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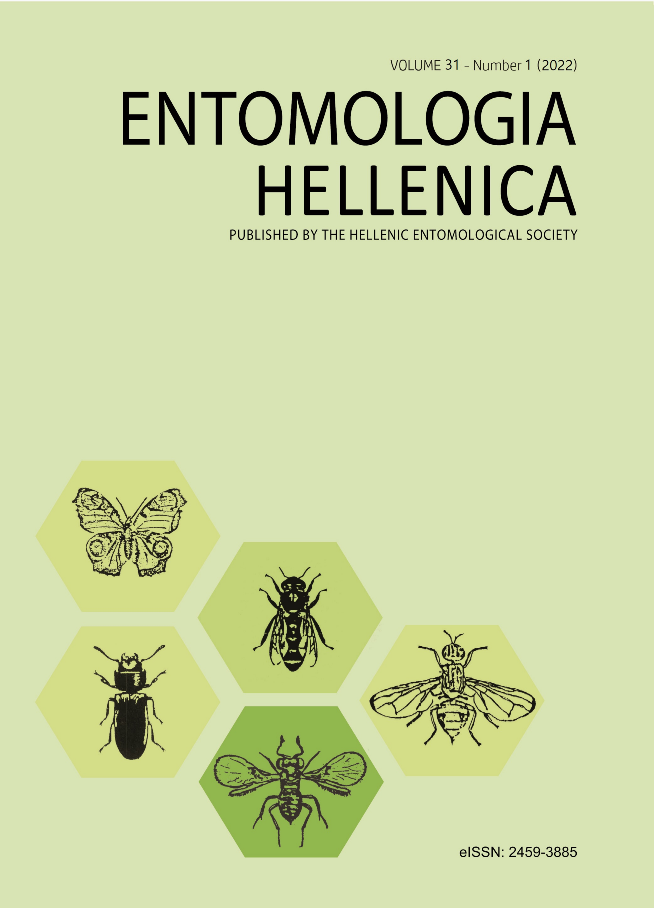

Steppe Habitats' Entomofauna At Ouled Djellel-Algeria: Statistical Analysis

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Steppe Habitats' Entomofauna At Ouled Djellal-Algeria

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ABSTRACT

Statistical analysis was performed on the data obtained from a study carried out on 97 species classified into 8 orders of 44 families belonging to the Insecta class, collected from the Ouled Djellal steppe ecosystem. By using the Principal Component Analysis (PCA) and the Ascendant Hierarchical Classification (AHC) of the XLSTAT software (2016 v. 3.1), we obtained a highest cumulative inertia (25.44%) explained by axis F1, represented by winter months (December, January, February) and summer months (June and July) and correlated with 31 species from a total of 97. In addition, more than eight (8) groups were obtained from the simultaneous representation of months and insect species. Using the AHC, four groups were validated, with a high indication for the second that groups 48 species, among which were *Dicranocephalus Albipes* (Fabricius, 1781), *Polistes gallicus* (Linnaeus, 1767), *Papilio saharae* (Oberthür, 1879), *Broscus cephalotes* (Linnaeus 1758) and *Sphaerophoria scripta* (Linnaeus, 1758), belonging to different orders.

KEY WORDS: Ouled Djellal, steppe, insects, ecosystem, Ziban.

Introduction

In the alarming context of global warming (Fontier *et al.*, 2008) and destruction of natural habitats (Belhamra *et al.*, 2020), a spectacular increase in the oasis and a decline of the natural steppe areas (from 20 million hectares in 1970 to 600 thousand) was observed during the last years (Le Houerou, 1985; Aidoud, 1989; Kadi-Hanifi, 1998, Aouissi *et al.*, 2021). The soil constitutes an essential element of biotopes, and its chemical and biological composition has an influence on the distribution of plants and animals. Steppes that are clearly distinct from the surrounding desert environments and marked by poor soils, limited natural resources and discontinuous plant formations (Halitim, 1988; El Zerey *et al.*, 2009), are also significant and play an important role in fixing dunes and maintaining a wild animal life (Schhiffers, 1971; Deghiche-Diab *et al.*, 2016).

Resulting from the new agrarian dynamics during the latest years, aggravated by increasing pressure on the natural resources - by the spread of invasive species and pollution - hampered by the lack of knowledge on the distribution, function, taxonomy and ecology of insect species. A few studies have evaluated the status of certain insect groups (Fontier *et al.*, 2008) in natural ecosystems. In the Algerian steppe and with the change of the modality of land use, questions are raised about the possible impact on the biological diversity in the natural habitats in Ouled Djellal region.

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Therefore, our study has as main objective the focus on the effect of habitat on the distribution of species according to the conditions of natural steppe habitats.

Materials and Methods

Study area and sampling sites: Established in 2019 and formalized in 2021, Ouled Djellal is a province (wilaya) located in the Algerian Sahara covering an area of 131,220 km². It is delimited to the north by the M'sila province, to the east by the Biskra and El M'Ghair provinces, to the west by the Djelfa province and to the south by the Ouargla province.

For collecting information about the effect of soil composition on the distribution of insect species, a survey was carried out at the steppe habitats (Fig. 1). We chose three (3) plots for our study (34 ° 32'05.12 "N5 ° 5 ° 04'08.54" E raised to 213 m). They were represented by the bushy steppe of *Haloxylon articulatum* in association with *Astragalus armatus* in the highly degraded facies (Farhi, 2014, Deghiche-Diab, 2019) that occupy vast areas (Ras El Mied, Basbes, Ouled Djellal, El Ghrous and Doucen) and represent a transition between the steppe sagebrush and that of Alfa (Deghiche-Diab and Deghiche, 2016).

