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Seasonal changes in carabid assemblages of Mostaganem, Algeria (Coleoptera Carabidae)

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ABSTRACT Seasonal changes in carabid assemblages (Coleoptera Carabidae) inhabiting four sites near Mostaganem (NW Algeria) were investigated from April 2019 to March 2020 by means of pitfall trapping. Notable changes were found in all sites. In a citrus orchard (31 species, 710 specimens) spring breeders were more frequent. An olive grove (34 species, 1219 specimens) was dominated by *Orthomus abacoides* (974 specimens). Activity-density was concentrated in spring and autumn. An *Eucalyptus* forest (21 species, 292 specimens) showed unexpected species diversity and is a secondary habitat for large predators and forest taxa. In a fallow humid zone, a high number of species (80) and specimens (4366) were captured. Activity-density peaked in spring but was intense in all seasons. Hygrophilous and generalist taxa were dominant throughout all seasons. Seasonal changes are thought to be due to varying phenology and life cycle of species. Diversity was influenced by a few dominant species in all sites, but it was high in the fallow humid zone and decreased in cultivated areas. Comparison between sites was difficult because of the heterogeneity of species composition, which also applies to other Algerian cultivated lands, forests, and wetlands. Fine ecological tunning to environmental factors and random dispersal of taxa are likely causing seasonal faunal heterogeneity.

KEY WORDS Community dynamics; ground beetles; seasonal and annual variation; Carabidae; Algeria.

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INTRODUCTION

Insect communities are useful witnesses of how environmental factors influence living beings, affecting the diversity of life histories and cycles, trophic needs, and abilities to react to changes and perturbations. Carabid beetles (Coleoptera Carabidae) make up one of the groups currently used to assess these changes as they show appropriate qualities: taxonomy is well-known and their ecology has been documented for many countries, populations can be easily sampled, and they show responses to both small-scale requirements and landscape and continent level-phenomena (Hengeveld, 1987; Kotze & O'Hara, 2003; Koivula & Spence, 2006). For these reasons they are considered as 'bioindicators' in a wide sense (Kotze et al., 2011), either as individual species or as local assemblages. This particularly applies to many European countries where a wealth of studies has been carried out (summarized in Kotze et al., 2011). Furthermore, ground beetles are also known to predate on pests, such as aphids, dipteran eggs and larvae, snails, caterpillars, eggs, and larvae of weevils, chrysomelids and other harmful insects (Kromp, 1999; Monzó et al., 2011; Bouvet et al., 2019).

The ground-beetle fauna of Algeria is fragmentarily known despite the great amount of collected material deposited in many institutions. This is possibly due to the lack of comprehensive identification keys for the entire fauna; the papers of Bedel (1895–1925) on North African fauna are outdated because of the many taxonomic and nomenclatural changes accumulated since the onset of the 20th century. Keys from Moroccan fauna (Antoine, 1955–1962) only partially address this taxonomic challenge. Contributions over the last few decades have significantly helped to overcome this challenge, including works by Pupier (2005), Wrase & Jeanne (2005), Wrase & Magrini (2011), Anichtchenko (2017), Renan et al. (2018), and Serrano (2021), among others.

Recent interest in faunistic conservation in Algeria has been focused on saline areas (chotts) and freshwater lakes, which have been studied by Boukli Hassaine (2010), Boukli-Hacene et al. (2012), Chenchouni et al. (2015), Matallah et al. (2016), Amri et al. (2019), Takieddine et al. (2023). Likewise, studies of forest fauna have been carried out by Belhadid et al. (2014) on cedar forests of Chrèa and Djurdjura, and by Daas et al. (2016) on oak forests near Constantine. Carabid assemblages of agricultural landscapes of northeast Algeria have been studied by Ouchtati et al. (2012) focusing on cereal fields, and by Saouache et al. (2014), who compared the fauna of cereal fields and cherry orchards from two sites near Constatine (northeast Algeria).

Our aim was to carry out an investigation on the carabid fauna occurring in the surroundings of Mostaganem (NW Algeria), looking for factors affecting faunal differences and the role of this fauna as potential controllers of insect pests. We looked for the seasonal succession of carabid assemblages in four sites; the effect of extrinsic factors on the faunal composition; and the value of these assemblages as predators of pests. Sites were a citrus orchard, an olive grove, a *Eucalyptus* forest, and a fallow humid area. Sampling was conducted using the standard method of pitfall trapping during a whole year.

MATERIAL AND METHODS

Study area

The four studied sites are found in the wilaya (province) of Mostaganem, along the Mediterranean coast (Table 1, Figs. 1, 2). Two of the sites were cultivated, a citrus orchard and an olive grove; there were also one eucalyptus forest and a fallow humid site besides the river Chéliff.

The Mostaganem area is characterized by a semi-arid climate with mild winters. In 2019, total precipitation reached 415 mm, distributed unevenly throughout the year: a peak in November (107 mm), moderate precipitation from April to September, low amounts in June and July (>10 mm), and scarcity from May to August. The annual average

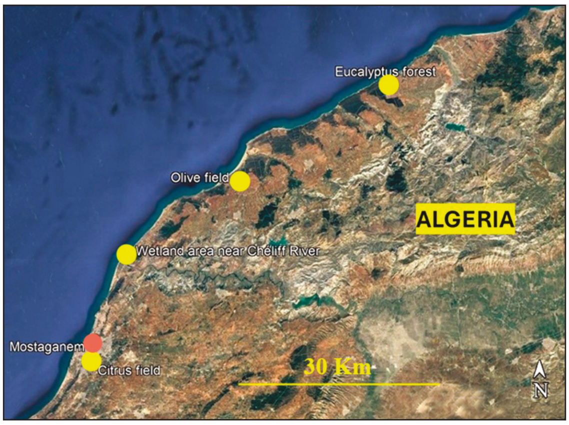


Figure 1. Map of the sampled sites around Mostaganem (NW Algeria).

Site	Geographic Coordinates	Area (ha)	Soil/Irrigation	Pesticides/ Agrochemicals
Citrus orchard	35°53’27.01”N 0°5’5.49”E	1.77	Sandy loam /Yes	No/No
Olive grove	36°7’37.15”N 0°19’14.06”E	2.38	Silt/No	No/No
Eucalyptus Forest	36°15’13.20”N 0°33’52.86”E	4.50	Loam /No	No/No
Humid zone	36°1’54.98”N 0°8’46.58”E	1.15	Alluvial/No	No/No

Table 1. Data of the four sites investigated for seasonal changes in carabid assemblages during 2019–2020 near Mostaganem (NW Algeria).

temperature was 20.5 °C, with peaks in July and August (27 °C) and minimum values in January (15 °C) and February (16 °C).

During the 2020 campaign, the precipitation decreased to 385 mm. The precipitation was moderate during September-November, January, and March-May; scarce in February, June-August, and high in December (112 mm). The annual average temperature was 21 °C, with a maximum of 27 °C in July and August and a recorded minimum in January (14 °C). Climatic data are summarized in Fig. 3.

The studied sites encompassed various ecosystems, including agricultural and forested areas as described below:

The citrus orchard was situated at the Experimental Farm No. 1 of the University of Mostaganem. The farm was located on the Mostaganem Plateau and included orange (*Citrus sinensis*) and lemon (*C. limon*) trees, bordered by *Cupressus sempervirens* windbreaks. The orchard was irrigated and ploughed without any pesticide treatment before or during the experiment.

The olive grove was located at the Experimental Station No. 3 of the University of Mostaganem, at the sub-coastal Plain of the region. This loamy site was planted with "Sigoise" variety olive trees (*Olea europea* L.) and was protected by windbreaks of cypress trees. Throughout the study period, this irrigated plantation was regularly ploughed, and pesticides were not applied.

The *Eucalyptus* forest included different tree species although it predominantly consisted of *Eucalyptus globulus*. It was located on the sub-coastal plain, at an altitude of 144 m and the soil was loamy.

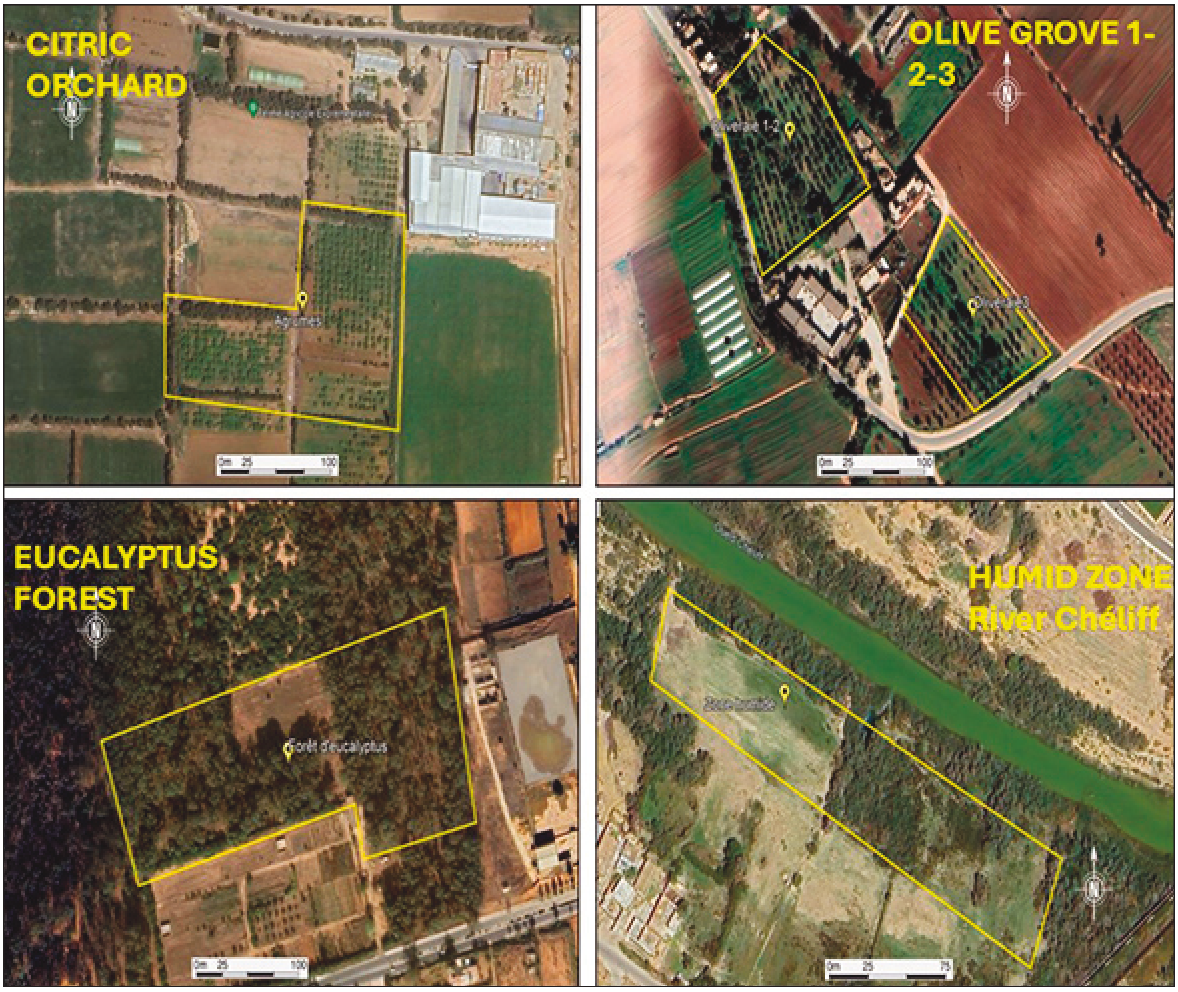


Figure 2. Aerial view of sampled sites around Mostaganem (NW Algeria).

The wetland fallow area was located on the banks of the river Chéliff. The soil consisted of silty alluvial particles (40%) partly covered with wild vegetation, the rest being bare soil.

Sampling

Carabids were collected at 15-day intervals using the pitfall trap method. The traps consisted of two plastic containers of different sizes buried into the ground. The larger container, with diameter 18 cm, height 20 cm, was inserted into the soil. Inside this, a smaller container of diameter 8 cm and height 11 cm served as the collector for trapping arthropods and contained 150 ml of 50% aqueous solution of monopropylene glycol. Each trap was shielded from rain, plant debris, and other animals by a wooden plate supported by sticks. At each site 60 traps were arranged in 15 spots; in each spot there were 4 traps forming a square of 5 m side; the spots were settled separated from each other by 15 m, not forming a linear arrangement but with a zigzag layout.

