Quantitative Study of Diet of *Calliptamus barbarus* (Orthoptera: Acrididae) in the Region of Jijel (Algeria)

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**ABSTRACT**

*Calliptamus barbarus* (Costa, 1836), (Orthoptera: Calliptaminae) is an important agricultural pest. In Algeria it causes a lot of damage. This species is known for its large chromatic and geographical polymorphism. To better understand the biology of this insect, we studied the quality and quantity of its diet. It is performed according to the conventional method of faecal analysis and complemented by quantification of ingested plants by using the method called “windows”. This method allows the identification with certainty of the quantity of plants ingested by the Orthoptera. It is based on calculation of the recovery rate of the plants, preparation of reference epidermis and analysis of feces. An index of palatability for each species is calculated from leaf surfaces ingested by each individual. It indicated that the trophic spectrum is very large and concluded that this insect is polyphagous with graminivorous trend. In fact, the most consumed vegetable species, any confused parameter, is *C. vesicaria*. It is followed respectively by *V. myuros, P. serraria* and *C. dactylon*. On the other hand, we noticed that the palatability index is not conforming to the recovery rate of the plants in the field and the most ingested plants are not necessarily the most appetizing.

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**Introduction**

The barbarine grasshopper: *Calliptamus barbarus* (Orthoptera: Acrididae) is an insect considered as a potential pest of crops in Algeria, especially during outbreaks. He is well known for his chromatic and geographical polymorphism. This locust has been the subject of several studies related to different aspects: morphometric (Larrosa *et al*., 2004), physiological (Benzara, 2004), sexual behavior (Larrosa *et al*., 2007), sound production (Larosa *et al*., 2008), or more recently a molecular study (Sofrane, 2015; Rouibah *et al*., 2016).

The knowledge of the biology of an insect and especially its diet is fundamental to know which are among its food spectrum these most attractive host plants and this to fight effectively against this devastating, hence the interest of this study. Food is the source of energy for every living being. It plays a very important role in growth. The diet of locusts has been the subject of numerous studies. These are generally based on differentiations in consumption and the relationships between locusts and plants in their habitats. There are different methods to study the diet of animals. We can mention among others:
the analysis of digestive content, direct observation of the animal in the field, captive study, examination of mandibles and especially the faecal analysis.

The method of faecal analysis is widely used in the world. It has been used successfully and effectively by different authors on different groups of animals and for different reasons. Indeed, According to Dickman and Huang (1988). This method is relatively reliable for determining the diet of generalist insectivores mammals that eat hard-bodied prey. Moreover, this technique has been tested by (Moreno-Black, 1978) to study the feeding of non-human primates. Regarding birds, we can mention the work of Burger et al. (1999) on the feeding ecology of California gnatcatcher: *Polioptila californica* (Passeriformes: Poliopiilidae) and Deloria-Sheffield et al.(2001) on the diet of Kirtland's warbler *Dendroica kirtlandii* (Passeriformes: Parulidae).

The techniques used to study the diet of locusts vary essentially according to the objective defined: field or laboratory study, qualitative or quantitative study. Daniel (1991) has successfully used faecal analysis to study the effect of diet-induced developmental plasticity on grasshopper head size: (*Melanoplus femurrubrum* (Orthoptera: Acrididae). This same method was used by Sword & Dopman (1999) to compare feeding of larvae and adults of *Schistocerca emarginata* (Orthoptera: Acrididae). For their part, Essakhi et al. (2015) used this method which allowed them to determine the diet of 9 locust species in the Middle Atlas (Morocco).

In Orthoptera, There are two main types of diet that are easily separable: consumers of Poaceae (graminivorous) and consumers of other vegetable or non-graminivorous families (Legall, 1989; Benzara et al., 1993 and 2003; Benfekih, 2006). According to Popov (1989) the graminivorous species, consume both wild and cultivated Poaceae. Forbivorous species generally ingest dicotyledonous.

