Evaluation of The Diversity of Durum Wheat Coleoptera (Triticum Durum Desf.) in the Region of Sigus Oum El Bouaghi (Eastern Algeria)

Amokrane Assia  
*University of Oum El Bouaghi, Algeria, saheb.menouar.ecology@gmail.com*

khammar hichem  
*University of Oum El Bouaghi, Algeria, khammar.eco.env@gmail.com*

Hadjab ramzi  
*University of Oum El Bouaghi, Algeria, ramzi_hadjab@yahoo.fr*

saheb menouar  
*University of Oum El Bouaghi, Algeria, saheb_tahar@yahoo.fr*

Follow this and additional works at: [https://corescholar.libraries.wright.edu/jbm](https://corescholar.libraries.wright.edu/jbm)

Part of the Biodiversity Commons, Evolution Commons, and the Population Biology Commons

**Recommended Citation**

Assia, A., hichem, k., ramzi, H., & menouar, s. (2020). Evaluation of The Diversity of Durum Wheat Coleoptera (Triticum Durum Desf.) in the Region of Sigus Oum El Bouaghi (Eastern Algeria), *Journal of Bioresource Management, 7*(4).

This Article is brought to you for free and open access by CORE Scholar. It has been accepted for inclusion in Journal of Bioresource Management by an authorized editor of CORE Scholar. For more information, please contact library-corescholar@wright.edu.
EVALUATION OF THE DIVERSITY OF DURUM WHEAT COLEOPTERA (TRITICUM DURUM DESF.) IN THE REGION OF SIGUS OUM EL BOUAGHI (EASTERN ALGERIA)

AMOKRANE ASSIA¹, KHAMMAR HICHEM¹, HADJAB RAMZI¹, SAHEB MENOUAR¹

¹. Laboratory of Functional Ecology and Environment, University of “Larbi Ben M'hidi”, Oum el Bouaghi, Algeria

*Corresponding author: saheb.menouar.ecology@gmail.com

ABSTRACT

The Oum El Bouaghi region in Eastern Algeria, long considered as a cereal-growing area is nowadays a durum wheat production region par excellence. Although the damage caused by Coleoptera is very significant, studies on the knowledge of their diversity are few and remain limited for some entomological groups. Our work is the first step to evaluate the diversity of Coleoptera and the long-term impact of taking biological management measures against harmful fauna in favour of more environment friendly agriculture. To assess the beetle community, different sampling methods were combined (Barber trap, coloured traps, mowing net and sight hunting). Evaluation of the results of a single campaign showed that Coleoptera infested with durum wheat vary in abundance and diversity. We identified more than 100 species of Coleoptera belonging to 22 different families for a total number of 5698 individuals belonging mainly to the Carabidae, Curculionidae, Chrysomelidae, Scarabidae and Staphylinidae families. Although the majority of Coleoptera collected are pests of durum wheat crops (47.57%) the case of Tropinota hirta, Notaris sp or Oulema melanopus in particular, there was an interesting presence of predators (28.15%) the case of Carabidae or Staphylinidae in particular even with low relative abundance. The temporal evolution of the Coleoptera showed that the species diversity indicated a peak of abundance at the full tillering stage following an accentuated vegetative development of the host plant, and the presence of weeds. The data collected in this way constitute a basis for a preliminary knowledge of the durum wheat Coleoptera and can thus be used to design pest control strategies.

Keywords: Triticum durum, Coleoptera, pests, predators, Oum El Bouaghi, Algeria.

INTRODUCTION

The eastern Algerian highland region is mostly dominated by cereal crops. The pedoclimatic conditions prevalent in this type of environment make it very important to have a diversified fauna, in particular the Coleoptera, which forms a category of arthropod animals recognized since ancient times and is a genus of insects. This constitutes 25 to 30 per cent of all animal populations (Powell, 2009; Moore, 2013). This order, the richest in species on earth, forms the average element of biodiversity and can intervene at all levels of the food web. They can be primary consumers (phytophagous), secondary consumers or tertiary consumers (predators or parasites) (Odegaard, 2000; Marniche et al., 2014; Labruyere, 2017). According to Elizabeth (2015) Coleoptera constitutes more than 300,000 described species; they live in all environments and are characterized by the ease of harvesting and conservation (Perrier, 1977; Barney and Pass, 1986). The sources of food for Coleoptera are as varied as their
lifestyles, ranging from a purely carnivorous diet to a phytophagous, mycetophagous or saprophagous diet (Zarazaga, 2015).

Cereals are by far the most important agricultural land use because they serve as staple food for a large proportion of the world’s population. In Algeria, as in North Africa, these crops represent the main speculation and drain several processing activities, in semolina, bakery and food industry. In Algeria, during the last decade, wheat represented an average of 67.1% of all cereal production. They also constitute the basis of food and occupy a privileged place in the food habits of populations in both rural and urban areas (Derbal et al., 2015).

Although the damage caused by the beetle fauna in Algeria is very significant in cereal fields, studies on the knowledge of the bio-ecology of this procession remain insufficient and poorly known and are generally quite localized and focused on limited taxa. This is particularly the case for the family Aphididae, which is the most studied group (Boughida, 2010; Dif, 2010; Laabdaoui and Guenaoui, 2015; Aggoun et al., 2016; Lebbal, 2017). The bibliography dealing with the Coleoptera fauna in different regions of the globe is abundant, but in the Maghreb (North Africa), in-depth studies on this fauna are rather rare. Note that studies carried out recently in Algeria concern in particular the entomological fauna associated with forest species such as cork oak, holm oak or cedar (Benia, 2011; Bairi and Mennous, 2017). Adding some recent studies carried out on the Carabidae fauna (Ouchtati et al., 2012; Saouache and Doumandji, 2014; Saouache, 2017). On the other hand, the studies concern the stands of the entomofauna of cereals as a whole are few and fragmentary. However, we can cite in particular the study carried out by Kellil (2019) in the region of the high plains of Algeria.

In Morocco, numerous fragmentary studies on this order have been carried out by Chavanon et al., (1995); Chavanom and Mahboub (1998) in the mouth of the Moulouya River; Slim et al., (2016) in reserve of Sidi Boughaba Mehdia. In Tunisia (Touaylia et al., 2009) an inventory of Helophoridae and Hydraenidae was made. In Algeria, the study conducted by Boukli Hacene et al., (2012) of the salt marshes at the mouth of the Tafna (Tlemcen) was cited.

