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Contribution to the study of entomofauna of the saline wetland of chott of Beida in Algeria

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Abstract
The present study aims at assessing entomofauna biodiversity in the Saline wetlands (Chott) located in the northeast of Algeria in the Setif region. To determine the environmental factors their predominant the distribution of insecta, an inventory was carried out to study the insect diversity and distribution in two stations were selected of Chott of Beida, during November 2014 to September 2015. The selected stations in the study area were divided to six transects according to distribution of plant and according to the soil salinity in each of stations. A total of 4213 insects belonging to 07 orders, 34 families, 57 species were collected from the Chott Beida. The Highest abundance of Coleoptera (49,12%) while lowest abundance of Collembola (05,26%). Highest number of (2520 individuals) found in station 2, while lowest number (1693 individuals) in station2. The Highest abundance of insects (50) were recorded in transect I station 2 and lowest abundance of species were recorded in transect III station 1. Diversity and Equitability indices showed highest values in station 1 (H =2,877; E= 0,7282), Similarly, while highest value at station 2 transect I (H =3,912; M= 12,53). Similarity Jaccard index (J) showed highest similarity was between station1 transect I and station 2 transect I (78,846%).

Keywords: Entomofauna, vegetation, Saline wetlands, soil salinity, Ecological Indices, Chott of Beida.

1. Introduction
Algeria by its unique geographical position, and its varied terrain, and climate. In addition to the various types of natural freshwater wetlands and saline wetlands (Chott and Sabkhas), also contribute to the floral and faunal diversity. Currently 42 out of the 300 lakes in Algeria are listed under the Ramsar Convention covering an area of 3 million ha [1]. The most characteristic type of the Algerian wetlands is endorheic lakes type (seasonal/intermittent) that consists of Sabkha and Chott "saline lakes", The Chotts and Sebkhas are typically seasonal lake which dry out in summer and re-flood in winter [1]. According to [2] Sabkha is the central zone of saline lake dominated by water and devoid of vegetation due to high salt concentrations. The chott is the surrounding zone which forms a vegetation ring around the water. The biodiversity values of the saline wetlands in the Chott Beida have been recognised as being of national and international significance, as demonstrated through their listing by the Ramsar Convention on Wetlands. Due to the outstanding diversity of their plant communities, and their role in conserving the large numbers of animals and migration of water birds that congregate during the dry season and also rare insect species. Insects are the earth's most diverse organisms, accounting for about half of the described species of living things and about three-quarters of all known animals. According to [3] most of the insects are terrestrial; their diversity also includes many species that are aquatic in habit. It can live in almost all ecosystems; swamps, jungles, deserts, due to their highest chance of survival and ability to adapt to changing conditions [4].
Our main goal was to study diversity of insects (species composition, abundance, density of insects) and vegetation cover of some saline wetlands (Chott and Sebkha) in the northeastern Algeria to determine the relationship between insects community structure and environmental factors (some soil factors and plants).

2. Materials and Methods
2.1 Description of the study area
Chott of Beida is located between(longitudes 5° 53' 20" E - 5° 53' 30" E and latitudes 35° 57' 80" N - 35° 54' 20" N) which is located at 20 km southeast of Setif city in northeastern Algeria, the total site area covers 12.223 ha and has an average altitude of 874 to 887 m

(Fig. 1) [5]. is a temporary natural salt lake which is called Sebkha, this Sebkha is a part of Chott of Beida region which is a saline wetland classified in the Ramsar Convention. In terms of the floristic and animal biodiversity, the saline wetland of Chott of Beida is characterized by steppic and halophyte species such as *Artemisia herba alba*, *Bromus madritensis*, *Hordeum murinum*, *Lygeum spartum*, *Juncus maritimus*, *Peganum harmala*, *Atriplex halimus*, *Salsola vermiculata*, *Suaeda fruticosa*, *Lygeum spartum* [1, 5].