The aim of the present work is to study qualitatively and quantitatively the diet of *C. barbarus*, analyzing the feces of different individuals. The technique designated by the "window method" is adopted. This is based on the faecal analysis, quantifying the food ingested by the insect. This technique is proposed by Doumandji et al. (1993a). This method allows the identification with certainty of the plant species swallowed by the Orthoptera. It is done by comparing the epidermis fragments of the plants found in the feces with those of a reference epidermis. This is prepared from the plant species present in the biotope of this Orthoptera. The window method gives reliable results and accurately reflects what is happening on the ground. However, sampling of individuals from the environment for short periods of time may unbalance the environment, especially if this study is carried out in parallel with another study on population dynamics.

**Material and Methods**

This study was conducted on the region of Jijel (Northern East of Algeria) during the period from September 2011 to August 2013. Several harvesting methods are used to harvest locusts based on their habitat. In this study, to capture the insects on the ground, the netting method is chosen. It involves randomly harvesting a sample of locusts, and collecting specimens of the plants therein for subsequent determination. Upon capture, trapped *C. barbarus* are individually isolated in plastic bags in order to collect them feces.

This animal material is stored in the laboratory until it is used.

To identify plant species, determination guides are used (Quezel and Santa, 1962; IDGC, 1976). The calculation of the rate of recovery of the plants makes it possible to recognize the abundance-dominance of the plant species on the ground. It is estimated according to the method given by Duranton et al. (1982) and already used by Benzara et al. (2003). It consists of estimating the surface of
At each exit, plant samples are taken in order to produce a reference epidermis and for the formation of a herbarium. Indeed, the elaboration of this collection facilitates the knowledge of the plant species ingested by the locusts (Ben Halima, 1983). To constitute a reference, it is necessary to study epidermis fragments when the plant is freshly harvested. The removal of the epidermis can be easy, if the dry samples are first softened. For this, the fragments are brought to a boil in water for 5 minutes. Then, the epidermis is isolated by scraping the selected plant fragment using a razor blade, until a transparent epidermis is obtained. The chlorophyll content is then destroyed. The epidermis thus obtained is macerated in 12% bleach for a few seconds to be lightened in order to better see the structures of the cell prey. The preparation and sealing of the preparation is carried out between the blade and the slide using Faure's liquid. To avoid the formation of air bubbles, the blades are passed for a few seconds on a hot plate. On each blade thus prepared, the names of the plant species are given.

The preparations are then observed under a microscope in order to produce microphotographs. According to Ben Halima (1983) the epidermis is easy to determine by microscopic observation by many characters, both for Poaceae and for dicotyledonous. Generally, the epidermis is not digested by the digestive liquid of the insects as are the other parts of the leaf. In Poaceae, the most interesting elements for the specific determination are long and short cells (siliceous and suberous), hairs and stomata (Garcia-Gonzalez, 1984). For dicotyledonous, the criteria for determining the species are the shape of the cells and the shape and distribution of the stomata. The operator can rely on the presence of basal body of the hair and on the nodular wall as well as on the size of the smooth or corrugated wall of the epidermal cells. Also the form of “trichomes” is very interesting, whether single or multi-cellular, branched or star-shaped, with a single or bifurcated end (Garcia-Gonzalez, 1984).

The method used for the preparation of feces is to identify and quantify the plant fragments contained in the excrements of the captured individuals (Launois-Luong, 1975). After collection of the feces, they are put in distilled water for 24 hours. This allows the fragments to be released without damaging them. Subsequently, the fragments are homogenized for a few seconds to one minute in alcohol. They thus undergo discoloration without the apparent destruction of the epidermis. The rest of the operations are identical to those used for the constitution of the epidermis reference. It is a question of analyzing the digestive contents or feces, which gives as precise information as possible (Chara, 1987). The advantage of the microscopic study of feces is that it makes it possible to obtain reliable and precise results because it is based on numerous criteria of identification. The technique adopted is simple and easy. But it needs a lot of clarification. It is not evident to observe several fragments of feces as small as those of locusts. To determine and quantify the diet of C. barbarus, the method proposed by Doumandji et al. (1993b) and also used by Benzara et al (2003) allow estimating the surfaces of the fragments contained in the feces.

