Bulletin of Pure and Applied Sciences.
Botany, Vol.41 B, No.1.
January-June 2022: P.1-14
Original Research Article

Print version ISSN 0970 4612
Online version ISSN 2320 3196
DOI: 10.5958/2320-3196.2022.00001.5
Available online at www.bpasjournals.com

Inventory of Invertebrates on Pear Crop ('*Pyrus communis*') in Makouda area (Tizi-Ouzou), Algeria

***Dyhia Guermah[1], Ferroudja Medjdoub-Bensaad[2] and Lynda Lakabi[3]**

Author's Affiliation
[1, 2, 3] Laboratoire de production, sauvegarde des espèces menacées et des récoltes. Influence des variations climatiques.
Département de biologie. Faculté des sciences biologiques et des sciences agronomiques.
Université Mouloud Mammeri de Tizi-Ouzou 15000. Algérie.

***Corresponding Author:**
Dyhia Guermah
Département de biologie. Faculté des sciences biologiques et des sciences agronomiques.
Université Mouloud Mammeri de Tizi-Ouzou 15000. Algérie

E-mail:
guermah.dy@gmail.com
Received on 30.01.2022
Revised on 11.05.2022
Accepted on 23.05.2022

Keywords:
Inventory, invertebrates, Pear, Makouda, Algeria.

Abstract
The inventory of invertebrates on pear cultivation using 2 methods of sampling, Barber traps and colored traps in Makouda region (Tizi-Ouzou) Algeria, allowed us to collect 77 species divided into 59 families, belonging to 18 orders and 5 classes. The values of the centesimal frequencies applied to invertebrates orders identified in the studied plot vary from one type of trapping to another, each sampling method relates to a representative order group. The diets of insects are extremely diverse, due to the structures and function of the mouth parts, the structural and functional division of the digestive tract. We have established a distribution according to the different trophic categories according to our personal observations and the bibliography consulted. We were able to distinguish 8 large groups among the 77 insect species selected. Shannon-Weaver diversity index values are quite high in the study plot, it is H '= 4.80 bits for Barber traps, H' = 4.59 bits for colored traps, H' = 4.83 bits for sweep net and H' = 2.64 bits for butterfly net. The fairness obtained for each type of trap varies from E = 0.87 to E = 0.94, these values tend towards 1, which reflects a balance between the species in the environment.

How to cite this article: Guermah D, Medjdoub-Bensaad F and Lakabi L. (2022). Inventory of Invertebrates on Pear Crop ('*Pyrus communis*') in Makouda area (Tizi-Ouzou), Algeria. *Bulletin of Pure and Applied Sciences-Botany,* 41B(1), 1-14.

1. INTRODUCTION

Fruit arboriculture is an integral part of the economic and social life of Algeria. This large country, due to its geographical position and its various pedoclimatic conditions, indeed has the privilege of cultivating several fruit species and to produce fresh fruit all year round. Cultivated environments provide habitat and the various food resources necessary for predatory and parasitic arthropods, as well as microbial pathogens that act as natural enemies of agricultural pests and constitute means of biological control in agricultural ecosystems.

The preservation of biodiversity represents an indisputable ecological stake in the functioning of agroecosystems, but also economical for society (Tscharntke *et al*., 2005). Pollination is another important ecosystem service provided by biodiversity. Klein and *al.* (2007) estimated that 75% of plant species of global importance for food production depend animal pollination, mainly by insects. In addition, the soil microfauna providing the structure and soil fertility provides essential ecosystem services to agroecosystems. In this context, we carried out an inventory of the invertebrates fauna associated with pear tree cultivation in Tizi-Ouzou area (Kabylia), with the aim of improving our knowledge of biodiversity invertebrates and their classification according to the different trophic regimes.

2. MATERIALS AND METHODS

This study was conducted in a '*Pyrus communis*' orchard not subject to treatment by pesticides. The parcel is located in Makouda area (36°47'31'' Nord, 4°03'45'' East) (Tizi-Ouzou, Algeria) situated at an altitude of 370 meters, in a Mediterranean climate characterized by a sub-humid bioclimatic stage with temperate winter (Figure 1).

The study orchard represents an appropriate environment and an extraordinary ecosystem whose biological functions bring together ecological conditions conducive to installation and the multiplication of various invertebrates. So, various sampling methods have been addressed in Makouda region from July2019 until June2020, covering vegetation, flowering and fruiting periods of *Pyrus communis* plants.

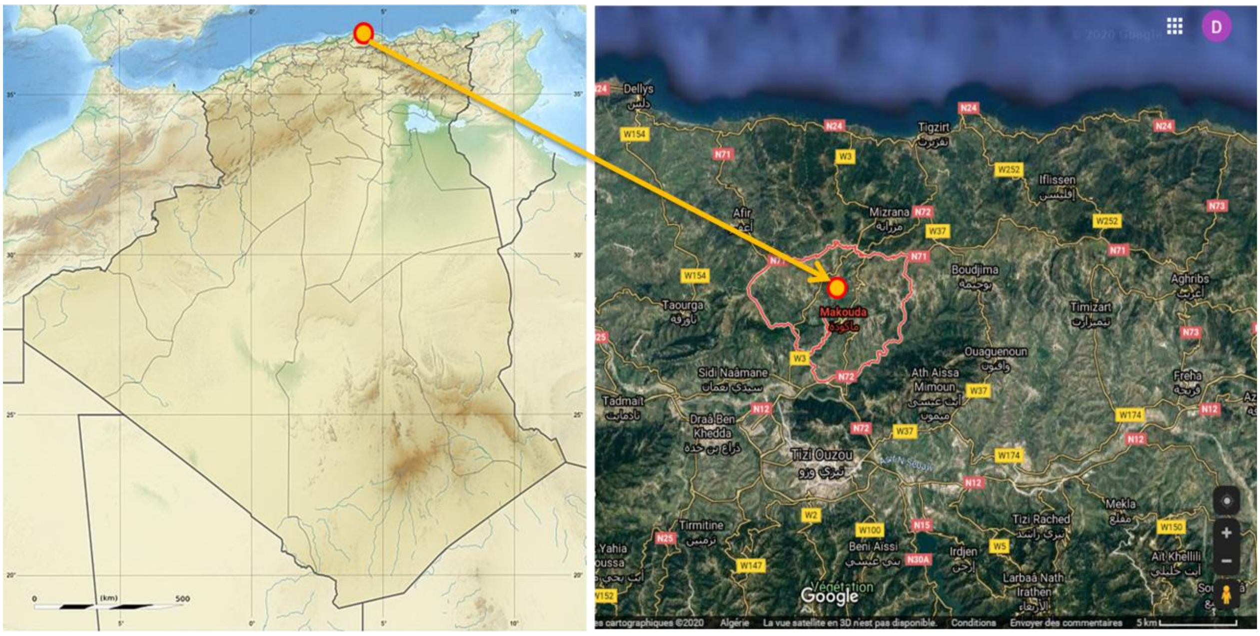

Figure 1: Location of the study area in Algeria (Google maps, 2021).