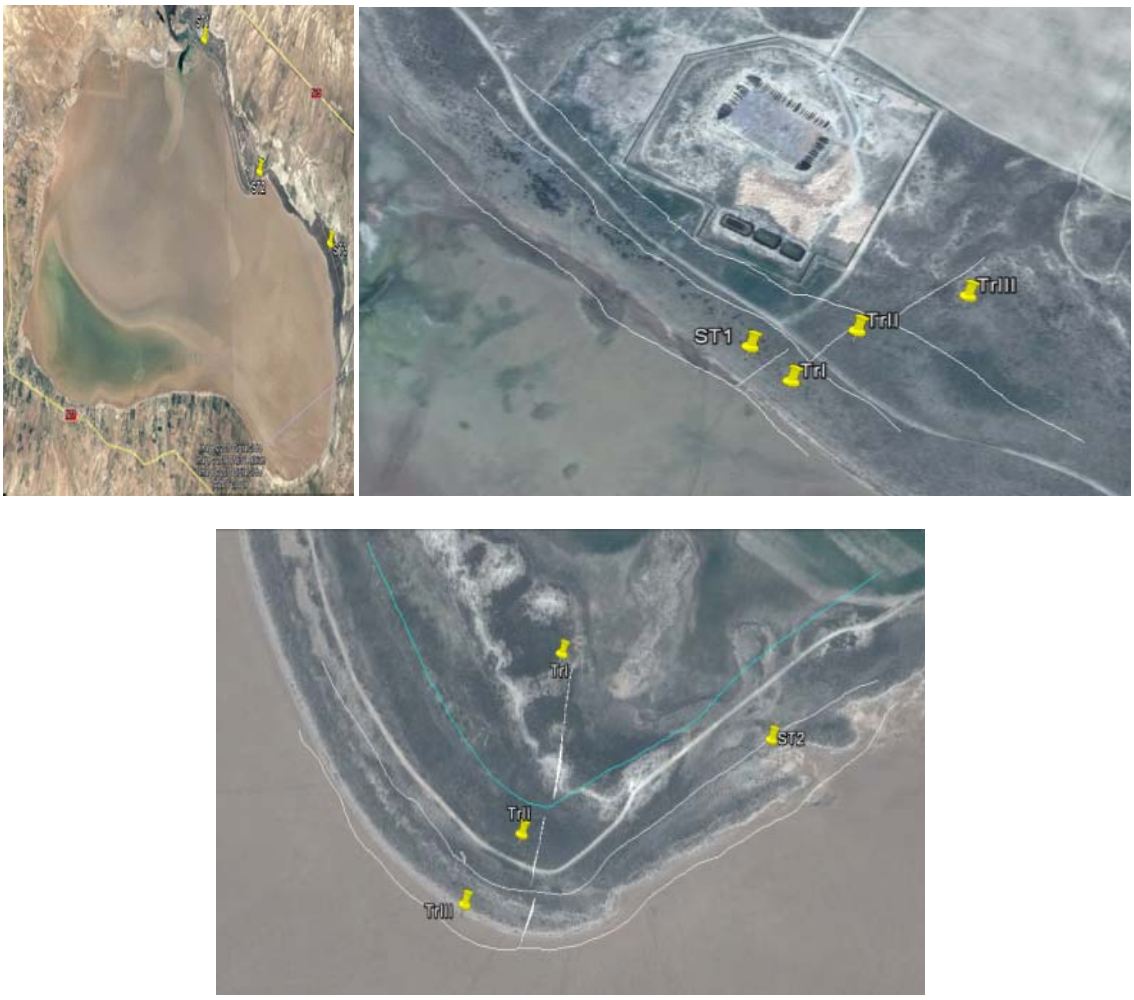

Fig 1: Locations of stations and transects in Chott of Beida of saline wetland in Setif region.

2.2 Sample collection

Insects were collected monthly in the period from November 2014 to September 2015, within halophytic plant belts surrounding directed from the periphery to centre. A total of six Transects representing two stations, with three transects for each station, within an area of 15m². Insects were collected at 9.00 am to 12.00 am local time in 2 week of every month, insects were collected by a insects nets, pitfall trap, hand collection, and sweeping net. The vegetation around each Sabkha or Chott was sampled along 3 transects. After collection were putting in plastic bag and preserved in 70% alcohol, date and time of sampling and place of collection were recorded on each specimens. The insects were indentified using binocular microscope and Identification was done on the basis of morphological characteristic of various body parts: pattern abdomen, wing venation features, wing venation, the genitalia, antennae length, coloration, and, number of stripes etc.