It consists of fixing with a rubbing adhesive a piece of graph paper on the microscope tray. In the center of this paper a 1 mm² window is pierced so that it is superimposed with the microscope objective. The preparation is then placed on it. The lamella is browsed and each time the window crosses a vegetal fragment, its surface is estimated according to

\[ R = \pi (d/2)^2 \times \frac{N}{S} \times 100 \]

R: % recovery rate of a given plant species

d: Average diameter of the plant in orthogonal projection expressed in centimeters

S: Area of the sampling

N: Number of feet (tufts) of the given plant species
whether it occupies a totality (1 mm²), half (0.5 mm²), quarter (0.25 mm²) etc.

Once the surface of the lamella has been completely scanned, the total area S of the fragments is calculated for each of the species ingested by summing the partial areas S1, S2, S3... Sn.

In this study we used 3 parameters: relative consumption frequency, consumption rate and index of palatability. The first parameter corresponds to the appearance of a given plant in the samples is calculated in the following way:

\[ F = \frac{N_i}{N} \times 100 \]

F: the relative frequency of the plant epidermis contained in the feces

ni: the number of times that the fragments of the plant i are observed in the feces

N: total number of samples examined

On the other hand, the consumption rate of a given plant species is the percentage of the leaf area of this ingested species, relative to the total leaf area ingested. Finally, the index of palatability is calculated by the ratio of the rate of consumption of the plant considered to its rate of recovery in the field (Rouibah, 1994).

Results

The qualitative and quantitative study of C. barbarus diet using the window method allowed us to first identify the food spectrum obtained by calculating the frequency and expressed in percentage. This led later to know which of the plant species ingested those that are most consumed using 2 parameters: ingested leaf area (calculated in mm²) and the consumption rate expressed in percentage. Finally with the attraction index it was possible to recognize the most attractive plants for C. barbarus. The result are shown in Table 1.

Traces of 26 of the 39 plants present in the Jijel station were found in C. barbarus feces. These are distributed among 12 families. These include 8 Poaceae, 5 Asteraceae, 3 Fabaceae, 2 Boraginaceae, 2 Lamiaceae, 1 Apiaceae, 1 Plantaginaceae, 1 Lythraceae, 1 Brassicaceae, 1 Pittosporaceae, 1 Ranunculaceae and 1 Solanaceae. Thus the great polyphy of this locust species is brought to light. The majority of these species (n = 18, 69.2%) are dicotyledonous and only 8 are monocotyledonous (30.8%). Each of these two groups of plants was recognized by their comparison with the previously prepared reference epidermis (Figure 1). It should be noted, however, that levels of consumption are different from one plant to another (Table 1).

In terms of frequencies, C. dactylon (Poaceae) with 15.6% is the most important. It is followed by C. vescicaria (Asteraceae) with 13.3%, P. serraria (Plantaginaceae) with 11.2% and V. myuros (Poaceae) with 10.5%. S. menthifolia (8.7%) and L. stoechas (Lamiaceae) (6.2%) are less frequent. The others plants are weakly represented as S. hispanicus (Asteraceae) with 5.1%, E. tricuspidatum (Apiaceae) with 3.8% and C. creticum (Boraginaceae) with 3.7%. Low-stress plants may be ingested accidentally.

Quantitatively, the most sought after species is C. vescicaria. The latter is strongly consumed corresponding to a leaf area of 84.3 mm². This Asteraceae is followed by P. serraria (36.8 mm²), V. myuros (32.6 mm²) and A. mauritanicus (8.1 mm²). Other plant species are less consumed. Their ingested surfaces are less than 4 mm². This is the case of S. menthifolia (3.7 mm²), L. stoechas (2.8 mm²), T. distachya (1.9 mm²), E. tricuspidatum (1.8 mm²) and C. dactylon (1.7 mm²). However, the last species mentioned are more or less attractive with respect to C. barbarus. On the other hand, C. vescicaria (IA = 93.4), V. myuros (IA = 40.2) and P. serraria (IA = 33.4) are by far the most attractive with fairly high indices of attraction (IA). However, for C. dactylon, it corresponds to a low index (IA = 0.04) although it is widely consumed (15.6%). This difference between the dietary preference of a species and its IA can be attributed to its recovery rate in the field. Thus, the more the species eaten is
**Table 1.** Plant species, estimate of recovery rates in the field, their, Frequencies in the feces, leaf area ingested, Consumption and indices of palatability for *C. barbarus* Plants consumed.