The richness and particular characteristics of the Beetles as auxiliary fauna is far from negligible and concerns several families (Carabidae, Silphidae, Cleridae, Anthisridae, Lampyridae...) and several hundred species (Kulkarni et al., 2015). They are mainly generalist predators but some groups or families are more or less specialised, such as the Coccinellidae which, depending on the genus and species, are consumers of aphids, mealybugs or mites. Some species are parasites of diptera Anthomyiidae (cabbage maggot), this is the case of certain staphylins of the genus Aleochara. Beetles represent an important biomass especially in the tropics. They are a part of food chains and their impact as decomposers and consumers (Gullan and Cranston, 2010). The distinctive characteristics of this fauna have aroused the interest of many researchers all over the world and also our interest, given that little work has been done on this fauna in Algeria, particularly on this group of insects and on durum wheat crops (Ouchtati et al., 2019). The aim of this work was to analyse the taxonomic composition of the beetle population harvested at the family and species level (Talmaciu, 2018). This study also aims to determine the bio-ecological status of the different species inventoried (abundance, constancy and trophic status) determined through their diets and their temporal distribution in relation to the phenology of the host plant.
MATERIAL AND METHODS

Study Area

The durum wheat field where our experiment took place is located in the Ghoul Moussa pilot farm located in the commune of Sigus. Among the activities carried out by this farm we can mention among others poultry fattening and industrial hatching with egg production; industrial fattening of cattle and sheep (in converted stables) and other slaughter animals for slaughter. The farm has an area of 1398 Ha intended mainly for the cultivation of durum wheat, soft wheat, barley, oats and certain vegetable crops such as chickpeas and lentils, adding 10 Ha intended for olive growing (A.S.D, 2018). The commune of Sigus located in the extreme northeast of the wilaya of Oum El Bouaghi (Figure 1),

Figure 1: Map of the geographical location of the study site in the Sigus region.

Figure 2: Barber pot at the start of tillering

Figure 3: Barber pot at full tillering
covers an area of 210.24 km². This region is under the dominance of a continental climate with strong thermal amplitudes, both annual and daily, which is characterized by cold winters, irregular rainfall, very frequent spring frosts and hot and drying winds at the end of the cereal cycle (Baldy et al., 1993). The soils at the experimental site are characterized by flat topography, belong to the clay loam group, and are 120 cm deep. The previous crop is an unworked fallow. The study focused on the durum wheat variety Waha.

For the second harvesting technique, we used 30 coloured traps (yellow plates) made of plastic (Figure 4) in which we placed water with an added wetting agent, which not only reduces the surface tension of the water but also acts on the integuments of the insects and causes drowning of those who come into contact with the liquid (Benkhellil, 1991). This type of trap is one of the models most frequently used in wildlife entomology in agricultural environments because they are effective and lend themselves to large-scale sampling (Mignon et al., 2003).

For the third capture technique, we used the mowing net (Figure 5), a method for harvesting Coleoptera that is not very mobile and is confined in the grass (Lamotte and Bourliere, 1969). The contents are examined regularly after a few shots of the net, and the species are removed with fingers, soft pliers or with the aid of a vacuum cleaner (Benkhellil, 1991).

The number of shots with the mowing net is 10 times. These three trapping techniques are complemented by the sight-hunting method, in which Coleoptera is captured on stems, leaves and ears and sometimes even moving over the ground. The Coleoptera captured by the different sampling methods are placed in small plastic bottles containing 70% ethanol and labelled with the dates of the different surveys.

The determination and identification of the collected Coleoptera were carried out at the ecology laboratory of Larbi Ben M’hidi University in Oum El Bouaghi using a binocular magnifying glass and through the consultation of several guides and keys: (Delvare and Aberlenc, 1989; Perrier, 1961; Perrier, 1963; Perrier, 1964; Chopard, 1943; Silva et al., 2012) as well as the consultation of several entomological web sites.

**Data Analysis**

The results are analysed by ecological structure indices such as relative abundance and occurrence and composition indices such as the Shannon Diversity Index and Equitability to get an idea of the structure and composition of the harvested beetle to stand at the agro-system level studied. The Shannon-Weaver Diversity Index, which quantifies the heterogeneity of biodiversity in the environment (Benyacoub, 1993) was calculated according to the following formula:

\[ H' = - \sum (P_i \cdot \log_2 P_i) \]
Amokrane et al. (2020). Diversity of Durum Wheat Coleoptera (*Triticum durum* Desf.) in the region of Sigus

*J Biores Manag.*, 7(4): 33-54

\[ P_i = n_i / N \]

\( N \): Number of species in the sample

\( P_i \): Frequency of species i

\( n_i \): number of individuals of a species of rank i

This index is a bit unit; its value depends on the number of species present, their relative proportions and the logarithmic base. To be able to compare the diversity of samples containing different numbers of species, Equitability (E’) is calculated.

\[ E' = H'/H_{max} \]

\[ H_{max} = \log_2 S \]

S: total richness

Equitability (E’) tends towards 0 when one species largely dominates the stand and is equal to 1 when all species have the same abundance (Dajoz, 2002). A study of the trophic composition of the identified species was carried out by classifying them according to diet to determine the role played by each species. We also studied the temporal variation in species richness at certain stages of the life cycle of the host plant.

**RESULTS**

The sampling system applied during the study year enabled us to draw up a taxonomic list of 103 species divided into 22 families for a total number of 5698 individuals belonging essentially to the following families: Carabidae, Curculionidae, Chrysomelidae, Scarabidae and Staphylinidae (Table.1).

The distribution of Coleoptera inventoried indicates that the family Staphylinidae is the most diverse and representative in the number of species with 16 taxa and a rate of 15.53% followed by Curculionidae and Chrysomelidae which also show species-rich with rates of the order of 12.62% and 11. 65% respectively. The least represented families were the Histeridae, Cerambycidae, Pubrestitidae, Elateridae, Cléridae and Meloidae each represented by a single species with similar rates of the order of 0.97% (Table.1, Figure. 6).

The settlement of the Coleoptera recorded in the study area is characterized by an apparent dominance of certain species, in particular, the species *Tropinota hirta* belonging to the Cetoniidae, which marks an extremely high number of 1296 individuals, followed by the species *Psilothrix viridicoerulae* and the species *Psilothrix aureola* belonging to the Melyridae, also the species *Oulema melanopus* belonging to the Chrysomelidae, followed by *Notaris sp* belonging to the Curculionidae. For the Carabidae, the dominance returns to species *Syntomus fuscomaculatus* and *Syntomus sp*.

