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BIOCENOTIC STUDY OF THE AUXILIARY ENTOMOFAUNA IN THE BIORESOURCES STATION CRSTRA, BISKRA, ALGERIA

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ABSTRACT: This study evaluated the richness and importance of the auxiliary entomofauna in the Bioresources station CRSTRA, Biskra .The methodology adopted is based on the usual method of striking and harvesting with a Japanese umbrella and Barber pots and yellow glue traps, and direct observations supported by the identification of insects using taxonomic keys. A rich diversity of 284 individuals of the entomofauna auxiliaries divided into 8 orders during the period that extends (from January 2015 to January 2017). The order of Coleoptera is the most dominant with (164 individuals) collected, they are followed by the orders of Neuroptera (37 individuals) and Diptera (34 individuals) are respectively in 2nd and 3rd place. The order of Hymenoptera with (18 individuals), Heteroptera, Dermoptera and Mantodea with 11.9 and 8 individuals are respectively for each order and in the last rank the Odonata with 3 individuals.

KEY WORDS: Entomofauna auxiliary, bioresources station, diversity, Biskra

The biodiversity we observe today is the result of billions of years of evolution of living organisms. It provides essential functions for all forms of life and provides essential services: it is the source of our food, provides raw materials, contributes to the maintenance of the quality of water, air and soil, and offers an invaluable cultural heritage.

Insects are of course part of it: bees, bumblebees and hoverflies pollinate the plants we need, bees produce honey, myriads of small animals like springtails help aerate the soil, the so diverse beauty of insects is part of our cultural heritage... To date, it is estimated that there are 1 million known insect species, whereas there are probably more than 5 million, or even 30 million.

Algeria has diversified biogeographically zones where flora and fauna have a high genetic potential. It also has biological resources of great interest in solving environmental, ecological, genetic, economic, social, economic, cultural and educational problems; however, there are serious threats to these resources through habitat destruction, environmental modification and exploitation.

However, inventories have evolved and detection, monitoring and control work is now focused on insects whose economic or social impact is recognized. A good inventory is fundamental not only to understanding the diversity and health

status of an environment, but also to understanding the functioning and complexity of interactions between organisms in the ecosystem.

For this purpose, our entomological inventory work is carried out during the period that runs (from January 2015 to January 2017) in the Bioresources station CRSTRA. This present work, carried out for the first time in an organic station, aims to better understand the auxiliary insects and the main groups of insects encountered at the study station.

The challenge of the study is to know and preserve biodiversity, not only to know the total number of species in the environment, but also to be aware locally of the abundant presence or disappearance of particular species that cause the ecosystem to be in balance.

I. Study methodology

1. Presentation of the study station

Our study was carried out in a Bioresources station in El Outaya (C.R.S.T.T.R.A). Biskra, Algeria. It is located at an altitude of 199m between the geographical coordinates: 36°5536.6N and 005°3856E (Fig. 1). The soil of the predominantly clayey study station, the crops planted are: date palm, olive tree, fig, plasticulture in addition to a tree and ornamental nursery and a lucerne field (Roumani et al., 2012).

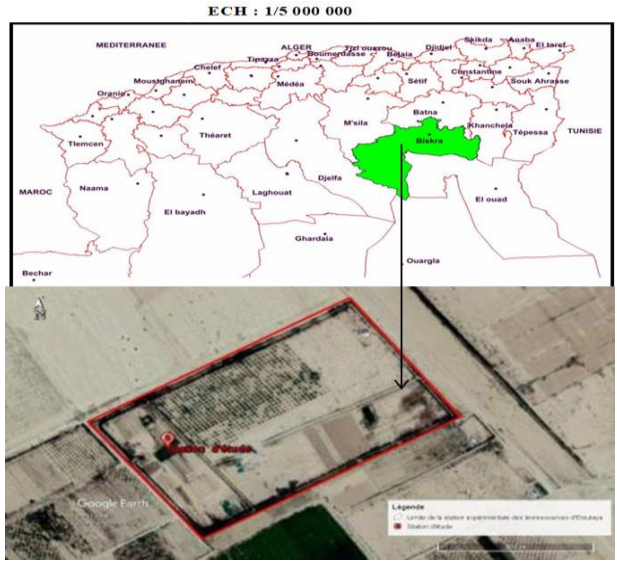

Figure 1. Geographical position of the site of the Bioresources station in El-Outaya (Satellite image, Google Earth, 2018).