2.1. In the field

We opted to use two trapping methods (Fig. 2) namely Barber pots or terrestrial traps as well as yellow aerial traps, at the rate of one outing per month.

- **Barber traps**

Nine pots are placed in the study plot, these pots consist of simple plastic containers, about 10cm deep, and these are buried at the foot of the trees, vertically so that the opening is flush with the ground, the earth being packed around, in order to avoid the barrier effect for small species. The traps are filled to 2/3 of their capacity with water added with preservation liquid.

The use of Barber pots allows the capture of diurnal and nocturnal species that frequent the soil. The detergent serves as a wetting agent, it dissolves the lipid layer of the epicuticle causing the death of arthropods by drowning, and thus it prevents captured individuals from emerging from the trap.

Weekly visit replaces water in Barber jars lost by evaporation due to too high heat in summer. Also, avoid the loss of content spilling outward (invertebrates previously caught) by excess water in case of heavy rain which can flood the basins (Baziz, 2002).

• **Colored traps**
Colored traps are plastic containers, yellow, filled to 3/4 of their content with water added with conservation product. We used 9 yellow traps, 15 cm in diameter and 15 cm deep, placed at a height of 1.5 meters and fixed with wire to the branches of the trees. These colored traps have a double attractiveness on the one hand, due to their complexion and on the other hand to the presence of water (Roth, 1963). This method makes it possible to capture purely hygrophilic insects for which yellow radiation is particularly attractive, it is easy to use and it is of lower financial cost.

2.2. Laboratory working methods
After each trip and according to the different capture methods used, the samples obtained are placed in Petri dishes, bearing labels on which are indicated the date of the exit and the trap concerned.

• **Sorting**
Samples collected in the field are sorted in the laboratory by separating the arthropods from the other branches (gasteropods, annelids, myriapods), then we proceeded to sort the individuals according to their orders, families to arrive at the species when possible.

• **Counting**
After counting individuals, small insects are kept in bottles containing 70% diluted alcohol with the following information: the date, the order, the family, the type of trap and the number of individuals according to the plot studied.

The same indications are mentioned on Petri dishes in which medium to large individuals are dried, fixed and spread out to prepare them afterwards for identification.

Figure 2: different sampling methods used (Original, 2020).
a: Yellow plastic bins serving as an aerial trap.
b: Barber pots buried in the ground.

• **Identification**
The identification of individuals of listed invertebrates is carried out using the different determination keys (Perrier, 1927, 1932, 1961); (Piham, 1986); (Delvare and Aberlenic, 1989); (Chinery, 1988).

• Trophic diet

After identification of the invertebrates species captured by the different sampling methods, their trophic regimes are determined after bibliographic research.

2.3. Exploitation of the results obtained by the sampling of invertebrates

In order to exploit the results relating to the inventoried species, we used ecological indices of composition and structure.

2.3.1. Exploitation of results by ecological indices

For our study, ecological indices in particular, ecological indices of composition and ecological indices of structure were used for the exploitation of the results of the global inventory obtained during the study period.

2.3.1.1. Ecological composition indices applied to invertebrates sampled in the environment studied

The results obtained from the arthropod census are analyzed by the ecological composition indices which are as follows: Total Wealth (S) and relative abundances (centesimal frequency) (AR%).

• Total specific wealth

According to Ramade (2003), the total wealth represent one fundamental parameters characteristic of a stand; the total wealth is the total number of species included in the stand considered in a given ecosystem.

• Abundance relative (centesimal frequency)

According to Dajoz (1971) the relative abundance is the number of individuals of the species (ni) in relation to the total of individuals N (all species combined). Relative abundance (AR) is expressed as follows:

$AR = ni (100) / N$

ni = Number of individuals of a species.

N = Total number of individuals (all species combined).

2.3.1.2. Ecological structural indices applied to the fauna captured in the study environment

These indices include the Shannon-Weaver Diversity Index, and the Fairness Index.

• Shannon diversity index

Shannon's diversity index corresponds to the calculation of the entropy applied to a community (Ramade, 2003). The basic idea of this index is to bring from the capture of an individual within a sample for more information when its probability of occurrence is low.It is given by the following formula:

$H' = \sum qi \ Log2 \ qi$

H': The diversity index expressed in bit units.

qi: The probability of encountering species i.

The latter is calculated by the following formula:

$qi = ni / N$

ni: Number of individuals of the species i.

N: Total number of all species combined.

The maximum diversity is represented by H'max; it corresponds to the highest possible value of the stand. It is given by the following formula:

$H'max = Log2 \ S$

S: Is the total number of species found during N surveys.

• Fairness index

Fairness is the ratio of observed diversity (H ') to maximum theoretical diversity (H' max) (Barbault, 1981).

$E = H'observed / H'max$

H'observed: diversity observed.

H'max: maximum diversity expressed as a function of specific richness.

3. RESULTS

During this study which focused on the inventory of invertebrates fauna associated to peartrees in an ecological orchard not subjected to pesticide treatments, 77 species were captured, distributed in 59 families belonging to 18 orders and 5 classes.

3.1 Total wealth and relative abundance

The collected arthropod in a '*Pyrus communis*' pear plot using different trapping methods allowed us to identify 77 species. The total wealth of the species caught by the three trapping methods was 39 for Barber pots, 34 species for the sweep net; 30 species for colored traps and 7 species for butterfly net (Table 1).

Table 1: Total wealth of species caught by different sampling methods

Total wealth (S)	Species
Barber traps	39
Coloredtraps	30
Sweep net	34
Butterfly net	7

Centesimal frequency (CF) of invertebrates orders captured in pear plot using different sampling methods is shown in figure 3 for Barber pots, figure 4 for colored traps, figure 5 for sweep net and figure 6 for butterfly net. Centesimal frequency of species identified according to the order, and family are presented in Table 2.