The collected material was transferred to plastic containers and transported to the laboratory. There, the arthropods were rinsed with tap water and the carabid specimens were separated and preserved in 70% ethanol until identification.

Sampling started on April 2019 and ended in March 2020. Spring captures were those between 06/04/2019 and 18/06; summer captures between 19/06 and 19/09; autumn captures between 20/09/ and 23/12; and winter data between 24/12 and 19/03/2020.

Species were identified with the works mentioned in the introduction, together with general works on taxonomy and species distribution (Jeannel, 1941, 1942; Coulon et al., 2011; Löbl & Löbl, 2017).

Data analysis

Analysis of data matrices was carried out with the PAST application (Hammer et al., 2001) version 4.03 (2023). The analysis procedure followed the pattern: (*i*) captures of each 15-days interval were scored in an Excel file; (*ii*) thereafter it was added columns summarizing captures for each season and a total year column. This allowed for the analysis of changes within each season and between seasons. Data matrices of the sites and the seasons were run in PAST, resulting in a Principal Component Analysis (PCA) and alpha- and beta-diversity seasonal indices, and a Bray-Curtis similarity dendrogram between seasons. The dendrogram was estimated using pairwise comparisons under the Whitaker option of PAST. Matrices with all trapping results are mentioned as the general matrix of each site. Due to their large size, they are provided in the supplementary material (Tables S1, S2, S3, and S4).

RESULTS

The citrus orchard

In this site a total of 31 species and 710 specimens were collected (Tables 2 and S1).

The Principal Component Analysis (not shown) of the general matrix showed that the total variance was mostly distributed within the first five axes indicating a moderate heterogeneity of species abundance through seasons. When the file with only seasonal data (Table 2) was run, it was found that total variance was now explained by the first three axes. In the scatter plot (Fig. 4) the Y axis separates the abundant taxa (*Pseudoophonus* spp.; *Licinus punctatulus*), whereas the X axis separates the species appearing in summer-autumn (*Pseudoophonus* spp.) and those with autumn-winter (*Licinus punctatulus*) activity.

Carabid assemblages notably changed through seasons, probably due to the different life cycles of species and their activity periods. Species typical of spring were *Amara* spp. and *Orthomus abacoides*. In summer there were many specimens of *Pseudoophonus* spp. that again were abundant in autumn; only *Microlestes luctuosus chobauti* was typical of the summer season. Species of *Calathus* were typical of autumn, as it was also the case with *Licinus punctatulus*. In winter, most collected species were already present in autumn, and only *Platyderus gregarius* seemed to be typical of this season.

Alpha-diversity indices calculated from Table 2 showed that spring was the season with the highest Shannon index (Table 3) even though autumn and winter were the seasons with more trapped specimens (Fig. 8).

Beta-diversity indices allowed calculating the similarity between assemblages of the four seasons

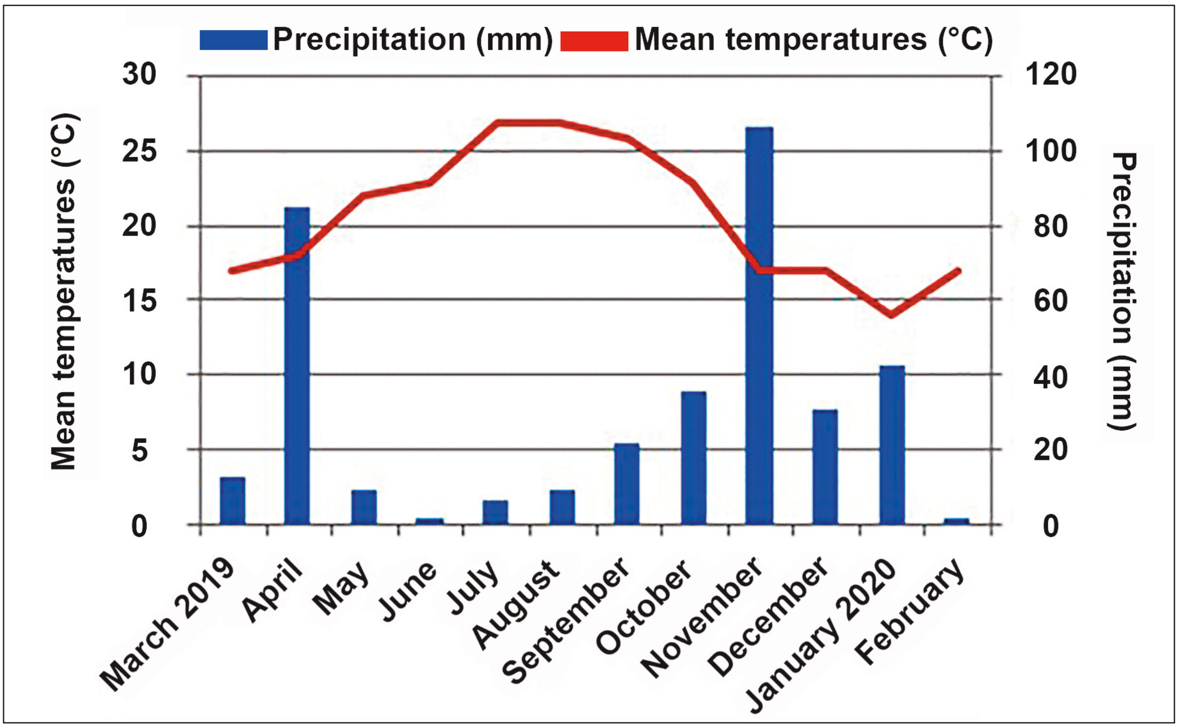


Figure 3. Climatogram of the study area of Mostaganem (2019–2020).

(Fig. 12). Similarity was in general low and only assemblages of autumn and winter appeared moderately related. The summer assemblage appeared quite distinct as only *Pseudoophonus* spp. were collected, with *Microlestes luctuosus chobauti*, and specimens of *Licinus punctatulus* starting field activity.

The chorological profile of the whole citrus orchard assemblage consists of Mediterranean and endemic elements (61.3% of Mediterranean, Siculo-Maghrebian, North-African endemics) and elements with a wide distribution (38.7% Palearctic, Turano-European- Mediterranean, European and others). It seems that the citrus assemblage is characterized by eurytopic species, as it happens (to a lower extent) with the chorological composition of the humid zone.

The olive grove

The site totaled 1219 specimens and 34 species (Table S2). When trapping events were grouped by seasons (Table 4) it can be noticed the strong dominance of *Orthomus abacoides* (968 specimens), a xerophilous and thermophilous species that is also common elsewhere. *Licinus punctatulus* was also abundant except during the summer.

Carabid assemblages changed through the seasons due to the varying phenology of the species; during spring there were taxa such as *Bembidion axillare* (but not *B. ambiguum*), *Percus lineatus, Amara* spp., *Bradycellus* spp., whereas other species showed field activity mostly in autumn, such as *Broscus politus* and *Calathus opacus*. Many species seemed to be active throughout the year but nearly disappeared in summer, probably to avoid high temperatures: *Bembidion ambiguum, Calathus* spp., and *Licinus punctatulus*. In the case of the abundant *Orthomus abacoides* the summer captures possibly correspond to beetles hatching in late spring or initiating the autumn hatching. Only the species of the tribe Lebiini (*Microlestes, Syntomus, Dromius*) showed a clear preference for summer conditions. Variation in the number of specimens was the sharpest within the four studied sites (Fig. 9).

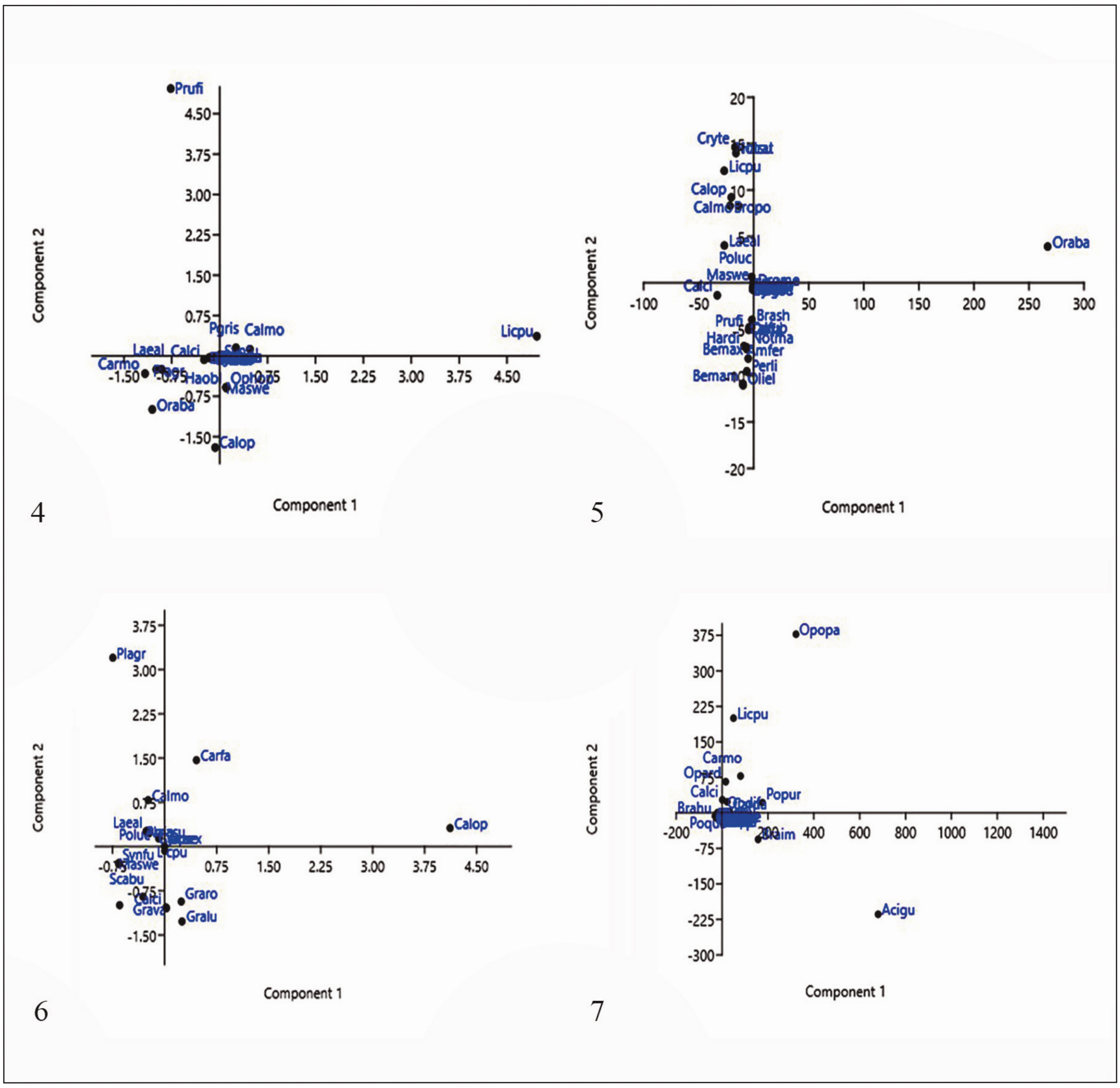
The scatter plot of the PCA corresponding to Table 4 (Fig. 5) showed that the Y axis reflects the high number of specimens of *Orthomus abacoides*, whereas the species more abundant in autumn or in

