Biodiversity Journal, 2023, 14 (2): 359–366 https://doi.org/10.31396/Biodiv.Jour.2023.14.2.359.366

Coleoptera Carabidae Beetles of El-Kala National Park (north-eastern Algeria)

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ABSTRACT The family Carabidae (Coleoptera) is one of the most diverse among beetles, but they are little studied in Algeria and, in particular, in the territory of El-Kala National Park. Therefore, a census of carabid communities with fortnightly trapping was carried out between 2018 and 2019 with the aim of analysing these populations around Lake Tonga, the first Algerian site to be classified as a Ramsar site and included in the Mediterranean Basin hotspot. These investigations have enabled us to record 1727 specimens belonging to 83 species of Carabidae. Six species are new to the Algerian entomofauna and six others are reported for the first time in North Africa.

KEY WORDS Ground beetles; Ramsar wetlands; Algeria; El-Kala National Park; diversity.

Received 01.10.2022; accepted 30.03.2023; published online 30.05.2023

INTRODUCTION

Lakes and wetlands cover a total of 16.7 millions km^2 worldwide, and wetlands are among the most productive environments on the Planet. They are habitats of high biological diversity and host more than 40% of the world's animal species (Mitra et al., 2003).

Algeria joined the Ramsar Convention in 1983 by designating the first two sites, Lake Tonga and Lake Oubeira, which are also integral reservoirs of El Kala National Park, classified as a 'Biosphere Reserve' by UNESCO under the 'Man and Biosphere' program in 1990. There are now 50 Ramsar-listed wetlands in Algeria (Balla, 2012).

The Lake Tonga Ramsar site is the most important wetland in North Africa (Samraoui & De Belair, 1998). Included in the Mediterranean basin hotspot, the wetlands of the entire coastal Numidia host an important and original set of Algerian flora (Véla & Benhouhou, 2007).

The beetles that inhabit this territory are particularly useful as bioindicators by responding strongly to changes in the conditions of their habitats (Rainio & Niemelä, 2003). The family Carabidae is one of the best known and most studied groups of beetles in the world and inhabits most terrestrial habitats (Arndt, 2005). Currently, about 38,600 species of Carabidae have been recorded worldwide and an estimated 100 new species are discovered each year (Lorenz, 2005).

This family is well known in some North African countries, particularly in Morocco (Antoine, 1955–1962; Chavanon & Mahboub, 1998), in Tu-

nisia thanks to the investigations of Normand (1933) and more recently of Ghanem et al. (2016, 2017). In Algeria, the Carabidae were studied in the past by Bedel (1895-1914), more recently by Pupier (2005), Ouchtati et al. (2012), Saouache et al. (2014), Chenchouni et al. (2015), Matallah et al. (2016), Daas et al. (2016) and Amri et al. (2019).

The Coleoptera of wetlands in Algeria remain little studied with the exception of a few general works on this order of insects (Boukli-Hacene et al., 2010, 2012, 2014, Bouregba et al., 2020). Among the works targeting the Carabidae of wetlands, we should mention the recent articles by Chenchouni et al. (2015) on the Djendli sebkha in Batna (western Algeria), Matallah et al. (2016) on the wetland of Dayet El Ferd, a Ramsar site, Daas et al. (2016) and Amri et al. (2019) on the Chott Tinsilt.

Despite the special protected status of Lake Tonga (strict reserve, Ramsar site and MAB), it remains under threat with various environmental changes. Furthermore, it is losing large amounts of water through agricultural use and high evapotranspiration. This will inevitably lead to a change in the animal and plant composition of the lake and a reduction in its biological richness in general and of the Coleoptera in particular, and specifically the Carabidae.

The objectives of the present study are to understand the composition of the Carabidae populations living in Lake Tonga, to define their systematic, biogeographical and ecological characteristics.