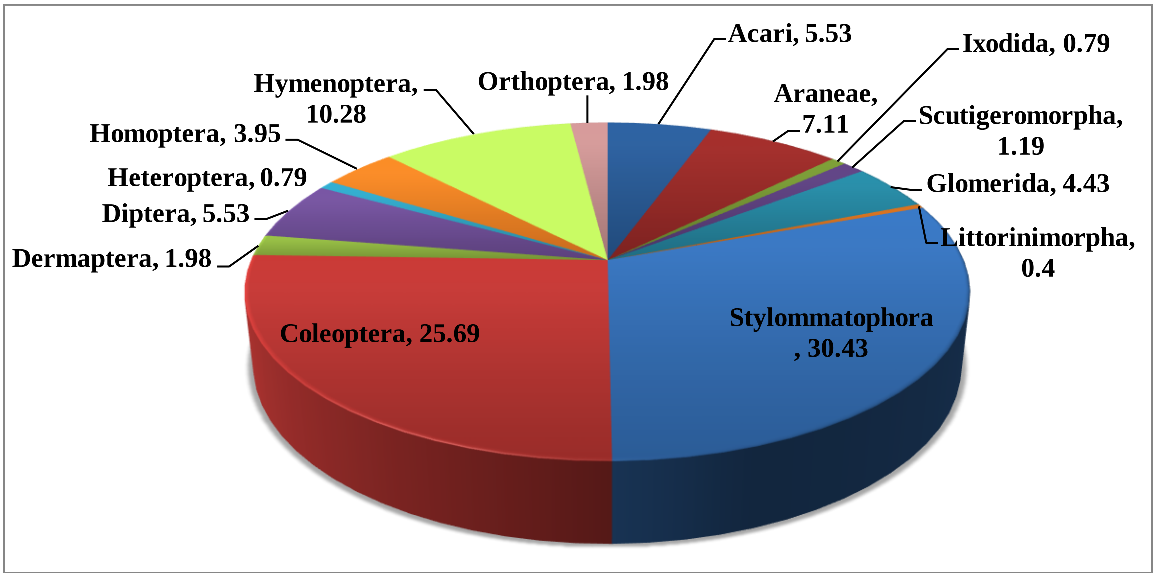

Figure 3: Centesimal frequency of invertebrate orders captured using Barber pots

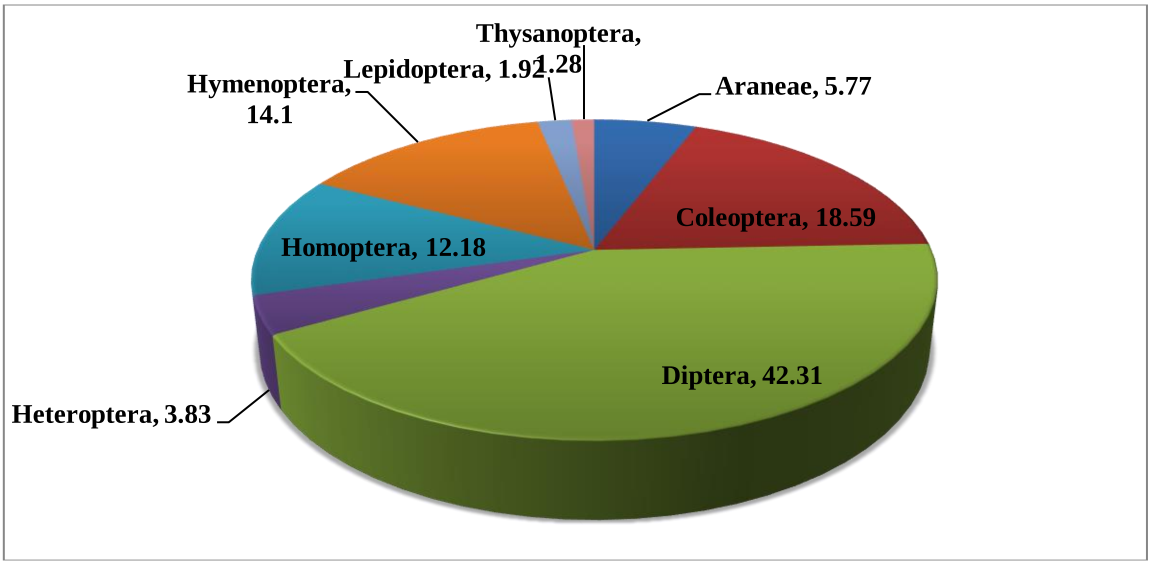

Figure 4: Centesimal frequency of invertebrate orders captured using colored traps

