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Biodiversity of entomofauna in the wilaya of Tebessa

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Dedicated

In the name of the true and living god, the beneficent, the mercifulthank you for bringing me up the rough side of the mountain like ertuğrul.

This thesis is dedicated to my cherished parents, who consistently offertheir moral, spiritual, and emotional assistance.

To my brother and sister, who have always given me courage, inspiration and motivation.

To my aunts, uncles, and all of my cousins for their support and assistance.

To my classmates and friends, thank you for your constant encouragement as well as your insightful advice and inspiring remarks.

Yassine.

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This thesis is dedicated to my beloved parents, whose unwavering love, guidance, and sacrifices have propelled me forward on this path of knowledge and understanding.

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Thank you

Abstract

Studies carried out in Algeria on insects are still in an embryonic state. The current research work aims to provide informations about the biodiversity of insects' fauna along a climatic gradient including; subhumid, semiarid, arid, and desertic climates at the region of Tebessa (northeastern Algeria). Research data were collected from July 2023 to April 2024 from four different stations by Malaise trap.

By using special identification keys, insects were differentiated into different orders. During the study time, a total of 20573 specimens of insects were collected belonging to15orders.

Diptera was the dominant order according to studied insects' samples numbers collected with 11620 specimens count (56.48%). While, the least dominant orders are Dermaptera and Mantodea which were represented by only a single individual(0.005%).

Moreover, the present study also shows great fluctuation in insects' occurrence with changing of seasons and climatic gradient. Indeed, the largest number of individuals collected in the station of Negrine and was obtained in spring with 5395 individuals. Whereas, the lowest collection was obtained in Ain Zarga station during the summer with only 78 individuals.

These findings underscore the dynamic nature of ecological communities and the need for comprehensive conservation strategies.

Keywords: biodiversity, insects, climatic gradient, Diptera, Tebessa, northeastern Algeria.

الملخص

الدراسات التي أجريت في الجزائر حول الحشرات لا تزال في مراحلها الأولية. يهدف البحث الحالي إلى توفير معلومات عن تنوع حيوانات الحشرات على طول تدرج مناخي يشمل المناخات شبه الرطبة وشبه القاحلة والقاحلة والصحراوية في منطقة تبسة (شمال شرق الجزائر). تم جمع بيانات البحث من يوليو 2023 إلى أبريل 2024 من أربع محطات مختلفة باستخدام فخ مالايس .باستخدام مفاتيح تعريف خاصة، تم تصنيف الحشرات إلى رتب مختلفة. خلال فترة الدراسة، تم جمع ما مجموعه 20573 عينة من الحشرات تنتمي إلى 15 رتبة .كانت رتبة الذباب (Diptera) هي الطاغية وفقًا لعدد عينات الحشرات المدروسة التي تم جمعها، حيث تم جمع 11620 عينة (56.48%). بينما كانت أقل الرتب طغيانا هي رتبة جلدية الأجنحة (Dermaptere) ورتبة السرعوفيات (Mantodea)التي تمثلها فرد واحد فقط (0.005 .(%علاوة على ذلك، أظهرت الدراسة الحالية تقلبات كبيرة في وجود الحشرات مع تغير الفصول والتدرج المناخي. بالفعل، تم جمع أكبر عدد من الأفراد في محطة نقرين وكان ذلك في الربيع بـ 5395 فردًا. بينما كان أقل جمع في محطة عين زرقة خلال الصيف بـ 78 فردًا فقط .

تؤكد هذه النتائج على الطبيعة الديناميكية للمجتمعات البيئية وضرورة وضع استراتيجيات شاملة للحفاظ عليها.

: التنوع البيولوجي، الحشرات، التدرج المناخي، الذباب، تبسة، شمال شرق الجزائر**الكلمات المفتاحية:**

Résumé

Les études réalisées en Algérie sur les insectes sont encore à un stade embryonnaire. Le présent travail de recherche vise à fournir des informations sur la biodiversité de la faune des insectes le long d'un gradient climatique comprenant : les climats subhumide, semi-aride, aride et désertique dans la région de Tébessa (nord-est de l'Algérie). Les données de recherche ont été collectées de juillet 2023 à avril 2024 sur quatre stations différentes à l'aide de pièges Malaise. En utilisant des clés d'identification spéciales, les insectes ont été différenciés en différents ordres. Au cours de la période d'étude, un total de 20573 spécimens d'insectes appartenant à 15 ordres ont été collectés. Les Diptères étaient l'ordre dominant selon le nombre d'échantillons d'insectes collectés avec 11620 spécimens (56,48%). Tandis que les ordres les moins dominants sont les Dermaptères et les Mantoptères, représentés chacun par un seul individu (0,005%). De plus, la présente étude montre également une grande fluctuation dans la présence des insectes avec le changement des saisons et du gradient climatique. En effet, le plus grand nombre d'individus collectés a été obtenu dans la station de Negrine au printemps avec 5395 individus. Alors que la plus faible collecte a été obtenue dans la station d'Aïn Zarga pendant l'été avec seulement 78 individus. Ces résultats soulignent la nature dynamique des communautés écologiques et la nécessité de stratégies de conservation globales.

Mots-clés : biodiversité, insectes, gradient climatique, Diptères, Tébessa, nord-est de l'Algérie.

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INTRODUCTION

Biodiversity refers to the comprehensive umbrella term for the degree of nature's variety or variation within the natural system; both in number and frequency. In general, it refers to the variety of all forms of life on earth. The different plants, animals, micro-organisms, the genes they contain and the ecosystem they form**(Mutia, 2009).** However, biodiversity encompasses not just hierarchies of taxonomic and ecological scale but also other scales such as temporal and geographical scales and scaling in the body size of organisms. Biodiversity represents different things to different people. To those working in museums and herbaria, it perhaps represents a new thrust for efforts to describe Earth's fauna and flora. To ecologists it may represent a growing concern about the balance of nature and how well ecosystems can function as biological diversity decreases. To economists and politicians, it may represent a new and largely untapped source of needed income for developing nations. To entomologists, biodiversity is insects because more than half of all described species on Earth are insects**(Resh&Cardé,2009).**

In addition to its intrinsic value, biodiversity also plays a fundamental role as ecosystem services in the maintenance of natural ecological processes. The economic or utilitarian values of biodiversity rely upon the dependence of man on biodiversity; products that nature can provide: wood, food, fibers to make paper, resins, chemical organic products, genes as well as knowledge for biotechnology, including medicine and cosmetic sub-products. It also encompasses ecosystem services, such as climate regulation, reproductive and feeding habitats for commercial fish, some organisms that can create soil fertility through complex cycles and interactions, such as earthworms, termites and bacteria, in addition to fungi responsible for cycling nutrients like nitrogen, phosphorus and sulfur and making them available to plant absorption. These services are the benefits that people indirectly receive from natural ecosystem functions (air quality maintenance, regional climate, water quality, nutrient cycling, reproductive habitats of commercial fish, etc.) with their related economic values **(Alho, 2008)**.

Insects are the most diverse group of organisms to appear in the 3-billion-year history of life on Earth, and the most ecologically dominant animals on land. By most measures of evolutionary success, insects are unmatched: the longevity of their lineage, their species numbers, the diversity of their adaptations, their biomass, and their ecological impact **(Grimaldi & Engel, 2005).**One of the major features of insects is their extraordinary diversity in terms of numbers and morphological forms **(Nasiruddin & Shiuli, 2017)**.These creatures possess several common features by which the group as a whole can be distinguished. They are generally small arthropods whose bodies are divisible into cephalic, thoracic, and abdominal regions.

The head carries one pair of antennae, one pair of mandibles, and two pairs of maxillae (the hind pair fused to form the labium). Each of three thoracic segments bears a pair of legs and, in the adult, the meso- and/or metathoracic segments usually have a pair of wings. Abdominal appendages, when present, generally do not have a locomotory function. The genital aperture is located posteriorly on the abdomen. With few exceptions' eggs are laid, and the young form may be quite different from the adult; most insects undergo some degree of metamorphosis **(Gullan,2014)**. Cold-blooded creatures, insects' body temperature drops when the environmental temperature drops, and their physiological processes slow down. Many insects can withstand short periods of freezing temperatures, and some can withstand long periods of freezing or subfreezing temperatures by storing in their tissues ethylene glycol**(Johnson &Triplehorn, 2004)**.

