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Ground beetles (Coleoptera: Carabidae) diversity in Center and Southern Tunisia.

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Abstract: The family Carabidae (Coleoptera) is one of the largest families of beetles. In Tunisia it has not been studied thoroughly. In the following paper, the material of Carabidae collected during expeditions to some regions of Tunisia between 2012 and 2013 was studied. Species belonging to 15 genera and 3 subfamilies were collected in seven different localities.
Key words: Coleoptera, Carabidae, faunistic study, distribution, Tunisia.

Resumen: Diversidad de carábidos (Coleoptera: Carabidae) en Túnez central y meridional. La familia Carabidae (Coleoptera) es una de las mayores familias de escarabajos. En Túnez no se ha estudiado a fondo. En el siguiente documento es ha estudiado el material de Carabidae recogido durante las expediciones a algunas regiones de Túnez entre 2012 y 2013. Se capturaron especies pertenecientes a 15 géneros y 3 subfamilias en siete localidades diferentes.
Palabras clave: Coleoptera, Carabidae, estudio faunístico, distribución, Túnez.

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Introduction

The family Carabidae (Coleoptera), or ground beetles, contains about 60,000 species (Gaston 1991) is characterized by a very wide adaptive success on the multiple ecological conditions and one of the best known (Luff 1998). They are one of the most important groups of invertebrate predators in terrestrial environments (Erwin & Adis, 1982), feeding on other invertebrates (such as snails), other insects, seeds, etc. Although this group has retained an easy-to-recognize generalist body plan, they are specialized for many life strategies in and on the ground, as well as under barks, on plants, or as "miners" spending most of their time digging underground, and their body shape and leg morphology reflect a wide range of adaptations for running, digging, burrowing, climbing, and swimming (Evans 1977, 1986). In addition, endemic and endangered species are used by conservationists to set priorities for establishing protected areas (Brooks *et al.* 2006). Ground beetles are considered good indicators of environmental change (Thakare *et al.* 2013). They are abundant, ubiquitous, easy to collect, and they often have well-known life cycles so that changes in activity abundance and in their diversity can be related to observed changes in the environment (Lovei & Sunderland 1996; Niemela *et al.* 2000). Carabidae include species groups and/or polytypic species whose evolutionary differentiation took place during or after the Quaternary ice ages (Palestrini *et al.* 2012). Researches on the potential determinants and spatial patterning of biodiversity have generated much interest over the last decades, particularly in light of global change and the assumed effects on the survival and distribution of many species (Kerr *et al.* 2007).

Our knowledge of the Tunisian fauna of Carabidae comes mainly from papers by Bedel (1895) and Normand (1933). But this work has been followed by only a few researchers (Guéorguiev 2012; Quéinnec & Ollivier 2012; Ghannem *et al.* 2014, 2015a, 2015b), and that prompted us to make a new contribution and update the list of ground beetles in Tunisia.

Material and methods

Study area

The specimens for this study were collected from various habitats between the years 2012 and 2013. The study areas (7 sites) are located in Center and Southern Tunisia. GPS coordinates, altitudes and morphodynamic characteristics of the study areas are listed in Table 1.

Sampling procedure

Several pitfall traps were installed in different fields and partially filled with acetic acid diluted at 30% to kill and preserve samples. The traps were emptied weekly, and the beetles were collected, separated, and identified. Additional specimens were collected directly by hand while walking through the area of study. Dates, locations, and number of specimens were recorded. The material was identified using literature and comparing already identified material, and determinations were confirmed by Mr. Olegario del Junco and Dr. Ildefonso Ruiz-Tapiador. The collected specimens from these surveys have been identified and deposited in the insect reference collection of the Life Science Department, Faculty of Science of Bizerte, Carthage University, Tunisia. In general, for practical reasons we follow the highest classification suggested by Bouchard *et al.* (2011).

Table 1.- Prospected sites with GPS relative coordinates.