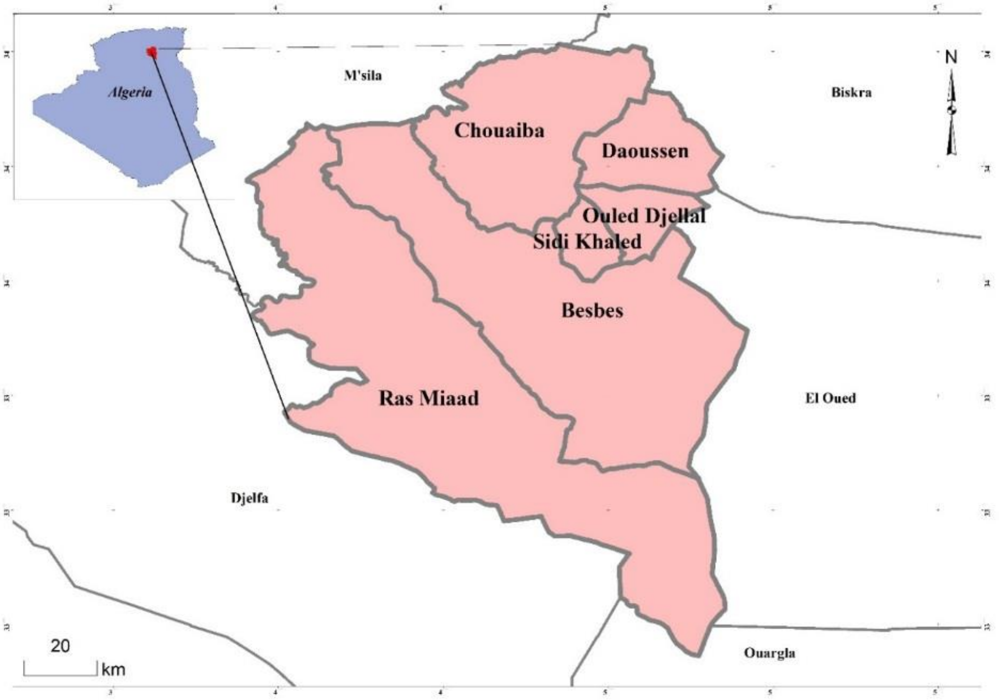

FIG. 1: Location of the study area

Sampling methods and identification: In order to collect insects in the selected habitat, a passive technique that does not exert any action of attraction and collects only insects that move on the surface of the ground or those in flight (Roume, 2001) was chosen. Pitfall traps are the most widely used sampling means to collect insects (Hertz, 1927; Barber, 1931; Benkhelil, 1990, Deghiche-Diab, 2009), so three (3) transparent cylindrical pots, 15cm deep and 20cm wide were 2/3 filled with water containing a detergent were and installed in three plots chosen within an area of 1 ha (Fig. 3) with a distance of 3-5m between pots and 10-30m between plots (Fig. 2).

Insects were captured and collected 4 times / month, then transferred to tubes containing 75% alcohol to be identified using appropriate keys (Chopard, 1943; Villiers, 1946; Blackman et Eastop, 1994; Blackman et Eastop, 2000) and guides (Chinery, 1993; Didier et Guyot, 2011; Saharaoui *et al*, 2014-2017; Hampt and Hampt, 1998; La Planches and Gorge, 2008; Brague-Bouragba, 2010; Dozière *et al.*, 2017).

Data treatment: The obtained results of sampling insect species from the steppe ecosystem between 2018 and 2019 were treated using a statistical processing with XLSTAT sofware (2016.V.3.1).

Principal Component Analysis (PCA)

Principal Component Analysis (PCA) is one of the most widely used multivariate data analysis methods. It is a factorial dimension reduction technique when studying **p** quantitative variables, it makes better plane representations of individuals and variables (Dufour and Lobry, 2010; Rakotomalala, 2015). Its objective is to represent in a simplified graphical form, the maximum information of the data and the variables (variables in reduced number contained in a table of quantitative data) resulting from a sampling procedure (Rakotomalala, 2015). This reduction in the number of variables causes a loss of information; PCA makes certain that this loss is as low as possible (Legendre and Legendre, 1998).

Also, PCA provides both optimal visualization of variables and data, and biplots mixing the two (Champely, 2005). These representations are reliable only if the sum of the percentages of variability associated with the axes of the representation space is sufficiently high. If the percentage is low, it is advisable to make representations on several pairs of axes, to consolidate the interpretation made on the first two factorial axes.

Interpretation of graphs

The graphical representation of the variables in the k-factor space makes it possible to visually interpret the correlations between the variables on the one hand, and between the variables and the factors on the other. Observations and variables are represented as two distant points in k-dimensional space, but which may appear close to a 2-dimensional space depending on the direction used for the projection. We may consider that the cosine as an indicator of the proximity of a point to an axis in a plane, the closest to 1. The squared cosines are displayed in the results proposed by XLSTAT, to avoid any misinterpretation. It is interesting to study the relative contribution expressed in percentage or in proportion of the different variables to the construction of each of the factorial axes (XLSTAT).

Ascending Hierarchical Classification (AHC)

The Ascending Hierarchical Classification (AHC) consists of gradually aggregating individuals according to their resemblance, it produces a series of nested partitions of the set of objects to be classified, measured using an index of similarity or dis-similarity (a measure of distance). The AHC produces a binary classification tree (dendrogram), the root of which corresponds to the class by grouping together all the individuals.

Results and Discussion

For an assessment of 45 samples during a study period that extended from September 2018 to August 2019, the entomo-faunistic composition led to a collection of 97 species unequally classified into 44 families of 8 orders as represented in Table 1.

TABLE 1. Collected insect species in steppe habitat during the study period

Order	**Family**	**Species**	**Code**
Coleoptera	Tenebrionidae	*Erodius emondi* ssp. *laevis* (Solier, 1834)	Co01
		Akis lusitanica (Solier, 1836)	Co02
		Pimelia sp.	Co03
		Pimelia payraudi (Latreille, 1829)	Co04
		Stenocara sp.	Co05
		Blaps gigas (Linnaeus, 1767)	Co06
	Curculionidae	Curculionidae	Co08
		Lixus angustatus (Fabricius, 1775)	Co09
		Larinus sp.	Co10
	Meloidae	Meloidae	Co11
		**Mylabris* sp.	Co12
	Coccinellidae	*Hippodamia variegata* (Goeze, 1777)	Co13
		Coccinella septempunctata (Linné, 1758)	Co14
	Brachyceridae	*Brachycerus algirus* (Olivier, 1790)	Co15
		Brachycerus undatus (Fabricius, 1798)	Co16
	Buprestidae	*Anthaxia nitidula* (Linné, 1758)	Co17
	Carabidae	*Graphipterus serrator* (Forskal, 1775)	Co18
		Anthia sexmaculata (Fabricius, 1787)	Co19
		Anthia duodecimguttatum (Bonelli, 1813)	Co20

		Brachinus explodens (Duftschmid, 1812)	Co21
		Lophyra flexuosa (Fabricius, 1787)	Co22
		Calosoma inquisitor (Linné, 1758)	Co23
		Chlaenius decipiens (L.Dufour, 1820)	Co24
		Timarcha sp.	Co25
		Broscus cephalotes (Linnaeus 1758)	Co26
		Chlaenius (*Trichochlaenius*) *chrysocephalus* (Rossi, 1790)	Co27
		Brachinus sp.	Co28
		Calathus sp.	Co29
	Geotrupidae	*Geotrupes intermedius* (Casta, 1827)	Co30
	Scarabaeidae	*Scarabaeus sacer* (Linné, 1758)	Co31
		Rhizotrogus pallidipennis (Blanchard, 1850)	Co32
		Ochadeus gigas (Merseul, 1913)	Co33
		Theroctes rugatulus (Jekel,1865)	Co34
	Staphylinidae	*Othius* sp.	Co35
	Elateridae	Elateridea	Co36
Lepidoptera	Papilionidae	*Papilio saharae* (Oberthür, 1879)	Le01
	Nymphalidae	*Venessa cardui* (Linné, 1758)	Le02
		Danaus chrysippus (Linné, 1758)	Le03
		Venessa cardui (Linné, 1758)	Le04
	Lycaenidae	Lycaenidae	Le04*
		Plebejus argyrognomon (Bergsträsser, 1779)	Le05