Within the class Insect, major forms of insects are grouped in orders. Ordinal-level groups represent divergent lineages that are nearly always recognizable by a set of distinctive characteristics. Almost always, an adult insect can be readily determined to order at a glance. The number of recognized orders has fluctuated slightly as entomologists' understanding of the included taxa and methods for classifying have developed **(Resh&Cardé, 2009).**Insects represent the largest and most diverse group of living organisms**(Volkoff*et al.*, 2020)**. Their most dominant orders include;

Diptera, which represent one of the dominant orders in terms of number of species. There are more than 150,000 species of flies described. This group includes species designated by the vernacular names of flies, hoverflies, mosquitoes, horseflies, midges, etc **(Wiegmann, 1996).**

Lepidoptera is an order of insects that includes butterflies and moths. About 180,000 species of the Lepidoptera have been described, representing ten percent of the total described species of living organisms, **(Mallet&Jim, 2007)** and placed in 126 families **(Capinera&John, 2008)**

Hymenoptera is a large order of insects, comprising the sawflies, wasps, bees, and ants. Over 150.000 living species of Hymenoptera have been described **(Mayhew, 2007; Janke *et al.*, 2013).**

Hemiptera, commonly known as true bugs, is a diverse order of insects that includes aphids, cicadas, and shield bugs. They are characterized by their piercing-sucking mouthparts, which they use to feed on plant sap or animal fluids. Hemipterans typically have two pairs of wings, with the forewings often being thicker and more protective. Their bodies are generally segmented and can vary widely in shape and size, ranging from very small (less than 1 mm) to relatively large (up to 15 cm in the case of some cicadas) **(Marshall, 2006).**

Coleoptera are recognizable by theirfront pair of wings are hardened into wing-cases (elytra), distinguishing them from most other insects. The Coleoptera, with about 400,000 described species, is the largest of all orders, constituting almost 40% of described insects and 25% of all known animal species **(Stork, 2018).**

Neuropteraor net-winged insects, includes the lacewings, Manti flies, antlions, and their relatives. The order consists of some 6,000 species**(Grimaldi &Engel, 2005).**

Although Algeria is regarded as a virgin region, studies still exist, even if they are scarce, in order to identify the biodiversity that characterizes this country known for its distinctive climatic characteristics. Most published research has focused on a few orders and families with commercial and medical value. We can cite, for example, the works of (**Deghiche-Diab *et al*.**, **2015**; **Bakroune**, **2012**; **Chouihet**, **2019**; **Askri**, **2020**; **Merabti*et al*.**, **2021**, **Benarfa**, **2005**; **Bouabida*et al*.**, **2012**; **Djellab*et al*.**, **2013**).

Research on wild insects has not aroused much interest, that's why this work aims to highlight the biodiversity of insects in the region of Tebessa, along a bioclimatic gradient (North-South). This original aspect seeks to carry out an inventory of the orders of insects found in the area, and to draw up a preliminary list of insects' orders correlated to their biogeographic distribution, which could make it possible afterwards, to better understand the final composition of insectsin this region.

MATERIALS AND METHODS

1. Presentation of the area and studied stations

1.1. Study area

The wilaya of Tebessa is located in the East of Algeria (35°20' N, 8°6' E, Altitude: 960 m). Its area is about 13878 km2. It is bordered to the North by the wilaya of Souk Ahras, to the South by the wilaya of El Oued, to the West by the wilayas of Oum El Bouaghi and Khenchla, and to the East by the Algerian-Tunisian border (**Fig.1**).

Figure 1. Map of the wilaya of Tebessa showing the geographical location of the studied area (google earth 2024)

The floristic composition is typical of steppe vegetation, with herbaceous plants dominated by esparto grass *(Stipa tenacissima)*, white wormwood *(Artemisia herba-alba)*, and saltbush *(Atriplex halimus)*. Wooded formations are found in the mountains and foothills, with the most abundant trees being; Aleppo pine *(Pinus halepensis)*, Prickly juniper *(Juniperus oxycedrus)*, Date palm *(Phoenix dactylifera)*,Olive tree *(Olea europaea)*, and Holm oak *(Quercus ilex)*.

1.2.Studied stations

According to a climatic gradient, we have chosen four study stations in the wilaya of Tebessa: Bir El Ater station, Negrine station, ElKouif station, and Ain Zarga station (**Fig.2**).

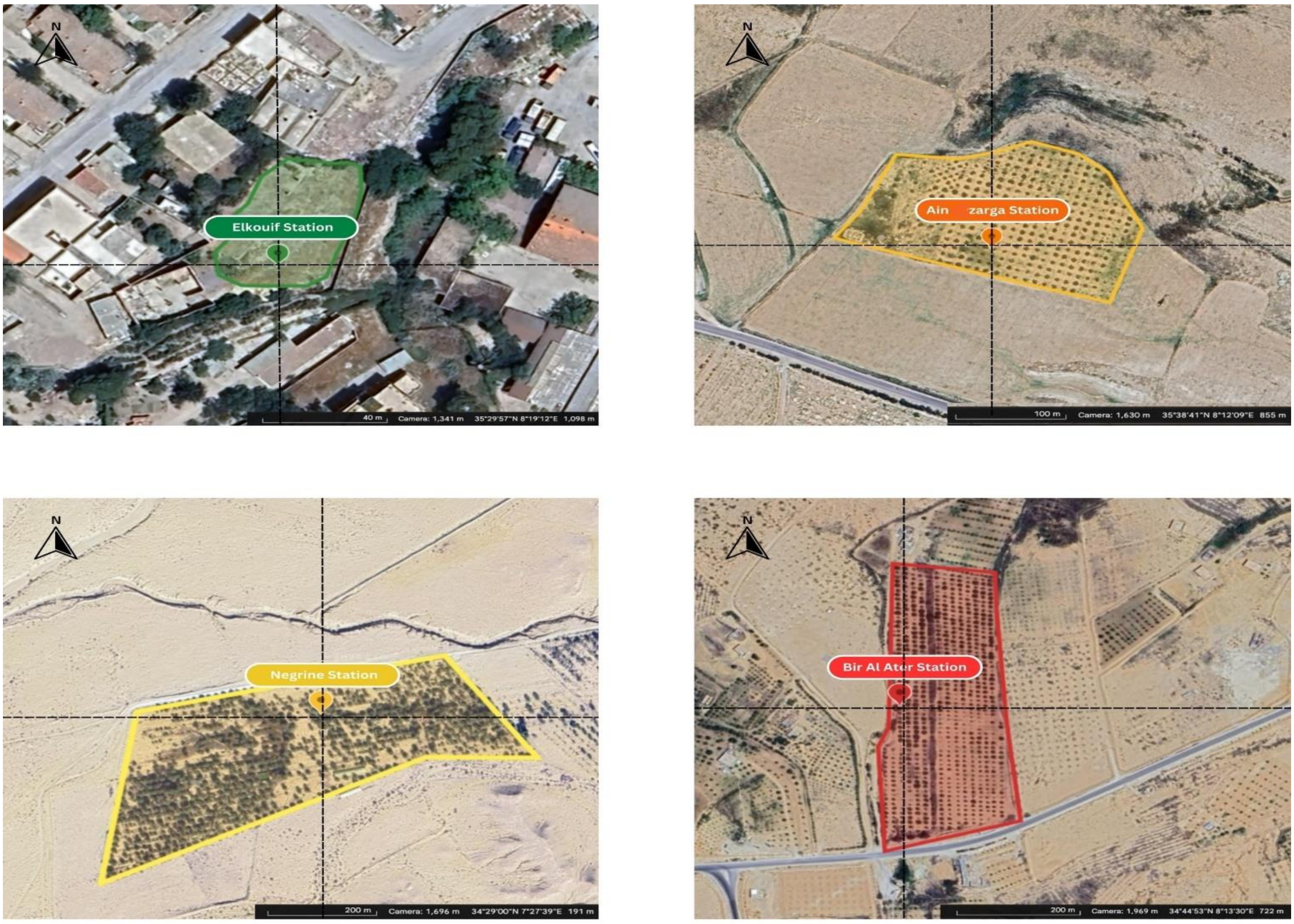

Figure2. Maps showing the four studied stations (google earth 2024)

- The first station "Bir Al Ater" (34°44'43.6"N 8°13'41.0"E), is located in an olive grove dominated, in appearance, by the olive tree (*Olea europaea*),and characterized by an attenuated sub desert climate, which is considered as an arid climate with with a short dry season(**Fig.3**).

- The second station "Negrine" (34°27'50.2"N 7°28'00.3"E), is located in an oasis dominated, in appearance, by date palm (*Phoenix dactylifera*) and Olive tree (*Olea europaea*).It is characterized by a desertic climate, which is considered an arid climate (**Fig.3**).

- The third station " Elkouif" (35°29'55"N 8°19'15"E), is a Barbary fig grove located in an urban area, in appearance, is dominated by Barbary fig (Opuntia ficus-indica), and characterized bya thermomediterranean climate, which is considered as a semi-arid climatewith a short dry season(**Fig. 3**).

- The fourth station "Ain Zarga"(35°38'39"N 8°12'11"E), is located inanorchard of different fruit trees,dominated, in appearance, by almond tree (*Prunus dulcis*)and Olive tree (*Olea europaea*).It is characterized by a Mesomediterranean climate, which is considered as a sub humid climatewith a long dry season (**Fig. 3**).

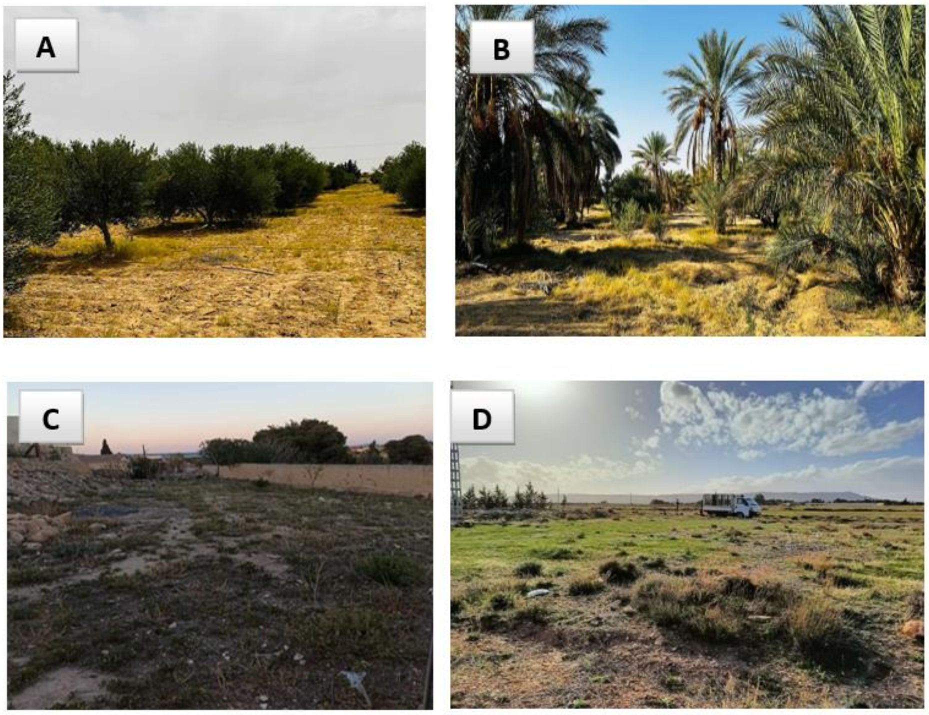

Figure3. Study stations; **A: Bir** El Ater, **B:** Negrine, **C:** El Kouif, **D:** Ain Zarga (Personal photos 2024)

1.3.Climate synthesis

Figure 4. Presents an ombrothermic diagram of Gaussen and Bagnouls of Tebessa, spanning 1972 to 2023, illustrating the region's climatic patterns. The data reveal a Mediterranean climate characterized by hot, dry summers and cool, wet winters. Peak temperatures exceed 25°C in July and August, while the lowest temperatures, below 10°C, occur in January and February. Precipitation is highest in the winter months, surpassing 30 mm and lowest in the summer, dropping below 10 mm. These findings underscore the seasonal variability in temperature and precipitation in Tebessa.