MATERIAL AND METHODS

Study area

Lake Tonga (36° 53 N and 8° 31 E) is located between the town of El-Kala (Fig. 1) and the Algerian-Tunisian border. The region is characterised by a sub-humid climate with an annual rainfall of 685 mm and an average annual temperature of 18.3 °C. It is a palustrine freshwater lake, connected to the Mediterranean Sea by an artificial canal, the Messida Canal (Bakaria, 2002). Its catchment area covers 15,000 ha, including 2,800 ha for the lake basin alone (Samraoui & De Belair, 1998; Kadid et al., 2007; Samraoui & Samraoui, 2008).

The abundant aquatic vegetation plays a major role in the distribution of waterbird species, and is mainly composed of patches of *Typha angustifolia*, *Iris pseudoacorus*, *Scirpus lacustris*, *Scirpus maritimus*, *Phragmites australis*, *Salix pedicellata* and

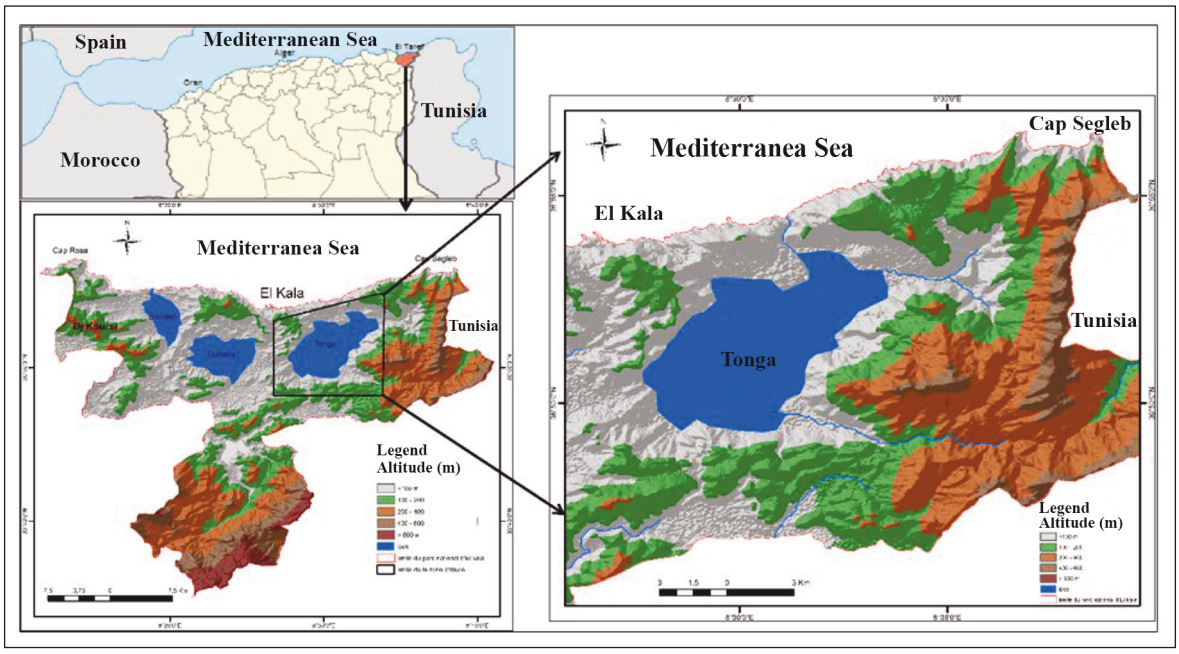

Figure 1. Study area: geographical location of Lake Tonga (Algeria).

Sparganium erectum. In spring, *Nymphaea alba* flowers abundantly and is a very invasive hydrophyte in open water areas (Abbaci, 1999).

Sampling protocol

Between March 2018 and December 2019, Carabidae were collected using systematic line sampling along two parallel transects 50 m apart. In each transect 15 pitfall traps separated by 10 m were buried at ground level. All traps were placed in the respective plots at a minimum distance of 15 m from the lake shore.

