

**CONTRIBUTION OF THE KNOWLEDGE ON LOCUST AND GRASSHOPPERS
 FAUNA IN THE AURES REGION (EASTERN ALGERIA) AND THE
 BIOECOLOGICAL STUDY OF *PRAEPHIPPIGERA PACHYGASTER* (LUCAS, 1849)
 (ENSIFERA, TETTIGONIIDAE)**

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Abstract

Description of the subject: This article presents the inventory of Orthopterans and bioecological study of the species *Praephippiger pachygaster* (Lucas, 1849).

Objective: The aim of this study is to make an inventory, to get an idea of the dispersion of the Orthopterans and to determine which species are of economic importance in the study area.

Methods: The sampling methods and the bio-ecological study make it possible to estimate the abundance of Orthopterans in the study area.

Results: The investigation results indicate 25 species belonging to 11 sub-families and five families. The distribution of Orthoptera species between study stations indicates that the Belezma station remains the richest with 22 species while the Ain Djasser station is the lowest with only five species. The bioecological study of the species *Praephippiger pachygaster* (Lucas, 1849) of the Tettigoniidae family shows that this species is polyphagous with a preference for family plants: Asteraceae and Poaceae. This species occurs in Khenchela region with a marked outbreak during the study period.

Conclusion: The study of the diversity and structure of the Orthopteran population shows that the study area is diverse (25 species). The species *Ocneridia volxemii*, *Dosiostaurus maroccanus* and *P. pachygaster* seem to be the most of economic important species in the Aures region.

Keywords: Aures; Bioecological study; Inventory; Orthopterans; *Praephippiger pachygaster*.

**CONTRIBUTION À LA CONNAISSANCE DE LA FAUNE DES ORTHOPTÈRES
 DANS LA RÉGION DES AURÈS ET ÉTUDE BIOÉCOLOGIQUE DE
PRAEPHIPPIGERA PACHYGASTER (LUCAS, 1849) (ENSIFERA, TETTIGONIIDAE)**

Résumé

Description du sujet : Le présent travail porte sur la réalisation d'un inventaire et l'étude bioécologique de l'espèce *Praephippiger pachygaster* (Lucas, 1849).

Objectifs : Cette étude a pour objectif de dresser un inventaire, d'avoir une idée sur la dispersion de la faune des orthoptères et de déterminer les espèces qui ont une importance économique dans la région d'étude.

Méthodes : Les méthodes d'échantillonnage et l'étude bioécologique permettent d'évaluer l'abondance des orthoptères dans la région d'étude.

Résultats : Les investigations ont révélé la présence de 25 espèces appartenant à 11 sous-familles et cinq familles. La répartition des espèces d'Orthoptères entre les stations d'étude indique que la station de Belezma reste la plus riche avec 22 espèces alors que la station d'Ain Djasser est la moins riche avec seulement cinq espèces. L'étude bioécologique de l'espèce *P. pachygaster* de la famille des Tettigoniidae montre que cette espèce est polyphage avec une préférence pour les plantes de la famille: Asteraceae et Poaceae. Cette espèce est présente dans la région de Khenchela avec une pullulation marquée durant la période d'étude.

Conclusion : L'étude de la diversité et de la structure du peuplement d'orthoptères montre que la région d'étude est diversifiée (25 espèces). Les espèces *Ocneridia volxemii*, *Dosiostaurus maroccanus* et *P. pachygaster* semblent être les plus importantes du point de vue économique dans la région des Aurès.

Mots clés : Aurès ; étude Bioécologique ; Inventaire ; Orthoptères ; *Praephippiger pachygaster*.

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INTRODUCTION

For many centuries, the problems caused by pests have received much attention. Among these insects, locust and grasshoppers that cause severe damage to crops and pastures. If the conditions for the development of these insects are favorable, the damage will be considerable. Algeria by its geographical location and the extent of its territory occupies a preponderant place in the air habitat of a very diverse locust fauna.

