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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)

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Abstract: The inventory of the grasshopper and locust fauna in the Constantine region (Eastern Algeria) revealed the presence of 30 species, divided into four families, Acrididae, Pyrgomorphidae, Pamphagidae and Acrydiidae. Among these families, we found that Acrididae is the best represented one with eight subfamilies. Subfamily Oedipodinae is the largest, consisting of **10** species. The subfamilies of Catantopinae, Truxalinae and Pyrgomorphinae are represented by only one species each. The value of the Shannon Weaver index (3.7 bits) shows that the grasshopper population is more or less diverse, as the Equitability value (0.89 bits) shows how this species is in balance. The species *Anacridium eagyptium, Acrotylus patruelis patruelis*, *Pezotettix giornii* and *Ocneridia volxemii* appear to be of economic importance in the region of Constantine, Algeria.

Keywords: Acrididae, *Anacridium eagyptium*, Caelifères, Constantine, inventory.

المساهمة في دراسة تصنيفية لفون الجراد والنطاط وبعض الخصائص البيئية للأنواع ذات الأهمية الاقتصادية بمنطقة قسنطينة (شرق الجزائر)

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الملخص: خلال عملية مسح ميداني لأنواع الجراد والنطاط بمنطقة قسنطينة بالشرق الجزائري ، تم التعرف على 30 نوع تتوزع على أربع عائلات وهى Acrididae, Pyrgomorphidae, Pamphagidae و Acrydiidae. عائلة Acrididae هي الأكثر تمثيلا بثماني عائلات تحتية. العائلة التحتية Oedipodinae واسعة التوزيع بثمانية أنواع في حين فان كل من العائلة التحتية Catantopinae, Truxalinae و Pyrgomorphinae كل منها ممثلة بنوع واحد فقط . دلت قيمة مؤشر التنوع الحيوي (3.7بيت) أن مجاميع الجراد والنطاط ذات تنوع لا بأس به في حين قيمة مؤشر التوازن (0.89 بيت) بينت أن هده المجاميع ذات توازن فيما بينها في منطقة الدراسة. الأنواع *Anacridium eagyptium, Acrotylus patruelis patruelis*, *Pezotettix giornii*, *Ocneridia volxemii* لها أهمية اقتصادية في منطقة قسنطينة.

الكلمات المفتاحية: الجراد، النطاط، Acrididae، *Anacridium eagyptium*، منطقة قسنطينة، مسح ميداني.

Introduction

Every year locusts and grasshoppers cause damage to crops and millions of people die from hunger. In addition to the loss of human lives, a number of areas have suffered from famine; entire regions have had to be abandoned (Appert and Deuse, 1982). Locusts are probably the most formidable enemy of man since the onset of agriculture. Algeria occupies a significant part of the area inhabited by locusts.

Although only a few species are considered serious pests, other non-gregarious species can become very

dangerous when climatic conditions facilitate their multiplication. Therefore, it is necessary to have comprehensive knowledge of all locust species that settle in a territory.

Presentation of the study area

The study was conducted in the Constantine area, which covers 2287 square kilometres and is located in the heart of eastern Algeria (Fig. 1), of coordinates 36° 36 'N latitude and 6° 62' E longitude. It is 431 km from the capital Algiers in the west and bordered by the region of Skikda in the north at a distance of 89 km. To the south, Constantine shares its border with the Oum El-Bouaghi region, to its east lies Guelma and to its west is the Mila region (Anonymous, 2004).