Carabidae were captured within a 2 m² square indirectly using "Barber traps", buried pots with the top of the trap flush with the soil surface, intercepting the ground-dwelling insects, and directly with a mouth aspirator. Three vegetation belts in each transect were identified, in each belt fauna was collected every fortnight during the study period, in 5 sampling points in each vegetation belt.

Carabidae species were inventoried and identified mainly by consulting the works of Bedel (1895), Du Chatenet (2005), specialist literature and then confirmed by Riccardo Sciaky (Italy).

Based on Euclidean distances and using Minitab16 software, a bottom-up hierarchical analysis was performed on the species absence distribution matrix in Lake Tonga.

RESULTS

The species composition of the Carabidae beetle community of Lake Tonga is given in Table 1. A total of 83 species (1727 specimens) of Carabidae were inventoried and identified. According to the Catalogue of Palaearctic Coleoptera (Löbl & Smetana., 2003), six species are new to the North African fauna: *Agonum muelleri*, *Harpalus rubripes*, *Poecilus cupreus*, *Poecilus cursorius*, *Anisodactylus signatus* and *Dyschirus chalceus*. In addition, six other species have never been recorded in Algeria: *Harpalus cupreus*, *Badister collaris*, *Siagona dejeani, Olistophus fuscatus*, *Oodes helopioides* and *Asaphidion stierlini*.

From a biogeographical point of view, the stand consists of different species contingents. Figure 2 shows the proportions of the different distribution types. Cosmopolitan species with a wide distribution in Europe and Asia are dominant with more than 58% of the total number of species, while Mediterranean species constitute 22% of the total population, followed by European species with 14%, then North African endemics and Ibero-Maghrebian species with 4% and 2%, respectively.

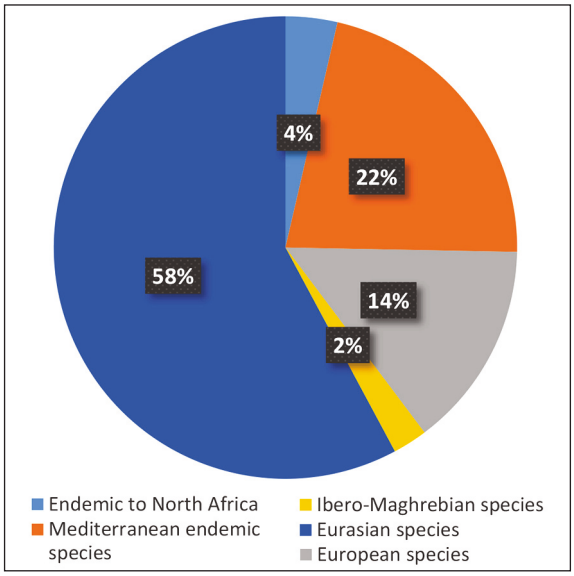

Figure 2. Biogeographic origin of the Carabidae community in Lake Tonga (Algeria).

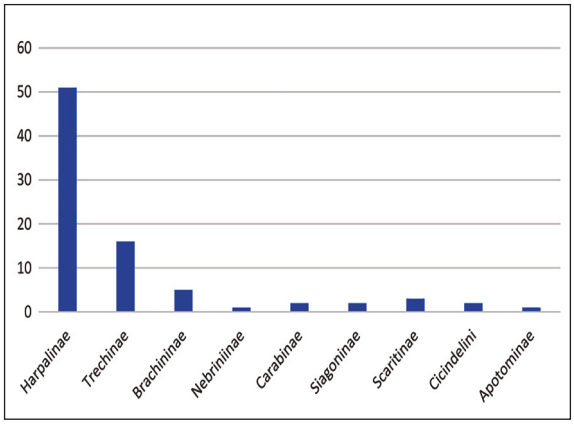

Figure 3. Subfamilies represented in the Carabidae community of Lake Tonga (Algeria).

