Journal of Agricultural Science and Food Technology
Vol. 4 (2), pp. 18-31, April, 2018
ISSN: 2465-7522
Full Length Research Paper
http://pearlresearchjournals.org/journals/jasft/index.html

Diversity and Bio Ecology of Orthoptera in some Habitat types in the North East of Algeria

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Accepted 15 March, 2018

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ABSTRACT

The biology and species diversity of Orthoptera was carried out in some habitat types of Jijel region from the year 2000 to 2001 and then from 2011 to 2013.The selected habitats were suitable for identified studies on Orthoptera. Random sampling was applied to estimate species richness, occurrence, abundance, fairness, and diversity. Population estimates were sampled from transects lines 50 m x 10m wide divided into 5 quadrates and numbers were used to generate data for Orthroptera species presence in various habitats. Collected specimens were killed using ethyl acetate and preserved in plastic bags for laboratory identification using keys. The results revealed that a total of 32 species were sampled during the study period. Majority of them are Cealifera in particular Acrididae represented mainly by Oedipodinae and Gomphocerinae. Texenna, Beni Caid and El Aouana presented the highest species diversities; Beni Bélaid and El Emir Abdelkader are the two poorest resorts. The majority of locust species are eurytopes. They are present at least in two habitat types except *Pyrgomorpha laevigata* and *Locusta migratoria* which have only been encountered in a single station and then considered as stenotopes.The most constant species were *Calilptamus barbarus Ailopus strepens Oedipoda caerulescens* and *Dociostaurus jagoi*.The important relative abundances Orthoptera were in order of importance *C. barbarus* and *D. jagoi* in Texenna, El Aouana, Beni Bélaid and Beni Caid. The other species were *Acrotylu longipes* (Jijel) and Ochrilidia tibialis (El Emir Abdelkader). Concerning the sex ratio males were more numerous than females especially in autumn 2011 and summer 2013 in Kissir. Ecological analysis was performed to quantify abiotic factors that impact abundance and distribution of the Orthoptera populations in Jijel region. From the result obtained we concluded that the most dominant Orthoptera species in the region of Jijel is *C. barbarus* particularly in the locality of Texenna. This species thus merit a special attention.

Keywords: Acridofauna, *C. barbarus*, diversity, Frequency, Jijel, species, sex-ratio

INTRODUCTION

Presence of Orthoptera in cropland habitats considered as a major constraint to small and medium food crop growers in the country. Species diversity of the common Orthoptera causing extensive damage is well documented, but their ecological factors are still not fully studied or known. The term Orthoptera derives from Orthos, which means "right" and pteron, "wing". It is a heterogeneous group of species known as grasshoppers, crickets, and locusts. They constitute a vast order of insects, currently composed of more than 26,000 species, including fossil forms (Eades et al., 2014). According to these authors, they are cosmopolitan insects, present almost in all regions of the world and in different terrestrial habitats. However, they are predominant in tropical and subtropical areas (Massa et al., 2012), especially in arid and warm regions, due to the

Figure 1. Geographic localisation of the Jijel region.

thermophilic and xerophilic characteristics of these insects (Ayala, 2014).

According to Copr (1982), there are 500 species of locusts out of 12000 described in the world that are pests of agricultural or pastoral productions. In 1986, agricultural losses caused by grasshoppers in seven Sahelian countries were estimated at $ 77 million, or 8% of the commercial value of cereals, the cost of locust control was $ 31 million (Lecoq, 1992). The objective of this study is to deepen the knowledge on the acridofauna of the Jijel region, which studies are rare apart from the work of Rouibah (1994); Tekkouk (2012); Rouibah and Doumandji (2013).

MATERIAL AND METHODS

Description of stations

Studies on the ecology of Orthoptera was carried out in Jijel region (Figure 1). Seven stations have been chosen. This choice was made to study the influence of certain environmental factors such as altitude, land relief, and especially the type of habitat. These include Texenna, Kissir, Jijel, Beni Caid, Beni Belaid, El Emir Abdelkader and El Aouana. Texenna is located at 18 Km South of Jijel at 487 m of altitude, with a slope of 7% and a southeast exposure. It is open garrigue, set on a calcareous soil, on which grows vegetation dominated by the Cyste: *Cystus monspeliensis*. The station of Kissir is located near the National Park of Taza, 10 Km west of Jijel with an altitude of 11m. It is a wasteland whose soil is flat and slightly acidic.The third station is located at the west exit of Jijel. It is bounded on the north by the Mediterranean Sea. These are fixed dunes of the littoral covered by sparse vegetation with Graminae dominant. The fourth habitat called Beni Caid is a cork oak forest with very dense undergrowth consisting mainly of *Erica arborea*. The soil is sandy-loamy and slightly acidic.The altitude is 125m. Béni Bélaid is located at the seaside, 50 km east of Jijel. They are also fixed dunes. The slope is about 5%, with East exposure.The sixth station is located in the locality of El Emir Abdelkader, 10 km south-east of Jijel. This habitat is a grassy lawn. The altitude is 87m. The slope is 10% with northwest exposure. The soil is clay-like. Herbaceous vegetation covers it. The last station is located at El Aouana about 20 km west of Jijel. A wasteland represents this site. The altitude is 29 m. This wasteland is located not far from the sea, on almost flat terrain. The texture is sandy loam.

Sampling method

In the field, samples were captured using a scythe net for capturing locusts, as well as a plastic bags were used for capturing larvae and imago. GPS was used for Orthoptera mapping. Identification of samples collected was carried out using microscope following identification key developed by Chopard (1943) and Louveaux and Benhalima (1987). A sampling of insects involves the capture and collection of some specimens for proper identification. The collection was carried out on a limited number of specimens and without destruction of habitats. Methods of sampling insects are numerous, among which are the traditional methods (hunting at sight, mowing, the method of the quadrats, the shaking of the branches). They must in all cases allow the harvesting of insects in good condition (Franck, 2008). For this study, the quadrat method was used. It is the best technique for an accurate density study. Entomologists who work on population dynamics often choose it. Surveys were conducted early in the morning for two hours. Sampling effort per quadrat was approximately 15 minutes. Sampling was carried out randomly from quadrats according to Barbault (1981). The size of each quadrat was 3 m length and width of 3m located in a transect line of 10m.

Sampling was done once a month. According to Barbault (1981) to obtain a satisfactory estimate of the population density, it is necessary to repeat the measurement with as many randomly distributed sample plots. When spotting the squares, it is necessary to proceed very slowly so as not to frighten the insects. The shadow of the operator must not appear inside the quadrat. In order

inorder to have no significant differences from the microclimate, the squares of each station are not far apart (Benkhelil, 1991). Ten meters may be considered sufficient distance between two neighboring squares. During sampling, the netting must be vigorously handled to sweep the vegetation by rapid and lateral movements. These energetic gestures take the individuals by surprise. All samples thus taken are collected in plastic bags and transported to the laboratory for determination. Finally, it should be pointed out that, at each exit, all observations are recorded on a prospecting notebook. Once in the laboratory, the insects are killed with ethyl acetate and then determined using the keys of Chopard (1943) and Louveaux and Benhalima (1987). After identification, the Orthopterans are kept in insect boxes. It should be noted that the surveys are carried out during the years 2000 to 2001 and then from 2011 to 2013.