Several studies have been conducted on locust fauna in Algeria: Chara [1], Doumandji *et al.* [2, 3], (Ould-Elhadj [4-6], Maurel [7], Moussi [8] and Benkenana *et al.* [9-13]. In locust survey, it is difficult to cover an entire region, so it was necessary to sample existing habitats and select representative sites. We have chosen the study stations in collaboration with the services of the National Institute of Plant Protection (INPV) of Batna and Khenchela region, where reported to us the high density of species of grasshoppers in our survey. Also, it was included the species

P. pachygaster (Lucas, 1849), which is observed with a marked outbreak during the study period. In Aures Algeria, the population of the Orthopterans has been the subject of few studies [14, 15]. In this prospect we are interested to make an inventory of the Orthoptera fauna in the Aures region and the study of *P. pachygaster* species, the bioecology of the latter species unknown in Algeria before. *P. pachygaster* is a very variable species in color with its tiny wings; it can produce loud and quite strident sounds. The posterior half of the horn-like pronotum acts like a megaphone, the song consists of short double sounds that can be transcribed by "tsi-schipp" which are also transmitted by the female [16].

MATERIALS AND METHODS

1. Study area

The stations of study chosen according to the presence of the grasshoppers and locusts, they are belonged Khenchela and Batna region. These eco-climatic characteristics in table (1).

Table 1: The eco-climatic characteristics of Batna and Khenchela regions

Characteristics / region	Batna	Khenchela
Geographic coordinates	35°33 North 7°55 East	35°05 North 7°08 East
Altitude	980m (until 1200 m at Belzma)	983m (until 2 328 m at Chilia)
T°C Average winter	1.4°C	/
T°C average summer	35.6°C	36°C
Annual precipitation	300-500mm	520mm
Bioclimatic floor	Semi-arid to cold winter	Semi-arid to cold winter (dry summer)
The vegetation	Cereal growing, arboriculture and fallow. The alfa (<i>Stipatana ssisima</i>) and the Diss(<i>Ampelodesmos mauritanicus</i>).	Forests and maquis. Market gardening and fruit growing. Cereals, Food legumes and cucurbits.
Prospected sites	Belezma (35°9' 47'' N, 7°55' 10 ''E, 991m), Oued Chaaba (35° 30' 17'' N, 6° 04' 40'' E) and Ain Djasser (35° 51' 40'' N, 6° 00' 04'' E, 831 m)	El-Hamma (35°12' 42'' N, 6°46' 13 ''E, 1049 m)

2. In the field

For the collection of Orthopterans hand capture was used for wingless individuals (Pamphagidae), however the filleting net was used winged individuals such as Acrididae and Pyrgomorphidae.

3. In the laboratory

The systematic determination of grasshoppers' species is carried out using several keys of determinations: Chopard [17], Jago [18], Launois [19], Massa *et al.* [20]. Classification and nomenclature have been updated through the websites: (<http://orthoptera.speciesfile.org> [21] and <https://acrinwafrica.mnhn.fr>) [22]. To identify the species of the family Pamphagidae, the assembly of male genitalia was used.

4. Morphometric analysis

For the morphometric analysis of the species *P. pachygaster*, the following parameters: the length of the head, the thorax, the abdomen, as well as the length and height of the posterior femur were measured. In addition, the items at the antennas were also counted. These measurements were made using a graph paper. For the study of female fecundity, number of eggs was counted for this species.

5. The diet study

Analysis of this diet is facilitated by the easy determination of the fragments of epidermis contained in the digestive tract or in the feces [23]. The epidermal fragments in the feces and in the digestive tract are homogenized for a few seconds to a minute in sodium hypochlorite and discoloration without apparent destruction of the epidermis.

After rinsing in distilled water, followed by a few minutes bathing in alcohol with a progressive concentration (70°, 80°, 96°). The treated epidermis is preserved between blade and coverslip in Canada balsam. A microscopic observation is performed. We have calculated the relative frequencies of plant families in faces.

RESULTS

1. Inventory

The inventory of Orthoptera fauna in present study area shows the presence of 25 species belonging to 11 sub-families and five families. Our inventory has had a rather interesting diversity. The results are shown in (Table 2).

