sweep net is also used to harvest the arthropods hidden in the vegetation. For each output, the date, and the type of trap used, the harvested species are kept for identification and enumeration in the laboratory.

Identification is achieved by the use of several identification keys (Seguy, 1923; Perrier, 1961 and Chinery, 1988).

3. EXPLOITATION OF THE RESULTS

Different analyzes are carried out on our samples recorded in the field, namely the ecological indices of composition (total richness and relative abundance), as well as the ecological indices of structures (Shannon-Weaver index and equitability).

3.1 Ecological composition indices

3.1.1 Specific wealth

It represents one of the fundamental parameters characteristic of a stand, the total wealth (S) of a biocenosis corresponds to all the species that compose it Ramade (1984).

3.1.2 Relative abundance or centesimal frequency

Relative abundance (AR%) (Faurie et *al*., 1980) is the percentage of the numbers of individuals of a species (ni) by contribution to the total number of individuals (N): AR% = ni / Nx100

3.2 Ecological indices of structure

3.2.1 Shannon-Weaver Diversity Index

According to Barbault (2008), the specific diversity is measured by various indices, the most used of which is Shannon-Weaver. It is calculated by the following formula:

$H' = - \sum qi \log_2 qi$

H ': Shannon-Weaver diversity index expressed in bit units.
qi: The probability of encountering the species, write qi = ni / N, where ni is the number of each species in the sample and N is the sum of all species combined.
Log2: logarithm based 2.

This index makes it possible to have information on the diversity of each environment taken into consideration, it varies both as a function of the number of species present and according to the abundance of each of them (Barbault, 2008).

3.2.2 Equidistribution or equitability index

It is the relationship between real diversity and maximum theoretical diversity (Blondel, 1979).
H 'max = Log 2 S
S: is the total wealth
H 'max: is expressed in bits
E = H '/ H max

Ramade (2003) found that Fairness ranged from 0 to 1 when nearly all of the population corresponds to a single species of the stand, and tends to 1 when each species is represented by a similar number of individuals

4. RESULTS AND DISCUSSION

The results of arthropods diversity obtained by using three sampling methods show the presence of79 species belonging to 40 families divided to 11 orders and 5 classes (table 1).

Table 1: Representative table of the species caught by the different sampling techniques in the study plot

Classe	Order	Familly	Species	Barber pots	Sweep net	Colored traps
Insecta	Coleoptera	Curculionidae	*Phyllobius sp.*	21	4	3
			Otiorynchus sp	11	2	4
			Lixus punctiventris	14	8	2
		Cantharidae	Cantharidae sp.	9	1	5
		Staphylinidae	*Staphylinidae sp.*	10	0	0
			Staphylinus olens	7		0
		Rutelidae	*Anisoplia floricola*	15	4	2
		Cetoniidae	*Oxytheria faunesta*	16	4	9
		Cleridae	*Thrichodes alvearius*	9	3	16
		Coccinellidae	*Coccinella algerica*	23	0	10
			Adalia bipunctata	12	0	16
			Harmonia axyridis	9	0	20
			Theaviguintiduo punctata	11	0	14
		Carabidae	*Harpalus sp.*	7	0	0
		Aphodiidae	*Aphodius sp.*	6	2	0
		Apionidae	*Apion sp.*	11	3	2
	Lepidoptera	Nymphalidae	*Pararge aegeria*	6	3	10
		Pieridae	*Pieris brassicae*	4	12	9
	Hemiptera	Pentatomidae	*Palomena sp.*	4	4	16
			Nezara viridula	11	9	24
			Pentatomidae sp .ind.	9	2	2
	Hymenoptera	Apidae	*Apis mellifera*	16	14	33
			Andrena labiata	5	1	10
			Eucera longicornis	7	3	10
		Formicidae	*Tapinoma sp.*	14	5	0
			Tapinoma nigerrimum	10	0	0
			Pheidol pallidula	30	0	0