Site	Coordinates	Altitude	Description
Kairouan (El Guatranya)	35°45'22.2"N 09°59'25.7"E	46 m	Dry area with presence of stones without plants. Semi-clayish soil.
Kairouan (Metbasta)	35°44'11.5"N 10°06'55.4"E	40 m	Salty area characterized by the presence of halophilic plants, Salsolaceae Menge (1839).
Chambi Park	35°10'48"N 8°41'43"E	1544 m	Chambi National Park (sometimes Chambi Mountain National Park or Djebel Chambi National Park) is a national park in Tunisia's Kasserine Governorate. It protects the flora and fauna surrounding Mount Chambi (Djebel Chambi), the highest mountain peak (1,544 m above sea level) in Tunisia. The park is part of the Mont de Tebessa forest massif which spans the area from Kasserine to the Algerian border. The park has no permanent rivers or streams, but it is one of the last refuges of the endangered Cuvier's gazelle and home to vulnerable Barbary sheep. The park is also the site of notable plant life (holm oak and *Cotoneaster nummularia*, Aleppo pine, and *Stipa tenacissima*) and birds (including the Tunisian crossbill, the Egyptian vulture, Bonelli's eagle, and peregrine falcon, among others).
Bou Hedma Park	37°10'0"N 9°40'0"E	840 m	This park ranges through a bioclimatic variation with inferior arid areas, temperate and cold, characterized by a "pseudo-savannah" like flora, represented mainly by the gum tree (*Acacia raddiana* Hayne). Other important plant species are *Retama raetam* Webb & Berthel, *Lygeum spartum* L., *Artemisia herba alba* Asso, *Rhus tripartitum* L., *Calycotome villosa* Link, *Periploca laevigata* L., *Stipa tenacissima* L., *Olea europea* L., and *Rosmarinus officinalis* L.
Sousse	35°47'49.8"N 10°38'59.1"E		Degraded area, marked by the presence of stones, gravel and pebbles. The vegetation is characterized by *Eucalyptus* sp.
Gafsa (Magroun River)	34°20'00.03"N 08°34'26.1"E	141 m	Saline area with a permanent watercourse and presence of stones from both sides of the river. Sandy soil and vegetation is marked by Salsolaceae and *Tamarindus* L.
Tozeur (Tamaghza)	34°22'41.4"N 07°54'50.9"E	191 m	The studied area is close to a large waterfall, surrounded by stones and rocks. The vegetation is mainly represented by *Typha* L.

Results and discussion

The present study gives data on 19 species belonging to 15 genera, 11 tribes and 3 subfamilies, found in Center and Southern Tunisia. All registered species belong to the following subfamilies: Carabinae (with 2 tribes, 2 genera, and 2 species), Scaritinae (with 1 tribe, 1 genus, and 1 species), and Harpalinae (8 tribes, 12 genera, and 16 species). The registered taxa are listed below.

Family CARABIDAE

Subfamily Carabinae Latreille, 1802

Tribe Calosomini

Campalita maderae* ssp. *maderae (Fabricius, 1775)

Material examined. Kairouan (El Guatranya): 3♂♂, 1♀, 17 July 2012.
Collection sites. This species is collected under stones and leaf litter.
Distribution. North Africa: Tunisia, Algeria, Morocco, Mauritania, and the Canary Islands (Löbl & Smetana 2003).

Tribe Carabini Latreille, 1802

Macrothorax morbillosus Fabricius, 1792

Material examined. Kairouan (El Guatranya): 3♂♂, 1♀, 18 March 2013.
Collection sites. This species was collected under stones on the edge of the woods and sometimes sheltered in snail shells.
Distribution. All North Africa. Europe: Spain, Italy (Sicily, Sardinia), France (Bedel 1895; Jeannel 1941; Antoine 1955; Machard 1997; Löbl & Smetana 2003).

Subfamily Scaritinae Bonelli, 1810

Tribe Dyschiriini Kolbe, 1880

Dyschirius pusillus Dejean, 1825

Material examined. Gafsa (Magroun river), 7♂♂, 3♀♀, 19 January 2013; Tozeur, 2♀♀; 20 January 2013.
Collection sites. This is a halophilic species, captured in a salty terrain, sandy clay bottom, close to the water.
Distribution. North Africa: Tunisia, Morocco, Algeria. Mediterranean coastline. Western Asian (Fedorenko 1996).

Subfamily Harpalinae Bonelli, 1810

Tribe Abacetini Chaudoir, 1873

Astigis salzmanni (Germar, 1824)

Material examined. Tamaghza, 2♂♂, 26 February 2013.