	Pieridae	*Pieris rapae* (Linné, 1758)	Le06
		Pieris brassicae (Linné, 1758)	Le07
		Colias crocea (Fourcroy, 1785)	Le08
	Pterophoridae	*Emmelina monodactyla* (Linné, 1758)	Le09
	Arctiidae	*Utetheisa pulchella* (Linnaeus, 1758)	Le10
Hymenoptera	Apoidae	**Xylocopa violacea* (Linné, 1758)	Hy01
	Formicidae	*Tetramorium biskrensis kahenae* (Menozzi 1934)	Hy02
		Tapinoma sp.	Hy03
		Messor capitatus (Latreille, 1798)	Hy04
		Messor barbara (Linné, 1767)	Hy05
		Tapinoma nigerrimum (Nylander, 1856)	Hy06
		**Cataglyphis bicolor* (Fabricius, 1793)	Hy07
		Cataglyphis bombycinus ((Roger, 1859))	Hy08
		Camponotus aethiops (Latreille, 1798)	Hy09
		Camponotus forelli (Emery, 1881)	Hy10
		Monomorium subopacum (Smith, F., 1858)	Hy11
	Vespidae	*Polistes dominula* (Christ, 1791)	Hy12
		**Polistes gallicus* (Linnaeus, 1767)	Hy13
	Scolitidae	*Megascolia maculata* (Drury, 1773)	Hy14
	Colletidae	*Hylaeus affinis* (Smith, 1853)	Hy15
	Andrenidae	*Andrena* sp.	Hy16
	Pompilidae	*Cryptocheilus notatus* (Rossius, 1792)	Hy17

		Arachnospila sp.	Hy18
	Ichneumonidae	*Ophion luteus* (Linnaeus, 1758)	Hy19
	Halictidae	*Stelis punctulatissima* (Kirby, 1802)	Hy20
		Dufourea sp.	Hy21
	Tenthredinidae	Tenthredinidae	Hy22
Orthoptera	Gryllidae	*Gryllus campestris* (Linnaeus, 1758)	Or01
	Gryllotalpidae	*Gryllotalpa gryllotalpa* (Linnaeus, 1758)	Or02
	Acrididae	*Sphingonotus rubescens* (Walker, 1870)	Or03
		Chorthippus biguttulus (Linné, 1758).	Or04
		Melanoplus bivittatus (Say, 1825)	Or05
		Acrida pellucida algeriana (Dirsh, 1949)	Or06
		Duroniella lucasi (Bolivar, 1881)	Or07
		Locusta migratoria (Linné, 1758)	Or08
Hemiptera	Pentatomidae	*Codophila varia* (Fabricius, 1787)	He01
		Graphosoma italicum (Müller,1766)	He02
		Ancyrosoma leucogrammes (Gmelin, 1790)	He03
	Aphididae	*Aphis craccivora* (Koch, 18541)	He04
		Rhopalosiphum maidis (Fitch, 1856)	He05
		Myzus persicae (Sulzer, 1776)	He06
	Stenocephalidae	*Dicranocephalus albipes* (Fabricius, 1781)	He07
	Nabidae	*Himacerus* sp. (1)	He08
		Himacerus sp. (2)	He09

	Psyllidae	*Cacopsylla* sp.	He10
	Thripidae	*Odontothrips loti* (Haliday, 1852)	Th01
		Odontothrips confusus (Priesner, 1926)	Th02
Thysanoptera	Aeolothripidae	*Aeolothrips intermedius* (Bagnall, 1934)	Th03
	Phlaeothripidae	*Liothrips vaneeckei* (Priesner, 1920)	Th04
	Syrphidae	*Sphaerophoria scripta* (Linnaeus, 1758).	Di01
Diptera	Muscidae	*Musca domestica* (Linné, 1758)	Di02
	Bombyliidae	*Systoechus vulgaris* (Loew, 1863)	Di03
	Myrmeleontidae	*Myrmeleon formicarius* (Linné, 1767)	Ne01
Neuroptera	Chrysopidae	**Chrysoperla oculata* (Say, 1839)	Ne02
	Osmylidae	*Osmylus fulvicephalus* (Scopoli, 1763)	Ne03
8	**44**	**97**	

Co: Coleoptera, Le: Lepidoptera, Hy: Hymenoptera, Or: Orthoptera, He: Hemiptera, Th: Thysanoptera, Di: Diptera, Ne: Neuroptera(*) Protected species in Algeria

TABLE 2. Eigenvalues of species present in the steppe habitat At Ouled Djellal-Algeria

Axes	**F1**	**F2**	**F3**	**F4**	**F5**
The eigenvalues	24,167	17,298	11,906	10,420	8,211
Variability (%)	25,439	18,208	12,533	10,968	8,643
% cumulated	**25,439**	**43,647**	**56,180**	**67,148**	**75,792**

An unequal distribution of species was observed in the steppe habitat where the most abundant species belonged to Hymenoptera: *Tetramorium biskrensis kahenae* (15.89%) and Coleoptera: *Erodius emondi* (7%), *Hippodamia variegata* (5.19%), *Coccinella septempunctata* (5.84%) and *Anthaxia nitidula* (4.36%). Among the above 97 species, 11 were constant, 20 accessory species and 32 accidental and classified as sporadic, from which 17 species were rare.

The eigenvalues

The eigenvalues obtained for the species of the steppe habitat are mentioned in Table 2. The obtained results lead us to select the 5 axes, which retain more than 75% of the total inertia and which allow interpretation of all data.

Contribution of observations (months) to the formation of axis

To determine the observations (months) that contribute the most to the factors of the steppe habitat, we use the square cosine. Each of the points on the plane of the factorial map presents indications on the values corresponding to each of the observations. The highest cosine squared values are the most indicative (contributory).

The interpretation of the factorial axis was done sequentially, for each axis and each cloud of points, by looking at the contributions to the formation of the axes. The variables that contribute the most to the formation of the axis are those whose coordinates on this axis are close to 1 in absolute value (XLSTAT).