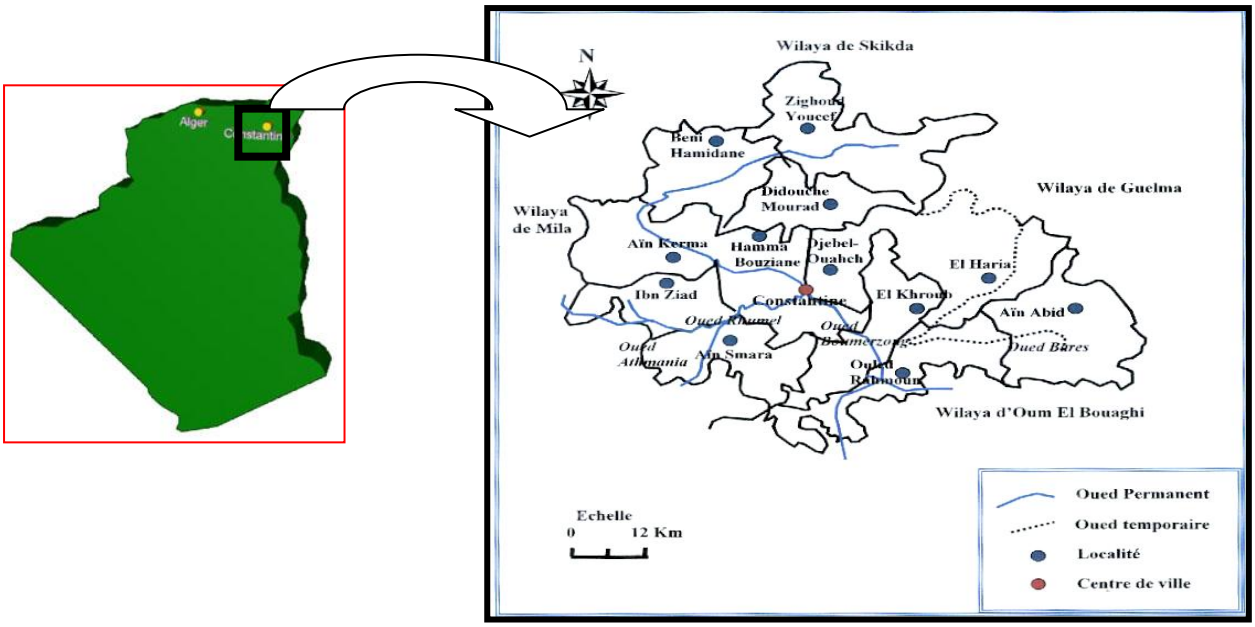

Figure 1. Administration limit of the Constantine region (LOUADI, 1999).

Materials and Methods

Sampling

The purpose of sampling is to obtain an instant image of the locust population structure (Lecoq, 1978; Voisin, 1986). There are various methods of capture used to collect the locusts in relation to their habitats. The methods by Lecoq (1978), Voisin (1980, and 1986) and Legall (1989) were used in this study. During our investigation, we used the quadrant method which is an accurate count of the number of individual locusts present in a well-defined area.

The quadrant method defines in each station an area of 100 square meters; within each square we sampled squares with nine square meters (3m x 3m). Techniques for sampling species are pickup applied to forms, fauchoir net used to catch adults and the capture by hand as the best ways to harvest the locust. The study spanned November 2004 to October 2005. During this period, sampling was repeated at a frequency of two times per month.

Preparation and storage of the locust species

Materials used for the conservation of

orthopters were a pincer, a layer, entomologic pins for spreading and fixing the individuals and a collector box for keeping the insects. In order to ensure better preservation, naphthalene was added to the boxes; a binocular lens was used for observing the morphological criteria.
The samples of locusts meant for study were sacrificed in a jar containing potassium cyanide. They were then placed on the layer with entomologic pins planted in the thorax, with the elytra and right wing laid out to form a right angle with the body. Finally, the locusts were allowed to dry in collection boxes, each attached with a tag bearing the details of date, place of collection and the name of the species.

Identifying the locust species

The systematic identification of species of Orthopterans was done with the help of several key determination techniques described by Chopard (1943), Jago (1963), Launois (1978), Voisin (1980) and Ihsan (1988).

Ecological analysis

The quality of sampling

The quality of sampling is the ratio of species once contacted by the total number of observed (Blondel, 1979). The sampling quality is great when the A / N is small and close to zero. In the equation: Q = a/N, a = the number of species contacted once and N = total number of records.

Total wealth

The biological richness is the total number of species observed during N surveys (Ramade, 1984).

Diversity index of Shannon-Weaver

According to Frontier (1982) the most commonly used diversity index is that of Shannon-Weaver. To measure the diversity of the locusts we used the Shannon-Weaver Index using the formula:

$$H' = -\sum_{i=1}^{i=s} \frac{ni}{N} \log_2 \frac{ni}{N}$$

Or

$$H = -\Sigma Pi \ln Pi$$

where S = the number of species;
Pi = ni / N is the probability of meeting of the rank of species i; Neither the number of individuals of each species in the sample;
N: the number of individuals of all species;
H: the diversity index of the sample.
The diversity index gives the specific richness and relative abundance of the species, thus reflecting the biological balance (Dajoz, 1971).

Equitability index

The Equitability index described as the ratio between diversity H bay and the diversity maximum H' max was calculated using the formula: E = H/H 'max, where E = Equitability index; H'= diversity index of Shannon-Weaver calculated; H' max = diversity index up; H' = log2; S = the total wealth. The value of equitability calculated varied from 0 to 1.

Results

Inventory

The inventory of the surveyed species demonstrated the presence of 30 locust and grasshopper species that belong to families Acrididae, Pyrgomorphidae, Pamphagidea and Acrydiidae. Among these the Acrididae family is best represented both in number of species and individuals.