2.3 Statistical analysis

Data were analyzed with the statistical software of Microsoft excel 2010 to count Ecological indices. Another statistic programme was used, Past. Where the results analyses the presence or absence of insects in the stations of the study and comparing how match at transects. In addition, the aim is to know the Specific species richness, Relative abundance, and these making different biological and Ecological indices. Analyses

The number of specie (specie richness or specie S) was measured by counting the number of insects found in the transects, to determine their diversity. Three indices were used to obtain estimation of species diversity, species richness and species evenness. Diversity index values were obtained by using the following equations:

2.3.1 Shannon-Weiner Index

Shannon Weaver diversity index (H) was calculated according to the expression of Shannon-Weaver, (1949):

$H = - \Sigma Pi \ln Pi$

Where:

H = Shannon Wiener index of diversity.

$Pi = S / N$

S = number of species

N = Total number of individuals of all species.

In = logarithm to base e

2.3.2 Evenness index
Evenness index (E) was calculated following the equation of Pielou (1966):
E = H / ln S

2.3.3 Richness index
Richness index (D) was calculated by the equation of Margalef (1968):
D = S-1 / ln N

2.3.4 Jaccard's similarity index
Jaccard's similarity index J was calculated according to Jaccard (1908):
J = (a/ a + b + c) x 100
Where:
a = number of species of Insects present at transects I and II.
b = number of species of Insects present at transects II and not present at transects I.
c = number of species of Insects present at transects I and not found at transects II.

3. Results
3.1 Species Composition
Total of 4213 individuals belonging to 9 orders, 34 families, 51 genera and 57 species were collected from the Chott of Beida. These insects belonging to seven orders: Collembola (2 families), Coleoptera (11 families), Diptera (7 families), Hemiptera (4 families), Hymenoptera (5 families), Lepidoptera (2 families) and Orthoptera (3 families) were collected from November 2014 to September 2015 from two stations of the Chott Beida or sebkha (Fig. 2). Overall species diversity and abundance revealed that insects of the Coleoptera order were most abundant (11 families constituted 32.35% of the total families, 28 species constituted 49,12% of the total species) and Collembola (2 families5.88%, 2 species 4%) least abundant. Among the 34 families of insects, Carabidae and Chrysomelidae represented maximum species (5 species, 09%), followed by the families Cetoniidae, Scarabaeidae and Tenebrionidae both shared 03 species (05%) while the remaining families shared between 01-02 species (Fig. 3 and Fig. 4) and (Table 1).

In terms of the number of individuals, the highest numbers of species were recorded in St2 (2520 individuals), while the lowest numbers of species were recorded in St1 (1693 individuals). During the present study the insects from six different transects were compared, The High number of species were recorded in St2TrI (50 species) while the lowest number of species were recorded in St1TrIII (3 species) (Table 1).

3.2 Abundance
A total of 4213 individuals of insects belonging to 57 species were recorded from different study transects during the study period. St1 supported 55 species with 2520 individuals followed by St1 with 52 species and 1693 individuals. Table 1 presents the relative abundance of different species of insects recorded in different study stations during the present study. *Messor barbarus* (Family: Formicidae) was the most abundant species and constituted 08.85% of the total insects. *Aphaenogaster sp*. (Family: Formicidae) constituted 06,84% of the total insects and was the second most abundant species. Maximum number of individuals of this species was recorded from St2 followed by St1, respectively. On the other hand, *Lixus algirus*, *Halictus sp and Pamphagidae sp* were the less abundant species in the study area (Table 1).

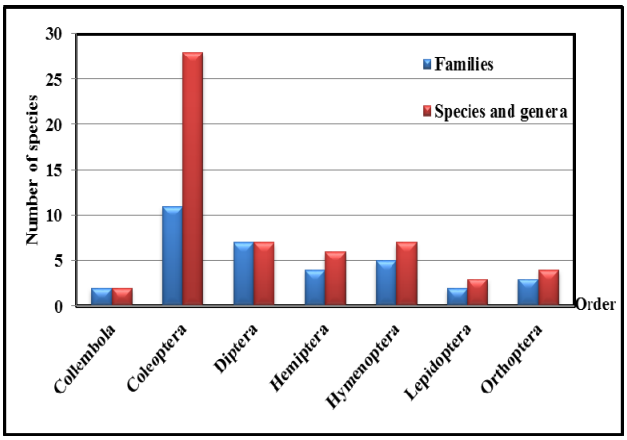

Fig 2: The total number of species and genera and families according to the Order insects.