<table>
<thead>
<tr>
<th>Botanical Families</th>
<th>Plant species</th>
<th>F(%)</th>
<th>S (mm²)</th>
<th>C (%)</th>
<th>R (%)</th>
<th>IA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poaceae</td>
<td><em>Avena sterilis</em></td>
<td>1,20</td>
<td>0,83</td>
<td>0,46</td>
<td>0,12</td>
<td>3,83</td>
</tr>
<tr>
<td></td>
<td><em>Cynodon dactylon</em></td>
<td>15,60</td>
<td>1,70</td>
<td>0,94</td>
<td>20,21</td>
<td>0,04</td>
</tr>
<tr>
<td></td>
<td><em>Ampelodesma mauritanicus</em></td>
<td>3,20</td>
<td>8,10</td>
<td>4,50</td>
<td>0,60</td>
<td>7,50</td>
</tr>
<tr>
<td></td>
<td><em>Vulpia myuros</em></td>
<td>10,50</td>
<td>32,6</td>
<td>18,07</td>
<td>0,45</td>
<td>40,15</td>
</tr>
<tr>
<td></td>
<td><em>Dactylis glomerata</em></td>
<td>2,10</td>
<td>1,56</td>
<td>0,86</td>
<td>0,85</td>
<td>1,00</td>
</tr>
<tr>
<td></td>
<td><em>Lolium multiflorum</em></td>
<td>3,40</td>
<td>1,30</td>
<td>0,72</td>
<td>0,13</td>
<td>5,53</td>
</tr>
<tr>
<td></td>
<td><em>Trachynia distachya</em></td>
<td>0,80</td>
<td>1,87</td>
<td>1,03</td>
<td>0,4</td>
<td>2,6</td>
</tr>
<tr>
<td></td>
<td><em>Phalaris aquatica</em></td>
<td>0,90</td>
<td>0,14</td>
<td>0,07</td>
<td>0,25</td>
<td>0,28</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>37,70</td>
<td>48,10</td>
<td>26,65</td>
<td>23,01</td>
<td>57,1</td>
</tr>
<tr>
<td>Apiaceae</td>
<td><em>Eryngium tricuspidatum</em></td>
<td>3,80</td>
<td>1,78</td>
<td>0,98</td>
<td>3,40</td>
<td>0,29</td>
</tr>
<tr>
<td>Boraginaceae</td>
<td><em>Echium plantagineum</em></td>
<td>0,7</td>
<td>0,08</td>
<td>0,04</td>
<td>1,14</td>
<td>0,03</td>
</tr>
<tr>
<td></td>
<td><em>Cynoglossum creticum</em></td>
<td>3,70</td>
<td>0,24</td>
<td>0,13</td>
<td>0,22</td>
<td>8,72</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>4,40</td>
<td>0,32</td>
<td>0,17</td>
<td>1,36</td>
<td>8,75</td>
</tr>
<tr>
<td>Asteraceae</td>
<td><em>Urospermum picroides</em></td>
<td>0,20</td>
<td>0,18</td>
<td>0,099</td>
<td>9,01</td>
<td>0,01</td>
</tr>
<tr>
<td></td>
<td><em>Senecio vulgaris</em></td>
<td>0,10</td>
<td>0,07</td>
<td>0,03</td>
<td>24,00</td>
<td>0,001</td>
