

## Bioecology of the Orthoptera Species of the Setifian Plateau, North-East Algeria

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**Abstract:** The bioecology of the Orthoptera species living in the Setif region of Algeria was studied between 1995 and 1999. The research was conducted at 12 ecologically homogeneous sites with typical biotopes for the Orthoptera species in the region. Thirty-six Orthoptera species were recorded, of which 6 belonged to Tettigoniodea and 30 to Acridioidea. The most abundant and frequent species in the area were *Ocneridia volxemi* (Bolivar, 1878), *Dociostaurus maroccanus* (Thunberg, 1815), *Tmethis laevisculus* (Krauss, 1892), *Calliptamus wattenwyllianus* (Pantel, 1896), *Praeophyppigera pachygaster* (Lucas, 1849), and *Platycleis laticauda* Brunner, 1882. Orthoptera of the Setifian Plateau are divided into 4 groups according to their life cycle. There are 33 annual species, of which 23 have embryonic hibernation, 4 have nymphal hibernation, and 6 have adult hibernation. The remaining 3 species have 2 generations per year and nymphal hibernation. Also, an ecological analysis was performed to clarify the relative importance of some abiotic factors that impact upon the distribution of the Orthoptera populations.

**Key Words:** Orthoptera, Tettigoniodea, Acridioidea, bioecology, Setif, Algeria

### Setif Platosu (Cezayir) Orthoptera Türlerinin Biyokolojisi

**Özet:** Beş yıl süre ile (1994-1999) Setif Platosu (Cezayir) Orthoptera türlerinin biyokolojisi çalışıldı. Çalışma, alanın ekolojik özelliklerini temsil eden ve tipik orthopter habitatu olan 12 istasyonda yürütüldü. Çalışma sonucunda, 6'sı Tettigoniodea ve 30'u Acridioidea'ye ait 36 türün varlığı tespit edildi. Çalışma sırasında en sık rastlanılan türler sırasıyla şunlardır: *Ocneridia volxemi* (Bolivar, 1878), *Dociostaurus maroccanus* (Thunberg, 1815), *Tmethis laevisculus* (Krauss, 1892), *Calliptamus wattenwyllianus* (Pantel, 1896), *Praeophyppigera pachygaster* (Lucas, 1849) and *Platycleis laticauda* Brunner, 1882. Setif platosunda saptanan Orthoptera türleri yaşam döngülerine göre 4 gruba ayrıldı. Bu 36 türden 33'ü yılda bir döl veren türler olup bunların 23'ü embriyonik kışlama, 4'ü nimfal kışlama ve 6'sı ergin evrede kışlama göstermektedir. Kalan 3 tür yılda 2 döl vermekte ve nimfal evrede hibernasyon göstermektedir. Ayrıca, çalışmada türlerin çalışma alanının abiyotik faktörleri ile ilişkisi de değerlendirildi.

**Anahtar Sözcükler:** Orthoptera, Tettigoniodea, Acridioidea, biyokoloji, Setif, Cezayir

### Introduction

In North Africa, the problem of the harmful Orthoptera dates back to time immemorial and remains one of the major concerns of farmers. In Algeria, important damage on various cultivated crops, particularly on the high plains, has been reported. Although the diversity and taxonomy of the Orthoptera species causing the damage are well known, their biological and ecological characteristics are still not fully known, despite the fact that a few studies have been

conducted in various regions of Algeria (Chopard, 1943; Benzécrici, 1973; Fellauine, 1984; Fellauine and Louveaux, 1994) Chara, 1987; Bounechada, 1991). As a result, detailed information on the biology, ecology, population dynamics, and diet of Orthoptera species are urgently needed. The aim of this study was to identify the biotic and abiotic variables that are most closely linked to the spatial distribution of Orthoptera species as well as to present a biological and ecological approach to understanding the Tettigoniodea (Ensifera) and Acridioidea (Caelifera) of the Setif region.

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**Materials and Methods**

This study was carried out in the Setif high plains (north-east Algeria, see Figure 1). The climate of Setif region is typically Mediterranean, characterised by a cool and wet winter and a summer that is usually very dry and hot. Two bioclimatic areas can be distinguished in the Setif high plain; the semi-arid southern region and the sub-humid north. The annual rainfall is irregular (Figure 2). On the basis of geomorphological, pedological, and climatological characteristics, the Setif region can be divided into 3 great zones; central, northern, and southern (Bounechada, 1991). The main environmental characteristics are summarised in Tables 1 and 2 and Figures 2 and 4.