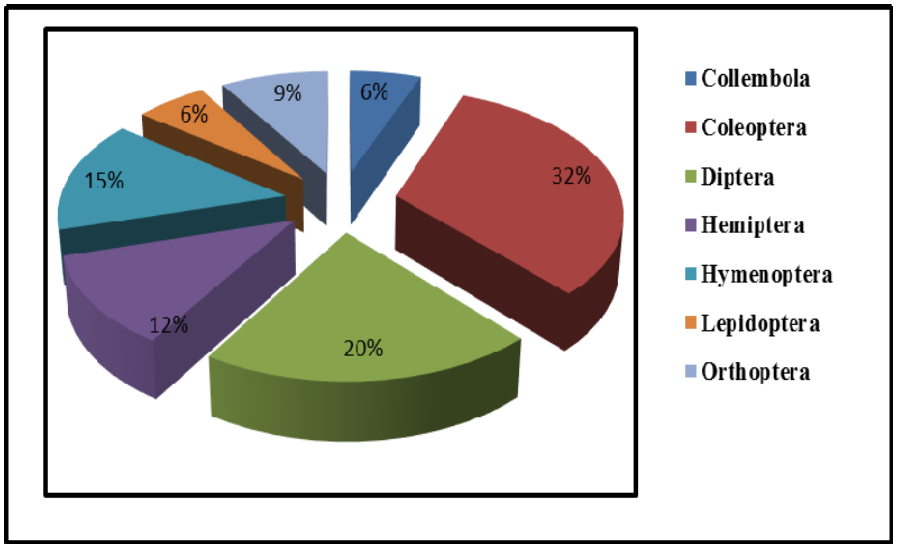

Fig 3: Percentage composition of order of insects in Chott of Beida.

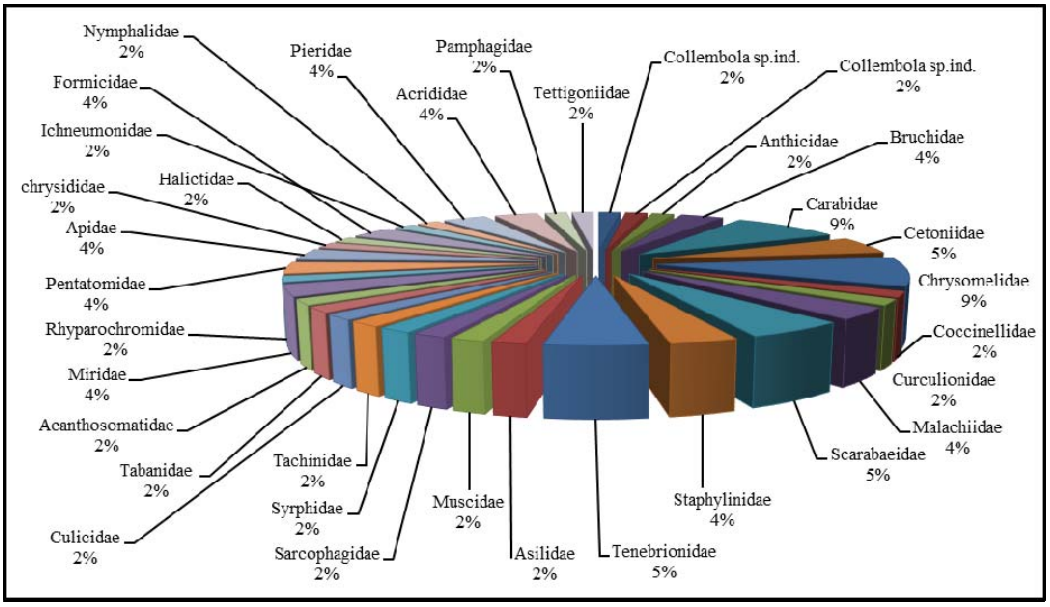

Fig 4: The Relative abundance (%) of insects family were recorded in Chott of Beida.

Table 1: Total insects species number and their groups in different station and transects of Chott of Beida.