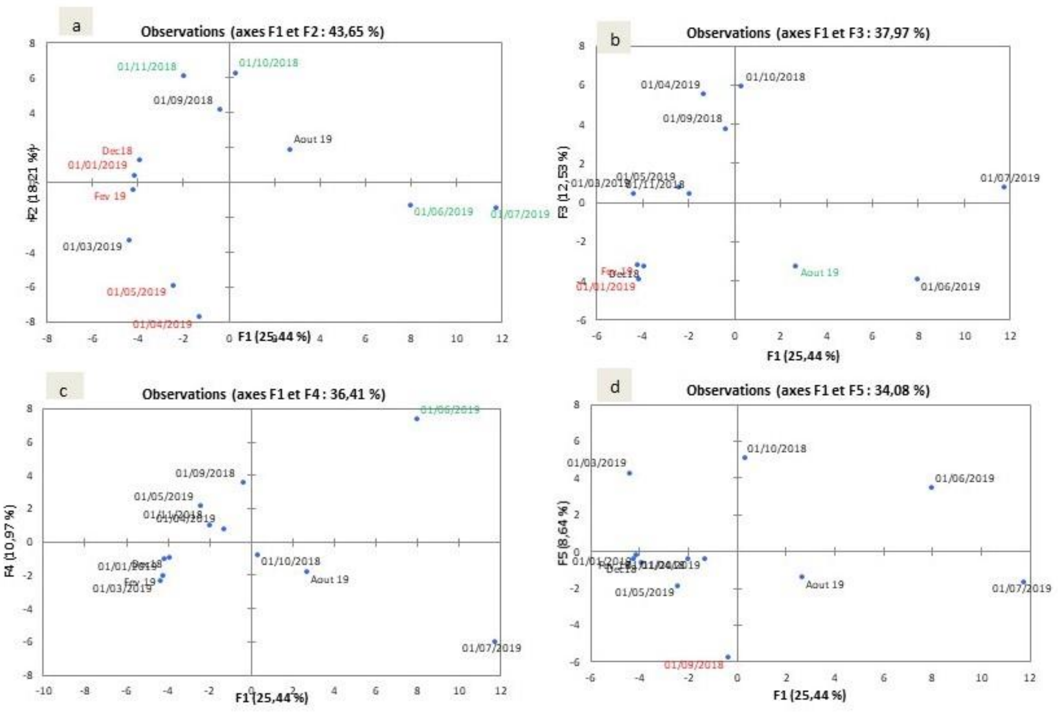

FIG.2: Representation of observations (months) on PCA factorial plan

From Figure 2a**,** axis F1 explains 25.44% of the total information we noticed from the contribution of December, January and February to the formation of this axis opposed to June and July which are in the positive part of the same axis. For the F2 axis that explains 18.21% of the overall information with the contribution of October and November in the positive part, whereas April and May also contribute to the formation of the F2 axis but are presented in the negative side of the same axis. The axis F3 explains 12.53% (Figure 2b) of the overall information, where we observe the contribution of January, February, and August to the formation of this axis. In distinction from January and February, August contributes to the formation of axis, in the positive side. The F4 axis explains 10.97% of the overall information of the total sample with the highest contribution of June (Figure 2c) in the positive side. On the other hand, F5 axis explains only 8.64% of the overall information of the sample (Figure 2d) where we notice the presence of September in the negative side of the axis.

Contribution of variables to the formation of axes

The obtained figures from processing the results from the insects collected at the steppe habitat using PCA of the XLSTAT program (v.2016.3.1) are reported below.

In figure 3a, 31 different species, including *Brachycerus undatus, Geotrupes intermedius, Pieris brassicae, Emmelina monodactyla*, *Camponotus aethiops* and *Chorthippus biguttulus* contribute to the formation of F1 axis that explains 25.44% of the overall information of our sample. In addition, 24 species, including *Pimelia payraudi*, *Blaps gigas, Brachycerus algirus, Lophyra flexuosa, Broscus cephalote, Plebejus argyrognomon, Cataglyphis bicolor, Gryllus campestris, Gryllotalpa gryllotalpa*, *Aphis craccivora, Chrysoperla oculate* and *Musca domestica* contribute to the formation of F2 axis that

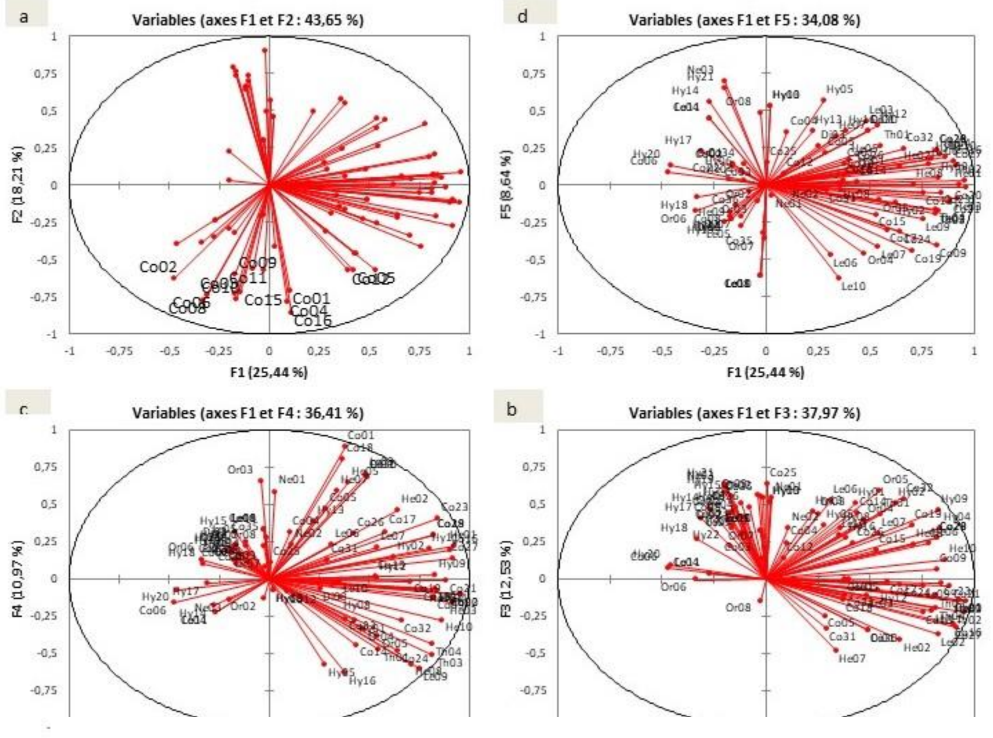

FIG. 3: Representation of variables (species) on a PCA factorial plan

explain 18.21% of the overall information of our sample (Fig. 3a).

Biplots representation of variables and observations on PCA

Figure 4 represents the simultaneous representations of observations (months) and variables (species) on the same plane of a PCA that is more informative.

Two groups were observed on the PCA plan, where the first is represented by the correlation of December, January, February and comprises: *Blaps gigas*, Elatearidae species, *Arachnospila* sp. And *Himacerus* spp. (two species). December, January and February were on the negative side of the F1 axis and this is explained by the negative correlation of these months with the low temperature that influences negatively the activity of the insects where we note a low entomological diversity. The correlation of species to the coldest months of the year can be explained by their adaptation to low temperatures, as insects, which are poikilothermic, change their activity depending on the temperature of the surrounding environment (Bale *et al.*, 2002), and according to Sparks and Parish (1995), the presence of some species during winter is probably linked to the presence of their hosts (animal or plant) adapted to steppe conditions characterized by the presence of few number of adapted plants, or because perhaps, they are just visitors seeking shelter (Joshua *et al.*, 2007) due to low ambient temperature.