2. Study of the entomofauna

2.1 Sampling

We have adopted several methods that consist of periodic and random sampling of stratified populations, are carried out during the period that extends (from January 2015 to January 2017) by the usual method of striking and harvesting with a Japanese umbrella as well as by Barber pots and yellow glue

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traps (Lamotte & Bourliere, 1969). The pots are filled with water at one-third of their height plus a detergent buried flush with the ground.

2.2 Retention of samples

The samples collected are stored in ethanol or 70% alcohol (Leclant, 1978) and the traps are stored in jars identified by the date of collection and the trapping station so that they can be identified under a binocular magnifying glass. Specimens are spread as (Lepidoptera, Coleoptera, ...) Large specimens are spread and stored in such a way that important organs (wings, antennae, etc...) are clearly visible for clear visibility during identification.

2.3 Statistical processing

In order to exploit the results relating to the auxiliary entomofauna inventoried at the study station during the period from (January to December 2015), ecological indices are applied followed by statistical processing using EXEL STAT, 2018.

Quality of sampling ..... $Q = \frac{a}{N}$

According to the formula given by Blondel (1979):

a: is the number of species observed only once in a single copy.

N: is the number of readings.

Processing of results by ecological indices

b. Processing of results by ecological indices, the ecological indices used in this study are those of composition and structure.

1. Ecological composition indices

- **Total wealth (S)**

Total wealth (S) is the total number of species in a stand considered in a given ecosystem. In this study, total wealth is the total number of species trapped.

- **Average wealth (Sm) .....** $sm = \frac{\sum_{i=0}^{n} ni}{r}$

  ni: is the number of species in survey i;

  r: is the total number of readings
- **Relative abundance (centesimal frequency) .....** ***R ou F=ni x 100/N***

  AR or F: Relative abundance or centesimal frequency of species in a given stand,

  ni: Number of individuals of the species (i) considered,

  N: Total number of individuals of all species combined.

2. Ecological structure indices

- **Shannon Diversity Index. .....** $H' = -\sum pi \log 2\ pi$

  H' : is Shannon's diversity index expressed in bit units;

  pi : Relative abundance of each species, is equal to ni/N;

  ni: Abundance of rank i species;

  N: Total number of copies collected;

  log 2: is the logarithm based on 2.
- **Equitability .....** $E = \frac{H'}{H'_{max}} = \frac{H'}{\log 2\ S}$

  E: is the equi-split.

  H': is Shannon's diversity index expressed in bit units.

  H' max: is the maximum diversity index expressed in bits.

  Log 2: is the logarithm to base 2.

  S: is the total wealth.

- **Margalef Index ..... I = (ni - 1) / log N**

I: biodiversity;
ni: is the number of species present;
N: is the total number, the individuals found (belonging to all species)
Log: notation refers to the natural logarithm of a number.
The diversity is minimal when I tends towards zero (0), and maximum when I tend towards ∞.

RESULTS

1. Results of the global inventory of the station's entomofauna

The surveys were carried out twice a month during the period from (January 2015 to January 2017) and resulted in a list of 118 species spread over 10 orders.

To get an overall idea of the importance of the main orders of insects inventoried, we have drawn up a summary figure in which the number of species per order is specified (Fig. 2).

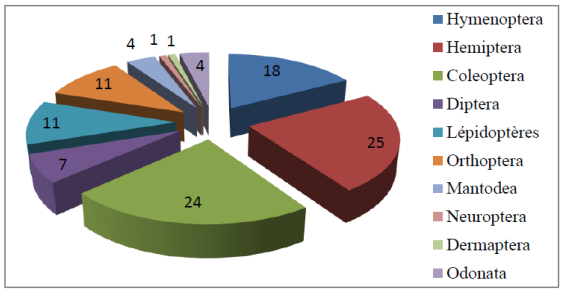

Figure 2. Importance of species by order.