Details of the inventory of the locust and grasshopper species are described in Table 1; Figure 2 shows the percentage of different subfamilies identified.

Table 1. Classification and inventory of locust and grasshopper species in the Constantine region.

Family	Subfamily	Species
Pamphagidae	Pamphaginae	*Pamphagus elephas* (Linné, 1758)
		Ocneridia volxemii (I. Bolivar, 1878)
		Pamphagus longicornis (Bolivar, 1878)
Acrydiidae	Acrydiinae	*Paratettix meridionalis* (Rambur, 1839)
Pyrgomorphidae	Pyrgomorphinae	*Pyrgomorpha cognata minima* (Uvarov 1943)
Acrididae	Calliptaminae	*Calliptamus barbarus barbarus* (Costa 1836)
		Calliptamus wanttenwylianus (Pantel 1896)
	Eyprepocnemidinae	*Eyprepocnemis plorans* (Charpentier, 1825)
		Heteracris adspersus (Redtenbacher 1889)
		Heteracris harterti (I. Bolivar, 1913)
	Catantopinae	*Pezotettix giornai* (Rossi, 1794)
	Cyrtacanthacridinae	*Anacridium aegyptium* (Linné, 1764)
		Schistocerca gregaria (Forskal, 1975)
	Gomphocerinae	*Dociostaurus jagoi jago*i (Soltani,1983)
		Euchorthippusalbolineatus albolineatus(Lucus,1849)
		Ochrilidia geniculata(I.Bolivar, 1913)
		Ochrilidia gracilis gracilis (Kraus, 1902)
	Acridinae	*Aiolopus thalassinus thalassinus* (Fabricius,1758)
		Ailopus strepens (Latereille,1804)
	Oedipodinae	*Locusta migratoria* (Linné,1758)
		Oedipoda fuscocincta fuscocincta (Lucas, 1849)
		Oedipoda miniata miniata (Pallas, 1771)
		Oedipoda caerulescens sulfurecens (Saussur,1884)
		Oedaleus decorus (Germar,1826)
		Sphingonotus caerulans(Linné, 1767)
		Sphingonotus rubescens (Walker,1870)
		Sphingonotus azurescens (Rambur, 1838)
		Thalpomena algeriana algeriana (Lucas, 1849)
		Acrotylus patruelis patruelis (Herrich-schaeffer, 1884)
	Truxalinae	*Truxalis nasuta* (Linné, 1758)

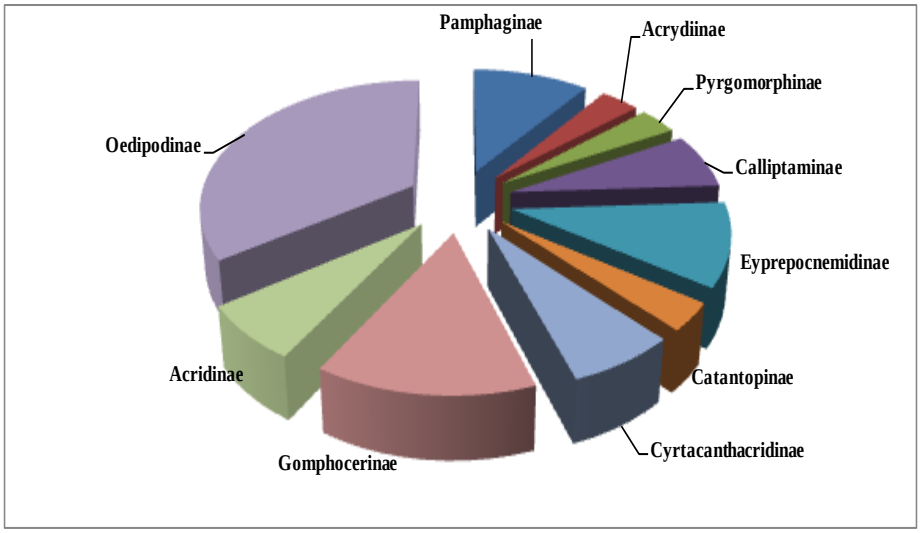

Figure 2. Percentage of different sub-families identified in the Constantine region.

Ecological indices

As the value of A/N is close to zero, the sample quality is good. The value of the Shannon-Weaver index (3.7 bits) shows that the locust population is more or less diverse as the Equitability Index value (0.89 bits) shows that the grasshopper's species are in balance (Table 2).

Table 2. Results for the ecological indices.