			Messor barbarous	16	5	6
			Cataglyphis bicolor	29	7	2
			Messor structor	11	0	0
			Cataglyphis viatica	14	0	0
		Halictidae	*Halictus quadvincinctus*	7	2	11
			Lasioglassum calceatum	2	4	8
			Halictus sp.	6	0	9
		Vespidae	*Vespula germanica*	4	4	11
			Polistes gallicus	3	0	7
		Ichneumonidae	Ichneumonidae sp. ind.1	2	2	15
			Ichneumonidae sp. ind. 2	0	0	4
	Diptera	Culicidae	*Culex pipiens*	9	6	20
			Aedes sp.	2	3	6
			Culicidae sp..ind .	7	2	11
		Ceratopogonidae	*Culicoiides sp.*	10	5	15
			Culicoides albicans	7	0	12
		Tipulidae	*Tipula latelaris*	5	3	11
			Tipula alternata	4	0	10
		Lauxanidae	Lauxanidae sp. ind.1	7	0	20
			Lauxanidae sp.ind. 2	9	0	11
			Calliphora vicina	10 ,	4	20
			Calliphora sp.	12	0	21
		Drosophilidae	Drosophilidae sp. ind.	11	3	31
		Sciaridae	*Zygoneura sp*1.	11	1	21
			*Zygoneura sp*2	10	0	19
		Tephritidae	Tephritidaesp.ind.	9	0	13
		Chironomidae	*Chironomus sp.*	14	0	16
		Empididae	*Empis sp*1	13	0	24
			*Empis sp*2	7	0	18
			Empis grisea	10	0	16
			Empididaesp. ind.	10	0	18

		Muscidae	Muscidaesp. ind.	7	0	16
		Stratiomydidae	*Chloromyia formosa*	11	7	26
		Psychodidae	Phlebotaminae sp.ind.	6	0	16
			Phlebotomus sp.	7	0	9
		Sepsiidae	*Sepside sp.*	9	0	10
		Syrphidae	*Eristalis tenax*	13	5	33
			Syrphus rebesii	15	7	26
Arachnida	Araneae	Lycosidae	Lycosidaesp.ind.	15	0	7
		Araneidae	*Aranea sp.*	10	6	0
		Thomisidae	*Thomisius sp.*	13	3	5
			Thomisidae sp..ind.	9	0	0
	Ixodida	Ixodidae	*Ixodes sp.*	9	0	0
Gasteropoda	Stylommatophora	Subulinidae	*Rumina decollata* *Cernuella vergata*	17 15	2 4	12 9
		Helicidae	*Helix aperta* *Helix aspersa*	24 14	5 9	12 4
Diplopoda	Julida	/	*Iulesp.*	5	0	0
Collembola	symphypleona	Sminthuridae	*Sminthurus viridis*	77	0	0
	Entomobryomorpha	Entomobrydae	Entomobrydae sp. ind.1	53	0	0
			Entomobrydae sp. Ind. 2	40	0	0

4.1 Exploitation of results by ecological indices of composition

4.1.1 Total wealth of invertebrate species caught

The total wealth of the species caught by the three types of traps is 41 species for the sweep net, 79 species for the barber pots and 62species for the colored traps (Table 2).

Table 2: **Total Wealth of Species Captured by Different Sampling Methods**

Traps	**Colored traps**	**Barber pots**	**Sweep net**
Total wealth	62 species	79 species	41 species
Total species caught	182		

4.1.2 Percentage frequency of the species caught by the different sampling methods

The results obtained by using sweep net show that the dominance of spices *Apis meliifera* with percentage of 7.65% and *Pieris brassicae* with 6.55%. The species who presented a low percentage are *Cantharidae* sp with 0.54% and *Andrena labiata* with 0.54%.