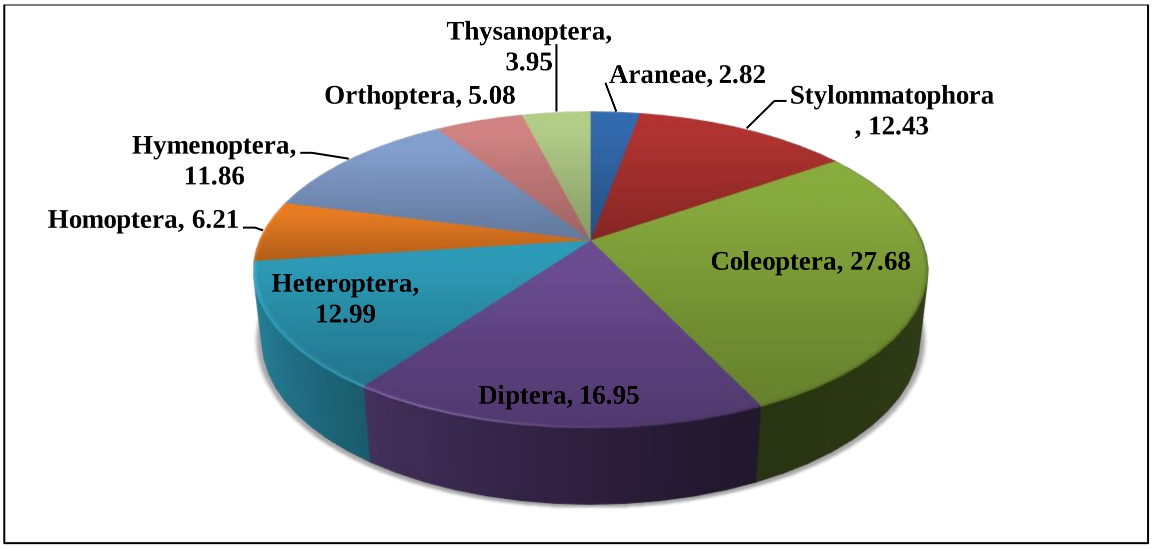

Figure 5: Centesimal frequency of invertebrate orders captured using sweep net

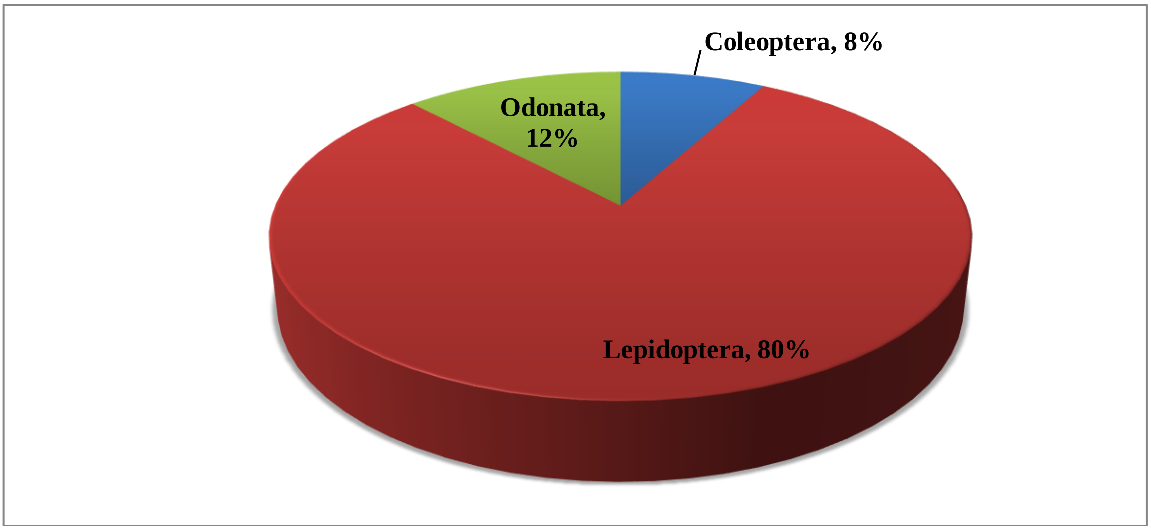

Figure 6: Centesimal frequency of invertebrate orders captured using sweep net

The most dominant order recorded for Barber pots is Stylommatophora with 30.43%. For colored traps, Diptera is the most dominant order with 42.31%. For Sweep net, Coleoptera is the most dominant order with 27.68% and for butterfly net, the most dominant order is Lepidoptera with relative abundance equal to 80 %.

Table 2: Centesimal frequency of invertebrates' species captured using different sampling methods

Classes	Orders	Families	Species	PB	CT	SN	BN
Arachnida	Acari	Tetranychidae	*Panonychus ulmi*	5.53	0.00	0.00	0.00
	Araneae	Clubionidae	*Clubiona* sp.	0.00	2.56	0.00	0.00
		Dysderidae	*Dysdera crocata*	2.77	0.00	0.00	0.00
		Lycosidae	*Lycosidae* sp.	3.95	0.00	0.00	0.00
		Phylodromidae	*Tibellus* sp.	0.00	1.92	0.56	0.00
		Segestriidae	*Segestrina florentina*	0.40	0.00	0.00	0.00
		Thomisidae	*Misumena vatia*	0.00	1.28	2.26	0.00

	Ixodida	Ixodidae	*Ixodes ricinus*	0.79	0.00	0.00	0.00
Chilopoda	Scutigeromorpha	Scutigeridae	*Scutigera* sp.	1.19	0.00	0.00	0.00
Diplopoda	Glomerida	Glomeridae	*Glomeris* sp.	4.35	0.00	0.00	0.00
Gasteropoda	Littorinimorpha	Pomatiidae	*Tudorella sulcta*	0.40	0.00	0.00	0.00
		Enidae	*Mastus pupa*	0.79	0.00	0.00	0.00
		Helicidae	*Helix aperta*	1.58	0.00	0.00	0.00
		Geomitridae	*Cochlicella barbara*	15.02	0.00	7.91	0.00
			Cernuella virgata	5.14	0.00	4.52	0.00
			Xerosecta caspitum	1.19	0.00	0.00	0.00
		Limacidae	*Lehmannia* sp.	1.58	0.00	0.00	0.00
		Subulinidae	*Rumina decollata*	2.37	0.00	0.00	0.00
		Trissexdntidae	*Caracolina lenticula*	2.77	0.00	0.00	0.00
Insecta	Blattodae	Blattelidae	*Blatta orientalis*	0.79	0.00	0.00	0.00
	Coleoptera	Buprestidae	*Ptosina undecimpunctata*	1.19	0.00	0.00	0.00
		Carabidae	*Carabus auratus*	1.58	0.00	0.00	0.00
			Harpalus affinis	2.77	0.00	0.00	0.00
			Maccrothorax morbillosus	1.98	0.00	0.00	0.00
		Chrysomellidae	*Cassida viridis*	1.19	0.00	1.69	0.00
			Chrysolina americana	0.00	1.92	1.13	0.00
		Coccinellidae	*Harmonia axyridis*	0.00	3.21	3.39	0.00
			Coccinella algerica	1.58	5.77	2.82	0.00
		Curculionidae	*Lixus punctiventris*	0.00	0.00	2.26	0.00
		Dermestidae	*Attagenus pelio*	0.00	0.00	0.56	0.00
		Oedemeridae	*Lytta vescicatoria*	0.00	3.21	6.78	0.00
			Oedemera nobilis	0.00	0.00	5.08	0.00
		Nitidulidae	*Carpophilus hemipterus*	3.16	3.85	0.00	0.00
		Scarabaeidae	*Anisoplia floricola*	0.00	0.00	3.39	0.00
			Cetonia aurata	0.00	0.64	0.56	8.00
			Rhizotrogus maculicollis	5.53	0.00	0.00	0.00
		Staphilinidae	*Ocypus olens*	5.53	0.00	0.00	0.00
		Trogossitidae	*Tenebroides mauritanicus*	0.40	0.00	0.00	0.00
	Dermaptera	Forficulidae	*Forficula auricularia*	1.98	0.00	0.00	0.00
	Diptera	Calliphoridae	*Calliphora vicina*	2.37	1.92	3.39	0.00
			Calliphora vomitoria	0.79	3.21	0.00	0.00
			Lucilia caesar	0.79	2.56	1.69	0.00
		Cecidomyiidae	*Cantarinia pyrivora*	0.00	0.00	1.69	0.00
			Dasyneura pyri	0.00	0.00	3.39	0.00
		Eleomyzidae	*Suilia variegata*	0.00	1.28	0.00	0.00
		Mydidae	*Mydas clavatus*	1.58	4.49	1.13	0.00
		Stratiomyiidae	*Chloromyia formosa*	0.00	7.69	5.65	0.00
		Syrphidae	*Eupeodes corollae*	0.00	4.49	0.00	0.00
		Tephritidae	*Ceratitis capitata*	0.00	10.90	0.00	0.00
			Oxyna flavipennis	0.00	3.21	0.00	0.00
		Alydidae	*Alydus calcaratus*	0.00	2.56	0.00	0.00

	Heteroptera	Lygaeidae	*Lygaeus saxatlis*	0.00	0.00	3.95	0.00
			Aphanus rolandri	0.00	0.00	2.26	0.00
			Nysius thymi	0.00	0.00	5.08	0.00
		Miridae	*Orthocephalus saltator*	0.00	0.64	1.69	0.00
		Veliidae	*Velia* sp.	0.79	3.21	0.00	0.00
	Homoptera	Coccidae	*Epidiasperis leperii*	0.00	1.92	0.00	0.00
		Aphididae	*Aphis fabae*	3.95	4.49	0.00	0.00
			Aphis gossypii	0.00	0.00	6.21	0.00
			Eriosoma lanigerum	0.00	5.77	0.00	0.00
	Hymenoptera	Apidae	*Apis mellifera*	2.77	9.62	4.52	0.00
		Formicidae	*Cataglyphis viatica*	2.77	0.00	0.00	0.00
			Messor barbarus	4.74	0.00	0.00	0.00
		Chrysidae	*Chrysis ignita*	0.00	1.28	1.69	0.00
		Ichneumonidae	*Netelia testacea*	0.00	1.28	2.26	0.00
		Sphecidae	*Sceliphron destillatorium*	0.00	0.00	1.13	0.00
		Trichogrammatidae	*Trichogramma* sp.	0.00	1.92	2.26	0.00
	Lepidoptera	Graccillaridae	*Phyllonorycter blancardella*	0.00	1.92	0.00	4.00
		Nymphalidae	*Vanessa cardui*	0.00	0.00	0.00	16.00
		Pieridae	*Pierris brassicae*	0.00	0.00	0.00	40.00
		Sessidae	*Synanthedan myopaeformis*	0.00	0.00	0.00	12.00
		Zygaenidae	*Zygaena ephialtes*	0.00	0.00	0.00	8.00
	Odonata	Calopterygidae	*Calopteryx virgo*	0.00	0.00	0.00	12.00
	Orthoptera	Acrididae	*Acrida ungarica*	0.00	0.00	2.26	0.00
			Anacridium aegyptium	0.40	0.00	1.13	0.00
		Gryllidae	*Gryllus campestris*	1.58	0.00	1.69	0.00
	Thysanoptera	Thripidae	*Franckiniella occidentalis*	0.00	1.28	3.95	0.00
5	18	59	77	100	100	100	100