For the Scarabidae the species *Aphodius consparctus* dominates. For Coccinellidae the species *Coccinella setempunctata* is the most representative. Finally, the Staphylinidae which constitutes the most diversified family the dominance is due to the species *Tachyporus Chrysomelidae* and *Tachyporus sp*. To better understand the role of the species in the wheat crop biocenoses and to understand their place in the food chains and food webs, a distribution of their trophic status has been carried out. This distribution takes into consideration the type of diet of adult states, although in nature there is no absolute trophic specialization (Beaumont and Cassier, 1983).
Table 1: Taxonomic Composition, Relative Abundance and Frequency Occurrence of Harvested Coleoptera on Durum Wheat Crop

| Family      | Species                                      | Diet          | Number of individuals | Relative abundance (%) | Occurrence (%) | Range of occurrence |
|-------------|----------------------------------------------|---------------|-----------------------|------------------------|----------------|---------------------|
| Carabidae   | *Carabus nemoralis* (C.F Muller, 1764)       | Predator      | 10                    | 0.175                  | 50             | RE                  |
|             | *Syntomus fuscomacalatus* (Hope, 1838)       | Predator      | 250                   | 4.387                  | 100            | OM                  |
|             | *Syntomus sp* (Hope, 1838)                   | Predator      | 121                   | 2.123                  | 80             | C                   |
|             | *Microlestes* (Schmidt-Godell, 1846)         | Predator      | 75                    | 1.316                  | 80             | C                   |
|             | *Harpalus tenebrosus* (Dejean, 1829)         | Predator      | 2                     | 0.035                  | 20             | A                   |
|             | *Harpalus sp* (Dejean, 1829)                | Predator      | 1                     | 0.017                  | 10             | A                   |
|             | *Amara aenea* (Degeer, 1774)                | Polyphagous   | 5                     | 0.087                  | 30             | AC                  |
|             | *Calathus fuscipes* (Goeze, 1777)           | Predator      | 1                     | 0.017                  | 10             | A                   |
|             | *Zabrus tenebrioides* (Goeze, 1777)         | Phytophagous  | 75                    | 1.316                  | 70             | RE                  |
|             | *Pterostichus melanarius* (Illiger, 1838)   | Predator      | 1                     | 0.017                  | 20             | A                   |
| Species | Family | Predation Type | Abundance | Predation Level |
|---------|--------|----------------|------------|-----------------|
| Trechus quadririliatus (Eriechen, 1837) | Predator | 2 | 0.035 | 20 | A |
| Trypocopris vernalis (Linnaeus, 1758) | Coprophagous | 4 | 0.07 | 20 | A |
| Onthophagus ovatus (Latreille, 1802) | Coprophagous | 3 | 0.052 | 30 | AC |
| Rhizotrogus aestivus (Olivier, 1789) | Phytophagous | 7 | 0.122 | 70 | RE |
| Aphodius consparctus (Linnaeus, 1758) | Coprophagous | 25 | 0.438 | 40 | AC |
| Aphodius obliteratus (Linnaeus, 1758) | Coprophagous | 5 | 0.035 | 40 | AC |
| Aphodius sp (Linnaeus, 1758) | Coprophagous | 6 | 0.105 | 10 | A |
| Rhizotrogus sp (Sabatinelli, 1975) | Phytophagous | 2 | 0.035 | 10 | A |
| Cyphonistes vallatus (Paulan, 1954) | Phytophagous | 1 | 0.017 | 10 | A |
| Onthophagus sp (Latreille, 1802) | Coprophagous | 1 | 0.017 | 30 | AC |
| Geotrogus deserticola (Guerin, Meneville, 1842) | Phytophagous | 5 | 0.0351 | 30 | AC |
| Cetonidae | Tropinota hirta (Poda, 1761) | Phytophagous | 1296 | 22.744 | 100 | OM |
Amokrane et al. (2020). Diversity of Durum Wheat Coleoptera (*Triticum durum* Desf.) in the region of Sigus