Our study resulted in the collection of 1727 specimens of which the vast majority (42%) belonged to only three species: *Percus lineatus, Chlaenius velutinus* and *Nebria andalusiaca* dominated the community studied (744 individuals) with 316, 289 and 139 individuals respectively.

Twenty-nine species (31%) of the total richness are represented by a single individual. Fourteen species are moderately represented with numbers of individuals varying between thirty and eighty specimens. These species account for a total of 656 individuals, i.e. 37% of the specimens collected. Nine subfamilies make up the entire fauna inventoried (Fig. 3). These are Harpalinae, Trechinae, Brachininae, Nebriniinae, Carabinae, Siagoninae, Scaritinae, Cicindelini and Apotominae. The nine subfamilies are represented by very different specific richness and abundance. The Harpalinae are the most diversified in terms of faunal composition with 51 species, i.e. nearly 61% of the total number, and with a clear dominance in terms of number of individuals with 1396 specimens recorded, i.e. 81% of the fauna. The Trechinae are in second place with sixteen species and a relatively small number of individuals (90). The Brachininae are represented by five species but these are less abundant (22 individuals), i.e. 1% of the total number. The subfamilies Scaritinae, Carabinae, Siagoninae and Cicindelini have two species each. Apotominae and Nebriniinae are poorly represented (one species each) but Nebriniinae are quite dominant, accounting for 7% of the total number of Carabidae with 139 individuals.

A hierarchical ascending classification (HAC) carried out on a biogeographical distribution matrix of the 83 species inventoried made it possible to subdivide all the species sampled into two large groups according to the type of distribution of each species (Fig. 4).

The first group includes 61 species characterised by a wide to very wide distribution, reported throughout Europe and in some Asian countries. One example is *Harpalus cupreus,* which was first recorded in Algeria. This group can be divided into four subgroups according to their distribution.

The first subgroup SG1 includes species with a very wide distribution throughout Europe to Asia such as *Chlaenius velutinus* and *Amara aenea*. The second subgroup SG2 contains species with a wide distribution but which are absent in Asia such as *Agonum marginatum*. SG3 includes species which