The colored traps allowed us to collect 30 species, represented mainly by *Ceratitis capitata* with10.90 %.Barber pots and Sweep net allowed us to collect 39and 34 species respectively, represented mainly by *Cochlicella barbara* with relative abundance of 15.02 % and 7.91 % respectively. The butterfly net allowed us to collect 7 species, represented mainly by the species *Pierris brassica* with relative abundance of 80 %.

3.2 Species centesimal frequency according to their trophic relationships

The relative abundance obtained for species according to their trophic relationships is illustrated for Barber pots (Fig. 7), for colored traps (Fig. 8), fort sweep net (Fig.9) and for Butterfly net (Fig. 10).

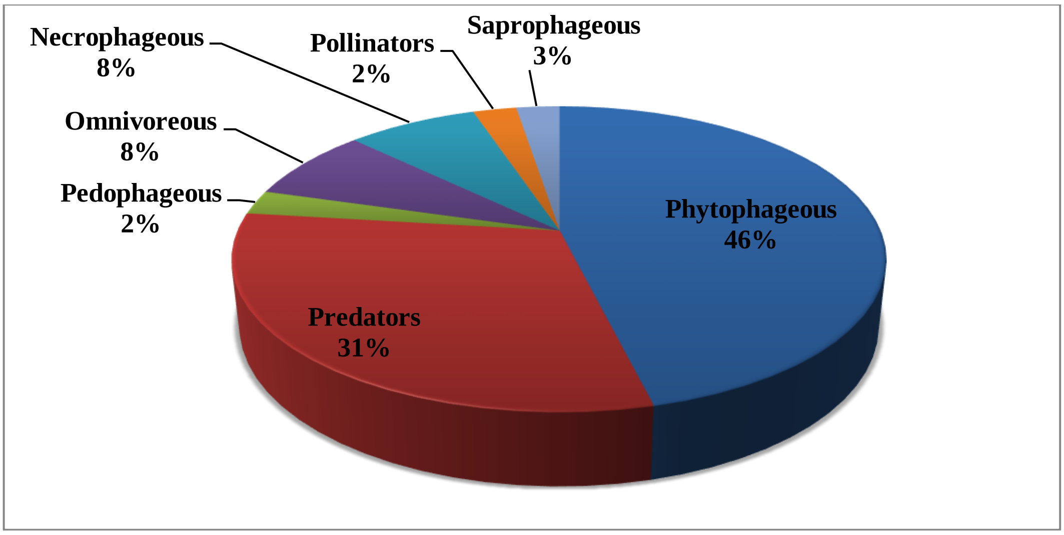

Figure 7: Relative frequency of species caught using Barber pot net following their diet.

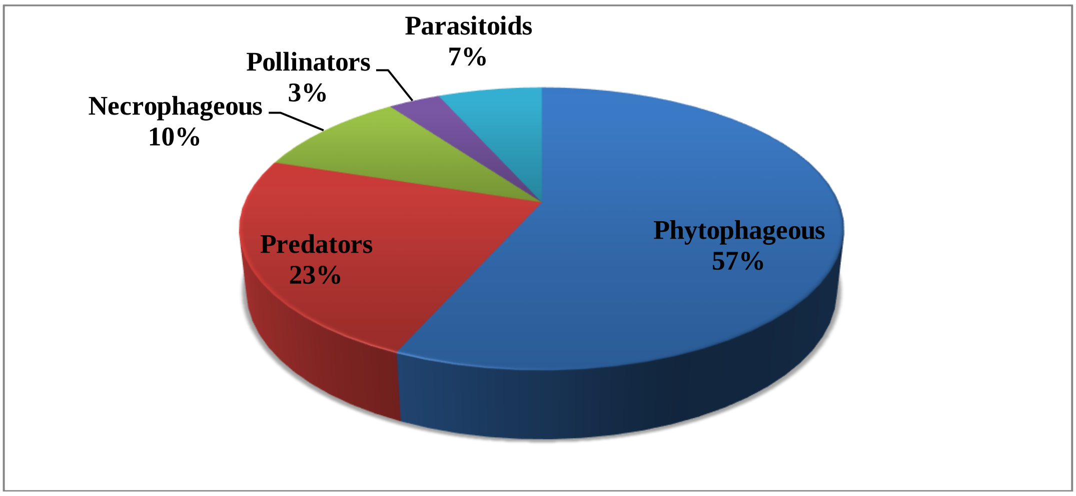

Figure 8: Relative frequency of species caught using colored traps following their diet.

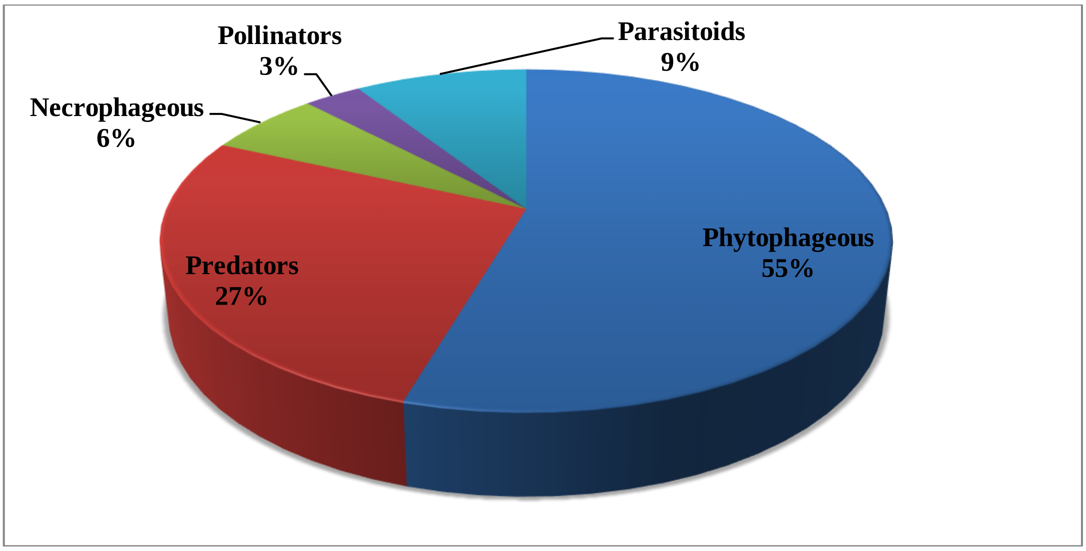

Figure 9: Relative frequency of species caught using sweep following their diet.