*J Biores Manag.*, 7(4): 33-54

| Taxon                          | Type          | Abundance | Density | Host Plant | Status |
|--------------------------------|---------------|-----------|---------|------------|--------|
| *Oxytheria squalida* (Scopoli, 1763) | Phytophagous  | 65        | 1.14    |            | RE     |
| *Cetonia sp* (Fabricus, 1798)    | Phytophagous  | 2         | 0.035   |            | A      |
| *Coccinella tredecimpunctata* (Linnaeus 1777) | Predator      | 3         | 0.052   |            | A      |
| *Coccinella undecimpunctata* (Linnaeus 1777) | Predator      | 1         | 0.017   |            | A      |
| *Coccinellidae*                 |               |           |         |            |        |
| *Coccinella variegata* (Linnaeus 1777) | Predator      | 4         | 0.07    |            | AC     |
| *Coccinella septempunctata* (Linnaeus 1777) | Predator      | 22        | 0.386   |            | C      |
| *Coccinella algerica* (Linnaeus 1777) | Predator      | 7         | 0.122   |            | A      |
| *Tenebrionidae*                 |               |           |         |            |        |
| *Pachychila sp* (Herbst, 1799)   | Saprophagous  | 85        | 1.49    |            | C      |
| *Tentyria bipunctata* (Solier, 1835) | Saprophagous  | 68        | 1.193   |            | RE     |
| *Opatrum sabulosum* (Linnaeus, 1761) | Saprophagous  | 13        | 0.228   |            | RE     |
| *Pimelia costata* (Walts, 1835)  | Saprophagous  | 2         | 0.035   |            | A      |
| *Blaps sp* (Fabricus, 1777)      | Saprophagous  | 1         | 0.017   |            | A      |
| *Gonocephalum sp* (Solier, 1834) | Saprophagous  | 3         | 0.052   |            | A      |
| Family               | Species                                           | Type       | Population | Frequency | Season  |
|----------------------|---------------------------------------------------|------------|------------|-----------|---------|
| Latridiidae          | *Enicmus sp* (C.G.Thomson, 1859)                  | Phytophagous| 7          | 0.122     | AC      |
|                      | *Corticaria sp* (Marshall, 1802)                  | Phytophagous| 3          | 0.052     | A       |
|                      | *Lathridius sp* (Herbst, 1793)                    | Phytophagous| 4          | 0.07      | A       |
| Nitidulidae          | *Meligethes sp* (Stephen, 1830)                   | Phytophagous| 13         | 0.228     | RE      |
|                      | *Meligethe aeneus* (Linnaeus, 1775)               | Phytophagous| 45         | 0.789     | C       |
| Curculionidae        | *Aulacobaris coerulescens* (Scopolis, 1763)      | Phytophagous| 1          | 0.017     | A       |
|                      | *Baris sp1*                                       | Phytophagous| 29         | 0.508     | RE      |
|                      | *Sitona lineatus* (Linnaeus, 1761)                | Phytophagous| 2          | 0.035     | A       |
|                      | *Sitonia sp* (Germar, 1817)                       | Phytophagous| 1          | 0.017     | A       |
|                      | *Baris sp2*                                       | Phytophagous| 1          | 0.017     | A       |
|                      | *Pachytychius hordei grandicollis* (Walt, 1835)  | Phytophagous| 6          | 0.105     | AC      |
|                      | *Brachycerus lutulentus* (Fabricus, 1798)         | Phytophagous| 19         | 0.333     | AC      |
|                      | *Brachycerus muricatus* (Oivier, 1790)            | Phytophagous| 10         | 0.175     | AC      |
|                      | *Notarisa sp* (Germar, 1817)                      | Phytophagous| 450        | 7.897     | OM      |
| Species                                      | Type         | Count | CI   | RE  | Type  |
|----------------------------------------------|--------------|-------|------|-----|-------|
| *Procas armillatus* (Fabricus, 1798)         | Phytophagous | 85    | 1.491| 80  | C     |
| *Otirohynchus striatus* (Germar, 1822)       | Phytophagous | 3     | 0.052| 30  | ACE   |
| *Omphalapion laevigatum* (G. Paykull, 1792) | Phytophagous | 1     | 0.017| 10  | ACI   |
| *Stenocarus sp* (C.G Thomson, 1858)          | Phytophagous | 21    | 0.368| 70  | RE    |
| *Psylliodes chrysocephalus* (Linneaus, 1783)| Phytophagous | 25    | 0.438| 60  | RE    |
| *Longitarsus parvulus* (Latreille, 1802)     | Saprophagous | 21    | 0.368| 50  | RE    |
| *Longitarsus ochroleucus* (Latreille, 1802) | Saprophagous | 17    | 0.298| 50  | RE    |
| *Smaragdina concolor* (Fabricus, 1792)      | Phytophagous | 35    | 0.614| 50  | RE    |
| *Gastrophysa viridula* (Degeer, 1778)       | Phytophagous | 31    | 0.544| 70  | RE    |
| *Clytra taxicornis* (Fabricus, 1792)        | Phytophagous | 1     | 0.017| 10  | ACI   |

**Chrysomelidae**

| Species                                      | Type         | Count | CI   | RE  | Type  |
|----------------------------------------------|--------------|-------|------|-----|-------|
| *Antipus sp* (Degeer, 1778)                  | Phytophagous | 1     | 0.017| 10  | ACI   |
| *Smaragdina concolor* (Fabricus, 1792)      | Phytophagous | 35    | 0.614| 50  | RE    |
| *Gastrophysa viridula* (Degeer, 1778)       | Phytophagous | 31    | 0.544| 70  | RE    |
| *Clytra taxicornis* (Fabricus, 1792)        | Phytophagous | 1     | 0.017| 10  | ACI   |
| Species                        | Type          | Numbers | Index | Method |
|-------------------------------|---------------|---------|-------|--------|
| Galeruca interrupta (Illiger, 1802) | Phytophagous  | 15      | 2.83  | ACE    |
| Oulema melanopus (Linneaus, 1758)  | Phytophagous  | 530     | 9.301 | OM     |
| Entomoscelis ruminicis (Fabricus, 1787) | Phytophagous  | 21      | 0.368 | ACE    |
| Chrysomelidae sp              | Phytophagous  | 1       | 0.017 | ACI    |
| Alleculidae                   |               |         |       |        |
| Heliotaurus ruficollis (Breitter, 1906) | Phytophagous  | 6       | 0.105 | ACI    |
| Heliotaurus sp (Mulsant, 1856) | Phytophagous  | 108     | 1.895 | ACE    |
| Allecula sp (Fabricus, 1787)   | Phytophagous  | 25      | 0.438 | ACI    |
| Cassidae                      |               |         |       |        |
| Cassida vittata (Villers, 1789) | Phytophagous  | 4       | 0.07  | ACI    |
| Cassida sp (Linneaus, 1758)    | Phytophagous  | 2       | 0.035 | ACI    |
| Silphidae                     |               |         |       |        |
| Silpha obscura (Illiger, 1798) | Predator      | 7       | 0.122 | ACE    |
| Silpha sp (Linneaus, 1758)     | Predator      | 2       | 0.035 | ACE    |
| Psilothrix viridicoerulea (Geoffroy, 1785) | Phytophagous  | 975     | 17.111| OM     |
| Family               | Genus                  | Species                        | Type          | Individuals | Weight (g) | Abundance (% of total) | J Biore Manag., 7(4): 33-54 |
|---------------------|------------------------|--------------------------------|---------------|-------------|-------------|------------------------|-----------------------------|
| Elateridae          | Conoderus sp           | (Candeze, 1865)                | Phytophagous  | 1           | 0.017       | 10                     | OM                          |
| Meloidae            | Lytta vesicatoria      | (Linneaus, 1758)               | Coprophagous  | 2           | 0.035       | 20                     | ACI                         |
| Dermestidae         | Anthrenus pimplinellae  | (Fabricus, 1775)               | Coprophagous  | 1           | 0.017       | 10                     | ACI                         |
| Dermestidae         | Attagenus unicolor     | (Latreille, 1802)              | Coprophagous  | 9           | 0.157       | 20                     | ACI                         |
| Dermestidae         | Dermestes murinus      | (Linneaus, 1758)               | Coprophagous  | 12          | 0.21        | 20                     | ACI                         |
| Staphylinidae       | Xantholinus linearis   | (Oivier, 1795)                 | Predator      | 3           | 0.052       | 20                     | ACI                         |
| Staphylinidae       | Philonthus quisquiliarius | (Gyllenhal, 1810)        | Predator      | 3           | 0.052       | 30                     | ACE                         |
| Staphylinidae       | Anthophagus sp         | (Gravenhorst, 1802)            | Predator      | 1           | 0.017       | 10                     | ACI                         |
| Staphylinidae       | Lestiva sp             | (Latreille, 1802)              | Predator      | 1           | 0.017       | 10                     | ACI                         |
| Staphylinidae       | Lithocharis nigriceps  | (Latreille, 1829)              | Predator      | 2           | 0.035       | 20                     | ACI                         |
| Staphylinidae       | Habrocerus Tachinus    | (Krantz, 1859)                 | Polyphagous   | 2           | 0.035       | 20                     | ACI                         |
| **Species** | **Family** | **Type** | **Abundance** | **LR** | **EC** |
|-------------|------------|----------|---------------|--------|--------|
| *Tachyporus chrysomelidae* (Linneaus, 1758) | | Polyphagous | 21 | 0.368 | 60 |
| *Tachyporus sp* (Gravenhorst,1802) | | Polyphagous | 15 | 0.263 | 50 |
| *Cryptobium fracticornis* (Paykull, 1800) | | Predator | 1 | 0.017 | 10 |
| *Stenus guttula* (Muller,1821) | | Predator | 1 | 0.017 | 10 |
| *Tychobythinus lavagnei* (Levitt, 1913) | | Polyphagous | 1 | 0.017 | 10 |
| *Philonthus nigrita* (Sharp, 1874) | | Predator | 2 | 0.035 | 20 |
| *Omalium sp* (Gravenhorst, 1802) | | Predator | 1 | 0.017 | 10 |
| *Oxytelinae sp1* | | Predator | 2 | 0.035 | 20 |
| *Oxytelinae sp2* | | Predator | 8 | 0.14 | 40 |
| *Ocypus olens* (O.F.Muller, 1764) | | Predator | 1 | 0.017 | 10 |
| *Histeridae* | | Predator | 4 | 0.07 | 10 |
| *Cleridae* | | Phytophagous | 4 | 0.07 | 20 |
| *Cerambycidae* | | Phytophagous | 1 | 0.017 | 10 |
| *Pubrestidae* | | Phytophagous | 1 | 0.017 | 10 |
Amokrane et al. (2020). Diversity of Durum Wheat Coleoptera (*Triticum durum* Desf.) in the region of Sigus