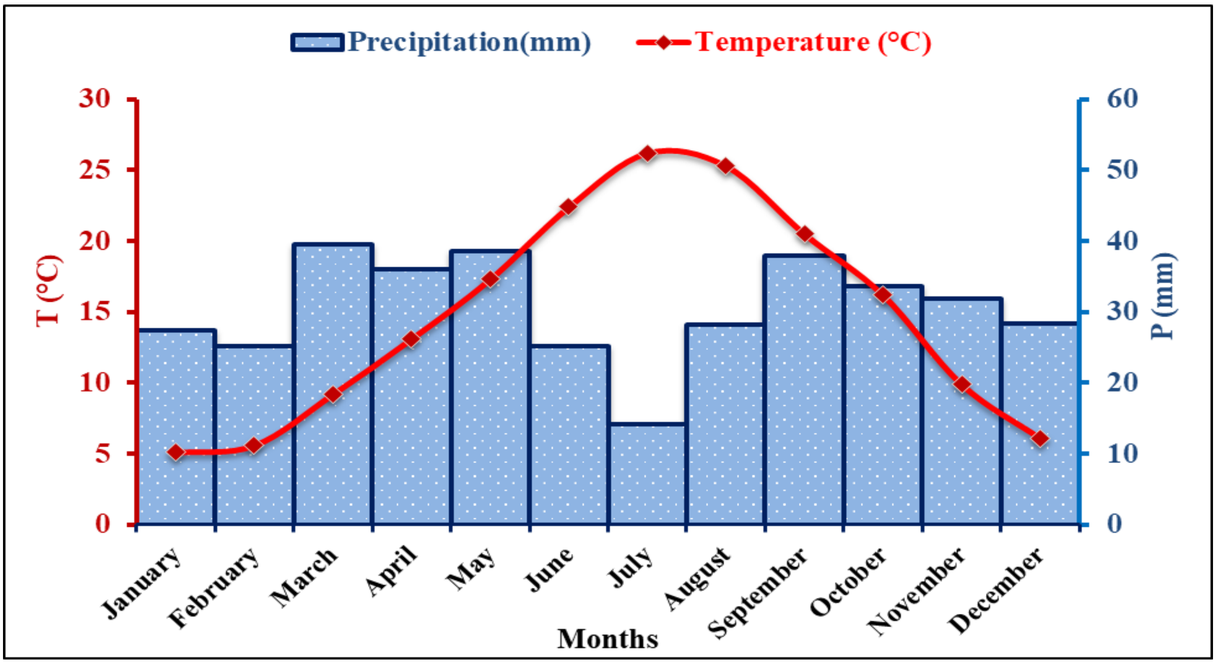

Figure 4. Gaussen and Bagnouls ombrothermal diagram of the study region during the period (1972-2023)

2. Sampling technics

To conduct our study, we used a mixed sampling approach. Two sampling technics were adopted simultaneously;

-The first, which involves stratified sampling, was used to select the study stations. The bioclimatic zone was chosen as the stratification criterion.

-The second sampling technic used is represented by a systematic sampling, using Malaise trap **(Fig.5**)

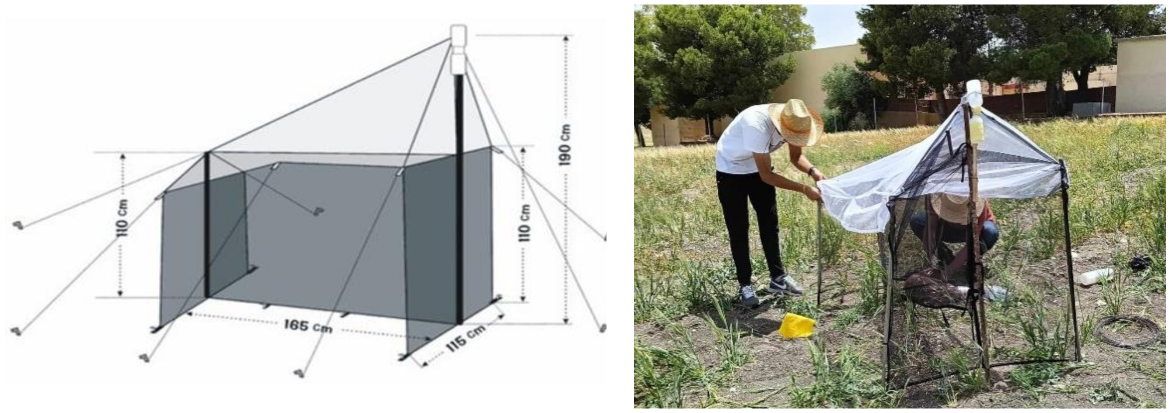

Figure5. Malise trap **(**personal photo 2024**)**

3. Study period, sample collection, and materials used

3.1. Study period

The study was conducted between July 2023 and April 2024, covering all the four seasons (summer, autumn, winter, and spring). In order to obtain a complete level of understanding of the insect biodiversity, 92 field trips were carried out (around twenty field trips in each station).

3.2. Insects sampling and identification

The insects were captured using Malaise traps, with samples collected every 10 days. The captured individuals were preserved in labeled plastic boxes containing 70% ethanol, and on which are mentioned the date, the station, and number of individuals.

The specimens were studied and measured. A morphological study was made among adults from samples taken in the different stations. Insects were described on the basis of a single specimen. Identification was carried out using a binocular magnifying glass, and based on morphological characters namely; shape and number of wings, body shape (structure), antenna and size.

The description was made according to nomenclature and measurements of (**Leahy, 1998**), (**Gullan & Cranston, 2014**), (**Brues, 1945**), **(Reed *et al.*, 2006**), (**Buck *et al*., 2009**), (**Marsh, 1994**), and (**Choate, 1999**).

4. Materials used

4.1 Insect-catching tools

- Malise trap: The Malaise Trap is a tent like structure - insects fly into the screen and migrate to the highest point where a collection head is situated. The head can be a plain bottle, a dry or wet killing bottle.
- Concentrated ethyl alcohol 70%.

4.2 Laboratory material

- Binocular loop.
- Diluted ethyl alcohol.
- Dry tubes.
- Petri dishes.
- Tweezers.
- Syringe.
- Labels.

5. Studied parameters

To explain the different results obtained on the encountered insect orders, several ecological descriptors were studied, namely:

5.1. Orders richness

This is the number of orders present in a given sample.

5.2. Relative abundance (RA)

The relative abundance of an order is the ratio of the number of individuals of that order to the total number of individuals of all orders combined. It provides information on the importance of each order relative to all orders present.

RA = (Na / Na + Nb + Nc + ...) * 100

RA = relative abundance of the considered order.

Na, Nb, Nc, = number of individuals of the orders a, b, c.

5.3. Occurrence

The frequency of occurrence (constancy) of an order is the ratio, expressed as a percentage, of the number of samples containing that order to the total number of samples taken: F = (Pa / P) * 100

F = frequency of occurrence of the order.

Pa = total number of samples containing the considered order.

P = total number of samples taken.

Constant order: $F \geq 50\%$

Common order: $25\% < F < 50\%$

Accidental order: $F \leq 25\%$

5.4. Shannon-Weaver Diversity Index (H')

This index represents the proportion of the number of individuals of the order of rank (i) on the total number of individuals (N). The calculation of this index allows us to evaluate thediversity of a given stations, and to compare diversity between different stations.

H' = -∑Filog2Fi (bits) / Fi = Ni/N

Fi: Frequency of an order.

Ni: Number of individuals for each order.

N: Total number of individuals of all orders.

5.6. Evenness

Evenness (E) is defined as the ratio of the calculated diversity to the maximum diversity.

E = H’ / H’max

H’: Diversity index, expressed in bits.

H’max: Maximum diversity expressed in bits.

H’max: $\log_2$ S (S: number of orders).

6. Statistic alanalytical

In order to test the significance of the variation in the mean of the ecological descriptors evaluated in the different stations according to the different seasons, and this for the different orders, three-way analyzes of variance (ANOVA) were adopted. All analyzes of variance were carried out using type I tests at a significance level of alpha=0.05.

Correlation matrices by using Pearson correlation test at a significance level of α =0.05, were used to study the correlation between the different ecological descriptors.
To match the different orders of insects encountered in the different sampling stations during the different seasons, correspondence factor analysis (CFA) was used.
Similarity indexes (Jaccard and Bray-Curtis) were used to understand the similarity between the stations during the different seasons.