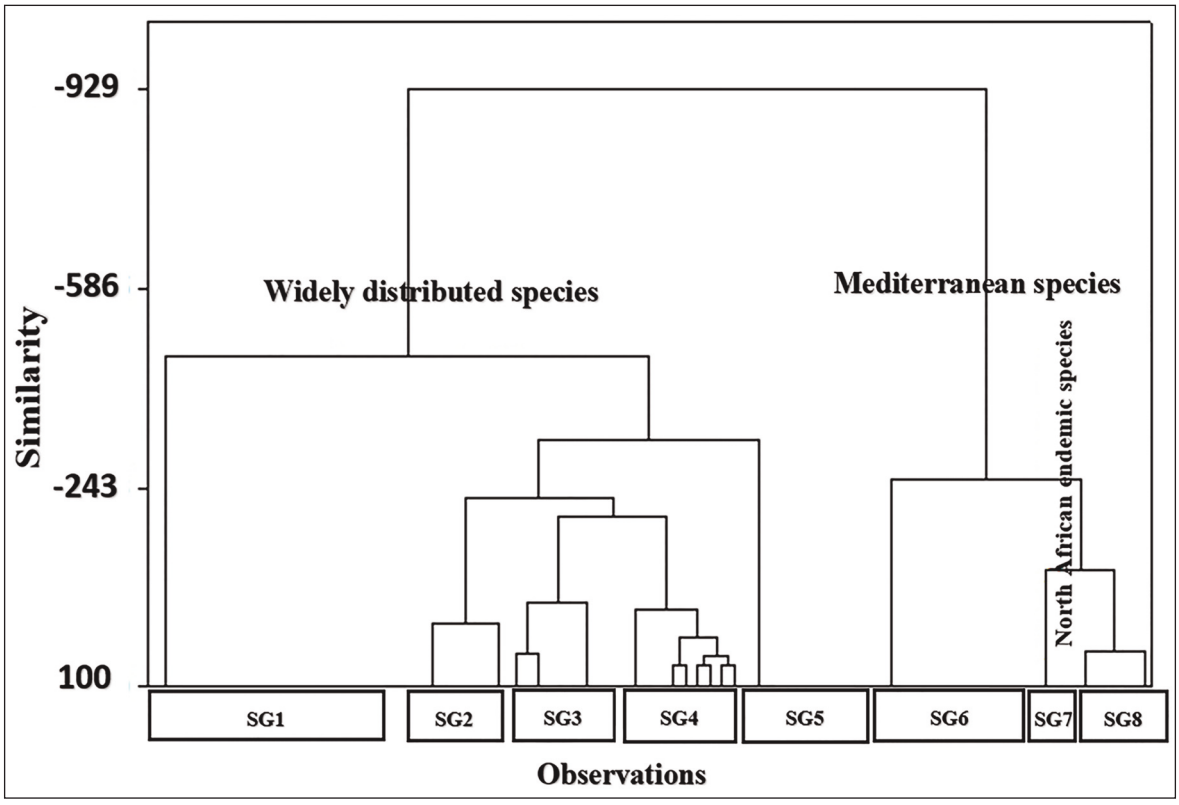

Figure 4. Dendrogram from the hierarchical clustering matrix of the biogeographic distribution of the Carabidae of Lake Tonga (Algeria).