After several field studies, 12 stations distributed over the 3 zones with different floristic compositions were established. Each station was visited twice per month in the season when Orthoptera nymphs or adults were available (see Table 3 for details of the field studies). During 5 years of study (1995-1999), 320 field studies were completed following the sampling procedure described by Lecoq (1978), and Duranton and Lecoq (1980). For ecological analyses, 9 ecological parameters were measured to determine the environmental factors that affect distribution of the Orthoptera populations in the Setif region (Table 2). The results were analysed by factorial analysis of correspondences (AFC), and hierarchical classification ascendante (CHA), described by

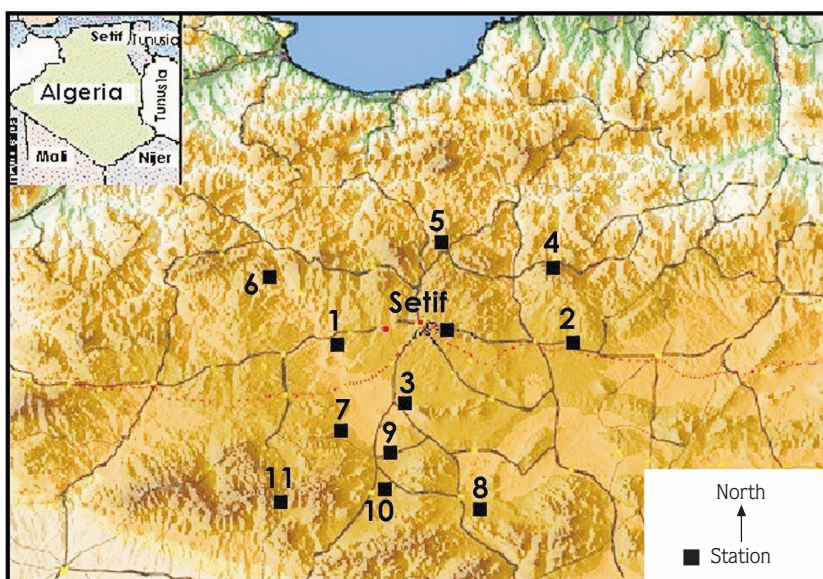


Figure 1. Map of the Setif region indicating stations (solid rectangles) where Orthoptera were collected: 1. Ain Arnat ; 2. El-eulma; 3. Mezloug; 4. Djemila; 5. Amoucha; 6. Hammam Guergour; 7. Guelal; 8. Ain Azel; 9. Draa el Maad; 10. Salah bey; 11. Ain Ben Aied.

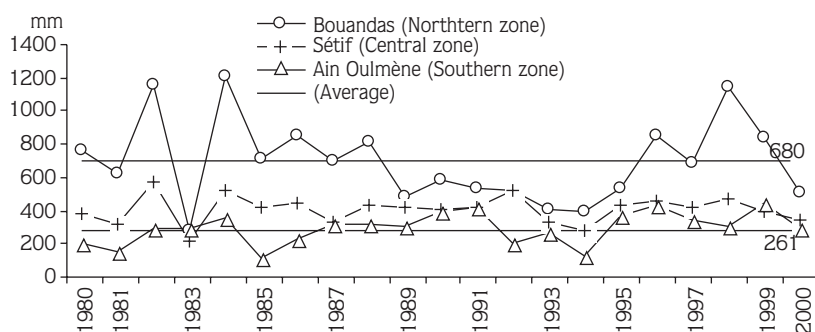


Figure 2. Annual variation of rainfall (mm) from 1980 to 2000 in the 3 types of stations selected in the Setif region.

Table 1. Main environmental characteristics of the Setif region.

	Mean annual rainfall (mm)	Coldest month mean min. temperature	Hottest month mean of max. temperature	Climatic area	Altitude (m)	Soil characteristics
Northern Zone	700-400	2 °C January	34 °C August	Sub-humid	100-1200	Clay soils, marly substrate
Central Zone	400-350	1.2 °C January	34.7 °C July	Semi-arid	1000-900	Calcareous
Southern Zone	350-300	0 °C December	36 °C July	Semi-arid	900-800	Calcareous

Table 2. Environmental variables and their modalities used in the ecological analysis.

- I- Nature of station: I1. Waste land; I2. Fallow; I3. Cereal; I4. Meadow.
- II- Moisture of soil: II1. Wet; II2. Slightly wet; II3. Dry; II4. Very dry.
- III- Slope: III1. Flat area; III2. Northwards; III3. Southwards; III4. Eastwards; III5. Westwards.
- IV- Average vegetation height: IV1. < 10 cm; IV2. 10-25 cm; IV3. > 25 cm.
- V- Precipitation (mm/year): V1. < 300 mm; V2. 350-400 mm; V3. >400 mm.
- VI- Temperature: VI1. Very high; VI2. High; VI3. Moderate; VI4. Low
- VII- Pasture: VII1. Low; VII2. Average; VII3. Heavily grazed.
- VIII- Stones: VIII1. Stony; VIII2. Few or no stones.