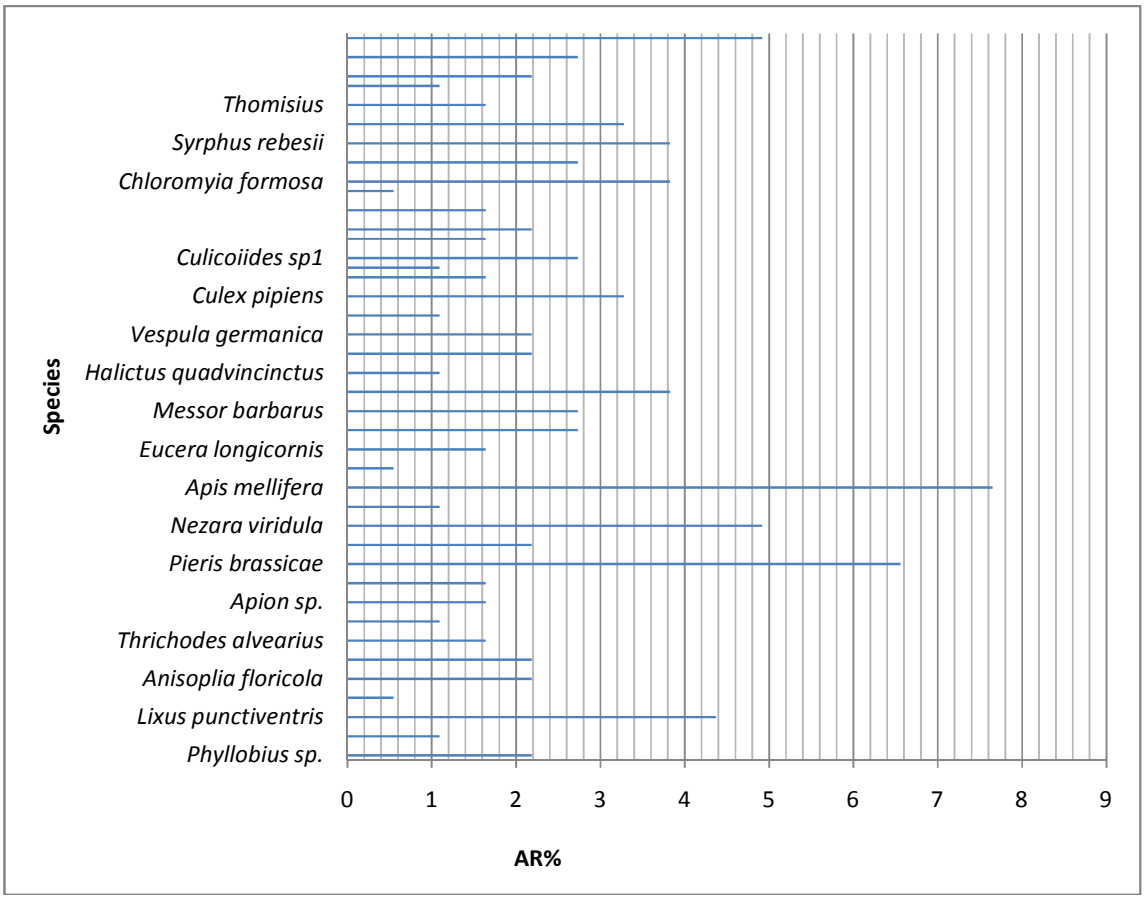

Figure 2: **Relative abundance of species caught by sweep net**

According to Figure 3, the species most captured by the barber pots are *Sminthurus viridis* with an AR = 8.13%, followed by Entomobridae sp.ind.1 and Entomobridaesp.ind.2 with a relative abundance of 5.46% and 4.12% respectively. The spices who presented a low percentage are Ichneumonidae sp and *Aedes* with an abundance equal to 0.21%