Table 2: Inventory of locust and grasshoppers fauna in the study area; S1: Ain Djasser, S2: Oued Chaaba, S3: Belezma, S4: El Hamma

Sub. Order	Family	Sub. family	Species	S1	S2	S3	S4	
Caelifera	Pamphagidae	Pamphaginae	<i>Pamphagus auresianus</i> (Massa, 1992)	+	+	+	+	
			<i>Pamphagus djelfensis</i> (Vosseler, 1902)	-	+	+	+	
			<i>Pamphagus batnensis</i> (Benkenana& Petit, 2011)	-	+	+	+	
			<i>Ocneridia volxemii</i> (Bolivar, 1878)	+	+	+	+	
			<i>Ocneridia nigropunctata</i> (Lucas, 1849)	-	-	+	+	
		<i>Acinipe sp</i> (Rambur, 1838)	-	+	+	-		
		Thrinchina	<i>Tmethis cisti cisti</i> (Fabricius,1787)	+	-	+	+	
			<i>Tmethis pulchripennis algerica</i> (Saussure, 1888)	-	-	-	+	
		Pyrgomorphidae	Pyrgomorphae	<i>Pyrgomorpha miniata</i> (Bolivar, 1914)	-	-	+	+
				<i>Pyrgomorpha vosseleri</i> (Uvarov, 1923)	-	-	-	+
	Acrididae	Gomphocerinae	<i>Dociostaurus jagoi jagoi</i> (Soltani, 1978)	-	-	+	-	
			<i>Dociostaurus maroccanus</i> (Thunberg, 1815)	-	-	+	-	
			<i>Heteracris harterti</i> (I.Bolivar, 1913)	-	-	+	-	
		Eyprepocnemidinae	<i>Eyprepocnemis plorans</i> (Charpentier, 1825)	-	-	+	-	
			Calliptaminae	<i>Calliptamus barbarus barbarus</i> (Costa, 1853)	-	-	+	-
		<i>Calliptamus wattenwylanus</i> (Pantel, 1896)		-	-	+	-	
		Cyrtacanthacridinae	<i>Anacridium aegyptium</i> (Linné, 1764)	-	-	+	-	
			<i>Oedaleus decorus</i> (Germar, 1853)	-	-	+	+	
		Oedipodinae	<i>Aiolopus strepens</i> (Latreille, 1804)	+	+	-	-	
			<i>Sphingonotus caeruleans</i> (Linnaeus, 1767)	-	-	+	-	
			<i>Acrotylus patruelis</i> (Herrich-Schaffer,1838)	+	+	+	+	
			<i>Thalpomena algeriana algeriana</i> (Lucas, 1849)	-	-	+	-	
			<i>Truxalis nasuta</i> (Linnaeus, 1758)	-	-	+	+	
	Dericorythidae	Dericorythinae	<i>Dericorys millierei</i> (Finot&bonnet, 1884)	-	-	+	-	
	Ensifera	Tettigoniidae	Bradyporinae	<i>Praehippiger pachygaster</i> (Lucas, 1849)	-	+	+	+
Total	5	11	25	5	8	22	13	

+: Present, - : Absent

2. Study of the species *Praehippiger pachygaster*

The genus *Praehippiger* Ebner, 1938; a single species living in Algeria is *Praehippiger pachygaster* Ebner, 1938

(Synonyms: *Ehippiger pachygaster* lucas, 1849=*Platystotus pachygaster* Krauss and Vosseler, 1896=*Ehippiger audryanus* (Bonnet and Finot, 1885) (Fig. 1, 2).



Figure 1: Photos of *Praehippiger pachygaster* in the field

2.1 Morphometric analysis

For morphometric analysis of males and females, the results are shown in the (Table 3).