Principles used to calculate the various ecological indices

To exploit the results, the sampling quality and the various ecological indices of the composition are studied. It is about total and average richness, constancy, and frequency. For structural indices, diversity and fairness are chosen.

Quality of sampling

The quality of the sampling is an indicator of good or bad sampling carried out in the field. It is calculated by the ratio a/N (Blondel, 1975). a is the number of species observed only once in a series of surveys. N is the number of the total readings performed. When this ratio tends to zero, the sampling is of good quality, as evidenced by sufficient sampling effort.

Total and average richness

The total or specific richness of a locust stand is the number of S species encountered in a given environment (Barbault, 2003). It can be used to analyze the taxonomic structure of this stand (Grall and Coic, 2006). However, this wealth has the disadvantage of giving equal weight to all species whatever their abundance. According to Oudjane et al. (2014) the mean richness corresponds to the average number of species present in a sample of the medium whose surface has been arbitrarily fixed. It also allows us to know the homogeneity of the population (Ramade, 2003).

Calculation of Frequency of Occurrence

The frequency of occurrence is the percentage of records (Pi) containing the species relative to the total number of surveys performed (P) (Dajoz, 1982).
F.O.(%)=Pi/P.100

Constancy is the interpretation of frequency of occurrence. The species is said to be constant, incidental or accidental depending on whether the frequency of occurrence is greater than 50%, between 25 and 50% or less than 25 %.

Calculation of relative abundance

It is also called the centesimal frequency. This is the percentage of individuals Species (ni) relative to stand individuals (N) (Ramade, 2009). Frequency is an important parameter for describing the structure of a stand. It is found that in any biocenosis and in any synecological entity certain species are very abundant and have a relatively high frequency. In the opposite, other species are rare or very rare and have only a low frequency in the community (Ramade, 1984).

Relative abundance(RA)=ni/N x 100

ni: number of individuals of species i
N: total number of individuals collected

Study of the diversity and Equitability of Orthoptera

To study the diversity of the orthopterological stands of the stations, the Shannon - Weaver diversity index was used. According to Dajet (1976), the Shannon diversity index is the amount of information a sample provides about the stand structures from which it is derived and how individuals are distributed among different species. The diversity index of Shannon-Weaver is chosen because it is simple and efficient. This is calculated as follows (Barbault, 1981; Zar 1999).
H′: -Σ pi ln pi
pi: the proportion of total sample belonging to the ith species. A greater H′ suggests higher species diversity and smaller H′ suggest low species diversity. The index of diversity can translate and express, using a single number, the species richness and relative abundance of individuals within each species. It is a reflection of the equilibrium of biocenosis (Dajoz, 1971; Gregoire et al., 2013).
Species diversity has two main important components, namely species richness and equitability. The Species evenness or equitability was calculated as:
J′: H′/ H′max (Zar, 1999)
H′: Shannon diversity index
H′max = theoretical maximal value for the Shannon Wiener index of the diversity
E = H′/lnS = H′/ H′max (Pielou, 1975). It is the ratio between the species diversity H ' and the maximum diversity H '(Weesie and Belemsobgo, 1997).
E: evenness or equitability of species
S is the number of species forming the stand.

Table 1. Species richness and diversity of Orthoptera during 2000 and 2001.

Species	Sub orders	Families	Sub families	Frequency of abundance (%)
Odontura algerica				
Odontura microptera			Phaneropterinae	6
Decticus albifrons		Tettigoniidae	Tettigoniinae	3.12
Gryllotalpa gryllotalpa		Gryllotalpidae	Gryllotalpinae	3.12
Ephippiger pachygaster		Ephippigeridae	Bradyporinae	3.12
Gryllus campestris	Ensifera	Gryllidae	Gryllinae	3.12
Calliptamus barbarus			Calliptaminae	3.12
Eyprepocnemis plorans			Eyprepocnemidinae	3.12
Anacridium aegyptium				
Acrida turrita				
Aiolopus strepens				
Aiolopus thalassinus			Acridinae	12.5
Acrotylus insubricus				
Acrotylus patruelis				
Acrotylus longipens				
Oedipoda caerulescens				
sulfurescens				
Sphingonotus lucasii				
Locusta migratoria			Oedipodinae	18.75
Dociostaurus jagoi jagoi				
Ochrilidia tibialis				
Omocestus lucasii				
Omocestus raymondi				
Omocestus ventralis			Gomphocerinae	15.62
Truxalis nasuta			Truxalinae	3.12
Pezotettix giornai				
Thysiocetrus littoralis		Acrididae	Catantopinae	6.25
Pamphagus elephas		Pamphagidae	Pamphaginae	3.12
Pyrgomorpha cognata				
Pyrgomorpha laevigata				
Pyrgomorpha conica		Pyrgomorphidae	Pyrgomorphinae	9.37
Paratettix meridionalis		Tetrigidae	Tetriginae	3.12
Acrydium brachypterum	Caelifera	Acrydiidae	Acrydiinae	3.12

Equitability makes it possible to compare the structures of locust stands. If E tends to 0, all individuals correspond to a single species. If E tends to 1, each of the species is represented by the same number of individuals.

RESULTS

General list of Orthoptera in the Jijel region

The distribution of acridofauna recorded in 2000 and 2001, by sub-orders, families and sub-families, is shown in Table 1.

A total of 32 species of Orthoptera was recorded in the various study stations. The Jijel region is home to well-diversified Orthopteric fauna. From the systematic point of view, the majority of the Orthoptera observed (26) belong to the suborder Caelifera against 6 species of Ensifera. Most Caelifers are Acrididae, except *Paratettix meridionalis* (Tetrigidae) and *Acrydium brachypterum* (Acrydiidae). In addition, the best-represented subfamily is the Oedipodinae, with 6 species corresponding to 19% of the subfamilies. These include *Acrotylus patruelis, A. longipes, Oedipoda caerulescens, Sphingonotus lucasii* and *Locusta migratoria*. Gomphocerinae (16%) is represented by five species: *Dociostaurus jagoi jagoi, Ochrilidia tibialis, Omocestus lucasii, O. raymondi and O. ventralis* (Figure 2). However, other subfamilies are represented by only one species (3%). These include Calliptaminae (*Calliptamus barbarus*), Eyprepocnemidinae (*Eyprepocnemis plorans*) and Catantopinae (*Pezotettix giornai*). On the other hand,