</tr>
<tr>
<td></td>
<td><em>Galactites tomentosus</em></td>
<td>1,30</td>
<td>0,26</td>
<td>0,14</td>
<td>0,29</td>
<td>0,50</td>
</tr>
<tr>
<td></td>
<td><em>Scolymus hispanicus</em></td>
<td>5,10</td>
<td>0,45</td>
<td>0,24</td>
<td>0,30</td>
<td>0,80</td>
</tr>
<tr>
<td></td>
<td><em>Crepis vesicaria</em></td>
<td>13,30</td>
<td>84,30</td>
<td>46,72</td>
<td>0,50</td>
<td>93,44</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>20,00</td>
<td>85,26</td>
<td>47,13</td>
<td>34,10</td>
<td>94,75</td>
</tr>
<tr>
<td>Plantaginaceae</td>
<td><em>Plantago serraria</em></td>
<td>11,20</td>
<td>36,80</td>
<td>20,40</td>
<td>0,61</td>
<td>33,44</td>
</tr>
<tr>
<td>Fabaceae</td>
<td><em>Trifolium repens</em></td>
<td>0,80</td>
<td>0,05</td>
<td>0,02</td>
<td>0,93</td>
<td>0,02</td>
</tr>
<tr>
<td></td>
<td><em>Lathyrus ochrus</em></td>
<td>0,90</td>
<td>0,06</td>
<td>0,03</td>
<td>0,07</td>
<td>0,42</td>
</tr>
<tr>
<td></td>
<td><em>Melilotus infestus</em></td>
<td>2,30</td>
<td>0,29</td>
<td>0,16</td>
<td>0,08</td>
<td>2,00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>4,00</td>
<td>0,40</td>
<td>0,21</td>
<td>1,08</td>
<td>2,44</td>
</tr>
<tr>
<td>Lythraceae</td>
<td><em>Lythrum junceum</em></td>
<td>1,50</td>
<td>0,20</td>
<td>0,11</td>
<td>3,40</td>
<td>0,03</td>
</tr>
<tr>
<td>Lamiaceae</td>
<td><em>Lavandula stoechas</em></td>
<td>6,20</td>
<td>2,84</td>
<td>1,60</td>
<td>0,20</td>
<td>8,00</td>
</tr>
<tr>
<td></td>
<td><em>Calamintha menthifolia</em></td>
<td>8,70</td>
<td>3,70</td>
<td>2,05</td>
<td>0,30</td>
<td>6,83</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>14,90</td>
<td>6,54</td>
<td>3,65</td>
<td>0,50</td>
<td>14,83</td>
</tr>
<tr>
<td>Brassicaceae</td>
<td><em>Raphanus raphanistrum</em></td>
<td>1,40</td>
<td>0,36</td>
<td>0,20</td>
<td>0,20</td>
<td>1,00</td>
</tr>
<tr>
<td>Pittosporaceae</td>
<td><em>Pittosporum coriaceum</em></td>
<td>0,30</td>
<td>0,04</td>
<td>0,02</td>
<td>0,10</td>
<td>0,20</td>
</tr>
<tr>
<td>Solanaceae</td>
<td><em>Solanum nigrum</em></td>
<td>0,80</td>
<td>0,54</td>
<td>0,30</td>
<td>15,00</td>
<td>0,09</td>
</tr>
</tbody>
</table>