Table 3: Morphometric analysis of males and females of the species; L: length, l: width

Organ Individuals	Head (mm)	Thorax (mm)	Posterior femur (mm)	Abdomen (mm)	Number of antenna articles
Males (n=5)	3.9±0.25	11.2±1.5	L : 21.8± 0.5 l: 2.9±0.25	24.6±5.5	92
Females (n=5)	4±0.5	10.2±1	L : 22±1.5 l : 2.8 ±0.5	22.3±2.25	120

2.2 Fertility study

In order to express the morphometric measurements of the females and its range (ootheca), we performed the dissection of the

females of *P. pachygaster* to count and measure the size of the eggs. The results are shown in (Table 4).

Table 4: Fertility study of females

Female /eggs	Number of eggs	Size of eggs (mm)
Female 01	46	6
Female 02	51	6.2
Female 03	49	6.2
Average	48.66	6.13

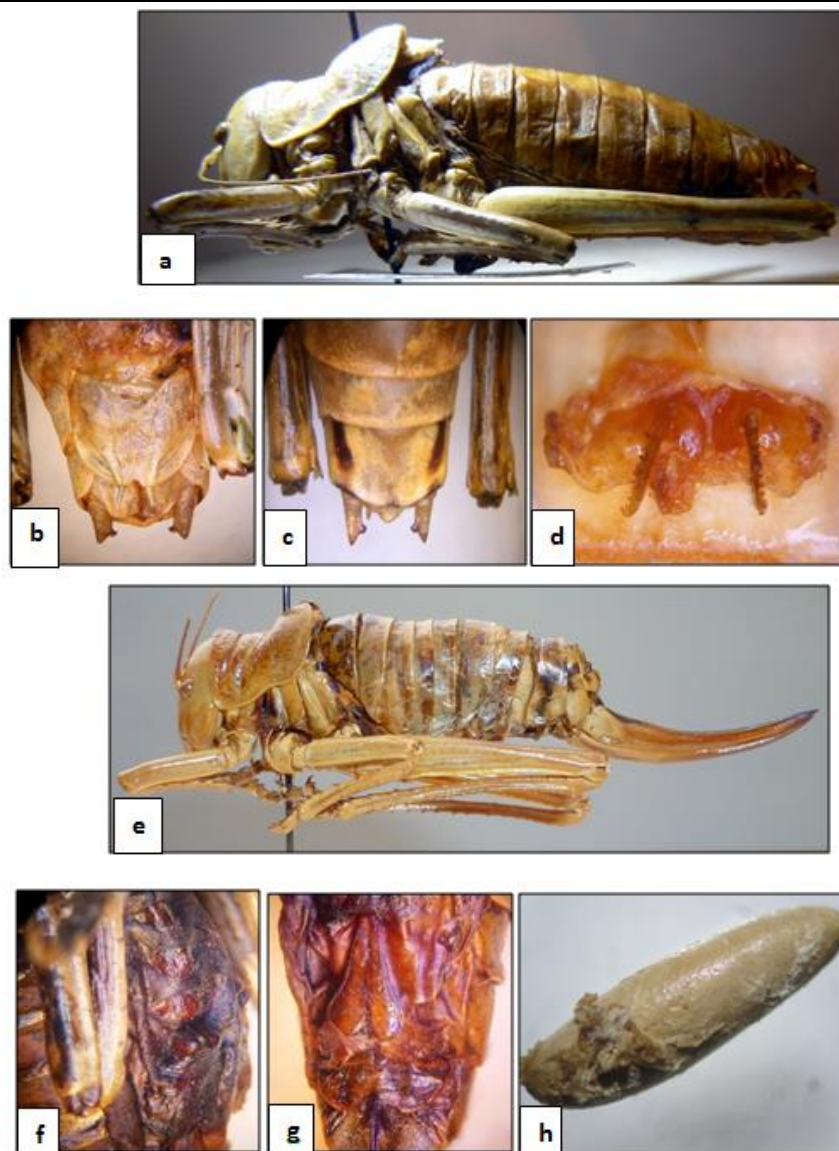


Figure 2: Microscopic photos of *Praehippiger pacygaster* (Lucas, 1849) (×40).
 a : SubgPlMale[1], b : SubgPlMale [1] c : LastTergite&CerciMale [1], d : Titillators Male[1], e : F1[1], f : Bulge6thSternite Female [1], g : SubgPl Female[1], h : Egg F1[1]

2.3 The diet study

In the study of the diet of the species *P. pachygaster* we followed three methods to know the type of plants preferred by this species: The first comes down to the analysis and the identification of the plants present at the sampling location (Table 5). The second method relates to the microscopic analysis of prepared slides based on feces of this species. For the third method, we tried to analyze with the microscope the prepared slides containing contents of the digestive tract.