		Spring	Summer	Autumn	Winter	Year
Calosoma maderae maderae (Fabricius, 1775)	Carma	1	0	0	0	1
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo	2	0	8	2	12
Notiophilus marginatus Gené, 1839	Nomar	1		0	0	1
Percus (Percus) lineatus (Solier, 1835)	Perli	0		1	0	1
Orthomus (Orthomus) abacoides (Lucas, 1846)	Oraba	11	1	10	6	28
Orthomus (Orthomus) lacouri pupieri Jeanne, 1988	Orlac	1		0	0	1
Amara (Amara) aenea (DeGeer, 1774)	Amaen	4	1	0	0	5
Amara (Amara) similata (Gyllenhal, 1810)	Amsim	4		0	0	4
Amara (Amara) subconvexa Putzeys, 1865	Amsub	5		0	0	5
Amara (Celia) fervida fervida Coquerel, 1859	Amfer	0		1	0	1
Platyderus (Platyderus) gregarius Reiche, 1862	Plagr	2		1	1	4
Calathus (Bedelinus) circumseptus Germar, 1827	Calci	5		8	2	15
Calathus (Calathus) opacus Lucas, 1846	Calop	0		18	2	20
Calathus (Neocalathus) melanocephalus antoinei Puel, 1939	Calme	2		0	0	2
Calathus (Neocalathus) mollis atticus Gautier des Cottes, 1867	Calmo	2		22	19	43
Laemostenus (Laemostenus) complanatus (Dejean, 1828)	Laeco	1		0	0	1
Laemostenus (Laemostenus) terricola terricola (Herbst, 1784)	Laete	0		3	0	3
Laemostenus (Pristonychus) algerinus algerinus Gory, 1833	Laeal	2		0	1	3
Cryptophonus tenebrosus (Dejean, 1829)	Cryte	0	1	1	0	2
Harpalus (Harpalus) attenuatus Stephens, 1828	Harat	1		0	0	1
Harpalus (Harpalus) distinguendus distinguendus (Duftschmid,1812)	Hardi	4	3	0	3	10
Harpalus (Harpalus) oblitus patruelis Dejean, 1829	Harob	0	1	0	0	1
Ophonus (Ophonus) opacus (Dejean, 1829)	Ophop	0	1	0	0	1
Pseudoophonus griseus (Panzer, 1796)	Psegr	35	38	43	5	121
Pseudoophonus rufipes (DeGeer, 1774)	Pseru	15	58	99	1	173
Bradycellus (Bradycellus) verbasci (Duftschmid, 1812)	Brave	1		0	0	1
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu	29	9	82	124	244
Microlestes abeillei brisouti Holdhaus, 1912	Micab	0		0	2	2
Microlestes luctuosus chobauti Jeannel, 1942	Miclu	0		0	2	2
Syntomus fuscomaculatus (Motschulsky, 1844)	Synfu	1		0	0	1
Masoreus wetterhallii axillaris Kuster, 1852	Maswe	0	1	0	0	1
Total specimens		**129**	**114**	**297**	**170**	**710**
Total species		**21**	**10**	**13**	**13**	**31**

Table 2. Trapping data of ground beetles grouped by seasons in a citrus orchard of Mostaganem (2019–2020).

	Spring	Summer	Autumn	Winter
Taxa S	21	10	13	13
Specimens	129	114	297	170
Dominance D	0.1458	0.3718	0.2176	0.5451
Simpson 1-D	0.8542	0.6282	0.7824	0.4549
Shannon H	2.389	1.295	1.816	1.155

Table 3. Seasonal changes of alpha-diversity indices of carabid assemblages in a citrus orchard near Mostaganem from April 2019 to March 2020.



Figures 4–7. Scatter plot resulting from a Principal Component Analysis of data matrices corresponding to seasonal captures of ground beetles in four different sites. Fig. 4: Citrus orchard. Fig. 5: Olive grove. Fig. 6: *Eucalyptus* forest. Fig. 7: Humid zone.

Trapping event		Spring	Summer	Autumn	Winter	Year
Carabus (Eurycarabus) faminii numidus Laporte, 1834	Carfa	1		1		**2**
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo				1	**1**
Notiophilus marginatus Gené, 1839	Notma	2			2	**4**
Notiophilus substriatus G.R. Waterhouse, 1833	Notsu			1		**1**
Broscus (Broscus) politus (Dejean, 1828)	Bropo			10		**10**
Bembidion (Emphanes) axillare occiduum Marggi et Huber, 2001	Bemax	12				**12**
Bembidion (Neja) ambiguum Dejean, 1831	Bemam	10		8	5	**23**
Percus (Percus) lineatus (Solier, 1835)	Perli	3				**3**
Orthomus (Orthomus) abacoides (Lucas, 1846)	Oraba	434	19	411	110	**974**
Orthomus (Orthomus) rubicundus (Coquerel, 1859)	Orrub	2				**2**
Poecilus (Poecilus) lucasii (Reiche, 1861)	Poluc	1			1	**2**
Amara (Amara) anthobia A. Villa et G.B. Villa, 1833	Amant	2				**2**
Amara (Celia) fervida fervida Coquerel, 1859	Amfer	9		2	1	**12**
Olisthopus elongatus Wollaston, 1854	Oliel	2				**2**
Platyderus (Platyderus) gregarius Reiche, 1862	Plagr				1	**1**
Calathus (Bedelinus) circumseptus Germar, 1827	Calci	4		5	1	**10**
Calathus (Calathus) fuscipes algiricus Gautier des Cottes, 1866	Calfu	1				**1**
Calathus (Calathus) opacus Lucas, 1846	Calop	1	1	5		**7**
Calathus (Neocalathus) mollis atticus Gautier des Cottes, 1867	Calmo	5		2	3	**10**
Laemostenus (Pristonychus) algerinus algerinus Gory, 1833	Laeal	4		6	1	**11**
Cryptophonus tenebrosus (Dejean, 1829)	Cryte			1		**1**
Harpalus (Harpalus) attenuatus Stephens, 1828	Harat		1	2		**3**
Harpalus (Harpalus) distinguendus distinguendus (Duftschmid,1812)	Hardi	4			2	**6**
Pseudoophonus rufipes (DeGeer, 1774)	Prufi	4				**4**
Bradycellus (Bradycellus) sharpi Joy, 1912	Brash	5				**5**
Bradycellus (Bradycellus) verbasci (Duftschmid, 1812)	Brave	2				**2**
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu	34		25	19	**78**
Chlaenius (Chlaeniostenodes) canariensis seminitidus Chaudoir, 1856	Chlca	2				**2**
Cymindis (Cymindis) setifeensis leucophthalma Lucas, 1842	Cymse				1	**1**
Microlestes abeillei brisouti Holdhaus, 1912	Micab				1	**1**
Microlestes luctuosus chobauti Jeannel, 1942	Miclu	4	9		5	**18**
Syntomus fuscomaculatus (Motschulsky, 1844)	Synfu		4			**4**
Dromius (Dromius) meridionalis Dejean, 1825	Drome	1				**1**
Masoreus wetterhallii axillaris Kuster, 1852	Maswe		3			**3**
Total specimens		**549**	**37**	**479**	**154**	**1219**
Total species		**24**	**6**	**13**	**15**	**34**

Table 4. Trapping data of ground beetles grouped by seasons in an olive grove near Mostaganem (April 2019–March 2020).

	Spring	Summer	Autumn	Winter
Taxa S	24	6	13	15
Specimens	547	37	479	154
Dominance D	0.6297	0.3243	0.7396	0.5255
Simpson 1-D	0.3703	0.6757	0.2604	0.4745
Shannon H	1.076	1.393	0.7045	1.218
Evenness e^H/S	0.1223	0.6712	0.1556	0.2253

Table 5. Seasonal changes of alpha-diversity indices of carabid assemblages in an olive grove near Mostaganem (April 2019–March 2020).

autumn and winter (*Licinus punctatulus, Broscus politus, Harpalus attenuatus*) were found below the X axis, and those more abundant in spring (e.g., *Bembidion* spp., *Percus lineatus, Bradycellus sharpi)* above it. In the middle, there were species abundant in summer.

Alpha-diversity indices (Table 5) of the seasons were relatively low, those of winter and summer were higher probably because the assemblages suffered from lower dominance effects; the autumn Shannon index of 0.7045 denotes the dominant effect of *Orthomus abacoides* and *Licinus punctatulus*.

The Bray-Curtis similarity dendrogram (Fig. 13) showed that the summer assemblage was the most distinct. The assemblage of the olive grove included a 70.6% of Mediterranean elements in a wide sense (West Mediterranean, North-African, Ibero-Maghrebian, Saharo-Sindic), whereas Palearctic, Centroasiatic, Turanic-Mediterranean and other elements with large distribution areas made a 29.4%.

The Eucalyptus *forest*

In this site, 292 specimens and 21 species were collected (Tables 6, S3). Up to five species of the genus *Graphipterus* Latreille, 1802 were found denoting that the soil of the forest is sandy and warm. These last species showed a marked activity during spring.

The PCA of the general matrix showed that total variance was explained by many components (up to 8 components totaled 98%). In contrast, the season matrix showed that more than 98% of the variability was explained by the first three components. The scatter plot (Fig. 9) highlighted two species, *Calathus opacus* and *Platyderus gregarius*. The first species seems to be an autumn breeder with larvae that hibernate in winter, complete the development during the spring (showing high activity), enter in summer diapause, and recover activity in autumn. Other autumn or autumn-winter breeders are possibly *Carabus famini, Scarites buparius, Calathus mollis*, *Licinus punctatulus,* and *Cymindis setifeensis*.

In addition to the abundance of *Graphipterus* taxa it was noted the presence of large predators of the genera *Carabus* and *Scarites*, and the medium-sized *Calathus opacus*.

Except for summer, activity density of carabids was relatively similar through seasons (Fig. 10). However, alpha-diversity indices notably varied between seasons (Table 7), indicating low similarity between seasonal assemblages (Fig. 14). The autumn assemblage was the most distinct, whereas those of spring and winter, which are moderately related in other sites, were divergent in this forest. This difference is attributed to the higher activity in spring of *Calathus opacus*, whereas *Platyderus gregarius, Calathus mollis,* and *Licinus punctatulus* were more active in winter.

On chorological grounds the eucalyptus assemblage was the most distinct as 5 species are endemic to Algeria, 7 are West Mediterranean, 7 are North-African and 1 is an Ibero-Maghrebian element. Only one species is a Turanic-Mediterranean element. Thus, common eurytopic species found in other sites were excluded from the eucalyptus assemblage; only a few forest species or others

Trapping event		Spring	Summer	Autumn	Winter	Year
Carabus (Eurycarabus) faminii numidus Laporte, 1834	Carfa	10		17	16	43
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo			1	3	4
Notiophilus marginatus Gené, 1839	Notma			1		1
Scarites (Scallophorites) buparius (Forster, 1771)	Scabu			6	3	9
Poecilus (Poecilus) lucasii (Reiche, 1861)	Poluc	2				2
Amara (Amara) subconvexa Putzeys, 1865	Amasu	1				1
Platyderus (Eremoderus) insignitus insignitus Bedel, 1902	Plain	1				1
Platyderus (Platyderus) gregarius Reiche, 1862	Plagr	4		3	28	35
Calathus (Bedelinus) circumseptus Germar, 1827	Calci				1	1
Calathus (Calathus) opacus Lucas, 1846	Calop	35	2	57		94
Calathus (Neocalathus) mollis atticus Gautier des Cottes, 1867	Calmo	2			11	13
Laemostenus (Pristonychus) algerinus algerinus Gory, 1833	Laeal	1				1
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu				7	7
Graphipterus exclamationis exclamationis (Fabricius, 1792)	Graex	8				8
Graphipterus luctuosus Dejean, 1825	Gralu	14	1		1	16
Graphipterus peletieri Laporte de Castelnau, 1840	Grape	6	11			17
Graphipterus rotundatus Klug, 1832	Graro	14			3	17
Graphipterus valdanii	Grava		1		1	2
Cymindis (Cymindis) setifeensis leucophthalma Lucas, 1842	Cymse	6	2		8	16
Syntomus fuscomaculatus (Motschulsky, 1844)	Synfu		2	1		3
Masoreus wetterhallii axillaris Kuster, 1852	Maswe			1		1
Total specimens		**104**	**19**	**87**	**82**	**292**
Total species		**13**	**6**	**8**	**11**	**21**

Table 6. Trapping data of ground beetles grouped by seasons in a *Eucalyptus* forest near Mostaganem (April 2019–March 2020).

	Spring	Summer	Autumn	Winter
Taxa S	13	6	8	11
Specimens	104	19	87	82
Dominance D	0.1658	0.3392	0.4678	0.184
Simpson 1-D	0.8342	0.6608	0.5322	0.816
Shannon H	2.172	1.469	1.142	1.978
Evenness e^H/S	0.6453	0.7241	0.3917	0.6569

Table 7. Seasonal changes of alpha-diversity indices of carabid assemblages in a *Eucalyptus* forest near Mostaganem (April 2019–March 2020).

adapted to the sandy and hot conditions proper of semi desertic areas (e.g., *Graphipterus*) seem to be able to colonize this environment.