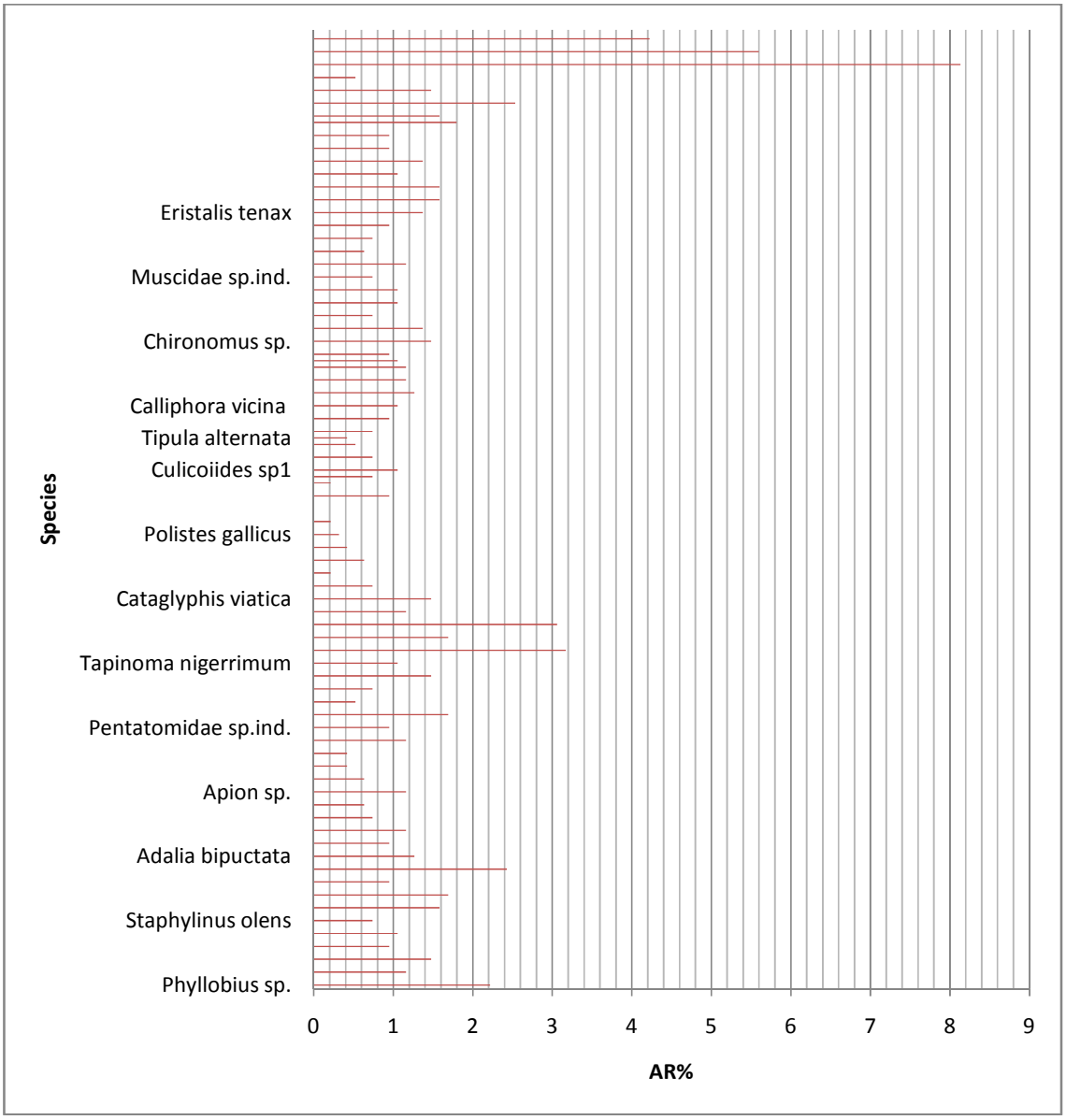

Figure 3: Relative abundance of species caught by the barber pots

The Figure 4 show that the species most captured by the colored traps are *Eristalis tenax* and *Apis mellifera* with equal AR = 4,08%, and Drosophilidaesp.ind. 3.84% followed by *Syrphus rebisii* and *Cloromyia formosa* with a relative abundance of 3.22% respectively and 1.22% *Coccinella algerica*, the less dominant species such as *Lixus punctiventris* 0.24%, *Anisoplia floricola* 0.24%.