Figure (2) shows that the order of Hemiptera is quantitatively the best represented with 25 species, followed by Coleoptera and Hymenoptera with 24 and 18 species respectively. Diptera, Orthoptera, and Lepidoptera rank fourth and fifth respectively with 13 and 11 species, followed by the other orders which are poorly represented.

2. Inventories of the auxiliary entomofauna

The data show that of the auxiliary entomofauna inventoried during the period (from January 2015 to January 2017) is represented by 25 species distributed in 14 families which are noted in the following table:

Table 1. List auxiliary entomofauna of inventoried.

Order	Family	Auxiliairy
COLEOPTERA	Coccinellidae	*Coccinella algerica*
		Coccinella undecimpunctata
		Hippodamia decimpunctata
		Hippodamia tredecimpunctata
		Hippodamia variegata
		Psyllobora vigintiduopunctata
	Carabidae	*Calosoma inquisitor*
	Meloidae	*Mylabris bipunctata*

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NEUROPTERA	Chrysopidae	*Chrysoperla carnea*
DERMOPTERA	Forficulidae	*Forficula auricularia*
DIPTERA	Syrphidae	*Episyrphus balteatus*
	Cecidomyidae	*Aphidolites aphidimyz*
HETEROPTERA	Anthocoridae	*Anthocoris nemoralis*
HYMENEPTERA	Formicidae	*Cataglyphis bicolor*
	Braconidae	*Phanerotoma* sp.
	Ichneumonidae	*Dusona* sp.
		Netelia sp.
ODONATA	Libellulidae	*Trithemis annulata*
		Sympetrum sanguineum
		Sympetrum vulgatum
MANTODEA	Mantidae	*Mantis religiosa*
		Sphodromantis viridis
		Sphodromantis viridis
		Rivetina fasciata
	Empusidae	*Blepharopsis mendica*

Coccinellidae are quantitatively dominant and the most active with 6 species, representing 54.72% of the station's auxiliary entomofauna stand. They are followed by Chrysopidae and Syrphidae accounting for 12.98% and 9.47% respectively with a single species, Anthocoridae and Braconidae with a single species for each, accounting for 3.85% and Forficulidae 3.15% followed by Mantidae with 3 species representing 2,80% and Formicidae, Cecidomyiidae with only one species for each, representing 2.45% and 1.75% sucking and in the last place Libellulidae with 3 species representing 1.05% and Ichneumonidae with 2 species representing 0.7% of the station's auxiliary entomofauna (Fig.3).

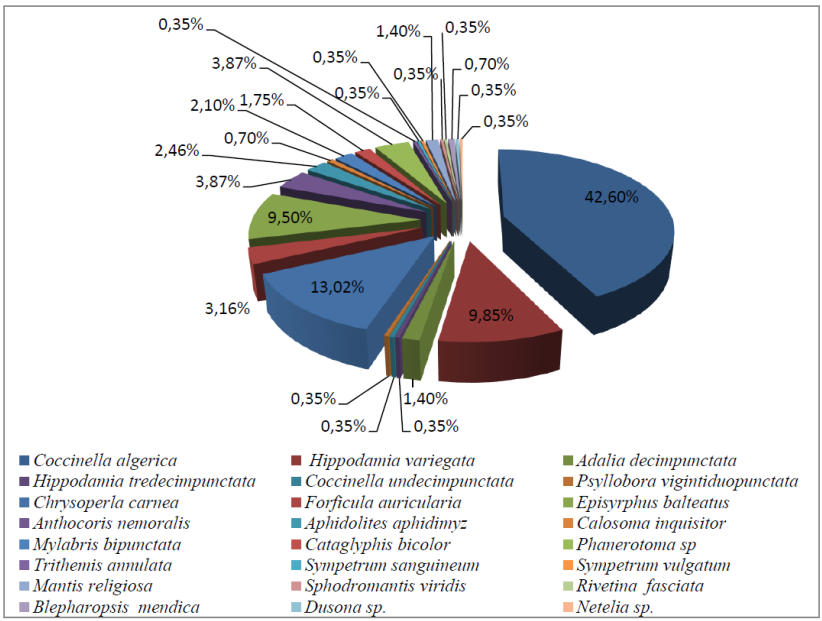

Figure 3. Proportions of auxiliary entomofauna.