Ecological indices	Value
Quality sampling	0.005
Total wealth	30
Diversity index of Shannon-Weaver	3.78 bits
Equitability Index	0.89 bits

Discussion

The census of wildlife grasshoppers in the study area totals 30 species. The Acrididae family is the most important one and is represented by 25 species of locusts. Lauveau and Benhalima (1987) cited 140 species of Caelifères in Algeria. 12 families found in the process of this study represent 66.66% of all Orthoptera. The subfamily Oedipodinae alone has 10 species, or 33.33%. Subfamily Gomphocerinae was represented by 4 species, or 13.33%, while the Pamphagidae and Eyprepocnemidinae families each had 10% (3 species) of representation. The subfamilies Pyrgomorphinae, Dericorythinae, Cyrtacantacridinae, Catantopinae, Truxalinae, Acrydiinae each had one species, or 3.33% of all Caelifères.

The distribution of locust species depends not only on the differences among them but also bio-geographical climate change. According to Chopard (1943) Orthoptera prefer warmer and dry weather.

Among the species that were surveyed in the region of Constantine we have Paratettix *meridionalis*, which is very common in the damp areas and along streams (Chopard, 1951). The presence of this species had been earlier reported in the region of Constantine (Moussi, 2002). The

Mitidja *Paratettix meridionalis* species transition from larvae to adults during all months of the year and was found in the same region (Ham**a**di, 1998). The *Pezotettix giorni* species has a very long life. The larvae and adults of this species have been captured in the Constantine region throughout the year. Our results agree with those of Felloune 1989, Guerciour1990, Bentamer 1993 and Hamdi 1998, and similarly to Seghier 2002.

Acrotylus patruelis patruelis is common in the Constantine region and according to Chopard (1943), this species is found in the adult form most of the year. These findings were confirmed by Hamdi (1989, 1992) on the Algerian coast, by Guerciour (1990) in the region of Lakhdaria and by Bourahla (1990) in the region of Chrea. These works show that the locust is in the imaginal over a period of many years and has only one generation per year. Mitidja (Benrima, 1993) and the Sahara septentrional (Ould -Elhadj, 1991) stated that *Patruelis* has one generation per year. In the region of Ghardaia, Zergoun (1991), Douadi (1992) and Babaz (1992) indicate that this locust species has one or two generations per year.

Anacridium eagyptium is a species large in size, found in the Biskra and Constantine region (Moussi, 2002). Benharzallah (2003) reported that it was found in the region of Batna. This species prefers cultivated areas, especially in hate and shrubs.

Ocneridia volxemii (I. Bolivar, 1878) species is very common in the highlands of Morocco. According to Chopard (1943) this species had a large outbreak and caused great damage. The same phenomenon was reported by Benharzallah (2004) in the Batna region.

Sampling was done with quality precision, the value of A/N was calculated as being close to zero, and was found to be 0.05. The species was identified only once and in one case was found to be *Truxalus nasuta*, when it was found as an adult. It seems that this species prefers more arid habitats to pulluler, and was seen in the region of Biskra (Moussi, 2002), and the region of Batna (Benharzallah, 2003).

The total wealth varies between regions and the sampling times. The value of the total wealth of locusts in the region of Constantine is 30 species. Moussi (2002) reported the presence of 21 locust species in the region of Biskra, Benharzallah (2003) found the total wealth to be 22 species in the Batna Region.

The diversity index was calculated to be 3.78 bits, and was explained by increased plant diversity in the region, and the wet climate with a high average temperature, all of which provide conditions conducive to the development of locust species. According to Viera Silva (1979) and Blondel (19**7**9), a community is more diversified when the index H was larger. According to Dajoz (1971), the diversity is dependent on the stability of the environment and the climate. The value of Equitability is close to 1 (0.89), therefore corresponding to the population balance between them. The latter seem to be characteristic of our study plots.

This indicates that the environment is stable and the locust population structure is an almost uniform and balanced one. According to Frontier (1982), a community with a small number of relatively abundant species other rare apparainrent a less diverse community including at the same total number of species frequencies more evenly distributed. Similarly, Lachelah (2002) reported that the value of Equitability is the highest at 0.98, at the areas of cultivation. This is because the species live in a balance, so their environment is stable.

Conclusion

There are a total of 30 species of grasshoppers and locusts in the Constantine region that belong to the suborder of Caelifères. They are divided into the four families, Pamphagidae,

Pyrgomorphidae, Acrydiidae and Acrididae. The species *Anacridium eagyptium*, *Acrotylus patruelis patruelis*, *Pezotettix giornii* and *Ocneridia volxemii* appear to be of economic importance in the region of Constantine.

Through this work, we have contributed to the identification of locust species in eastern Algeria. We intend to conduct very detailed studies on the locust species that can access the status of crop pests, namely systematics, bio-ecological, diet, morphometry and to recommend methods of struggle.

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