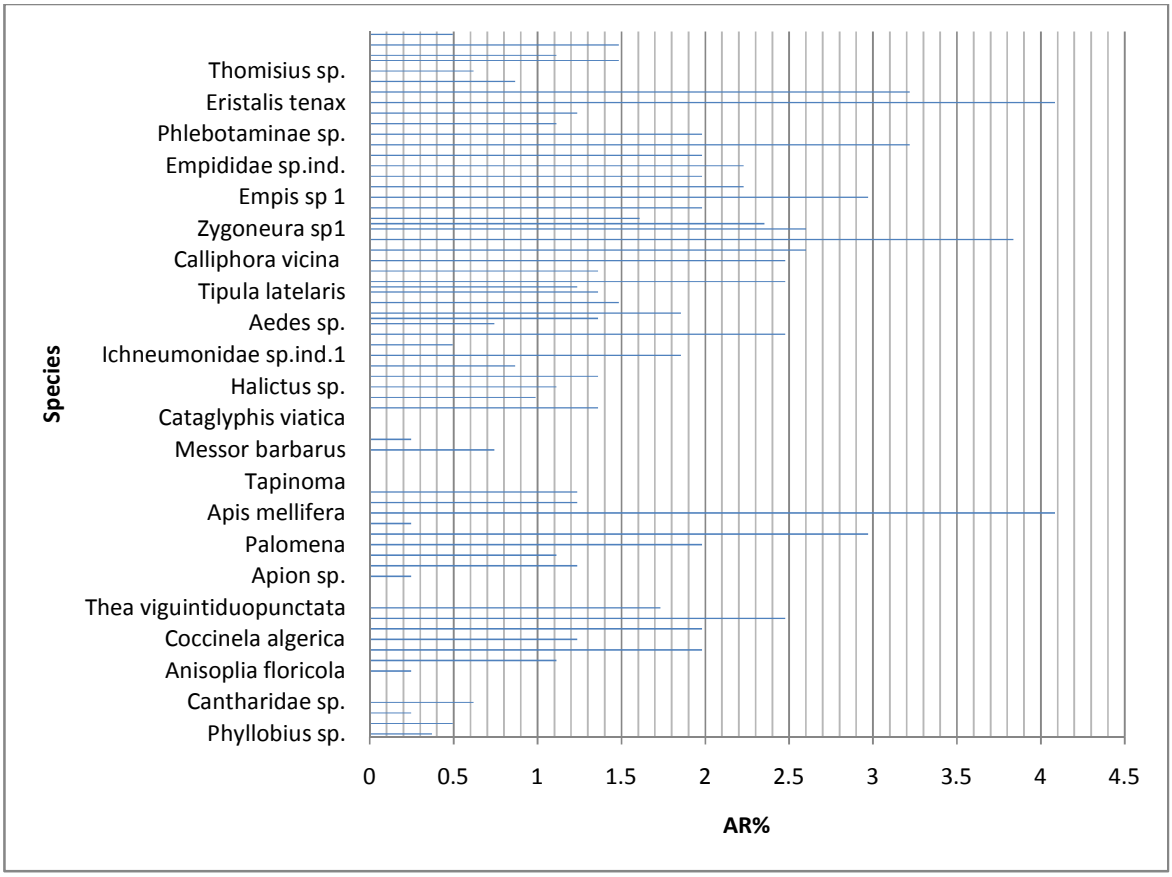

Figure 4: **Relative abundance of the species caught by the yellow traps**

4.1.3 Percentage frequency obtained for invertebrate orders captured by yellow traps

The relative abundances of orders of arthropods captured by the use of yellow traps are presented in figure 5.

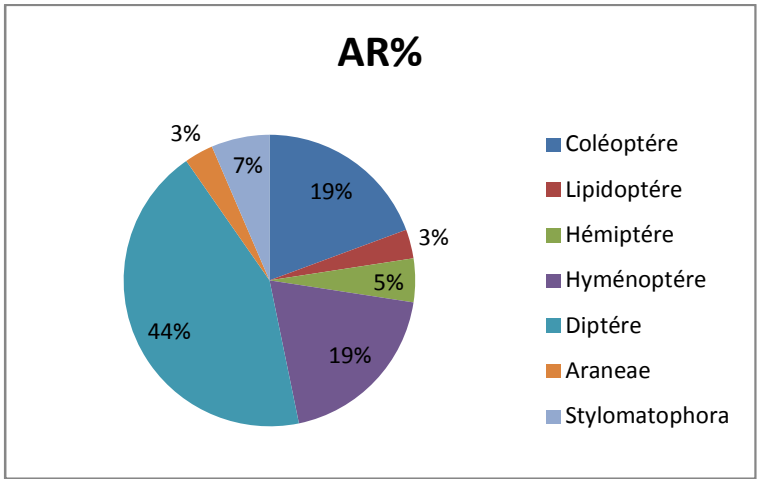

Figure 5: **Relative Abundance of Insect Orders Captured by Yellow Traps**

According to the results mentioned in figure 5, the order best presented by this type of trap is the Diptera with a relative frequency of 44% and the least order presented is that of the Araneae with a percentage of 3%.

4.1.4 Percentage frequency obtained for the orders of arthropods captured by the Sweep net:
The relative abundances of orders of arthropods captured by the use of the sweep net are presented in figure 6.