Statistical tests were performed using; Xlstat (2016), EstimateS (9.1.0), and Rsoftware (4.2.0).

RESULTS

RESULTS

The 92 samples taken almost equally in the four stations and which took place during the period from July 2023 to April 2024 made it possible to collect 20,573 individuals distributed across the different stations.

1. taxonomic composition of insect community

The faunal inventory carried out in the different stations made it possible to draw up a systematic list for the different orders encountered. The keys used to identify the insects collected allowed us to identify a total of 15 orders across the 4 stations (Negrine, Bir El Ater, Elkouif, and Ain Zarga):

- **Order1.** Psocoptera (**Fig.6**)

Figure6. Representative individuals of the Psocoptera order (personal photo 2024)

- **Order2.** Blattodea (**Fig.7**)

Figure7. Representative individual of the Blattodea order (personal photo 2024)

- **Order3.** Odonata (**Fig.8**)

Figure8. Representative individual of the Odonata order (personal photo 2024)

- **Order4.** Dermaptera (**Fig.9**)

Figure9. Representative individual of the Dermaptera order (personal photo 2024)

- **Order5.** Orthoptera (**Fig.10**)

Figure10. Representative individuals of the Orthoptera order (personal photo 2024)

- **Order6.** Mantodea (**Fig.11**)

Figure11. Representative individual of the Mantodea order (personal photo 2024)

- **Order7.**Thysanoptera (**Fig.12**)

Figure12. Representative individual of the Thysanoptera order (personal photo 2024)

- **Order 8.**Hemiptera (**Fig.13**)

Figure13. Representative individuals of the Hemiptera order (personal photo 2024)

- **Order 9.**Embioptera(**Fig.14**)

Figure14. Representative individuals of the order Embioptera (personal photo 2024)

- **Order10.**Hymenoptera(**Fig.15**)

Figure15. Representative individuals of the order Hymenoptera (personal photo 2024**)**

- **Order11.**Coleoptera(**Fig.16**)

Figure16. Representative individuals of the order Coleoptera (personal photo 2024**)**

- **Order12.**Lepidoptera(**Fig.17**)

Figure17. Representative individuals of the order Lepidoptera (personal photo 2024**)**

- **Order13.**Trhichoptera(**Fig.18**)

Figure18. Representative individuals of the order Trhichoptera (personal photo 2024**)**

- **Order14.**Diptera(**Fig.19**)

Figure19. Representative individuals of the order Diptera (personal photo 2024**)**

- **Order15.**Neuroptera(**Fig.20**)

Figure20. Representative individuals of the order Neuroptera (personal photo 2024**)**

2. Ecological descriptors

2.1. Absolute abundance (AA) and Relative abundance (RA)encountered in the studied stations

2.1.1. Absolute abundance (AA) and relative abundance (RA) of the orders encountered in Bir El Ater station

The values of the absolute abundance and the relative abundance for the Bir El Ater station are mentioned in **Table A.**

TableA. Absolute abundance (AA) and relative abundance (RA) of the orders encountered in Bir El Ater station

Region	Bir el ater							
Season	Summer		Autumn		Winter		Spring	
	AA	RA(%)	AA	RA(%)	AA	RA(%)	AA	RA(%)
Psocoptera	0	0	12	0.713	42	10.096	11	1.574
Blattodea	0	0	2	0.119	1	0.240	0	0
Odonata	0	0	0	0	0	0	0	0
Dermaptera	0	0	0	0	0	0	1	0.143
Orthoptera	87	11.154	199	11.831	4	0.962	0	0
Mantodea	0	0	0	0	0	0	0	0
Thysanoptera	0	0	7	0.416	0	0	0	0
Hemiptera	40	5.128	158	9.394	80	19.231	203	29.041
Embioptera	0	0	0	0	0	0	0	0
Hymenoptera	131	16.795	225	13.377	21	5.048	18	2.575
Coleoptera	8	1.036	26	1.546	23	5.529	3	0.429
Lepidoptera	148	18.974	201	11.950	10	2.404	39	5.579
Trhichoptera	0	0	20	1.189	1	0.240	2	0.286
Diptera	353	45.256	789	46.908	234	56.250	420	60.086
Neuroptera	13	1.667	43	2.556	0	0	2	0.286
TOTAL	780	100	1682	100	416	100	699	100

Table A shows that the spatio-temporal relative abundance of the insects recorded is very variable, In the Bir El Ater station, the order of Diptera was the most dominant order regardless of the sampling season with 353 individuals collected in summer (AR=45.26%), 789 individuals collected in autumn (AR=46.91%), 234 individuals collected in Winter (AR=56.25%) and 420 individuals collected in spring (AR=60.09%).

2.1.2. Absolute abundance (AA) and relative abundance (RA) of the orders encountered in Negrine station

The values of the absolute abundance and the relative abundance for the Negrine station are mentioned in **Table B.**

Table B. Absolute abundance (AA) and relative abundance (RA) of the orders encountered in Negrine station

Region	Negrine							
Season	Summer		Autumn		Winter		Spring	
	AA	RA(%)	AA	RA(%)	AA	RA(%)	AA	RA(%)
Psocoptera	0	0	2	0.038	22	0.851	12	0.222
Blattodea	0	0	1	0.019	0	0	0	0
Odonata	0	0	0	0	0	0	2	0.037
Dermaptera	0	0	0	0	0	0	0	0
Orthoptera	23	1.772	35	0.665	20	0.773	0	0
Mantodea	0	0	0	0	0	0	0	0
Thysanoptera	0	0	14	0.266	3	0.116	35	0.649
Hemiptera	46	3.544	262	4.974	765	29.582	622	11.529
Embioptera	6	0.462	3	0.057	2	0.077	5	0.093
Hymenoptera	247	19.029	169	20.296	84	3.248	579	10.732
Coleoptera	73	5.624	54	1.025	17	0.657	73	1.353
Lepidoptera	341	33.205	551	10.461	54	2.088	377	6.988
Trhichoptera	1	0.077	332	6.303	6	0.233	7	0.130
Diptera	468	36.055	2926	55.553	1584	61.253	3636	67.396
Neuroptera	3	0.231	18	0.342	29	1.121	47	0.871
TOTAL	1298	100	5267	100	2586	100	5395	100

Table B shows that the spatio-temporal relative abundance of the insects recorded is very variable, In the Negrine station, where the order of Diptera was the most dominant order regardless of the sampling season with 468 individuals collected in summer

(AR=36.05%), 2926 individuals collected in autumn (AR=55.55%), 1584 individuals collected in Winter (AR=61.25%), and 3636 individuals collected in spring (AR=67.40%).

2.1.3. Absolute abundance (AA) and relative abundance (RA) of the orders encountered in Elkouif station

The values of the absolute abundance and the relative abundance for the Elkouif station are mentioned in**TableC.**

Table C. Absolute abundance (AA) and relative abundance (RA) of the orders encountered in Elkouif station

Region	Elkouif							
Season	Summer		Autumn		Winter		Spring	
	AA	RA(%)	AA	RA(%)	AA	RA(%)	AA	RA(%)
Psocoptera	2	0.429	3	1.523	10	5.714	5	1.445
Blattodea	0	0	0	0	0	0	0	0
Odonata	0	0	0	0	0	0	0	0
Dermaptera	0	0	0	0	0	0	0	0
Orthoptera	8	1.717	4	2.030	2	1.143	0	0
Mantodea	0	0	0	0	0	0	0	0
Thysanoptera	0	0	0	0	0	0	0	0
Hemiptera	23	4.963	11	5.584	12	6.857	41	11.850
Embioptera	0	0	0	0	0	0	0	0
Hymenoptera	81	17.382	46	23.350	10	5.714	19	5.491
Coleoptera	9	1.931	17	8.629	9	5.143	8	2.312
Lepidoptera	234	50.215	25	12.69	4	2.286	12	3.468
Trhichoptera	11	2.361	0	0	0	0	0	0
Diptera	98	21.030	90	45.685	124	70.857	259	74.855
Neuroptera	0	0	1	0.508	4	2.286	2	0.578
TOTAL	466	100	197	100	175	100	346	

Table C shows that In El Kouif, the order of Lepidoptera was the dominant order during the summer with 234 individuals (AR=50.21%). However, the order of Diptera was the dominant order during the other seasons with 90 individuals collected in autumn (AR=45.68%), 124 individuals collected in winter (AR=70.86%), and 259 individuals collected in spring (AR=74.85%).

2.1.4. Absolute abundance (AA) and relative abundance (RA) of the orders encountered in Ain zarga station

The values of the absolute abundance and the relative abundance for the Ain Zarga station are mentioned in **Table D.**

Table D. Absolute abundance (AA) and relative abundance (RA) of the orders encountered in Ain Zarga station

Region	Ain Zarga							
Season	Summer		Autumn		Winter		Spring	
	AA	RA(%)	AA	RA(%)	AA	RA(%)	AA	RA(%)
Psocoptera	0	0	6	2.034	4	5.128	6	0.863
Blattodea	0	0	0	0	0	0	0	0
Odonata	0	0	0	0	0	0	0	0
Dermaptera	0	0	0	0	0	0	0	0
Orthoptera	4	2.020	10	3.390	1	1.282	1	0.144
Mantodea	0	0	0	0	1	1.282	0	0
Thysanoptera	0	0	0	0	0	0	2	0.288
Hemiptera	10	5.051	20	6.780	4	5.128	114	16.403
Embioptera	0	0	0	0	0	0	0	0
Hymenoptera	38	19.912	41	13.898	4	5.128	57	8.201
Coleoptera	3	1.515	3	1.017	4	5.128	19	2.734
Lepidoptera	70	35.354	84	28.475	1	1.281	60	8.633
Trhichoptera	25	12.626	14	4.746	2	2.564	0	0
Diptera	48	24.242	110	37.288	55	70.513	426	61.295
Neuroptera	0	0	7	2.373	2	2.564	10	1.439
TOTAL	198	100	295	100	78	100	695	100

Table D shows that in the Ain Zarga station, where the order of Lepidoptera was the dominant order during the summer with 70 individuals (AR=35.35%). However, the order of Diptera was the dominant order during the other seasons with 110 individuals collected in autumn (AR=37.29%), 55 individuals collected in winter (AR=70.51%) and 426 individuals collected in spring (AR=61.29%).