			Sites	Chott El Beïdha Hammam Essoukhna							
			Stations	St1			St2				
			Transects	St1TrI	St1TrII	St1TrIII	St2TrI	St2TrII	St2TrIII		
Order	**Families**	**Species and genera**	**Code**							St1	St2
Collembola	Collembola sp.ind.	Collembola sp.ind.	COCOsp1		■			■		15	29
	Collembola sp.ind.	Collembola sp.ind.	COCOsp2		■		■	■		12	23
Coleoptera	Anthicidae	*Anthicus* sp.ind.	COANsp		■					3	0
	Bruchidae	*Bruchus luteicornis* (Illiger, 1794).	COBRLU	■			■	■		17	44
		Bruchus pisorum (Linnaeus, 1758).	COBRPI				■	■		9	21
	Carabidae	*Bembidion* sp1.ind.	COCABsp1			■		■	■	13	39
		Bembidion tetracolum(Linnaeus, 1761).	COCABT			■		■	■	7	28
		Broscus sp.ind.	COCABrsp		■		■	■		2	5
		Calomera lunulata (Fabricius, 1781).	COCALU					■	■	0	9
		Nebria andalusia (Rambur, 1837).	CONEAN		■		■	■		4	7
	Cetoniidae	*Cetonia* sp1.ind.	COCECsp1	■			■	■		29	34
		Cetonia sp2.ind.	COCECsp2	■			■	■		6	6
		Tropinota hirta (Poda, 1761).	COTRHI	■	■		■	■		14	25
	Chrysomelidae	*Chaetocnema aridula* (Gyllenhal, 1827).	COCHAR	■	■		■	■		23	34
		Labidostomis taxicornis (Fabricius 1792)	COLATA	■	■		■	■		113	267
		Lachnaia pubescens (Dufour, 1820).	COLAPU	■			■			78	93
		*Longitarsus absynthii (*Kutschera, 1862).	COLO SP1		■		■	■		11	23
		Longitarsus pellucidus (Foudras, 1860).	COLO SP2		■		■	■		5	14
	Coccinellidae	*Coccinella septempunctata algerica* (Kovar, 1977).	COCOSP	■	■		■	■		89	67
	Curculionidae	*Lixus algirus*(Fabricius, 1801).	COCULA	■			■	■		1	5
	Malachiidae	*Cordylepherus viridis* (Fabricius, 1787).	COMACV	■	■		■			122	301
		Malachius bipustulatus (Linnaeus, 1758).	COMAMB	■	■		■			91	245
	Scarabaeidae	*Aethiessa floralis* (Fabricius, 1787).	COSC1F	■	■		■	■		8	4
		Bubas bison(Linnaeus, 1767).	COSCBB	■	■		■	■		2	2
		Tropinota squalida (Scopoli, 1763).	COSCTS	■	■		■	■		11	9
	Staphylinidae	*Bledius tricornis* (Herbst, 1784).	COSTBT	■	■		■	■		7	5
		Ocypus olens (Müller, 1764).	COOCOL	■			■			3	5
	Tenebrionidae	*Blaps* sp.ind.	COBL SP	■	■		■	■		3	2
		*Pimelia interstitialis (*Solier, 1836).	COPIIN	■			■			6	9
		Pimelia grandis (Klug, 1830).	COPIGR	■			■			3	7
Diptera	Asilidae	*Asilus*sp.ind.	DIASAsp	■	■		■	■		9	4
	Muscidae	*Musca domestica* (Linnaeus, 1758).	DIMUMD	■	■		■	■		134	91
	Sarcophagidae	*Sarcophaga carnaria* (Linnaeus, 1758).	DISASA	■	■		■	■		77	13
	Syrphidae	*Syrphus* sp.ind.	DISYSsp	■				■		2	6
	Tachinidae	*Tlephusa* sp.ind.	DITATsp	■			■			5	2
	Culicidae	*Culex pipiens* (Linnaeus, 1758).	DICUCP	■	■		■	■		133	48
	Tabanidae	Tabanidae sp.ind.	DITATasp	■	■		■	■		6	4
Hemiptera	Acanthosomatidae	Acanthosomatidae sp.ind.	HEACsp	■			■			3	5
	Miridae	*Campyloneura sp.ind.*	HEMICsp	■			■			11	21
		Lygus sp.ind.	HEMILsp	■			■	■		7	10
	Rhyparochromidae	*Pachybrachius luridus* (Hahn, 182).	HERHPL				■	■		0	12
	Pentatomidae	*Graphosoma italicum* (Linnaeus, 1758).	HEPEGI	■			■	■		11	19
		Carpocoris purpureipennis (De Geer, 1773).	HEPECP	■			■			3	8