Table 5: Frequency of plant occurrence present in the feces of males and females of *P.*

Families	Frequency (%)	Frequency (%)
	females	males
Asteraceae	52.17	49.99
Poaceae	26.08	21.42
Fabaceae	4.34	7.14
Other families with fragments (insects and arthropods)	17.36	21.42

pachygaster

In the field

During our follow-up of the individuals of this species in the field, we noticed that *P. pachygaster* preferred plants belonging to two plant families, Asteraceae and Poaceae.

In the laboratory

Microscopic analysis of male and female feces slides, revealed the presence of six plants of different shapes and colors, which enabled us to establish the frequency table of each plant family (Table 5). The most consumed families are Asteraceae with both species (*Carthamus lanatus*, *Echinops spinosus*) and Poaceae with *Hordeum sp.*

Analysis of the contents of the digestive tract

The microscopic analysis of the slides of the contents of the digestive tract of males and females each time revealed to presence of three plants; *Carthamus lanatus*, *Echinops spinosus*, and *Hordeum sp.* Fragments of insects and other arthropods were also observed.. Diet of males was similar to as almost of females. This analysis confirms the previous results concerning the type of diet of *P. pachygaster*.

DISCUSSION

Despite the unfavorable circumstances and the limited duration of our study, it was possible to identify 25 species. The inventory of locust fauna totals the presence of 73 species in eastern Algeria according to Gabel and Boutrouf [24].

Louveaux and Benhalima [25] cite 140 locust species for all of Algeria. So our inventory has experienced a rather interesting diversity that presents 36% of the fauna of eastern Algeria and 20% for all the country.

The obtained results are complementary to those obtained before, among them [26] which has managed to identify 20 species in the Oued Chaaba station (Batna region). However the diversity of this station has totally changed during these years with the appearance of new species like (*P. pachygaster*).

A big change has emerged concerning families; now, the most abundant family is Pamphagidae with a percentage of 75.43% with seven species, follows the family Tettigoniidae with 14.8%, but with a single species that is *P. pachygaster*. The remaining 9.76% is shared between Acrididae and Pyrgomorphidae. Unlike Benharzallah [26] who found that the family Acrididae is the most abundant with nine species.

Ocneridia volxemii is a common species between most of the sites surveyed with a very strong increase of individuals especially for the region of Batna.

P. pachygaster is collected at two stations (Oued Chaaba and El Hamma) with a very high density. It was found that its presence increased in large numbers at each field trip, this species still poorly known in Algeria with a lack of studies carried on it pushed us tried to know more.

The results of the diet study shows that this species consumes several plant families plus other fragments. However, the correlation between field abundance and faeces content is not important. This leads us to confirm that this species has food preferences. According to Benkenana [11], species of the family Pamphagidae have food preferences. This has also been mentioned in other Acridomorpha, known to be polyphagous including *Schistocerca gregaria* [27]. Several types of diet can be defined; forbivore (hervivores) predominant food on dicotyledonous plants, graminivores, mainly restricted to the Poaceae family, and ambivorous, consume plants of both groups. On the other hand, the monkey species are few; including *Tropidopola cylindrica* on *Phragmites australis* in Algeria [28]. Our result also shows the presence of fragments in the digestive tract of *P. pachygaster* that are; parties of small insect bodies and other arthropods, these shows that this species can also be carnivorous. According to literature, the carnivorous diet is known in certain species of Orthoptera.