2.1.5. Absolute abundance (AA) and relative abundance (RA) of the orders encountered in the four stations

The values of the absolute abundance and the relative abundance for the four stations are mentioned in **TableE.**

Table E. Absolute abundance (AA) and relative abundance (RA) of the orders encountered in the four stations

Order	AA	RA (%)
Psocoptera	137	0.666
Blattodea	4	0.019
Odonata	2	0.010
Dermaptera	1	0.005
Orthoptera	398	1.935
Mantodea	1	0.005
Thysanoptera	61	0.297
Hemiptera	2411	11.719
Embioptera	16	0.078
Hymenoptera	2670	12.978
Coleoptera	349	1.696
Lepidoptera	2301	11.185
Trhichoptera	421	2.046
Diptera	11620	56.482
Neuroptera	181	0.88
TOTAL	20573	100

Table E indicates that the total abundance for the different orders in the different stations shows that the most abundant order is that of Diptera with a total of 11620 individuals collected (AR=56.48%), followed by the order of Hymenoptera with 2670 individuals collected (AR=12.98%), then the order of Hemiptera with 2411 individuals collected (AR=11.72%), and the order of Lepidoptera with 2301 individuals collected (AR=11.18%).

However, with only a single individual collected during the entire sampling period (AR=0.005%), the orders of Dermaptera and that of Mantodea were the least present orders.

2.2.Occurrence

The identified insect order's occurrence percentage per station is represented in **figure21.**

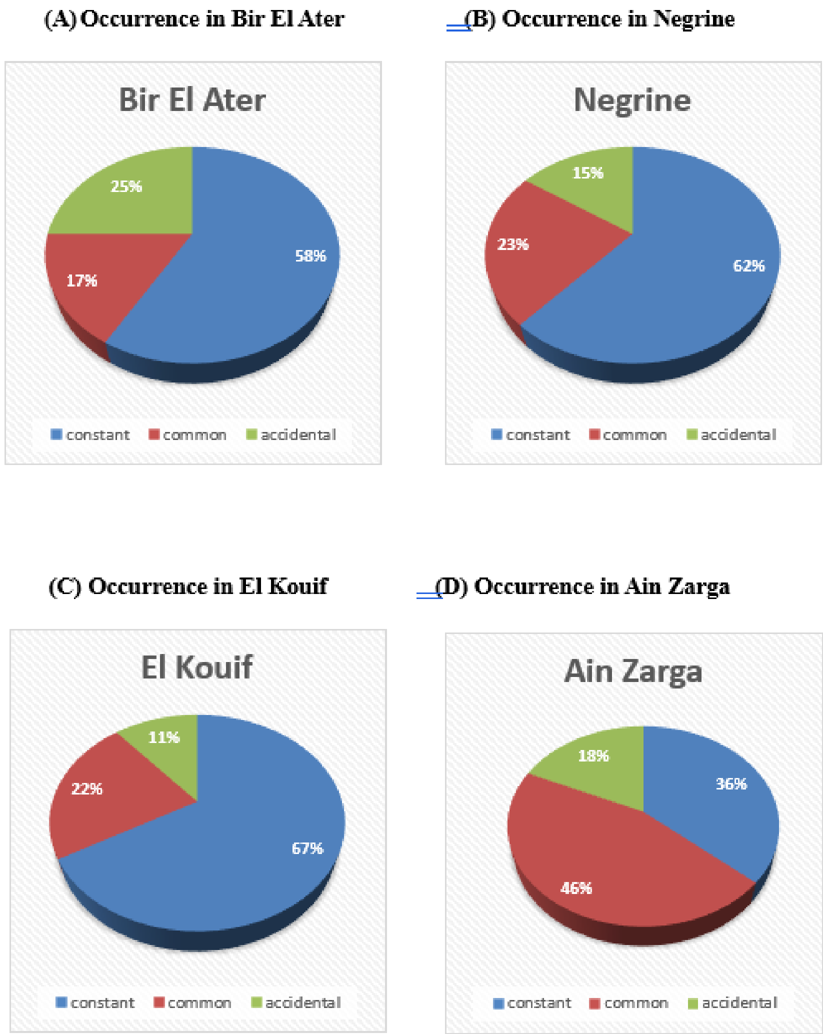

Figure21. Occurrence of the orders encountered in the different stations

According to the data presented in the **figure12**,in the Bir El Ater station constant insect orders (Psocoptera, Orthoptera, Hemiptera, Hmenoptera, Coleoptera, Lepidoptera, Diptera) are the most prevalent, succeeded by accidental orders (Blattodea, Dermaptera, Thysanoptera) and common orders (Trichoptera, Neuroptera).

Negrine station predominantly exhibit constant insect orders (Hemiptera, Hymenoptera, Coleoptera, Lepidoptera, Trichoptera, Diptera, Neuroptera, Orthoptera) followed by common orders (Embioptera, Thysanoptera, Psocoptera) and accidental orders(Blattodea, Odonata).

Similarly, ElKouif station predominantly exhibit constant insect orders (Hemiptera, Hymenoptera, Coleoptera, Lepidoptera, Diptera, Psocoptera) followed by common orders (Orthopera, Neuroptera) and accidental orders (Trichoptera).

Conversely, in Ain Zarga station, the distribution differs, with common orders comprising a majority of common orders (Coleo, Trichoptera, Neuroptera, Psocoptera, Orthoptera)followed by constant orders (Hemiptera, Hymenoptera, Diptera) and accidental orders (Mantode, Thysanoptera).

2.3.Shannon diversity index (H')

The results obtained from (H') are mentioned in **figure 22**.

Shannon Weaver diversity index values vary between 1.51 during spring and 2.35 in autumn at Bir El Ater. This index varies between 1.50 in winter and 2.08 in summer at Negrine, and between 1.33 in spring and 2.16 in autumn at El Kouif. The Ain Zarga station recorded rates varying between 1.74 in winter and 2.38 in autumn.

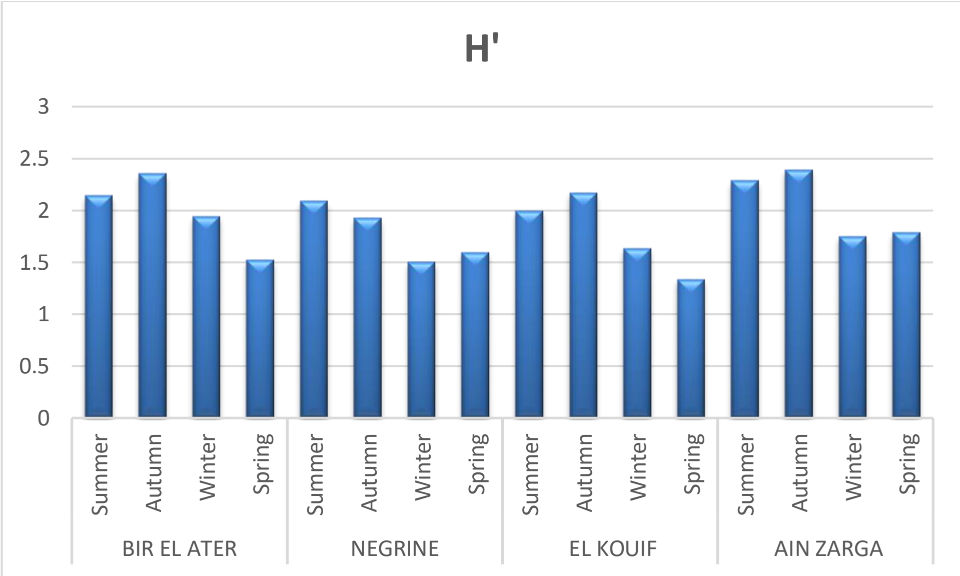

Figure22. Spatiotemporal variation in the parameter of Shannon Weaver

The analysis of variance for the parameter Shannon Weaver diversity index (**Table F**) showed that there is a very highly significant difference, whether between stations or seasons, and a significant difference with the interaction between stations and seasons.

Table F. Test ANOVA for the parameter Shannon Weaver diversity index

	DF	SUM SQ	MEAN SQ	F VALUE	PR(>F)	
Station	3	0.4808	0.16026	12.134	1.43E-06	***
Seasons	3	0.5725	0.19084	14.45	1.54E-07	***
Stations. Seasons	9	0.2751	0.03056	2.314	0.0233	*
Residuals	76	1.0038	0.01321			

2.4.Eveness

The calculation of the equitability index (**Figure 23**) shows rates changing with stations and seasons. These rates show that Ain Zarga station remains in balance during all seasons of the year with E values ranging from 0.52 to 0.81. For Bir El Ater and El Kouif stations, this calculation shows a balance during all seasons with E rates ranging from 0.54 to 0.76, except for the spring season which is marked by a slight imbalance corresponding to E=0.47. As for the Negrine station, the calculated values of E show a balance during the summer and autumn seasons with, respectively, rates of 0.65 and 0.53, and an imbalance during the winter and spring seasons with, respectively, rates of 0.43 and 0.46.