2.1 Time distribution

For the results of glue and water traps, we established a distribution of the species of auxiliary entomofauna inventoried during the study period from (January to December 2015) and this in time according to the months of capture (Fig. 4).

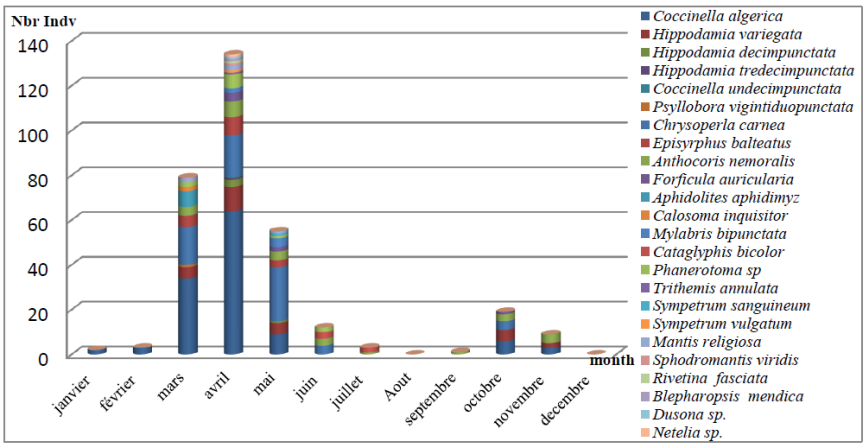

Figure 4. Temporal variations in the entomofauna auxiliary populations recorded in the station.

The results obtained show that the Coccinellidae family shows intense activity on all crops in the station. All these species reproduce viable offspring between January and June and then in October and November. A peak of 64 individuals of *C. algerica* was recorded in April. On the other hand, the other auxiliaries *Chrysoperla carnea* and *Hippodamia variegata* with peaks of 24 and 11 individuals successively were recorded in April and May. The species *Episyrphus balteatus* and *Anthocoris nemoralis* with a maximum of 8 and 7 individuals in April.

The abundance of other auxiliary species follows almost the same pattern at the end of the summer season, in August and September with a marked peak in October and a cancellation in December.

2.2 Trophic distribution

The distribution according to the different trophic groups is established according to our personal observations and the support of our sources. Thus, we were able to distinguish 4 major groups among the 25 insect species (Tab. 2).

Table 2. Distribution of entomofauna auxiliaries by trophic group.

Trophic groups	Species
Aphidiphage predators	*Coccinella algerica*
	Hippodamia variegata
	Hippodamia decempunctata
	Hippodamia tredecimpunctata
	Coccinella undecimpunctata

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Phyophages Predators	*Chrysoperla carnea*
	Calosoma inquisitor
	Anthocoris nemoralis
	Cataglyphis bicolor.
	Forficula auricularia
	Trithemis annulata
	Sympetrum sanguineum
	Sympetrum vulgatum
	Mantis religiosa
	Sphodromantis viridis
	Sphodromantis viridis
	Rivetina fasciata
	Blepharopsis mendica
	Dusona sp.
	Netelia sp.
Mycophagus	*Psyllobora vigintiduopunctata*
Parasites and parasitoids	*Episyrphus balteatus*
	Aphidolites aphidimyz
	Mylabris bipunctata
Sarcophagus	*Phanerotoma* sp.

