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RESEARCH ARTICLE

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Contributions to the Aphodiinae (Coleoptera-Scarabaeidae) fauna of the Eskişehir Bozdağ

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Abstract

Insects are amazing creatures used to determine the biodiversity of terrestrial ecosystems. It is well known that the order Coleoptera, which includes dung beetles, has a wide variety of species. Thus, depending on the three elevations of the Eskişehir Bozdağ region, the fauna of the subfamily Aphodiinae was studied in this study. As a result, this study included 14 species and 3 subspecies from 12 genera that are members of the Scarabaeidae subfamily Aphodiinae. The first records for the province of Eskişehir are *Volinus sticticus* (Panzer 1798), *Esymus pusillus pusillus* (Herbst, 1789), *Nimbus johnsoni* (Baraud, 1976), and *Euorodalus paracoenosus* (Balthasar & Hrubant 1960). Furthermore, three new species have been recorded for the Central Anatolia Region: *Nimbus johnsoni* (Baraud, 1976), *Esymus pusillus pusillus* (Herbst, 1789), and *Volinus sticticus* (Panzer, 1798).

Keywords: Aphodiinae; Dung beetles; Eskişehir; Fauna; Scarabaeidae; Turkey.

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1. Introduction

Scarabaeidae has twelve subfamilies, according to Löbl and Löbl, 2016 [1], the Catalogue of Palaearctic Coleoptera. The Scarabaeinae and Aphodiinae subfamilies are the largest. The Aphodiinae subfamily, known as small dung beetles, is represented by 2.204 species and 98 subspecies of about 258 genera worldwide [2]. In addition, this subfamily is distributed in the Palaearctic region, with 1.084 species belonging to 155 genera in 6 tribes [3, 4, 5]. Also, in Turkey, 152 species and four subspecies belong to 45 genera in this subfamily, with the new genus published by Şenyüz (2017) [4]. The Aphodiinae subfamily, spread worldwide, is the dominant species group in scarab communities in the Palearctic region [6, 7]. Most of the species from these subfamilies show special morphological, behavioral, and ecological adaptations to the consumption of mammal (mainly herbivore) feces [8].

Many studies have understood that dung removed and buried by dung beetles has many ecological benefits. The most important of these are soil fertilization and aeration, improvement of the nutritional cycle, intake of nutrients by plants, increased meadow quality, intestinal parasites [12, 13, 14, 15, 16] and biological control of harmful flies [9], increasing plant yield [10], soil bioperturbation, and pollination [11, 22] Due to their mentioned ecological niches, these insects have been proposed as an ideal group for biodiversity inventories and imaging [9, 17, 18].

This study aims to determine the 12-month seasonal activities of species belonging to the Aphodiinae subfamily at different altitudes. As a result of the study, both the seasonal and altitude preferences of these species will be determined.

2. Materials and Methods

This study was done from October 2012 to September 2013 in Bozdağ region at Eskişehir. The specimens were collected at three different localities (Table 1 and Figure 1) at altitudes varying between 207 to 1133 m. from October 2012 to September 2013, dung baited pitfall traps [19] were placed at each locality, and fresh cattle dung ($\approx$ 1000 g) was used as forage for each trap. All the pitfall traps remained in the field for 72 hours. The collected samples were brought to the laboratory with jars with ethyl alcohol. In the laboratory, the dung beetle specimens were identified using Zeiss Stemi 2000 stereomicroscope following the -identification keys of Dellacasa et al., 2001 [20] and Baraud J. (1976) [21]. Turkey distribution data of the species belonging to the studied subfamily were obtained. [23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54].

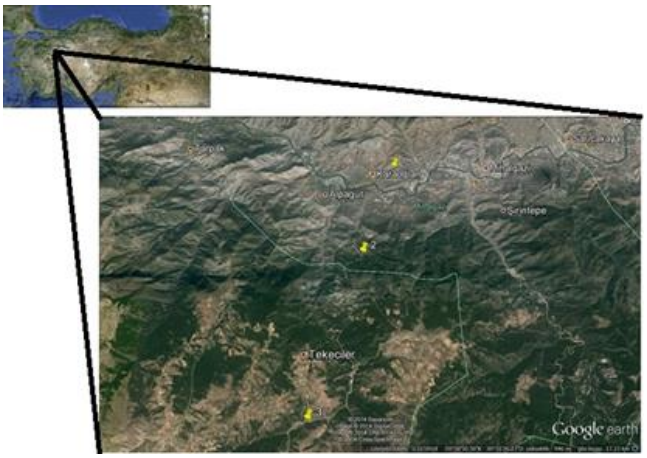

Fig. 1. Map of Locaiton.