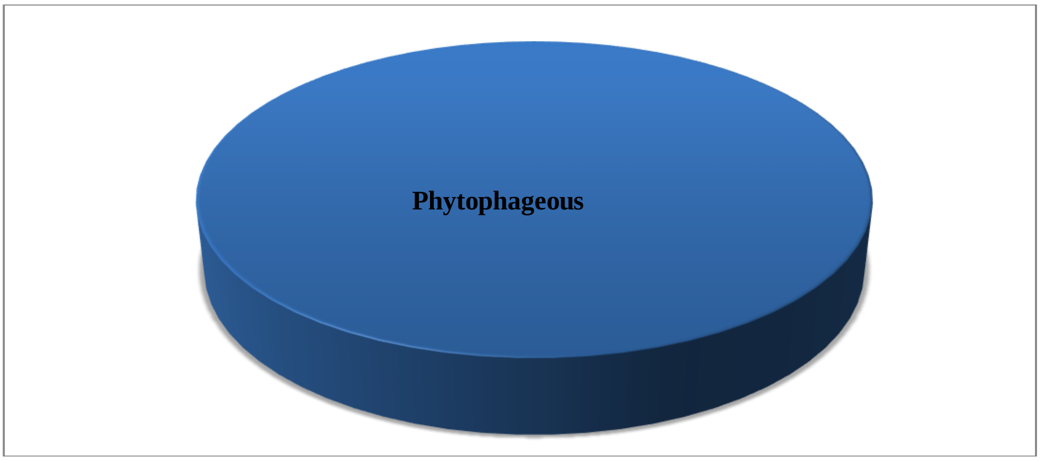

Figure 10: Relative frequency of species caught using butterfly net following their diet.

The best represented group using Barber pots is phytophageous with relative abundance of 46 %, following by predators with relative abundance of 31%, whereas the least abundant group is saprophagous and pollinators and pedophageous with only 2 %. The best represented group using colored traps is pests with 57%, following by predators with relative abundance of 23%, whereas the least abundant group is pollinators with only 3%. When using sweep net, the best represented group is pests with relative abundance of 55%, following by predators with relative abundance of 27%, while the group of pollinators is the least represented recording only 3 %. When using butterfly net, the pests is represented with relative abundance of 100%.

3.3 Shannon Weaver diversity index and evenness index (E)

Shannon-Weaver diversity index (H '), maximum diversity (H'max.) and equitability (E) applied to species trapped by the different sampling techniques are presented in Figure 11.

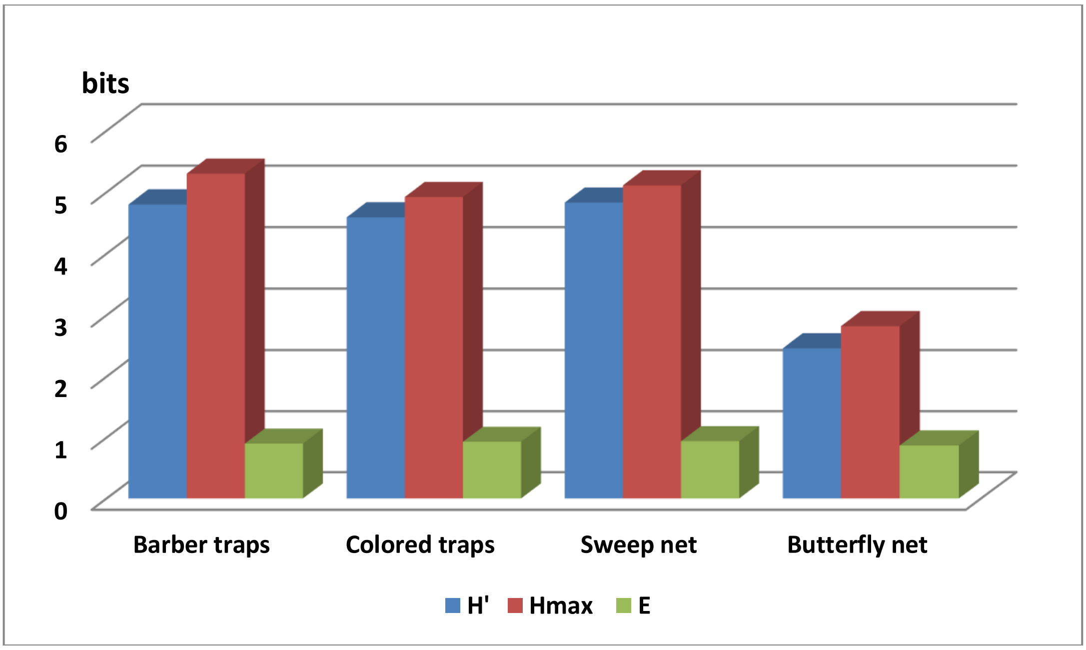

Figure 11: Shannon-Weaver diversity values H' and evenness of species trapped by the various traps.

Shannon-Weaver diversity values for the various species caught by trapping methods are equal to H' = 4.80 bits; H max = 5.30 bits for Barber pots; H' = 4.59 bits; H max = 4.92 bits for colored traps, H' = 4.83 bits; H max = 5.11 bits for sweep net and H' = 2.46 bits; H max = 2.82 bits for butterfly net. The species evenness values are E = 0.90 for Barber pots, E = 0.93 for colored traps; E = 0.94 for sweep net and E = 0.87 for butterfly net. A fairly high evenness is recorded for three sampling methods (sweep net, colored traps and barber pots) this value approaches a value of 1 which reflects a balance between the middle of species.

4. DISCUSSIONS

Our results are relatively weak compared to those inventoried by Chalane and Djouder (1999) which counts 209 species in a garrigue station at the level of the region of Béjaia. Naceri (2011) obtained similar results in an olive grove in Batna with a total of 156 species belonging to 16 orders and 80 families. Chafaa (2013) recorded in three olive groves in the region of Batna 206 species of insects belonging to 11 orders and 74 families. Chafaa *et al*. (2019) finded in their study on apricot orchards 125 species belonging to 54 families and 9 orders in Batna region of North-East Algeria.