June and July (Fig. 4a) correlate with *Hippodamia variegata*, *Anthia sexmaculata*, *Calathus* sp., *Odontothrips confusus, Aeolothrips intermedius, Liothrips vaneeckei, Camponotus aethiops, Monomorium subopacum, Messor capitatus* etc., because these months are characterized by temperature elevation and this explains their position on the positive side of the F1 axis. Therefore, the activity of insects is influenced, and higher populations are recorded (Deghiche-Diab, 2020). Ramade (1984) has also confirmed the positive effect of temperature to control all the metabolic phenomena of insects, as well as their distribution (Dreux, 1980).

October and November contribute to the formation of the F2 axis in the positive direction (Fig. 4a) and correlate to *Cheilosia variabilis, Tapinoma* sp., *T. nigerrimum, Glaucopsyche melanops, Harpalus rufipes, Coccinella septempunctata*, *Akis lusitanica*, *Pimelia payraudi*, etc., the presence of which during this time of the year is probably correlated to availability of seeds and roots of different plant species present (Grangier, 2008) and thus the presence of certain species such as ants is promoted. Their presence can also be related to rainfall water that contributes to the spread of many species (Bachelier, 1978).

April and May contribute to the formation of the F2 axis; they are on the negative direction (Fig. 4a) and correlate to *Aspidapion aeneum*, *Tropinota squalida*, *Eumenidae sp*, *Hylaeus affinis*, etc. which are phytophagous species linked to the environmental architecture, the variety of plant species and the diversity of ecological niches (Barbault, 1981) in the steppe area. This is also in correlation with (Jaworski and Hilszczański, 2013) who indicate reported that long and intense droughts, which are one of the results of the average temperature increase, have a negative impact on the condition of plants, thus increasing their susceptibility to phytophagous insects.

Figure 4b shows that February and January that are in the negative part of the F3 axis are opposite to August that is in the positive part of the same axis and correlated to *Timarcha* sp., *Othius* sp., *Pieris rapae, Xylocopa violacea, Hylaeus affinis* and *Melanoplus bivittatus*. The presence of these species during summer, especially during August, can be related to the climate effect in this region, that is characterized by height temperatures, low and irregular rainfalls, intense luminosity, high evaporation and intense temperature fluctuation (Ozenda, 1991), which may favor the development of certain species with strong resistance to rising temperatures (Dajoz, 1985; Ward, 2009). On the opposite of the axis, we have a negative correlation of other species with January and February that could be explained by the inverse influence of temperature on their activity.

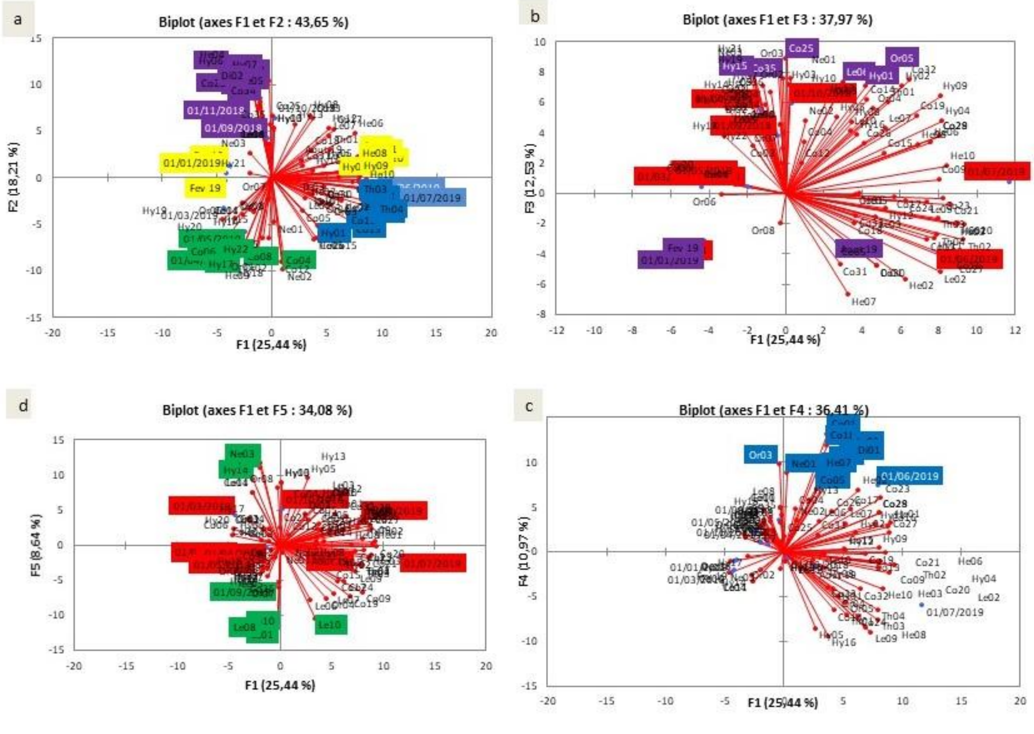

FIG. 4: Simultaneous representation of variables and observations on the PCA plan

June was correlated to *Myrmeleon formicarius, Sphaerophoria scripta, Dicranocephalus albipes, Rhopalosiphum maidis, Sphingonotus rubescens, Andrena* sp., *Messor barbara, Venessa cardui, Geotrupes intermedius, Danaus chrysippus, Graphipterus serrator, Stenocara* sp. and *Erodius emondi* (Fig. 4c). It should be noted that June is characterized by a significant activity of insect species indicated by higher populations as compared to other months, explained by the environmental conditions that have improved due to rainfalls during the preceding months. Likewise, as indicated by Cachan (1960), humidity that depends on temperature, precipitation and wind is one of the most important factors for insect survival, distribution and reproduction. Soil texture may also be a reason for certain species presence, such as ants (Bardgett *et al.*, 2005) that can survive during high temperature periods.

The F5 axis represents the September correlation with *Osmylus fulvicephalus, Papilio saharae, Tapinoma* sp., *Camponotus forelli, Megascolia maculata, Dufourea* sp., *Utetheisa pulchella, Colias crocea,* and *Larinus* sp. (Fig. 4d). In fact, water is an ecological factor of fundamental importance (Ramade, 1983) that exerts an influence on insect population density

(Ramade, 1984). During September, we observed insect activity commencement, following vegetation cover emergence induced by rainfalls. Likewise, the presence of certain species, such as *Utetheisa pulchella*, is probably linked to the presence of its host *Echium trygorrhizum* (Borraginaceae), characteristic of steppes (Deghiche-Diab and Deghiche, 2016; Deghiche –Diab *et al*., 2020) that appear after precipitation. Also, *Zizyphus lotus*, another characteristic shrub from steppe habitats was recorded to be inhabited by *Tarucus theophrastus* Fabricius, 1793 feeding on its leaves (Deghiche-Diab *et al*., 2021a). This species has also been recorded from different localities in the North of Algeria (Koçak and Kamel, 2015). Because of the large number of species that contribute to the formation of the five axes, it is important to study our results using the ACH and to validate the most homogeneous groups.