F(%): frequency of consumption. R: rate of recovery of each plant species in the field, S: plant area consumed; C: consumption rate; IA: index of attraction
Continued on next page
scarce and the more its IA is high. This hypothesis can be confirmed by the case of *S. vulgaris* (R: 24%), *C. dactylon* (R: 20%) and *S. nigrum* (R: 15%), which represent the three most dominant species. However, all three of them are distinguished not only by their very low consumption rates (less than 0.94%), but also by their negligible IA (less than 0.04). Some species such as *L. stoechas* and *S. menthifolia* have shown some balance in terms of quality / quantity ratio. Indeed, these two species have respective frequencies of 6.2% and 8.7% and IA of 8 and 7 respectively.

In term of botanical families, 11 out of 20 families in the station are consumed by *Calliptamus* (Table 1). The Poaceae (38%) and Asteraceae (20%) are by far the most important. (Figure 2). They are followed by Lamiaceae (15%) and Plantaginaceae (11%). Borraginaceae, Fabaceae and Apiaceae have almost the same importance for *C. barbarus*. Indeed, they are consumed with almost the same rate of 4%.

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**Table 2.** Linear correlation matrix between the different parameters

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>S</th>
<th>C</th>
<th>R</th>
<th>IA</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>0.73</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0.72</td>
<td>0.99</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>0.64</td>
<td>0.82</td>
<td>0.99</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IA</td>
<td>0.77</td>
<td>0.82</td>
<td>0.99</td>
<td>0.84</td>
<td>1</td>
</tr>
</tbody>
</table>

F: frequency of consumption; R: rate of recovery of each plant species in the field; S: plant area consumed; C: consumption rate; IA: index of attraction
Other families, such as Lythraceae, Brassicaceae, Solanaceae and Pittosporaceae, are very poorly ingested at rates of about 1% (Figure 2).

Quantitatively, this order is not respected. In fact, Asteraceae are the most ingested with a leaf area of 85.3 mm$^2$. The Poaceae are half as much ingested with 48.1 mm$^2$. Plantaginaceae are well placed (36.8 mm$^2$). However, apart from Lamiaceae (6.54 mm$^2$) and Apiaceae (1.78 mm$^2$), all other families are ingested with leaf areas below 1 mm$^2$ (Table 1). By comparing mono and dicotyledonous, it should be noted that with a recovery rate (R) of only 23% in the field, Poaceae provide 38% of the C. barbarus feed at a rate of consumption (C) of 27% (Fig.4). In contrast, Asteraceae have a recovery rate of 34%, while having a consumption rate of 47% (Figure 3); however they ensure only 20% of the diet to the insect. Plantaginaceae are well consumed with consumption rates of 20% (Figure 3) provide 11% of alimentation, but occupy only 1% of overlay (Table1).
The statistical analysis (Table 2) has made it possible to obtain a linear correlation coefficient very close to 1 (p < 0.05). This shows that the different parameters are very well correlated or interrelated, and in particular the leaf area with the consumption rate of one side and the recovery rate compared to the consumption rate on the other side where r is equal to 0.99. On the other hand, the two least correlated factors are the frequency of consumption compared to the recovery rate (r = 0.64).

**Discussion**

In the light of the results obtained, it is clear that *C. barbarus* behaves like a very polyphagous insect with a tendency towards the graminivorous diet. This has been confirmed by the listing of 26 plant species distributed among 11 families (Table1). It should be noted that the Asteraceae are as important a source of food as the Poaceae. The other botanical families are only very poorly eaten in the image of Pittosporaceae, Ranunculaceae and especially Solanaceae. Their ingestion can therefore be considered as accidental.

In the light of the results obtained on the trophic spectrum, it seems that the species most sought after by *C. barbarus* in the region of Jijel are in order of importance: *C. vesicaria*, *V. myuros*, *P. serraria* and *C. dactylon*.

By comparison between consumption and recovery rates, it should be noted that plant species, despite their good representativeness on the ground, constitute only a weak source of food for *C. barbarus*. This is particularly the case for *S. vulgaris* and *S. nigrum*, both of which are characterized by very low consumption, despite their very high occupancy rate on the soil.

The results obtained by the quantification of the feed and the analysis of the index of attraction confirm this strong selectivity with regard to the plants available in the field. However, although the consumption rate is related to IA, the most ingested plants are not necessarily the most appetizing. Nevertheless, IA varies from one species to another depending on whether it is abundant in the field. This may indicate that appetite is due as much to internal factors, essentially biochemical to the plants themselves, as to external factors, that is to say to the environmental conditions. The structure of this environment can in some cases at least influence the feeding behavior of locusts (Legall and Gillon, 1989). Food intake activity is apparently conditioned by several factors such as temperature, condition and age of the locusts. The food choice of locusts is unrelated to the abundance of overgrowth of ingested plants (Launois-Luong, 1975).