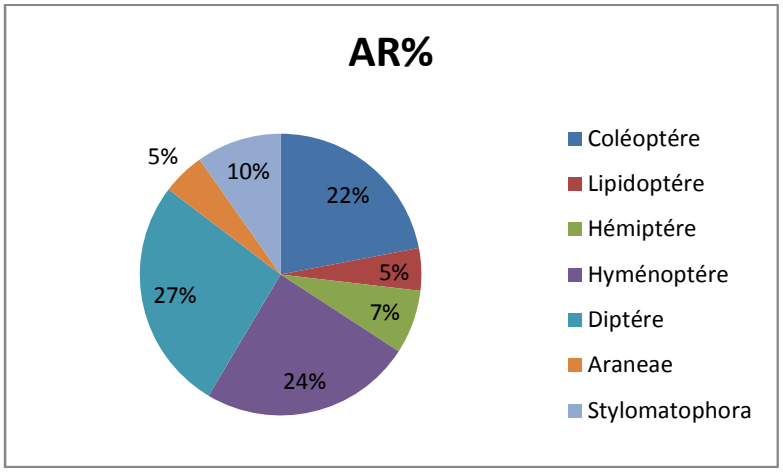

Figure 6: **Relative Abundance of Insect Orders Captured by the Sweep net.**

According to figure6, the order most presented is that of Diptera with a relative frequency of 27% followed by 24% of Hymenoptera.

4.1.5 Percentage frequency obtained for orders of invertebrates captured by the barber pots
The relative abundances of orders of arthropods captured by the use of barber pots are presented in figure 7.

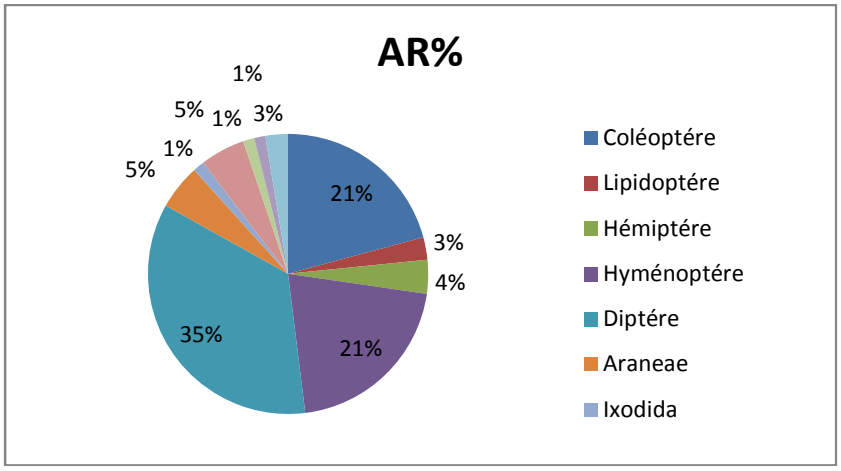

Figure 7: **Relative abundance of insect orders captured by barber pots.**

Figure 7 shows that the most captured orders by the method of pot barber and those of Diptera, Coleoptera and Hymenoptera with relative frequencies of 35%, 21%, 21% for each order respectively.

4.2 Exploitation of results by ecological indices of structure

Results of the Shannon-Weaver (H ') diversity indices, the maximum diversity (H'max) and the equitability (E) values applied to the orders of insects trapped by the different types of traps are presented in Figure 8.

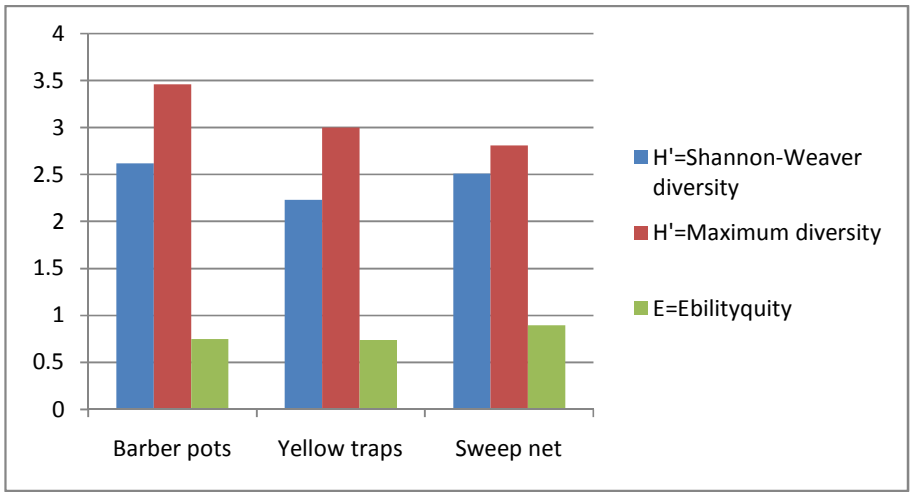

Figure 8: Shannon-Weaver Diversity Index and Equitability Values for Different Trapping Techniques Used

The Shannon-Weaver diversity index values are high for the three types of traps, they are represented by H '= 2.62 bits for the barber pot and a maximum diversity equal to H max = 3.46 bits; for the Sweep net, the diversity H 'is equal to 2.51 bits with a maximum diversity of H max = 2.80 bits; then come the yellow traps with a diversity H 'equal to 2.23 and Hmax = 3.