The dendrogram obtained for the collected species from Ouled Djellal steppe shows the presence of four homogeneous groups (Fig. 5). To proceed to the cut of the obtained tree from the ascending hierarchical classification, it is important to have an idea about the species that contribute to the construction of the partition, which is not optimal but interesting. This partition (cutoff) is good if the intra-class partition (or within-class variability) is small compared to that of the inter-class (or between-class variability), which should be higher. We note that individuals from the same class should be similar (or close). When moving from one class to another, a loss of inertia is observed, so the tree is cut where the loss is large and must be compared to the cumulative information obtained from the axes constituting the PCA plan and that helps interpretation of our results.

The tree cut was obtained at a distance of 75, where observe four groups: the second being more homogeneous than the others, indicated by the low distance between grouped species; it includes 48 species from different orders. The third group is represented by Meloidae species, *Brachycerus algirus, Graphipterus serrator, Lophyra flexuosa, Broscus cephalotes*, *Geotrupes intermediu*, *Papilio saharae*, *Vanessa cardui*, *Plebejus argyrognomon*, *Emmelina monodactyla*, *Tapinoma* sp., *Cryptochellilus notatus*, *Camponotus* sp., *Grycephalus* spp., *Sphaerophoria scripta, Myrmeleon formicarius*, etc. that were indicated as sporadic species in the region (Deghiche-Diab, 2020). The fourth group was obtained from the comparison of *Systoechus vulgaris*, *Cataglyphis bombycinus*, *Messor capitatus, Lophyra flexuosa*, etc. that qualify as the most abundant species in the habitat (Deghiche-Diab, 2020). One ant species, *Tetramorium biskrensis kahenae*, that shows good adaptation to steppe conditions, forms the first group. In their study on ants' diversity, Chemala *et al.* (2017) postulate that the greatest diversity of ants was observed in two arid ecosystems, one natural and one cultivated. Our results also agree with studies carried out at the Biskra arid region on ant species that can adapt to different areas; natural (Cagniant, 1966), cultivated (Cagniant, 1970) or even dune (Cagniant, 2006).

Conclusions

In general, the desert or/and Saharan zones support a relatively low number of species per unit (Ozenda, 1983; Catalisano, 1986). However, the Ouled Djellal that is an arid region presents a surprising and diversified fauna on which few studies are devoted because of the difficulty to observe them due to their homochromic coloring and nocturnal behavior (Vial and Vial, 1974). In general, a low total variation of species is observed in steppe environments that is poor in water and plant diversity.

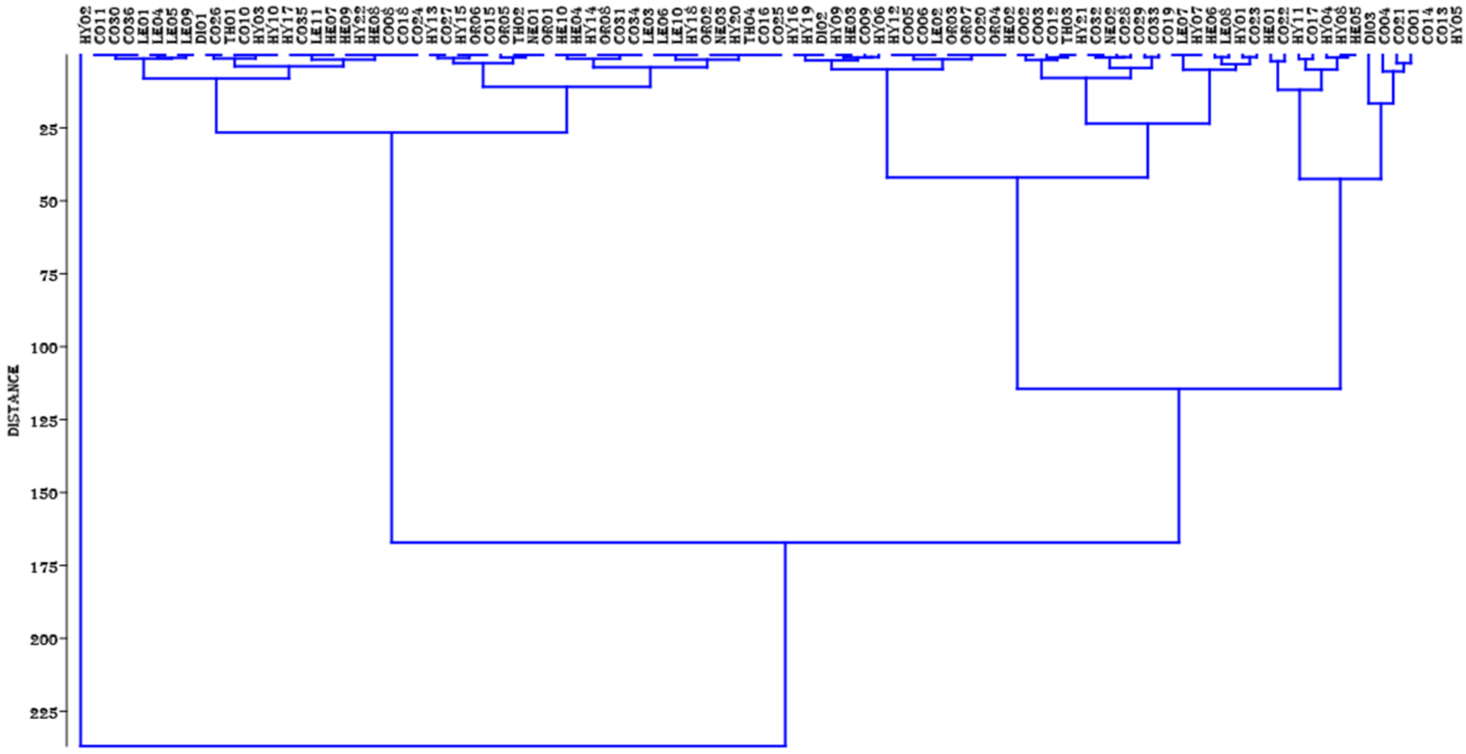

FIG. 5: Hierachical Ascending Classification (HAC) of species from steppe habitat

All obtained results during this study show that steppe is a natural habitat surrounded by a desert environment, that is characterized by rain scarcity, high temperatures and winds that can constitute limiting ecological factors for insect survival (Ramade, 1984). The wind which increases evapotranspiration, contributes to atmosphere drying out (Mutin, 1977) and inhibits plant growth (Mackenzie *et al*., 2000; Monod, 1992) has an influence on the existence and the activity or development of certain insect species (Faurie *et al*., 1984; Ramade, 1983). Vegetation cover is strongly associated with insect accumulation (Sperber *et al*., 2004). Thus, certain species can adapt to the harshest climatic conditions in the region by building their own ecological niches behind natural resources (Brague-Bouragba, 2010) by feeding on seeds of growing species (Grangier, 2008; Deghiche-Diab *et al.*, 2015a,b), by using indigenous plants as host plants (Deghiche-Diab *et al.*, 2021b), or maybe for egg laying (Deghiche-Diab and Deghiche, 2021a). The soil texture can be also one of the conditions that has great effect on the distribution and presence of species in the steppe region (Bardgett *et al*., 2005; Deghiche-Diab *et al*, 2020b).