Collection sites. The species was collected in wet gravel at the edge of running waters in Tamaghza, near the waterfall.
Distribution. North Africa: Tunisia, Algeria, Morocco. Europe: Spain, Italy, France (Löbl & Smetana 2003).

Tribe Anthiini Bonelli, 1813

Anthia (Termophilum) sexmaculata Fabricius, 1787

Material examined. Bou Hedma Park, 2♂♂, 1♀, 27 April 2013.
Collection sites. This species was captured in a desertic region, roaming in the sand under sunlight.
Distribution. North Africa: Tunisia, Algeria, Morocco, Libya, Egypt (Löbl & Smetana 2003; Ghannem *et al.* 2014).

Tribe Graphipterini Latreille, 1802

Graphipterus serrator Forsskal, 1775

Material examined. Gafsa (Magroun river), 4♂♂, 3♀♀, 19 January 2013; Bou Hedma Park, 2♂♂, 1♀, 27 April 2013.
Collection sites. This species was collected along the coastline, around grass patches and, in the southern provinces, captured around small mounds of sand.
Distribution. North Africa: Tunisia, Algeria, Morocco, Egypt, Libya, Mauritania (Bedel 1895; Antoine 1955; Machard 1997; Ghannem *et al.* 2014).

Tribe Harpalini Bonelli, 1810

Subtribe Anisodactylina Lacordaire, 1854

Anisodactylus (Hexatrichus) poecilodes Stephens, 1829

Material examined. Tozeur, 2♂♂, 1♀, 20 January 2013.
Collection sites. This species was collected in saline soils, under stones.
Distribution. North Africa: Tunisia, Algeria, Morocco. Europe: Spain, Italy, France, Germany, Croatia (Löbl & Smetana 2003).

Subtribe Stenolophina Kirby, 1837

Dicheirotrichus (s. str.) obsoletus (Dejean, 1829)

Material examined. Gafsa (Magroun river), 7♂♂, 9♀♀, 19 January 2013; Kairouan (Metbasta), 1♂, 2♀♀, 18 January 2013.
Collection sites. This species has been collected in a very salty ground.
Distribution. North Africa: Tunisia, Morocco, Algeria. Europe: Spain, Italy, France (Bedel 1895; Antoine 1955; Rueda 1990; Machard 1997; Löbl & Smetana 2003).

Dicheirotrichus (s. str.) punicus Bedel, 1899

Material examined. Gafsa (Magroun river): 8♂♂, 6♀♀, 19 January 2013.
Collection sites. This species was collected in a very salty ground beside a river.
Distribution. North Africa: Tunisia, Morocco. Europe: Spain, Italy (Bedel 1895; Antoine 1955; Machard 1997; Löbl & Smetana 2003).

Tribe Lebiini Bonelli, 1810

Subtribe Cymindidina Laporte, 1834

Cymindis setifensis Lucas, 1842

Material examined. Bou Hedma Park, 2♂♂, 3♀♀, 27 April 2013.
Collection sites. The species was found under small stones.
Distribution. *C. setifensis* is unique to North Africa and widespread in all the Barbary states, and Madeira and Canary Islands (Bedel 1895; Ghannem *et al.* 2014).

Subtribe Dromiusina Bonelli, 1810

Syntomus fuscomaculatus (Motschoulsky, 1844)

Material examined. Chambi, 3♂♂, 4♀♀, 1 April 2013.
Collection sites. The species was collected in the roots of vegetation and under stones.
Distribution. North Africa: Tunisia, Morocco, Egypt, Algeria, Mauritania, Libya. Europe: Spain, Italy, France, Portugal, Greece (Antoine 1955; Machard 1997; Löbl & Smetana 2003).

Syntomus obscuroguttatus Duftschmid, 1812

Material examined. Chambi, 4♂♂, 2♀♀, 1 April 2013.
Collection sites. The species was collected in high mountains under plant debris.
Distribution. North Africa: Tunisia, Algeria, Morocco, Libya. Europe: Spain, Italy, France (Antoine 1955; Machard 1997; Löbl & Smetana 2003).

Microlestes fulvibasis Reitter, 1900

Material examined. Tamaghza, 3♂♂, 2♀♀, 19 January 2013.
Collection sites. The species was captured in small stones and plant debris.
Distribution. North Africa: Tunisia, Algeria. Europe: Spain, Italy, France, central Asia (Bedel 1895; Löbl & Smetana 2003).