Species	exx
Acupalpus brunnipes (Sturm, 1825)	**75**
Acupalpus elegans (Dejean, 1829)	**1**
Acupalpus maculatus (Schaum, 1860)	**51**
Agonum marginatum (Linnaeus, 1758)	**13**
Agonum muelleri (Herbst, 1784) ***	**19**
Agonum nigrum Dejean, 1828	**19**
Agonum numidicum (Lucas, 1846)	**5**
Agonum viridicupreum (Goeze, 1777)	**1**
Agonum viridicupreum fulgidicolle (Erichson, 1841)*	**1**
Amara aenea (DeGeer, 1774)	**41**
Amblystomus metallescens (Dejean, 1829)	**2**
Anisodactylus binotatus (Fabricius, 1787)	**1**
Anisodactylus signatus (Panzer, 1796*)* ***	**22**
Anthracus flavipennis (Lucas, 1846)	**48**
Apotomus rufus (P. Rossi, 1790)	**8**
Asaphidion stierlini (Heyden, 1880) **	**1**
Badister collaris Motschulsky, 1844**	**2**
Bembidion (Philochthus) iricolor Bedel, 1879 **	**2**
Bembidion (Phyla) obtusum Audinet-Serville, 1821	**1**
Bembidion (Phyla) tethys Netolitzky, 1926	**1**
Bembidion axillare (Motschulsky, 1844)	**1**
Bembidion quadripustulatum Audinet-Serville, 1821	**4**
Brachinus exhalans (P. Rossi, 1792)	**10**
Brachinus humeralis Ahrens, 1812	**7**
Brachinus immaculicornis Dejean, 1826	**2**
Brachinus plagiatus Reiche, 1868	**1**
Brachinus sclopeta (Fabricius, 1792)	**2**
Bradycellus harpalinus (Audinet-Serville, 1821)	**4**
Calathus circumseptus Germar, 1823	**2**
Carabus (Eurycarabus) faminii Dejean, 1826 *	**8**
Carabus (Macrothorax) morbillosus Fabricius, 1792	**1**
Carterus rotundicollis Rambur, 1837	**4**
Chlaenius aeratus Quensel, 1806*	**56**
Chlaenius circumscriptus (Duftschmid, 1812)	**1**
Chlaenius olivieri Crotch, 1871	**15**
Chlaenius spoliatus (Rossi, 1792)	**26**
Chlaenius velutinus (Duftschmid, 1812)	**288**
Cicindela (Calomera) lunulata (Fabricius, 1781)	**1**
Cicindela campestris atlantis Mandl, 1944	**1**
Drypta distincta (P. Rossi, 1792)	**2**
Dyschirius chalceus Erichson, 1837 ***	**2**
Elaphropus globulus (Dejean, 1831)	**3**
Elaphropus grandicollis (Chaudoir, 1846)	**40**
Harpalus cupreus Dejean, 1829 **	**2**
Harpalus distinguendus (Duftschmid, 1812)	**1**
Harpalus fuscicornis Ménétriés, 1832	**1**
Harpalus lethierryi Reiche, 1860 *	**2**
Harpalus oblitus Dejean, 1829	**21**
Harpalus punctatostriatus Dejean, 1829	**12**
Harpalus rubripes (Duftschmid, 1812) ***	**2**
Microlestes abeillei (Brisout de Barneville, 1885)	**50**
Microlestes corticalis (L. Dufour, 1820)	**2**
Nebria andalusia Rambur, 1837	**139**
Ocys harpaloides (Audinet-Serville, 1821)	**1**
Olisthopus fuscatus Dejean, 1828 **	**4**
Olisthopus glabricollis (Germar, 1817)	**1**
Oodes helopioides (Fabricius, 1792) **	**1**
Ophonus ardosiacus (Lutshnik, 1922)	**2**
Percus lineatus (Solier, 1835)	**319**
Platytarus faminii (Dejean, 1826)	**1**
Poecilus cupreus (Linnaeus, 1758) ***	**6**
Poecilus cursorius (Dejean, 1828) ***	**8**
Poecilus purpurascens (Dejean, 1828)	**36**
Pogonus littoralis (Duftschmid, 1812)	**1**
Pseudoophonus griseus (Panzer, 1796)	**1**
Pseudoophonus rufipes (DeGeer, 1774)	**1**
Pterostichus nigrita (Paykull, 1790)	**16**
Scarites buparius (Forster, 1771)	**31**
Scarites laevigatus Fabricius, 1792	**40**
Siagona dejeani Rambur, 1837 **	**4**
Siagona europaea Dejean, 1826	**2**
Stenolophus abdominalis Gené, 1836	**34**
Stenolophus mixtus (Herbst, 1784)	**34**
Stenolophus skrimshiranus Stephens, 1828	**51**
Stenolophus teutonus (Schrank, 1781)	**69**
Syntomus foveatus (Geoffroy in Fourcroy, 1785)	**1**
Syntomus fuscomaculatus (Motschulsky, 1844)	**1**
Tachys bistriatus (Duftschmid, 1812)	**1**
Tachys cardioderus Chaudoir, 1850	**5**
Tachys micros (Fischer von Waldheim, 1828)	**1**
Tachys scutellaris Stephens, 1828	**14**
Trechus quadristriatus (Schrank, 1781)	**8**
Trechus rufulus Dejean, 1831	**6**

Table 1. Carabidae of Lake Tonga. ***New species for North Africa. **New species for Algeria. *Endemic to North Africa.

are absent from Algeria and the Greater Maghreb such as *Agonum muelleri*, while the fourth subgroup SG4 includes species which are absent from at least two regions of the Palaearctic zone, namely *Brachinus immaculicornis*. The fifth subgroup SG5 corresponds to species with a wide distribution but all absent from northern Europe, such as *Siagona europaea*.

Twenty-three species are included in the second group. This group is subdivided into three subgroups according to their frequency of occurrence.

Subgroup SG6 consists of the Mediterranean species *Harpalus oblitus patruelis*. Another subgroup SG7 contains three species with a very limited distribution in North Africa. These are *Agonum fulgidicolle*, *Harpalus lethierryi* and *Chlaenius aeratus* (but the latter has probably been imported into France) and finally a last subgroup SG8 composed of Maghrebian species but which are also present in at least one southern European country. Typical representatives of this last subgroup are two Iberian-Maghrebi species *Siagona dejeani* and *Cicindela campestris atlantis*.