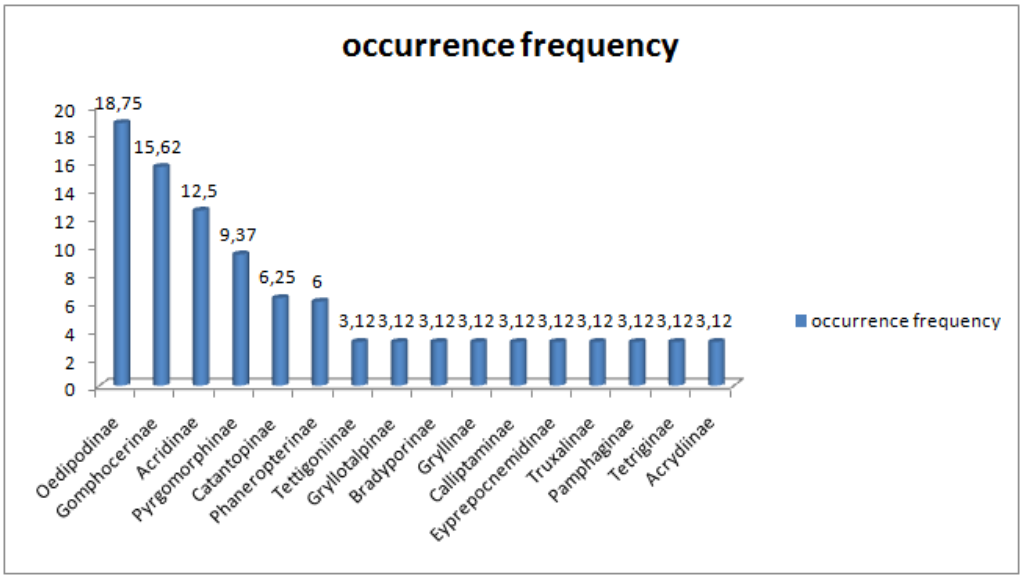

Figure 2. Distribution according to subfamilies of Jijel region acridofauna.

the presence or absence of locust species on the ground is irregular from one station to another (Table 2). This is the case of *Acrida turrita, Aiolopus strepens, Calliptamus barbarus, Eyprepocnemis plorans* and *Omocestus lucasii*. These 5 species were common species recorded from all stations. Rare species such as *Locusta migratoriae* and *Pyrgomorpha laevigata* were recorded only once.

Quality of sampling

The sampling quality values of the locust species caught in the different stations are shown in Table 3.
It appears from this table that the sampling quality values, month by month, for the two years of prospecting 2000 and 2001, are all less than or equal to 0.38, which is close to zero. This is a sign of excellent quality sampling. This shows that the effort provided is very sufficient.

Total and average wealth

The purpose of studying wealth, whether total or average, is to obtain information on the importance of species at each of the stations. The stationary wealth is shown in Table 4.
The values of the total and average wealth are variable according to the months and the stations. The Béni Caid forest, the Texenna garrigue and the El Aouana wasteland present the highest species diversity (Table 4). The first contains 25 species. The other two have 23 species sampled. On the other hand, Beni Bélaid and El Emir Abdelkader are the two least diverse resorts, with only 13 and 14 species respectively. As regards the average wealth obtained by the ratio of the total number of species cumulated from two years of surveys to the total number of surveys carried out (17), this is almost identical for the six stations. Indeed, it varies between 4.6 (El Emir Abdelkader) and 8.6 (ElAouana).

Frequency of occurrence

The frequency of occurrence makes it possible to know what are the constant species, the accessory species and the accidental species among the whole Orthopteran population. Results for the frequency of occurrence of species are shown in Table 5.
The number of classes of constancy calculated is 3. These classes are 0 <F.O. <25% for accidental species, 25% <F.O. < 50% for incidental species and F.O. > 50% for constant species.
Five constant species are observed at Jijel habitat. These include *C. barbarus, A. strepens O. caerulescens sulphidescens, D. jagoi jagoi* and especially *A. longipes* which recorded among all other species the highest frequency of occurrence (94%). In this same station, four accessory or accidental species are present. They are *A. turrita, A. patruelis, S. lucasii* and *P. giornai*. The rest is accidental species. This is the case of *O. ventralis, O. raymondi* and *T. littoralis*. The constant species at the El Aouana station are *C. barbarus, A. turrita, D. jagoi jagoi, O. caerulescens, A. strepens* and *A. patruelis*. The accessory species are *P. giornai, O. tibialis, T. nasuta, E. pachygaster, E. plorans* and *O. ventralis*. The most important accidental species in this station are *A. aegyptium, O. lucasii* and *A. insubricus*. In Texenna, 5 constant species are observed: *C. barbarus, A. aegyptium, D. jagoi jagoi, O. caerulescens* and *P. giornai.* The accessory species are *A. strepens, A. insubricus, O.*

Table 2. Presence-absence of locust species in different habitats.

Species	Jijel	El Aouana	Texenna	Béni Caid	El Emir Abdelkader	Béni Bélaid
Odontura algerica	+	+	+	+	+	-
Odontura microptera	-	+	-	+	+	-
Decticus albifrons	-	+	+	+	+	-
Gryllotalpa gryllotalpa	-	-	+	+	-	-
Ephippiger pachygaster	-	+	+	-	+	-
Gryllus campestris	-	-	+	+	+	-
Paratettix meridionalis	+	-	+	+	-	+
Acrydium brachypterum	-	+	+	+	-	-
Calliptamus barbarus	+	+	+	+	+	+
Eyprepocnemis plorans	+	+	+	+	+	+
Pezotettix giornai	+	+	+	+	-	-
Anacridium aegyptium	-	+	+	+	-	-
Acrida turrita	+	+	+	+	+	+
Aiolopus strepens	+	+	+	+	+	+
Aiolopus thalassinus	+	+	-	+	-	+
Acrotylus insubricus	-	+	+	-	-	+
Acrotylus patruelis	+	+	+	+	-	+
Acrotylus longipes	+	-	-	-	+	-
O. caer. sulfurescens	+	+	+	+	-	+
Sphingonotus lucasii	+	-	-	-	-	+
Dociostaurus jagoi jagoi	+	+	+	+	-	+
Ochrilidia tibialis	-	+	+	+	-	-
Omocestus lucasii	+	+	+	+	+	+
Omocestus raymondi	+	-	+	+	-	-
Omocestus rufipes	+	+	-	+	-	-
Truxalis nasuta	-	+	+	+	+	-
Thysiocetrus littoralis	+	+	-.	+	-	-
Pamphagus elephas	-	+	-	+	-	+
Pyrgomorpha cognata	-	-	-	+	+	-
Pyrgomorpha laevigata	-	-	+	-	-	-
Pyrgomorpha conica	-	+	+	-	-	-
Locusta migratoria	-	-	-	-	+	-

+ Species present; - Species absent.

Table 3. Locust sampling quality in the habitats.