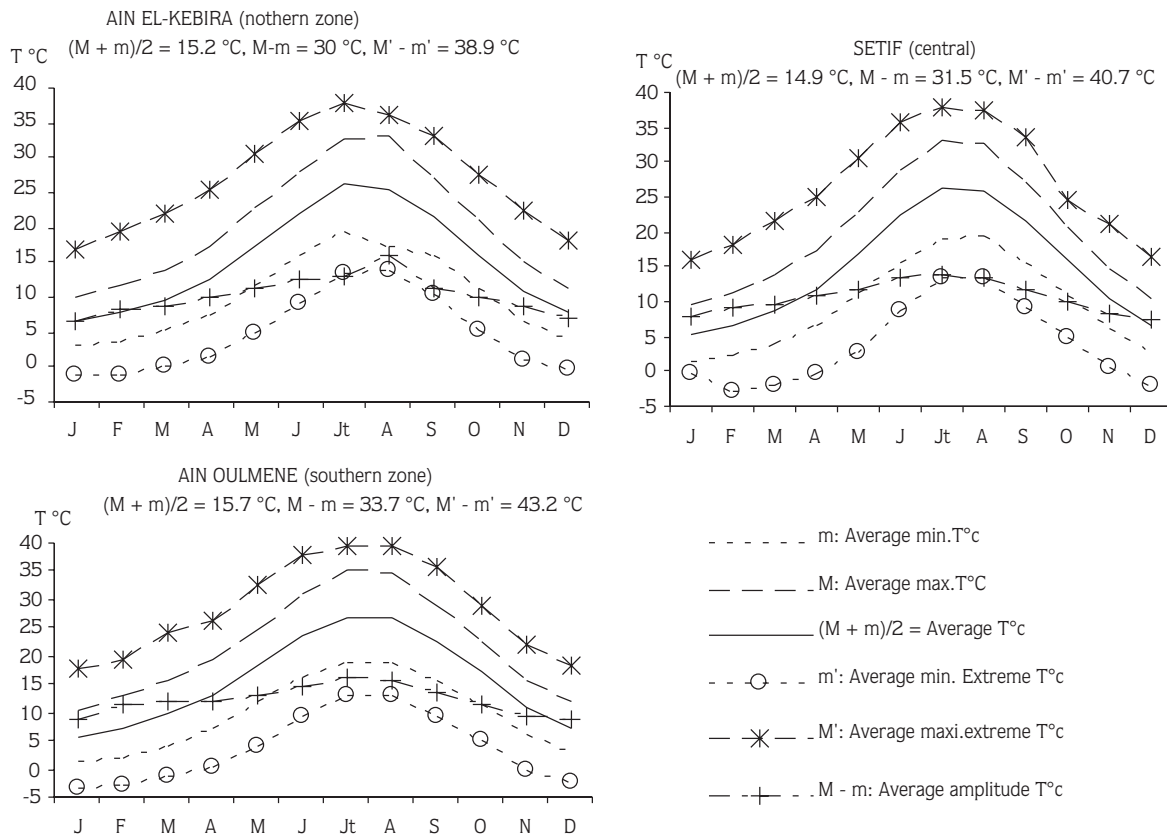


Figure 3. Annual temperatures (average of the months) at 3 types of stations in the Setif region. Temperature in centigrade (T °C), min.(minimum), max. (maximum).