*J Biores Manag.*, 7(4): 33-54

| Anthicidae                     | Species                  | Taxonomic Order | Population | Abundance | RE |
|-------------------------------|--------------------------|-----------------|------------|-----------|----|
| *Omonadus floralis* (Linneaus, 1758) | Polyphagous              | 35              | 0.614      | 60        | RE |
| *Cyclodinus sp* (Germar, 1824)  | Polyphagous              | 15              | 0.263      | 40        | RE |
| **Total**                     |                          |                 | 5698       |           |    |

ACI: Accidental; ACE: Accessor; C: Constant; UB: Ubiquitous; RE: Regular
The trophic status of collected Coleoptera indicates that the majority of species belonging to the category of phytophagous with 49 species and a rate of 47.57% found in particular in the Curculionidae with 13 species and the Chrysomelidae with 12 species; followed by the category of predators with 29 species and a rate of 28.15% found in particular in the Staphylinidae with 12 species and the Carabidae with 9 species. The lowest categories are Polyphagous and Saprophagous with quite similar rates (Figure. 7, Table.1).

The phenology of the host plant, was divided into distinct periods (emergence, early tillering, full tillering, run-in, heading and maturity), as well as the monthly variations in abundance and species richness, show that the periods when durum wheat crop zoocenosis was richest and most abundant in species coincide with the period of full tillering, which was less reduced at run-in, heading and maturity. The emergence stage was characterized by a low species richness rate of about 1.35% (all species combined). A number which tends to increase in an apparent way from the early tillering stage reaching a peak of abundance at the full tillering stage presenting a rate of about 49.21%. The heading stage was characterized by a reduction in species richness but is still of interest following the appearance of new species in the adult state, such as the species Heliotaurus sp belonging to the Alleculidae family. The same observation concerns the period of maturity of the grain. It should be noted that each period of the life cycle of the host plant is marked either by the appearance or disappearance of a given species.

**DISCUSSION**

The taxonomic composition of the diversity of the harvested Coleoptera included 103 species divided into 22 families for a total population of 5698 individuals. To give an idea of the representativeness of the species within the beetle population, we have calculated ecological indices. The Shannon-Weaver diversity index (total diversity index) \( H' \) indicated a value of 2.70. This interesting value reflected the richness and complexity of the stand at the level of the agro-system under study. The value of the equitability index in our study was 0.58. It reflected a disturbed distribution of species. This anomaly in the stand composition of the Beetles harvested from the agro-ecosystem studied could be explained by the dominance of certain expansionist species, mainly Tropinota hirta, Psilothrix viridicoerulea, Psilothrix auréola and Oulema melanopus (Table. 2).

**Table 2: Structural parameters of the stands of Harvested beetles**

| Structural parameters | Corresponding values |
|-----------------------|----------------------|
| Diversity index       | \( H' = 2.70 \)       |
| H maximal             | 4.63                 |
| Equitability index    | \( E' = 0.58 \)       |

As for the scale of occurrence, accidental or rare species played an important part in our results with extremely low relative abundances, this allowed us to say that species observed once considered rare were not specified to be neglected since they can play an important role in the functioning and
Amokrane et al. (2020). Diversity of Durum Wheat Coleoptera (*Triticum durum* Desf.) in the region of Sigus
*J Biores Manag.*, 7(4): 33-54

Figure 6: The abundance of Coleoptera caught by the number of families and the number of species