Table 1. Data of locations of the study area.

Location	Latitude	Longitude	Elevation (m)
Karaoğlan-Mihalgazi	40˚01'.334"	30˚32'.019"	207 m.
Kalekaya Top- Erenler Site	39˚59'.569"	30˚31'.186"	612 m.
Sulukaraağaç Site	39˚56'.159"	30˚29'.590"	1133 m.

3. Result

Family SCARABAEIDAE Latreille, 1802

Subfamily APHODIINAE Leach, 1815

Tribe APHODIINI Leach, 1815

Genus *Aphodius* Hellwig, 1798: 101

Aphodius fimetarius (Linnaeus, 1758)

Material examined: Karaoğlan-Mihalgazi, 207 m., 22-25.I.2013, Gülmez M. leg. and det., 1 ex.; 16-19.V.2013, Gülmez M. leg. and det., 1 ex.; Kalekaya Top-Erenler Site 612 m., 17-20.XI.2012, Gülmez M. leg. and det., 1 ex.; 16-19.V.2013, Gülmez M. leg. and det., 1 ex.; Sulukaraağaç Site, 1133 m., 18-21.VII.2013, Gülmez M. leg. and det., 1 ex.

Distribution in Turkey: It is widespread in all geographical regions [23, 27, 32, 33, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 48, 51, 52, 54].

Genus *Volinus* Mulsant & Rey, 1870c: 537

Volinus sticticus (Panzer 1798)

Material examined: Sulukaraağaç Site, 1133 m., 17-20.XI.2012, Gülmez M. leg. and det., 1 ex., 16-19.V.2013, Gülmez M. leg. and det., 2 exx.

Distribution in Turkey: It is distributed only in the Marmara Region [36, 41].

Genus *Acrossus* Mulsant, 1842: 269

Acrossus luridus (Fabricius, 1775)

Material examined: Sulukaraağaç Site, 1133 m., 16-19.V.2013 Gülmez M. leg. and det., 1 ex.

Distribution in Turkey: It is widespread in all geographical regions [23, 28, 32, 33, 35, 36, 37, 38, 39, 40, 41, 42, 45, 46, 48, 51].

Genus *Bodilus* Mulsant & Rey, 1870c: 518

Bodilus lugens (Creutzer, 1799)

Material examined: Karaoğlan-Mihalgazi, 207 m., 17-20.XI.2012, Gülmez M. leg. and det., 1 ex.; Kalekaya Top-Erenler Site 612 m., 18-21.VII.2013, Gülmez M. leg. and det., 1 ex.

Distribution in Turkey: It is distributed in all geographical regions [23, 28, 32, 35, 36, 38, 45, 48, 52].

Bodilus ictericus (Laicharting 1781)

Bodilus ictericus ictericus (Laicharting 1781)

Material examined: Kalekaya Top-Erenler Site 612 m., 17-20.XI.2012, Gülmez M. leg. and det., 1 ex.; Sulukaraağaç Site, 1133 m., 17-20.VI.2013, Gülmez M. leg. and det., 6 exx.; Sulukaraağaç Site, 1133 m., 18-21.VII.2013, Gülmez M. leg. and det., 1 ex., 17-20.VIII.2013, Gülmez M. leg. and det., 1 ex.

Distribution in Turkey: It is spread in Marmara, Aegean, and Central Anatolia Region [23, 32, 36, 48, 54].

Genus *Colobopterus* Mulsant, 1842: 165

Colobopterus erraticus Linnaeus, 1758

Material examined: Karaoğlan-Mihalgazi, 207 m., 16-19.V.2013, Gülmez M. leg. and det., 2 exx.; Sulukaraağaç Site, 1133 m., 16-19.V.2013, Gülmez M. leg. and det., 1 ex., 17-20.VI.2013, Gülmez M. leg. and det., 1 ex.; 18-21.VII.2013, Gülmez M. leg. and det., 1 ex.