		Stations											
		Jijel		Béni Caid		El	Emir Abdelkader	Texenna		El Aouana		Béni Bélaid	
	Months												
Years		**a**	a/N	a	a/N	a	a/N	a	a/N	a	a/N	a	a/N
	APRIL	2	0.11	2	0.11	0	0	1	0.05	4	0.22	2	0.11
	MAY	3	0.16	5	0.27	0	0	5	0.27	0	0	1	0.05
	JUNE	1	0.05	4	0.22	0	0	4	0.22	3	0.16	0	0
	JULY	1	0.05	2	0.11	0	0	2	0.11	2	0.11	1	0.05
	AUGUST	1	0.05	1	0.05	1	0.05	0	0	0	0	1	0.05
	SEPTEMBER	2	0.11	3	0.16	1	0.05	2	0.11	7	0.38	3	0.16
	OCTOBER	2	0.11	2	0.11	2	0.11	7	0.38	2	0.11	2	0.11
2000	NOVEMBER	3	0.16	2	0.11	1	0.05	2	0.11	0	0	2	0.11
	MARCH	2	0.11	1	0.05	4	0.22	1	0.05	5	0.27	1	0.05
	APRIL	1	0.05	5	0.27	1	0.05	5	0.27	4	0.22	3	0.16
	MAY	5	0.27	4	0.22	0	0	1	0.05	2	0.11	4	0.22
	JUNE	1	0.5	6	0.33	1	0.05	4	0.22	2	0.11	0	0
	JULY	2	0.11	4	0.22	2	0.11	4	0.22	0	0	2	0.11
	AUGUST	1	0.05	2	0.11	3	0.16	4	0.22	1	0.05	1	0.05
	SEPTEMBER	3	0.16	3	0.16	1	0.05	3	0.16	4	0.22	4	0.22
	OCTOBER	1	0.05	4	0.22	0	0	3	0.16	1	0.05	1	0.05
2001	NOVEMBER	4	0.22	3	0.16	1	0.05	3	0.16	3	0.16	3	0.16

a: number of species observed only once in a series of surveys. N: number of total readings performed (17).

Table 4 . Total species richness of Orthoptera in different habitats.

Years/Stations	Month	Jijel	Texenna	El Aouana	Béni Caid	El Emir Abdelkader	Béni Bélaid
	APRIL	9	8	5	4	3	4
	MAY	6	9	8	7	5	5
	JUNE	5	9	9	7	4	13
	JULY	5	6	6	5	4	12
	AUGUST	5	5	5	4	6	10
	SEPTEMBER	6	7	12	9	4	11
	OCTOBER	10	11	9	9	7	6
2000	NOVEMBER	7	4	3	6	5	3
	MARCH	4	4	7	6	5	2
	APRIL	5	7	8	9	3	4
	MAY	5	8	10	8	4	9
	JUNE	5	10	12	12	7	12
	JULY	6	9	8	14	6	12
	AUGUST	6	8	12	11	6	11
	SEPTEMBER	7	10	10	10	4	10
	OCTOBER	8	8	11	8	3	6
2001	NOVEMBER	5	5	11	9	2	2
Standard deviation		1.61	2.12	2.71	2.73	1.46	3.91
Total wealth (S)							
∑ Months		17	23	23	25	14	13
		6.11	7.52	8.6	8.11	4.6	7.76
Average wealth (s)							

raymondi, A. brachypterum and *E. pachygaster.* There are many accidental species. These include: *A. turrita, G. campestris* and *O.* algerica. The acridofauna at Beni Caid consists of four constant species. These are *A. strepens, C. barbarus, A. turrita* and *O. caerulescens*. In this same station, nine accessory species are noted, among others: *P. giornai, D. jagoi jagoi* and *O. lucasii*. The others are accidental species such as *T. nasuta, P. meridionalis* and *O. algerica*. In El Emir Abdelkader, four constant species are noticed. These are *C. barbarus, E. pachygaster, L. migratoria* and *A. strepens.* On the other hand, the number of accessory species noted is only three, namely *O. tibialis, O. microptera* and *P. cognata*. The accidental species are only two it is *D. albifrons* and *O.*

Table 5. Frequencies of occurrence and constancy (%) of Orthoptera in the different stations.

Species/Stations	Jijel	El Aouana	Texenna	Béni Caid	El Emir Abdelkader	Beni Bélaid
O. algerica	11.8	17.6	23.5	23.5	23.5	-
O. microptera	-	11.8	-	5.9	35.3	-
D. albifrons	-	17.6	17.6	41.2	23.5	-
G. gryllotalpa	-	-	5.9	11.8	-	-
E. pachygaster	-	35.3	29.4	-	58.8	-
G. campestris	-	-	23.5	5.9	-	-
		-	17.6	23.5	-	
P. meridionalis	5.9	11.8	29.4	1.6	-	35.3
A. brachypterum	-	88.3	82.3	76.5	76.5	-
C. barbarus	76.5	35.3	17.6	11.8	5.9	88.2
E. plorans	17.6	47	52.9	47	-	47
P. giornai	29.4	23.5	76.5	11.8	-	-
A. aegyptium	-	76.5	23.5	70.6	17.6	-
A. turrita	41.2	52.9	41.2	82.3	52.9	52.9
A. strepens	76.5	17.6	-	29.4	-	70.6
A. thalassinus	5.9	23.5	41.2	-	-	23.5
A. insubricus	-	52.9	11.8	29.4	-	58.8
A. patruelis	41.2	-	-	-	5.9	64.7
A. longipes	94	70.6	64.7	70.6	-	-
O. caerulescens	52.9	-	-	-	-	76.5
S. lucasii	35.3	76.5	76.5	47	-	52.9
D. jagoi jagoi	52.9	47	23.5	11.8	47	70.6
O. tibialis	-	23.5	17.6	47	11.8	-
O. lucasii	11.8	-	35.3	17.6	-	58.8
O. raymondi	17.6	35.3	-	29.4	-	-
O. ventralis	23.5	41.2	17.6	23.5	5.9	-
T. nasuta	-	5.9	-	35.3	-	-
T.littoralis	17.6	17.6	-	29.4	-	-
P. elephas	-	-	-	11.8	-	-
P. cognata	-	-	11.8	-	-	35.3
P. laevigata	-	17.6	11.8	-	35.3	-
P. conica	-	-	-	-	58.8	-
L. migratoria	-					-

algerica. Finally, the Beni Bélaid station recorded the highest number of constant species (9), such as *C. barbarus, O. caerulescens, D. jagoi jagoi* and *A. strepens*. At the same time, it showed the number of incidental and incidental species lowest: 3 for the first (*E. plorans, P. meridionalis* and *P. elephas*) and only 1 for the second (*A. thalassinus*).