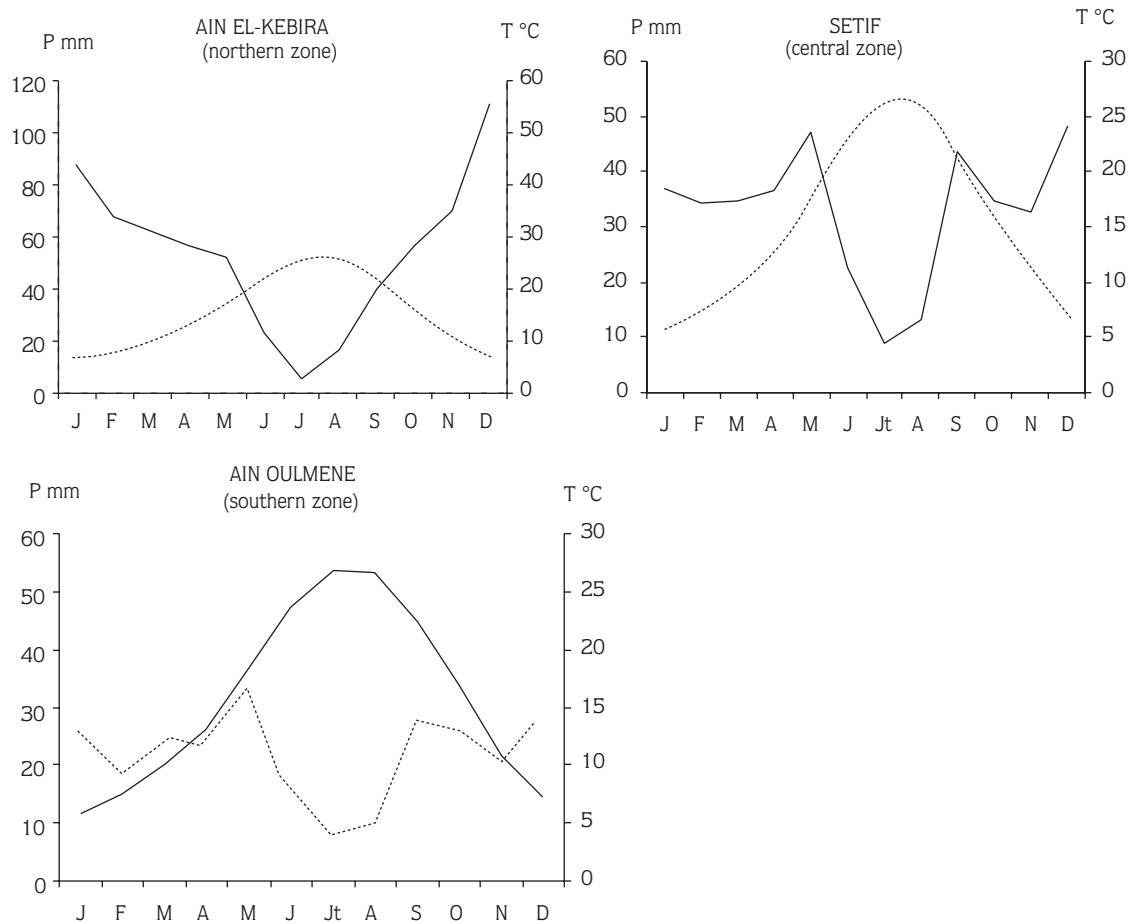


Figure 4. Dry season in northern, central and southern zones of the study area.

Table 3. List of the stations and dates of the field studies.

	1994					1995					1996					1997					1998					1999				
	M	A	M	J	J	M	A	M	J	J	M	A	M	J	J	M	A	M	J	J	M	A	M	J	J	M	A	M	J	J
Setif	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
Ain Arnat	**	**	**			**	**	**			**	**	**			**	**	**			**	**	**			**	**	**		
El-eulma	**	**	**			**	**	**			**	**	**			**	**	**			**	**	**			**	**	**		
Mezloug	**	**	**			**	**	**			**	**	**			**	**	**			**	**	**			**	**	**		
Djemila											**	**				**	**				**	**				**	**			
Amoucha		**	**	**	**		**	**	**	**	**	**	**			**	**	**			**	**	**			**	**	**		
Hamмам	0					0					**	**				**	**				**	**				**	**			
Guergour																														
Guelal	**	**	**			**	**	**			**	**	**			**	**	**			**	**	**			**	**	**		
AinAzel						**					**					**					**					**				
DraaelMaad	**	**				**	**				**	**				**	**				**	**				**	**			
Salahbey		**				**					**	**				**	**				**	**				**	**			
AinBenAied	0					0					0					**					**					**				

Each \* indicates a field study carried out in the respective month; 0 indicates no field study because of security conditions. Second line of the table shows the first letter of the months in which field studies were performed, from March to July.

Benzecri (1973). All statistical analyses were conducted using Statistica for Windows (STATISTICA pour Windows -Manuel du programme-Ed. StatSoft France, Charenton-le-Pont, France).

For identification of the Orthoptera species, we benefited from Chopard (1943), Dirsh (1965), Doumandji et al. (1972), Uvarov (1977), Louveaux and Benhalima (1986), the collections in the Department of Zoology, National Agronomic Institute, Institute of Plant Protection (Algiers), and the Orthoptera collection in the Department of Biology, Akdeniz University (Antalya, Turkey).