References

Aidoud, A. 1989. Contribution à l' étude des écosystèmes steppiques pâturés des hautes plaines Algéro-Oranaises (Algérie): Fonctionnement et évaluation des ressources végétales. Thèse. Doct. U.S.T.H.B. Alger. 240pp.

Aouissi, H.A., Deghiche-Diab, N., Farhi, Y., 2021. Etat actuel de la faune Algérienne, sauvage et domestique. *Edition Universitaies Européenne*, 149p.

Bachelier, G. 1978. La faune des sols: son écologie et son action. Paris, O.R.S.T.O.M.

Bale, J. S., Masters, G. J., Hodkinson, I. D., Awmack, C., Bezemer, T. M., Brown, V. K., Butterfield, J., Buse, A., Coulson, J.C., Farrar, J., Good, J. E. G., Harrington, R., Hartley, S., Jones, T. H, Lindroth, R. L., Press, M. C., Symioudis, I., Waltt, A. D. and Whittaker, J. B. 2002. Herbivory in global climate change research: direct effects of rising temperature on insect herbivores. *Global Change Biology*, 8(1): 1–16.

Barber, H.S. 1931. Traps for cave inhabiting insects. *Journal of the Elisha Michell Scientific Society* 46: 259-266.

Bardgett, R.D., Usher, M.B. and Hopkins, D.W. 2005. *Biological diversity and function in soils*. Cambridge University Press, Cambridge, New York. 411pp.

Benkhelil, M.L. 1991. Les techniques de récolte et de piégeage utilisées en entomologie terrestre. Ed. OPU, Alger, 66 p.

Belhamra, M., Farhi, Y., Aouissi H.A., Deghiche-Diab N., Absi K., Meradi S., 2020. Etat actuel de la faune sauvage Algérienne. Rapport final. *CRSTRA*, 300p.

Blackman, R.L. and Eastop, V.F. 1994. *Aphids on the World's Trees: An Identification and Information guide.* Ed. C.A.B. International, Wallingford, 987 pp.

Blackman, R.L and Eastop, V.F. 2000. *Aphids on the World's Crops: An identification and information guide*. Ltd JWS (ed.), The Natural History Museum, London, 466 pp.

Bougherara, A. and Lacaze, B. 2009. Etude préliminaire des images Landsat et Alsat pour le suivi des mutations agraires des Ziban extrême nord-est du Sahara Algérien de 1973 à 2007 journées d'animation scientifique. Alger. 6p.

Brague-Bouragba, N. 2010. Guide de quelques Arthropodes en région semis arides. MADR, INRF., 100 pp.

Cachan, P. 1960. Etude de l’ action simultanée de la température et de l’humidité sur le développement des in sectes en climat artificiel (I) Vie Et Milieu, Tome XII, 26 pp.

Cagniant, H. 1966. Note sur le peuplement en fourmis d’une montagne de la région d’ Alger, l’ Atlas de Blida. *Bulletin de la Société d' Histoire Naturelle de Toulouse* 102: 278-284.

Cagniant, H. 1970. Deuxième liste de fourmis d’ Algérie récoltées principalement en forêt (1re partie). *Bulletin de la Société d’Histoire Naturelle de Toulouse* 105: 405-430.

Cagniant, H. 2006. Liste actualisée des fourmis du Maroc. *Myrmecologische Nachrichten* 8: 193-200.

Catalisano, A. 1986 Le désert saharien, Ed. Bruno Masson et Cie, Paris. 127 pp.

Champely, S. 2005. Introduction à l' analyse multivariée (factorielle) sous R. 57pp.

Chemala, A., Benhamacha, M., Ould El Hadj, DM., Marniche, F. and Daoudi, S. 2017. A preliminary list of the Ant Fauna in Northeastern Sahara of Algeria (Hymenoptera: Formicidae). Sociobiology. *An international journal on social insects* 64(2): 146-154.

Chinery, M. 1993. *Collins guide insects of Britain and Northern Europe*. 3rded of (1973). Harper Collins publishers. London.

Chopard, L. 1943. Orthopteroïdes de l’ Afrique du Nord. Larose, Paris, 450 p.

Dajoz, R. 1985. Précis d’ écologie. Ed. Dunod, Paris, 505pp.

Deghiche-Diab, N., Porcelli, F. and Belhamra, M. 2015 (a). Entomofauna of Ziban oasis. *Journal of Insect Science* Oxford.15(41).

Deghiche –Diab, N., Deghiche, L. and Belhamra, M. 2015 (b). Inventory of Arthropods in an agro-ecosystem Ziban oasis, Ain Ben Noui, Biskra, Algeria. *Journal of Entomology and Zoology Studies* 3(4): 229-234.

Deghiche-Diab, N. and Deghiche, L. 2016. La flore spontanée des oasis des Ziban. Edition Universitaires Europiènne. 300pp.

Deghiche-Diab, N., Deghiche, L. and Khachai S. 2016. Importance of spontaneous plants of steppe arid regions. Oueled Djellel. Biskra. Algéria. *International Journal of Botany Studies* 1(3): 03-07.

Deghiche-Diab, N. 2019. Flore adventice des oasis des Ziban. Edition INRAA. 150 pp.

Deghiche Diab, N., Belhamra, M., Deghiche, L. and Boultif, M. 2020a. Cartography and distribution of insects’ species according to habitats diversity in Ziban Biskra-Algeria. *Munis Entomology and Zoology Journal* 15(2): 412-419.

Deghiche-Diab, N. 2020b. Entomofaune des habitats humides, steppique et phoenicicole des Ziban; approche, structurale et fonctionnelle. Thèse doctorat, université de Biskra, 178pp.

Deghiche Diab, N., Belhamra, M. and Deghiche L. 2020c. Study of spontaneous plants and their associated arthropods in Ziban oases agroecosystem, Biskra-Algeria. *Commission for IP and Biocontrol in North-African Countries IOBC-WPRS Bulletin* Vol. 151, 2020 pp. 127-134.

Deghiche-Diab, N., and Deghiche, L. 2021. The first record of Tarucus theophrastus (Fabricius, 1793) from steppe Ziban habitat (Biskra-Algeria). *Munis Entomology & Zoology* 16 (2), 1216.