The fallow humid zone

In this site 80 species and 4374 specimens were collected. Total sampling results are shown in Table S4. The high number of collected specimens is likely related to the hygrophilous preferences shown by many ground beetles. Based on the PCA of the general data matrix, up to nine Principal Components were needed to explain 98% of the total variance, which indicates the occurrence of a heterogeneous assemblage. In the scatter plot (not shown) the most abundant species *Acinopus gutturosus* and *Ophonus opacus* appeared notably distant from a compact and central group of taxa.

After running the data matrix with seasonal captures (Table 8) almost 99% of total variance was explained by the first three axis. The first component seems to be related to dominant taxa whereas axes 2 and 3 seem to be related to seasons (Fig. 7).

Ten or more beetles were captured for 31 species, and 10 of these were represented by more than 100 specimens (Table 8). Spring was the season with the highest abundance and diversity (57 species, 1566 specimens) although captures were also abundant in the other seasons. The activity density of taxa through seasons was diverse as there were species notably active in spring (*Poecilus* spp., *Acinopus gutturosus*, *Chlaenius* spp.), in summer (*Siagona* spp., *Distichus planus*, *Carterus dama, Ditomus tricuspidatus*), in autumn (*Agonum* spp., *Calathus circumseptus*, *Harpalus attenuatus*), or in winter (*Microlestes mauritanicus*). Numerous species showed a progressive increase of captures from spring to autumn, or from summer to autumn (*Ophonus*), whereas others disappeared during summer possibly by burying into the soil; a few were active during all seasons, as *Microlestes levipennis*.

Reproductive season of many species was inferred from the activity pattern. Among the spring breeders it can be cited *Distichus planus*, *Siagona* spp., *Poecilus* spp., *Dixus sphaerocephalus*, *Acinopus gutturosus, Chlaenius* spp., *Microlestes luctuosus,* and *Brachinus immaculicornis*.

Summer conditions seemed to be preferred by *Carterus* spp. and several Lebiini taxa. Species that possibly are autumn breeders are *Carabus morbillosus, Calathus circumseptus, Ophonus* spp., and *Licinus punctatulus*. Winter breeding was inferred for *Poecilus purpurascens*, *Agonum* spp., *Licinus punctatulus*, *Chlaenius aeratus*, *Microlestes mauritanicus* and *Syntomus pallipes*.

Alpha-diversity indices of assemblages through seasons were high (Table 9). Although the highest number of species was trapped during spring, the Shannon index was greater in winter, as this assemblage was less influenced by the abundant taxa. Furthermore, the winter fauna included species of the genera *Agonum, Chlaenius, Microlestes,* and *Brachinus*, almost exclusively trapped in this season. Many of the sampled species during spring were only represented by a few specimens.

Comparatively to the other sites, the Bray-Curtis dendrogram showed (Fig. 15) higher similarity values. The winter assemblage was the most distinct both because the exclusive species indicated above and the reduction of captured beetles, approximately, to one half (Fig. 11) in comparison to the other seasons.

As expected from the abundance of generalist hygrophilous taxa in the humid zone, the species with a wide distribution area (Palearctic, various Asiatic-European and European chorological types) made up the highest percentage of the four studied sites (33.8%). Mediterranean elements (in a wide sense) made up an intermediate percentage (66.2%) between that of the citrus orchard and the olive grove.

DISCUSSION

The citrus orchard

This site showed a high Shannon diversity index during spring (2.389) and a moderate decrease in autumn (1.816), that dropped to 1.155 during winter. The highest diversity during spring suggests that the site was dominated by spring breeders that hatched in early spring or during the previous winter. The driest and hottest season (Fig. 2) was dominated by *Pseudoophonus rufipes, P. griseus* and *Licinus punctatulus* (Fig. 4). This last species is likely a specialized predator of snails (as other *Licinus* taxa: Brandmayr & Zetto Brandmayr, 1986; Baur et al., 2023) that become active with autumn-

Trapping event		Spring	Summer	Autumn	Winter	Year
Carabus (Eurycarabus) faminii numidus Laporte, 1834	Carfa	5	0	4	3	12
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo	85	1	114	79	279
Distichus (Distichus) planus (Bonelli, 1813)	Displ	17	20	1	0	38
Siagona europaea europaea Dejean, 1826	Siaeu	3	7	0	0	10
Siagona jenissoni Dejean, 1826	Siaje	0	1	0	0	1
Siagona rufipes (Fabricius, 1792)	Siaru	12	3	3	0	18
Apotomus rufus (Rossi, 1790)	Aporu	4	0	0	0	4
Trechus (Calotrechus) rufulus Dejean, 1831	Treru	0	0	0	1	1
Bembidion (Philochthus) iricolor Bedel, 1879	Bemir	0	0	0	1	1
Bembidion (Philochthus) vicinum Lucas, 1846	Bemvi	1	0	0	1	2
Bembidion (Phyla) rectangulum Jacquelin du Val, 1852	Bemre	2	1	1	0	4
Orthomus (Orthomus) abacoides (Lucas, 1846)	Oraba	3	0	0	0	3
Orthomus (Orthomus) rubicundus (Coquerel, 1859)	Orrub	0	0	0	2	2
Poecilus (Ancholeus) gisellae gisellae Csiki, 1930	Pogis	6	0	0	1	7
Poecilus (Carenostylus) purpurascens purpurascens (Dejean, 1828)	Popur	184	47	88	109	428
Poecilus (Poecilus) lucasii (Reiche, 1861)	Poluc	2	0	0	0	2
Poecilus (Poecilus) quadricollis (Dejean, 1828)	Poqua	38	1	0	15	54
Amara (Acorius) metallescens (Zimmermann, 1831)	Amame	0	0	1	0	1
Amara (Amara) aenea (DeGeer, 1774)	Amaen	1	0	0	0	1
Amara (Amathitis) rufescens shismatica Antoine, 1957	Amaru	1	0	3	0	4
Amara (Celia) sollicita Pantel, 1888	Amaso	0	0	3	0	3
Agonum (Agonum) nigrum Dejean, 1828	Agoni	0	2	3	10	15
Agonum (Olisares) lugens (Duftschmid, 1812)	Agolu	0	0	1	11	12
Olisthopus fuscatus Dejean, 1828	Olifu	0	0	1	0	1
Olisthopus elongatus Wollaston, 1854	Oliel	0	0	0	3	3
Platyderus (Eremoderus) insignitus insignitus Bedel, 1902	Plain	1	0	0	0	1
Calathus (Bedelinus) circumseptus Germar, 1827	Calci	18	0	42	22	82
Laemostenus (Pristonychus) terricola terricola (Herbst, 1784)	Later	0	0	2	0	2
Gynandromorphus etruscus (Quensel, 1806)	Gynet	0	0	1	0	1
Scybalicus oblongiusculus (Dejean, 1829)	Scyob	0	0	1	0	1
Carterus (Carterus) rotundicollis Rambur, 1837	Carro	5	0	0	0	5
Carterus (Carterus) dama (Rossi, 1792)	Carda	26	61	22	1	110
Carterus (Carterus) gilvipes (Piochard de la Brulerie, 1873)	Cargi	0	0	1	0	1
Carterus (Microcarterus) gracilis Rambur, 1837	Cargr	1	0	5	0	6
Carterus (Microcarterus) microcephalus Rambur, 1837	Carmi	6	4	6	0	16
Ditomus tricuspidatus (Fabricius, 1792)	Ditri	2	17	0	0	19
Dixus sphaerocephalus (Olivier, 1795)	Dixsp	23	14	0	0	37

Acinopus (Acmastes) haroldii (Schaum, 1863)	Achar	1	0	0	0	1
Acinopus (Oedematicus) gutturosus Buquet, 1840	Acigu	622	395	32	3	1052
Harpalus (Harpalus) attenuatus Stephens, 1828	Harat	4	3	11	0	18
Harpalus (Harpalus) distinguendus distinguendus (Duftschmid,1812)	Hadis	2	0	0	1	3
Harpalus (Harpalus) siculus Dejean, 1829	Harsi	5	0	1	1	7
Ophonus (Metophonus) rufibarbis (Fabricius, 1792)	Opruf	0	3	0	0	3
Ophonus (Metophonus) subsinuatus Rey, 1886	Opsub	8	29	11	0	48
Ophonus (Ophonus) ardosiacus (Lutshnik, 1922)	Opard	2	30	81	5	118
Ophonus (Ophonus) diffinis (Dejean, 1829)	Opdif	13	51	39	4	107
Ophonus (Ophonus) opacus (Dejean, 1829)	Opopa	111	215	468	10	804
Parophonus (Parophonus) hispanus (Rambur,1838)	Phisp	1	0	0	0	1
Pseudoophonus rufipes (DeGeer, 1774)	Prufi	0	0	1	0	1
Bradycellus (Bradycellus) distinctus (Dejean, 1829)	Bradi	0	0	0	1	1
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu	5	1	202	152	360
Chlaenius (Chlaeniostenodes) canariensis seminitidus Chaudoir, 1856	Chlca	34	19	3	15	71
Chlaenius (Chlaenius) festivus velutinus (Duftschmid, 1812)	Chlfe	11	0	0	0	11
Chlaenius (Dinodes) decipiens (Dufour, 1820)	Chlde	8	7	10	0	25
Chlaenius (Trichochlaenius) aeratus (Quensel, 1806)	Chlae	40	0	7	68	115
Chlaenius (Trichochlaenius) chrysocephalus (Rossi, 1790)	Chlch	16	7	1	15	39
Graphipterus peletieri Laporte de Castelnau, 1840	Gralu	3	0	0	0	3
Platytarus faminii faminii (Dejean, 1826)	Plafa	1	1	0	0	2
Platytarus gracilis gracilis (Dejean, 1831)	Plagr	0	1	0	0	1
Paradromius linearis (Olivier, 1795)	Parli	0	0	0	1	1
Microlestes abeillei brisouti Holdhaus, 1912	Micab	0	1	0	1	2
Microlestes levipennis levipennis (Lucas, 1846)	Micle	6	6	9	9	30
Microlestes luctuosus chobauti Jeannel, 1942	Miclu	11	1	2	2	16
Microlestes mauritanicus Lucas, 1846	Micma	0	0	0	10	10
Microlestes negrita negrita (Wollaston, 1854)	Micne	2	0	0	0	2
Microlestes vittatus vittatus (Motschulsky, 1860)	Micvi	0	0	0	1	1
Syntomus barbarus (Puel, 1938)	Synba	2	0	0	0	2
Syntomus bedeli (Puel, 1924)	Synbe	1	0	0	0	1
Syntomus foveatus (Geoffroy, 1785)	Synfo	1	0	0	0	1
Syntomus impressus impressus Dejean, 1825	Synim	0	5	0	4	9
Syntomus montanus (Bedel, 1913)	Synmo	1	0	0	0	1
Syntomus obscuroguttatus (Duftschmid, 1812)	Synob	2	0	0	0	2
Syntomus pallipes (Dejean, 1825)	Synpa	4	10	4	16	34
Zuphium olens (Rossi, 1790)	Zupol	2	0	0	0	2
Drypta (Deserida) distincta (Rossi, 1792)	Desdi	1	0	0	0	1
Drypta (Drypta) dentata (Rossi, 1790)	Dryde	4	0	0	1	5

Brachinus (Brachinus) efflans Dejean, 1830	Braef	2	0	0	0	2
Brachinus (Brachinus) elegans Chaudoir, 1842	Brael	1	0	0	0	1
Brachinus (Brachynolomus) immaculicornis immaculicornis Dejean, 1826	Braim	192	48	25	7	272
Brachinus (Dysbrachinus) humeralis Ahrens, 1812	Brahu	1	0	0	0	1
Total specimens		**1566**	**1012**	**1210**	**586**	**4374**
Total species		**58**	**32**	**37**	**34**	**80**

Table 8. Trapping data of ground beetles grouped by seasons in a humid zone near Mostaganem (April 2019- March 2020).