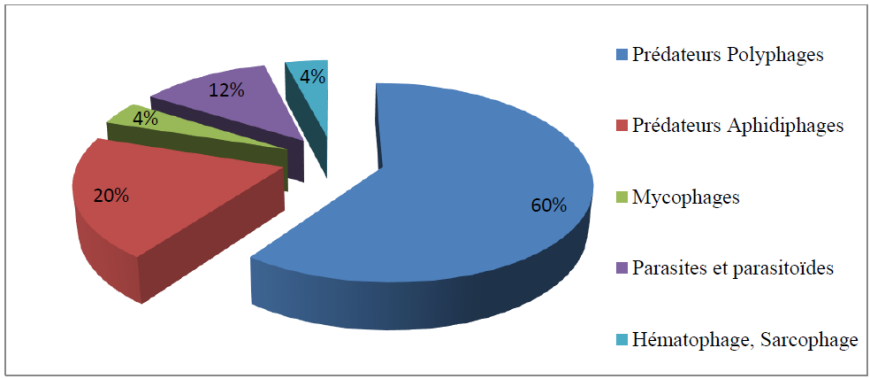

Figure 5. Trophic distribution of auxiliary entomofauna.

Figure (5) shows the high representation of polyphagous predators, the largest group with 60% of inventoried insects, followed by the presence of 20% of aphidiphage predators, and 12% represented by the parasites and parasitoids group. Finally, sarcophagi and mycophagi have low rates with 4% of the total catch, making them the least wealthy groups.

3. Interpretation of the results by the ecological indices of the auxiliary entomofauna

3.1 Sampling quality

The number of species seen once in a single copy during the 48 surveys at the station is recorded in Table 3.

Table 3. Sampling quality values of the entomofauna auxiliary species captured.

Species (a)	N	a/N
Hippodamia tredecimpunctata	48	0,20
Coccinella undecimpunctata		
Psyllobora vigintiduopunctata		
Sphodromantis viridis		
Dusona sp.		
Rivetina fasciata		
Netelia sp.		
Trithemis annulata		
Orthethrum sp.		
Sympetrum sanguineum		
Sympetrum vulgatum		

The value of the sampling quality is close to zero (0.20) (Tab. 3), which shows that the sampling carried out in the station is relatively good and that the inventory is carried out with sufficient precision. Therefore, species observed only once during our study are classified as accidental species.

3.2 Ecological composition indices

The ecological indices used to study the station's auxiliary entomofauna include total wealth, average wealth, relative abundance, Shannon's diversity index, equitability and Margalef's diversity index.

- **Total wealth (S) and average wealth (Sm);**

We caught a total of 8 species of auxiliaries, with 284 individuals. The average wealth calculated for each month is represented in Table 4.

Table 4. Average richness of the species of auxiliaries caught per month.

Month	J	F	M	AV	MA	JU	JUI	A	S	O	N	D
Wealth S	6	12	113	195	86	25	0	0	0	36	8	0
Sm	0,25	0,5	4,7	8,12	3,58	1,04	0	0	0	1,5	0,33	0

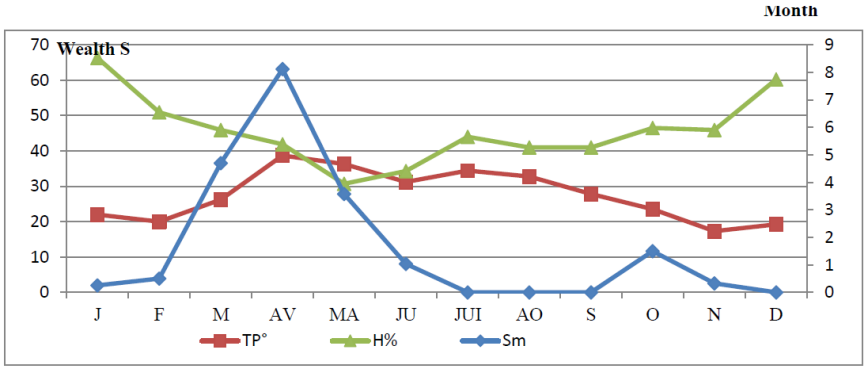

Figure 6. Evolution of the specific richness of auxiliary species per month.