We proposed that, the diet of *P. pachygaster* is polyphagous and a mixture of phytophagous and carnivorous with marked preference for Asteraceae. The plants consumed are limited to six plants, three of which are the most consumed by males and females and which have been identified (*Carthamus lanatus*, *Echinops*, *Hordeum sp.*). The fertility rate is varied in 48 eggs per ootheca. Our study in the laboratory has led us to clarify many points concerning its morphology that differentiates this species.

CONCLUSION

The inventory of Orthoptera fauna in the Aures region shows the presence of 25 species. They are divided into 11 sub-families and five families. Our inventory has had a rather interesting diversity.

The present research is judged collective for the collaboration of the services of locust control of each region which indicated to us the zones touched by locusts this year. However our study remains incomplete and needs to be deepened even better. This modest work completes the research work carried out in this region especially that the area of the Aures in Algeria, presents a very great diversity of relief, climate, and vegetation therefore it can be deduced that new species of locusts remain to be discovered in this region in future work.

REFERENCES

- [1] Chara B., (1987). Etude comparée de la biologie et de l'écologie de *Calliptamus barbarus* (Costa, 1836) (Orthoptera, Acrididae). Thèse de Doctorat. Université d'Aix Marseille. p. 190.
- [2] Doumandji, S. ; Doumandji – Mittiche, B. & Tarai, N. (1993). Les peuplements orthoptérologiques dans les palmeraies à Biskra : Etude du degré d'association entre les espèces d'orthoptères. *Med. Fac. L and bouwww*. Univ. Gent, 58 a, 355-360.
- [3] Doumandji S. & Doumandji– Mittiche, B. (1994). *Criquets et sauterelles (Acriologie)*. Ed .OPU (office de publications universitaire), pp 99.
- [4] Ould-Elhadj M.D., (1992). Bioécologie des sauterelles et sauteriaux des trois Zones au Sahara. Thèse de Magister. Institut National d'Agronomie, El-Harrach, Alger. p. 85.
- [5] Ould-Elhadj, M.D. (2001). Etude du régime alimentaire de cinq espèces d'Acridiens dans les conditions naturelles de la cuvette d'Ouargla (Algérie). *Sciences & Technologie*, 16, 73-80.
- [6] Ould Elhadj, M.D. (2004). Le problème acridien au Sahara algérien. Thèse de doctorat, Institut National des sciences agronomiques, El-Harrach, Algérie. p .276.
- [7] Maurel, H. (2008). Premiers inventaires des Orthoptères de la « collection systématique du laboratoire de zoologie de l'Institut National Agronomique d'El-Harrach (Algérie) (Ensifera, Caelifera). *Matériaux entomocénétiques*, 13, 33–42.
- [8] Moussi A., (2012). Analyse systématique et étude bio-écologique de la faune des acridiens (Orthoptera, Acridomorpha) de la région de Biskra, Thèse de doctorat. Université Frères Mentouri Constantine 1 (UFMC1), Constantine. p. 140.
- [9] Benkenana, N. & Harrat, A. (2009). Contribution to the systematic study of grasshopper fauna (Orthoptera, Caelifera) and some bio-ecological aspects of economic importance of species in the Constantine region (Eastern Algeria). *Emir. J. Food Agric.* 21 (1): 40-47.
- [10] Benkenana, N.; Harrat, A. & Petit, D. (2012). The Pamphagidae (Orthoptera) from East Algeria and description of a new species. *Zootaxa* 3168: p 22-38.
- [11] Benkenana, N.; Harrat, A. & Petit, D. (2013). Analysis of the number of sensilla on the labrum and the diet of grasshoppers belonging to the family Pamphagidae (Orthoptera). *Eur. J. Entomol.* 110(2): 355–364
- [12] Benkenana, N.; MASSA, B. (2017). A new species of Pamphagus (Orthoptera: Pamphagidae) from Algeria with a key to all the species of the genus. *Zootaxa* 0000 (0): 000–000.
- [13] Benkenana, N.; Benchiheb, S. & Zaabat, N. (2019). Contribution à la connaissance de la faune acridienne (Orthoptera, Caelifera) dans la région de Mila (Est algérien). *Revue Agrobiologia.* 9(1): 1302-1310.
- [14] Benharzallah N., (2004). Contribution à l'inventaire et étude bio systématique de la faune acridienne dans la région des Aurès, wilaya de Batna. Thèse de Magister. Université Frères Mentouri Constantine1 (UFMC1), Constantine. p. 162.
- [15] Betina, S.I.; Harrat, A. & Petit, D. (2017). Analysis grasshopper diversity and associated factors involved in grasshopper diversity in arid Aurès mountains (Batna, Algeria). *Journal of Entomology and Zoology Studies*; 5(5): 339-348.
- [16] Heiko B. (2015). *450 insecte*. 2^{ème} édition française: Delachaux et Nestlé, Paris ISBN 978-2-603-02155-2, pp 256.
- [17] Chopard L. (1943). *Orthoptéroïdes de l'Afrique du Nord*. Faune de l'empire français 1. Librairie Larose, Paris, France. 405 pp.r-Villars, Paris, pp. 549.
- [18] Jago, N. (1963). A revision of the genus *Calliptamus* (Orthoptera, Acrididae). *Bull. Brit. Mus. (Nat. Hist), Entomology*, 3 n° 9, 289 – 350.
- [19] Launois M. (1978). *Manuel pratique d'identification des principaux acridiens du Sahel*. Ministère de la coopération et G.E. R. D. A. T, Paris, pp. 303.
- [20] Massa B., Fontana P., Buzzetti F.M., Kleukers R. & Ode B. (2012). *Fauna d'Italia*. XLVIII. Orthoptera. Calderini, Bologna, 563 + CCXIV pp.
- [21] Eades D.C., Otte D., Cigliano M.M. & Braun H. (2011). Orthoptera Species File Online. Version 2.0/4.0. <http://orthoptera.speciesfile.org/> (Pages consultées le 20/05/2021).
- [22] Louveaux A., Amedegnato C., Poulain S. & Desutter-Grandcolas L. Orthoptères Acridomorpha de l'Afrique du Nord-ouest. Version [May 2021]. <http://acrinwafrica.mnhn.fr/> (Pages consultées le 06/06/2021).
- [23] Launois-Luong, H. (1975). Méthode d'étude dans la nature du régime alimentaire du criquet migrateur *Locusta migratoria capita* (Sauss). *Ann. Zool. écol. Anim.* (Paris) 8(1) : 25-32.