Distribution in Turkey: It is widespread in all geographical regions [17, 23, 25, 28, 29, 32, 33, 35, 36, 37, 38, 39, 40, 41, 42, 45, 48, 53, 54].

Genus *Esymus* Mulsant & Rey, 1870c: 519

Esymus pusillus (Herbst, 1789)

Esymus pusillus pusillus (Herbst, 1789)

Material examined: Sulukaraağaç Site, 1133 m., 17-20.XI.2012, Gülmez M. leg. and det., 1 ex.; 17-20.IV.2013, Gülmez M. leg. and det., 7 exx.; 16-19.V.2013, Gülmez M. leg. and det., 9 exx.; 17-20.VI.2013, Gülmez M. leg. and det., 1 ex.

Distribution in Turkey: It is distributed in Marmara, Aegean, Blac Sea, and Eastern Anatolia Region [32, 36, 44, 45, 51].

Genus *Eudolus* Mulsant & Rey, 1870

Eudolus quadriguttatus (Herbst, 1783)

Material examined: Kalekaya Top-Erenler Site 612 m., 17-20.IV.2013, Gülmez M. leg. and det., 1 ex.; 17-20.IV.2013, Gülmez M. leg. and det. 1 ex.; 17-20.IV.2013, Gülmez M. leg. and det., 1 ex.

Distribution in Turkey: It is distributed in all geographical regions [28, 32, 33, 36, 37, 38, 39, 40, 42, 45, 52, 54].

Genus *Melinopterus* Mulsant, 1842

Melinopterus consputus (Creutzer, 1799)

Material examined: Karaoğlan-Mihalgazi, 207 m., 15-18.II.2013, Gülmez M. leg. and det., 1 ex.; Kalekaya Top-Erenler Site 612 m., 22-25.I.2013, Gülmez M. leg. and det., 13 exx.

Distribution in Turkey: It is spread in all geographical regions, except the Black Sea and Eastern Anatolia Region [23, 32, 33, 38, 48].

Melinopterus prodromus (Brahm, 1790)

Material examined: Karaoğlan-Mihalgazi, 207 m., 22-25.I.2013, Gülmez M. leg. and det., 18 exx.; Kalekaya Top-Erenler Site 612 m., 17-20.XI.2012, Gülmez M. leg. and det., 1 ex.; 22-25.I.2013, Gülmez M. leg. and det., 27 exx.; 15-18.II.2013, Gülmez M. leg. and det., 1 ex.; 17-20.IV.2013, Gülmez M. leg. and det., 1 ex.; Sulukaraağaç Site, 1133 m., 22-25.I.2013, Gülmez M. leg. and det., 2 exx.; 16-19.III.2013, Gülmez M. leg. and det., 6 exx.

Distribution in Turkey: It is distributed in all geographical regions [23, 28, 32, 33, 36, 38, 40, 41, 45, 48, 52].

Melinopterus pubescens (Sturm, 1800)

Material examined: Karaoğlan-Mihalgazi, 207 m., 22-25.I.2013, Gülmez M. leg. and det., 1 ex.

Distribution in Turkey: It is widespread in all geographical regions in our country, except Marmara and Eastern Anatolia Region [17, 23, 28, 33, 36, 38, 48].

Genus *Nimbus* Mulsant & Rey, 1870c: 578

Nimbus johnsoni (Baraud, 1976)

Material examined: Karaoğlan-Mihalgazi, 207 m., 22-25.I.2013, Gülmez M. leg. and det., 1 ex.; Kalekaya Top-Erenler Site 612 m., 17-20.XI.2012, Gülmez M. leg. and det., 3 exx.; 22-25.I.2013, Gülmez M. leg. and det., 78 exx.; 16-19.III.2013, Gülmez M. leg. and det. 1 ex.; Sulukaraağaç Site, 1133 m., 19-22.X.2012, Gülmez M. leg. and det. 1 ex.; 17-20.XI.2012; Gülmez M. leg. and det. 1 ex.; 13-16.XII.2012, Gülmez M. leg. and det. 4 exx.; 22-25.I.2013, Gülmez M. leg. and det. 632 exx.; 15-18.II.2013, Gülmez M. leg. and det. 1 ex.; 16-19.III.2013, Gülmez M. leg. and det. 4 exx.