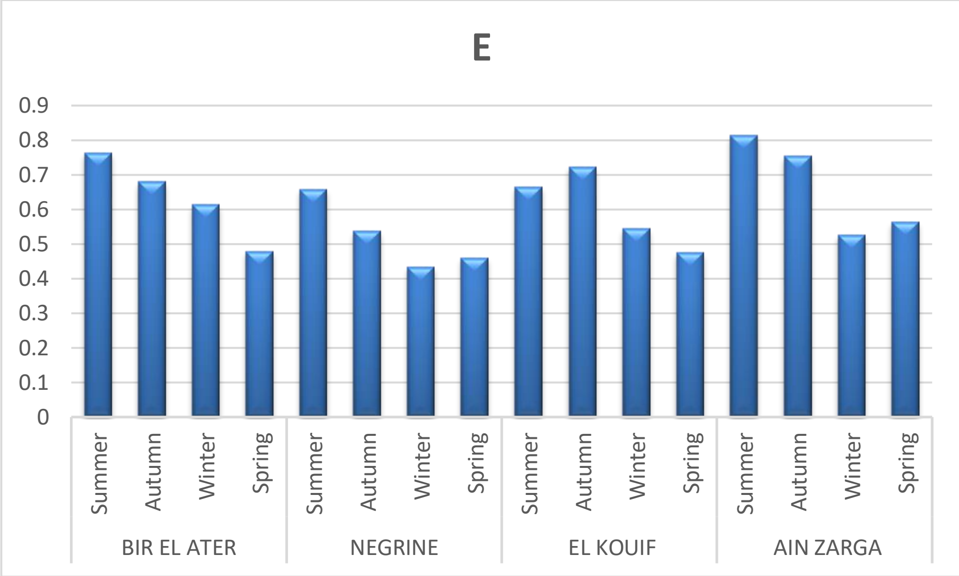

Figure23. Spatiotemporal variation in the parameter of Eveness

The analysis of variance for the parameter Eveness (**Table G)** showed that there is a very highly significant difference, whether between stations or seasons, and a significant difference with the interaction between stations and seasons.

Table G. Test ANOVA for the parameter Eveness

	DF	SUM SQ	MEAN SQ	F VALUE	PR(>F)	
Station	3	0.4808	0.16026	12.134	1.43E-06	***
Seasons	3	0.5725	0.19084	14.45	1.54E-07	***
Stations. Seasons	9	0.2751	0.03056	2.314	0.0233	*
Residuals	76	1.0038	0.01321			

2.5. Correlations betweene cological descriptors

The results displayed in Tables 10 and 11 show positive and very highly significant correlations between the parameters; N and S, N and H, and between H and E. These results also show the existence of a negative and very highly significant correlation between the parameters N and E.

Table H. Pearson correlations between the different ecological descriptors

	N	S	H	E
N	1	0.5202	-0.0067	-0.3383
S	0.5202	1	0.5031	-0.1752
H	-0.0067	0.5031	1	0.73
E	-0.3383	-0.1752	0.73	1

Table I. Pairwise two-sided p-values for the different ecological descriptors

	N	S	H	E
N		<.0001	0.9492	0.001
S	<.0001		<.0001	0.0949
H	0.9492	<.0001		<.0001
E	0.001	0.0949	<.0001	

3. Spatiotemporal variation in the number of taxa

Figure24.Shows that the orders richness varies between stations and seasons. According to stations, Negrine station recorded the highest value (13 orders), then Bir El Ater and Ain Zarga stations with respectively (12 orders and 11 orders), and finally El Kouif station (9 orders). Depending on seasons, the number of orders shows rates ranging from 13 orders recorded in winter and spring. Whereas autumn and summer recorded, respectively, 12 and 10 orders.

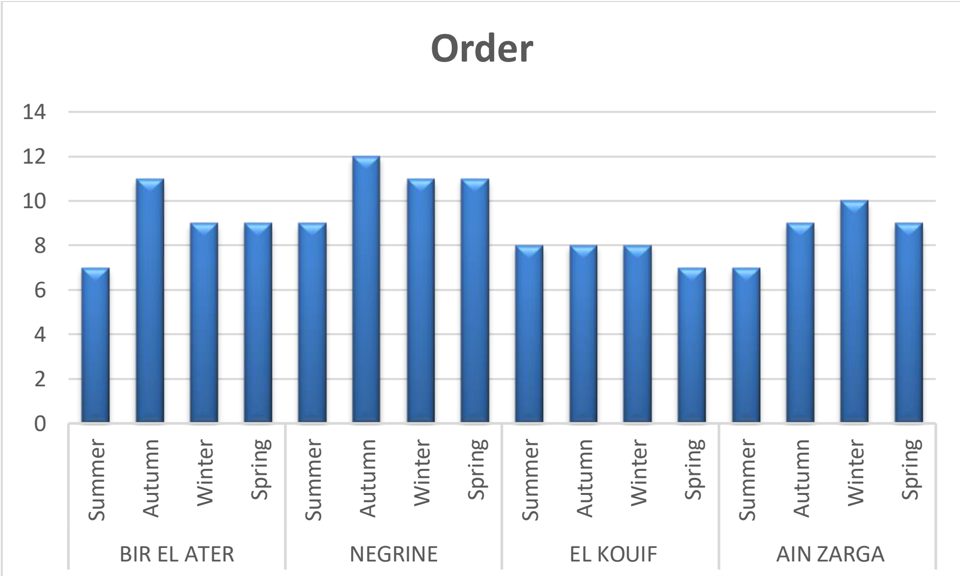

Figure.24 Spatiotemporal variation in the number of the orders of the collected insects

4. Estimated rarefaction of taxa

The statistical projection (**Figure25**) shows that even if we increase the number of samples to 100, there will be no change in the number of orders inventoried, except for the Negrine station where the number will increase by only one order, and also for the winter and spring seasons where the number of orders will become, respectively, almost 14 and 17 instead of 13 orders.

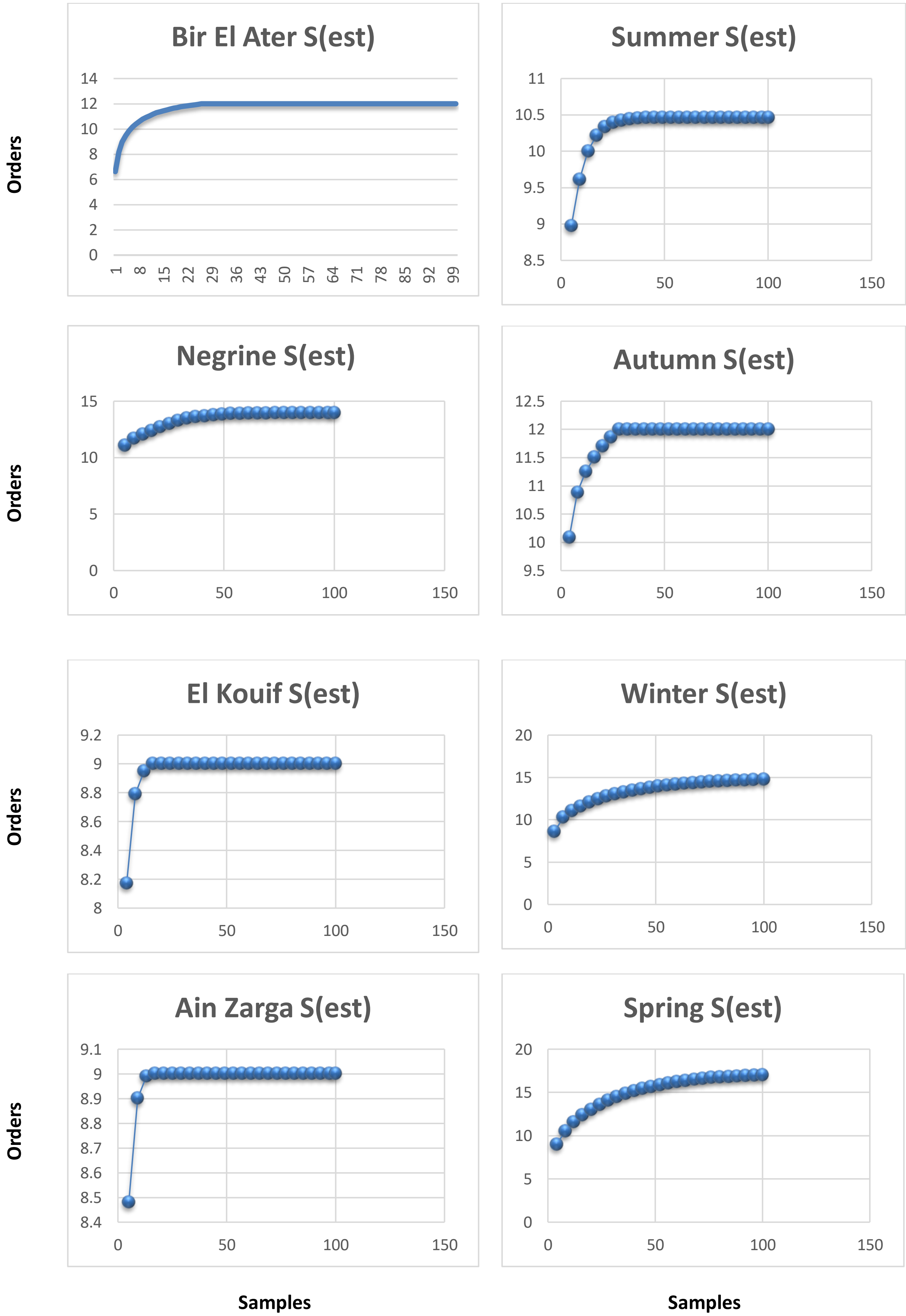

Figure25. Sample-based rarefaction curves of orders richness estimated for insects

5. Similarity analysis

The similarity calculation between the different stations (**Table J**) showed that the most important similarity was between El Kouif and Ain Zarga stations with 81.8% similarity for the Jaccard index. The Bray-Curtis dissimilarity index showed that the greatest dissimilarity exists also between El Kouif and Ain Zarga stations with 89%.