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The reading of Table 4 and Figure 6 shows that the lowest wealth is recorded in January (0.25) with a (T= 22°C and HR= 66.3%) and completely cancels out during the period from July to September. The greatest wealth is recorded in April with (8.12) with a (T= 38.7°C and HR= 41.9%) followed by March and May with (4.7) and (3.58) in order.

The average wealth calculated was 20.02.

- **Relative abundance (centesimal frequency)**

We caught 284 individuals of the entomofauna auxiliaries divided into 8 orders. The order of Coleoptera is the most dominant with (164 individuals) collected. They are followed by the orders of Neuroptera (37 individuals) and Diptera (34 individuals) are respectively in 2nd and 3rd place. The order of Hymenoptera with (18 individuals), Heteroptera, Dermoptera and Mantodea with 11.9 and 8 individuals are respectively for each order and in the last rank the Odonata with 3 individuals.

- **Depending on the family**

The most abundant family is that of Coccinellidae (156 individuals) followed by Chrysopidae (37 individuals). Syrphidae (27 individuals), Forficulidae and Anthocoridae (11 individuals) and Cecidomyidae (7 individuals) and other families.

- **Depending on the species**

The most abundant are those belonging to the order Beetles *Coccinella algerica* 42.6%. Followed by a species belonging to the order Neuroptera, *Chrysoperla carnea* 13.02%, *Hippodamia variegata* 9.85% (Coleoptera) *Episyrphus balteatus* 9.5% (Diptera) and other species with low abundances that do not exceed 4%.

3.3 Ecological structure indices

- **Shannon-Weaver diversity indices and Equitability**

The values of the Shannon-Weaver H' diversity index and equitability E are applied to the species of auxiliaries caught in the station Table 5.

Table 5. Values of the Shannon Diversity Index (H') and Equitability Index (E) applied to the species of auxiliaries caught.

Parameters	Value
H' (bits)	6,77
H' max (bits)	11,25
E	0,60

H': Shannon-Weaver index.
H' max: Shannon-Weaver maximum diversity index.
E: Equitability Index

The values obtained for the auxiliary entomofauna caught during the study period are indicated by a high value (6.77 bits) of the Shannon-Weaver diversity index (Tab. 5). This specific diversity varies from month to month, a clear increase was recorded in April (4.7 Bits), from July to February when the auxiliary

fauna decreases considerably, the diversity starts to increase again from March until reaching the maximum in April.

In addition, the equitability value calculated for our study, E=0.60, shows that the numbers of the different species of auxiliaries caught are in equilibrium with each other.

- **Margalef diversity indices**

The results of the diversity of auxiliary species collected during the sampling study period are recorded in Table 6.

Table 6. Margalef diversity index calculated for the auxiliary species collected during the study period (January 2015 to January 2016).

Month	Winter			Spring			Summer			Autumn		
	D	J	F	M	Av	Ma	J	Jt	A	S	O	N
Auxiliary Entomofauna	0	0	0	4,08	7 ,34	4,08	1,22	0,40	0	0	1,63	0,81

Table 6 shows that by using the Margalef index, the specific diversity of the study station is clearly variable from one month to the next. It was at its peak in spring especially in April, at 7.34. From July to February (autumn and winter) the auxiliaries decrease considerably until they are cancelled in August and September.

DISCUSSION

1. Global entomofauna inventory.

The entomofauna inventory carried out in the El Outaya Bioresource Station during the period from January 2015 to January 2017, using a sampling method based on periodic and random counts of stratified populations, resulted in a list of 118 species belonging to 10 orders. The orders Hemiptera and Coleoptera are quantitatively the best represented respectively 25 and 24 species, followed by Hymenoptera with 18 species. Diptera, Orthoptera, and Lepidoptera rank fourth and fifth respectively with 13 and 11 species, followed by other orders that are poorly represented.