Distribution in Turkey: It is distributed in the Aegean and Mediterranean Regions [33, 51].

Nimbus obliteratus (Panzer, 1823)

Material examined: Karaoğlan-Mihalgazi, 207 m., 17-20.XI.2012, Gülmez M. leg. and det., 1 ex.; Kalekaya Top-Erenler Site 612 m., 17-20.XI.2012, Gülmez M. leg. and det., 2 exx.; 22-25.I.2013, Gülmez M. leg. and det., 55 exx.; Sulukaraağaç Site, 1133 m., 19-22.X.2012, Gülmez M. leg. and det., 2 exx; 13-16.XII.2012, Gülmez M. leg. and det., 8 exx.; 22-25.I.2013, Gülmez M. leg. and det. 242 exx.; 15-18.II.2013, Gülmez M. leg. and det. 2 exx.; 16-19.III.2013, Gülmez M. leg. and det 1 ex.; 17-20.VI.2013, Gülmez M. leg. and det. 1 ex.

Distribution in Turkey: It is distributed in Aegean and Central Anatolia Region [23, 48, 51].

Nimbus contaminatus (Herbst 1783)

Material examined: Sulukaraağaç Site, 1133 m., 22-25.I.2013, Gülmez M. leg. and det. 1 ex.

Distribution in Turkey: It is distributed in Marmara and Central Anatolia Region [23, 32, 42, 48].

Genus *Otophorus* Mulsant, 1842: 178

Otopherus haemorrhoidalis Linnaeus, 1758

Material examined: Kalekaya Top-Erenler Site 612 m., 17-20.XI.2012, Gülmez M. leg. and det. 2 exx.; 16-19.V.2013, Gülmez M. leg. and det. 6 exx.; Sulukaraağaç Site, 1133 m., 18-21.VII.2013, Gülmez M. leg. and det. 1 ex.

Distribution in Turkey: It is distributed in all geographical regions, except the Eastern and Southeastern Anatolia Region [23, 28, 32, 36, 37, 38, 40, 41, 45, 48, 53].

Genus *Eupleurus* Mulsant, 1842: 170

Eupleurus subterraneus (Linnaeus 1758)

Eupleurus subterraneus subterraneus (Linnaeus 1758)

Material examined: Karaoğlan-Mihalgazi, 207 m., 17-20.VI.2013, Gülmez M. leg. and det. 1 ex.

Distribution in Turkey: It is spread out in all geographical regions [23, 28, 33, 36, 40, 41, 45, 46, 51].

Genus *Euorodalus* G. Dellacasa, 1983a: 260

Euorodalus paracoenosus (Balthasar & Hrubant 1960)

Material examined: Sulukaraağaç Site, 1133 m., 16-19.V.2013, Gülmez M. leg. and det. 9 exx.

Distribution in Turkey: It is distributed in all geographical regions, except the Black Sea and Southeastern Anatolia Region [32, 33, 36].

4. Conclusions

This study found 14 species and three subspecies of 12 genera belonging to the Aphodiinae subfamily of Scarabaeidae. These species have different altitudes and month preferences. *Aphodius fimetarius*, *Melinopterus prodromus*, *Nimbus johnsoni*, and *Nimbus obliteratus* preferred every three altitudes, 207-612-1133m., within different months. *Melinopterus pubescens* and *Eupleurus subterraneus subterraneus* were found at just 207m in just one month, respectively, January, and June. *Eudolus quadriguttatus* was found 612m. in other months. Despite *Volinus sticticus* and *Esymus pusillus pusillus* preferred at 1133m. within different months, *Nimbus contaminatus* (January), *Acrossus luridus* (May), and *Euorodalus paracoenosus* (May) also preferred this altitude in only one month.

Volinus sticticus, *Esymus p. pusillus*, *Nimbus johnsoni*, *Euorodalus paparacoenosus racoenosus* are the first record for Eskişehir province. Moreover, *Volinus sticticus*, *Esymus pusillus pusillus*, *Nimbus johnsoni* species are new records for the Central Anatolia Region. Information on these species is important for different studies (systematic, molecular, population, etc.) that are planned to be planned in the future

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