Centesimal frequencies or relative abundances

The relative abundance values calculated for each species month by month and station by station between April 2000 and November 2001 are shown in Table 6. The most common Orthoptera is in order of importance *C. barbarus* (47.9% in Texenna, 28.8% in El Aouana, 18.4% in Beni Bélaid and 16.6% in Beni Caid (Tab.6) The other species that attracted attention was *D. jagoi jagoi*, which was captured at average rates (24.4% in El Aouana, 19.8% in Texenna and 19.2% in Béni Bélaid, but also in an irregular manner, including *A. longipes* (31% in Jijel) and *O. tibialis* (22.6 %) and *P. cognata* (18.3%) both recorded in El Emir Abdelkader, and most of them have been encountered rarely or very rarely. The presence of *E. pachygaster* (16% in El Emir Abdelkader) is also noted and is the only common Ensifera.

Species Diversity

The Shannon diversity index is presented, station by station. It shows the population dynamics. The index values vary between stations and between months (Table 7). They reach a maximum of 2.83 bits in October 2000 in the station of Jijel and 2.82 bits in May 2000 in Texenna. In El Aouana, the maximum of 3.11 bits is reached in August 2001. This one is 3.08 bits in July 2001 at Beni Caid. Finally, this value was 2.30 bits in October 2000 and 3.36 bits in July of the same year respectively in El Emir Abdelkader and Beni Bélaid.

Fairness

Equitability is the ratio between the specific diversity H

Table 6. Relative abundances (%) of Orthoptera in different stations.

Species	Stations					
	Jijel	El Aouana	Texenna	Béni Caid	El Emir Abdelkader	Beni Bélaid
	1.26	0.9	1.56	2.38	2	
O. algerica	-	0.25	-	0.32	4.13	-
O. microptera	-	1.15	0.27	1.63	2.64	-
D. albifrons	-	-	0.41	0.43	-	-
G. gryllotalpa	-	2.05	0.97	-	16.01	-
E. pachygaster	-	-	2.23	0.97	-	-
G. campestris		-				-
		-	0.41	1.14		
P. meridionalis	1.13	0.4	4.05	1.95	-	-
A. brachypterum	-	28.76	47.9	16.63	12.06	18.64
C. barbarus	4.1	1.28	0.83	1.14	0.16	3
E. plorans	1.9	3.47	6	9.13	-	-
P. giornai	1.51	1.02	3.63	0.32	-	-
A. aegyptium	-	2.18	1.53	6.19	1	3
A. turrita	1.26	3.34	1.4	13.21	12.4	12.03
A. strepens	12	0.51	-	2.93	-	1.2
A. thalassinus	0.56	0.77	1.67	-	-	6.01
A. insubricus	-	3.1	0.41	0.81	-	4.81
A. patruelis	4.1	-	-	-	0.16	-
A. longipes	30.97	7.72	3.21	9.78	-	13.53
O. caerulescens	14.63	-	-	-	-	7.81
S. lucasii	9.64	24.4	19.8	3.09	-	19.24
D. jagoi jagoi	11.53	5.4	0.97	0.81	22.64	-
O. tibialis	-	2.44	0.41	7.83	0.33	7.7
O. lucasii	2.86	-	1.11	0.81	-	-
O. raymondi	0.7	4.4	-	9.3	-	-
O. ventralis	0.75	4.5	0.55	1.63	0.16	-
T. nasuta	-	0,.5	-	4.23	-	-
T.littoralis	1.4	0.77	-	1.63	-	1.5
P. elephas	-	-	-	1.14	18.3	-
P. cognata	-	-	0.27	-	-	-
P. laevigata	-	0.51	0.41	-	-	-
P. conica	-	-	-	-	8	-
L. migratoria	-					

'and the maximum diversity H'max. The results are summarized in Table 7. It should be noted that the fairness values obtained tend towards 1 in almost all stations for almost every month. This implies that the numbers of species tend to be in equilibrium with each other. The extremes are obtained in November 2001 in Béni Bélaid (E = 1) and during the same month in El Emir Abdelkader (E = 0.33).

Density and sex ratio calculation of *C. barbarus*

To better understand the bioecology of *C. barbarus* in the Jijel region, the density of this species per unit of 45 m^2 of surface area and its sex ratio are calculated. This study was carried out during the months of April 2000 until October 2001 in 6 stations (Beni Bélaid, Texenna, El Aouana, El Emir Abdelkader, Beni Caid and Jijel). Then the work is resumed from September 2011 until August 2013 in three stations (Texenna, Jijel and Kissir). The results are summarized in Tables 8-10.

In terms of density, it should be mentioned that outbreaks begin early in March in Jijel or April in El Emir Abdelkader, Beni Bélaid and Béni Caid (Table 8). However, the numbers increase to reach their peak in June and July, especially in Texenna where a density of 58 individuals is noted. Subsequently, the numbers of this species regress to become very weak in November. The density reaches a single individual per 45 m^2 in El Emir Abdelkader, Béni Bélaid, and Texenna, except in El Aouana where it remains relatively high (10 individuals).
In 2011, 2012 and 2013, the density of *C. barbarus* was calculated in Jijel, Texenna and Kissir (Tab.9).It should be noted from this table that the Jijel station almost always records the lowest numbers (18 individuals maximum) despite a slight increase (average of 12 individuals in 2012 against 2 in 2001). The conditions of the seaside dunes environment seem to be unfavorable for the barbarin locust, which has shown a clear preference for the Texenna garrigue, which is situated at a high altitude (500 m). Indeed, the numbers are very

Table 7.Shannon-Weaver Diversity Index and Month by Month Fairness for Different stations.

		Stations											
		Jijel		Texenna		El Aouana		BéniCaid		El Emir Abdelkader		Beni Bélaid	
Years	Months	H'	E	H'	E	H'	E	H'	E	H'	E	H'	E
	April	2.45	0.77	2.73	0.91	2.03	0.87	1.67	0.83	1.06	0.66	1.90	0.95
	May	2.18	0.84	2.82	0.88	2.36	0.78	2.19	0.78	1.94	0.83	1.84	0.79
	June	2.01	0.86	1.88	0.59	2.33	0.73	2.50	0.89	1.47	0.73	3.33	0.87
	July	1.92	0.82	1.54	0.59	2.02	0.78	2.06	0.88	1.28	0.64	3.36	0.93
	August	1.48	0.63	1.65	0.71	1.97	0.84	1.59	0.79	1.93	0.74	2.93	0.88
	September	2.02	0.78	2.12	0.75	2.46	0.68	2.76	0.87	1.36	0.68	2.94	0.84
	October	2.83	0.85	2.17	0.62	2.65	0.83	2.74	0.86	2.30	0.81	2.45	0.94
2000	November	2.45	0.87	1.68	0.84	1.49	0.94	2.22	0.85	1.38	0.59	1.35	0.85
	March	1.61	0.80	1.09	0.54	2.46	0.87	2.17	0.83	1.58	0.68	0	0
	April	1.87	0.80	2.06	0.73	2.43	0.81	2.56	0.80	1.33	0.83	1.97	0.98
	May	1.84	0.79	2.77	0.92	2.98	0.89	2.65	0.87	1.55	0.77	2.65	0.83
	June	1.83	0.78	1.70	0.51	2.90	0.80	3.06	0.85	2.18	0.77	3.21	0.89
	July	1.99	0,.6	1.68	0.52	2.54	0.84	3.08	0.80	1.49	0.57	3.07	0.85
	August	1.98	0.76	1.96	0.65	3.1	0.86	3.03	0.87	1.90	0.73	3.13	0.90
	September	2.22	0.79	2.29	0.68	2.69	0.80	2.69	0.80	1.48	0.74	2.93	0.88
	October	2.69	0.89	2.25	0.75	3.10	0.89	2.20	0.73	1.37	0.86	2.22	0.85
2001	November	1.91	0.82	2.11	0.90	2.94	0.84	2.45	0.77	0.33	0.33	1.00	1.00