Hymenoptera	Apidae	*Apis* sp.ind.	HYAPPM							3	4
		Apidae sp.ind.	HYAPAsp							0	7
	chrysididae	*chrysididae* sp.ind.	HYCHCsp							0	4
	Halictidae	*Halictus* sp.ind.	HYHAHsp							0	1
	Formicidae	*Aphaenogaster* sp.ind.	HYFOAsp							221	376
		Messor barbarus (Linnaeus, 1767).	HYFOMB							332	487
	Ichneumonidae	Ichneumonidae sp.ind.	HYICIsp							4	7
Lepidoptera	Nymphalidae	*Vanessa cardui* (Linnaeus, 1758).	LENYVC							4	9
	Pieridae	*Pieris rapae* (Linnaeus, 1758).	LEPIPR							6	8
		Pieris brassicae (Linnaeus, 1758).	LEPIPB							5	4
Orthoptera	Acrididae	*Dociostaurus maroccanus*(Thunberg, 1815).	ORACDM							2	3
		Locusta migratoria(Linné, 1767).	ORACLM							5	2
	Pamphagidae	Pamphagidae sp.ind.	ORPAsp							1	0
	Tettigoniidae	Tettigoniidae sp.ind.	ORTEsp							2	3
7	34	57	57	**57**	**57**	**57**	**57**	**57**	**57**	1693	2520
				43	30	3	50	40	7	4213	

Biological Indices

During the present study the insects diversity between six of different transect were compared and Shannon-Wiener diversity indexes, Equitability index, Simpson index and Margalef index were calculated as a measure of diversity within the stations and transects.

Stations level

The highest diversity index (H =2,877) observed at St1, the lowest diversity index was found at St2 (H =2,814), similarly, the St2 showed a low value of Simpson index (D-1 = 0,8998) as compared to St1 (D-1 =0,9113), in the other hand the St2 showed high species richness which is indicated by high value of Margalef index (M = 6,895) compared to St1, the highest value of the index Equitability (E= 0,7282) at St1, while reached the lowest value at St2 (E= 0,7022) (Table 2).

Table 2: The different dominance and diversity indices (Shannon-Weiner index, Margalef's diversity index and Evenness index, Equitability), abundance and number of Insects species in the two study stations.

Index	Station 1	Station 2
Taxa_S	52	55
Individuals	1693	2520
Dominance_D	0,08869	0,1002
Simpson_1-D	0,9113	0,8998
Shannon_H	2,877	2,814
Margalef_M	6,86	6,895
Equitability_J	0,7282	0,7022

Stations and transects level

Lowest value of Shannon-Wiener diversity (H =1,099) and Simpson index (D-1 = 0,6667) and Margalef index (M = 1,82) were recorded at St1Tr III, while highest value at St2TrI. (Table3).

Table 3: Jaccard similarity index of insect's communities recorded in the different stations and transects.

Index	St1TrI	St1TrII	St1TrIII	St2TrI	St2TrII	St2TrIII
Dominance_D	0,02326	0,03333	0,3333	0,02	0,025	0,1429
Simpson_1-D	0,9767	0,9667	0,6667	0,98	0,975	0,8571
Shannon_H	3,761	3,401	1,099	3,912	3,689	1,946
Margalef_M	11,17	8,526	1,82	12,53	10,57	3,083

Similarity Jaccard index

Results showed similarities in the presence of the species between the six transects studied using Jaccard similarity index. However, highest similarity (78,846%) was observed between St1TrI and St2TrI, while lowest similarity (1,921%) was shown between St1TrIII and St2TrI (Table 4).

Table 4: The percentages for degree of similarity among species by using similarity Jaccard index according to presence or absence insect's species in the different transects of two stations.