## Results and Discussion

### Orthoptera species of the Setif plateau

A total of 36 species of Orthoptera were recorded from Setif; 6 belonging to Tettigonioidae, 8 belonging to Pamphagidae, 2 belonging to Pyrgomorphidae, and 18 belonging to Acrididae (Table 4). The most frequent and abundant species (according to our observations during 320 field visits) were *O. volxemi* (observed in 256 visits), *Dociostaurus maroccanus* (in 172 visits), *Thmetis cisti* (in 162 visits), *T. laevisculus* (in 159 visits), *Platycleis laticauda* (in 158 visits) *Calliptamus wattenwyllianus* (in 156 visits), and *Praehippiger pachygaster* (in 148

Table 4. List Orthoptera species collected (Code: abbreviation for species used in ecological analyses in Figures 5 and 6).

Species	Code	Sub-order	Families
<i>Decticus albifrons</i> (Fabricius, 1793)	DEA	Ensifera	Tettigoniidae
<i>Platycleis laticauda</i> Brunner, 1882	PLA	Ensifera	Tettigoniidae
<i>Platycleis tessellata</i> (Charpentier, 1825)	PLT	Ensifera	Tettigoniidae
<i>Odentura algeriana</i> (Brunner, 1878)	ODA	Ensifera	Tettigoniidae
<i>Odentura maroccana</i> (Bolivar, 1908)	ODM	Ensifera	Tettigoniidae
<i>Praehippiger pachygaster</i> (Lucas, 1849)	PRP	Ensifera	Tettigoniidae
<i>Thmetis cisti</i> (Fabricius, 1787)	TMC	Caelifera	Pamphagidae
<i>Thmetis laevisculus</i> (Krauss, 1892)	TML	Caelifera	Pamphagidae
<i>Acinipe tibialis</i> (Fieber, 1853)	ACT	Caelifera	Pamphagidae
<i>Pamphagus elephas</i> (Linnaeus, 1758)	PAE	Caelifera	Pamphagidae
<i>Pamphagus marmoratus</i> (Burneister, 1838)	PAM	Caelifera	Pamphagidae
<i>Ocneridia volxemi</i> (Bolivar, 1878)	OCV	Caelifera	Pamphagidae
<i>Ocneridia microptera</i> (Brisout, 1850)	OCM	Caelifera	Pamphagidae
<i>Ocneridia nigropunctata</i> (Lucas, 1849)	OCN	Caelifera	Pamphagidae
<i>Pyrgomorpha conica</i> (Olivier, 1791)	PYC	Caelifera	Pyrgomorphidae
<i>Pyrgomorpha cognata</i> (Krauss, 1877)	PYG	Caelifera	Pyrgomorphidae
<i>Calliptamus wattenwyllianus</i> (Pantel, 1896)	CAW	Caelifera	Acrididae
<i>Calliptamus barbarus</i> (Costa, 1836)	CAB	Caelifera	Acrididae
<i>Anacridium aegyptium</i> (Linnaeus, 1764)	ANA	Caelifera	Acrididae
<i>Truxalis nasuta</i> (Linnaeus, 1758)	TRN	Caelifera	Acrididae
<i>Pezotettix giornae</i> (Rossi, 1794)	PEG	Caelifera	Acrididae
<i>Thalmpena algeriana</i> (Lucas, 1849)	THA	Caelifera	Acrididae
<i>Acrotylus patruelis</i> (Herrich-Schaffer, 1838)	ACP	Caelifera	Acrididae
<i>Acrotylus longipes</i> (Charpentier, 1843)	ACL	Caelifera	Acrididae
<i>Acrotylus insubricus</i> (Scopoli, 1786)	ACI	Caelifera	Acrididae
<i>Aiolopus strepens</i> (Latreille, 1804)	AIS	Caelifera	Acrididae
<i>Oedaleus decorus</i> (Germar, 1826)	OED	Caelifera	Acrididae
<i>Oedipoda miniata</i> (Pallas, 1771)	OEM	Caelifera	Acrididae
<i>Oedipoda fuscocineta</i> (Lucas, 1849)	OEF	Caelifera	Acrididae
<i>Oedipoda coerulea</i> (Linnaeus, 1758)	OEC	Caelifera	Acrididae
<i>Sphingonotus coeruleus</i> (Linnaeus, 1767)	SPC	Caelifera	Acrididae
<i>Dociostaurus maroccanus</i> (Thunberg, 1815)	DOM	Caelifera	Acrididae
<i>Dociostaurus jagoi jagoi</i> Soltani, 1978	DOJ	Caelifera	Acrididae
<i>Omocestus ventralis</i> (Zetterstedt, 1821)	OMV	Caelifera	Acrididae
<i>Omocestus raymondi</i> (Yersin, 1863)	OMR	Caelifera	Acrididae
<i>Omocestus lucasi</i> (Brisout, 1851)	OML	Caelifera	Acrididae

visits), suggesting that these species are well-adapted to the environmental conditions of the Setif region.