As for the similarity between the different seasons (**Table J**), the results show that the maximum similarity exists between autumn and winter with a rate of (92.3%) for the indice of Jaccard. The Bray-Curtis dissimilarity index shows that the greatest dissimilarity exists between autumn and spring (78.4%).

Table J. Similarity indexes according to stations and seasons

	First Sample	Second Sample	Jaccard Classic	Bray-Curtis
Stations	Bir El Ater	Negrine	78.6%	36.8%
	Bir El Ater	El Kouif	75.0%	49.7%
	Bir El Ater	Ain Zarga	76.9%	51.5%
	Negrine	El Kouif	69.2%	15.1%
	Negrine	Ain Zarga	71.4%	16.0%
	El Kouif	Ain Zarga	81.8%	89.0%
Seasons	Summer	Autumn	83.3%	53.4%
	Summer	Winter	76.9%	46.1%
	Summer	Spring	76.9%	44.5%
	Autumn	Winter	92.3%	52.2%
	Autumn	Spring	78.6%	78.4%
	Winter	Spring	73.3%	61.0%

6. Correspondence factor analysis (CFA)

Correspondence factor analysis (CFA) was applied to the distribution of the orders identified according to the four stations (**Figure 26**). The symmetrical graph of the CFA is represented on a factorial plane with 100% inertia (axis F1=81.66%, axis F2=14.72%) which demonstrates good quality of analysis.

It separates the Bir El Ater station in the negative side of the F1 axis and the positive side of the F2 axis, and characterizes this station by the orders; Hemiptera, Dermaptera, Orthoptera, and Blattodea. Negrine station is located on the negative sides of the two axes. It is characterized by the following orders; Odonata, Thysanoptera, and Embioptera.

As for the El Kouif and Ain Zarga stations, they are on the positive side of the two axes, and are characterized by the following orders; Psocoptera, Mantodea, Coleoptera, Lepidoptera, and Neuroptera.

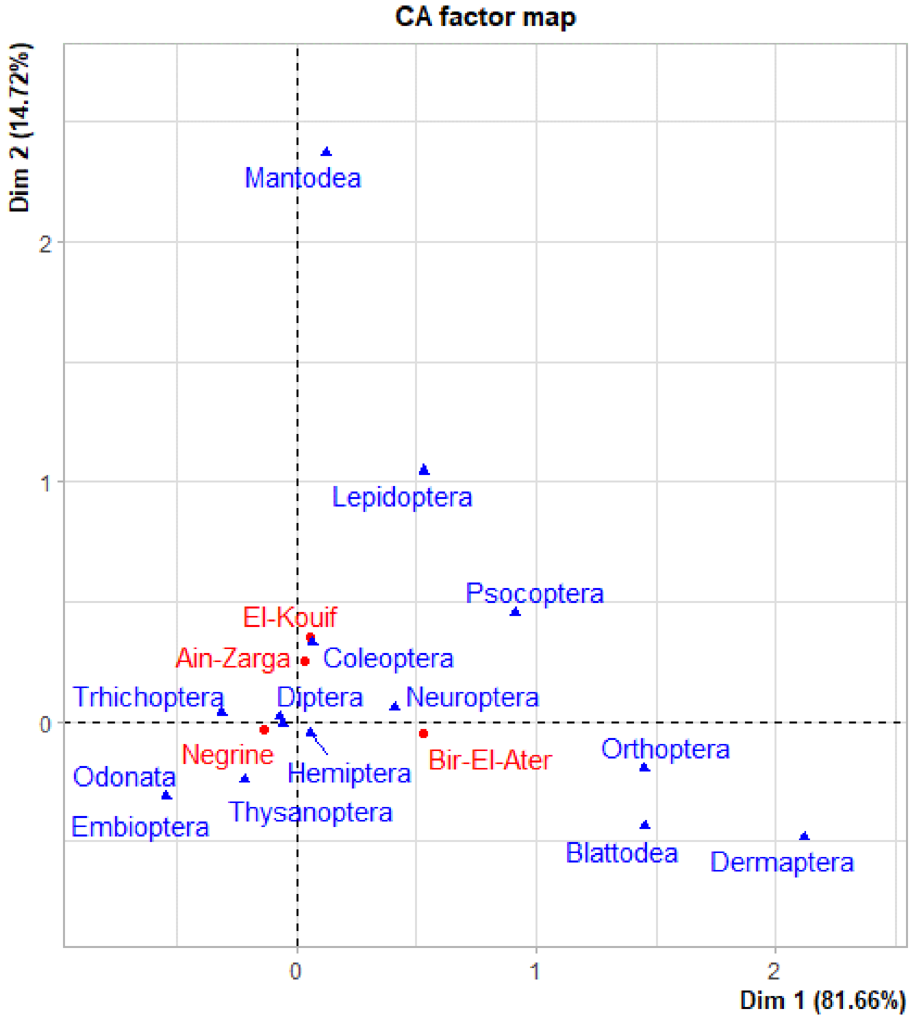

Figure26. Correspondence factor analysis according to stats

DISCUSSION

We have set ourselves the objective of making a contribution to a better knowledge of the insect orders of the region studied in general. The period of our study was chosen to coincide with the highest insect emergence.

The inventory of insects carried out using the malaise trap method in the Tebessa region during the study period revealed the presence of 15 orders belonging to the class Insecta(Psocoptera, Blattodea, Odonata, Dermaptera, Orthoptera, Mantodea, Thysanoptera, Hemiptera, Embioptera, Hymenoptera, Coleoptera, Lepidoptera, Trhichoptera, Diptera, Neuroptera). By comparison, 10 orders (Coleoptera,Hymenoptera, Lepidoptera, Dermaptera, Orthoptera, Hemiptera, Odonata, Diptera,Neuroptera, Ephemeroptera) were found by **Deghiche-Diab*et al*. (2015)** in Biskra, 10 orders(Orthoptera, Dermaptera, Mantodea, Blattodea, Hemiptera, Coleoptera, Neuroptera, Hymenoptera, Lepidoptera, Diptera) were found by **Aissat*et al.*** (2023) in Bejaia , and 9 (Coleoptera, Orthoptera, Phasmatodea, Lepidoptera, Dermaptera, Blattodea, Diptera, Hemiptera, Hymenoptera) orders were reported by **Hedjouli et *al.*(2022)**in Biskra.Among all the studies above, the orders Embioptera, Psocoptera, and Thysanoptera were only captured in our study. Meanwhile, the order Ephemeroptera was only captured by **Deghiche-Diab *et al.* (2015)**, and the order Phasmatodea was only captured by **Hedjouli *et al.* (2022)**.

Insect abundance varied significantly in space and time between July 2023 and April 2024 at the four stations studied, as demonstrated by the 20,573 individuals that the malaise trap captured. With 14,546 individuals collected, Negrine stands out as the station with the greatest number of individuals. This finding may be due to habitat-specific characteristics or favorable conditions that promote higher insect populations. El Kouif, on the other hand, recorded least number of individuals (1,184), which may indicate that there are limited resources or unfavorable environmental factors that impact insect survival and reproduction.

There were clear seasonal patterns, with the highest number of insect collected (7,441 and 7,135 individuals, respectively) coming from the fall and spring. Extreme cold or heat, which is less conducive to insect.

Activity and survival may be the cause of the lower collections observed in the winter (3,255 individuals) and summer (2,742 individuals). According to **Palumbo** (**2010**); Temperature is the driving force behind insect development, growth and behavior. Unlike many animals, insects are poikilothermic (“coldblooded”); that is they are unable to regulate their body temperature and their internal temperature varies along with that of the ambient environmental temperature.

In this study, Diptera was the most abundant order at 65.4%, followed by Hymenoptera at 12.9% and Hemiptera at 11.7%. This result disagrees with **Kourim et al. (2010)** in Tamanrasset (using several sampling methods: barber pots, quadrat, swwep net and direct hand capture), who found Hymenoptera to be the most abundant at 41.4%, followed by Coleoptera at 22.6%, with Diptera and Orthoptera both at 6.9**%. Laakel and Haoucine (2018) in Bejaia**reported different results (using several sampling methods: visual hunting, barber pots, swwep net and Japanese umbrella), with Coleoptera as the most abundant at 31%, followed by Diptera at 25% and Hymenoptera at 16%. Similarly, **Hedjouli et al. (2022) in Biskra**(Pitfall traps sampling method) identified Coleoptera as the most abundant at 48.1%, followed by Hemiptera at 22.2% and Orthoptera at 11%. These discrepancies highlight significant variations in the relative abundance of insect orders across different studies. While our study identifies Diptera as the predominant order, other studies have identified Hymenoptera or Coleoptera as the most abundant, indicating differing ecological conditions or methodological approaches.

The presence of Diptera across most stations and seasons is notable, particularly in Negrine and Bir El Ater. The remarkable abundance of this order may be attributed to the ecological adaptability and vast range of habitats and resources that its individuals can utilize.