Microlestes abeillei Brisout, 1885

Material examined. Tamaghza, 2♂♂, 1♀, 19 January 2013; Gafsa, 1♂, 3♀♀, 22 January 2013.
Collection sites. The species was collected under low plants, plant debris and under stones in sandy clay.
Distribution. North Africa: Tunisia, Algeria, Morocco. Europe: Spain, Italy, France (Bedel 1895; Antoine 1955; Zaballos 1984; Machard 1997; Löbl & Smetana 2003).

Microlestes mauritanicus Lucas, 1846

Material examined. Tamaghza: 1♂, 1♀, 19 January 2013; Tozeur, 3♀♀, 21 January 2013.
Collection sites. The species was collected under stones and plant debris.
Distribution. North Africa: Tunisia, Algeria, Morocco. Europe: Spain (Andalusia), Italy (Sicily) (Bedel 1895; Antoine 1955; Machard 1997; Löbl & Smetana 2003).

Subtribe Trichina Basilewsky, 1984

Trichis maculata Klug, 1841

Material examined. Gafsa, 1♂, 2♀♀, 19 January 2013; Tozeur, 2♂♂, 1♀, 20 January 2013; Tamaghza, 2♀♀, 21 January 2013.

Collection sites. The species was collected under the roots of Salsolaceae in a salty clay soil.
Distribution. North Africa: Tunisia, Algeria, Morocco, Egypt. Europe: Spain, Greece (Bedel 1895; Antoine 1955; Machard 1997; Löbl & Smetana 2003).

Tribe Licinini Bonelli, 1810

Subtribe Licinina Bonelli, 1810

Licinus punctatulus Fabricius, 1792

Material examined. Kairouan (El Guatranya), 2♂♂, 3♀♀, 18 January 2013; Sousse, 5♂♂, 4♀♀, 20 January 2013.
Collection sites. This species was collected under stones, pieces of wood and plant debris often in arid lands.
Distribution. North Africa: Tunisia, Algeria, Morocco. Europe: Spain, France (Antoine 1955; Machard 1997; Löbl & Smetana 2003).

Tribe Pterostichini Bonelli, 1810

Subtribe Pterostichina Bonelli, 1810

Orthomus barbarus Dejean, 1828

Material examined. Sousse, 2♂♂, 5♀♀, 20 January 2013.
Collection sites. The species was caught under stones and pieces of dead wood.
Distribution. North Africa: Tunisia, Morocco, Egypt. Europe: Spain, Italy, Portugal, Greece, France (Bedel 1895; Antoine 1955; Löbl & Smetana 2003).

Tribe Sphodrini Laporte, 1834

Subtribe Sphodrina Laporte, 1834

Laemostenus (Pristonychus) algerinus Gory, 1833

Material examined. Kairouan (El Guatranya), 1♀, 28 August 2013.
Collection sites. The specimen was collected under stones.
Distribution. North Africa: Tunisia, Algeria, Morocco. Europe: Spain, France, Italy (Bedel 1895; Antoine 1955; Löbl & Smetana 2003).

Faunistic studies are a useful tool to get a better knowledge of the distribution of carabids in different localities and ecosystems of Tunisia. The structure of vegetation affects carabid spatial distribution maybe due to the microclimatic differences found in different plant structures, as well as perhaps due to the differentiation of faunal communities and faunal interactions by plant architectures (den Boer 1977; Luff 1998).

In this study, a total of 19 species belonging to 3 subfamilies were collected from different localities. Of the three subfamilies studied here, Harpalinae is the most abundant with 16 species (84.2% of total), while the subfamily Carabinae is the less abundant with 2 species (10.5% of total). The subfamily Scaritinae is only represented by 1 species (5.2% of total). The subfamily Harpalinae with 19,000 species is the richest group of ground beetles (Lorenz 2005). Carabids respond more to the physical structure of the environment than to the species composition (Brose 2003; Jeanneret *et al.* 2003).

More effort must be made to get more information about the spatio-temporal distribution of carabid species in all ecosystems of the country to help to identify and locate endemic species, rare or endangered species for conservation.

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