According to Legall (1989), there are many plant biochemical involved in feeding behavior that can play a phagostimulating or repulsive role. Some secondary substances can inhibit consumption, limit protein assimilation or metabolism, and even reproduction. They may render some plants unappetizing. On the other hand, the good water balance of the plant is an essential factor of their use.

According to Benzara et al. (2003) *C. vesicaria* and *V. myuros* are the preferred species for *C. barbarus*. On the other hand, Ben kenana and Harrat (2011) have indicated that *Hordeum murinum* and *Triticum sativum* are the plants best searched by this Calliptaminae. By comparing the results of this work with the quantitative dietary study carried out by Rouibah (1994) in the Taza National Park, there is a great similarity between the two. Indeed, it has been found among the food spectrum of this insect, several common species but consumed differently. These include *C. vesicaria*, *V. myuros*, *L. multiflorum*, *C. dactylon* and *G. tomentosus*.

In the Oran region, Chara (1987) found that the most consumed botanical families of *C. barbarus* are mainly Zygophyllaceae, Plantaginaceae, Brassicaceae and Papilionaceae. There is therefore a great diversity in consumption. According to the latter, the non-consumption of certain plant species probably results from the fact that these plants contain toxins (Euphorbiaceae) repellent for phytophagous insects. Some plants may also be
difficult to digest because of the hardness of their leaves (the case of the Grasses) or the rigid hairiness as in the Compounds (Chara, 1987). For Benzara et al. (1993) the highest frequency among the trophic spectrum of C. barbarus is Pancratium maritimum. It is an Amaryllidaceae, yet one of the plants whose occupation of the soil is the weakest. They continue by specifying that the consumed parts of this plant are the stamens and the petals and not the leaves. They conclude that this locust species appears to be non-graminivorous but highly polyphagous (Benzara et al., 1993). As far as the present work is concerned, according to the results obtained, C. barbarus clearly appears as a highly polyphagous species that feeds both Poaceae and dicotyledonous.

In their interesting study Zaim et al., (2013) have attempted to explain the tendency towards polyphagy, oligophagy or monophagy by the number of sensilla (type A1 A2 and A3) present on their labrum. According to these authors, there is a close relationship between the diet and the number and types of sensilla on the labrum of grasshoppers. For them the polyphagous species possess a greater number of sensilla than the oligophagous species. They go on to explain that during an evolutionary transition from oligophagy to monophagy the specialized diet of a grasshopper species is related to a reduction in the number of labrum sensilla (Zaim et al., 2013). They specify that this is insufficient to infer the diet for all grasshopper species. They cite the case of, Sphingonotus rubescens a species that can feed on several plant families, but whose number of sensilla resembles that of oligophagous species. For these same authors this suggests that the dietary change during evolution may precede the modification of the number and types of sensilla on the labrum which are closely linked to the diet and are probably an adaptation and not the cause of a change in dietary (Zaim et al., 2013).

Conclusion

The majority of studies on the diet of Orthoptera are mainly carried out by the traditional method of feces analysis. Thanks to the so-called window method, based on the quantity of plants ingested, the trophic spectrum of C. barbarus was identified and quantified. This made it possible to recognize the range of plants ingested and the notion of food preference with regard to all the plant species present on the field. This trophic study indicated that C. barbarus showed a clear choice of plants for its diet, thanks to the discordance between the consumption of plant species and their abundance in the biotope. The most sought after species by C. barbarus in the station of Jijel are in order of importance: C. vesicaria, V. myuros, P. serraria and C. dactylon, although the latter species has distinguished itself by its rate Very low consumption. This explains the hypothesis that the food intake of a plant species depends on its nutritive value for the growth and reproduction of the locusts. But on the whole, the Poaceae are the most consumed plants among botanical families. The Barbary Desert showed a marked preference for this botanical family but also for the dicotyledonous. Therefore, it is indeed a polyphagous species that sometimes behaves like a graminivorous insect and sometimes as a forbivorous.

References


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