Deghiche-Diab, N., Deghiche, L. and Belhamra, Y. I. 2021a. New record of *Phloeotribus scarabaeoides* (Bernard, 1788) on introduced olive trees in Biskra region–Algeria. *Munis Entomology & Zoology* 16 (2): 1093-1102.

Deghiche-Diab, N., Fraih, A., Deghiche, L. and Tarai, N. 2021b. Biodiversity and ecological studies of arthropods associated to Quinoa (*Chenopodium quinoa* Willd.) in Biskra region. *Munis Entomology & Zoology* 16 (1): 427-434.

Dozière, A., Valarcher, J. and Clément, Z. 2017. *Papillons des jardins, des prairies et des champs.* Guide de terrain pour les observatoires de sciences participatives. Escourbiac, 133.

Dreux, P.H. 1980. Précis d'écologie. Ed. Presses universitaires, Paris, 231 pp.

Dubost, D. and Larbi, Y. 1998. Mutations agricoles dans les oasis Algériennes: l' exemple des Ziban. Sécheresse (103-110).

Dufour, A.B. and Lobry, J.R. 2010. Initiation à l' analyse en composantes principales Logiciel R version 2.11.1. 18p. http://pbil.univ-lyon1.fr/R/pdf/tdr601.pdf.

El Zerey, W., Bouiadjra, S.E.B., Benslimane, M. and Mederbal, K. 2009. L' écosystème steppique face à la désertification: cas de la région d' El Bayadh, Algérie. Vertigo - la revue électronique en sciences de l' environnement V9(2). http://journals.openedition.org/vertigo/8821; DOI: 10.4000/vertigo.8821.

Farhi, Y. 2014. Structure et dynamique de l' avifaune des milieux steppiques présahriens et phoenicicoles des Ziban. Thèse doctorat. Université de Biskra.384pp.

Faurie, C., Ferra, C. and Medori, P. 1984. Écologie. Éd. Baillière J. B., Paris. 168pp.

Fontier, S., Denis, P.V., Le Pretre, A., Devoult, D. and Luczak, C. 2008. Ecosystèmes structures fonctionnement, évolution: 4ième édition. Dunod. 588.

Grangier, J. 2008. Stabilite evolutive d'un mutualisme plante/fourmis obligatoire et specifique. These doctorat Toulouse. 188 pp.

Halitim, A. 1988. Les sols des régions arides d' Algérie. Ed. O.P.V, Alger, pp. 83-86 et 325- 384.

Hampt, H. and Hampt, J. 1998. Guide des mouches et des moustiques l'identification des espèces europiènnes Allemmenggne.de la chaux et Nustlé. 350 pp.

Hertz, M. 1927. Huomioita petokuoriaisten olinpaikoista. Luonnon Ystävä, 31: 218-222.

Jaworski, T. and Hilszczański, J. 2013. The effect of temperature and humidity changes on insect development and their impact on forest ecosystems in the context of expected climate change. *Forest Research Papers* 74(4): 345–355.

Kadi Hanifi, H. 1998. L' alfa en Algérie: Syntaxonomie, relation milieu-végétation, dynamique et perspectives d'avenir. Thèse Doctorat. USTHB. 270pp.

Koçak, AO. and Kamel, M. 2015. Annotated lists on the Lepidoptera of Algeria, based upon the info-system of the Cesa. *Center of Entomological Studies Ankara. Priamus* 34:1-794.

La Planches, G. and Gorge, A. 2008. Papillons de médeterannée. Edition Sud., 203 pp.

Legendre, L. and Legendre, P. 1998. Numerical ecology. Ed. Elsevier, Netherlands. 853 pp.

Le Houerou, H.N. 1985. La régénération des steppes algériennes. Rapport de mission de consultation et d' évaluation. Ministère de l' agriculture, Alger.

I.N.R.A.A. 2006. Gestion participative de la lutte biologique contre les ravageurs du palmier dattier dans les oasis Algériennes. Unité I.N.R.A de Biskra, 53pp.

M.A.T.E. 2015. Etude diagnostique sur la Biodiversité et les changements climatiques en Algérie. Projet Mate-Pnud-Fem; Planification Nationale sur la Diversité biologique et mise en œuvre en Algérie du plan stratégique de la convention sur la diversité biologique 2011-2020 et des objectifs d'Aichi, rapport final. 135p.

Monod, T. 1992. Du désert. Sécheresse, (3): 7-24.

Mutin, L. 1977. La Mitidja, Décolonisation et espace géographique. Edition officiel Publication Université d' Alger. 607 p.

Ozenda, P. 1983. Flore du Sahara. 2ème Edition. Ed. Centre National de la Recherche Scientifique. Ed. CNRS Paris. 622 pp.

Ozenda, P. 1991. Flore et végétation du Sahara. 3ième édition. Centre National de la Recherche Scientifique. Paris. 622pp.

Rakotomalala, R. 2015. Analyse de corrélation. Étude des dépendances-Variables quantitatives Version 1.1. Université Lumière Lyon.

Ramade, F. 1983. Eléments d'écologie. Ecologie fondamentale. Ed. Mc GrawHill, Paris, 397 pp.

Ramade, F. 1984. Eléments d' écologie-Ecologie fondamentale. Ed. Mc GrawHill, Paris, 400 pp.

Roume, A. 2001. Quelle est la contribution des mileiux semi-naturels à la diversité et à la répartition des assemblages des carabidae circulants et hivernants dans un paysage rural tempéré? Thèse doctorat. Université de toulouse.197pp.

Saharaoui, L., Hemptinne, J.L. and Magro, A. 2014. Biogéographie des coccinelles (Coleoptera: Coccinellidae) d' Algérie. Entomologie Faunistique. 67: 147-164.

Saharaoui, L. 2017. Les coccinelles algériennes (Coleoptera, Coccinellidae): analyse faunistique et structure des communautés. Biodiversité. Université Paul Sabatier-Toulouse.195pp.

Schhiffers, H. 1971. Die Sahara undihre randgebiete. Ed Welforum Verlac-Mumchen, 674pp.

Sperber, C. F., Nakayama, K., Valverde, M. J., and De Siqueira Neves, F. 2004. Tree Species Richness and Density Affect Parasitoid Diversity in Cacao Agroforestry. *Basic and Applied Ecology* 5(3), 241-251.

Vial, Y. and Vial, M. 1974. Sahara milieu vivant, Guide du voyageur-naturalistes. Edition Hatier. Paris. 223pp.

Villiers, A. 1946. Coléoptères Cérambycides de l'Afrique du Nord, Faune de l'Empire Français, ORSC Paris 5: 152pp.

Ward, D. 2009. Biology of desert. Edition DUNOD. 365pp.

XLSTAT. 2016.V.3.1. https://www.xlstat.com/fr/solutions/fonctionnalites/analyse-en-composantes-principales-acp.