Jaccard index	St1TrI	St1TrII	St1TrIII	St2TrI	St2TrII	St2TrIII
St1TrI	1	0,46	0,022222	0,78846	0,53704	0,086957
St1TrII	0,46	1	0,03125	0,53846	0,55556	0,12121
St1TrIII	0,022222	0,03125	1	0,019231	0,075	0,42857
St2TrI	0,78846	0,53846	0,019231	1	0,63636	0,075472
St2TrII	0,53704	0,55556	0,075	0,63636	1	0,175
St2TrIII	0,086957	0,12121	0,42857	0,075472	0,175	1

Cluster analysis for similarity degree of composition qualitative of insects among different study transects and station showed two different main groups (Fig.5).

The first main group (I) include three of subgroups, the first subgroup formed of St1TrI and St2TrI at the level of similarity (78,846%) and the second subgroup had only St2Tr II (58%), While the third subgroup included St1TrII only when the level of similarity of 50 %. Whilst the second main group (II), also included St1TrIII and St2TrIII at the level of similarity (43 %) (Fig.5).

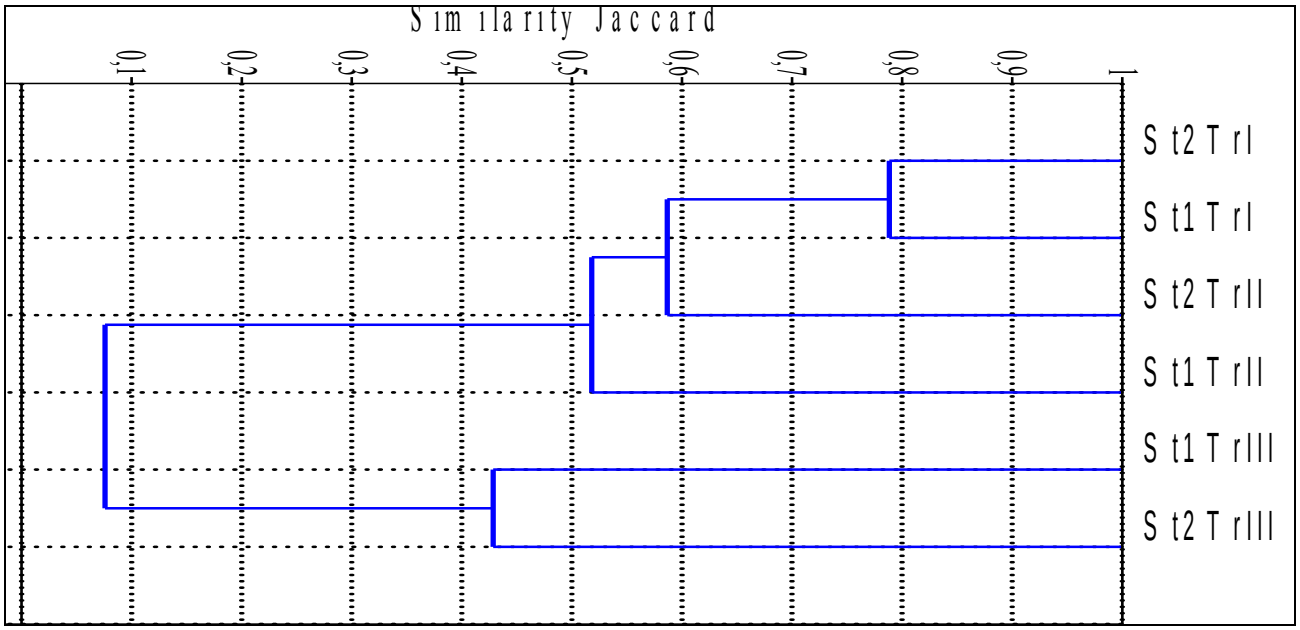

Fig 5: Dendrogram showing the similarity between stations and transects by using Jaccard's Index of Similarity.

4. Discussion

Species composition

The study was carried in Chott of Beida. The place of study let as to count 57 species of the total number of all species from of insects distributed on 07 orders and 34 families. These results agree with many researchers in saline wetlands among which the study carried [6] also study [7].