Figure 7: Distribution Percentage of Coleoptera trophic diet censused

Figure 8: Frequency of abundance of captured Beetles according to Durum Wheat phenology
Studies concerning the systematics of Staphylinidae or their identification in Algeria were absent or rare and dozens or even hundreds of species await a description or discovery as this group of insects occupied or colonised almost all terrestrial biotopes with certainly a large specific diversity. Concerning the Carabidae currently used in biogeographic studies and conservation biology, research on Carabidae populations in Algeria remains generally limited (Ouchtati et al., 2012; Saouache and Doumandji, 2014; Saouache, 2017). The species that best represented this group in our results with an interesting relative abundance was *Syntomus fuscomaculatus*, which had a very wide distribution in the Palaearctic region Oleg A and Artsiom O (2017), followed by *Syntomus sp* and Microlestes. The study carried out by Boukli (2010) in the mouth of Tafna in Tlemcen showed that Microlest and Syntomus are plastic species which belong to a family characterised by a very wide adaptive success to multiple ecological conditions with which explained their high abundance and occurrences. The majority of the ubiquitous species were considered among the groups of insects potentially most harmful and specific to cereals in the highland’s region the case of the species *Tropinota hirta* and the species *Oulema melanopus* in particular, one of the most formidable primary pests of cereal crops in the Algerian highlands with yield losses of up to 25%. If the flag leaf is 90% damaged, the yield loss was about 23%. Most of the damage was caused by larvae feeding on the leaf tissue, leaving long stripes on the upper leaf surface while the lower surface remained intact (Rouag, 2012). Concerning the ubiquitous *Tropinota hirta* species with the highest relative abundance, no previous studies had been done on this polyphagous ketoid causing severe crop damage in Algeria(Good and Giller, 2020). Insect families considered useful and have shown uninteresting relative abundances are part of the predatory fauna, are groups to be preserved and used in particular during biological control programmes, for example, by establishing uncultivated herbaceous ‘crop border’ area where useful fauna species can overwinter (Bohan et al., 2011, Eyre et al., 2013; Robin, 2014). These biotopes could constitute a refuge, allowing Coleoptera such as carabid Coleoptera, for example, to shelter, reproduce, feed and could serve as a corridor for their dispersal. Thus, the preservation of these grassy strips is very important to maintain their presence in crops (Rouabah, 2015; Saouache and Doumanji, 2014; Rouabah et al., 2015).

The trophic specialization of the Coleoptera was an important criterion in the functioning of the settlement. According to Beaumont and Cassier (1983) the insects’ diet was extremely diverse, and there was no absolute trophic specialization in nature. It was also important to note that in some groups, also, it was possible to observe the transition from one diet to another so that some predators can become phytophagous. Indeed, our results revealed the dominance of phytophagous species that are part of the crop pest fauna, which was very selective as to which plant species they prefer rather than which part of the plant they will eat. They feed on the expense of the chlorophyll plants they gnawed or grazed on. Any part of the plant (root, stem, leaf) can be attacked (Kellil, 2018). The dominance of phytophagous Coleoptera as a pest had always been reported in cereal crops Since durum wheat is a foliaceous crop for almost all its above-ground biomass, it was a favourite food source for phytophagous Coleoptera. The latter occupied the first place in the number of species concentrated much more in the Curculionidae, Chrysomelidae and Merylidae. Predators which were part of the auxiliary fauna, and were also well represented in the number of species but with a low relative abundance, especially in Staphylinidae, Carabidae and Coccinellidae. Concerning the Coccinellidae the study carried out by Saharaoui et al.,
Amokrane et al. (2020). Diversity of Durum Wheat Coleoptera (Triticum durum Desf.) in the region of Sigus J Biores Manag., 7(4): 33-54

(2014) in Algeria revealed the presence of 46 species of ladybirds belonging to 12 tribes and 22 genera have been inventoried. The latter played a very important role in limiting the populations of insect pests. They feed on the larvae of different insects. Therefore, a good knowledge of the systematics, biology and ecology of predators was essential for the management of their populations in crops and their practical used in biological pest control (Ghezal, 2019). Coprophagous represented in particular by Scarabidae were favoured by the presence of cattle breeding which ensured their maintenance at the studied agroecosystem level. This particularly useful fauna was inferred from dung. The latter facilitated the burial and recycling of faecal matter by improving the soil structure and its nitrogen content. Coprophagous animals made an important contribution to soil improvement in grazing areas (Labidi et al., 2012). Saprophagous as useful fauna were poorly represented, consuming decomposing plant and animal organic matter through the action of microorganisms, fungi and insects that will constitute humus (Meyer, 2016). Concerning the polyphagous which forms the category the least represented have a more eclectic diet, feed on animal and vegetable organic matter in different forms. They can play a double role, both beneficial and destructive (Dajoz, 2002).

Concerning the distribution of Coleoptera according to the development cycle of durum wheat, the low species richness at emergence could be explained by the fact that the plant cover is less dense. The climate itself acts as a factor dependent on density during the winter by eliminating individuals that have not been able to find favourable wintering sites. In winter, as the temperature drops, the entomofauna decreases. From spring onwards, the climatic conditions become milder as the temperature rises, and we have seen a gradual increase in the total species richness. The most dominant families were the Cetoniidae, the Melyridae, and the Chrysomelidae. The specific diversity showed a peak of abundance at the full tillering stage as a result of an accentuated vegetative development of the host plant, as well as the climatic conditions, especially the temperature, which had a very beneficial role in the activity, survival and hatching of insect eggs (Régnière., 2012; Pernet., 2015; Sebastião et al., 2015) adding species selectivity to the plant organs which coincided reciprocally with the different stages of development of the host plant. The seasonal climate was important factor acting on insect density by favouring the nutritional needs of the species and consequently their movements, proliferation and distribution. It was in the spring, when the plants were in bloom, that the different groups of insects recorded experience the highest frequencies of abundance (Bensaada et al., 2014). Noting the significant proliferation of weed flora in the experimental field tends to favour the importance of insects. Among the dominant weed species in the cereal, the field was Papaver-rooms (Poppy), Malva marviflora (Mallow), Avena sativa (Wild oats), Bromus rigidus (rigid bromine), Hordeum murinum (Rat barley) and many other species. According to Dajoz (2002), monocultures were frequently invaded by insect pests, weeds that may be abundant or by parasitic diseases and the variability in the abundance of arthropod populations was higher in agro-systems than in natural ecosystems; certain botanical families were more or less sought after by insects and within a species, varietal, morphological or chemical characteristics increased their attractiveness or repellent power (Bennett and Cahill (2013), Eyre et al., 2013, Duflot et al., 2017) the seasonal climate was an important factor influencing insect density. By favouring the nutritional quality of the pests and consequently their movements, proliferation and distribution. It was in the spring, when the plants were in bloom, that the different groups of insects recorded experience the highest frequencies of abundance.
CONCLUSION

Our study indicates a diversity of 103 species of Coleoptera divided into 22 families for a total number of 5698 individuals, with interesting specific diversity in favour of Staphylinidae, followed by Curculionidae, Chrysomelidae and Carabidae. Phenology as well as monthly variations in abundance and species richness showed that the Beetle fauna presents a peak of abundance, at the full tillering stage. The dominant diet is that of the Phytophagous category which characterizes in particular the Curculionidae and the Chrysomelidae with very strong effects on durum wheat cultivation, followed by the Predatory category represented in particular by the Carabidae, the Staphylinidae and the Coccinellidae which are important biological agents for the control of crop pests. The results obtained constitute a first database for the knowledge of the biodiversity of this fauna in the study region and for the cultivation of Durum Wheat in order to acquire even preliminary knowledge of the trends in the biodiversity of Beetles in cereal agro-ecosystems, which was an urgent concern for agronomists in the region who were seeking to determine the actual and potential impact of insect pests and their natural enemies in regions with a cereal vocation.