H '= Index of diversity; E = Fairness= H/lnS.

Table 8. Density of *C. barbarus* by 45 m^2 during the years 2000 and 2001.

		Stations					
Years	Months	Béni Bélaid	Texenna	El Aouana	El Emir Abdelkader	Béni Caid	Jijel
	April	1	-	-	-	-	2
	May	16	6	20	3	6	3
	June	12	27	23	7	5	6
	July	10	50	11	4	5	3
	August	10	30	11	9	9	2
	September	8	15	13	6	9	2
	October	4	23	16	9	9	1
	November	1	3	2	2	-	-
2000	Mean	7.7	22	13.7	5.7	7.2	2.7
	March	-	-	-	-	-	1
	April	2	-	2	-	1	1
	May	10	5	8	2	4	3
	June	10	58	26	7	11	1
	July	14	46	27	3	14	2
	August	10	23	6	18	19	2
	September	7	37	21	-	-	-
	October	9	19	12	2	2	-
	November	-	1	10	1	-	-
2001	Mean	8.8	27	13	5.5	8.5	1.7

high in this station where the average density was 27 individuals in 2001 and 32 in 2012. The fallow Kissir seems also suitable for *C. barbarus* where an average number of 23.5 is noted in 2013 (Table 9).

As for the sex ratio, it is generally balanced and close to 1 in the three stations studied. These numbers are recorded for most of 2011-2012 and 2013. However, males were more numerous in September 2011 and July 2013 in Kissir where a maximum value of 2.5 was recorded. For females, a minimum value of 0 is observed in November 2011 in Texenna and in May 2013 in Kissir (Table 10). The month of November coincides generally with the end of the reproduction in *C. barbarus* causing the death of the females.

DISCUSSION

The Orthopteran fauna of the Jijel region, with these 32

Table 9. Density of *C. barbarus* by 45 m² during the years 2011, 20012 and 2013.

Years	Stations Months	Texenna	Kissir	Jijel
	September	15	14	11
	October	21	20	13
	November	8	5	1
2011	Mean	14.7	13	8.3
	May	21	5	10
	June	20	16	18
	July	67	20	13
	August	22	22	9
	September	53	30	9
	October	32	22	-
	November	10	-	-
2012	Mean	32.1	19.2	11.8
	May	18	11	5
	June	16	12	6
	July	41	35	10
	August	35	36	8
2013	Mean	27.5	23.5	7.25

Table 10 .Sex ratio of *C. barbarus* in the stations.

		Texenna			Kissir			Jijel		
					Sex					
Years	Months	M	F	M/F	M	F	M/F	M	F	M/F
	September	9	6	1.5	10	4	2.5	4	7	0.57
	October	10	11	0.9	9	11	0.81	4	9	0.44
2011	November	4	4	1	1	4	0.25	0	1	0
	May	10	11	0.9	2	3	0.66	1	9	0.11
	June	11	9	1.22	8	8	1	10	8	1.25
	July	27	40	0.67	10	10	1	5	8	0.62
	August	12	10	1.2	10	12	0.83	3	6	0.5
	September	21	32	0.65	16	14	1.14	5	4	1.25
	October	13	19	0.68	13	9	1.44	-	-	-
2012	May	2	8	0.25	-	-	-	-	-	-
	June	3	2	1.5	2	9	0.22	3	2	1.5
	July	8	8	1	5	7	0.71	3	3	1
	August	19	22	0.86	25	10	2.5	5	5	1
2013	May	16	19	0.84	16	20	0.8	4	4	1

M = male individuals; F: female individuals.

species, is considered to be very diverse. Majority of them are Caelifera. It is possible that trapping techniques are not suitable for catching Ensifera. Indeed, a very clear evolution is observed in comparison with the 22 species recorded by Tekkouk (2012) in the locality of El Aouana and the 24 species inventoried by Rouibah (2011) in the Taza National Park. The latter cited, among the acridofauna, three species not found during the surveys at the various stations in the Jijel region. These include *Talpomena algeriana, Heteracris annulosus* and *Oedaleus decorus*. On the other hand, these results confirm those of Rouibah and Doumandji (2013) concerning the predominance of Oedipodinae, Gomphocerinae and to a lesser extent Acridinae compared to other sub-families of locusts.

The majority of these locust species are eurytopes. They are present at least in two stations except *Pyrgomorpha laevigata* and *Locusta migratoria* which have only been encountered in a single station. It is Texenna for the first and El Emir Abdelkader for the second species. They are therefore considered as stenotopes.

In terms of sampling quality, the values obtained are all very close to zero. This shows that the number of surveys is sufficient. It should be remembered that an inventory is accurate and sufficient when the quality of the sampling tends towards 0 (Ramade, 1984).

Some stations have had a fairly large total wealth, such as Béni Caid (25), Texenna and El Aouana (23 species

each). Others are less rich, such as Beni Bélaid (13) and El Emir Abdelkader (14).

The reasons for the high species richness at Béni Caid may be the very dense vegetal cover which characterizes this habitat. Indeed, it is a maquis very rich in Mediterranean species surrounded by a cork oak forest. Adds to that, the total lack of human activity because of its remoteness and its isolation. These are ideal conditions for the installation of a rich and diverse acridofauna. It is quite the opposite of what exists at Béni Bélaid where the human activity is very intense, knowing that the dunes in question are very close to an agricultural farm very strongly frequented by the peasants. This resulted in poor and less diverse wealth (only 13 species). As for the effect of the altitude, it was not very influential. Indeed, Texenna culminating at 500 m has hosted an acridofauna composed of 23 species, while El Aouana and Jijel where the altitude is almost zero recorded 23 and 17 species respectively.