The equitability obtained for each type of trap tends to 1, which makes it possible to say that the numbers of the species present tend to be in equilibrium with each other.

DISCUSSION AND CONCLUSION

The insect inventory allowed us to collect 79 species, belonging to 40 families, divided into 11 orders and 5 classes. In 2016, upon cultivation of beans crop, in Tizi-Ouzou Mezani et *al*., obtained with different methods of trapping (yellow traps, barber pots, sweep net) 52 species divided into 5 classes, the class of insecta is best represented with 11 order of which the most important are the hymenoptera and Homoptera. In 2004, in a bean field on the farm of El Alia, 48 species of invertebrates are captured by Boussad and Doumandji, in the same culture in 2004, in Oued Smar in Algeria, these authors found 73 species for the class of insecta and a species for Arachnida, Homoptera was the best represented order.

Elsewhere, Bello et *al.* (2018), have harvested 39 gender and 39 species on the different plots of cowpeas, the beetles of 13 species are the most dominant with a frequency of 33%. Lozano et *al.* (2013), harvested using yellow traps 34,073 insects distributed in 10 order and 65 families in the zucchini culture and 32,790 insects distributed in 10 order and 68 families.
The relative abundance of arthropods varies according to the types of traps used during sampling

Mezani et *al.* (2016), indicating that in the pot-barber method, the order of Coleoptera and Hymenoptera is captured with a high percentage of 23.80% for Coleoptera and 23.38% for Hymenoptera. The order of Orthoptera is the least represented with a frequency of 0.4% adding also for yellow traps and the sweep net, the order of beetles is the most dominant with a percentage equal to 28.62% and 3% respectively. Against the least abundant orders are Orthoptera with a percentage of

1.62% for yellow traps and the order Homoptera with a relative frequency of 1.5% for the filleting net, during an inventory of invertebrates on bean crops in the Tizi-Ouzou region. The use of the barber pots method to evaluate arthropod biodiversity at three sites studied in the Djelfa region steppe in Algeria, Guerzou et *al*. (2014), noted that the Shannon -Weaver diversity values range from 1.9 to 3.7 bits in Taicha, from 03.02 to 3.5 bits at el Khayzar and from 3.6 to 4.0 bits at Guayaza. Souttou et *al*. (2011), in a census arthropodofaune study by the use of method of barber pots in an Aleppo pine reforestation at Sehary Guebly (Djelfa) have noted an H 'value ranging from 2.58 bits in January to 4.75 bits in June.

Lopes et *al*. (2011) in a study evaluating the diversity of aphids and their natural enemies in vegetable crops in eastern China, noted the presence of the two species of ladybird *Coccinellaseptempunctata* and *Harmoniaaxyridis*on the culture of zucchini with relative abundance of 21.7% and 0.2% respectively and 2.9% and 2.7% in the potato crop. In 2013, Lozano et *al*. reported that the most dominant order was that of Hemiptera with a frequency of 90.8% in zucchini culture and 88.1% in potato crops followed by beetles and cucumbers. Order of Collombola with frequencies that are 1% and 0.3% respectively in the zucchini culture and 1.1% and 0.8 respectively in the potato crop.

According to Mezani et *al*. (2016), the Shannon-Weaver diversity for barber pots is H '= 4.95 and the colored traps are H' = 4.6 respectively, and for the sweep net is H '= 3.98

According to the same authors the fairness close to 0 is 0.89 for the barber pots and the sweep net and 0.86 for the yellow traps.

Benia (2010), in a study of the entomological fauna associated with green oak (*Quercus ilex* L.) in the forest of Tafat (Setif, northeast Algeria) and bio-ecology of the most representative species states that the value equitability is greater than 0.5 which indicates that there is a balance between the entomological populations for the four stations studied at Setif.

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