This largely develops the representation of Hemiptera and Coleoptera in the different traps used. According to Niemela & Spence (1994), the effective importance of the other orders could be explained by the effectiveness of the traps used (Barber pots, glue traps) with regard to the different behaviours (walking or stealing) of the species. Thus, the traps used make it possible to capture insects that stay on herbaceous plants during egg laying, diapause or foraging, fall into traps deposited also next to vegetation (Couturier, 1973).

However, the list is far from complete as several species have escaped identification.

In comparison with other work on entomofauna either in the palm groves of the Biskra or in other surrounding regions, Farhi (2004) identified 128 species divided into 64 families and 14 orders in the palm groves of the Biskra, Deghich & Diab (2009). He also counted, in the oases of Biskra, 115 species divided into 61 families and 17 orders, Bacha (2010), who worked at the Foum El Kherza dam in Biskra, counted 113 species divided into 70 families and 12 orders, Achoura & Belhamra (2010), they mentioned a wealth of 48 taxa in two palm groves in El

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Kantara. Similarly, Deghiche (2014), showed the presence of 127 species belonging to 4 classes. The insect class is the most represented in the study station.

The abundance of Beetles is primarily related to trap design (Niemela & Spence, 1994), and biotic factors such as prey-predator relationships and their host plants (Hanski & Cambefort, 1991; Ettema & Wardle, 2002) as well as abiotic factors such as favourable climate conditions and soil type and trophic resource.

2. Inventory of the auxiliary entomofauna.

Biological control therefore represents a way forward for establishing agriculture and forestry that is more in harmony with the environment, and, as Huffaker et al. (1971) mention, in this context, an inventory of the entomofauna auxiliary to crops and on the possibilities of setting up biological control using some of the species identified was carried out between January 2015 and January 2017 at the Bio-resource station.

Many species have been harvested as Coleoptera. This group consists primarily of Coccinellidae with 54.72% of the population of the auxiliaries of the Neuroptera (Chrysopidae) and Diptera (Syrphidae) station representing 12.98% and 9.47% for Hymenoptera, Heterotera, Neuroptera, etc. The other orders are poorly noted and do not exceed 4% of the population of the station's auxiliaries.

The number of Coccinellidae is dominant compared to other families due to the activity of the 6 species. Then come Chrysopidae and Syrphidae, Anthocoridae and Braconidae represented by only one species for each and Forficulidae and Mantidae with 3 species, Formicidae and Cecidomyiidae with only one species for each, and at the last place Libellulidae with 3 species and Ichneumonidae with 2 species. According to Sahraoui (2018), who worked on the axillae of a palm grove in the Biskra region, his study showed populations of 47.32% Coccinellidae and 35.09% Nutilidae and 17.59% Chrysopidae.

Data on the diversity of entomofauna auxiliaries and their temporal and trophic distribution show that in balanced communities, there are close relationships between the quality and diversity of available resources on the one hand, and the diversity of species present on the other (Mac Arthur, 1972). To validate this hypothesis, we monitored the dynamics of auxiliary insects and their trophic categories during the one-year period in the study station. Thus, we determined 5 diets, 5 aphidiphage predatory species, 15 polyphagous predatory species, one mycophagus, parasites and parasitoids species and one Saprophagus species.

According to Achoura & Belhamra (2010), the predator rate is 20.83% of the total catch. They are in second place. They are followed by saprophages and lastly by parasites and polyphages, in a work carried out in the palm grove of El Kantara.

In parallel, Sahraoui et al. (2001), aphidiphages, in their larval and adult forms, are very active aphid killers. Their antagonistic role is as important as that of hoverflies and chrysopes, after that of parasites. Deghiche-Diab (2009), mentioned a high percentage of phytophages 41.73%, Zoophages 36.52% and polyphages 21.73% in the Biskra oases.

According to Belhamra et al. (2014), among the entomological auxiliaries identified, such as *Coccinella septempunctata*, *Mylabris variabilis, Chrysopa carnea, Cataglyphis bicolor, Mantis religiosa, Stenotus binotatus*, there are species protected by Algerian regulations.