Under the same ecological conditions, Doumandji-Mitiche et al. (1991) captured 13 species of Orthoptera in fallow land and 14 others in a bush near Lakhdaria. This result partly confirms that of the authors mentioned above, since 14 species were also caught in the fallow land of El Emir Abdelkader. But the number differs for the bush where 25 species were observed in Béni Caid. According to Benzara et al. (2010) the zone of the Little Kabylie in the North East of Algeria (of which the region of Jijel belongs to) is distinguished by a great specifics richness (32). This is due to ecological conditions favorable to the life of locusts, in particular, because they are rich in plant species (Lachaise, 1979).

Constant species are almost the same in all stations. The order of importance is *C. barbarus, A. strepens, O. caerulescens sulfurescens, D. jagoi jagoi* and *A. turrita*. These results are different from those reported by Rouibah and Doumandji (2012). According to the latter, the constant species in the National Park of Taza (P.N.T.) near Jijel, are two. These include *Paratettix meridionalis* and *Talpomena algeriana*. On the other hand, *C. barbarus, D. jagoi jagoi* and *Oedipoda caerulescens* were considered as incidental species because of the disturbances that Taza National Park (P.N.T.) has experienced mostly development and clearing. In the current work, the different study sites have been stable during the years of prospecting.

This has resulted in a high number of constant species. The most abundant species, all stations confounded, is incontestably *C. barbarus*. It has been collected abundantly especially in the station of Texenna, an open scrubland and well exposed to the sun. This seems, therefore very logical since according to Monard (1986); Fontana et al. (2002) and Olmo-vidal (2006), it is a thermophilic and xerophilic species, with a preference for arid lands with sparse vegetation. It has been reported both on dunes and in garrigues (Chara, 1987; Defaut, 1988).

Furthermore, other studies (Tekouk, 2012) reported that the most abundant species are *Aiolopus strepens* with variable frequencies of 17 to 30.5% depending on the station. The results of this work seem to contradict those obtained by the author above. Indeed, in the present study, this same species is captured with only frequencies oscillating between 1.4 and 14%. As regards *Calliptamus wattenwylianus*, it is likely that the author confound it with *C. barbarus*. Indeed, during all the years of field surveys, first between 1990 and 1994 in the Taza National Park (Rouibah and Doumandji, 2006) or during this work (2000-2014), this Calliptaminae was never found in the locality of El Aouana where the study above was carried out. The only species of the genus *Calliptamus* present therefore in the region of Jijel is *C. barbarus*.

Among the acridofauna of the Jijel region, the most important species are *C. barbarus*. Not only it is a potential pest of cultivated plants, but also infests a wide range of wild plant species. The barbarin locust has been regularly collected, both in time and space. These species were sampled at all stations and for almost all years. A large part of this work is devoted to it, starting with the calculation of density and sex ratio in three stations: Texenna, Kissir and Jijel.

By comparing density year by year and station by station, it can be seen that 2012 is the year when the maximum number of individuals per area is recorded especially at Texenna that by far recorded the highest densities. This may be due to the climatic conditions that prevailed during this time, particularly the very favorable temperature that allowed large-scale outbreaks. On the contrary, Jijel showed its poorly represented in *C. barbarus* during almost all the months of 2001. Apparently, this station of dunes located at the seashore, is not suitable for the barbarin locust which prefers to frequent open garrigues as reported by Monard (1986). This is the case of Texenna located at 500 m altitudes.

In terms of sex ratio, in all three stations, the ratio between males and females is generally very balanced, with a few exceptions where there is a biased sex ratio in favor of one or the other partner (0 in Jijel in favor of the females and 2.5 in Kissir in favor of the males.) According to Fisher (1930) natural selection favors parents equitably investing in their sons and daughters, resulting in sex-ratio close to 1. If the latter is biased, there will be a rapid return to equilibrium, and this is an evolutionarily stable strategy (Fisher, 1930). The 1: 1 sex ratio is therefore the evolutionary strategy stable, or the equilibrium value of the sex ratio (Hamilton, 1967). However, sex-ratio biases are frequent in nature for many animal species (Razouls et al., 2008). The causes are many, including the amount of food (Charnov et al., 1981), Population density (Loeske et al., 1999), climate (Quinn et al., 2007), competition (Macke et al., 2011) and parasites (Verne et al., 2011). Finally, it should be noted that the individual ability to modify his sex ratio is an adaptation to changes

in the environment and biotic interactions.

CONCLUSION

The realization of this work falls within the framework of the knowledge of the bioecology of the Orthoptera of the Jijel region. These Orthoptera is still very poorly known, despite a few works carried out in recent years.

The acridofauna of the Jijel region is composed of 32 species, the majority of which are Cealiferous and notably Acrididae. It is mainly represented by Oedipodinae and Gomphocerinae. The scrubland of Texenna, the forest of Béni Caid and the fallow of El Aouana have presented the highest specific diversities. On the other hand, Beni Bélaid and the cultivated land of Kissir are the two least diversified resorts. Moreover, *Acrida turrita, Aiolopus strepens* and especially *Calliptamus barbarus*, are the species most regularly present in all stations they are therefore considered as Eurytopes species. In contrast, other species are present in only one station such as *Locusta migratoria* and *P. laevigata*. So these are stenotropic insects.

Among this acridofauna, *C. barbarus* is the most economically important species. It was found mostly at the station of Texenna an open and sunny garrigue. The conditions are ideal for the installation of this species where it has been collected in large numbers. Indeed, the density per 45 m^2 of surface reached sometimes 67 individuals, especially during times of hatching. The study of the sex ratio of this species showed a certain balance between males and females, sometimes with a bias for either sex depending on the sampling period and the stations.

REFERENCES

Ayala LM (2014). Study and monitoring of the fauna of Orthoptera from a natural environment subjected to an ecological restoration program in the south of the Iberian Peninsula. Doctoral Thesis, University of Córdoba, Spain. pp: 284

Barbault R (1981). Ecology of populations and stands. Ed Masson, Paris. pp: 200.

Barbault R (2003). General ecology. Structure and functioning of the biosphere. Ed. Dunod, Paris. pp: 326.

Benkhelil ML (1991). Harvesting and trapping techniques used in terrestrial entomology. Ed. Office Pub. Univ, Alger. pp: 60.

Benzara A, Khalfi-Habes O, Lazib Z, (2010).Efficacy of aqueous extracts of Peganum harmala (Zygophylaceae) on locust L5 larvae, Schistocerca gregaria (Forsskâl, 1775) (Orthoptera, Acrididae). Proceedings of the 7th Congress of the Moroccan Association for Plant Protection, Rabat. pp: 469- 474.

Blondel J (1975). Analysis of Bird Stands-Element of an Ecological Diagnosis: The Progressive Frequency Sampling Method (E.F.P). Rev. écol. (Terre et vie). 29 (4): 533-589.

COPR (1982). The locust and grasshopper. Agricultural Manual. Centre for overseas pest Research. London. pp 690.