**Life-cycle diversity among the Orthoptera of the Setif region**

The life cycle of a species varies according to local ecological conditions. In the area of Setif, we noted 4 groups of species with different biological cycles. There were 33 annual species, including 23 with embryonic hibernation, 4 with nymphal hibernation, and 6 with adult hibernation. The remaining 3 species had 2 generations per year and nymphal hibernation (Table 5).

During our field studies, we noted that rather clear differences existed in the life cycles of the various species from one station to another and from one year to another. Ecological factors, such as temperature, pluviometry, moisture content of the ground, vegetation (density and diversity of the plant species in the stations), and the degree of human activity are all clearly factors related to observed variations in the life cycles. It should be noted that uncultivated areas with poor vegetation, dry soil, rainfall < 300 mm per year, high temperatures, and extreme amounts of sunshine are the sites most preferred by the xerophilous and meso-xerophilous Orthoptera. This phenomenon applies to the majority of the Orthoptera of the Setif region, and in particular, the following species: *Thmetis* spp.; *Dociostaurus*

*maroccanus*; *Calliptamus wattenwyllianus*; *Oedipoda miniata*; *O. fuscocineta*; *Platypleis laticauda*; *Decticus albifrons*; *Ocneridia volxemi*; *O. microptera*. The life cycles are affected by the duration of the winter season and vary from year to year, especially for the species with embryonic hibernation. Although there were differences in the life cycles of the species from station to station and from year to year, Orthoptera of the Setif region can be divided into 4 groups according to their life cycles.

**First group:** There were 23 species with one generation per year. These species spend the cooler season, characterised by rainfall, snow, and lower temperatures, in the egg stage. They may have either a slow embryonic development or a delay of development in the embryonic stage. The pause of embryonic development could be related to many factors, in particular, the rise in temperature and moisture content of the ground, which undoubtedly explains the appearance of the majority of the species in a larval stage after the rainy season.

Generally, Orthoptera species of this group hatch in April and March. Earlier hatching takes place in February or even sometimes very early in November (e.g., in 1995 and 1997) as in the case of *Ocneridia volxemi*, which benefits from the rise in rainfall and temperature that usually occur in October. This situation was also observed

Table 5. Life cycle diversity of the Orthoptera species recorded from Setif.

Type of cycle	Species	Percentage
Group 1 Embryonic diapause with one generation per year	<i>Ocneridia nigropunctata</i> , <i>O. volxemi</i> , <i>O. microptera</i> , <i>Calliptamus barbarus</i> , <i>C. wattenwyllianus</i> , <i>Decticus albifrons</i> , <i>Platypleis tessellata</i> , <i>P. laticauda</i> , <i>Odentura algerica</i> , <i>Praehipigera pachygaster</i> , <i>Tmetis cisti</i> , <i>T. laevisculus</i> , <i>Dociostaurus maroccanus</i> , <i>D. jagoi jagoi</i> , <i>Sphingonotus coerulans</i> , <i>Truxalis nasuta</i> , <i>Oedalus decorus</i> , <i>Acinipe tibialis</i> , <i>Oedipoda miniata</i> , <i>O. fuscocineta</i> , <i>O. coerulescens</i> , <i>Aiolopus strepens</i> , <i>Odentura maroccana</i>	63.89 (23 species)
Group 2 Nymphal diapause with one generation per year	<i>Pyrgomorpha conica</i> , <i>P. cognata</i> , <i>Pamphagus elephas</i> , <i>P. marmoratus</i>	11.11 (4 species)
Group 3 Adult diapause with one generation per year	<i>Anacridium aegyptium</i> , <i>Pezotettix giornai</i> , <i>Thalmopena algeriana</i> , <i>Acrotylus longipes</i> , <i>A. patruelis</i> , <i>A. insubricus</i>	16.67 (6 species)
Group 4 Nymphal diapause With two generations per year	<i>Omocestus ventralis</i> , <i>O. raymondi</i> , <i>O. lucasi</i>	08.33 (3 species)

in *Ocneridia microptera*, *Tmethis cisti*, and *Odentura algeriana*. In other cases, particularly in *Oedipoda* spp., *Calliptamus* spp., and *Oedalus* spp., hatching occurs later, in the beginning of May and April. The nymphal development of these orthopters takes place during March-June and even in the beginning of July. The winged nymphs of the last group of species to hatch appear in May and June and remain sometimes until October. With the exception of the some early hatching species, such as *Dociostaurus jagoi jagoi* and *Decticus albifrons*, late hatching species copulate during the summer season (June to August) and lay eggs from July through October.