	Spring	Summer	Autumn	Winter
Taxa S	58	32	37	34
Specimens	1567	1013	1208	578
Dominance D	0.1968	0.2101	0.2003	0.1417
Simpson 1-D	0.8032	0.7899	0.7997	0.8583
Shannon H	2.374	2.163	2.182	2.44
Evenness e^H/S	0.1853	0.2717	0.2396	0.3373

Table 9. Seasonal changes of alpha-diversity indices of carabid assemblages in the humid zone near Mostaganem from April 2019 to March 2020.

winter rainfalls. Likewise, *Pseudoophonus* spp. are generalist predators that possibly hatch in late spring but can cope with the high summer temperatures and become notably active by autumn. Reproduction activity of *Pseudoophonus* probably coincides with phenology, as the species is considered an autumn-breeder (Pizzolotto et al. 2018). Similarity values between season assemblages were discrete, the most closely related values were that of autumn and winter (Fig. 12).

It is worth mentioning the role of *P. rufipes* as predator of the fruit fly *Ceratitis capitata* (Wiedemann, 1824). According to Monzó et al. (2005, 2011) this species shows high densities in citrus orchards of Valencia (SE Spain). The difference between the Algerian and Spanish data is that in Mostaganem, both *Pseudoophonus* species were abundant, whereas in Valencia, only *P. rufipes* was prevalent (Monzó et al., 2005). This suggests that a second pest might be present in the Mostaganem citrus orchard, which *P. griseus* could be targeting.

The olive grove

The olive grove and the citrus orchard exhibited similar species diversity, but the assemblage's structure differed due to the strong dominance of *Orthomus abacoides* and the low number of species collected during summer. Beetles were mainly trapped in spring (547 specimens) and autumn (479 specimens), whereas the total number of trapped beetles in citrus orchard was more evenly distributed throughout the seasons (Table 2). The strong dominance of *Orthomus abacoides* accounts for the low Shannon index values in spring and autumn; notably, the highest Shannon value was observed in the summer assemblage, when *O. abacoides* specimens were few.

The proportion of hygrophilous taxa (*Notiophilus* Dumèril, 1806, *Bembidion axillare, Bradycellus* Erichson, 1837, *Chlaenius canariensis*) (33%) was higher than that of citrus orchard (14%), suggesting better soil moisture retention between autumn rainfall and late spring. However, the olive soil likely becomes quite dry during summer, as indicated by the notable decrease of beetle activity during this season.

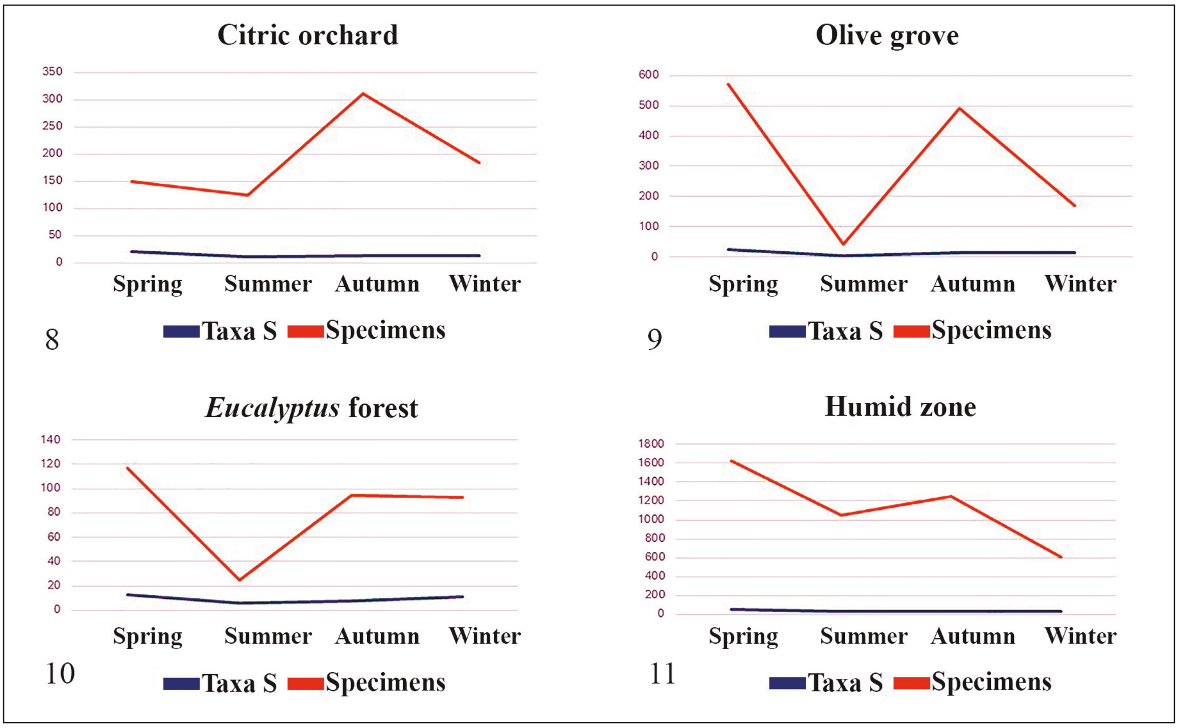
Our results can be hardly compared with those reported by Pizzolotto et al. (2018), because they studied 17 olive grove sites in southern Italy that were planted in three areas with different climax vegetation; in addition, traps were sampled every 20 days from April to December, and the plots were subjected to various managements. Notwithstanding, predominating taxa in Mostaganem and Calabria were Mediterranean elements of the genera *Amara* Bonelli, 1810*, Calathus* Bonelli, 1810, *Harpalus* Latreille, 1802, *Ophonus* Dejean, 1821*,* and *Pseudoophonus* Motschulsky, 1844. Spring breeders were the principal reproductive type in Mostaganem, in contrast to Calabria. In this last area frequent activities (mowing, tillage) are disturbing factors that negatively select species laying eggs in spring, thus favoring autumn breeders (Pizzolotto et al., 2018).

Pseudoophonus rufipes, the dominant species in the citrus orchard, was not abundant in the olive grove but other species may play the same predatory role according to body size and higher abundance: *Broscus politus, Orthomus abacoides, Calathus* spp. Olive trees may be attacked by *Theba pisana* snails (Spooner et al., 2002; Tandingan et al., 2020), but the abundance of the specialized predator *Licinus punctatulus* might prevent snail infestation.

Comparison of results of the citrus orchard and the olive grove with those of a cereal field and a cherry orchard in northeastern Algeria (Salaouine et al., 2014), is also difficult due to different sampling strategies. These authors placed the traps at the edge of the plots instead of inside the plantation. Species in common to both geographic areas are few, particularly regarding those most important in terms of abundance, body size and food preferences. These are *Carabus morbillosus, Pseudoophonus rufipes,* and *Licinus punctatulus.* However, xerophilic, macropterous, and medium-sized predators are common in both areas. The same considerations also apply to the cereal field studied by Ouchtati et al. (2012) in Tebessa (NE Algeria).

The Eucalyptus *forest*

The lower abundance of ground beetles of this site in comparison to that of the other investigated sites is likely related to the decomposition of leaves and bark of the trees, that affects negatively to soil properties and prevents the development of shrub



Figures 8–11. Seasonal changes in the number of captured taxa and specimens, in sampled sites around Mostaganem (Algeria), 2019–2020. Citrus orchard, Olive grove, *Eucalyptus* forest, Humid zone.

and herbaceous substrates (Chu et al., 2017), that is, the basis of the ecological trophic web. Despite these considerations, the eucalyptus forest provided a suitable habitat for two large predators, *Carabus famini* and *Scarites buparius* (Forster, 1771), allowing them to thrive outside their usual habitat preferences. Besides the forest taxa of the genus *Platyderus, Calathus opacus* is a medium-sized predator that is usually found in Mediterranean forests of NW Africa, as it happens with its counterpart in Iberia *C. granatensis* Vuillefroy, 1866. Undoubtedly, the most characteristic taxa of the eucalyptus forest were the *Graphipterus* beetles, active in spring and summer probably searching for ants. The presence of these predators, often found in desert habitats, agrees with existence of an assemblage with a simple structure that is adapted to cope with harsh environmental factors. Autumn rainfall seems to favor the activity of autumn breeders as *Calathus opacus* and *Carabus famini.* Among the *Graphipterus* species only *G. luctuosus* was common in summer.

The *Eucalyptus* forest assemblage was quite different from those inhabiting the *Quercus* forests of El-Kala and Souk-Ahras (NE Algeria) studied by Daas et al. (2016). These were characterized by typical species of temperate Mediterranean forests (genera *Carabus* Linnaeus, 1758*, Nebria* Latreille, 1802, and *Harpalus*). These authors used different sampling methods to trap the Coleopteran fauna in oak forests, which are likely of natural origin rather than man-made. Likewise, in the study of cedar forests of Chrèa and Djurdjura (Belhadid et al., 2014), the carabid fauna consisted of typical forest taxa of the genera *Calathus* and *Nebria*, although generalist species such as *Harpalus attenuatus* and *Zabrus jurjurae* Peyerimhoff, 1908, which are more suited to open habitats, were also found. These first data on carabid assemblages from Algerian forests, show the need of more detailed studies to assess the factors influencing faunal heterogeneity.

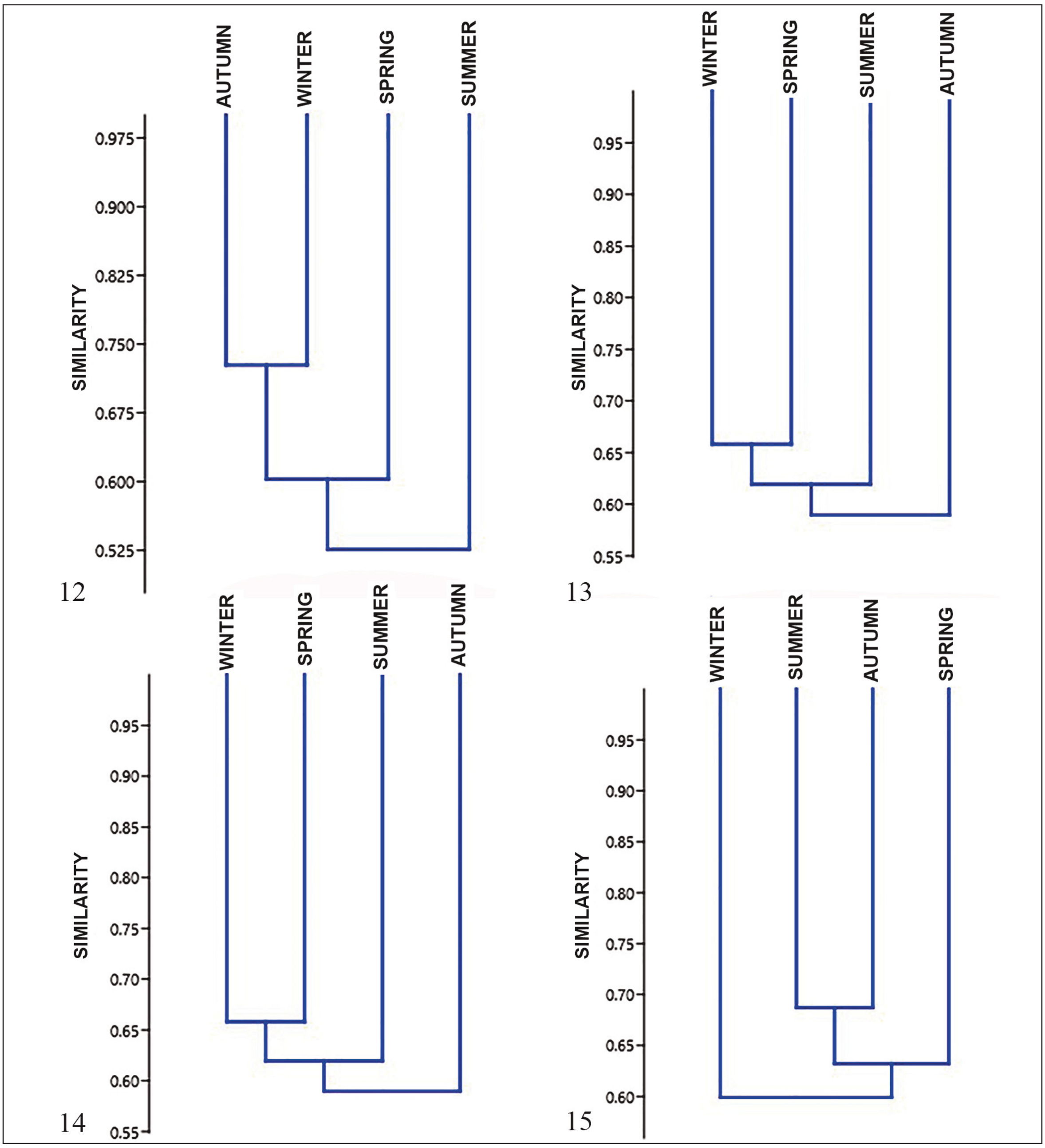
The fallow humid zone

The high species diversity and abundance of this site indicates that there must be a well-developed trophic web able to maintain a rich carabid fauna throughout the whole year. It is well known that a major proportion of ground beetles have hygrophilous preferences (Thiele, 1977) due to a phylogenetic component inherited from the ancestors of the family Carabidae, that are hypothesized to have their origins in the humid tropics (Erwin, 1985). Both generalist and specialized predators may find out suitable conditions in these environments. In this fallow and humid zone, shrubs and weeds also provide resources to phytophagous groups, thus contributing to a developed trophic web.