The present results indicate that there were differences in the species richness and abundance of insects among the two stations and six transects, station 2 and transect I apparently is the richest. This is probably due to the presence of plant species richness and abundance of insects varied across vegetation gradient and soil salinity. Low soil salinity and high plant cover (TrI) supported higher number of species and individuals followed by low number of species and individuals decreased with increasing vegetation is very poor and low soil salinity (TrII) and high soil salinity and vegetation is very rare (TrIII), respectively. It is suggested that the number of species and individuals of insects found at the higher soil salinity and vegetation is very rare is much lower compared to at lower low soil salinity and high plant cover.

The Coleoptera order in the present study was dominated by the families Chrysomelidae and Carabidae which comprises 09 % of the total species, also recorded similar findings. In the present study [7-9].

Our results showed that some species of Hymenoptera and Coleoptera, Diptera and Lepidoptera such *as Messor barbarus, Aphaenogaster sp, Vanessa cardui, Pieris rapae, Pieris brassicae, Culex pipiens, Coccinella septempunctata algerica* and *Tropinota hirta* were recorded in different transects. According to [10-14]. Hymenoptera and Coleoptera and Diptera is reported as ecologically tolerant and has an extensive geographical range and in all types of environments, whereas those species of insects which were rare in abundance at transect III such as *Halictus sp*, chrysididae sp (Hymenoptera), Pamphagidae sp (Orthoptera) and *Anthicus sp* (Coleoptera). May have narrow range of tolerance to these environmental conditions, especially higher soil salinity and low vegetation [15, 16].

Diversity indices

The results of biological indices showed different values among stations and transects and species richness. The highest number of species and Margalef index were observed at St2 and St2TrI and St1TrI, compared to St1TrIII (Table 2 and Table 3). While highest values of Simpson, Shannon and equitability were observed at St1 and St2TrI, compared to St1TrIII. diversity and richness recorded at St2TrI (Table 2 and Table 3). Might be due to environmental factors, such as availability of plants, which play a vital role in insects diversity and distribution, indicating the dominance of some insects species like *Messor barbarus, Aphaenogaster sp, Cordylepherus viridis, Malachius bipustulatus* and *Labidostomis taxicornis*. While the low species richness recorded in St1 might be due to anthropogenic factors and overgrazing [17]. And pollution discharge which in turn affected the distribution of insects. And low insects density recorded at TrIII was apparently due to the effect of high soil salinity or low soil organic matter and the vegetation is very poor and rare or it can be explained also by unfavourable conditions due to predation by water birds.

Jaccard similarity index

The jaccard similarity index showed that St1TrI and St2TrI were strongly similar (78,846%) (Table 4). This index revealed that there was a minimum similarity between transects and the two stations.

This observation might be due to the low species richness in this station. In the other hand, the insect species identified in the others stations had high similarity. This similarity may go back to the similarity of climatic. Circumstances or to the nature of plant cover and its density, type of soil or to other factors.

The observed dissimilarity in presence of insects species between TrI and TrIII could be due to variability in soil salinity characteristic and vegetation type (Halophytes).

The results of cluster analysis in this study show two major groupings, mainly segregated by stations and transects.

St1TrI and St2TrI clustered together. The increased abundance of insects, species richness and diversity observed

in St1TrI and St2TrI could be due to the presence of vegetation cover [1].

St1TrIII and St2TrIII clustered together based on low abundance and diversity, perhaps due to the vegetation is very poor and high salt content and low soil organic [15, 16].

5. Conclusions

This study provides insights into the effects of a range of environmental parameters on insects of Chott of Beida in Algeria. Altogether 57 species of insects, belonging to 34 families, were identified at the two stations and six transects.

Our results documented differences in insects diversity and abundance between stations and transects.

Transect I and station 2 was characterized by low salinity and vegetation and relatively high abundance species, richness and species diversity. Stations 1 and transect III high salinity and lower vegetation, with relatively low species diversity. We consider that salinity and vegetation cover may be responsible for this density of insects. According to [18] soil community diversity affects plant diversity which, in turn affects insect diversity.

This study offers new information for insects diversity over study in Chott of Beida and provides important knowledge for better understanding of Saline wetlands in the Algeria.

The information gathered from this study will hopefully help for further study by researchers, students and officers (Forest Conservation, Setif) who have given responsibility in conservation of flora and fauna, especially the flora in Chott of Beida of Forest Conservation Hammam Sokhna, Setif.

6. References

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