REFERENCES

Abba N, Aouimeur S and Guezoul O (2015). Criocère des céréales (Oulema melanopus). Laboratoire de Bioressources Sahariennes : Préservation et Valorisation Faculté Science de la Nature et de la Vie, Ouargla 30 000 (Algérie).

Aggoun H, Laamari M and Tahar Chaouche S (2016). Associations tri-trophiques (parasitoides -puceron - plantes) notées dans le milieu naturel de la région de khenchela (Est-Algérien).

Alonso-Zarazaga MA (2015). Orden Coleoptera. Revista IDE@-S.E.A., 55: 1-18. www.sea-entomologia.org/IDE@. (Consulter le 27/10/2018)

ASD (2018). Agricultural services directorate: Conservation, transformation et amélioration de la qualité des produits agricoles wilaya d’Oum El Bouaghi.

Bairi W and Mennous S (2017). La Biodiversité Entomologique dans la Forêt d’Erriche (Bouira). Université Akli Mohand Oulhadj Bouira .59p

Baldy C, Ruelle P, Fernandes A (1993). Résistance à la sécheresse du sorghograin en climat méditerranéen. Séch., 4: 85-93.

Barney RJ and Pass BC (1986). Ground beetle Coleoptera Carabidae population in Kentucky alfalfa and influence of tillage. J. Econ. Entomol. 79: 511-517.

Beaumont A, Cassier P (1983). Biologie animale des protozoaires aux Métazoaires épithélineurien. Tom II. Dunod, Paris.

Benia F (2010). Étude de la faune entomologique associée au chêne vert (Quercus ilexL.) dans la forêt de Tafat (Sétif, Nord-est d’Algérie) et bio-écologie des espèces les plus représentatives. Thése de Doctorat Université Farhat Abass Sétif, 250p

Benkhellil M (1991). Les techniques de récolte et de piégeage utilisées en entomologie terrestre. Éd. Office des publications universitaires, Alger, 57 p.

Bennett J.A. & Cahill J.F., 2013. Conservatism of responses to environmental change is rare under natural conditions in a native grassland. Perspectives in Plant Eco, Evol and Syst., 15(6): 328-337. DOI: https://doi.org/10.1016/j.ppees.2013.1 0.001.
Amokrane et al. (2020). Diversity of Durum Wheat Coleoptera (Triticum durum Desf.) in the region of Sigus
J Biores Manag., 7(4): 33-54

Bensaada F, Nadir BA, Saifi M and Doumandji S (2014). First data on insects to forensic interest in the region of Gouraya, Algeria. Int J Agric Innov Res., 3(2), 461-466.

Benyacoub S (1993). Écologie de l’avifaune forestière nicheuse de la région d’ElKala Nord Est Algérien. Thèse de l’Université de Bourgogne, Dijon.

Bohan D. A., Bourrault A., Brooks D. R. and Petit S., (2011). – National-scale regulation of the weed

Boughida S (2010). Puceron russe du blé Diuraphis noxia Mordvilko, 1913 Homoptera, Aphididae : Répartition et ennemis naturels à travers quelques localités dans l’Est algérien.Mém. Ing. Agro. Dép. Agro., Batna, 38 p.

Boukli Hacene S, Hassaine K, Ponel P (2012). Les peuplements des coléoptères du marais salé de l’embouchure de la Tafna Algérie. Revue d’écologie.

Chavanom G, Mahboub M (1998). Etudes sur la Basse Moulouya Maroc oriental: 5. Les Carabiques des berges du fleuve et de son affluent l’oued Za: corrections et additions. L’Entomo, 54 (3): 119-127.

Chavanon G, Rahou I et Chaavanon L (1995). Etudes sur la Basse Moulouya Maroc Oriental. 4: Les carabiques des berges de l’oued Zeghzel. Bull. mens. Soc. linn. Lyon, 64 (4):188-192.

Chopard L (1943). Faune de l’empire Français Orthoptéroides de l’Afrique du Nord. TomeI. Éd. La rose, Paris, 450 p.

Dajoz R (2002). Les Coléoptères Carabidés et Ténèbrionidés: Écologie et Biologie. Éd. Lavoisier Tec & Doc., Londres, Paris, New York, 522 p.

Derbal, N., Benbelkacem, A., & Tahar, A. (2015). Spatial variation of quality traits in Algerian durum wheat cultivated in different environments. Afric Jour of Agricu Rese, 10(9), 919-925.

Dif A (2010). Les pucerons inféodés aux céréales dans la station régionale de l’ITGC de Guelma: étude écobiologique et essai de lutte chimique. Mém. Ing. Agro. Dép. Agro. Batna, 39 p.

Duflot R., Ernoult A., Aviron S., Fahrig L. and Burel F., (2017). – Relative effects of landscape composition and configuration on carabid beetle and vascular plant multi-habitat gamma diversity in agricultural landscapes. Agricu, Ecosyand Envi., 241: 62-69.

Elizabeth C (2015). The Book of Beetles: A Life-size Guide to Six Hundred of Nature's Gems, edited by Patrice Bouchard » , The American Biology Teacher, vol. 77, no 9, p. 714 (DOI 10.1525/abt.2015.77.9.12f).

Eyre MD, Luff LM and Leifert C (2013). Crop, field boundary, productivity and disturbance influences on ground beetles (Coleoptera, Carabidae) in the agroecosystem. Agricu, agrosy and enviro., 165: 60-67.

Ghezal H (2019). Bio-ecological of the acarofaune in area semi-arid (Djelfa-Algeria). Inter Jour., 75:1-11.

Good JA and Giller P (2020). A contribution to a check-list of Staphylinidae (Coleoptera) of potential importance in the integrated protection of cereal and grass crops.

Gullan PJ and Cranston PS (2010). The Insects: An Outline of Entomology.4th edition.Wiley-Blackwell, 565p.