**Second group:** This group is represented by 4 species. These acridoids have one generation per year. They seem to experience a pause of development at the embryonic stage or a rather long hopper development during the cooler season between November and January. These species have nymphal stage from August until April-May, the period when the first winged nymphs appear (e.g., *Pyrgomorpha conica*). The coupling and the egg laying occur between May and July in the majority of these species. The nymphs appear in August and September and remain until the following spring.

**Third group:** Six species in this group have one generation per year and they seem to have an imaginal diapause. We assume that these locusts have either a slow imaginal development or a pause of development of the genital apparatuses; however, sexual maturation ends only in the beginning of spring in these species. The immature adults were captured during the autumn-winter period and as late as the beginning of spring. The females in the vitellogenesis phase were captured in April and March (*Anacridium aegyptium*, *Thalmopena algeriana*, and *Acrotylus patruelis*). Copulation probably occurs at the end of the winter. The nymphal development of the species in this group takes place during the dry season (summer). In *Pezotettix giornae*, which has its larval development in summer, copulation occurs in autumn and winter. Of the last-to-hatch species, the females in the vitellogenesis phase were captured during the rainy months in November and April. In this case, the eggs are laid in late April. From these observations, it appears as though this species would present an imaginal diapause during the summer. The coupling probably takes place at the end of the winter. The larval development of the species of this group occurs

during the dry season (or the summer season).

**Fourth group:** There are 3 species with 2 generations per year (*Omocestus ventralis* and *O. raymondii*) in this group. They spend the winter season in the hopper stage and copulate in May and June, to produce a first generation of low density in the summer. The adults of this generation do not present a diapause and are observed in September, October, and November. They copulate to produce a second generation that spends the winter and the beginning of spring in the hopper stage.

#### Ecological analysis

Overall analyses not only enabled us to present an evaluation of the ecology of Orthoptera in the Setif region, but also permitted a more objective determination of the main factors affecting that ecology. The influence of environmental factors is represented by a factorial axis of correspondence analysis. We have retained 2 axes (axis 1 and axis 2) because they give the best information about the distribution of the Orthoptera of the Setif region.

Axis 1 of analysis, with 23.80% of total inertia, corresponds to the main ecological characteristics of the Orthoptera of the Setif region, which is in contrast to the xerotrophic biotopes, especially those situated in the southern zone, mesotrophic biotopes in the central zone, and the hygrotrophic biotopes in the northern zone of the Setif high plain (Tables 1 and 2 and Figures 1-5). The species observed in the xerophytic biotopes are numerous, such as *Oedalus decorus*, *Sphynonotus coeruleans*, *Dociostaurus jagoi jagoi*, *Decticus albifrons*, *Platycleis tessellata*, *P. laticauda*, *Thmetis* spp., and *Ocneridia nigroptera*, so they have a xerotrophic tendency (Group 1). On the other hand, *Thalmopena algeriana*, *Acrotylus longipes* A. *patruelis*, *Omocestus* spp., *Pyrgomorpha cognata*, *Acinipe tibialis*, *Calliptamus barbarus*, *Praehippiger pacygaster*, and *Ocneridia volxemi* are located on the medial side of axis 1, which is characterized by the abiotic ecological conditions of the central zone. They also diffuse into northern or southern zones and thus they have a mesotrophic tendency. Of these species, *Praehippiger pacygaster*, *Ocneridia volxemi*, and *Oedipoda coerulescens* are more resistant to the weather conditions than the others. The third group (Group 3) is situated in the negative area of axis 1, which is characterised by the stations of the northern zone. The species that represent this site are *Pamphagus elephas*, *P.*

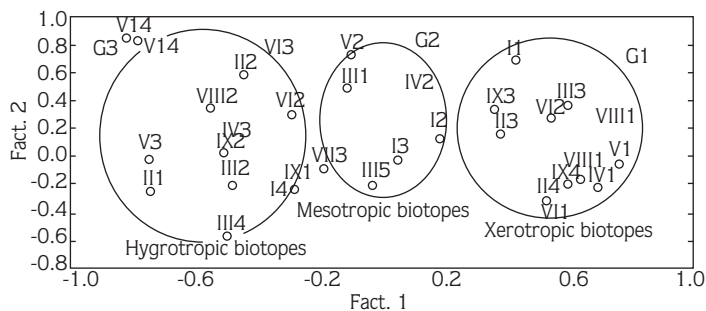


Figure 5. Correspondence variable analysis of the matrix of ecology/species (Table 2 and 3). Distribution of the ecological variables defined according to axes 1 and 2.