Most species of this order are known to be present in almost all zoogeographic areas of the world. They have proved to be well adaptable to a wide diversity of habitats; they can survive in almost every habitable environment on the earth, except the ocean depths **Badii. (2020)**.

This result aligns with the fact that Malise trap is useful for the sampling of Hymenoptera, Diptera and Lepidoptera **Sheikh *et al.* (2016).**

The calculation of the equitability index (E) across various stations and seasons reveals important insights into the distribution balance of orders. At the Ain Zarga station, E values range from 0.52 to 0.81 throughout the year, indicating a consistent balance in orders distribution across all study period. This suggests that the ecological conditions at Ain Zarga are relatively stable and supportive of an even species distribution.

For Bir El Ater and El Kouif stations, the E values indicate a general balance in orders distribution across most seasons, with rates ranging from 0.54 to 0.76. However, both stations exhibit a slight imbalance during the spring season, marked by an E value of 0.47. This seasonal imbalance could be attributed to specific ecological changes or disturbances that occur during spring, affecting the evenness of species distribution.

The Negrine station presents a more varied pattern. During the summer and autumn seasons, E values of 0.65 and 0.53, respectively, indicate a balanced orders distribution. Conversely, the winter and spring seasons show an imbalance, with lower E values of 0.43 and 0.46, respectively. This variation suggests that Negrine experiences significant seasonal fluctuations in ecological conditions, leading to uneven species distributions during certain times of the year.

The Shannon diversity index (H') provides insights into the species diversity within different stations and seasons. At Bir El Ater, H' values range from 1.51 in spring to 2.35 in autumn, indicating a notable variation in diversity throughout the year. Negrine shows diversity ranging from 1.50 in winter to 2.08 in summer, suggesting relatively consistent diversity with some seasonal variation. El Kouif exhibits diversity ranging from 1.33 in spring to 2.16 in autumn, indicating a similar pattern of seasonal variation as observed in other stationss. Ain Zarga demonstrates diversity values between 1.74 in winter and 2.38 in autumn, showing a higher overall diversity compared to the other stations.

The variation in H' values across stationss and seasons reflects the complex interplay of ecological factors influencing species diversity. Higher diversity values indicate a more diverse and balanced ecosystem, while lower values may suggest environmental stress or habitat disturbance. Understanding these patterns can help in assessing the health and stability of ecosystems and guiding conservation efforts to maintain biodiversity.

The statistical projection the estimated rarefaction of taxa, specifically focusing on insect order richness across various stations and seasons reveals that increasing the number of samples to 100 will not significantly change the number of orders inventoried, except at the Negrine station and during the winter and spring seasons. At Negrine, one additional order is expected, while winter and spring will see increases to almost 14 and 17 orders, respectively, compared to 13 orders in other seasons.

The similarity and dissimilarity calculations between different stations indicate that El Kouif and Ain Zarga have the highest similarity in orders composition, with an 81.8%

similarity according to the Jaccard index. However, they also exhibit the greatest dissimilarity in orders abundance, with 89% dissimilarity according to the Bray-Curtis index. This suggests that while the types of species are similar between these two stations, their abundances vary significantly. Other stations comparisons, such as between Bir El Ater and Negrine or Bir El Ater and El Kouif, show moderate similarity in orders composition (69.2% to 78.6% Jaccard index) and lower dissimilarity in orders abundance (15.1% to 51.5% Bray-Curtis index).

The seasonal comparison reveals that autumn and winter have the highest similarity in orders composition, with a 92.3% similarity according to the Jaccard index. Despite this high similarity, there is a moderate difference in orders abundance between these two seasons, with 52.2% dissimilarity according to the Bray-Curtis index. In contrast, the greatest dissimilarity in orders abundance is between autumn and spring, with a 78.4% Bray-Curtis dissimilarity. Other seasonal comparisons show moderate to high similarity in orders composition (73.3% to 83.3% Jaccard index) and moderate differences in orders abundance (44.5% to 61% Bray-Curtis index), indicating that seasonal changes significantly impact orders abundances.

The significant differences in insect abundance and order richness between stations and seasons, as shown by the ANOVA, highlight the dynamic nature of insect populations in response to environmental variables.

The Correspondence Factor Analysis (CFA) unveils unique insect order distributions among the study stations. Bir El Ater stands out with a prevalence of Hemiptera, Dermaptera, Orthoptera, and Blattodea. Negrine, on the other hand, is notable for its abundance of Odonata, Thysanoptera, and Embioptera. In contrast, El Kouif and Ain Zarga exhibit a distinct profile, featuring Psocoptera, Mantodea, Coleoptera, Lepidoptera, and Neuroptera.

CONCLUSION

This study was carried out with the aim of studying the biodiversity of insects in the wilaya of Tebessa, and this in four stations according to a climatic gradient and during the period from July 2023 to April 2024.

At the end of this work a total of 20,573 individuals belonging to 15 orders were collected.

The results obtained from this work show that the order which was the most present was that of Diptera, followed by the order Hymenoptera, then the order Hemiptera. However, several other orders were rarely present, notably those of Dermaptera and Mantodea.

After the census of the individuals of the insects collected, it emerged that several parameters impact the biodiversity and the dispersion of insects, including: the bioclimatic zone which differs from one station to another, the type of biotope of each station, and the variation of the seasons.

Indeed, the variation of bioclimatic stages and seasons, is often synonymous with the change of several parameters which reign in the environment, in particular the composition, nature, and density of the plant cover, which plays a crucial role in the presence and distribution of insects, due to the fact that certain orders of insects prefer one biotope over another.

Moreover, the analysis of variance for the different ecological descriptors demonstrated that the parameters (seasons, stations, or the seasons*stations interaction) have a significant effect on all of these descriptors.

The results of this study are not definitive results. They should be continued by subsequent research, aimed above all at the identification of the species encountered in these orders, and the inventory of new stations, which could make it possible to deepen the data obtained concerning the biodiversity of insects in the Tebessa region.

Therefore, it would be desirable to increase the number of studies and research which could make it possible to obtain new discoveries concerning the biodiversity of insects in this wilaya.

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ATTACHMENTS

Table. Occurrence of the orders encountered in the different sites

	Sites							
	Bir El Ater		Negrine		El Kouif		Ain Zarga	
Order	**F (%)**	**Class**	**F (%)**	**Class**	**F (%)**	**Class**	**F(%)**	**Class**
Psocoptera	69.23	Constant	40.00	Common	50.00	Constant	38.10	Common
Blattodea	11.54	Accidental	4.00	Accidental	0.00	-	0.00	-
Odonata	0.00	-	4.00	Accidental	0.00	-	0.00	-
Dermaptera	3.85	Accidental	0	-	0.00	-	0.00	-
Orthoptera	53.85	Constant	68.00	Constant	35.00	Common	38.10	Common
Mantodea	0.00	-	0	-	0.00	-	4.76	Accidental
Thysanoptera	11.54	Accidental	36.00	Common	0.00	-	9.52	Accidental
Hemiptera	96.15	Constant	100.00	Constant	80.00	Constant	61.90	Constant
Embioptera	0.00	-	28.00	Common	0.00	-	0.00	-
Hymenoptera	100.00	Constant	100.00	Constant	80.00	Constant	80.95	Constant
Coleoptera	73.08	Constant	80.00	Constant	70.00	Constant	42.86	Common
Lepidoptera	80.77	Constant	92.00	Constant	70.00	Constant	71.43	Constant
Trhichoptera	23.08	Common	56.00	Constant	15.00	Accidental	38.10	Common
Diptera	100.00	Constant	100.00	Constant	95.00	Constant	100.00	Constant
Neuroptera	42.31	Common	88.00	Constant	35.00	Common	47.62	Common

Table. Distribution of the orders encountered in the different sites

	Sites								Total	
	Bir El Ater		Negrine		El Kouif		Ain Zarga			
UTO	**DI**	**FD**	**DI**	**FD**	**DI**	**FD**	**DI**	**FD**	**DI**	**FD**
Psocoptera	3.27	Clumped	6.39	Clumped	1.6	Clumped	1.49	Clumped	3.95	Clumped
Blattodea	0.88	Regular	0.96	Regular	-	-	-	-	0.96	Clumped
Odonata	-	-	1.92	Clumped	-	-	-	-	1.98	Clumped
Dermaptera	0.96	Regular	-	-	-	-	-	-	0.99	Regular
Orthoptera	27.03	Clumped	4.11	Clumped	1.73	Clumped	2.11	Clumped	25.11	Clumped
Mantodea	-	-	-	-	-	-	0.95	Regular	0.99	Regular
Thysanoptera	2.45	Clumped	22.42	Clumped	-	-	0.90	Regular	20.57	Clumped
Hemiptera	33.57	Clumped	79.15	Clumped	4.95	Clumped	28.76	Clumped	90.03	Clumped
Embioptera	-	-	2.24	Clumped	-	-	-	-	2.70	Clumped
Hymenoptera	19.21	Clumped	108.44	Clumped	21.16	Clumped	12.45	Clumped	117.81	Clumped
Coleoptera	2.69	Clumped	18.97	Clumped	2.62	Clumped	4.93	Clumped	15.37	Clumped
Lepidoptera	22.08	Clumped	69.62	Clumped	85.18	Clumped	12.62	Clumped	72.87	Clumped
Trhichoptera	4.64	Clumped	85.24	Clumped	3.18	Clumped	9.19	Clumped	78.33	Clumped
Diptera	35.14	Clumped	203.71	Clumped	16.27	Clumped	53.13	Clumped	303.04	Clumped
Neuroptera	7.56	Clumped	5.88	Clumped	0.65	Regular	1.78	Clumped	6.72	Clumped