Kellil H (2019). Contribution à l’étude de la bio-écologie fonctionnelle des peuplements entomologiques inféodés aux agro-écosystèmes céréaliers dans la région du nord-est algérien (Sétif, Constantine) Thèse de doctorat.Université Mohamed Kheider Biskra.364p.

Kellil H (2018). Dynamique des populations d’Oulema Linné, 1758 (Coléoptéra ;Chrysomelidae) sur six variétés de Blé dur (Triticum durum...
desf.) dans la région des hautes plaines de l’Est Algérien.

Kulkarni S. S., Dosdall L. M. & Willenborg C. J., 2015. – The Role of Ground Beetles (Coleoptera:carabidae) in Weed Seed Consumption: A Review. Weed Scie., 63: 355-376.

Labdaoui ZE and Guenaoui Y (2015). The aphids infesting citrus orchards and their natural enemies in the Northwestern Algeria. In: 6th International Scientific Agricultural Symposium, 15 - 18 October 2015, Jahorina Bosnia and Herzegovina.

Labidi I, Erouissi F, Nouira S (2012). Spatial and Temporal Variation in Species Composition, Diversity, and Structure of Mediterranean Dung Beetle Assemblages (Coleoptera: Scarabaeidae) Across a Bioclimate Gradient. Comm and Ecos Ecol Vol. (41). 4.

Labruyere SD (2017). Déterminants multi-échelles de la dynamique spatio-temporelle des coléoptères carabiques prédateurs de graines d’adventices. Thèse de Doctorat Université de BourgogneEcole Doctorale Environnements – Santé.23.3pLamotte M, Bourliere F (1969). Problèmes d’écologie: l’échantillonnage du peuplement d’animaux en milieu terrestre. Éd. Masson et Cie, Paris, 1100p.

Lebbali L (2016). Etude bioécologique des pucerons inféodés aux agrumes dans la région de Skikda. Thèse de Doctorat Université de Batna.125p.

Marniche F, Perreau M, Yahia N, barkat F, Milla A and Doumandji S (2014). (Coleoptera, leiodidae) du parc national de chréa (Blida, Algérie).

Meyer JR (2016). Décomposeurs d'insectes. General entomology.NC state University

Moore A (2013). Insect Orders. AG/BIO 345 - General Entomology. University of Guam, 24 p.

Odegaard F (2000). How many species of arthropods? Erwin’s estimate revised. Biojor of the Linn Soci., 71: 583-597.

Oleg A and Artsiom O (2017). Symtomus pallipes (Dejean, 1825) (Coleoptera: Carabidae) – ground beetle new to Belarus . Acta Biologica, 2017:pp15-18

Ouchtati N, Doumandji S and Brandmayr P (2012). Comparison of ground beetle (Coleoptera: Carabidae) assemblages in cultivated and natural steppe biotopes of the semi-arid region of Algeria. Afri entomo., 20 (1) : 134-143.

Ouchtati N, Meliani A, Abdelkrim A and Kolli ZE (2019). Community composition of ground beetles (Coleoptera, Carabidae) in citrus orchard in North-Eastern of Algeria.

Pernet L (2015). Stratégies de régulation et d'optimisation thermique chez les insectes. Université de Rennes.15p

Perrier R (1961). La faune de la France. Tome V: Les Coléoptères 2ème Partie. Éd. Lib. Delagrave, Paris, 230 p.

Perrier R (1963). La faune de la France. Tome VIII: Les Diptères. Éd. Lib. Delagrave, Paris, 216 p.

Perrier R (1964). La faune de la France. Tome VI: Les Coléoptères 1ère Partie. Éd. Lib.Delagrave, Paris, 192 p.

Perrier R (1977). La faune de France illustrée. Coléoptère 1. Edt. Delagrave. 188p.

Powell J A (2009). Coleoptera. In: Resh V.H. & Cardé R.T. (Eds.). Encyclopedia of Insects, Academic Press, NewYork, NY, USA, 2nd Edition, 199 p.

Régnière J, Powell J, Bentz B and Nealis V (2012). Effects of temperature on development, survival and reproduction of insects: Experimental design, data analysis and modelling. Jour of Inse Physi., 58(5): 634-647.
Robin M (2014). Analyse et modélisation des effets des pratiques culturales et de la situation de production sur les dégâts causés par les bioagresseurs des cultures. Application au blé d'hiver. Thèse Doctorat. Université De Toulouse, 251 p.

Rouabah A (2015). Effets de la gestion des bandes enherbées sur le contrôle biologique des ravageurs de cultures : rôle de la diversité fonctionnelle des carabes (Coleoptera - Carabidae) et de la structure végétale. Thèse de doctorat Université de Lorraine.159p.

Rouabah A, Villerd J, Amiaud B, Plantureux S and Lasserre-Joulin F (2015). Response of carabid beetle’s diversity and size distribution to the vegetation structure within differently managed field margins. *Agric, Ecos & Envir.*, 200 : 21-32.

Saouache Y (2017). Etude biosystématique des Coléoptères carabiques de la région de Constantine. Université Badji Mokhtar Annaba.140 p.

Saouache Y and Doumandji SE (2014). Ground beetles (Coleoptera: Carabidae) assemblages in two agricultural landscapes in North-Eastern Algeria. *Ecolo medite.*, 40: (2) :5-16.

Saouache Y, Doumanji S (2014). La faune carabique d’une zone cultivée dans une région semi aride du Nord Est de l’Algérie AFPP Dixième conférence international sur les ravageurs en agriculture. Montpellier.

Sebastião D, Borges I and Soares AO (2015). Effect of temperature and prey in the biology of Scymnus subvillosus. *Bio Control.*, 60: 241-249.

Slim M, Zouaki N, Lougraimzi H, Elghali L, Zidane L,Fadli M (2016). Diversity, Composition and Systematic Structure of the Terrestrial Entomofauna of a Ramsar site: The Biological Reserve of Sidi Boughaba, Mehdia (Morocco) - *Jour of Ento and Zool Stud.*, 4(4):975-982.

Talmaciu M (2018). New contributions to the knowledge of the coleoptera species from some cereal crops.

Touaylia S, Bejaoui M, Boumaiza M and Garrido J (2009). Nouvelles données sur la famille des Hydraenidae Mulsant, 1844, de Tunisie Coleoptera. *Bull Soc entomo France.*, 114 (3): 317-326 p.