DISCUSSION

The preliminary inventory of the Carabidae of Lake Tonga provided a comprehensive list of 83 species. From these observations, it is clear that Lake Tonga has a significant faunal capital, attesting to the high heritage value and biological richness of this wetland.

Although this site has not been subjected to detailed carabidological surveys apart from those of Ouchtati et al. (2012) and Daas (2016), which found 53 and 10 species of Carabidae respectively in Lake Tonga, our results are relatively important when compared to other inventories in other regions of eastern and western Algeria, North Africa and the Mediterranean basin. Amri et al., 2019 reported 42 species at Chott Tinsilt (Algeria), a similar richness to that highlighted by Boukli-Hacene et al. (2011) in the Tafna salt marshes in the west of the country. Saouache et al (2014) and Matallah et al. (2016) identified 55 species of Carabidae in eastern and western Algeria respectively.

Ghanem et al. (2017) reported 39 species in different localities in Tunisia, while 157 species were found by Chavanon & Mahboub (1998) in the river mouth of the Moulouya in Morocco. Serrano et al. (2015) reported in the Balearic Islands 114 species against 105 species reported by Andujare et al. (2001) in the Cordovilla salt marsh, and 46 species in the Venice lagoon in Italy by Zanella & Scarton (2017).

The vast majority of species encountered (64) in Lake Tonga are represented by a rather small number of individuals, a similar observation reported by Amri et al. (2019), Boukli-Hacene et al. (2011) and Matallah et al. (2016), with the exception of three species *Percus lineatus*, *Chlaenius velutinus* and *Nebria andalusia.*

Biogeographically, the Carabidae of Lake Tonga are dominated by cosmopolitan species representing 72% of the overall community (60 species). The same findings were found by Matallah et al. (2016), Boukli-Hacene et al. (2011) and Amri et al. (2019) with respectively 57%, 55% and 41% of the overall fauna; while the population identified by Zanella & Scarton (2017) is dominated by more than 97% of cosmopolitan species

Mediterranean species represent more than 22% (23) of the carabid population, compared to 12 species identified by Matallah et al. (2016), 10 by Boukli-Hacene et al. (2011), 15 by Amri et al. (2019) and only one species by Zanella and Scarton in 2017.

The objective of this study was also to report the presence of seven species that have never been reported in Algeria before, *Harpalus cupreus*, *Bembidion iricolor*, *Badister collaris*, *Siagona dejeani*, *Oodes harpaloides*, *Asaphidion stierlini* and six species not yet explicitly mentioned in North Africa, to our knowledge, *Agonum muelleri, Harpalus rubripes, Poecilus cuprus, Poecilus cursorius, Anisodactylus signatus* and *Dyschirius chalceus*.

Among this remarkable fauna, three species endemic to the Maghreb have been identified, *Chlaenius aeratus, Agonum fulgidicolle, Harpalus lethierryi* and two species that also occupy the Iberian peninsula and Morocco, *Cicindela campestris atlantis* and *Siagona dejeani*. We cannot neglect the other species, which have been well studied from an entomological point of view and are nevertheless witnesses to the richness of the entomological biodiversity of the lake.

Our main contribution allows us to integrate a new dimension to the carabidological biodiversity

of El-Kala National Park. In conclusion, the maintenance of these riches is mandatory and depends essentially on adequate, ecological and sustainable management and we aspire that this research will encourage measures to be taken in order to protect this wetland. This study is in progress; there are still observations to be made and perhaps other species new to the Algerian fauna to be listed. In this respect, the preservation of this wetland appears to be a major objective.

ACKNOWLEDGEMENTS

Special thanks to the Carabidae specialist Sciaky Riccardo (Italy) for his contribution to the determination of the species.

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