First evidence of the availability of enough resources is the outbreak of the spring breeders, that may reach notable abundances: *Poecilus purpurascens, Acinopus gutturosus, Chlaenius* Bonelli, 1813 spp., and *Brachinus immaculicornis*. The trapping of many specimens in summer and autumn suggests that favorable trophic conditions and soil moisture are maintained during these seasons, supporting the abundance of both resident predators and species hatching in this season, such as *Carabus* spp., *Poecilus* Bonelli, 1810 spp., *Carterus* spp., *Ophonus* spp., and *Licinus punctatulus*. By winter, active species included *Agonum* Bonelli, 1810 spp., and Lebiini taxa.

Comparison between the results of the humid zone studied here and those reported by Boukli-Hacene et al. (2012), on the salty marshland near the Tafna River (Rachgoun, NW Algeria), is difficult because of the distinct environmental factors characteristic of the sites. Alongside the Tafna River, at least five distinct habitats were identified based on soil salinity, vegetation cover, and inundation regime. The carabid assemblages in these habitats differed significantly between them, likely due to the specific habitat preferences of most species. Only a few species of the genera *Microlestes*, *Syntomus* Hope, 1838, and *Amblystomus* Erichson, 1837 were found in all the five habitats. Seasonal changes were also notable, corresponding with variations in soil moisture and salt content. As expected, the species common to both this site and the humid zone of Mostaganem were generalist hygrophilous predators, often of large size, such as *Carabus morbillosus* and *Broscus politus*.

Results reported by Matallah et al. (2016) on the temporary pond of Dayet El Ferd in south Tlemcen (NW Algeria) are generally similar, as species diversity was also high, with 55 species and 2893 beetles collected after one-year sampling. Faunal similarities are more notable at the tribe and genus



Figures 11–15. Bray-Curtis similarity dendrogram corresponding to comparisons among seasonal assemblages of ground beetles from four sites near Mostaganem (NW Algeria). Fig. 12: Citrus orchard. Fig. 13: Olive grove. Fig. 14: *Eucalyptus* forest. Fig. 15: Humid zone.

levels (Harpalini, Bembidiini, Chlaeniini, etc.), but the most abundant species differed between this site and the fallow humid site of Mostaganem. In Dayet El Ferd, the water is brackish, which explains the presence of halophilous and halobiont taxa from the genera *Calomera* Motschulsky, 1862, *Bembidion*, *Pogonus* Dejean, 1821, and *Harpalus*.

The study carried out by Amri et al. (2019) in the Chott Tinsilt (Oum El Bouraghi, NE Algeria) showed that only the T1 plot, with a high stability in water levels through the year, had a notable carabid assemblage. Despite the chott having salty water, the assemblage was mostly characterized by hygrophilous generalist taxa; the halophiles were only a few Harpalini taxa. Species activity was more intense during November-December and June-July, clearly denoting the abundance of autumn and spring breeders with either winter (from January to May) or summer (August-September) diapause. Shared taxa between this chott and the Mostaganem humid zone were found at the genus level: *Brachinus* spp. and *Chlaenius* spp. However, omnivores as *Acinopus gutturosus* were less abundant in Chott Tinsilt whereas phytophagous Harpalini (*Ophonus* spp.) of Mostaganem were possibly replaced by *Amara (Amathitis) metallescens* (Zimmermann, 1831) in Tinsilt.

Takieddine et al. (2023) found different results in the freshwater Lake Tonga near El-Kala (NE Algeria) after sampling two linear transects with pitfall traps for 22 months. Although precise details of the site were not indicated, the finding of many ripicolous and halophilous taxa clearly shows that sampling was carried out in favorable spots (in terms of vegetation and soil characteristics), which allowed to collect 1727 specimens of 83 species. It is difficult to explain the high abundance of *Nebria andalusia* Rambur, 1837, a forest species proper of North African *Quercus* forests (e.g., Daas et al., 2016).

Faunal differences in species composition between the Algerian water bodies seem to be due to subtle ecological factors, as clearly appreciated in the contiguous assemblages of the River Tafna (Boukli-Hacene et al., 2012). In addition, random dispersal of taxa between these spots, often isolated, should also be considered.

Humid and water bodies studied during the last 20 years in Algeria have proved to harbor a notable species diversity of ground beetles with a fair degree of distinctness between them. These findings show the importance of conserving the humid areas of Algeria, as these are faunistic reservoirs of main interest for both ecological and applied reasons. In the future, non-destructive sampling methods should be performed to preserve as much as possible these valuable insect faunas. To this aim, recommendations as those found in Lövei & Ferrante (2024) should be put in practice in future studies.

CONCLUSIONS

Carabid assemblages in four sites of Mostaganem (Algeria) showed notable seasonal changes due to varying phenology and life cycle of species. Diversity was affected by the occurrence of a few dominant species in each site; it was rather high in a fallow humid zone with stable soil moisture and decreased in cultivated areas. Members of the assemblages inhabiting cultivated sites may play a beneficial role in controlling insect pests. Mediterranean and both hygrophilous and xerophilous taxa were abundant. Comparisons between the studied site were difficult because of the heterogeneity of species composition, and the same was found when comparing with other Algerian sites with water bodies and cultivated sites.

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Table S1. Total captures (general matrix) of ground beetles in a citrus orchard near Mostaganem during 2019-2020 (Spring and Summer).

		Spring						Summer					
Sampling date		7-4	23-4	7-5	20-5	2-6	18-6	8-7	22-7	7-8	22-8	5-9	22-9
Calosoma maderae maderae (Fabricius, 1775)	Calma					1							
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo				1		1						
Notiophilus marginatus Gené, 1839	Nomar		1										
Percus (Percus) lineatus (Solier, 1835)	Perli												
Orthomus (Orthomus) abacoides (Lucas, 1846)	Oraba	1	2	2	4	1						1	
Orthomus (Orthomus) lacouri pupieri Jeanne, 1988	Orlac				1								
Amara (Amara) aenea (DeGeer, 1774)	Amaen	2				2		1					
Amara (Amara) similata (Gyllenhal, 1810)	Amsim	1		2		1							
Amara (Amara) subconvexa Putzeys, 1865	Amsub	3		1	1								
Amara (Celia) fervida fervida Coquerel, 1859	Amfer												
Platyderus (Platyderus) gregarius Reiche, 1862	Plagr	1	1										
Calathus (Bedelinus) circumseptu s Germar, 1827	Calci			5									
Calathus (Calathus) opacus Lucas, 1846	Calop												
Calathus (Neocalathus) melanocephalus antoinei Puel, 1939	Calme		1		1								
Calathus (Neocalathus) mollis atticus Gautier des Cottes, 1867	Calmo		1	1									
Laemostenus (Laemostenus) complanatus (Dejean, 1828)	Laeco				1								
Laemostenus (Laemostenus) terricola terricola (Herbst, 1784)	Later												
Laemostenus (Pristonychus) algerinus algerinus Gory, 1833	Laeal			1		1							
Cryptophonus tenebrosus (Dejean, 1829)	Cryte							1					
Harpalus (Harpalus) attenuatus Stephens, 1828	Harat						1						
Harpalus (Harpalus) distinguendus distinguendus (Duftschmid,1812)	Hardi		1		1	2		3					
Harpalus (Harpalus) oblitus patruelis Dejean, 1829	Harob												1

Ophonus (Ophonus) opacus (Dejean, 1829)	Opopa												1
Pseudoophonus griseus (Panzer, 1796)	Psegr				1	35	9	9	3	3	2	3	17
Pseudoophonus rufipes (DeGeer, 1774)	Pseru				1	6	9	1	5	4	2	2	34
Bradycellus (Bradycellus) verbasci (Duftschmid, 1812)	Brave					1							
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu	4	4	2	4		8	1		1			5
Microlestes abeillei brisouti Holdhaus, 1912	Micab												
Microlestes luctuosus chobauti Jeannel, 1942	Miclu							4	1				
Syntomus fuscomaculatus (Motschulsky, 1844)	Synfu				1								
Masoreus wetterhallii axillaris Kuster, 1852	Maxwe												1

Table S1 (continued). Total captures (general matrix) of ground beetles in a citrus orchard near Mostaganem during 2019-2020 (Autumn and Winter).

		Autumn						Winter					
Sampling date		4-10	19-10	4-11	19-11	4-12	23-12	7-1	22-1	6-2	19-2	4-3	19-3
Calosoma maderae maderae (Fabricius, 1775)	Calma												
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo			6		1	1	1	1				
Notiophilus marginatus Gené, 1839	Nomar												
Percus (Percus) lineatus (Solier, 1835)	Perli						1						
Orthomus (Orthomus) abacoides (Lucas, 1846)	Oraba		1		1	3	5	1		2	2		1
Orthomus (Orthomus) lacouri pupieri Jeanne, 1988	Orlac												
Amara (Amara) aenea (DeGeer, 1774)	Amaen												
Amara (Amara) similata (Gyllenhal, 1810)	Amsim												
Amara (Amara) subconvexa Putzeys, 1865	Amsub												
Amara (Celia) fervida fervida Coquerel, 1859	Amfer					1							
Platyderus (Platyderus) gregarius Reiche, 1862	Plagr					1		1		6			
Calathus (Bedelinus) circumseptus Germar, 1827	Calci			1		3	4			2	1		
Calathus (Calathus) opacus Lucas, 1846	Calop	4	9	3	2					2			
Calathus (Neocalathus) melanocephalus antoinei Puel, 1939	Calme												
Calathus (Neocalathus) mollis atticus Gautier des Cottes, 1867	Calmo					9	13	17		6	1		
Laemostenus (Laemostenus) complanatus (Dejean, 1828)	Laeco												
Laemostenus (Laemostenus) terricola terricola (Herbst, 1784)	Later			3									
Laemostenus (Pristonychus) algerinus algerinus Gory, 1833	Laeal							1					
Cryptophonus tenebrosus (Dejean, 1829)	Cryte						1						
Harpalus (Harpalus) attenuatus Stephens, 1828	Harat												
Harpalus (Harpalus) distinguendus distinguendus (Duftschmid,1812)	Hardi									1	1		
Harpalus (Harpalus) oblitus patruelis Dejean, 1829	Harob												
Ophonus (Ophonus) opacus (Dejean, 1829)	Opopa												
Pseudoophonus griseus (Panzer, 1796)	Psegr	26		7	6					5			
Pseudoophonus rufipes (DeGeer, 1774)	Pseru	47	36	7	9					1			

Bradycellus (Bradycellus) verbasci (Duftschmid, 1812)	Brave										
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu	14	23	20	24	57	32	60	13	4	5
Microlestes abeillei brisouti Holdhaus, 1912	Micab							2			
Microlestes luctuosus chobaut i Jeannel, 1942	Miclu								1		
Syntomus fuscomaculatus (Motschulsky, 1844)	Synfu										
Masoreus wetterhallii axillaris Kuster, 1852	Maxwe										

Table S2. Total captures (general matrix) of ground beetles in a olive grove near Mostaganem during 2019-2020 (Spring and Summer).