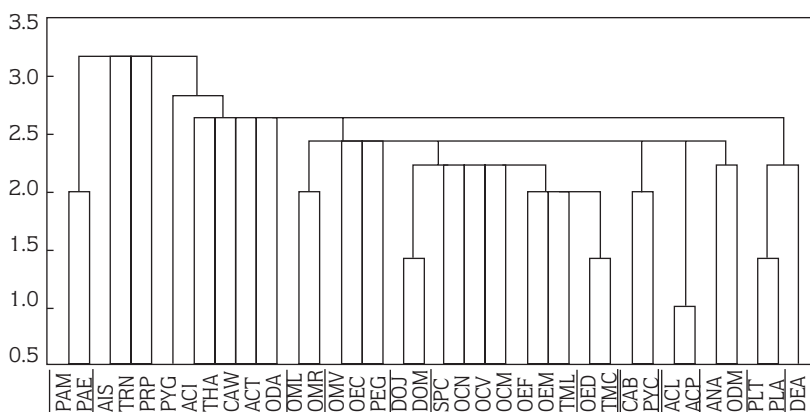


Figure 6. Ascending hierarchical clustering of the 36 species of Orthoptera according to 32 ecological variables defined in Table 2.

*marmoratus*, *Aiolopus strepens*, *Odentura algeriana*, *O. maroccana*, and *Truxalis nasuta*. Thus, species of the third group have a hygro- to meso-hygrophilic tendency.

Axis 2, with 12.53% of total inertia, is closely associated with the stations' temperatures. This axis demonstrates a clear contrast between the very high temperatures characteristic of the stations of the southern zone and the low temperatures characteristic of the stations of the northern zone (Figure 5). So, we consider that this axis expresses the influence of temperature on the distribution of Orthoptera. It is likely that several mechanisms operate simultaneously to influence population dynamics of Orthoptera species. Additionally, the effect of weather may operate synergistically with other ecological factors, such as

nature of the station and soil characteristics (moisture), which seemed to be apparent in the distribution of certain Orthoptera.

The ascending hierarchical clustering (CHA) confirms the results obtained by AFC; however, in hierarchical clustering, xerotrophic and mesotrophic species are grouped within the same branch, indicating that there is no clear difference between the ecological demands of these 2 species groups. Species pairs that have similar ecological preferences (according to CHA) are (Figure 6) *Acrotylus patruelis*-*A. longipes*, *Platypleis tessellata*-*P. laticauda*, *Oedalus decorus*-*Tmethis cisti*, *Dociostaurus jagoi jagoi*-*D. maroccanus*, *Omocestus raymondi*-*O. lucasi*, and *Pamphagus elephas*-*P. marmoratus*.



## Conclusion

Thirty-six species of Orthoptera were recorded from the Setif region of Algeria, 4 of which (*Ocneridia volxemi*, *Dociostaurus maroccanus*, *Calliptamus wattenwyllianus* and *Praehippiger pacygaster*) are of economic importance because they are responsible for a considerable agricultural damage. The majority of species recorded on the Setif Plateau have one generation per year. The interactions of weather, soil, and Orthoptera population may hold the key of understanding the grasshoppers, and locusts, distributions in the area of Setif. By analyzing the species composition of grasshoppers and their distribution in the Setif region we defined 3 groups. The first group includes 9 species, *Oedalus decorus*, *Sphynonotus coerulans*, *Dociostaurus jagoi jagoi*, *Decticus albifrons*, *Platycleis tessellata*, *P. laticauda*, *Thmetis* spp., and *Ocneridia microptera*, and they seem to show a xerotrophic tendency. The second group includes 11 species, *Thalmpena algeriana*, *Acrotylus longipes*, *Omocestus* spp., *Pyrgomorpha*

*cognata*, *Acinipe tibialis*, *Acrotylus patruelis*, *Calliptamus barbarus*, *Praehippiger pacygaster*, and *Ocneridia volxemi*, and have a xerophilic to thermophilic tendency. The third group includes 6 species, *Pamphagus elephas*, *P. marmoratus*, *Aiolopus strepens*, *Odentura algeriana*, *O. maroccana*, and *Truxalis nasuta*, which prefer meso-hygrophilic and meso-thermophilic conditions and present a low density in the area. Remaining species do not show a close relationship to defined ecological variables. There may be 2 explanations for this pattern: (i) it can be concluded that in these ecological conditions, these species are wide-ranging, or (ii) the present sampling may be insufficient for a better understanding their ecological preference.

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