Chara B (1987). Comparative study of the biology of Calliptamus barbarus (Costa, 1836) and Calliptamus wattenwylianus (Pantel, 1896) (Orthoptera-Acrididae) in western Algeria. Thesis Doc. Ing., Univ. Aix-Marseille, France. pp 191.

Charnov EL, Hartogh RL, Jones WT, Van den Assem J, (1981). Sex ratio evolution in a variable environment. Nature. 289: 27-33.

Chopard L (1943). Orthoptera of North Africa. Fauna of the French Empire. Ed. Larose, Paris. pp 450.

Dajet P (1976). Mathematical models in ecology. Ed. Masson, Paris. pp 172.

Dajoz R (1971). Précis of ecology. Ed. Gauthiers-Villars, Paris. pp 434.

Dajoz R (1982). Précis of ecology. Ed. Gauthiers-Villars, Paris. pp 503

Defaut B (1988). Determination of Western Palearctic Orthoptera. *L'entomologiste.* 44(6): 337-345.

Doumandji-Mitiche B, Doumandji S, Benzara A, Guecioueur L, (1991). Ecological comparison between several Orthoptera stands in the Lakhdaria region (Algeria). Announcements Faculty Agriculture, Univ. Ghent., 56 / 3b: 1075-1082.

Eades DC, Otte D, Cigliano MM, Braun H, (2014). OrthopteraSpecies File. Version 5.0/5.0. Disponible sur http://Orthoptera.SpeciesFile. Online (Accessed September 20, 2016).

Fisher RA (1930). The Genetical Theory of Natural Selection. Ed. Clarenton, Oxford. pp307.

Fontana P, Buzetti FM, Cogo A, Odé B, (2002). Guida al riconoscimento e allo studio i cavaletti Grilli, Mantidi e insetti affini del venetto. Museo Naturalistico Archeologico, Vicenza. pp 592.

Franck A (2008). Capture, packaging, shipping, collection of insects and mites for identification. Ed. CIRAD, Montpellier. pp 50.

Grall J, Coïc N (2006). Summary of methods for assessing the quality of benthos in the coastal environment, European University Institute of the Sea. Marine Environment Sciences Laboratory, Univ. from Western Brittany. pp 90.

Gregoire P, Abriak NE, Brakni S, Achour R (2013). Evaluation of the benthic quality of the disposal zones of dredged sediments. Rev. Paralia. 6: 313-324.

Hamilton WD, (1967). Extraordinary sex ratios. Science, 156:477-488.

Lachaise D, (1979). The concept of niche in Drosophila. Earth and life. 33: 130-137.

Lecoq M, (1992). Locust surveillance in the Sahel. Newsletter n ° 4, Sahel Locust Surveillance, French Interdisciplinary Research Program on Locusts in the Sahel, Montpellier. pp 17-18.

Loeske EB, Clutton-Brock TH, Steve DA, Pemberton JM., Fiona E, (1999). Guinness Population density affects sex ratio variation in red deer. Nature, 399: 459-461.

Louveaux A, Ben Halima T (1987). Catalog of Orthoptera Acridoidae of North West Africa, Bull. So. Ent. France. 91 (3-4): 73-87.

Macke E, Magalhães S, Bach F, Olivieri I, (2011). Experimental Evolution of Reduced Sex Ratio Adjustment Under Local Mate Competition. Science, 334: 1127-1129.

Massa B, Fontana P, Buzzetti FM, Kleukers R, Odé B, (2012). Fauna d'Italia, 48. Orthoptera. Ed. Calderini, Buckinghamshire. pp. 563.

Monard A (1986). Bioecological study of locusts in Bas-Languedoc. Thesis. Doct. University of Paris 6. pp543.

Olmo-Vidal JM, (2006). Atlas Ortòpters de Catalunya and red book. Generalitat de Catalunya, Barcelona. pp 428.

Oudjane A, Doumandji S, Daoudi-Hacini S, Boussad F (2014). Biodiversity of entomological inventories in the Tigzirt region. AFPP – Proceedings of the Tenth International Conference on Agricultural Pests,22- 23 October, Montpellier France, pp:1- 7.

Quinn AE, Georges A, Sarre SD, Guarino F, Ezaz T, Graves JA, (2007). Temperature Sex Reversal Implies Sex Gene Dosage in a Reptile. *Science.* 316 (5823): 411, DOI: 10.1126.

Pielou EC (1975). Ecological Diversity. A Wiley-Interscience Publication, New York

Ramade F (1984). Elements of ecology. Fundamental ecology. Ed. Mac. Graw Hill, Paris. pp 197.

Ramade F, (2003). Elements of ecology. Fundamental ecology.Ed.Dunod,Paris. pp 690 .

Ramade F, (2009) - Elements of ecology. Fundamental ecology. Ed. Dunod, Paris. pp 689.

Razouls C, De bovee F, Kouwenberg J, Desreumaux N (2008). Diversity and Geographic Distribution in Marine Planktonic Copepods. Available on http://copepodes.obs-banyuls.fr (Accessed October 15, 2016).

Rouibah M (1994). Study of the diet of *Calliptamus barbarus* and

Dociostaurus jagoi jagoi in the Jijel region. Acridology Day, 21 mars, INA El Harrach, Algéria. pp: 7-8.

Rouibah M (2011). Study by factor analysis of the distribution of Orthoptera in three stations of the Taza National Park. Proceedings of the National Symposium on Plant Health and the Environment, 3-4 May, University of Mascara, Algéria, pp: 20.

Rouibah M, Doumandji S (2006). Study of the ovarian development of *Calliptamus barbarus* in the Jijel region. Proceedings of the 1st International Congress of Entomology and Nematology, 17- 20 avril, INA, El Harrach, Algérie, pp:50.

Rouibah M, Doumandji S (2012). Systematic of Orthopthera in the Taza National Park (Jijel). *Proceedings* of the 3rd Franco-Maghreb Congress of Zoology and Ichthyology, 6-10 November, Marrakech, Maroc, pp: 138.

Rouibah M, Doumandji S (2013). Inventory of three stands of Orthoptera in the Taza National Park (Jijel, Algérie). Atlas Ortòpters de Catalunya and red book. Generalitat de Catalunya, Barcelona. pp 428.

Tekkouk F, (2012). Ecological study of four population acridians (*insecta-Orthoptera*) area of El-Aouana (Jijel-Algeria). Agric. Biol. Journal of North America,3(2): 57-68.

Verne S, Johnson M, Bouchon D, Grandjean F (2011). Effect of parasitic sex ratio distorters on host genetic structure in the Armadillidium vulgare-Wolbachia association. Journal of evolutionary biology. 25: 264-276.

Weesie PDM, Belemsobgo U, (1997). The diurnal raptors of the Game Ranch Nazinga (Burkina Faso). Alauda, 65 (3): 263 - 278.

Zar JH, (1999). Biostatistical analysis. 4th Ed. Prentice-Hall, Inc Englewood cliffs New Jersey. USA.