		Spring						Summer					
Sampling date		11-4	20-4	4-5	18-5	1-6	20-6	6-7	20-7	6-8	21-8	5-9	19-9
Carabus (Eurycarabus) faminii numidus Laporte, 1834	Carfa		1										
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo												
Notiophilus marginatus Gené, 1839	Notma	1			1								
Notiophilus substriatus G.R. Waterhouse, 1833	Notsu												
Broscus (Broscus) politus (Dejean, 1828)	Bropo												
Bembidion (Emphanes) axillare occiduum Marggi & Huber, 2001	Bemax	10	1	1									
Bembidion (Neja) ambiguum Dejean, 1831	Bemam	5	3	2									
Percus (Percus) lineatus (Solier, 1835)	Perli	1	1	1									
Orthomus (Orthomus) abacoides (Lucas, 1846)	Oraba	47	54	117	103	65	48	9		3		0	7
Orthomus (Orthomus) rubicundus (Coquerel, 1859)	Orrub	1	1										
Poecilus (Poecilus) lucasii (Reiche, 1861)	Poluc						1						
Amara (Amara) anthobia A. Villa & G.B. Villa, 1833	Amant	2											
Amara (Celia) fervida fervida Coquerel, 1859	Amfer	6	3										
Olisthopus elongatus Wollaston, 1854	Oliel			1	1								
Platyderus (Platyderus) gregarius Reiche, 1862	Plagr												
Calathus (Bedelinus) circumseptus Germar, 1827	Calci			3	1								
Calathus (Calathus) fuscipes algiricus Gautier des Cottes, 1866	Calfu			1									
Calathus (Calathus) opacus Lucas, 1846	Calop			1									1
Calathus (Neocalathus) mollis atticus Gautier des Cottes, 1867	Calmo	4		1									
Laemostenus (Pristonychus) algerinus algerinus Gory, 1833	Laeal			2		1							
Cryptophonus tenebrosus (Dejean, 1829)	Cryte												
Harpalus (Harpalus) attenuatus Stephens, 1828	Harat										1		
Harpalus (Harpalus) distinguendus distinguendus (Duftschmid,1812)	Hardi	1		1		2							
Pseudoophonus rufipes (DeGeer, 1774)	Prufi				4								
Bradycellus (Bradycellus) sharpi Joy, 1912	Brash	3	2										
Bradycellus (Bradycellus) verbasci (Duftschmid, 1812)	Brave	2											
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu	4	24		4	1	1						
Chlaenius (Chlaeniostenodes) canariensis seminitidus Chaudoir, 1856	Chlca	2											

Cymindis (Cymindis) setifeensis leucophthalma Lucas, 1842	Cymse				
Microlestes abeillei brisouti Holdhaus, 1912	Micab				
Microlestes luctuosus chobauti Jeannel, 1942	Miclu	4	5	4	
Syntomus fuscomaculatus (Motschulsky, 1844)	Synfu		3	1	
Dromius (Dromius) meridionalis Dejean, 1825	Drome	1			
Masoreus wetterhallii axillaris Kuster, 1852	Maswe		2		1

Table S2. Total captures (general matrix) of ground beetles in a olive grove near Mostaganem during 2019-2020 (Autumn and Winter).

		Autumn					Winter					
Sampling date		19-10	4-11	19-11	4-12	23-12	7-1	23-1	5-2	19-2	4-3	19-3
Carabus (Eurycarabus) faminii numidus Laporte, 1834	Carfa			1								
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo								1			
Notiophilus marginatus Gené, 1839	Notma								1	1		
Notiophilus substriatus G.R. Waterhouse, 1833	Notsu		1									
Broscus (Broscus) politus (Dejean, 1828)	Bropo		9			1						
Bembidion (Emphanes) axillare occiduum Marggi & Huber, 2001	Bemax											
Bembidion (Neja) ambiguum Dejean, 1831	Bemam				3	5			2	2		1
Percus (Percus) lineatus (Solier, 1835)	Perli											
Orthomus (Orthomus) abacoides (Lucas, 1846)	Oraba	7	216	53	71	64	50	17	15	12	1	15
Orthomus (Orthomus) rubicundus (Coquerel, 1859)	Orrub											
Poecilus (Poecilus) lucasii (Reiche, 1861)	Poluc								1			
Amara (Amara) anthobia A. Villa & G.B. Villa, 1833	Amant											
Amara (Celia) fervida fervida Coquerel, 1859	Amfer			1	1		1					
Olisthopus elongatus Wollaston, 1854	Oliel											
Platyderus (Platyderus) gregarius Reiche, 1862	Plagr						1					
Calathus (Bedelinus) circumseptus Germar, 1827	Calci		2	1	1	1	1					
Calathus (Calathus) fuscipes algiricus Gautier des Cottes, 1866	Calfu											
Calathus (Calathus) opacus Lucas, 1846	Calop	3	2									
Calathus (Neocalathus) mollis atticus Gautier des Cottes, 1867	Calmo		2				2		1			
Laemostenus (Pristonychus) algerinus algerinus Gory, 1833	Laeal		4	1	1		1					
Cryptophonus tenebrosus (Dejean, 1829)	Cryte		1									
Harpalus (Harpalus) attenuatus Stephens, 1828	Harat		2									
Harpalus (Harpalus) distinguendus distinguendus (Duftschmid,1812)	Hardi						1				2	1
Pseudoophonus rufipes (DeGeer, 1774)	Prufi											
Bradycellus (Bradycellus) sharpi Joy, 1912	Brash											
Bradycellus (Bradycellus) verbasci (Duftschmid, 1812)	Brave											
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu		3	4	7	11	5			1	7	6
Chlaenius (Chlaeniostenodes) canariensis seminitidus Chaudoir, 1856	Chlca											
Cymindis (Cymindis) setifeensis leucophthalma Lucas, 1842	Cymse						1					

Microlestes abeillei brisouti Holdhaus, 1912	Micab		1
Microlestes luctuosus chobauti Jeannel, 1942	Miclu	2	3
Syntomus fuscomaculatus (Motschulsky, 1844)	Synfu		
Dromius (Dromius) meridionalis Dejean, 1825	Drome		
Masoreus wetterhallii axillaris Kuster, 1852	Maswe		

Table S3. Total captures (general matrix) of ground beetles in a *Eucalyptus* forest near Mostaganem during 2019-2020 (Spring and Summer).

		Spring						Summer				
Date of sampling		12-4	24-4	4-5	19-5	1-6	20-6	7-7	20-7	6-8	21-8	19-9
Carabus (Eurycarabus) faminii numidus Laporte, 1834	Carfa	7	1	2								
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo											
Notiophilus marginatus Gené, 1839	Nomar											
Scarites (Scallophorites) buparius (Forster, 1771)	Scabu											
Bembidion (Neja) ambiguum Dejean, 1831	Bemam	1										
Poecilus (Poecilus) lucasii (Reiche, 1861)	Poluc	1				1	1					
Amara (Amara) aenea (DeGeer, 1774)	Amaen	1				2			1			
Amara (Amara) subconvexa Putzeys, 1865	Amsub	1										
Platyderus (Eremoderus) insignitus insignitus Bedel, 1902	Plain				1							
Platyderus (Platyderus) gregarius Reiche, 1862	Plagr	3	1	2								
Calathus (Bedelinus) circumseptus Germar, 1827	Calci											
Calathus (Calathus) opacu s Lucas, 1846	Calop	4	19	9	1	1	1					2
Calathus (Neocalathus) mollis atticu s Gautier des Cottes, 1867	Calmo		1		1							
Laemostenus (Pristonychus) algerinus algerinus Gory, 1833	Laeal	3										
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu											
Graphipterus exclamationis exclamationis (Fabricius, 1792)	Graex		1	1	4							
Graphipterus luctuosus Dejean, 1825	Gralu		1		7	6	5		12		1	
Graphipterus peletieri Laporte de Castelnau, 1840	Grape											
Graphipterus rotundatus Klug, 1832	Graro	3	2	3	2	2	1					
Cymindis (Cymindis) setifeensis leucophthalma Lucas, 1842	Cymse	2		4						1	1	
Syntomus fuscomaculatus (Motschulsky, 1844)	Synfu								1		1	
Masoreus wetterhallii axillaris Kuster, 1852	Maswe											

Table S3 (continued). Total captures (general matrix) of ground beetles in a *Eucalyptus* forest near Mostaganem during 2019-2020 (Autumn and Winter).

		Autumn						Winter					
Date of sampling		4-10	19-10	4-11	19-11	4-12	23-12	7-1	23-1	5-2	20-2	8-3	19-3
Carabus (Eurycarabus) faminii numidus Laporte, 1834	Carfa			3	2	6	6	5	4		1	1	3
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo						1	1			2		
Notiophilus marginatus Gené, 1839	Nomar	1											
Scarites (Scallophorites) buparius (Forster, 1771)	Scabu			5			1	2			1		
Bembidion (Neja) ambiguum Dejean, 1831	Bemam												
Poecilus (Poecilus) lucasii (Reiche, 1861)	Poluc												
Amara (Amara) aenea (DeGeer, 1774)	Amaen												
Amara (Amara) subconvexa Putzeys, 1865	Amsub												
Platyderus (Eremoderus) insignitus insignitus Bedel, 1902	Plain												
Platyderus (Platyderus) gregarius Reiche, 1862	Plagr				2	1		1	6	12	5		4
Calathus (Bedelinus) circumseptus Germar, 1827	Calci								1				
*Calathus (Calathus) opacu*s Lucas, 1846	Calop	12	28	7	7	3							
*Calathus (Neocalathus) mollis atticu*s Gautier des Cottes, 1867	Calmo							2	4	4		1	
Laemostenus (Pristonychus) algerinus algerinus Gory, 1833	Laeal												
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu								7				
Graphipterus exclamationis exclamationis (Fabricius, 1792)	Graex												
Graphipterus luctuosus Dejean, 1825	Gralu										1	1	
Graphipterus peletieri Laporte de Castelnau, 1840	Grape												1
Graphipterus rotundatus Klug, 1832	Graro											1	
Cymindis (Cymindis) setifeensis leucophthalma Lucas, 1842	Cymse								1	1	3	2	1
Syntomus fuscomaculatus (Motschulsky, 1844)	Synfu	1											
Masoreus wetterhallii axillaris Kuster, 1852	Maswe	1											

Table S4. Total captures (general matrix) of ground beetles in a wetland near Mostaganem during 2019-2020 (Spring and Summer).

		Spring						Summer					
Date of sampling		11-4	20-4	4-5	18-5	1-6	20-6	6-7	20-7	6-8	21-8	5-9	19-9
Carabus (Eurycarabus) faminii numidus Laporte, 1834	Carfa	2	2	1									
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo	32	15	11	7	15	5						1
Notiophilus germiny i Fauvel, 1863 (hypocrita Puel, 1938)	Noger												
Distichus (Distichus) planus (Bonelli, 1813)	Dipla		5	1	7	3	1	7	2	7	4		
Siagona europaea europaea Dejean, 1826	Sieur			1	1		1	2		2			3
Siagona jenissoni Dejean, 1826	Sijen							1					
Siagona rufipes (Fabricius, 1792)	Siruf		3	4	3	1	1	1					2
Apotomus rufus (Rossi, 1790)	Aporu	1		1			2						
Trechus (Calotrechus) rufulus Dejean, 1831	Treru												
Bembidion (Philochthus) iricolor Bedel, 1879	Bemir												
Bembidion (Philochthus) vicinum Lucas, 1846	Bemvi			1									
Bembidion (Phyla) rectangulum Jacquelin du Val, 1852	Phyre				2				1				
Orthomus (Orthomus) abacoides (Lucas, 1846)	Oraba	1		2									
Orthomus (Orthomus) rubicundus (Coquerel, 1859)	Orrub												
Poecilus (Ancholeus) gisellae gisellae Csiki, 1930	Pogis	3	1	1		1							
Poecilus (Carenostylus) purpurascens purpurascens (Dejean, 1828)	Popur	67	4	58	23	6	26	36	6	2			3
Poecilus (Poecilus) lucasii (Reiche, 1861)	Poluc		1	1									
Poecilus (Poecilus) quadricollis (Dejean, 1828)	Poqua	26	3	2	2	2	3		1				
Amara (Acorius) metallescens (Zimmermann, 1831)	Ammet												
Amara (Amara) aenea (DeGeer, 1774)	Amaen	1											
Amara (Amathitis) rufescens shismatica Antoine, 1957	Amant	1											
Amara (Celia) sollicita Pantel, 1888	Amsoc												
Agonum (Agonum) nigrum Dejean, 1828	Agnig							1	1				
Agonum (Olisares) lugens (Duftschmid, 1812)	Aglug												
Olisthopus fuscatus Dejean, 1828	Olfus												
Olisthopus elongatus Wollaston, 1854	Olelo												