Analysis of the results shows that ladybirds are the most dominant species in the aphidiphage category. Thus, studies carried out in 2009 by Guettala-Frah in apple trees in the Aurès region show that the total of 25.84% of auxiliaries represents 15.98% of polyphagous predators, 5.10% represents aphidiphage predators and 4.76% represents parasites and parasitoids. Saprophage/fungivores with 2.38% and scavage/coprophagus in last position with 2.04% of the total catch.

3. Ecological indices.

The result of the a/N ratio calculated for the study station is 0.20. The number of species reported only once in a single individual is (11), it is: *Hippodamia tredecimpunctata, Coccinella undecimpunctata, Psyllobora vigintiduopunctata, Sphodromantis viridis,Dusona sp, Rivetina fasciata, Neteliasp, Trithemis annulata, Orthethrum SP, Sympetrum sanguineum, Sympetrum vulgatum.*

The value of the equitability index 60%. They therefore tend towards 100% and indicate a certain balance between the numbers of auxiliary populations in the station.

Our results are close to those obtained by Sahraoui (2018), where the equitability indices vary between 61% and 68% in most Saharan areas of Algeria, which shows that the numbers of the different species caught are in balance with each other.

The value of the station's Shannon index (6.77 bits) has a homogeneous stand or the value of equitability is greater than (0.5), so there is a certain balance between entomological populations and clearly variable from one month to the next.

According to Aberkane-Ouanes (2012) and Benia (2010), it is shown that the high values of the diversity index at the level of study stations in the Tafat forest (Setif) indicate that stands are more homogeneous where ecological niches are more or less diversified.

The total absence of the auxiliary entomofauna during winter is due to changes in the insect's development cycles, either through estivation, hibernation or migration (Dajoz, 2003). According to Bale et al. (2002), insects spend the wrong season, as nymphs or adults, hidden in the soil or debris from plants or bark under stones or by the effect of temperature on foliar insects than on insects on the ground because temperature variations are greater there. On the other hand, during the spring there was a significant richness, where vegetation is abundant and temperatures are favourable for the development of most of the axillaries. (Macqueen et al., 1986). The low occurrence rates of species recorded during December and January can be explained by Schowalter (2006), low temperatures, wind or rain slow feeding and the majority of insects enter diapause.

CONCLUSION

Our investigations at the Bioresources station during the successive seasons 2015/2017 of all 48 surveys revealed the following results:

The study of entomofauna diversity is represented by 118 species distributed over 10 orders, those of Hemiptera and Coleoptera with (25 species distributed over 9 families, 24 species distributed over 8 families) for each order, those of Hymenoptera with (18 species over 11 families) and those of Diptera with 13

species and those of Orthoptera and Lepidoptera with (11 species over only 2 families) for each. And those of the Odonata and Mantodea with 4 species for each of them and those of the Neuroptera and Dermaptera with only one species and do not exceed one family for each of the two orders.

The most abundant auxiliary entomofauna in the study station are those belonging to the order of ladybugs, namely: Coccinellidae 54.72%, Chrysopidae and Syrphidae representing 12.98% and 9.47% respectively, Anthocoridae and Braconidae 3.85% and Forficulidae 3.15%, Mantidae 2.80%, Formicidae, Cecidomyiidae representing 2.45% and 1.75% sweetening Libellulidae1.05%, Ichneumonidae 0.7%.

The results of the analysis of ecological diversity indices, based on the Shannon index (6.77) and whose equity value is greater than 0.5, indicate that the populations of entomofauna auxiliaries are homogeneous and that there is a certain balance between them, whose average calculated wealth was 20.02.

The greater diversity of ladybugs within the station could be due to the relative stability of the crops, which make it possible to create an ecological balance, unlike market gardening, where cultivation cycles are short. The total absence of pesticides in the station and the presence of vegetation cover under trees (as an additional food source) can also influence the presence of ladybirds (Hemptinne et al., 2005; Smith & Cave, 2006).

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