Guermah (2019) reports that the total richness of the species caught is very variable, it depends on the type of trap used and the plot studied. Guermah *et al*. (2019) reported a total wealth of the species caught by the three trapping methods on apple crop in Tizi-Ouzou region; it was 80 species for the sweep net; 63 species for colored traps and 56 species for Barber pots. Ben-Ameur (2009) estimated the total wealth at S = 142 in the palm groves of Ouargla. Chouiet and Doumandji-Mitiche (2012) during a study on the biodiversity of the arthropodo fauna of the cultivated areas of the Ghardaia region noted a total richness of 188 species, which is 133 species captured using Barber pots and 124 species using yellow traps. Souttou and *al*. (2006) in a study on the biodiversity of arthropods in natural environments in the palm of Oued Sidi Zarzour in Biskra, reported a total wealth equal to 70 species of arthropods.

Guermah *et al*. (2019) registred the most dominant order recorded for sweep net and colored traps who is Hymenoptera with relative abundance of 36.38% and 37.13% respectively, for Barber pots, the most dominant order is Coleoptera with relative abundance equal to 50.35%.

Ounis *et al*. (2014) during an estimate of soil biodiversity in an apricot plot, reported that the order of Coleoptera dominates with a centesimal frequency of 46.67%. Achoura and Belhamra (2010), reported that the order of Orthoptera dominates with a centesimal frequency of 18.75%, followed by Coleoptera with 16.67%, and finally Lepidoptera and Hymenoptera with a centesimal frequency of 14.58% in the palm grove (Biskra). Diab and Deghiche (2014) induce a centesimal frequency equal to 58% for Diptera, 42% for Hymenoptera, and 25% for Coleoptera on a crop olive tree in the Sahara. Chouiet and Doumandji-Mitiche (2012) in a study on the biodiversity of arthropodo fauna in cultivated areas of the Ghardaia region noted that the order of Hymenoptera is best represented with an abundance equal to 42% by the use of Barber pots, by using sweep net the coleoptera dominate with a centesimal frequency equal to 17.33%, the yellow traps attract in large numbers the Homoptera with a frequency equal to 33.66%.

Insecticides particularly affect auxiliary fauna, which is sensitive to them, inducing the disappearance of useful arthropods and the appearance of resistance phenomena in arthropod pests.

Guermah *et al*. (2019) notes that the best-represented group using sweep net is predators with relative abundance of 33%, whereas the least abundant group is saprophagous with only 1%. The best-represented group using colored traps is pests with 30%, whereas the least abundant group are saprophagous and bioindicators with only 1%. When using barber pots, the best-represented group is pests with relative abundance of 42.88%, while the group of saprophagous is the least represented recording only 2.43%.

According to the trophic diet of arthropods, Achoura and Belhamra (2010) noted five groups whose phytophageous are best represented with 56.25%. They are followed by predators with 20.83%, saprophageous with 18.78% and finally parasites and polyphageous with 2.08%. Diab and Deghiche (2014) indicate a dominance of phytophageous with 53%, followed by predators with 35%, then polyphageous with 12% in an olive crop in the

Sahara region. Guettala-Frah (2009), in its study on the economic impact and the bioecology of the main apple pests in the Aurés region, recorded 69.72% of phytophageous, followed by predators and parasitoids with a percentage equal to 15.98%, and 4, 76% respectively. Finally, saprophageous, necrophageous and coprophageous represent small percentages below 3%. Mahdjane (2013) obtained a frequency of 57.4% for phytophageous, followed by predators worth 20.63% and polyphageous with 18.87%, in its inventory on plum insects in the Tadmait area, Tizi- Ouzou. Our results confirm those of previous work which demonstrated the dominance of the trophic category of phytophageous (Collignon *et al*., 2000; Hautier *et al*., 2003 and Debras, 2007).

Guermah *et al*. (2019) reported a diversity of Shannon-Weaver values for the various species caught by trapping methods, they are equal to H′ = 5.90 bits; H max = 6.40 bits for sweep net; H′ = 5.58 bits; H max = 6 bits for colored traps and H′ = 5.33 bits; H max = 5.95 bits for Barber pots. Chalane and Djouder (1999) note Shannon diversity worth 2.29 bits. Benkhelil and Doumandji (1992) mention for Shannon Diversity Index values 4.82 bits for the degraded scrubland, 3.96 bits at the level of the cedar and 5.64 bits for the mixed forest, in the region of Bordj Bou Arriridj. According to Blondel (1979), a community is even more diverse as the index of diversity is higher. Variations in the values of the Shannon index are explained by N'zala *et al*., (1997) who reported that if the living conditions in a given environment are favorable, there are many species, each of which is represented by a small number of individuals. If the conditions are unfavorable there are only a small number of species each of which is represented by a large number of individuals. Barbault in (1981) adds that the quantity of plant species available affects the richness of the animal procession. So the insect community is linked to architecture, the quantity of plants and the diversity of ecological niches.

Guermah and Medjdoub-Bensaad (2016) report a Shannon diversity equal to H = 4.31 bits with a maximum diversity equal to H max = 6.64 bits applied to arthropods sampled by the use of sweep net on a plot of apple trees in the Tizi-Ouzou region.

The Pielou's evenness values reported by Guermah *et al*. (2019) are equal to E = 0.92 for the sweep net and colored traps; and E = 0.89 for Barber pots. A high evenness is recorded for three sampling methods (sweep net, colored traps and barber pots) this value approaches a value of 1 which reflects a balance between the middle of species.

Very low fairness is reported by Guettala-Frah (2009) during a wildlife inventory on apple trees carried out in the Aurès with a value equal to E = 0.44 for the auxiliaries of the Ichemoul station, and also by Belmadani *et al*. (2014) in a study on the distribution of arthropods in the pear orchard in Tadmait with an equal value E = 0.3.

Ounis *et al*. (2014) found fairness ranging from 0.12 to 0.47. Guermah and Medjdoub-Bensaad (2016) rated fairness at 0.65. In a study on the arthropodofauna of corn cultivation.

REFERENCES

1. Achoura A., Belhamra M. (2010). Aperçu sur la faune arthropodologique des palmeraies d'El Kantara. Courrier du savoir. Université de Biskra, (10), 93-101.
2. Barbault R. (1981). Ecologie des populations et des peuplements. Ed., Masson.et C, Paris, 200p.
3. Baziz B. (2002). Bioécologie et régime alimentaire de quelques rapaces dans différentes localités en Algérie- cas du faucon crécerelle *Falco tinnunculus* Linné, 1758, de la Chouette effraie *Tyto alba* (Scopoli, 1769), du hibo moyen duc *Asiootus* (Linné, 1758) et du Hibou grand-duc ascalaphe *Bobo ascalaphus* Savigny, 1809. Thèse de Doctorat d'Etat, Inst. nati. agro. El Harrach, 499p.
4. Belmadani K., Hadjsaid H., Boubekka A., Metna B., Doumandji S. (2014). Arthropods distribution to vegetal strata in pears tree orchards near Tadmaït (Grande Kabylie). International Journal of Zoology and Research, 4(3), 1-8.
5. Ben-Ameur-Saggou H. (2009). La faune des palmeraies d'Ouargla : interactions entre les principaux écosystèmes. Thèse de magister, université KasdiMerbah Ouargla, 184p.
6. Benkhelil M.L., Doumandji S. (1992). Notes écologiques sur la composition et la Notes écologiques sur la composition et la

structure du peuplement des coléoptères dans le parc national de Babor (Algérie). Med. Fac. Landbouww. Univ., Gent, (57/3a), 617-626.