Platyderus (Eremoderus) insignitus insignitus Bedel, 1902	Plain		1										
Calathus (Bedelinus) circumseptus Germar, 1827	Calci	6	4	3	3	1	2						
Laemostenus (Pristonychus) terricola terricola (Herbst, 1784)	Later												
Gynandromorphus etruscus (Quensel, 1806)	Gynet												
Carterus (Carterus) dama (Rossi, 1792)	Cadam	2	5	2	3	6	8	3	8	12	14	4	20
Carterus (Carterus) gilvipes (Piochard de la Brulerie, 1873)	Cagil												
Carterus (Carterus) rotundicollis Rambur, 1837	Carot		1	1	1		2						
Carterus (Microcarterus) gracilis Rambur, 1837	Cagra						1						
Carterus (Microcarterus) microcephalus Rambur, 1837	Camic		1		1	2	2	1	1	1	1		
Ditomus tricuspidatus (Fabricius, 1792)	Ditri					2		2	2	4	2	5	2
Dixus sphaerocephalus (Olivier, 1795)	Disph	1	2	1	11	5	3	5	7	2			
Acinopus (Acmastes) haroldii (Schaum, 1863)	Aciha						1						
Acinopus (Oedematicus) gutturosus Buquet, 1840	Acigu	1	2	9	56	292	262	184	44	28	31	46	62
Scybalicus oblongiusculus (Dejean, 1829)	Scyob												
Harpalus (Harpalus) attenuatus Stephens, 1828	Harat	1				1	2						3
Harpalus (Harpalus) distinguendus distinguendus (Duftschmid,1812)	Hardi	2											
Harpalus (Harpalus) siculus Dejean, 1829	Harsi	2	3										
Ophonus (Metophonus) rufibarbis (Fabricius, 1792)	Opruf								1	2			
Ophonus (Metophonus) subsinuatus Rey, 1886	Opsub				2	4	2			1		24	4
Ophonus (Ophonus) ardosiacus (Lutshnik, 1922)	Opard	1				1		1	1	1		1	26
Ophonus (Ophonus) diffinis (Dejean, 1829)	Opdif	1		1	3		8	1		1	3	1	45
Ophonus (Ophonus) opacus (Dejean, 1829)	Opopa	2	1	3	16	51	38	43	4	2	15	52	99
Parophonus (Parophonus) hispanus (Rambur,1838)	Parhi					1							
Pseudoophonus rufipes (DeGeer, 1774)	Pseur												
Bradycellus (Bradycellus) distinctus (Dejean, 1829)	Bradi												
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu		1		1	1	2			1			
Chlaenius (Chlaeniostenodes) canariensis seminitidus Chaudoir, 1856	Chlca	5	10	3	10	2	4	10	4	2	2	1	
Chlaenius (Chlaenius) festivus velutinus (Duftschmid, 1812)	Chlfe	2	1	5	3								

Chlaenius (Dinodes) decipiens (Dufour, 1820)	Chlde		1		1	2	4	1	2	2		1	1
Chlaenius (Trichochlaenius) aeratus (Quensel, 1806)	Chlae	30		9			1						
Chlaenius (Trichochlaenius) chrysocephalus (Rossi, 1790)	Chlch	1	1	6	2	4	2	2	2	3			
Graphipterus peletieri Laporte, 1840	Grape	3											
Platytarus faminii faminii (Dejean, 1826)	Plafa				1						1		
Platytarus gracilis gracilis (Dejean, 1831)	Plagr									1			
Microlestes abeillei brisouti Holdhaus, 1912	Miabe								1				
Microlestes levipennis levipennis (Lucas, 1846)	Milev	5		1				5	1				
Microlestes luctuosus chobauti Jeannel, 1942	Miluc	1			1	2	7		1				
Microlestes mauritanicus Lucas, 1846	Mimar												
Microlestes negrita negrita (Wollaston, 1854)	Mineg	1			1								
Syntomus barbaru s (Puel, 1938)	Synba	2											
Syntomus bedeli (Puel, 1924)	Synbe	1											
Syntomus foveatus (Geoffroy, 1785)	Synfv						1						
Syntomus impressus impressus Dejean, 1825	Synim							2	3				
Syntomus montanus (Bedel, 1913)	Synmo		1										
Syntomus obscuroguttatus (Duftschmid, 1812)	Synob	1		1									
Syntomus pallipes (Dejean, 1825)	Synpa	1		2	1			2	5			3	
Paradromius linearis (Olivier, 1795)	Parli												
Drypta (Deserida) distinct a (Rossi, 1792)	Drydi				1								
Drypta (Drypta) dentata (Rossi, 1790)	Dryde		2	2									
Zuphium olens (Rossi, 1790)	Zuole				1		1						
Brachinus (Brachinus) efflans Dejean, 1830	Braef			2									
Brachinus (Brachinus) elegans Chaudoir, 1842	Brael		1										
Brachinus (Brachynolomus) immaculicornis Dejean, 1826	Braim		3	51	39	84	15	22	24	1		1	
Brachinus (Dysbrachinus) humeralis Ahrens, 1812	Brahu			1									

Table S4 (continued). Total captures (general matrix) of ground beetles in a wetland near Mostaganem during 2019-2020 (Autumn and Winter).

		Autumn						Winter					
Date of sampling		4-10	19-10	4-11	19-11	4-12	23-12	7-1	22-1	5-2	19-2	4-3	19-3
Carabus (Eurycarabus) faminii numidus Laporte, 1834	Carfa			1	1	1	1	1		1	1		
Carabus (Macrothorax) morbillosus morbillosus Fabricius, 1792	Carmo	5	1	47	19	24	18	13	19	17	20	7	3
Notiophilus germiny i Fauvel, 1863 (hypocrita Puel, 1938)	Noger												
Distichus (Distichus) planus (Bonelli, 1813)	Dipla			1									
Siagona europaea europaea Dejean, 1826	Sieur												
Siagona jenissoni Dejean, 1826	Sijen												
Siagona rufipes (Fabricius, 1792)	Siruf				3								
Apotomus rufus (Rossi, 1790)	Aporu												
Trechus (Calotrechus) rufulus Dejean, 1831	Treru									1			
Bembidion (Philochthus) iricolor Bedel, 1879	Bemir							1					
Bembidion (Philochthus) vicinum Lucas, 1846	Bemvi									1			
Bembidion (Phyla) rectangulum Jacquelin du Val, 1852	Phyre			1									
Orthomus (Orthomus) abacoides (Lucas, 1846)	Oraba												
Orthomus (Orthomus) rubicundus (Coquerel, 1859)	Orrub											2	
Poecilus (Ancholeus) gisellae gisella e Csiki, 1930	Pogis									1			
Poecilus (Carenostylus) purpurascens purpurascens (Dejean, 1828)	Popur	23	1	7	28	17	12	3		22	23	26	35
Poecilus (Poecilus) lucasii (Reiche, 1861)	Poluc												
Poecilus (Poecilus) quadricollis (Dejean, 1828)	Poqua												15
Amara (Acorius) metallescens (Zimmermann, 1831)	Ammet					1							
Amara (Amara) aenea (DeGeer, 1774)	Amaen												
Amara (Amathitis) rufescens shismatica Antoine, 1957	Amant			1	2								
Amara (Celia) sollicita Pantel, 1888	Amsoc			3									
Agonum (Agonum) nigrum Dejean, 1828	Agnig						3	7			3		
Agonum (Olisares) lugens (Duftschmid, 1812)	Aglug						1		2	7		2	
Olisthopus fuscatus Dejean, 1828	Olfus			1									
Olisthopus elongatus Wollaston, 1854	Olelo									2	1		
Platyderus (Eremoderus) insignitus insignitus Bedel, 1902	Plain												
Calathus (Bedelinus) circumseptus Germar, 1827	Calci			2	27	8	5	5	9	7	1		
Laemostenus (Pristonychus) terricola terricola (Herbst, 1784)	Later					2							

Gynandromorphus etruscus (Quensel, 1806)	Gynet					1							
Carterus (Carterus) dama (Rossi, 1792)	Cadam	8	1	5	8					1			
Carterus (Carterus) gilvipes (Piochard de la Brulerie, 1873)	Cagil		1										
Carterus (Carterus) rotundicollis Rambur, 1837	Carot												
Carterus (Microcarterus) gracilis Rambur, 1837	Cagra			4		1							
Carterus (Microcarterus) microcephalus Rambur, 1837	Camic	2	3		1								
Ditomus tricuspidatus (Fabricius, 1792)	Ditri												
Dixus sphaerocephalus (Olivier, 1795)	Disph												
Acinopus (Acmastes) haroldii (Schaum, 1863)	Aciha												
Acinopus (Oedematicus) gutturosus Buquet, 1840	Acigu	18	3	4	7			1			2		
Scybalicus oblongiusculus (Dejean, 1829)	Scyob			1									
Harpalus (Harpalus) attenuatus Stephens, 1828	Harat	4		3	2	2							
Harpalus (Harpalus) distinguendus distinguendus (Duftschmid,1812)	Hardi									1			
Harpalus (Harpalus) siculus Dejean, 1829	Harsi			1							1		
Ophonus (Metophonus) rufibarbis (Fabricius, 1792)	Opruf												
Ophonus (Metophonus) subsinuatus Rey, 1886	Opsub	4			4	3							
Ophonus (Ophonus) ardosiacus (Lutshnik, 1922)	Opard	11	38	15	7	7	3	3		1	1		
Ophonus (Ophonus) diffinis (Dejean, 1829)	Opdif	1		28	3	5	2	3	1				
Ophonus (Ophonus) opacus (Dejean, 1829)	Opopa	166	52	104	129	13	4		2	8			
Parophonus (Parophonus) hispanus (Rambur,1838)	Parhi												
Pseudoophonus rufipes (DeGeer, 1774)	Pseur			1									
Bradycellus (Bradycellus) distinctus (Dejean, 1829)	Bradi							1					
Licinus (Licinus) punctatulus punctatulus (Fabricius, 1792)	Licpu		2	44	37	54	65	45	41	34	29	3	
Chlaenius (Chlaeniostenodes) canariensis seminitidus Chaudoir, 1856	Chlca			3					3	10			2
Chlaenius (Chlaenius) festivus velutinus (Duftschmid, 1812)	Chlfe												
Chlaenius (Dinodes) decipiens (Dufour, 1820)	Chlde	7		1	2								
Chlaenius (Trichochlaenius) aeratus (Quensel, 1806)	Chlae			1	3	1	2			16	8	21	23
Chlaenius (Trichochlaenius) chrysocephalus (Rossi, 1790)	Chlch						1	1		3		8	3
Graphipterus peletieri Laporte, 1840	Grape												
Platytarus faminii faminii (Dejean, 1826)	Plafa												

Platytarus gracilis gracilis (Dejean, 1831)	Plagr											
Microlestes abeillei brisouti Holdhaus, 1912	Miabe								1			
Microlestes levipennis levipennis (Lucas, 1846)	Milev			5	2	2				4	3	2
Microlestes luctuosus chobauti Jeannel, 1942	Miluc	1	1							2		
Microlestes mauritanicus Lucas, 1846	Mimar								10			
Microlestes negrita negrita (Wollaston, 1854)	Mineg											
Syntomus barbaru s (Puel, 1938)	Synba											
Syntomus bedeli (Puel, 1924)	Synbe											
Syntomus foveatus (Geoffroy, 1785)	Synfv											
Syntomus impressus impressus Dejean, 1825	Synim									4		
Syntomus montanus (Bedel, 1913)	Synmo											
Syntomus obscuroguttatus (Duftschmid, 1812)	Synob											
Syntomus pallipes (Dejean, 1825)	Synpa		2	1	1				9	4	2	1
Paradromius linearis (Olivier, 1795)	Parli									1		
Drypta (Deserida) distinct a (Rossi, 1792)	Drydi											
Drypta (Drypta) dentata (Rossi, 1790)	Dryde							1				
Zuphium olens (Rossi, 1790)	Zuole											
Brachinus (Brachinus) efflans Dejean, 1830	Braef											
Brachinus (Brachinus) elegans Chaudoir, 1842	Brael											
Brachinus (Brachynolomus) immaculicornis Dejean, 1826	Braim	3		6	12	3	1	1		4	2	
Brachinus (Dysbrachinus) humeralis Ahrens, 1812	Brahu											