- [24] **Boutrouf M., Gabel C., (2017).** Inventaire de la faune acridienne (Orthoptera, Caelifera) de l'Est algérien à partir des collections du laboratoire de biosystématique et écologie des Arthropodes (LBEA). Mémoire de Master en biologie évolution et contrôle des populations d'insectes, Université Frères Mentouri Constantine 1(UFMC1), Constantine. p. 84.
- [25] **Louveaux, A. & Benhalima, T. (1986).** Catalogue des Orthoptères Acridoidea d'Afrique du Nord-Ouest. *Bull. Soc. Ent. Fr.*, 91 (3-4) : 73-87.
- [26] **Benharzallah N., (2004).** Contribution à l'inventaire et étude bio systématique de la faune acridienne dans la région des Aurès, wilaya de Batna. Thèse Magister., Université Frères Mentouri. Constantine1 (UFMC1), Constantine. p.162.
- [27] **Guendouz-Benrima, A. ; Duranthon, J.F. & Doumandji-Mitiche, B. (2010).** Préférences alimentaires de *Schistocerca gregaria* (Forsk., 1775) à l'état solitaire dans les biotopes du Sud Algérien. *J. Orth. Res.* 19: 7–14.
- [28] **Benkenana N., (2006).** Analyse bio systématique, écologique et quelques aspects de la biologie des espèces acridiennes d'importance économique dans la région de Constantine. Thèse de magister, Université Frères Mentouri Constantine 1(UFMC1), Constantine. P. 169.