7. Blondel J. (1979). Biogéographie et écologie. Edition Masson, Paris, 173p.
8. Blondel J. (1975). L’analyse des peuplements d’oiseaux, éléments d’un diagnosticécologique. La méthode des échantillonnages fréquentiels progressifs (E.F.P.). Revue Ecologie (Terre et vie), 29(4), 533 – 589.
9. Chafaa S. (2013). Contribution à l’étude de l’entomofaunede l’olivier. Oleaeuropaeaet de la dynamique despopulations de la cochenille violette *Parlatoriaoleae*Colvée, 1880 (Homoptera:Diaspididae) dans la régionde Batna. Thèse Doctorat: Ecole NationalSupérieure Agronomique. El-Harrach. Alger, Algérie, 168 pp.
10. Chafaa S., Belkhedria ET., Mimeche F. (2019). Entomofaune investigation in the apricotorchard, Prunusarmeniaca L. (Rosales Rosaceae), in Ouledsislimane, Batna, North Est Algeria. Biodiversity journal, 10(2) : 95-100
11. Chalane S., et Djouder N. (1999). Etude de l’entomofaune de trois stations selondifférents types de formations végétales dans la région de Bejaia. Mémoire demagister.univ. de Béjaia, 128p.
12. Chinery M. (1988). Insectes d'Europe occidentale. Ed. Arthraud. Paris, 307p.
13. Chouiet N., Doumandji-Mitiche B. (2012). Biodiversité de l’arthropodofaune des milieux cultivés de la région de Ghardaïa (sud Algérien). 3ème congrès de zoologie et d’Ichtyologie, Marrakech, 13p.
14. Colignon P., Hastir P., Gaspar C., Francis F. (2000). Effets de l'environnement proche sur la biodiversité entomologique en cultures maraîchères de plein champ. Parasitica 56 (2- 3), 59- 70.
15. Dajoz R. (1971). Précis d’écologie. Ed. Bordas, Paris, 434 p.
16. Debras, JF. (2007). Rôles fonctionnels des haies dans la régulation des ravageurs : Le cas de Psylle Cacopsyllapyri L. dans les vergers du Sud- est de la France. Thèse de Doctorat en sciences de la vie. Université D'Avignon, pays de Vaucluse. 240 p.
17. Delvare G., Aberlenc HP. (1989). Les insectes d'Afrique et d'Amérique tropicale. Clé
18. pour la reconnaissance des familles. Ed. Cirad, France, 298 p.
19. Diab N., Deghiche L. (2014). Arthropodes présents dans une culture d’olivier dans les régions Sahariennes, cas de la plaine d’El Outaya. Dixième conférence international sur les ravageurs en Agriculture, Montpellier, 11p.
20. Guermah D. (2019). Bioécologie du carpocapse du pommier *Cydiapomonella* L. (Lepidoptera : Tortricidae) et inventaire de la faune arthropodologique dans des vergers de pommier traités et écologique dans la région de Tizi-ouzou (Sidi Nâamane et Draa Ben Khadda).Doctorat 3éme cycle LMD.UMMTO. pp188.
21. Guermah D., Medjdoub-Bensaad F. (2016). Inventaire de la faune arthropodologique sur pommier de variété Dorset golden dans la région de Tizi-Ouzou. Algérie. Best journal of medecine, arts and science.
22. Guermah D., Medjdoub-Bensaad F., Aouar-Sadli M. (2019). Evaluation of arthropods diversity on apple crop (‘Red Delicious’) in SidiNaâmane area (Tizi-Ouzou), Algeria .ActaAgriculturae Sloverica.113(1):10P
23. Guettala F. (2009). Entomofaune, Impact Economique et Bio- Ecologie des principaux Ravageurs du Pommier dans la région des Aurès. Université Batna .166P.
24. Hautier L., Patiny S., Thomas-Odjo A., Gaspar M.Ch. (2003). Evaluation de la biodiversité de l’entomofaune circulante au sein d’associations culturales au Nord Bénin. Notes faunistiques de Gembloux, 52, 39 – 51.
25. Klein A.M, Vaissière B.E, Cane J.H, Steffan-Dewenter I., Cunningham S.A., Kremen C., Tscharntke T. (2007). Importance of pollinators in changing landscapes for worldcrops. Proceeding of the royal society B, 274(1608).
26. Mahdjane H. (2013). Inventaire qualitatif et quantitatif des insectes inféodés au prunier dans la région de Tadmait dans la région de Tizi-Ouzou. Mémoire magister. Sci. agro. univ. Mouloud Mammeri. T.O
27. N'zala D., Noungamani A., Moutsambote JM., Mapangui A. (1997). Diversité floristique dans les monocultures d'eucalyptus et de pins au Congo. Cahier d'Agriculture 6: 169-174.
28. Naceri T. (2011). Contribution a l’étude de l’arthropodofaunede l’Olivier dans une oliveraie à Boumia(W. de Batna). Mémoire Ingénieur. Université deBatna, Batna, 78 pp.

29. Ounis F., Frah N., Medjdoub-Bensaad F. (2014). Diversité de la faune du sol dans une parcelle d'abricotier à Takout (Batna, Est de l'Algérie). International journal of Agriculture Innovation andResearch, Vol. 2, 4p.

30. Perrier R. (1927). La faune de la France illustrée. Coléoptères, partie 1. Tome 5. Edition Reprint, Aubin. Paris, 192p.

31. Perrier R. (1932). La faune de la France illustrée. Coléoptères. Tome 2. Edition Librairie Delagrave. Paris, 229 p.

32. Perrier R. (1961). La faune de la France. Tome V : Coléoptères, partie 2. Edition Librairie Delagrave. Paris, 230p.

33. Piham J C. (1986). Les Insectes. Paris, 160P.

34. Ramade F. (2003). Eléments d'écologie. Ecologie fondamentale. 3èm Ed. Dunod, Paris, 690 p.

35. Roth M. (1963). Comparaison des méthodes de capture en écologie entomologique. Revue de pathologie végétale et d'entomologie agricole de France, 42 (3): 177- 179.

36. Souttou K., Farhi Y., Baziz B., Sekkour M., Guezoul O., Doumandji S. (2006). Biodiversité des arthropodes dans la région de Filiach (Biskra, Algérie). OrnithologicaAlgerica4 (2): 25-28.

37. Tscharntke T., Milder J.C., Schroth G., Clough Y., DeClerck F., Waldron A., Rice R., Ghazoul J. (2015). Landscape perspectives on agricultural intensification and biodiversity –ecosystem service management. Ecology Letters, 8(8), 857-874.

****